

**Bielefeld University  
Bielefeld School of Public Health**

**HEALTH IN URBAN SLUMS: CHALLENGES AND  
OPPORTUNITIES FOR PUBLIC HEALTH RESEARCH.  
EXAMPLE OF DHAKA, BANGLADESH**

A Cumulative Dissertation Thesis Submitted in Partial Fulfilment of the Requirements  
for the Degree Doctor of Public Health (DrPH) of the Bielefeld School of Public  
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**I dedicate this work to my children Jean-Philippe and Annabelle**



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## ACKNOWLEDGEMENT

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This doctoral thesis draws upon findings from the DHAKA-INNOVATE project in the frame of the Priority Program "Megacities-Megachallenge - Informal Dynamics of Global Change" (SPP 1233) funded by the German Research Foundation (DFG). Cohort studies on health of people living in urban slums of Dhaka in Bangladesh delivered the basis for the peer-reviewed publications included into my thesis.

First of all I would like to thank my first advisor Prof. Dr. Alexander Kraemer without whom this project had not been possible. He had encouraged me to pursue the doctoral studies and had always been a brilliant mentor and supervisor. During my years of work in his international team AG2 I learned a lot about infectious diseases and global health and had an opportunity to work with scholars and scientists from different countries and make good friends.

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## SUMMARY

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The rapid and intensive growth of urban slums in megacities in South East Asia, including Dhaka, has been accompanied by the growing attention from the scientific community. Yet the scientific evidence collected specifically in slum areas is still limited. The aim of this thesis is to gain a broad understanding of multiple factors which determine the health of residents of urban slum areas using the example of Dhaka, the capital of Bangladesh, and identify major challenges as well as opportunities for public health research in this context.

Four English-language original papers are included into this cumulative doctoral thesis. The papers have been published as part of the Priority Programme SPP 1233 “Megacities – Megachallenge: Informal Dynamics of Global Change” funded by the German Research Foundation (DFG). Primary data included 3.207 adult respondents, systematically selected from twelve slum areas in Dhaka and three villages located nearby Dhaka in 2008 and 2009. The secondary data was based on six nationally representative data sets from Bangladesh Demographic and Health Surveys (BDHS) conducted between 1993 and 2011. Various statistical analyses were performed using SPSS (20.0).

The findings of paper I illustrated that housing quality and neighbourhood characteristics highly correlated with self-reported housing satisfaction and self-perceived health among people living in urban slums. Access to clean water and adequate toilet facilities appeared to be the factors strongly related to housing satisfaction. Papers II and III confirmed moreover that certain aspects of housing, such as tenure, residential density as well as water supply, sanitation, and garbage disposal were highly associated with the frequency of diarrhoeal and respiratory diseases and symptoms. Paper III could also demonstrate women’s higher vulnerability to respiratory symptoms particularly in relation to adverse housing conditions and environmental influences. Finally, paper IV confirmed that though urban-rural health disparities in women’s health in Bangladesh decreased over time since the beginning of the 90s, disparities based on socio-economic differences like education and income are still existing and growing, particularly in urban areas.

Urban slums represent a difficult but simultaneously fruitful and informative research environment. They can serve to better understand associations between risks and health, since many diseases in urban slums share the same exposures. Both challenges and opportunities for further research in urban slums lie in bringing together efforts from different disciplines so that slum dwellers can benefit collectively from implemented interventions despite political and economic hardships.

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## LIST OF PUBLICATIONS INCLUDED INTO THE THESIS

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### Original papers (published)

#### Paper I

**Arina Zanuzdana**, Md. Mobarak Hossain Khan, Alexander Kraemer. Housing satisfaction related to health and importance of services in urban slums: Evidence from Dhaka, Bangladesh. *Social Indicators Research* (2013) 112:163-185. (IF 1.743)

#### Paper II

Md. Mobarak Hossain Khan, **Arina Zanuzdana**, Katrin Burkart, Alexander Kraemer. Determinants of diarrhoea in 'urban' slums of Dhaka and adjacent rural areas: a household-level analysis. *Population Space and Place*. 08/2014; 20(6). (IF 1.683)

#### Paper III

**Arina Zanuzdana**, Md. Mobarak Hossain Khan, Johanna Katharina Brinkel, Alexander Kraemer. Factors associated with high prevalence of coughs, colds and fever among urban slum dwellers in Dhaka, Bangladesh. *South East Asia Journal of Public Health* 08/2014. (IF n.a.),

#### Paper IV

Md. Mobarak Hossain Khan, **Arina Zanuzdana**, Alexander Kraemer. Levels, trends and disparities in public-health-related indicators among reproductive-age women in Bangladesh by urban-rural and richest-poorest groups, 1993-2011. *PLoS One*. 2013 Sep 25;8(9). (IF 2.806)

### Book chapters

Md. Mobarak Hossain Khan, **Arina Zanuzdana**. Urban Health Research: Study Designs and Potential Challenges. *Health in Megacities and Urban Areas*, First Edition edited by Alexander Kraemer, Md. Mobarak Hossain Khan, Frauke Kraas, 01/2011: chapter 4: pages 53-71; Springer.

### **Other relevant contributions (conference abstracts)**

**Zanuzdana, A;** Khan, M; Kraemer, A.: Socioeconomic inequalities persist in utilisation of health services in urban slum and rural areas in Dhaka, Bangladesh. Das Gesundheitswesen; Ausgabe 08/09, 2010

Warich, J; Anders, M; Scheunert, S; Engemann, A; **Zanuzdana, A;** Khan, M; Kraemer, A.: Changing food patterns in developing countries: Income is related to Body Mass Index (BMI) and nutritional status among the urban and rural population of Dhaka, Bangladesh. Das Gesundheitswesen; Ausgabe 08/09, 2010

Reiss, K; Kreimeier, S; Roehren, A; Bueltemeier, D; Knittel, M; **Zanuzdana, A;** Khan, M; Kraemer, A.: Cigarette smoking prevalence in Dhaka (Bangladesh). Das Gesundheitswesen; Ausgabe 08/09, 2010

Gradel, C; Buermann, C; Steckling, N; **Zanuzdana, A;** Khan, M; Kraemer, A.: Socio-demographic determinants of musculoskeletal pain incidence among slum and rural dwellers living in and around Dhaka, Bangladesh: A survival analysis. Das Gesundheitswesen; Ausgabe 08/09, 2010

*Urbanization has helped millions escape poverty through higher levels of productivity, employment opportunities, improved quality of life via better education and health, large-scale public investment, and access to improved infrastructure and services.*

World Cities Report 2016, UN-HABITAT

*...but cities can also concentrate threats to health such as inadequate sanitation and refuse collection, pollution, road traffic accidents, outbreaks of infectious diseases and also unhealthy lifestyles,*

Dr Margaret Chan, former WHO Director-General

## 1 INTRODUCTION

---

In 2015, approximately 54% of the world lived in urban settlements and The United Nations predicts an increase up to 66% in 2050. Although the observed levels of urbanisation as well as its definition differ across countries and continents, countries of Asia and Africa and other predominantly tropical countries are estimated to be urbanising faster than the rest of the world. Asia is projected to be home to about 52% of the world's urban population in 2050 (United Nations 2014; Leon 2008; Voigtlaender et al. 2008). Bangladesh and six other countries (Indonesia and Pakistan, the Democratic Republic of Congo, Ethiopia, the United Republic of Tanzania, and the United States of America) are estimated to contribute significantly to the increase and overall world's proportion of urban population (United Nations 2014; UN-HABITAT 2016).

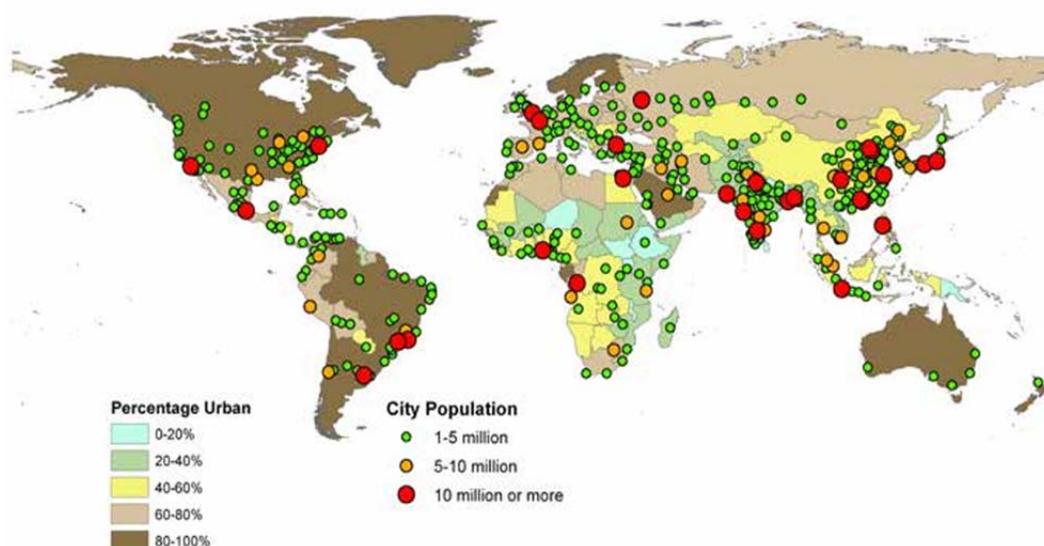


FIGURE 1: GLOBAL PATTERNS OF URBANISATION IN 2015 (UN-HABITAT 2016)

Global urbanisation is accompanied by the growth of megacities with populations of more than 10 million people and large cities with populations between 5 and 10 million people (Figure 1). In the present time most of the megacities are situated in the southern hemisphere, particularly in India and China. To compare, the aggregated annual population increase in six major megacities, including Dhaka, Mumbai and Karachi, outweighs the entire population of Europe (UN-HABITAT 2012).

Scottish economist Adam Smith emphasised the dependence of physical geography and chances of a country for economic growth and long-term development (Sachs et al. 2001). Economic growth of different countries in the 20th century indeed showed that not all countries over the world have the same prospects for economic success. Geography, including country location and climate variability, plays a central role in the distribution of world income and influences economic growth through its multifaceted impact on population health. Countries lying in tropical zones are known for example to face much higher burden of infectious diseases endemic to tropical zones (e.g. malaria, dengue, Zika virus) than countries with moderate climate. Higher child mortality in tropical countries is often accompanied by higher levels of fertility leading to a higher proportion of younger people in the age pyramid of a country (for example, in Bangladesh 48 percent of the population is younger than 24 years, 47 percent are between 25 and 64 years, and only about 6 percent are 65 or older) (Bangladesh Bureau of Statistics 2015).

Multidimensional challenges of urbanisation, as described in the recent report on world cities, cannot be adequately addressed in many developing countries leading to unsustainable social (inequality, deprivation and exclusion, slum growth), economic (unemployment, informal economies, unequal access to services and amenities) and environmental (climate change, air pollution) developments (UN-HABITAT 2016). The combination of these challenges with underdeveloped institutional and governmental structures renders urbanisation inadequate in providing the potential for sustainable development and the possibility of profiting from the rising economy for disadvantaged populations, like those living in urban slums.

While there is a significant body of literature on urban health both from developed and developing countries, there is still a lack of empirical evidence from studies on health from urban slum areas. About a quarter of the world's urban population already lives in slum areas, of them approximately 863 million in developing countries, compared to 760 million in 2000 and 650 in 1990 (UN-HABITAT 2012). The health of populations living in urban slum areas has gained an increased attention under conditions of growing urbanisation and rural-urban migration driven by economic factors, particularly in low-income countries of global South. Studies on health in urban slums are therefore an essential part of a larger domain of urban health research (Galea and Vlahov 2005).

According to the recent systematic literature review by Ezeh et al., the subject of "slum health" is underrepresented in contrast to the research domains of urban and rural health or to poverty and health (Ezeh et al. 2016). Although some aspects of all these research domains overlap, the accentuation of the urban slum health topic is crucial for attracting

more political and scientific attention and for achieving significant progress in the improvement of life quality of slum dwellers on the way to the Millennium Development Goals and The Sustainable Development Goals (United Nations 2018). The target 11.1 of The Sustainable Development Goals is “to ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums”, by 2030 (United Nations 2019). In order to respond to the emerging issues of urban health and slum health, the Priority Program 1233 "Megacities-Megachallenge - Informal Dynamics of Global Change" funded by the German Research Foundation (DFG) was initiated and run over 8 years, from 2006 to 2014 (<http://www.megacities-megachallenge.org>). The major topics included mega-urbanisation, informality, dynamics of globalisation and global change in the Pearl River Delta (China) and Dhaka (Bangladesh). This doctoral thesis is based on the research conducted within the sub-project DHAKA-INNOVATE “Informal settlements, economic and environmental changes, and public health - Strategies to improve the quality of life in Dhaka” of a Berlin-Bielefeld Consortium of the DFG Priority Programme 1233. One of the central goals of this project was to collect evidence on population health in informal settlements in the megacity Dhaka, its social, economic and environmental dimensions, using different epidemiologic and geographic methods as well as GIS-based modelling approaches (GIS, a geographic information system). The following sections of the synthesis paper describe the settings of the studies (section 2), elaborate the conceptual framework used throughout the analyses (section 3), and give a brief overview of the state-of-the-art on health in urban slums worldwide and in Bangladesh (section 4). The objectives of the thesis, the methodology of the studies conducted in urban slums are outlined in the sections 5 and 6, respectively, and the results are briefly described subsequently in the section 7. The joint discussion of the main findings as well as methodological considerations and challenges follow in the section 8 and the conclusions are drawn in the section 9.

## 2 SETTING THE CONTEXT: BANGLADESH AND DHAKA MEGACITY

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Bangladesh is different from other tropical countries due to its special geographical location and therefore its especially high climate vulnerability (Cash et al. 2013). According to the United Nations Development Programme (UNDP), Bangladesh is the most vulnerable country in the world to tropical cyclones and the sixth most vulnerable country to floods (of major flood-affected countries with an average of over 200 deaths per year) (Ricardo Fuentes 2006; UNDP 2004). In Bangladesh more than 60% of the urban population lived in slum areas in 2009 and about 55% in 2014, which was the highest rate in South Asia according to the World Bank (World Bank 2018). This number differs from the earlier national census results, which showed up to 40% of population living in urban slum areas, with great differences among divisions (Angeles et al. 2009).

The megacity of Dhaka is the ninth largest city in the world and is classified by the United Nations Human Settlements Programme (UN-Habitat) as a city with a weak prosperity factor (CPI, city prosperity index) (the higher the index value the more prosperous is the city) (Figure 2). The CPI measures the creation and distribution of socio-economic benefits and prosperity, using the city level data. The cities on the graph below are very heterogeneous in regard to different dimensions of the index and characterised among others by low quality of life (e.g. Harare, Lusaka, Dhaka) chronic inequality of opportunities and chronic poverty due to structural problems, inadequate capital investments in public programs and lack of pro-poor social projects. Dhaka's indices are all above 0.5, which means its relatively high prosperity index in comparison to other cities in this group. The equity (and inclusion) index<sup>1</sup> of Dhaka (brown line in the graph) is one of the highest in comparison to other countries, whereas the environmental sustainability and the quality of life indices are rather low. Whether the used indexes can correctly reflect the situation of all urban dwellers, including residents of urban slums, is an issue worth further discussion and beyond the scope of the thesis. However, these measures allow drawing global comparisons and tracking changes over time in different cities.

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<sup>1</sup> The equity index of the UN is a statistical measure of inequality of income and consumption (Gini coefficient) and inequality of access to services and infrastructure.

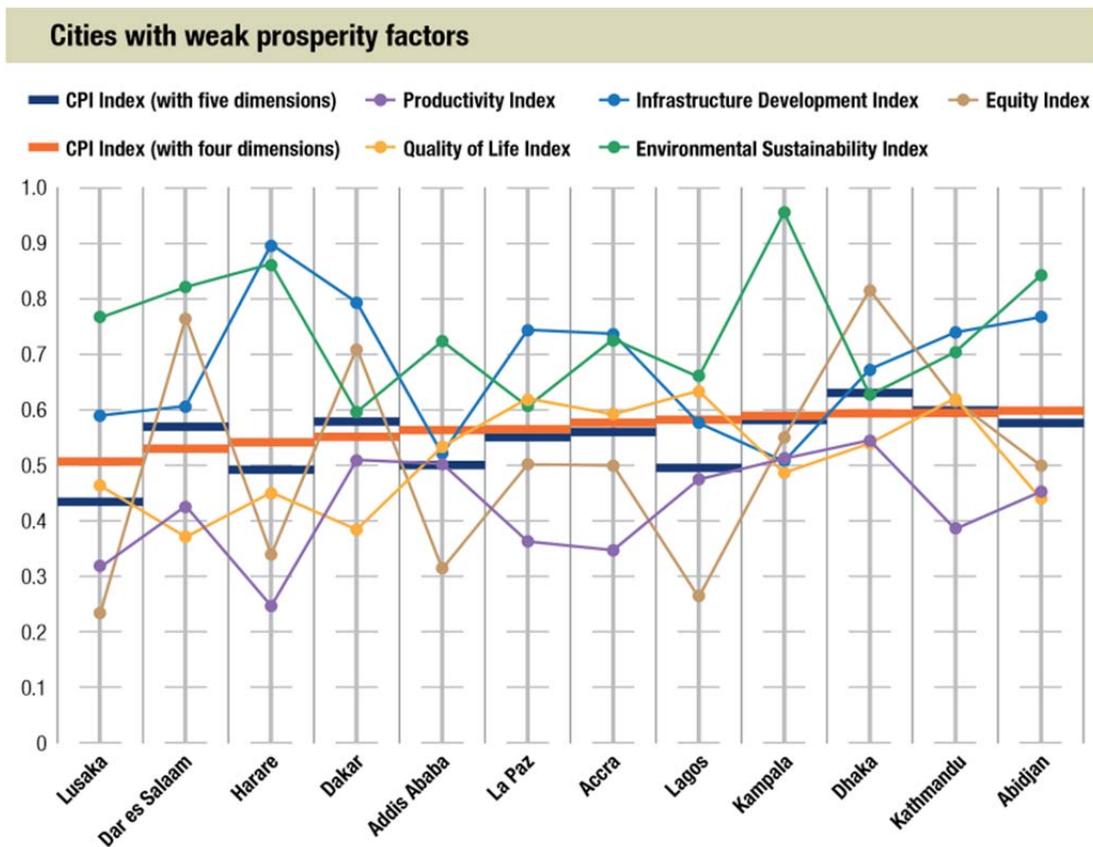


FIGURE 2: UN-HABITAT DEFINED CITIES WITH WEAK PROSPERITY FACTORS (UN-HABITAT 2012)

Although the megacity Dhaka is progressing in terms of telecommunications, manufacturing and finances, the GDP per capita is one of the lowest in comparison to other megacities due to unequal distribution of the gained resources (UN-HABITAT 2012).

Moreover, though Dhaka profits from the migrating labour force as one of the fastest growing megacities (4.4% per year as of 2008), the distribution of public goods and access to basic services is not managed appropriately and profits are not distributed in an equal manner to those who need it most. Dhaka is projected to be home to more than 20 million inhabitants by 2025, although the pace of growth is estimated to decline, as seen from the lower part of Figure 3.

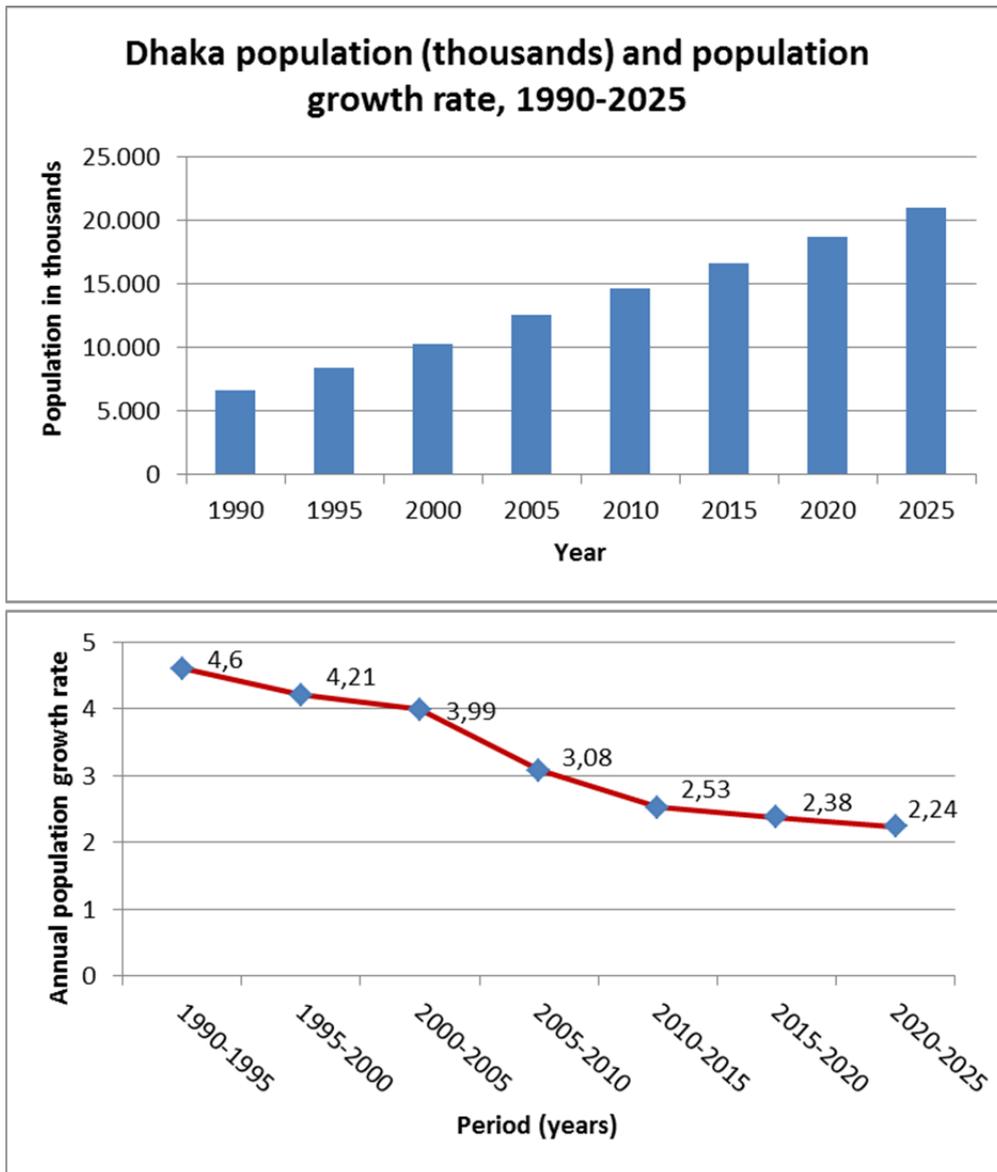


FIGURE 3: DHAKA POPULATION SIZE AND POPULATION GROWTH RATE, 1990 – 2025 (OWN ILLUSTRATION BASED ON UN-HABITAT DATA (UN-HABITAT 2016))

The majority of the residents of Dhaka live in highly crowded urban slums with high degree of informality and extremely adverse living conditions with multiple health risks. The geographical location creates an additional burden on its population, since rise in the sea level put coastal zones in danger of flooding (Khan et al. 2014a). At the same time, Dhaka represents an informative research environment as an example of a rapid and mostly uncontrolled urbanisation leading to the worsening of urban living conditions and environment and major effects on public health (Baumgart et al. 2011; World Bank 2007). Noteworthy is that one of the leading research institutes in the global South, The International Centre for Diarrhoeal Disease Research, Bangladesh, ICDDR, B, is operating in Dhaka, focusing its international research on diarrhoeal and other infectious diseases, as

well as other threats to public health, and methods of healthcare delivery and modern surveillance of infectious diseases (ICDDR 2018).

### 3 CONCEPTUAL FRAMEWORK OF URBAN HEALTH

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Urban health emerged as a distinct field of inquiry in international public health in the mid-1980s, highlighting issues of poverty, urban morbidity and mortality, and burden of communicable and non-communicable diseases in low-income urban populations (Harpham and Molyneux 2001). Studying of health in urban slums is an essential part of a larger urban health research which is based upon different theoretical concepts and is a highly interdisciplinary field of research.

Most of the existing frameworks to study urban health have been developed and tested in the context of industrialised and developed countries. They offered concepts on different aspects and links between population health and social determinants as well as globalisation processes, climate change, environmental impacts (Gee and Payne-Sturges 2004; Solar and Irwin 2010; Hollander and Staatsen 2003; Ompad et al. 2007; Huynen et al. 2005; World Health Organization 2012; Vlahov et al. 2006). However, application of these frameworks to the (local) context of developing countries and in particular urban settings is rather limited and has to be adapted for different situations. The most comprehensive concept designed for developed countries but either applicable for the settings of developing countries is the urban health framework proposed by Galea, Freudenberg and Vlahov and described in the work “Cities and population health” (Galea et al. 2005). The framework demonstrates the complex interplay of socio-economic and demographic, environmental, public health, geopolitical and other factors at global, municipal, household and individual levels. This theoretical framework is nowadays widely accepted and was employed in a number of scientific works (Gruebner et al. 2011b; Shrestha et al. 2016; Christiani et al. 2015; Gomez et al. 2015). As Galea suggests, the most challenging aspect of research on urban health lies in the attempt “to explain differences in health between urban and non-urban areas and among different types of cities and urban neighbourhoods” (Galea et al. 2005). Different aspects of urban living conditions and their interaction with higher level determinants (e.g. city administration in general) as well as national and global social, economic and political trends and developments are united in this conceptual framework.

The “heart” of the framework is built on the assumption that urban living conditions are the principal determinants of urban health and should be addressed through targeted interventions in the first place in order to achieve substantial improvements in health of

urban residents. The framework implies that all individuals living in a city are directly or indirectly affected by physical, social, economic and political living conditions in a city irrespective of their socio-economic status. Although not hierarchically built, the framework - if viewed from left to right or vice versa – suggests the pathways from global and national policies through to local municipal structures, which in turn shape the specific physical and socio-economic environment of people and their health which is the outcome of the framework. The single pillars of the framework are comprehensively explained and discussed in the source papers (Galea et al. 2005; Vlahov et al. 2007).

One of the advantages of this framework is its flexibility and adaptability to the context of specific research, as well as its ability to “accommodate” additional variables of interest and make the results comparable with the findings from other scientific disciplines.

For the purpose of own research and using a spatial epidemiological approach on well-being and mental health in urban slums of Dhaka, Gruebner et al. conducted a profound review of each element of this framework and delivered a list of supplementary elements, levels and components which make the theoretical concept of urban health more robust to the realities of a developing country on the example of Bangladesh (Gruebner et al. 2011b; Gruebner et al. 2011a). The resulting framework from that work is illustrated in Figure 4.

Gruebner et al. adapted the proposed framework and applied it to the research context in Dhaka (Gruebner et al. 2011b) in frame of the project “Megacities-Megachallenge - informal dynamics of global change”. They added a number of elements related to bio-geophysical systems and assumed that urban population is exposed to health risks on different levels depending on factors which can be analysed at the various scales or dimensions. The modified elements can be seen as blue highlighted boxes in the framework illustration below.

Noteworthy is that the adaptation of the framework for Bangladesh was based on knowledge and evidence regarding context- and country-specific social (e.g. no social or health insurance), economic (extreme poverty), geographic (tropical climate with heavy floods and rainfalls) and political (weak democracy and high levels of corruption) developments in the country, described in detail by Gruebner et al. 2011. Accordingly, there are aspects of development currently typical for Bangladesh: a huge export-oriented garment industry with poor and dangerous working conditions (e.g. collapse of Rana Plaza building in 2013), intensive rural-urban migration and uncontrolled growth of urban slums in Dhaka, humanitarian and public health crisis in relation to Rohingya refugees, and numerous activities of national and international non-governmental organisations (Habib 2009; Ahmed et al. 2018).

In the following paragraph, main assumptions behind the urban health framework relevant for its correct application in research are briefly summarised:

- *Health of urban population reflects larger processes* taking place in the society and it is assumed that there are multiple factors interacting in urban context, which (can) shape population health
- *Enduring social structures and the bio-geo-physical system* underlie all aspects of urban living
- *The framework provides a set of variables* which can be combined in one or several models (geography, climatology, public health, demography, urban planning etc.)
- *The framework can be read either from left to right or vice versa*, depending on what factors and levels are considered first and research can be focused either on special areas or extended to more general perspectives without losing the view of other important factors
- *The framework helps shifting the research focus away from disease outcomes to urban exposures* and different dimensions may help define the direction for potential interventions
- Two aspects should be considered when applying the framework: *place (or context) and time (dynamics of urbanisation and related processes)*
- *Existing differences across cities and countries are simplified* in the framework; study of urban health must assume the “reality of complexity”, meaning that no simple solution can immediately improve the multidimensional problem of population health.

The main advantages of the framework however lie in its ability to suit all three directions of urban health and urban slum health research which are inter-urban, intra-urban and urban-rural or else urban-non-urban studies (Galea et al. 2005).

Based on the mentioned frameworks and existing knowledge own set of variables (determinants of health and diseases) at individual’s, household’s, neighbourhood’s and country’s levels was developed for the studies in urban slums of Dhaka (Section 6.1.3, Figure 6).

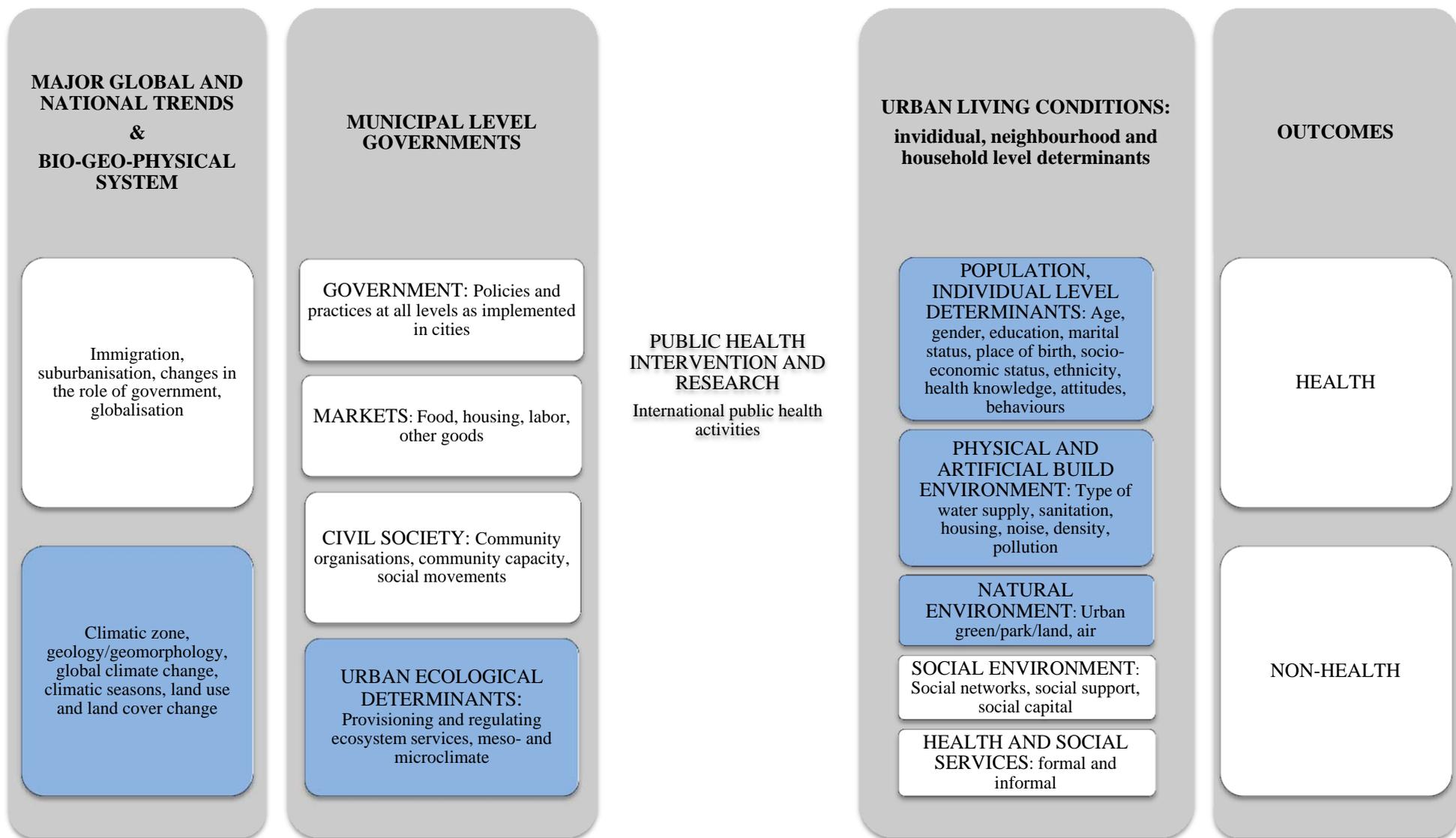


FIGURE 4: CONCEPTUAL FRAMEWORK FOR URBAN HEALTH BY GALEA ET AL. 2005 AND EXTENDED FRAMEWORK FOR URBAN HEALTH ADAPTED FOR DEVELOPING COUNTRIES. MODIFIED FROM GALEA ET AL. 2005 AND GRUEBNER ET AL. 2011. BLUE BOXES ARE THE ELEMENTS OF THE FRAMEWORK ADDED AND MODIFIED BY GRUEBNER ET AL. 2011.

## 4 THEORETICAL BACKGROUND: HEALTH IN URBAN SLUMS

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Formation and growth of urban slums and inadequate housing is not a new issue on the world's urbanisation agenda. Since the report "Challenge of slums" in 2001 and its partly revision in 2010 the research on urban slum has been intensified worldwide leading to a large amount of literature from interrelated areas of epidemiology, public health, geography, economics and social sciences (United Nations Human Settlements Programme 2003; UN-HABITAT 2010).

To inform the objectives of the thesis, we refer to the existing empirical evidence regarding urban slums and the health of populations living there, with special focus on countries lying in South East Asia.

In the first line, the recent systematic and narrative reviews investigating the problems of urban health in slum settings were considered (McNair and Lewis 2012). If relevant, original studies cited in the reviews were referred to as well. Selected papers published within the frame of the project "Megacities-Megachallenge" were furthermore included as well as selected expert interviews and journalist projects.

A comprehensive 'The Lancet' series on health of people living in urban slums consisting of two systematic reviews has recently been published and thus no separate systematic review was necessary to inform the broad purpose and the state-of-the-art of the synthesis paper (Ezeh et al. 2016; Lilford et al. 2016). The methodology and the search strategy of this systematic review is available as a supplement (Ezeh et al. 2016). Another systematic review work by van de Vijver et al. (van de Vijver et al. 2015) on challenges of health programmes in slums completed the overview of the current research agenda on health in urban slums. Different overarching reports and reviews by organisations and institutions like United Nations, WHO, and World Bank are used and referred to as gold standard sources of data on global health and strategic development goals in areas of urban health, housing, urbanisation, and other health-related issues.

### 4.1 DEFINITION OF URBAN SLUMS

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According to the 2009 definition by the United Nations Educational, Scientific and Cultural Organization (UNESCO), slums are "a contiguous settlement where the inhabitants are characterised as having inadequate housing and basic services" (United Nations Educational Scientific and Cultural Organisation 2009). The earlier definition by

the UN-HABITAT from 2003 used by Ezeh et al., describes slum (household) as a “group of individuals that live under the same roof that lack one or more of the following conditions: access to improved water, improved sanitation, sufficient living space, durability of housing and secure tenure” (United Nations Human Settlements Programme 2003). There is a detailed specification of what is meant by “improved” in the original text of the UN-HABITAT. Whereas the first definition by UNESCO sees slums as a “space”, the second one emphasises a “household”. Both definitions are important, because slums are multidimensional and should be treated throughout the research as spatial entities, like Ezeh et al. suggest. Moreover, urban slum health is and should be distinguished from topics of urban health and poverty-related health (UN-HABITAT 2016). The complexity of understanding the term “slum” is discussed in the updated Chapter 1 of the Global Report on Human Settlements 2003 in view of the Millennium Agenda (UN-HABITAT 2010).

Due to methodological and infrastructural challenges in counting slum populations, there are also disparities in estimates and numbers. For instance, the percentage of the urban population living in slums has been in fact declining since 1990, however, absolute numbers are rising (UN-HABITAT 2016).

#### 4.2 DETERMINANTS OF HEALTH, HEALTH SERVICES AND INTERVENTIONS IN URBAN SLUMS

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Health of individuals and communities is affected by many factors, determined by their living circumstances and environment. Basically, the major determinants of health include:

- the social and economic environment (income, social status, education),
- the physical environment (water, air, working environment, housing and neighbourhood),
- individual characteristics and person’s behaviours (genetics, gender, personal behaviour, coping skills, health behaviour)
- health services (access and use of services) (World Health Organization 2018).

Individuals often have no or very limited control over many of the health determinants, thus making them dependent on the context and existing living conditions (i.e. genetics, family environment, socio-economic status at birth). In urban environments, the health determinants are mostly the same, each of them having more or less impact on individuals

and community health in different countries. The health determinants for urban settings in developing countries are elaborated in the conceptual framework presented in the previous section and in the own illustration (Figure 6) presented in the section 6.

### *Social determinants of health in urban slums*

In their systematic review, Ezeh et al. names at least three reasons why living in a slum or living in poverty can lead to different health outcomes as compared to (non-slums) urban settings. First, people living in urban slums share common environmental health risks (e.g. garbage disposal or poor sanitation) in the same neighbourhood and are strongly affected by neighbourhood effects (van Ham et al. 2012; Meijer et al. 2012). Next, people in urban slums can profit from interventions of slum upgrading collectively (Lilford et al. 2016). Finally, interventions that are designed and effectively implemented in non-slum environment may not work in slum settings (the example of pit latrines, which are unsuitable for slums is well-known in the literature on slum health (Nakagiri et al. 2016)). Income inequality, usually starting at birth for most humans, leads to health inequality. Ezeh et al. refers to the term “the circle of poverty”, which begins with poor maternal health placing newborn at increased risk for certain children diseases leading to reduced educational and life chances and finally poverty. High fertility rates in urban slums due to reduced breastfeeding prevent mothers from giving the necessary time and care to each child (NIPORT, icddr,b, MEASURE Evaluation 2015; Stecklov 1999).

In urban slums, multiple health-influencing challenges often meet together arising from the poor quality of housing, crowding, unhygienic water and sanitation, and poor environmental services (Sclar et al. 2005). Although rural-urban health and health-related disparities gradually decrease, intra-urban disparities (e.g., between poor versus non-poor and between slum versus non-slum dwellers) are emerging or increasing in many developing countries (Hazarika 2010; Khan and Kraemer 2008; Stephens et al. 1997; McMichael et al. 2004; Izutsu et al. 2006; Moran et al. 2009; Rice and Rice 2009). For instance, urban slum dwellers in Bangladesh reported worse health indicators when compared with non-slum dwellers despite the availability of health services in urban areas (Moran et al. 2009). Although the neonatal mortality during the period of 2002-2006 was 43.7 per 1000 live births in slums of Bangladesh, it was only 20.1 per 1000 live births in non-slum areas (National Institute of Population Research and Training 2008). In Africa, the highest health burden was found among the children of slum vs. non-slum areas (African Population and Health Research Center 2002; Bocquier et al. 2011). In Kenya in

particular, child mortality in the slums of Nairobi was 2.5 times higher than in other areas of the city (McMichael et al. 2004). Similarly in Ecuador, infant mortality was reported many times more in slums than in wealthier neighbourhoods (Stephens 1996). In India, women in slums were more likely to belong to lower economic groups and have lower level of education (Hazarika 2010).

People living in urban slums contribute significantly to the rise of the informal economy and have an opportunity to earn a living, however, lack of social security and insurance lead to a high degree of instability as well as diminished long-term perspectives to settle down (e.g. tenure) (Baumgart et al. 2011). In Bangladesh income inequality in urban settings is higher as compared to the rest of the country, and there are remarkably large differences socially and economically within different slums. The existing inequality and poverty lead to even deeper poverty creating a vicious circle of poor health and low productivity and less social and economic chances (Jahan et al. 2015), reinforced by adverse housing conditions in slums and existing negative neighbourhood effects.

#### *Environmental and neighbourhood level determinants of health in urban slums*

Urban slums represent an unsafe crowded living environment with multiple risk factors for health and little possibility for relaxation or privacy, which might especially be problematic for children and women making them more vulnerable (Osrin et al. 2011). In the report on environmental burden of disease in relation to inadequate housing (2011), the World Health Organization (WHO) defines housing through four interrelated dimensions:

- the physical structure of the dwelling,
- the home including psychosocial, economic and cultural attributes of the household,
- the neighbourhood infrastructure and
- the community environment.

In its initiative 'Healthy housing', the WHO outlines the negative health impact of certain housing conditions (e.g. injuries, indoor air quality, pests etc.) and the particular vulnerability of different population groups (poor, children, sick or disabled, housewives) spending most of the time in their home setting and thus being exposed to negative impacts (Zanuzdana et al. 2014; World Health Organization 2018b). Urban slum dwellers are especially heavily affected by adverse living conditions and their health is threatened by a range of factors related to their housing. It has been shown that poor quality housing may have a range of negative impacts on human health, such as increased frequency of infectious diseases, poor mental health, respiratory infections, chronic diseases, injuries

etc. (Krieger and Higgins 2002; WHO 2008, 2011; Howden-Chapman 2004). Adequate water quality and supply and sanitation are reported to be the most urgent needs among slum dwellers (Parikh et al. 2013).

Health in urban slums is affected by so called neighbourhood effects, independently of individual or household level risk factors as well as poverty. Lilford et al. (2016) note, that “the supposed neighbourhood effect in slums is both a problem and an opportunity. It is a problem because it is likely to amplify health hazards and it is an opportunity because one intervention can simultaneously improve so many lives in one densely packed community”. Neighbourhood effects can be best measured either in experimental or quasi-experimental studies (e.g. manipulation of living environment) or from studying directly the mechanisms of how, for instance, contamination with faeces in some slums can influence health in next-door slums or whether industry pollution of air close to slum areas affects individual health. It is methodologically a challenging task and even some of the established survey systems or censuses often tend not to consider differences between slum and non-slum, overlooking the potential neighbourhood effect (Ezeh et al. 2016). The assumption or the concept of neighbourhood effects is one of the reasons why multilevel modelling techniques have gained a greater attention in studying slum effects on health (Diez-Roux 2000; Subramanian et al. 2003; Luke 2004).

#### *Diseases of people who live in urban slums and access to health care*

People living in urban slums are known to suffer from chronic non-communicable and communicable diseases like diabetes, hypertension, diabetes, rheumatic heart disease, injuries, tuberculosis, HIV infection and others, respectively, mainly due to the prolonged course of these diseases and only the treatment of their complications by the formal health sector (Riley et al. 2007; Khan et al. 2014b; Banu et al. 2013). Yet there is little known about the risk factors for these illnesses, their frequency and severity before they end up in life-threatening complications as a stroke, myocardial infarction, kidney failure, suicide, multidrug-resistant tuberculosis, heart valve disease, and HIV/AIDS (Riley et al. 2007).

Largely, diarrhoea and pneumonia remain the two main death causes in children under five years, and those children living in slums and in poverty are particularly affected (Black et al. 2003; Sverdlik 2011). Mortality statistics among under-five children is also dominated by pneumonia (18%), diarrhoea (15%) and malaria (8%) (Black et al. 2010). Diarrhoea is associated with undernutrition in children which in turn causes stunted growth, affecting particularly populations in slum areas (Marx et al. 2013; Ernst et al. 2013). Of all

infectious diseases, diarrhoeal diseases are estimated to have the greatest effects on childhood, due to their association with appetite reduction, feeding practices, decreased absorption of nutrients and its negative impact on growth. Furthermore, economic costs of medical treatment of diarrhoeal diseases (e.g. antibiotics) are high and represent an economic burden especially in regions with high rates of childhood diarrhoea. Moreover, breastfeeding known to reduce incidence of diarrhoea and pneumonia is low in slums, due to factors such as poor maternal health and labour conditions (Ahmed et al. 2005; Kimani-Murage et al. 2015).

High concentration of poor and low quality housing offer a breeding ground for disease vectors, like leptospirosis (Hagan et al. 2016), dengue fever (Global Burden of Disease Study 2013 Collaborators 2015; Cousins 2019), tuberculosis and even highly pathogenic emerging diseases like Ebola, just to name a few (Snyder et al.). Tuberculosis was included into the questionnaire used in the studies of the DHAKA-INNOVATE project, however, it was not diagnosed in respondents and an underreporting of this disease is probable. Tuberculosis in urban slums is highly prevalent (four times higher prevalence in comparison to urban areas in the study of (Banu et al. 2013) ) and was reported to be associated with risk factors like poor environmental conditions, poor housing, overcrowding, smoking, low BMI, previous history of anti-TB treatment as well as low perception and poor knowledge on tuberculosis and its treatment (Zaman et al. 2012; Banu et al. 2013; Bam et al. 2014).

In the Indian study in Vellore's informal settlements, 400 babies were followed up for the first year of life, and only one child of all had not fallen ill (Gladstone et al. 2008; Sverdlik 2011). Respiratory illnesses and gastrointestinal diseases were among the most frequently reported diseases in this study.

Data from epidemiologic studies in urban slums in Bangladesh used for this thesis showed that the most frequently reported diseases and symptoms among adults were fever and cold, gastro-intestinal tract illnesses, musculoskeletal pain, mental disorders, headache and diarrhoea (own analyses, data not shown). The following Figure 5 presents in addition the leading causes of disability-adjusted life years (DALYs) and their percent change from 1990 to 2010 in Bangladesh. The top 25 causes of DALYs are ranked from left to right in order of the number of DALYs they contributed in 2010. Bars going up show the percent by which DALYs have increased since 1990. Bars going down show the percent by which DALYs have decreased. The graph shows a decrease of communicable diseases, including diarrhoea, tuberculosis, neonatal sepsis, and at the same time an increase in non-communicable diseases typical for developed countries like ischemic heart disease,

diabetes, low back pain, chronic obstructive pulmonary disease (COPD) and asthma. Low back pain as well as COPD belong to the first five causes of DALYs in 2010, along with preterm birth complications, neonatal encephalopathy and lower respiratory infections (Institute for Health Metrics and Evaluation 2010).

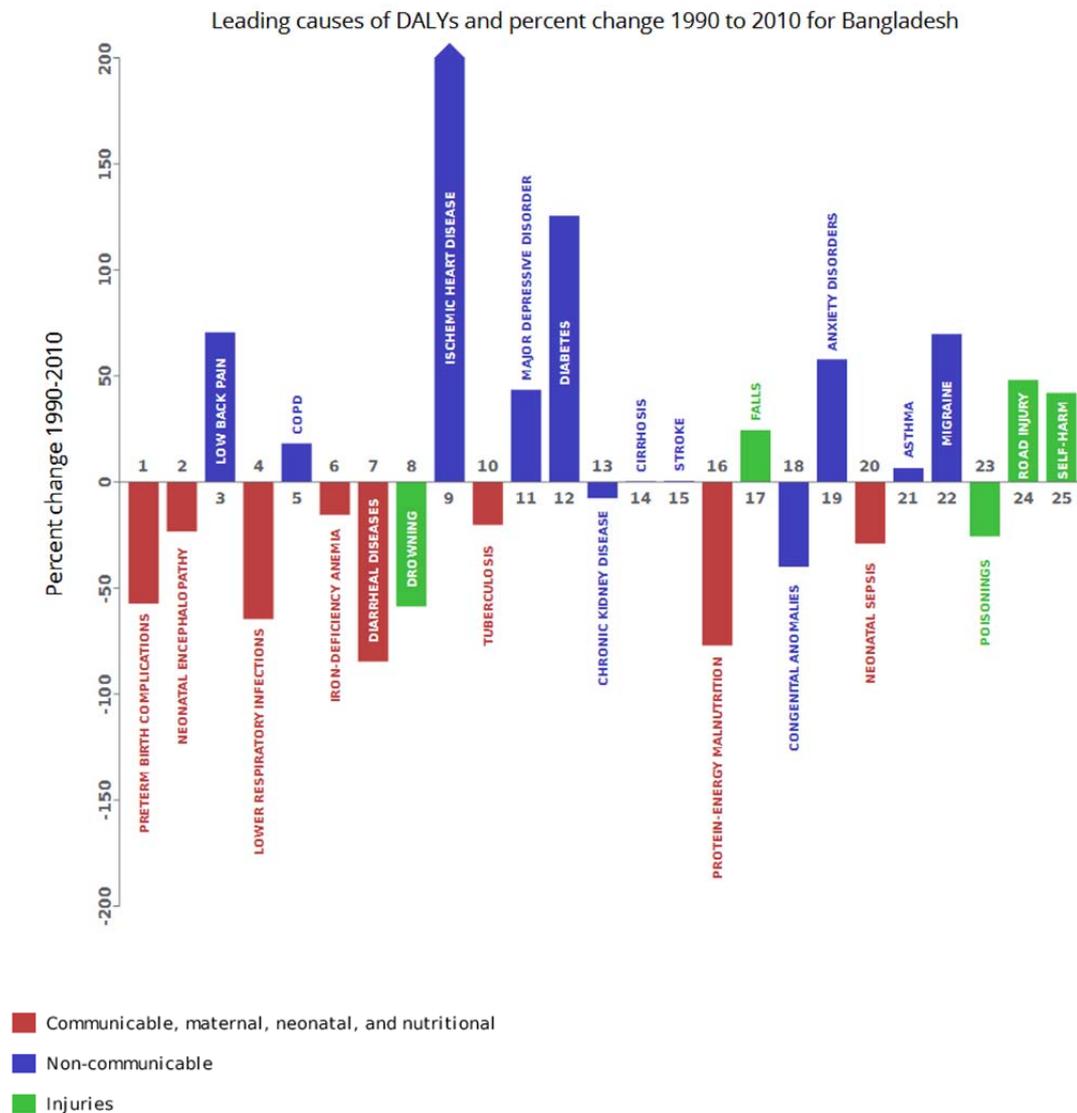


FIGURE 5: LEADING CAUSES OF DALYS AND PERCENT CHANGE 1990 TO 2010 FOR BANGLADESH. SOURCE: [HTTPS://WWW.HEALTHDATA.ORG/SITES/DEFAULT/FILES/FILES/COUNTRY\\_PROFILES/GBD/IHME\\_GBD\\_COUNTRY\\_REPORT\\_BANGLADESH.PDF](https://www.healthdata.org/sites/default/files/files/country_profiles/gbd/ihme_gbd_country_report_bangladesh.pdf)

Noteworthy is that, in many countries, most information on disease burden or mortality among people who live in urban slums is based on clinic, hospital, or national mortality registry data. These data is however, only the "tip of the iceberg" and therefore not sufficient to plan for a better health care and particularly the necessary health care resources (Riley et al. 2007).

### *Access and affordability of health services*

Another important milestone as a part of research on health in urban slums is access to health services (Khan et al. 2012; Adams et al. 2014; Gusmano and Rodwin 2005; Palepu and Tyndall 2005; Rice and Rice 2009). Since urban slum dwellers are often not considered as a part of urban society due to the informality of their living conditions, they usually cannot access affordable health care (Shetty 2011).

As Hazarika explains, it is partly due to the “ineffective outreach and weak referral system of the urban public health system”. Moreover, such factors as social exclusion and poor knowledge or lack of information prevent poor population groups from using private health care services, which make them more and more vulnerable (in (Shetty 2011). Among recommendations based on existing studies are design of services typical for local needs of slums, for example, with office hours outside of normal working day, comprehensive use of technologies like mobile technologies and combination of community health workers know-how and clinics free of charge (El Arifeen et al. 2013) .

A comprehensive overview of Bangladesh’s successes and innovation in universal health coverage was published as a six-part Lancet journal series and provided important insights into the developments which happened in the pluralistic health care system in Bangladesh during decades, however, without a specific focus on urban slums (Adams et al. 2013; El Arifeen et al. 2013).

### *Evidence of interventions to improve health of people living in urban slums*

Lilford et al. (Lilford et al. 2016) closely analysed systematic reviews of micro-level interventions conducted in slum settings. Reduction in diarrhoea was reported after connecting households to water supply (Galiani et al. 2009), and reduction in waterborne diseases after piped water connection with street paving and drainage (Butala et al. 2010). A non-slum study based on data from seventy DHS surveys reported a 13% reduction of diarrhoea from improved water and 7% from improved sanitation (Chaplin 1999). Furthermore, diarrhoea reduction had been measured in other interventions studies, like a provision of cement floor in Mexico (Cattaneo et al. 2009) (reduction of diarrhoea in children under 6 years RR 0.87, 0.76–1.00) or a raised floor in El Salvador and Mexico (Galiani et al. 2013) (2.7% absolute risk reduction from 15.1% diarrhoea incidence). Numerous further studies as well as meta-analyses showed benefits resulting from behavioural intervention like hand-washing in regard to reduction of diarrhoea, specifically in slums (Bowen et al. 2012; Ernst et al. 2013) or reduction of indoor pollution in 20 countries and its positive impact on respiratory diseases (up to 21% reduction) (Goodwin

et al. 2015). Improved nutritional status were reported from India and Bangladesh based on provision of snack bars (Kehoe et al. 2015; Ahmed et al. 2014).

Although reviewed studies showed different sizes of effect (also statistically insignificant) the overall trends showed a positive effect of different kind of interventions in slum settings. Lilford et al. (2016) concluded that existing intervention studies from slum settings would not yet be sufficient for judging about the effectiveness of interventions so consideration of and comparison with studies from other (non-slum and/or urban) settings is necessary.

Summing up, the literature review showed that communicable diseases, such as diarrhoea, pneumonia, and tuberculosis, are highly incident in urban slums areas and can be linked to inadequate housing and environmental conditions. Besides, children and women are particularly affected by adverse health outcomes, also during pregnancy and in the first life years. It can also be concluded that despite the growing amount of published literature on the topics of health in urban slums, there is a lack of observational longitudinal studies conducted in urban slums. Noteworthy is also a lack of studies focusing specifically on men's health. Finally, there is a lot of evidence of successful interventions conducted in urban slums worldwide; however, more studies on the long-term impact of such interventions are clearly needed.

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## 5 AIM AND OBJECTIVES

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### **Aim**

The general aim of this doctoral thesis is to gain a broad understanding of factors which determine the health of residents of urban slum areas using the example of Dhaka, Bangladesh, and identify major challenges as well as opportunities for public health research in this context. To reach this aim our specific objectives were:

### **Objectives**

1. To explore housing and environmental living conditions of urban slum dwellers in Dhaka and determine the level of housing satisfaction and its relation to health (Paper I).

2. To identify major risk factors at different levels (individual, household and neighbourhood) associated with morbidity from diarrhoeal and respiratory diseases among urban slum dwellers in Dhaka (Paper II and III)
3. To identify and assess trends in development of health disparities of slum and non-slum population of urban Bangladesh since early 1990s, taking into account gender differences, education and poverty (Paper IV).

The publications and the synthesis paper aim to look from different angles on methodological and other challenges of conducting health research in urban slum areas as well as to draw conclusions about the opportunities for and implications of existing and future research on changes in public health in countries with high proportion of population living in urban slum areas.

## 6 METHODS

This doctoral thesis is based on two sources of data: primary data collected in two studies conducted in urban slums of Dhaka in 2008 and 2009 and secondary data obtained from six Bangladesh Demographic and Health Surveys (BDHS) in the period from 1993 to 2011. Table 1 summarises the basic information on the papers I-IV.

TABLE 1: OVERVIEW OF THE MAIN CHARACTERISTICS OF THE STUDIES WHICH FORM THE BASIS OF THE THESIS

	<b>Title of the paper</b>	<b>Study objective</b>	<b>Study design and methods</b>	<b>Study population and sample size</b>	<b>Settings and study period</b>
<b>I.</b>	Housing Satisfaction Related to Health and Importance of Services in Urban Slums: Evidence from Dhaka, Bangladesh	To investigate the associations of individual, family and neighbourhood factors with individual satisfaction with housing	Cross-sectional study (baseline studies of two consecutive cohort studies); structured questionnaire; face-to-face interviews	Respondents aged 10 years and older, N=3,207	Twelve urban slum areas in Dhaka and three rural villages, 2008, 2009
<b>II.</b>	Determinants of Diarrhoea in 'Urban' Slums of Dhaka and Adjacent Rural Areas: a Household-level	To report household-level socio-economic and environmental determinants and seasonality of	Two cohort studies (baseline study and three follow-up surveys); structured questionnaire;	Respondents aged 10 years and older, N=3,207	Twelve urban slum areas in Dhaka and three rural villages, 2008, 2009

	Analysis	diarrhoea	face-to-face interviews		
<b>III.</b>	Factors Associated with High Prevalence of Coughs, Colds and Fever among Urban Slum Dwellers in Dhaka, Bangladesh	To identify the major factors associated with coughs, colds and fever among adult residents of urban slums in Dhaka	Cross-sectional study; structured questionnaire; face-to-face interviews	Adult household members, N=1,893	Nine urban slum areas in Dhaka, 2009
<b>IV.</b>	Levels, Trends and Disparities in Public-Health-Related Indicators among Reproductive-Age Women in Bangladesh by Urban-Rural and Richest-Poorest Groups, 1993-2011	To demonstrate the trends and disparities in various public health-related indicators by comparisons of rural versus urban location and richest versus poorest wealth index	Bangladesh Demographic and Health Survey (cross-sectional studies); face-to-face interviews; structured questionnaire	Women aged 15-49 years; N=9,493 (1993-94), N=8,991 (1996-97), N=10,373 (2000), N=11,300 (2004), N=10,996 (2007) and N=17,749 (2011).	Nationally representative samples for Bangladesh, 1993-94 to 2011

## 6.1 PRIMARY DATA

### 6.1.1 STUDY DESIGN AND SAMPLING

For papers I, II and III primary data collected in the course of two cohort studies in urban slums of Dhaka and adjacent rural areas was used.

The baseline data including information on major individual, household and neighbourhood characteristics and health of respondents was collected in two cross-sectional baseline surveys (conducted in March in 2008 and 2009 in Dhaka). At an interval of 3 months, three consecutive follow-up surveys were conducted to collect information on recent health problems.

A total of 3,207 respondents aged 10 years and older were systematically selected from twelve urban slums and three villages located nearby Dhaka (paper I and II). For paper III only baseline data from the survey in 2009 was used (n=1,938).

A systematic sampling approach to select households for interview was applied. First, slum information (e.g. name of slum, number of households, estimated population, and area of

slum) provided by the Centre for Urban Studies (CUS) (Centre for Urban Studies, National Institute of Population Research and Training, MEASURE Evaluation 2006) was assessed (4,900 slum settlements in 2005 in Dhaka). Next, further inclusion criteria were defined: a minimum of 500 households in a slum and a minimum land size of six acres and administrative units not neighbouring each other. Third, an individual household map for each slum was prepared and each household was provided with one unique identification number and global positioning system (GPS) coordinates were furthermore used to show and record the location of each interviewed household. The household sketch map with numbers was considered as the sampling frame of the study. Fourth, the representative sample of families for each slum was estimated using the statistical formulae (not given here) proposed by Bartlett et al. (2001). A 95 % confidence level (i.e.,  $\alpha = 0.05$ ) and an acceptable error margin of  $d = 6\%$  were applied. Slums with the highest and the lowest number of households required the highest and the lowest number of samples, respectively. The sampling rate “r” was defined by dividing the number of families in the slum by the calculated sample size. An adult in every “r<sup>th</sup>” household was interviewed. Further details on the sampling procedure are given in papers I, II or III.

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#### 6.1.2 DATA COLLECTION TOOL

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Household surveys were conducted using a pre-tested questionnaire and face-to-face interviews. The baseline version of the questionnaire contained items on socio-demographic and socio-economic characteristics, household properties, housing conditions, occupation and health, common diseases and symptoms, mental health, body measures, migration history, available health services, satisfaction with different aspects of daily life, health competencies and addictions, and dietary habits. In follow-up surveys, only recent health problems (diseases and symptoms) in the preceding three months were enquired.

Based on the existing conceptual frameworks (urban health, social determinants) and previous research in urban slums, own chart of health determinants/variables at individual, household and neighbourhood and country level has been elaborated for analysis and interpretation of results (Figure 6 on page 25). It is important to note, that although all illustrated factors are equally placed in the same manner around individual’s health in the middle of the graph, some of the variables would be hypothesised to contribute stronger as a determinant of health or have a greater impact on health depending on the context of the research (for example, quality of water and sanitation facilities would be expected to have

a greater impact on health in the settings of urban slums than an NGO membership). This aspect is taken into account when interpreting and discussing the results of the studies.

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### 6.1.3 MAIN OUTCOMES

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The outcome of interest in paper I included self-reported satisfaction with housing measured by satisfaction with, for example:

- area of the house,
- electricity and water supply,
- water and air quality,
- water drainage,
- surrounding noise, and
- garbage management and toilet.

The outcome variable contained four categories of different satisfaction levels. For the binary multiple logistic regression analysis the variable was dichotomised into categories “Satisfied” and “Unsatisfied”.

In paper II the outcome variable was the occurrence of diarrhoea at the household level. Every respondent was asked to report (either ‘yes’ or ‘no’) ‘whether anybody (including the respondent) in the family suffered from diarrhoea during the last three months preceding the survey month’. Two dependent variables were built: (1) Whether at least one household member was sick from diarrhoea during the 1-year period (categories: yes = 1, no = 0); (2) Whether diarrhoea at the household level was zero, one time, or more times in a year (where 0 = household was not affected, 1 = household was affected only one time, and 2 = household was affected twice or more during the 1-year period).

In paper III the outcomes included the variables “Cough and cold” and “Fever, cough and cold”. The latter variable implied a higher severity of illness in comparison to just “cough and cold”. Respectively, the respondents were asked to report whether she or he suffered from “Cough and cold” and/or “Fever” in the preceding three months. Both variables were dichotomous.

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#### 6.1.4 STATISTICAL ANALYSIS

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All statistical procedures were performed using SPSS 17.0 as well as SPSS 20.0 (SPSS Inc., 2008, SPSS Statistics for Windows, Chicago and IBM SPSS Statistics for Windows. Armonk, NY: IBM Corp.).

Various methods of descriptive statistics were used to describe the dataset in general, selected characteristics of study population and major variables as well as to test potential associations between two variables using the Chi-square test or (paper II-III) cumulative percentage plots (paper I).

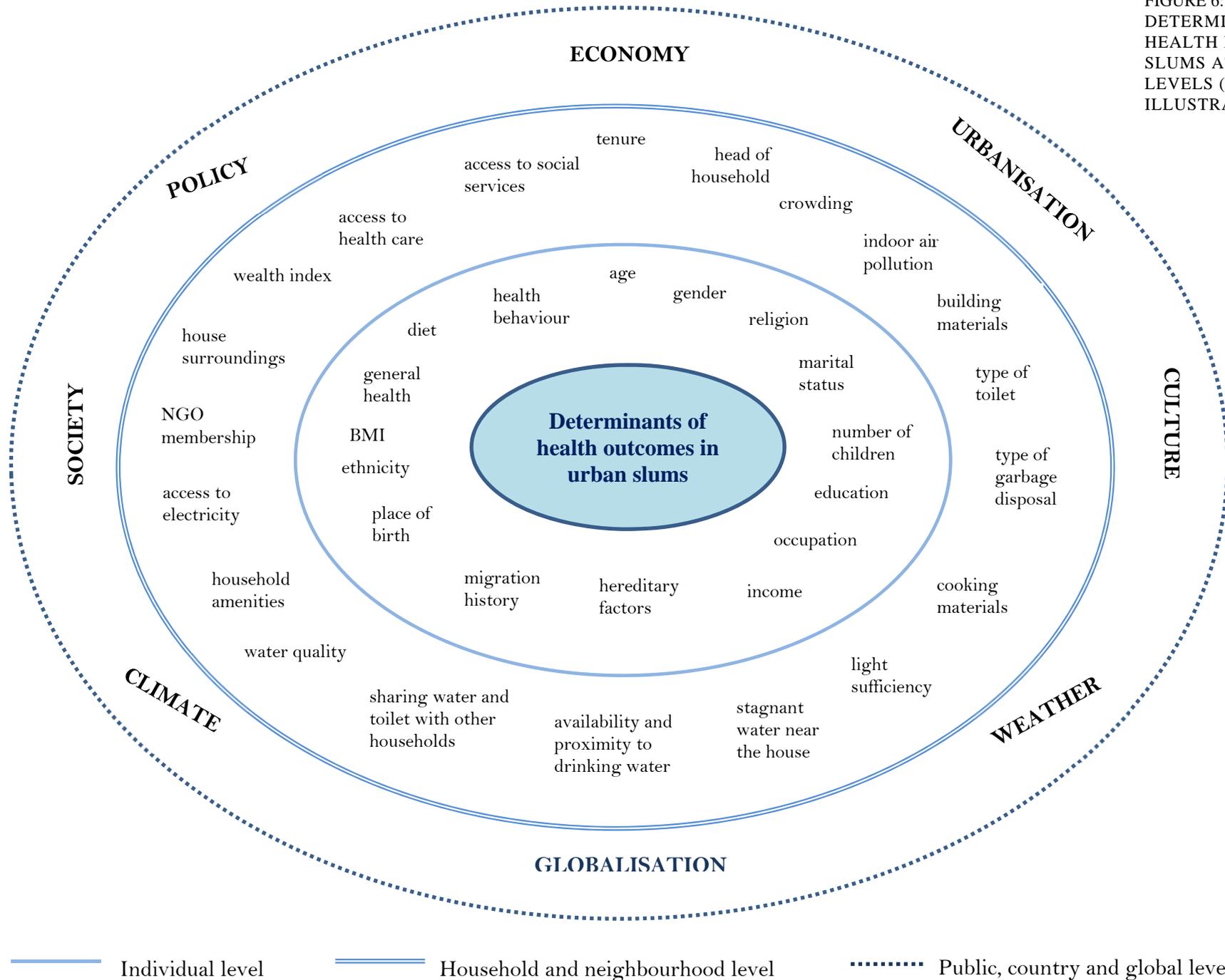
In paper I, ordinal logistic regression analysis was used to explore associations between housing satisfaction and multiple independent variables taking into account the ordinal nature of the outcome. Additionally, multiple logistic regression was applied to examine the strength of associations between independent variables and housing satisfaction and adjust for potential confounders.

In paper II multivariable Cox's (proportional hazards) regression was applied to find significant covariates associated with occurrence of diarrhoea at household level. A multinomial logistic regression was furthermore applied to examine factors associated with frequency of diarrhoea in households, taking into account the outcome variable with three levels.

In paper III multiple binary and multinomial logistic regression analysis was applied to explore factors associated with different respiratory symptoms 'cough', 'cold' or 'fever'.

Further details of the statistical analyses are described in the respective papers.

FIGURE 6:  
DETERMINANTS OF  
HEALTH IN URBAN  
SLUMS AT DIFFERENT  
LEVELS (OWN  
ILLUSTRATION)



## 6.2 SECONDARY DATA

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### 6.2.1 STUDY DESIGN AND SAMPLING

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The source of data for paper IV were six nationally representative Bangladesh Demographic and Health Survey (BDHS) carried out in 1993-94, 1996-97, 1999-2000, 2004, 2007 and 2011. Detailed descriptions of the study designs, including informed consent and data collection, are explained in the country-specific reports (National Institute of Population Research and Training (NIPORT), Mitra and Associates, and ICF 1993-2011).

Using a multistage stratified cluster sampling, a representative sample of women, aged 15 to 49 years, was identified for each survey.

### 6.2.2 DATA COLLECTION TOOL

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A group of trained interviewers conducted face-to-face interviews using a DHS model questionnaire including four questionnaires: Household, Woman's, Man's and Biomarker. Details of the model questionnaire are provided at the website of The DHS program at <https://www.dhsprogram.com/What-We-Do/Survey-Types/DHS-Questionnaires.cfm>.

### 6.2.3 MAIN OUTCOMES

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Six public-health-related indicators were included into analysis as outcome variables: age at marriage in years, ideal number of children, adequate antenatal care, delivery of the most recent child in any healthcare facility, and being underweight and being overweight.

### 6.2.4 STATISTICAL ANALYSIS

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Statistical analysis was conducted using IBM SPSS 20.0 (Released 2011. IBM SPSS Statistics for Windows, Armonk, NY: IBM Corp.). For creating graphs Microsoft Office Excel was used (bar diagrams and dotted lines). Multiple logistic regression analyses (binary or multinomial) were performed to examine associations of selected socio-demographic, socio-economic and household characteristics with dichotomous variables (health indicators 'age at marriage in years', 'ideal number of children', 'adequate antenatal care', 'delivery of the most recent child in any healthcare facility' and with variables with three categories (being overweight, having normal weight or being

underweight, as measured by the BMI). Further details of the statistical analyses are described in paper IV.

## 7 RESULTS

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In this section, the main results of the papers are presented. A joint discussion of the results under consideration of the theoretical background and existing evidence as well as implications for public health and future research follow in the last chapter.

### 7.1 SATISFACTION WITH HOUSING AND ITS LINK TO HEALTH

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There is little knowledge on housing satisfaction in the setting of urban slums. Our study aimed to fill the gap in this knowledge and examined self-perceived housing satisfaction in relation to individual, household and neighbourhood factors among urban slum dwellers in Dhaka, in comparison to rural areas where applicable.

Housing satisfaction was measured through nineteen items and contained five categories from “highly unsatisfied” to “satisfied”. A set of explanatory variables was selected for analysis.

Rural residents were more satisfied with their housing compared to urban residents; 99.2 % of rural respondents reported being owner of their house, whereas in urban slums this proportion was 21.9%. Higher family wealth status was positively associated with a higher housing satisfaction, as were a good access and reachability of the house. In contrast, sharing the rooms with high number of other persons (crowding) and inadequate drinking water source led to decreased satisfaction. Respondents who perceived the location of the house as not harmful to their health and those with houses not far from medical care reported higher levels of housing satisfaction. In general, satisfaction with educational, recreational, medical and other facilities were directly associated with the level of housing satisfaction.

Findings showed several important predictors of housing satisfaction in urban slum areas and demonstrated the complexity of measurement of this outcome in terms of necessity of inclusion of different dimensions (socio-economic individual characteristics, neighbourhood factors, environmental variables) into statistical models and the interplay of the direct and indirect effects on the outcome.

## 7.2 RISK AND PROTECTIVE FACTORS OF DIARRHOEAL AND RESPIRATORY DISEASES IN URBAN SLUMS

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In paper II socio-economic and environmental determinants of diarrhoeal diseases at the household-level were analysed in a longitudinal manner. The motivation of conducting the analysis at the household level was based on the assumption that diarrhoeal morbidity depends not only on individual factors but also is strongly related to factors measured at household- or even community level.

Despite the rich amount of research on this topic, diarrhoeal diseases remain one of the main causes of morbidity and mortality in Bangladesh and South East Asia populations. According to the WHO and UNICEF, up to 90% of disease burden of diarrhoea can be attributed to environmental risk factors, such as poor water quality, lack of hygiene, sanitation deficits and other housing and neighbourhood characteristics (UNICEF 2009).

The results of the study showed not only a high frequency of diarrhoeal diseases (42.5% of households were affected in at least one of four follow-up periods), but also statistically significant high correlation of diarrhoeal incidence with lower average age, larger size of households, lower education level and income. The highest rate of diarrhoea was reported between September to November (after monsoon) and the lowest during the period from December to February. Families with adverse living and housing conditions reported diarrhoea more frequently. Following selected characteristics related to quality of housing were significantly associated with diarrhoea in bivariate analysis:

- sharing the same potable water source with more households,
- using surface water for drinking,
- insufficient space of the house and
- higher residential density.

Living in a permanently structured house (compared to provisional) as well as sharing sanitation facilities (water and toilet) with a lower number of families indicated a lower risk of diarrhoea in the multinomial logistic regression.

Respiratory diseases (paper III) belong next to diarrhoea to the main causes of morbidity and mortality in developing countries worldwide. In Bangladesh, even such unspecific symptoms like fever and coughs are among the main causes of morbidity and acute respiratory infections (ARI) remain the main cause of morbidity and mortality among children. In paper III we examined fever, cough and cold as typical symptoms of acute respiratory infections and their associations with different individual factors and housing characteristics.

The reported prevalence of respiratory symptoms within the previous three months was 21.5%. In the study areas with exposure to stagnant water the respondents reported respiratory symptoms three times more frequently and the proportion of women affected by symptoms was higher as compared to men. Using kerosene or heaters for cooking equipment increased the odds of reporting respiratory symptoms two times. Stratified analysis by gender showed even stronger associations between respiratory symptoms in women and their exposure to stagnant water, inadequate garbage disposal and smoking inside the house. Lower residential density showed a strong protective effect against respiratory diseases.

Women were more vulnerable to respiratory symptoms in our study when exposed to adverse housing conditions and a polluted environment in the neighbourhood.

### 7.3 TRENDS IN MAJOR WOMEN'S HEALTH INDICATORS: URBAN VERSUS RURAL

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In the last paper, the overarching analysis of development and trends in relation to different health outcomes was performed using a comprehensive dataset from the DHS Bangladesh, from 1993 to 2011. The aim of the analysis was to track the development of selected women's health-related indicators over a longer period of time. The analysis also compared - where it was possible - differences between urban and rural areas as well as the richest and the poorest wealth index quintiles.

Results showed positive trends in maternal health-related indicators, both for urban and rural areas. The prevalence of underweight individuals decreased from 51.5% to 27.0% in rural area and from 36.2% to 13.3% in urban areas during 1993-2011. Still, the actual disparities between some indicators persist, revealing better outcomes for urban residents. For instance, urban pregnant women received adequate antenatal care services more often (43.3%) than rural women (18.0%). The same indicator also differed significantly between the richest (53.1%) and the poorest (9.0%) groups. In multivariable models, higher education and use of adequate sanitation facilities exhibited strong association with better status of health-related indicators. In total, richest-poorest disparities were more pronounced than rural-urban.

Population groups affected by poverty and especially in the combination with living in urban slum areas are not profiting in sufficient manner from the improvements in health indicators over the years as compared to those in higher income groups.

## 8 JOINT DISCUSSION

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In this section the results of the conducted studies are summarised and jointly discussed in light of previous research, current trends, and the overall research results of the Priority Program "Megacities- Megachallenge - Informal Dynamics of Global Change". Major challenges and opportunities in public health research in urban slums are systematically highlighted in Table 2. Conclusions drawn from the study findings and literature as well as existing recommendations to improve public health in countries with high prevalence of urban slums round off this section.

### 8.1 SUMMARY OF THE RESULTS

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The level of national achievement or failing towards MDGs depends mostly on outcomes measured in urban areas, and particularly in slum areas (World Bank 2007).

This cumulative doctoral thesis sheds some light on complex links between the health of people living in urban slums and their conditions of life using the megacity Dhaka as example. The findings of the papers I-IV together with other articles and papers published within the frame of the Priority Program "Megacities- Megachallenge - Informal Dynamics of Global Change" provide a snapshot on challenges of daily life in urban slums in Bangladesh and give a comprehensive overview of related major health problems. The work therefore contributes significantly to a better understanding of the current state of research in this area and reveals a potential for using the findings of public health and epidemiologic research to improve the quality of life of people living in highly urbanised areas like Dhaka.

The findings of paper I illustrated **housing quality and neighbourhood characteristics highly correlated with self-reported housing satisfaction and self-perceived health among people living in urban slums**. Interestingly, those living in rural areas were more often satisfied with their housing than their urban neighbours living in slum areas. Furthermore, access to clean water and adequate toilet facilities appeared to be the factors strongly related to housing satisfaction. Papers II and III confirmed moreover that **certain aspects of housing, such as tenure, residential density as well as water supply, sanitation, and garbage disposal were highly associated with the frequency of diarrhoeal and respiratory diseases and symptoms**. In paper II, a novel approach of studying diarrhoeal incidence at the household level was applied using an average measure of selected indicators (age, income, education) to explore associations of diarrhoeal diseases with potential risk factors and socio-economic characteristics as well

as seasonal variations. Paper III could demonstrate **women’s higher vulnerability to respiratory symptoms particularly in relation to adverse housing conditions** and environmental influences. Finally, paper IV confirmed that **though urban-rural health disparities in women’s health in Bangladesh decreased over time since the beginning of the 90s, disparities based on socio-economic differences like education and income are still existing and growing**, particularly in urban areas.

## 8.2 JOINT DISCUSSION

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Using the example of Dhaka, we could observe in papers I-III of the present thesis as well as in other works of the DHAKA-INNOVATE project that adverse housing conditions in urban slums represent the major challenge in relation to health and health risks. Provision of migrating rural populations to Dhaka with adequate housing remains a considerable challenge for the city since decades (Khan and Kraemer 2014; Baumgart et al. 2011; Adams et al. 2014; World Bank 2007). A very high population density and spatial organisation of the city intensify previously existing problems related to public health and lead to new challenges.

Research showed that urban households living in slums do not have (or only very bare) advantages of living in urban areas: “no investigation has yet shown that the health benefits of urban living generally outweigh the health risks” (Dye 2008). This of course should not obscure that existing intra-urban differences in health outcomes are heterogeneous within different urban slums (Sverdlik 2011).

In our study, only 21.9% of urban slum residents reported ownership of their house, compared to 99.2% in rural areas. Insecure tenure, an essential problem of living in informal settlements, is presumed to be linked to fear of forced eviction, mostly affecting disadvantaged groups and causing considerable mental and physical stress (Baumgart et al. 2011).

One of the most fundamental problems seen in urban slums in Dhaka and observed in our data is a high population density or residential crowding, measured for example through a number of people sharing a room with the respondent, or a number of families using the same water source or sanitation facilities. It can be argued that crowding, substandard and adverse living and working conditions are willingly accepted by urban dwellers, in order to achieve an overall higher livelihood outcome (Sverdlik 2011). High population density facilitates the distribution of diseases transmitted via respiratory and faecal–oral routes, like influenza, tuberculosis, measles, and diarrhoeal diseases. Densely populated living

areas offer favourable conditions for the spread of emerging diseases, as seen in the epidemics of the severe acute respiratory syndrome, the A(H1N1)2009pdm influenza or the recent Ebola epidemic in Africa. Therefore thoughtful urban planning is essential to prevent overcrowding in urban slums and provide people with recreational area and open spaces (Alirol et al. 2011).

Families living in urban slum areas bear a higher burden of diarrhoeal diseases as compared to rural areas, especially if they have younger family members, higher crowding, have an inadequate source of drinking water and live in provisional houses. One of the reasons is a limited ability of a megacity to keep up with the pace of population growth, particularly in urban slums and also local political regulations, like a regulation of water supply only to residents who can provide the proof of land ownership. Higher income and higher education level seem to have an (indirect) positive impact on incidence of diarrhoea, whereas adverse environmental conditions present a strong and persistent link to diarrhoeal morbidity. It is alarming that despite the knowledge and evidence on epidemiology and effective interventions to reduce the frequency of diarrhoea, the burden of this disease is still significant. Moreover, the fact that diarrhoea remains one of the main causes of morbidity (and mortality) in urban slums means that the basic housing conditions, water quality, quantity and supply are massively deficient in Dhaka. Water supply is a considerable burden of daily life in Dhaka and is a well-known problem being discussed by scientists, international organisations, NGOs and journalists and deserves a separate presentation (The Water Project 2018).

Access to education and mass media showed to be among the strongest predictors of health outcomes in women in urban Bangladesh (Khan and Kraemer 2008). Overall, educated women and mothers were shown to be more aware of the importance of immunisation, breast-feeding, and hygienic measures, despite significant intra-urban disparities in these indicators (Kishk 2002). Literacy rates were reported to be higher in rural areas (80.6% literacy) and urban areas (94.3%) as compared to slum areas (65.3%) in the study by Gupta et al. (Gupta et al. 2008). The same study showed that socioeconomic disparities as described above have a negative impact on access and use of health care for impoverished neighbourhoods, with a substantial and long-term effect on prevention and treatment.

Analysis of DHS surveys, including own published and unpublished analyses, revealed that when controlling for wealth status of households, the secondary education of mothers in Bangladesh would be the major factor to promote a reduction in fertility and child malnutrition rates. Statistical models simulating all mothers in Bangladesh having either

primary or secondary education showed decrease of fertility rates to 2.5 or 2.0, correspondingly (World Bank 2007). However, reaching towards this aim, while taking into account rapidly growing slum areas and poverty linked to this growth is not likely to be an easy task and would depend on common political, cultural, economic and societal efforts.

Papers II and III and partly paper I highlighted a number of factors directly related to neighbourhood environment, including quality of air and water, and water supply. Those factors were in particular stagnant water as well as garbage disposal near the house, proximity to drinking water sources, quality of drinking water, sharing of facilities with other families, and availability and access to different types of facilities. All these factors are of such fundamental importance for living quality and adequate housing in any country, that they need to be prioritised when planning interventions and improvement in resource-limited settings like urban slums of Dhaka. Neighbourhood related factors gain more importance in the health risk factors research and intervention planning despite the methodological challenges in measuring neighbourhood effects (Oakes 2004).

Despite remarkable achievements in the country's development, urban planning activities in Dhaka are not executed according to legal documents and guidelines beginning already in late 1950s. There should be particularly mentioned "The Dhaka Improvement Trust (DIT)" (1956) and the three-tier Dhaka Metropolitan Development Plan (DMDP) produced by RAJUK (Capital Development Authority) grounded at the end of 1980. Concerning public health there are about fifty actors involved into its planning and development and coordination between them is practically not available (Islam et al.; Islam et al. 2000; Siddiqui 2000). Based on the example of two slum areas Islamabag and Korail (the largest slum in Dhaka), several of the following aspects and fundamental challenges in urban slums as an evidence of a failed urban planning can be summarised:

- High density and poor accessibility, due to lack of open spaces used for extended livelihood activities
- Changed perception of privacy and publicness, especially for women
- Low-quality houses, with low ventilation, insufficient daylight and high vulnerability to floods
- Transformation of all available land (river banks, canals and flood plains) into land for building activities for high income groups and real estate actors
- Unregulated mixed land use, leading to integration of local industries into residential areas with high air and water pollution as a consequence.

All these aspects of a complex urban development in Dhaka create on one hand numerous methodological challenges in health research and on the other hand offer unique opportunities built upon previous successes in health research in Bangladesh.

### 8.3 METHODOLOGICAL CONSIDERATIONS AND CHALLENGES FOR HEALTH RESEARCH IN URBAN SLUMS

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Research of urban health poses many challenges, some of which concern definitions of the most common terms like “urban” and “urbanisation”. These terms vary from country to country, as uniform definitions of these words are not found. To define urban areas, for example, some countries use administrative boundaries or size and density of population, or some functional characteristics like economic activity. Urbanisation can, for instance, be described in terms of “pushing out” factors (people are compelled to leave less attractive rural areas) and “pulling in” factors (people move in to more attractive urban areas) (Khan and Zanuzdana 2011). The complexity of understanding the term “slum” is discussed in the updated Chapter 1 of the Global Report on Human Settlements 2003 in view of the Millenuim Agenda (UN-HABITAT 2010).

Intra-urban studies comparing health outcomes within cities are widely used to examine specific features and differences in the urban environment of a city. Such studies can focus on different urban slum, neighbourhoods, poor and affluent areas or other pre-defined geographic areas (Ompad et al. 2007).

Problematic definitional issues of “urban” and “urbanisation” across different countries are only “the tip of the iceberg” in the research on urban health (Leon 2008; Cohen 2004). One of the most important steps for any etiologic research is to clearly specify the research question at the beginning. According to Galea and Vlahov (Galea et al. 2005), specification of a research question in urban areas is difficult due to several reasons. One of them is the interdisciplinary nature of urban health research and application of different theoretical frameworks and terminologies typical for certain fields (e.g., epidemiology, geography and molecular biology). The need for inter- and trans-disciplinary research is apparent for researching the urban phenomena because social and environmental changes are multi-causal and require combinations from multiple disciplines. Multidisciplinary techniques, knowledge and interpretations are in turn required to study interdependent research questions in urban health, which are often interlinked and do not meaningfully exist in isolation (Galea et al. 2005; Goebel et al. 2010). According to Goebel et al, one challenge of the transdisciplinary approach is the

difficulty in transforming a real life problem into a research problem that can be addressed with available academic tools, and within a theoretical framework.

Bangladesh is one of the countries where surveys include “slums” as a separate entity, similarly to the study design within the DHAKA-INNOVATE project. Moreover, Bangladesh belongs to developing countries, which initiated the mapping of the slums in order to improve geographical identification of slums within urban areas. For example, mapping deaths attributed to flood may be useful for predicting future populations at risk in coastal areas (Kovats et al. 2003) or mapping data on vector-borne disease distribution may help to predict the patterns of disease distribution in relation to climate and temperature variations (Lowe 2018). These factors contribute to higher quality of epidemiological and geo-epidemiological research in these settings.

In the public health study in the megacity of Dhaka within the German Research Foundation (DFG) priority programme “Megacities – Megachallenges: Informal Dynamics of Global Change”, multiple study designs were applied (cross-sectional, cohort, focus group discussions, and key informant method). Major study findings have been also validated against other sources of information, statistics and literature. Through triangulation, bias originated from a single-method or single observer can be reduced and the confidence about the findings can be increased. Different methods may inform each other and can act as partial correctives to each other (Khan and Zanuzdana 2011)

Yet not only epidemiological methods can be applied to study urban health and diseases. There are situations when dynamic mathematical models can also be used to predict outbreaks of diseases, e.g., climate-sensitive diseases (Patz and Balbus 1996). Furthermore, such outbreak prediction models can be integrated into broader systems approach, which enclose more complex relationships between climate and its changes, ecosystem changes, human health and human adaptive capacity (Lowe 2018; Kraemer et al. 2016). Socioeconomic factors are an essential part of research on urban health, however, human diseases are determined by many other factors (adequate food and water provision, secure housing), which in turn are related to sectors of agriculture and water resources. Integrated mathematical modelling is a method, which in this regard represents an incorporation of all relevant factors and systems into human health assessment, making it possible to accurately predict changes in health and susceptibility to disease, including climate change (Patz and Balbus 1996; Chen et al. 2016).

Generalisation of public health results from one city to another city is another challenge because cities generally differ by multiple factors such as geographical location, population density, ethnicity, environment, governance and infrastructure, and pace of

urbanisation (Galea et al. 2005). Even within the same city, results are different by different sub-groups and geographical locations. For instance, people living in urban slums suffer more often from communicable diseases whereas affluent people suffer more from non-communicable diseases in Dhaka (Khan and Kraemer 2008).

Although researchers often operate in terms of “communities”, “families” or “households”, heterogeneity of these groups and diversity of gender relations is gaining weight in urban health studies (Fadda and Jirón 1999).

One further ultimate challenge for public health research on urban slums lies in the intersection of urbanisation processes with the underlying urban environment through constant changes in sociodemographic and –economic characteristics of the population land use and availability, population movements and natural resources. Additionally, national and international political processes, governmental and regional changes, and climate change form the external basis to reinforce the cities and the population (Ompad et al. 2007).

The major methodological and other challenges based on own research and project evidence that should be taken into account in the research domain of urban slum health are summarised in Table 2. Additionally, identified opportunities and priorities in research are listed in the last column. This summary of challenges and opportunities does not claim to provide a complete overview of the existing evidence of challenges and needs as well as research priorities, but should rather serve as a guide for the direction of the future research on health in urban slums and particularly the translation of research into practice and policies.

TABLE 2: CHALLENGES FOR RESEARCH ON HEALTH IN URBAN SLUMS AND IDENTIFIED OPPORTUNITIES AND PRIORITIES

	Identified challenges of research	Identified opportunities and priorities in research
<b>Applying different study designs</b>	<ul style="list-style-type: none"> <li>▪ Persistence of rural bias in research, more studies contrasting slum vs. non-slum areas needed</li> <li>▪ Obtaining a broadly representative slum sample</li> </ul>	<ul style="list-style-type: none"> <li>▪ Using novel methods in identifying slum clusters or households (e.g. census data) to obtain a representative slum sample</li> </ul>
	<ul style="list-style-type: none"> <li>▪ Designing and conducting studies on particular vulnerable, disadvantaged groups</li> <li>▪ Lack of recognition of urban slums as highly vulnerable communities at the political level</li> </ul>	<ul style="list-style-type: none"> <li>▪ Analysis of existing coping strategies in communities and households, e.g. in context of climate change</li> <li>▪ More politically driven research, translation of public health evidence into health knowledge, accessible to the target groups.</li> <li>▪ Assessing relation of women’s health and inadequate sanitation and indoor pollution</li> <li>▪ Studies to explore health knowledge and health-seeking behaviours to plan targeted evidence-based interventions</li> <li>▪ Exploring gender-related health risks, including data on health knowledge, behaviour, diets, mortality and morbidity, occupational risks, indoor pollution, adolescent health</li> <li>▪ Studies on impact of health insurance</li> </ul>
	<ul style="list-style-type: none"> <li>▪ Lack of studies on intervention in slums with a potential to be effectively implemented and adapted to local context (“robust large-scale comparative studies”, Lilford et al. 2016)</li> <li>▪ Understanding the overlap between urban poverty and slum residence</li> <li>▪ Understanding of different approaches to interventions (holistic interventions vs. partly interventions)</li> </ul>	<ul style="list-style-type: none"> <li>▪ Evaluation of micro-credit programmes and interventions for the ultra-poor population (for example, such as BRAC’s Challenging the Frontiers of Poverty Reduction: Targeting Ultra Poor, Targeting Social Constraints (CFPR-TUP))</li> <li>▪ Assessing the impact of tenure on physical and mental health</li> <li>▪ Analysis of impact of social networks and social capital (e.g. how health is related to community membership) on individual’s health</li> <li>▪ Social innovations, neglected health challenges (skilled birth attendance, nutritional status, climate change and emerging chronic diseases) (Arifeen, Christou 2013).</li> <li>▪ Addressing epidemiological transition (emergence of chronic diseases, combination of communicable and non-communicable diseases)</li> <li>▪ Further analysis of potential effectiveness of water and sanitation improvement interventions for prevention of diarrhoeal diseases</li> </ul>
<b>Using and advancing multidisciplinary approaches</b>	<ul style="list-style-type: none"> <li>▪ Understanding slum health research as a part of a broader academic discipline of urban health, with high degree of multidisciplinary inputs and outcomes</li> <li>▪ Limited research capacity in developing countries, lack of resources for health system research (longitudinal), lack of multisectoral cooperation</li> <li>▪ Difficulties in translating research into policy</li> <li>▪ Research activities conducted by international</li> </ul>	<ul style="list-style-type: none"> <li>▪ Promoting and building upon existing public health research institutions (for example, Centre for Urban Studies (CUS) in Bangladesh, with a specific mandate regarding urban issues, including poverty)</li> <li>▪ Building partnerships for success of public health programmes, like for example the People’s Health Movement in Bangladesh</li> <li>▪ Translation of public health evidence into health knowledge, accessible to the target groups</li> <li>▪ Applying frameworks on social determinants and urban health into planning of epidemiological studies</li> <li>▪ Studies on implementation of universal health coverage (Adams, Ahmed 2013) and</li> </ul>

	<p>actors and NGOs, distant from local research-driven policies</p> <ul style="list-style-type: none"> <li>▪ Domination of internationally and externally funded and led projects, producing few policy-driven knowledge, not fully adapted to national local interests and current needs</li> </ul>	<p>health care needs of slum populations</p> <ul style="list-style-type: none"> <li>▪ Training of local scientists for conducting epidemiological studies based on Good Epidemiological Practice</li> </ul>
<b>Understanding the settings of slum</b>	<ul style="list-style-type: none"> <li>▪ Poor infrastructures of slum areas for research activities (poor access, poor quality roads, affected by floods, poor connectivity, crime)</li> <li>▪ Mobility of slum dwellers, instability of slum networks, and difficulties in planning long-term interventions; time-consuming and expensive</li> <li>▪ Poor access during surveys and follow-ups, and/or provision of health care services and interventions</li> </ul>	<ul style="list-style-type: none"> <li>▪ Strengthening multilateral cooperation between formal and informal sectors (social, economic, cultural, environmental sectors), community participation, research on new approaches of reaching out population groups living in urban slums (Adams, Rabbani 2013)</li> <li>▪ Involving community and slum residents as a source of information to identify not officially recognised slum communities, for mapping exercises, for identifying less known or neglected health problems, for insights into local neighbourhood structures</li> <li>▪ Studying approaches and best practices for community-based participation in the delivery of health care</li> <li>▪ Recommendation for navigation in slums with regard to project activities by Van de Vijver (van de Vijver et al. 2015) (Appendix 1)</li> </ul>
<b>Applying and developing appropriate research methods</b>	<ul style="list-style-type: none"> <li>▪ Using novel research methods, combination of qualitative and quantitative research, to produce relevant knowledge, which can be translated into policy</li> <li>▪ Difficulties in establishing contact between research teams, government and policy-makers (e.g. due to corruption)</li> <li>▪ Lack of follow-up studies on policies, programmes and interventions</li> <li>▪ Best practice interventions from high- or middle-income countries not applicable in urban slums</li> <li>▪ Research priorities different from those in high- and middle-income countries, and/or non-slum areas</li> <li>▪ Lack of high-quality systematic reviews in low-income countries</li> </ul>	<ul style="list-style-type: none"> <li>▪ Translation of theoretical approaches of multi-level analyses into practice (Diex-Roux 2000, Vlahov, Galea 2003).</li> <li>▪ Analysing the heterogeneity and socioeconomic diversity of slums and neighbourhoods for planning targeted interventions</li> <li>▪ Using longitudinal studies for examination of factors producing chronic poverty in urban slums (Montgomery and Ezeh 2005)</li> <li>▪ Extension of existing reliable health and demographic data (e.g. from DHS) extended by qualitative studies in slum areas focusing on certain research questions</li> <li>▪ Research on how neighbourhood effects in urban slums are generated and how corresponding interventions can profit from this effect</li> <li>▪ Further application of geo-spatial data (Gruebner et al. 2011a) in the research in urban slums, to improve spatial identification of slums (slums as “spatial entities”)</li> <li>▪ Conducting systematic reviews on health and health interventions in slums</li> <li>▪ Use of new (mobile) technologies and research on them; close multisectoral collaboration projects for implementing and using such technologies in public health research</li> </ul>
<b>Considering slum health as an academic discipline</b>	<ul style="list-style-type: none"> <li>▪ Separation of the topic of slum health from the topic of poverty</li> </ul>	<ul style="list-style-type: none"> <li>▪ Promotion and advocacy of the research on health in urban slums through cooperation between policy-makers, scientists, NGOs, public health research institution in country</li> <li>▪ Using the existing research network in country, for example, such as ICDDR, B, BRAC research and Bangladesh Institute of Development Studies (Lancet series on Bangladesh 2013, e.g. Chowdhury, Bhuiya 2013)</li> </ul>

## 9 CONCLUSIONS

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The rapid and intensive growth of urban slums in megacities in South East Asia, including Dhaka, has been accompanied by the growing attention from the scientific community. Yet the scientific evidence collected specifically in slums areas is still limited, partly due to limitation in research settings, as described in the previous section. The fundamental problem of urban low-income groups is the persistence of inequalities throughout their life and lack of chances to change this long-term (Khan et al. 2011; Cohen 2004).

Bangladesh has changed over the last years. Substantial improvements have been achieved in women's education, fertility rate reduction, and in types of professional occupation (e.g. garment industry) (The World Bank 2018). Whereas in urban slums the epidemiological transition is still in the stage where infectious diseases like diarrhoea, pneumonia, and tuberculosis dominate, it becomes more and more evident from the current research, that non-communicable diseases emerge and add to burden of disease in slum areas. Non-communicable diseases known from high-income countries like diabetes and overweight cause higher morbidity in the population due to changed health behaviours, dietary habits and activities requiring less physical activity. The further change in profile of diseases over time in Bangladesh can be forecasted only in a limited manner, partly due to climate change-related impact on population health. Moreover, since August 2017 Bangladesh faces a crisis with more than estimated 900 000 Rohingya refugees in Cox's Bazar (World Health Organization 2019). Due to crowding and poor sanitation in refugee settlements, several outbreaks of diphtheria have been continuously reported with more than 8000 cases (Ahmed et al. 2018; World Health Organization 2018a), and they required an immediate public health action in the form of vaccination campaigns as well as treatment of cases. Apart from diarrhoea acute respiratory infections and acute watery diarrhoea have been reported to cause the highest morbidity among the refugee population. Recent reports from Bangladesh also highlight worsening of the public health situation due to antimicrobial resistance, caused by different factors, such as improper prescription, selling, lack of diagnostic and patients knowledge (Global Antibiotic Resistance Partnership - Bangladesh, GARP-Bangladesh National Working Group 2018).

In Dhaka the poverty and urban slums are "deep-rooted in economic, political, and social processes and is the outcome of multidimensional factors" (Asian Development Bank & Asian Institute of Management 2016). This poverty is a result of all those factors discussed previously including failed urban planning and weak infrastructure, lack of tenure and informality, corruption, natural disasters, as well as rural-urban migration.

The particular link between health and housing quality is well described and documented. In the context of urban slums this aspect becomes more important the faster slums grow within megacities. The conceptual framework by Galea and Vlahov used and adapted for this thesis offers herewith a well-established and a solid frame to compare and interpret the findings of studies designed and conducted in slum settings.

Reducing rich-poor and urban-rural health inequalities is imperative for public health and sustainable development. Future strategies should be based on the principles of equity and quality, particularly: (i) focusing on the poorest groups through specific interventions; (ii) setting reasonable targets to improve their health; (iii) providing healthcare services according to peoples' need irrespective of socioeconomic status; (iv) fostering and expanding public-private partnerships; (v) developing and strengthening the public health infrastructure and (vi) strategies to effectively address accessibility barriers, education and security (Khan et al. 2011; Pathak et al. 2010; Singh et al. 2012; Ghosh 2009). Beyond that, health-related policy should incorporate strategies for increasing women's level of education, economic status and decision-making power to improve maternal healthcare and survival (Ahmed et al. 1998). The public health system must be equipped to provide emergency services during pregnancy and delivery to encourage poor and deprived women (Pathak et al. 2010).

Ultimately, there are at least three major challenges for governments of developing countries with high prevalence of urban slums. The first two are urban planning and sustainable improvement of housing and the third one is enabling of access to health care services particularly for population with low income and those living in urban slums (Shetty 2011). Access to health care alone however is not likely to solve the problem of ill health of the urban slum population because providing someone with modern treatment and sending him or her back to harmful living conditions would not provide a long-lasting positive outcome. It would be much more reasonable to bring "people under a social security net, to provide financial assistance and facilitate their access to health services" as well as "assure the affordability of health care rather than only its physical access" (Shetty 2011). Selected examples of methods and interventions for the amelioration of slums have already been presented in other sections.

Immediate actions and planning can prevent urban societies from catastrophic consequences like rise of violence, emergence of epidemics in slums and deepening of health inequalities. Independent from the area of research, urban health studies should provide an evidence base for policy and action, base for strategies of poverty reduction and elimination of extreme intra-urban health inequities (Harpham and Molyneux 2001).

Concluding, it is worth taking one more look at the criteria of prosperity of a city used by the UN-HABITAT (UN-HABITAT 2012) and referred to in Section 2. A city is prosperous, if it contributes to economic development through productivity, making it possible for the whole population to afford adequate housing and living standards. Next, infrastructure of a prosperous city, its physical characteristics and amenities include adequate water and sanitation, power supply, roads, information technology and other parameters needed for the city's development. Third, social services are provided by prosperous cities, like education, health, recreation facilities, to enable the population a safe, secure and fulfilling life. Fourth, a prosperous city minimises poverty and social inequalities, and establishes measures to prevent new forms of poverty. Finally, a prosperous city guarantees gender equality, non-discrimination of minorities and vulnerable groups, creates and distributes the benefits of prosperity among all people, protecting and preserving the environment. In the case of urban slums, several of these conditions are far from being fulfilled and will require further research and government interventions to achieve this status. Poverty reduction strategies, urban planning, improvement of health care and other social services delivery to the poor, as well as addressing environmental issues are all priorities needed for future development of a megacity like Dhaka.

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## APPENDIX

### Recommendations for navigation of the challenges in slums (van de Vijver et al. 2015)

<ul style="list-style-type: none"><li>• Before the start of a project, engage in effective sensitisation that includes even those groups that might not directly benefit, but that have the potential to threaten implementation of the research or programme.</li></ul>
<ul style="list-style-type: none"><li>• Advertise jobs within the community, but use well-structured competitive recruitment procedures because these processes should not be left to the whims of local leadership. Due diligence needs to be done before any individual is confirmed as part of the project team.</li></ul>
<ul style="list-style-type: none"><li>• Use of local community security groups is, in general, sufficient to address threats within the same community. However, if external partners, especially foreigners, are involved, use of formal and armed security personnel is strongly advised.</li></ul>
<ul style="list-style-type: none"><li>• Give priority to locals for staffing because this measure might benefit the project in several ways, such as access, acceptability, ownership, participation, and indirect financial support of the neighbourhood.</li></ul>
<ul style="list-style-type: none"><li>• Obtain as diverse staffing as possible to ensure that various interests within the community are represented. This diversity will ensure that cultural, religious, and language barriers are broken.</li></ul>
<ul style="list-style-type: none"><li>• Local politics might only be handled by constitution of a formal diverse team of community leaders that represent all of the various constituencies within the community. Depending on the duration of the programme, representatives might be rotated so as to avoid them developing a sense of self-importance that could work against the success of the project.</li></ul>
<ul style="list-style-type: none"><li>• Field staff need to be ready and committed to work outside of conventional working hours, including weekends and public holidays, to trace the highly mobile population in the slums.</li></ul>
<ul style="list-style-type: none"><li>• To improve appeal and acceptability, engage with the community about general development activities that might not necessarily be directly related to the programme that they are working on, such as supporting sports, education, or health activities.</li></ul>



## **ERKLÄRUNG**

Rahmenpromotionsordnung der Universität Bielefeld vom 15. Juni 2010

von

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