Quantification of Urbanization in Relation to Chronic Diseases in Developing Countries: A Systematic Review

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ABSTRACT *During and beyond the twentieth century, urbanization has represented a major demographic shift particularly in the developed world. The rapid urbanization experienced in the developing world brings increased mortality from lifestyle diseases such as cancer and cardiovascular disease. We set out to understand how urbanization has been measured in studies which examined chronic disease as an outcome. Following a pilot search of PUBMED, a full search strategy was developed to identify papers reporting the effect of urbanization in relation to chronic disease in the developing world. Full searches were conducted in MEDLINE, EMBASE, CINAHL, and GLOBAL HEALTH. Of the 868 titles identified in the initial search, nine studies met the final inclusion criteria. Five of these studies used demographic measures (such as population density) at an area level to measure urbanization. Four studies used more complicated summary measures of individual and area level data (such as distance from a city, occupation, home and land ownership) to define urbanization. The papers reviewed were limited by using simple area level summary measures (e.g., urban rural dichotomy) or having to rely on preexisting data at the individual level. Further work is needed to develop a measure of urbanization that treats urbanization as a process and which is sensitive enough to track changes in “urbanicity” and subsequent emergence of chronic disease risk factors and mortality.*

KEYWORDS *Urbanization, Chronic disease, Systematic review, Developing countries*

INTRODUCTION

During and beyond the twentieth century, the proportion of the world's population living in urban areas has grown from 14% to over 50%.¹ This transition was most keenly observed in developing countries; in South Korea, for example, there has been a fivefold increase in the number of people living in urban areas in the past 30 years.² These demographic shifts are associated with many other changes including improved public hygiene, environmental sanitation, greater access to health care, increased individual wealth, changing employment and work force structures, and shifts in dietary and physical activity patterns.^{3,4} These fundamental changes have clear implications for disease patterns and particularly for the emergence of noncommuni-

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Electronic supplementary material The online version of this article doi:10.1007/s11524-008-9325-4 contains supplementary material, which is available to authorized users.

cable diseases (NCD).⁵ Between 1990 and 2000, the population prevalence of NCDs rose from 47% to 56% in developing countries. It is predicted that NCDs will account for 69% of all deaths in developing countries by 2020 and that cardiovascular disease will become the leading cause of mortality.⁶ The burden of this transition in the disease epidemiology will be heavier in the developing world compared to the developed because, in the developing world, the majority of sufferers are expected to be relatively young, of lower socioeconomic status, and to suffer from a more severe and premature onset of disease.⁷

The MESH term urbanization is used to describe “*The process whereby a society changes from a rural to an urban way of life. It refers also to the gradual increase in the proportion of people living in urban areas*” (see <http://www.ncbi.nlm.nih.gov/sites/entrez>).

Despite this, most studies that examine the relationship between urbanization and chronic disease use a national level rural/urban dichotomy to summarize urbanization. Vlahov and Galea show that for the 228 countries for which the United Nations (UN) collect data, almost half use a basic administrative definition of urban (e.g., living in the capital city), around a quarter define urbanization using population measures (e.g., size and density), and one in eight use functional characteristics (e.g., economic activity).⁸ In a cross-country analysis of over 100 countries, Ezatti et al. found that body mass index (BMI) and cholesterol increased rapidly with national income and level of urbanization.¹ Reporting results from the Chinese Health and Nutrition Survey and data from the UN Food and Agriculture Organization, Mendez and Popkin show that urbanization and globalization enhance access to nontraditional foods resulting in less healthy dietary patterns.⁹ A large risk factor surveillance study conducted in India found that the prevalence of diabetes was two and a half times higher in urban areas when compared to rural areas.¹⁰

The broad measures of urbanization described above have been useful in establishing associations between level of urbanization, chronic disease risk factors and chronic diseases, also known as the *urban health penalty*. These studies are limited, however, because they lack the specificity to identify the exact changes within the urbanization process that are responsible for the emergence of chronic disease risk factors. Research about the structure of modern urban living and the ways that this can influence health have received scant academic attention,⁸ and this scarcity of research makes it impossible to examine temporal changes in the urban environment and subsequently changes in patterns of disease. A second complication is the disparate academic traditions involved in this type of research including geography, epidemiology, sociology, and urban planning.¹¹ Many define urbanization using a simple dichotomy (urban/rural) or even a single continuous variable (population density). This removes the potential to understand the specific changes within the process of urbanization that lead to changes in risk and disease. Furthermore, the idea of a “threshold” delineating an urban area as opposed to other types of living environment ignores the graduation in disease states between and within geographical areas and assumes that populations remain static.

Socioeconomic, cultural, political, and environmental factors have a powerful influence on population health-related behaviors and subsequent health outcomes. A number of authors propose a framework for understanding the relationship between the social and physical environments that define “urban” as being influenced by municipal factors including government, civil society, and national and global trends.^{9,10} This framework posits that the physical, social, economic, and political elements of the urban environment have some effect on the health of *all* residents. In

addition, there are a number of upstream influences on living conditions including municipal (governments, markets, etc.), national, and international trends that may effect health. This taxonomy describes how population composition relates to the demographic characteristics of the population living within a city including fertility, migration, and immigration. The social environment describes properties of the urban community such as socioeconomic status, crime and violence, the population mix and attendant risk factors, and so on. In practice, elements of interest in the physical environment may include features of the built environment or levels of air, water, and noise pollution. For public health and chronic disease, areas of interest might include access to sanitation, supermarkets, paved roads, etc. A second important consideration is the provision of health and social services, which in turn is interrelated to the physical and social environment, health insurance arrangements, and availability, equity, and quality of services.

We know that “urbanization” is associated with the emergence of NCDs. We do not know what this process of “urbanization” entails nor do we know which of the elements of “urbanization” are associated with which NCDs. An understanding of the individual elements of “urbanization” and how these lead to the development of NCD risk is an important first step in identifying potential sites for intervention at a population level. This review is the first step in developing a more detailed picture of the ways in which previous peer-reviewed research has shown how “urbanization” contributes to the emergence of chronic diseases in the developing world.

In this paper, we set out to identify how urbanization has been measured in studies that examine the relationship between urbanization and chronic diseases in developing countries. We aim to list the elements of urbanization that have been studied in relation to chronic diseases and their risk factors. In response to this aim, our research question was:

How has urbanization been defined and measured in previous observational studies of urbanization and chronic disease in developing countries?

METHODS

Search Strategy

The full systematic review of urbanization and chronic disease was preceded by a pilot phase in order to develop the correct search terms for our full review. In April 2007, we searched PUBMED for studies under the MESH terms “urbanization,” “chronic disease,” or “coronary heart disease” using the appropriate truncation and wildcards. This initial search returned 83 papers, of which 21 were review papers and two were primary studies reporting some quantification of urbanization. We categorized all of the MESH terms from all 83 papers ($n=492$) in this pilot set into four subcategories: (1) urbanization as an exposure; (2) other exposures and outcomes; (3) outcomes related to a specific chronic disease; and (4) participant demographics. Full results of this pilot phase are available from the authors upon request. A full search strategy was developed by two of the researchers (SA and CF) using this set of 492 MESH terms as the basis for the search strategy used in the full review.

Terms used for urbanization included “acclimatization,” “urbanization,” and “modernization.” Terms used for chronic disease included “chronic disease,” “cardiovascular disease,” and “cancer.” Chronic disease is a root term that includes specific diseases such as cardiovascular disease, obesity, and diabetes. Terms used for

developing countries included “developing countries,” regional descriptors (such as Africa), and the full list of developing countries and regions listed by the World Bank.¹² Truncation was used to overcome differences between American and English spelling. The full search strategy is available online from the journal website.

We searched the MEDLINE, EMBASE, CINAHL, and GLOBAL HEALTH electronic databases for English language studies published after January 1990 and before August 2007. We also searched reference lists of reviews found from the pilot search study, from the main search, and from the final included studies.

Study Selection and Inclusion Criteria

We included any study that aimed to examine the relationship between urbanization and chronic disease in a developing country (Table 1). The study also had to report details on the construction of the urbanization variable used and had to have at least one chronic disease as an outcome. Once duplicate studies were removed from the total hits ($n=1,285$), two reviewers (SA, LH) independently assessed the remaining titles and abstracts ($n=868$) for inclusion. The full paper was assessed against the inclusion criteria where ambiguity remained after reading the title or abstract. Any disagreements at this stage were resolved by a third reviewer (CF). A number of studies were excluded because they did not include a measure of urbanization and several others because they reported data from a developed country.

Data Extraction

We extracted data from the final included studies using two independent reviewers, and the discrepancies in final data extraction were resolved by discussion with the third reviewer. We extracted all available data from the publication reporting each study. We categorized the studies into high or low quality based on the level of detail reported by the paper on the method of development of a measure of urbanization. We adopted this approach because the focus of our review was to describe the methods used to quantify urbanization rather than presenting results against criteria for internal or external validity.

Data collected from each paper were methods, definition and measurement of urbanization, sources of data, sampling frame, individual or area level data, and statistical and analytical methods for creating summary variables. The final data corpus of included studies is presented in Table 2.

RESULTS

Of 868 titles and abstracts identified by the searches, nine studies remained after application of the exclusion criteria. These studies are presented (in quality and publication date order) in Table 2. Five studies were conducted in a single developing country while the remainder was conducted in at least two or more countries.

We divided the studies into two types: studies that examined the relationship between urbanization and health at a single time point and those that used repeated measures over time. The most common comparisons were made between populations living in urban and rural areas across a range of outcomes. These outcomes included measures of behaviors for communicable and noncommunicable diseases (e.g., physical activity, calorific intake, and sexual/reproductive health), anthropometric data (weight, body mass index, and blood pressure), morbidity (diabetes), mortality and sociodemographic data (income and education).

TABLE 1 Results of search and application of inclusion criteria

	Papers removed	Total remaining
Database (hits from initial search)		1,285
MEDLINE (<i>n</i> = 605)		
EMBASE (<i>n</i> = 545)		
CINAHL (<i>n</i> = 20)		
GLOBAL HEALTH (<i>n</i> = 115)		
Duplicates removed	417	868
Exclusions based on title and abstract		38
Did not examine the relationship between urbanization and chronic disease	668	
Did not report data from a study in a developing country	148	
Review paper only	12	
Study did not involve human participants	2	
Inclusions		40
Papers identified from the references of reviewed papers (<i>n</i> = 2)		
Exclusions based on full paper		9
Papers entered into final stage		
Study did not quantify urbanization	17	
Did not examine the relationship between urbanization and chronic disease	7	
Did not report data from a study in a developing country	4	
Review paper only	3	
Papers included in review		9

We found considerable differences in the definitions and measurements of urbanization. Studies adopted either a simple definition of urbanization using demographic data or a complex one that summed categories of variables into an urbanization index. Table 3 presents the different components of measures of urbanization by included studies in quality and publication date order.

Studies using a Single Demographic Measure to Define Urbanization

In this first group, we found four studies that defined urbanization as a simple product of population density within an area.² This definition was based on the UN dichotomy of urban/rural and was obtained from secondary data sources (e.g., population census data, aggregated to an area level measure). Dahly and Adair have described a number of problems with the UN dichotomy, including differing definitions and measurement across different countries.¹³ One additional study classified their sample into urban or rural groups using the proportion of the respondent’s life spent in an urban environment.¹⁴ This data was collected at an individual level from the study population using an unspecified measure of urbanization.

Studies using Composite Measures to Define Urbanization

The remaining four studies defined urbanization from a range of different types of variables using either individual level data or secondary data collected at an area level. One South African study categorized respondents into one of five groups based on where they lived and their occupations.¹⁵ This study categorized people according to whether they lived in rural traditional villages, worked on commercial farms, lived in informal housing and whether they were laborers in industry or professionals. An earlier South African study constructed an urbanization score

TABLE 2 Summary of characteristics of included studies by quality and publication date

Author (date)	Country	Aim of study	Design
1. Dahly and Adair (2007)	China, Russia, and the Philippines	To investigate how urbanicity has affected the health of study participants living in a rapidly urbanizing metropolitan area over a 20-year period	Observational study
2. Mendez and Popkin (2004)	China and 36 developing countries	To assess the extent of obesogenic dietary patterns in rural and urban areas	Observational study
3. Choi et al. (2006)	South Korea	To examine the trends in diabetes mortality and associated socioenvironmental changes between 1983 to 2001	Cross-sectional study Observational study Comparison of 20 years of mortality rates against social, economic and behavioral changes
4. Ezzati et al. (2005)	Global	To examine age-standardized mean population levels of BMI, systolic blood pressure, and total cholesterol in relation to national income, food share of household expenditure, and urbanization in a cross-country analysis	Observational study Association between risk factors and national income, average share of household expenditure spent on food, and urbanization
5. Vorster et al. (2005)	South Africa	To describe how urbanization influences the nutrition and health transition in South Africa	Observational study
6. Sobngwi et al. (2004)	Cameroon	To assess the association between lifetime exposure to urban environment (EU) and obesity,diabetes, and hypertension in an adult population of Sub-Saharan Africa	Observational study Age, BMI, fasting glycemia, and blood pressure were compared between rural and urban dwellers
7. Popkin (1998)	China and Russia	To examine the evidence of nutrition transition across developed and developing countries through population migration from rural to urban living and socioeconomic changes	Observational study
8. Pick and Cooper (1997)	South Africa	To examine the association between urbanization and health of women in South Africa	Observational study Association between social, health, and economic variables and health
9. Steyn et al. (1997)	South Africa	To investigate urban exposure among black people of the Cape Peninsula, South Africa, in relation to unhealthy lifestyles and the risk factors for chronic diseases of lifestyle	Observational study Descriptive analysis to examine differences between urban and rural adults. Correspondence analysis used to identify clusters of variables including exposure to urban environment

Sample	Quantification of urbanization and data source	Outcome, exposure, and confounder variables
1. Women aged in general health survey from selected urban and rural areas	Urbanization was defined by the study authors using a multivariable scale Components included: population size, communications, transportation, educational facilities, health services, markets. Each component can theoretically take a value from 0 to 10, resulting in scale ranging from 0 to 70 Individual and secondary data source	Total caloric intake, percent calories from fat, days breastfed Urbanicity score
2. Chinese adults aged 20 to 45 years Nonpregnant women aged 20 to 49 years with a total of 157,844	Urbanization was defined using the China Urbanization Index—a multidimensional index of infrastructure and resources in ten categories: population size, population density, access to markets, transportation, communications/media, economic factors, environment/sanitation, health, education, and housing quality Individual and secondary data source	Not stated Anthropometric data, dietary intake, e.g., animal source foods; caloric sweeteners; fruit and vegetable consumption; energy (total calories); edible oil consumption; high-energy food consumption; overweight and obesity
3. Annual deaths standardized by population age	Urbanization ratios (the proportion of the population living in urban areas) obtained from the existing data Secondary data source	Income Weight status Age Mortality by cause Socioeconomic changes, physical activity and dietary pattern indicators Mortality rate, standardized for age and population Mean population prevalence of SBP, cholesterol, and BMI
4. County-specific data on BMI, SBP, and total cholesterol from systematic reviews	Urbanization defined as the proportion of population in urban areas using dichotomous urban/rural measure from UN. Measure considered a proxy for environmental and behavioral variables, e.g., physical activity Secondary data source	Socioeconomic variables national income, average share of household expenditure spent on food, and proportion of population in urban areas Socioeconomic and education profiles, dietary patterns, nutrient intakes, anthropometric and biochemical nutrition status, physical and mental health indicators, and risk factors for noncommunicable diseases Not reported
5. Random sample of 1,854 adults aged 15 and older	Subjects were categorized in one of five groups based on where they lived and their occupations. Characteristics included rural traditional villages, workers on commercial farms, informal housing, laborers in industry and professionals Individual level data	

TABLE 2 Continued

Sample	Quantification of urbanization and data source	Outcome, exposure, and confounder variables
6. Randomly selected 999 women and 727 men aged over 25 years from urban and rural areas	Urbanization was defined using population density statistics Secondary data source	Anthropometric data, BP, blood glucose, and physical activity Chronological data on lifetime migration were collected retrospectively and expressed as the total (Eut) or percentage (EU%) of lifetime exposure to urban environment Proportion of energy from different food sources, national income levels per capita Physical activity Urbanicity
7. National country level nutrition surveys, World bank and UN	Proportion of residents with urban area	Four variables of social well-being and seven variables of women's reproductive health
8. Purposive sample of 659 women and 61 men	Urbanization was constructed from proxy measures of place of birth, number of years spent in urban area since leaving school, home ownership, land, livestock, and presence of family in area Data collected at individual level	Age, years of education, urban years, housing, employment, marital status, social well-being, social isolation, child care organizations, power relationships, attitudes to area of residence Not stated
9. Random sample of 986 adults aged 15–64 years stratified by area and housing status	Percentage of life spent in an urban environment (PLU) Individual level data	Anthropometric data, lipids, BP, risk factor, and dietary measures Education level, employment status, physical environment and facilities, place of birth and number of years spent in a city, urbanization. Smoking, alcohol, exercise habits, personal family history of ischemic heart disease, and related diseases Age, gender, PLU, smoking, cholesterol, obesity, and alcohol

Findings	Quality
1. The new scale illustrated misclassification by the urban/rural dichotomy, and was able to detect differences in urbanicity, both between communities and across time, that were not apparent before. Furthermore, using a continuous measure of urbanicity allowed for better illustrations of the relationships between urbanicity and health. The new scale is a better measure of urbanicity than the traditionally used urban/rural dichotomy	High
2. Simple urban/rural disparities masked substantial heterogeneity in dietary patterns across differing environments. Dietary patterns in rural areas with very high urbanicity scores closely resemble diets in areas formally designated as urban, with high intakes of animal foods and oils. Only rural communities with very low levels of urbanicity have maintained low intakes of animal foods and edible oils	High
3. Diabetes-related mortality tripled along with increases in related economic, social and behavioral indices, including urbanization	Low
4. There was a positive relationship between BMI/cholesterol and the food share of household expenditure and with proportion of population in urban areas	Low
5. Increasing urbanization was seen to improve micronutrients and status but was also accompanied by increases in body weight, obesity, BP and cholesterol	Low
6. Lifetime exposure to urban environment was correlated with higher BP, glucose, and BMI. However, both lifetime EUT and current residence were independently associated with obesity and diabetes. The association between lifetime EUT and hypertension was not independent of current residence and current level of physical activity	Low
7. The paper describes rapid changes in diet, obesity, and physical activity among lower and middle income countries	Low
8. Urban dwellers were more likely to report an increased likelihood of being a member of a civic association and a better awareness of AIDS. Rural dwellers were more likely to take up cervical screening	Low
9. Those who had spent larger portions of their lives in anurban setting tended to have unhealthier lifestyles and higher risk for chronic diseases of lifestyle compared with their less urbanized counterparts	Low

TABLE 3 Components of measures of urbanization by included studies in quality and publication date

Component study	Demographic	Geographic	Economic	Social	Education	Housing	Transportation	Health services	Communication
Dahly and Adair (2007)	C		C			C		C	C
Mendez and Popkin (2004)	C		C	C	C		C	C	C
Choi et al. (2006)	A								
Ezzati et al. (2005)	A								
Vorster et al. (2005)		I	I						
Sobngwi et al. (2004)	A								
Popkin (1998)	A								
Pick and Cooper (1997)		I	I	I	I				
Slevn et al. (1997)	A								

A data collected at an area level, e.g., proportion of residents living within defined urban area using UN definition; I data collected at an individual level; C combination of both sources used

from measures of place of birth, number of years spent in urban area since leaving school, home ownership, land, livestock, and presence of family in the area.¹⁶

Two studies created multivariate indices of urbanization by using measures taken at both an individual and area level. Mendez and Popkin created an urbanization index using ten measures: population size, population density, access to markets, transportation, communications/media, economic factors, environment/sanitation, health, education, and housing quality.⁹ The index was developed using data from community surveys, supplemented with household level information. The authors classified areas into different levels of urban and rural according to scores.

Dahly and Adair¹³ used an approach based on Mendez and Popkin⁹ to define urbanization using a multivariable scale. Their “urbanicity scale” was based on two criteria: content validity (an a priori assessment, based on authoritative sources such as peer-reviewed literature, of whether an item truly reflects urbanicity) and the availability of relevant data. The authors did provide an a priori definition of urbanization mimicking the variable used previously. However, they were unable to obtain the same data sources for comparable community level data on housing infrastructure, economic indices, and sanitation as Mendez and Popkin.⁹ They were forced to develop their scale on a mix of measures thought appropriate by the researchers and the data available.

The “urbanicity scale” used the following items: population size; population density; communications (e.g., the presence of phone service, mail, newspapers, the internet, cable TV, and cellular phones); transportation (e.g., the density of paved roads and the availability of public transportation); educational facilities (e.g., the presence of educational institutions, including primary and secondary schools, colleges, and vocational schools); health services (e.g., the presence of health services, including hospitals, medical clinics, maternal health clinics, family planning clinics, and community health centers); and markets (e.g., the number of sari-sari stores [small, retail shops] and the presence of drug stores, grocery stores, and gas stations).

Each of the seven components was scored to create a value from 0 to 10, resulting in a scale ranging from 0 to 70 across all items. The authors argued that using a continuous measure of urbanicity allowed for better illustrations of the relationships between urbanicity and health. Their scale allowed comparisons of similar measures over time, and analyses of its components could identify specific factors which vary consistently across urbanizing environments. Their new scale was a better measure of urbanicity than the traditionally used urban/rural dichotomy. The scale allowed a better reflecting of differences between urban and rural areas as well as heterogeneity across areas. These differences might not exist within a developed country as all participants might share similar access to services or goods.

DISCUSSION

Statement of Principal Findings

We identified nine studies that quantified urbanization in relation to chronic disease or chronic disease risk factors. Most studies relied on secondary demographic and geographic measures of urbanization comparing populations living in urban and rural areas across a range of outcomes. Four studies used either secondary or primary data or combinations of the two at area and individual level to develop summary scores from multiple proxy measures of an urban environment.

Area level measures include population size, population density, proportion of population living in urban areas, health, education, housing quality, economic factors, environment/sanitation, and access to markets, transportation, and communications/media.

Individual measures include place of residence, number of years spent in urban area since leaving school, proportion of life spent in an urban environment, occupation, home, land and livestock ownership, and proximity of family. None of these studies provided an objective validation of these measures of urbanization.

Strengths and Weaknesses of the Study in Relation to Other Studies, Discussing Particularly any Differences in Results

This is the first review of its kind which takes a systematic approach to identifying the ways in which urbanization is measured as an exposure variable in relation to chronic disease. The strengths of the approach include the systematic nature of the review. The initial pilot phase made it possible to generate a broad range of search terms before a full search strategy was built. The application of inclusion criteria ensures that only those studies relevant to the research question as posed are included in the review.

xStringent inclusion criteria meant we conducted a focussed review but that the number of papers ($n=9$) included was limited. The data corpus could be expanded by including those studies without an explicit definition of urban. Such an exercise could compare and contrast the relationships between *urban* and whichever outcome is of interest to the paper with an examination of how comparable outcomes varied by the measure of urban utilized by the study authors. This would not suit the current research question, however, as we were interested specifically in how these studies had defined “urban.”

Some of these studies appeared to be of low quality and the quality measure described in the methods was an attempt to take this into account within the review. The majority of studies reviewed provided poor explanations of the methods for deriving the reported urbanization measure. This happened most often in those studies using secondary measures (e.g., population density).^{2,17}

Our initial pilot study led us to believe that the MESH term urbanization is being misused. The majority of studies reviewed does not consider “urbanization” as a process but rather compare geographical or administrative locations based on urban/rural dichotomies. We have tried to overcome this problem by expanding the terms used to represent urbanization to include modernization, etc. Identifying the possible misuse of “urbanization” proved an invaluable result of the pilot study and should be an important step of any systematic review in an untried area.

Finally, our requirement that papers be published in English may have limited the number of papers returned. This may be particularly so for studies reporting data from developing countries who do not have English as their first language.

Meaning of the Study: Possible Mechanisms and Implications for Clinicians or Policymakers

While most authors agree that urbanization refers to the process of becoming urban, there is little agreement about how these phenomena can be measured or studied in association with population health or other outcomes.¹⁸ The majority of studies reviewed relied on preexisting measures of urbanicity using an urban rural

dichotomy, identifying that urban settings adversely affect health but not *how* or *why* such settings may affect health.⁸ A subset of these studies use arbitrary cut points to create a third intermediate level of urbanization. These measures are, therefore, crude and may mask variations (intra—within country and inter—between countries) across population areas because of the scale used in classifying population density.

Using this crude dichotomy means that it is not possible to understand why urbanization affects chronic disease risk. It also makes it impossible to track changes that may occur in the urban environment or indeed identify components of the urbanization process that may affect disease risk.

There are other, more recent measures, which may serve as surrogates for urbanization. At an area level, this list might include the proportion of households living below the poverty line, the human development index, etc. The measures have their own limitations and as with those found in this review have not been validated as measures of the process of “urbanization.” They may be hampered by their timeliness and by the pace of urbanization outstripping the collection and attribution of these measures.

Unanswered Questions and Future Research

Our study suggests that we need definitions of “urbanization” that are culturally and country-specific to study the effects of urbanization both within and between developing countries. For researchers planning studies taking urbanization as an exposure, it is important to consider urbanization as *a process* rather than a static measure. Any scale measure attempting to capture proxies for “urbanization” should ensure that individual and area level measures are included. Any subsequent analysis should then consider multilevel models providing comparisons at individual and area level. Similarly, outcome measures might be considered both at population and individual level. Area level measures that should be considered include those used traditionally such as population size and density but other measures should also be considered including quality of roads, distances to markets, types of markets available, transport options, types and accessibility of employment, health services, and so on. Other methods of data collection such as geographical information systems should also be considered.

At a macro level, we suggest that comprehensive measure of urbanization should be constructed using qualitative and quantitative data. The definition of urbanization should be validated where appropriate at an area level (defined by the population studied) using ground truthing methods (environmental audits). Ideally, data informing this process should be contemporaneous and have temporal and seasonal stability at baseline and follow-up points.

It will not be sufficient only to observe the problem that urbanization is associated with an increasing risk of morbidity and mortality. This situation offers little in terms of public health interventions to combat the inevitable changes that will happen within developing countries. This transition is happening in the developing world. More precise and validated measures of urbanization are, therefore, needed urgently to identify which aspects of urbanization are associated with different health and social outcomes within which population groups and communities. Identifying these “tipping points” for the emergence of chronic disease risk opens the potential for policy and regulatory intervention within the development cycle.

CONCLUSION

Our systematic review of studies that measure urbanization as an exposure for chronic disease has found that there are limited empirical studies. Most studies rely on secondary data providing population level summaries at an area level. A more comprehensive measure is used that is sensitive and specific to the process of urbanization as it affects chronic disease risk.

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