

Burden of Disease in China

Contrasting Disease Burden Patterns of the General and the Migrant Workers Populations

*Alexander Kraemer, Florian Fischer, Dietrich Plass, Paulo Pinheiro,
Li Ling, Yuanyuan Sang, Jianli Kan and Heiko J. Jahn*

Migration and Health in China

A joint project of

United Nations Research Institute for Social Development

Sun Yat-sen Center for Migrant Health Policy

Working Paper 2014–11

July 2014

Working Papers are posted online to
stimulate discussion and critical comment.



The United Nations Research Institute for Social Development (UNRISD) is an autonomous research institute within the UN system that undertakes multidisciplinary research and policy analysis on the social dimensions of contemporary development issues. Through our work we aim to ensure that social equity, inclusion and justice are central to development thinking, policy and practice.

UNRISD, Palais des Nations, 1211 Geneva 10, Switzerland; Tel: +41 (0)22 9173020; Fax: +41 (0)22 9170650; info@unrisd.org; www.unrisd.org



The Sun Yat-sen Center for Migrant Health Policy (CMHP) is a multidisciplinary research institution at Sun Yat-sen University (SYSU), Guangzhou, China. Funded by the China Medical Board (CMB), CMHP was established by the School of Public Health, School of Business, School of Government, School of Sociology and Anthropology and Lingnan College of SYSU in 2009. CMHP aims to take a leading role and act as a hub for research, communication and policy advocacy on issues relating to health and migration in China.

Sun Yat-sen Center for Migrant Health Policy, Sun Yat-sen University, #74, Zhongshan Road II, Guangzhou City 510080, P.R. China; Tel: +86 20 8733 5524; Fax: +86 20 8733 5524; cmhp@mail.sysu.edu.cn; <http://cmhp.sysu.edu.cn/>

Copyright © United Nations Research Institute for Social Development/Sun Yat-sen Center for Migrant Health Policy

The responsibility for opinions expressed in signed studies rests solely with their author(s), and availability on this website does not constitute an endorsement by UNRISD or CMHP of the opinions expressed in them. No publication or distribution of these papers is permitted without the prior authorization of the author(s), except for personal use.

Introduction to Working Papers on Migration and Health in China

This paper is part of a series of outputs from the research project on [Migration and Health in China](#).

China is confronted by major challenges posed by the massive population movement over the past three decades. In 2009, approximately 230 million rural inhabitants moved temporarily or permanently to cities in search of employment and better livelihoods. Such large-scale mobility has huge implications for the pattern and transmission of diseases; for China's health care system and related policies; and for health of the Chinese population in both receiving and sending areas. The health and social issues associated with population movement on such an unprecedented scale have been inadequately addressed by public policy and largely neglected by researchers. Based on interdisciplinary research across the health, social science and policy fields, this project constitutes a major effort to fill research and policy gaps. Collectively, the papers and commentaries in this series aim to provide a comprehensive assessment of the health and public policy implications of rural to urban migration in China, to inform policy and to identify future research directions.

This project is a collaboration between UNRISD and the Center for Migrant Health Policy, Sun Yat-sen University, Guangzhou, China, and funded by the China Medical Board.

Series Editors: Sarah Cook, Shufang Zhang and Li Ling

Working Papers on Migration and Health in China

Burden of Disease in China: Contrasting Disease Burden Patterns of the General and the Migrant Workers Populations

Alexander Kraemer, Florian Fischer, Dietrich Plass, Paulo Pinheiro, Li Ling, Yuanyuan Sang, Jianli Kan and, Heiko J. Jahn, July 2014

A Longitudinal Study of Migration and Health: Empirical Evidence from Thailand and its Implications

Chalermpol Chamchan, Win Kit Chan and Sureeporn Punpuing, May 2014

*Two Decades of Research on Migrant Health in China: A Systematic Review
Lessons for Future Inquiry*

Li Ling, Manju Rani, Yuanyuan Sang, Guiye Lv and Sarah L. Barber, May 2014

Coming Home: The Return of Migrant Workers with Illness or Work-Related Injuries in China's Hubei and Sichuan Provinces

Chuanbo Chen, Shijun Ding, Sarah Cook and Myra Pong, March 2014

Environment, Health and Migration: Towards a More Integrated Analysis

Jennifer Holdaway, March 2014

Chinese Migrant Workers and Occupational Injuries: A Case Study of the Manufacturing Industry in the Pearl River Delta

Bettina Gransow, Guanghuai Zheng, Apo Leong and Li Ling, January 2014

Reproductive Health and Access to Services among Rural-to-Urban Migrants in China

Zhenzhen Zheng, Ciyong Lu and Liming Lu, December 2013

The Influence of Migration on the Burden of and Response to Infectious Disease Threats in China: A Theoretically Informed Review

Joseph D. Tucker, Chun Hao, Xia Zou, Guiye Lv, Megan McLaughlin, Xiaoming Li and Li Ling, November 2013

Contents

Acronyms.....	ii
Summary.....	iii
1. Introduction	1
2. The Burden of Disease Approach.....	1
Disability weights	2
Major methodological adjustments in the GBD 2010 study	3
3. Burden of Disease Patterns in China	3
Overall distribution of diseases	4
Distribution of group I conditions: Communicable diseases	7
Distribution of group II conditions: Non-communicable diseases	8
Distribution of group III conditions: Injuries	9
Ranking of leading causes of DALYs	9
4. Rural-to-Urban Migrant Workers in Urban China and their Health-Related Characteristics	10
Excursus: Internal migration and its effects on the sending areas.....	11
5. Health Risks and Disease Patterns of the Migrant Population in China	12
Migrants and group I conditions.....	12
Tuberculosis	12
Sexually transmitted infections	13
Human immunodeficiency virus (HIV).....	14
Migrants and group II conditions	15
Impact of smoking.....	15
Mental health	16
Migrants and group III conditions.....	17
Occupational health	17
Road traffic injuries	17
6. Burden of disease in Chinese Cities Influenced by Internal Migration.....	17
7. Limitations.....	18
8. Conclusions and Implications for Health Policy	19
Infectious disease prevention	19
Road traffic safety	20
Hukou, labour legislation and (gender) equality	21
Data availability and demand	21
References	23

Acronyms

AIDS	Acquired immunodeficiency syndrome
BoD	Burden of Disease
COPD	Chronic obstructive pulmonary diseases
DALY	Disability-Adjusted Life Year
DOT	Directly observed therapy
GBD	Global Burden of Disease
HIV	Human immunodeficiency virus
HPV	Human papilloma virus
ICD	International Classification of Diseases
PWC	Pair-Wise Comparisons
SMPH	Summary Measure of Population Health
STI	Sexually transmitted infection
TB	Tuberculosis
UI	Uncertainty Interval
WHO	World Health Organization
YLD	Years of Life Lived with Disability
YLL	Years of Life Lost due to premature Death

Summary

One of China's major challenges in terms of socio-demographic changes and population health is the large mobile population mainly represented by rural-to-urban migrant workers. After enacting of the "open door-policy" in 1978, economic growth, particularly in the large coastal urban centres, dramatically accelerated. Massive urbanization processes took place fuelled by rural-to-urban migration. The sheer quantity of these rural-to-urban migrant workers highlights the importance of this group for societal changes and population health in China. This also concerns the influence of migrant workers' specific disease burdens and their health-related behaviours on the health of the Chinese population in general.

Despite the obvious significance for population health in China, there is no systematic burden of disease (BoD) assessment available for the migrant subgroup. The BoD approach, a comparative methodology enabling, among other things, the analyses of the distribution of diseases and symptoms and their temporal changes within and between countries, was used to describe the "background" disease burden in the general population, focusing the typical age group of migrant workers (aged 15 to 49 years). This detailed description should highlight the most important disease patterns in the general population in this age group in China. By means of a BoD assessment and the analysis of the specific health-related characteristics of migrant workers reported by the available key literature, this paper aims at describing the disease burdens of migrants and their specific health needs in contrast to those of the general population. The paper further discusses the potential influence of this large subpopulation on the health status of the general Chinese population.

Data provided by the recent GBD 2010 Study was used to provide a description of the disease burden in China in terms of Disability-Adjusted Life Years (DALYs) representing both population-based mortality and morbidity in one summary measure of population health. The DALYs were stratified for three main disease groups (group I representing communicable, maternal, perinatal and nutritional conditions; group II representing non-communicable diseases; group III representing injuries) and related subgroups. This was done in detail for the year 2010 but also changes over time were considered (1990 to 2010). Additionally, the key literature on migrant workers' health and related determinants was reviewed to examine how migrant workers differ from the general population in terms of health-related factors.

In total, over all age groups, about 316 million DALYs (95 per cent Uncertainty Interval [UI]: 292-342 million) were lost in China (complete Chinese population) in 2010 which results in an age-standardized DALY rate of 22,806 (95 per cent UI: 21,125-24,630) per 100,000 population. About 10.1 per cent were due to communicable, maternal neonatal and nutritional disorders (group I), 77 per cent due to non-communicable diseases (group II), and 12.9 per cent due to injuries (group III). Group I conditions mainly contributed to the disease burden in the age groups below 15 years. The DALYs attributable to non-communicable diseases rose with increasing age and injuries reached their peak in the 20-24 age group (30 per cent) with a steady decline with increasing age. Most DALYs in China in the age group 15 to 49 years were due to non-communicable diseases (11,092 DALYs per 100,000; 95 per cent UI: 9,859-12,438), followed by injuries (3,243 DALYs per 100,000; 95 per cent UI: 2,856-3,899) and infectious diseases (1,261 DALYs per 100,000; 95 per cent UI: 1,041-1,601). The DALY rates for women were lower than for

men for all three groups, especially for injuries. The DALY rates declined in the observed period between 1990 and 2010 indicating a median decline of 34.2 per cent for the age-standardized DALY rate. This decrease is the result of the rapid health transition in China, which is characterized by demographic and epidemiological changes influenced by declines in fertility, child and adult mortality, and increasing life expectancy in the past decades.

The main text provides more details about the groups of causes and single disease entities and their contribution to the disease burden, including a ranking of leading causes of DALYs for the population aged 15-49 years in China and its changes from 1990 to 2010. The disease patterns indicate that China is in a transitional phase: there is already a large non-communicable diseases burden but group I and III conditions still play an important role. Besides the BoD assessment of the general Chinese population, this paper focuses on the health and associated factors of the estimated 190 million internal rural-to-urban migrant workers. This subpopulation usually is relatively young (around the age of 15 to 39 years), with the majority being male. Due to their low socioeconomic status, migrant workers are frequently forced to live in low-standard, crowded conditions, often accompanied by poor hygiene increasing the risk of (infectious) diseases and are typically engaged in the dirtiest and most dangerous jobs. Migrants also are under higher risk of psychological problems due to work load, stress, discrimination and societal exclusion in the cities. On the other hand, migrants are more likely to engage in risky behaviour, such as having multiple sex partners or providing and utilizing commercial sex which inheres additional health risks.

Considering DALYs for the age group 15-49 and the literature review on the health of migrant workers, one conclusion is that rural-to-urban migration has a non-negligible effect on the disease burden of the general population in China. The results show that the specific demographic and behavioural characteristics deviating from the general Chinese population can lead to an increased disease burden. This is particularly true for diseases and injuries related to their low socio-economic status, the kinds of typical occupations and behaviours. However, the health risks among migrant workers and their potential effects on the general population must not lead to further stigmatization of migrants in the cities. Many factors besides migration status—such as sex, marital status, employment status, income and education—also play a role. The findings of this paper emphasize the need for improved living and working conditions as well as for migration-specific (health) education to minimize health risks for migrant workers and the general Chinese population.

Alexander Kraemer, Florian Fischer, Dietrich Plass, Paulo Pinheiro and Heiko J. Jahn are at the Department of Public Health Medicine, School of Public Health, Bielefeld University, Germany. Li Ling and Yuanyuan Sang are at the Center for Migrant Health Policy, School of Public Health, Sun Yat-sen University, Guangzhou, China. Jianli Kan is at the Office for Epidemiology, Chinese Center for Disease Control and Prevention, Beijing, China.

1. Introduction

China, as a fast developing middle-income country, faces several challenges influencing its population's health. The country is undergoing a fast epidemiological transition characterized by a decrease of communicable diseases and an increase of non-communicable, mainly chronic and not primarily fatal, diseases (Cook and Dummer 2004; Yang et al. 2008).

One of China's major challenges in terms of socio-demographic changes and population health is the large mobile population mainly represented by rural-to-urban migrant workers. After enacting of the new "open door-policy" in 1978, economic growth, particularly in the large coastal urban centres, accelerated dramatically in China. Massive urbanization processes, fuelled by strong rural-to-urban migration, accompanied this development (Chai and Chai 1997; Zhang and Song 2003). Economic development led to life style changes in the fast-growing cities in terms of nutrition and physical activities. These changes also influenced the disease patterns in China, particularly in the large cities. Non-communicable and chronic diseases increased while communicable, maternal, neonatal, and nutritional conditions declined.¹

The sheer quantity of the rural-to-urban migrant workers alone highlights the importance of this group for societal developments in China. This also concerns the influence of migrants' specific disease burdens and their health-related behaviours on the health of the Chinese population in general. Despite the obvious significance for public health in China, there is no systematic burden of disease (BoD) assessment available. The BoD approach is a comprehensive and comparative methodology, enabling the analyses of the distribution of diseases and symptoms and their temporal changes in and between countries (Pinheiro et al. 2011; WHO 2008). This methodology was used in the following part to describe the "background" disease burden in the general population in the typical age group of migrant workers (15 to 49 years). The detailed description should highlight the most important disease patterns in the general population in this age group in China. Related to this BoD assessment and the analysis of the specific health-related characteristics of migrant workers reported by the available key literature, this paper aims at describing the disease burdens of migrants and their specific health needs in contrast to the general population. Assuming that several diseases are more frequent in the migrant population, the literature review illustrates the relevance and challenges of selected diseases for this subpopulation. It further discusses the potential influence of this large subpopulation on the health status of the general Chinese population.

2. The Burden of Disease Approach

The following paragraphs focus on the level of BoD in China in terms of Disability-Adjusted Life Years (DALYs) according to the results of the Global Burden of Disease (GBD) 2010 study (Murray, Vos et al. 2012). Population health measures provide important information sources for decision makers and researchers in the field of public health. To assess the health situation of a population, it is necessary to analyse the current disease patterns and identify the disease entities that, (i) due to their frequency of occurrence and/or (ii) due to their severity, are the main drivers influencing population health. Facing the emerging (or already passed) epidemiologic transition in most countries of the world, with decreasing fatal effects of for example, infectious

¹ Mou et al. 2013; Cui et al. 2010; He et al. 1991; Yang et al. 2013.

conditions, it is important to include the effects of long-lasting, primarily non-fatal, chronic conditions into the assessments of population health. The changing disease patterns posed the need for indicators that were able to comprehensively capture the health status of populations.

Tackling this, the World Health Organization (WHO) in cooperation with the World Bank and Harvard School of Public Health introduced the GBD study. The main goal of this study was to generate a comprehensive, internationally consistent and thus comparable set of estimates of global mortality and morbidity. With the first results for 1990, the GBD study introduced estimates for 107 disease and injury conditions for WHO regions and the World Bank's economic regions (Murray and Lopez 1996). The diseases and injuries were arranged in a practical and instrumental way using a tree-structured disease classification system ordered by several levels of disaggregation. At first level of disaggregation the conditions are split up by group I, II, and III entities. Group I represents communicable, maternal, perinatal and nutritional conditions, group II represents non-communicable diseases, and group III represents injuries. All categories of the GBD classification system are directly and mutually exclusively related to the International Classification of Diseases (ICD).

The GBD study also introduced a new indicator to measure the disease burden in a population. DALYs were used to estimate the global disease burden (Murray and Lopez 1996; Murray et al. 2002; Lopez et al. 2006). The DALY as a Summary Measure of Population Health (SMPH) allows combining the impact of mortality and effects of non-fatal conditions on health and presenting the health status in a single measurement unit (Murray 1994). DALY is a composite health measure consisting of two single complementary measures: the Years of Life Lost due to Premature Death (YLL), measuring the impact of premature mortality, and the Years of Life Lived with Disability (YLD), measuring the impact of non-fatal conditions on health. As a normative health gap measure the DALY quantifies the health losses (in years) based on the difference between the observed and ideally expected population based health goal (Murray 1994). The calculation of DALYs requires data on several epidemiologic indicators.² To calculate the YLLs, cause of death statistics (for example, from vital registration systems) stratified by age and sex are needed. There are two different approaches to estimate YLDs—the incidence and prevalence approach. For the incidence approach information on the number of new cases in a certain time (incidence), duration of the disabling condition, and a disability weight indicating the severity of a condition is necessary. The prevalence approach as used currently in the GBD 2010 study combines the currently prevalent cases (point prevalence) with a disability weight (Murray, Vos et al. 2012). The DALY is then calculated as the simple sum of the YLLs and YLDs.

Disability weights

To allow comparisons of morbidities due to diseases with different characteristics and to be able to compare health losses due to mortality and morbidity, it was necessary to introduce a weighting factor to quantify the impact of a disease on health (disability).

In the GBD study so called disability weights were introduced, presenting the severity of a condition on a scale from zero to one, with zero indicating a health state of full health and one considered to be a health state equal to death. The disability weights, as derived in the first GBD study, were consequently used in several updates of this global

² Mathers et al. 2001; Murray 1994; Murray and Lopez 1996.

assessment and also in numerous national burden of disease studies. Alternative country- and disease-specific disability weights sets are increasingly available and provide a more sensitive quantification of the impact of diseases on health, and also incorporate preferences of the general population.³ Facing some of the important points of criticism raised against the disability weights for the first GBD study, a new set of disability weights was derived for the new GBD 2010 study. Here, disabilities were defined as any departure from the state of optimal health and should only consider health loss and by no means introduce any welfare trade-offs (Salomon et al. 2012a). This time preferences of the general population were assessed, instead of relying on the preferences elicited by health professionals (Salomon et al. 2012a). Two complementary surveys were conducted, with a multicountry household survey in Bangladesh, Indonesia, Peru, Tanzania and the United States, and a worldwide web-based survey (Salomon et al. 2012a). Pairwise Comparisons (PWC) were used as the main method to capture the preferences of the general public (Salomon et al. 2012a).

Major methodological adjustments in the GBD 2010 study

In addition to the renewal of the disability weights there are several other important adjustments in the GBD 2010 study, which lead to an increased quality and usability of the GBD estimates. One important point relates to the health goal for the calculation of YLLs. In the new GBD study, a new standard reference life expectancy, based on the lowest globally observed mortality rates, was introduced with a life expectancy at birth of 86 years both for men and women (Murray et al. 2012b).

A highly criticized choice in the previous estimations was the use of time-discounting and age-weighting. Both adjustments strongly focus on economic and welfare aspects and were used to value the lost years (i) in different age groups and (ii) in the future (time discounting) differently. It was argued that human life should not in principle be considered an economic good, and after intensive debates it was decided not to weight years. Neither concepts were considered for the estimation of the burden of disease in GBD 2010 (Murray et al. 2012b).

To ensure a comprehensive assessment of the epidemiology of all health states included in the GBD 2010 study, extensive reviews of available data sources were conducted. In addition to freely available data sets provided by institutions such as WHO or the World Bank, data from published and unpublished studies were gathered, pooled, adjusted and used for several modelling purposes. All the data were combined and analysed using the newly developed Bayesian meta-regression tool DisMod-MR (Murray et al. 2012a).

A major advantage of the new GBD 2010 study is that in addition to the estimates for the year 2010, the developed methodology was also used to estimate the disease burden from 1990 to 2010. These estimates provide the opportunity to analyse the trends of burden of disease for two decades and identify both the achievements and also the unfinished agendas from the population health perspective.

3. Burden of Disease Patterns in China

To understand a subpopulation's impact on a country's burden of disease profile, it is important to first understand the general population's disease patterns and the current stage of the country in the epidemiological transition. For instance, based on findings

³ Stouthard et al. 2000; Lai et al. 2009; Haagsma et al. 2008.

from literature, China's highly mobile migrant workers seem to suffer from a higher risk of contracting infectious diseases as compared to the general population. This means that even if a country follows the typical development of the epidemiological transition with an increase of non-communicable disease burden and non-fatal health outcomes in the general population, the burden of infectious diseases may not decrease (as much as it would be usually expected) due to the impact of migration-induced spread of infectious agents. This could lead to challenges for the health care system because it has to be prepared for both an increasing trend in the occurrence of non-fatal chronic health outcomes and a constant high level of infectious diseases.

It can be assumed that in China, a country with large differences in the development between rural and urban areas, especially the progress of epidemiologic and economic transition shows high regional variations, with more developed (urban) regions showing disease patterns comparable to high-income countries and less developed (rural) regions still affected by disease patterns mainly found in low-income societies. This is highly important when considering the health impact of rural-to-urban migration processes with rural-to-urban migrant workers serving as a bridging population for infectious disease transmission. Unfortunately, up to now there are no specific burden of disease assessments available for the subgroup of Chinese internal migrants, because this is a highly mobile and hard to reach subgroup.

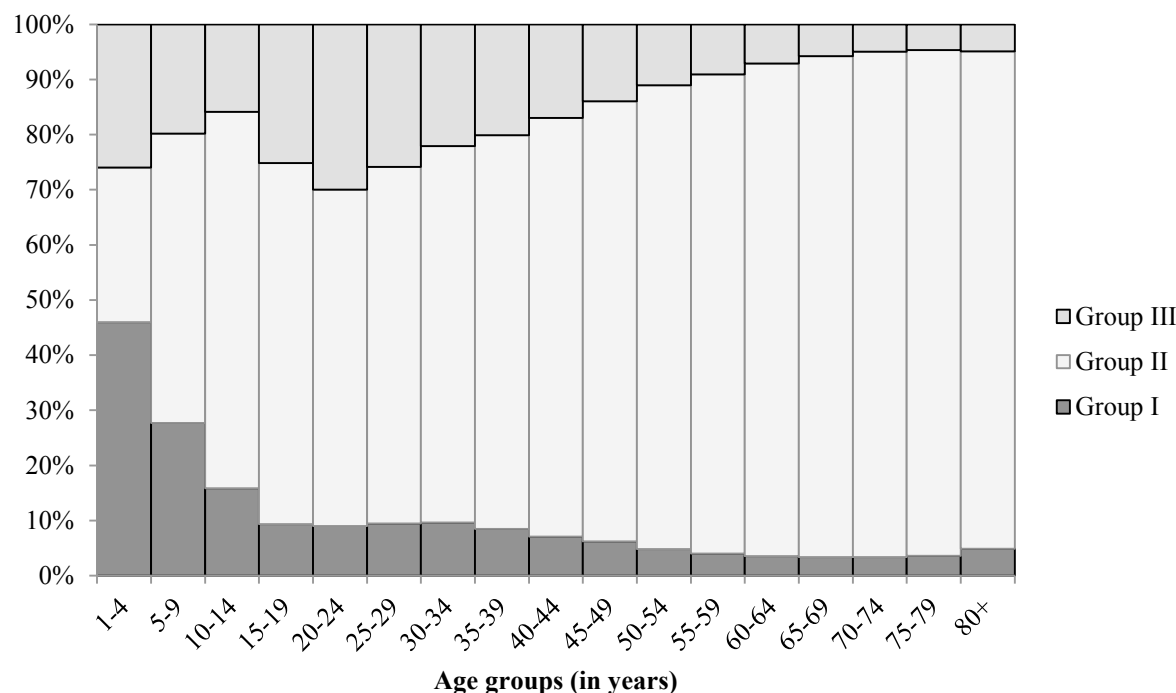
After a broader overview about the disease burden in China, first for all age groups and in the following for the age group of 15 to 49 years, we additionally provide a more detailed picture of most important conditions differentiated by the three main disease groups in that age group. These conditions were selected according to the ranking by the GBD 2010 study.

Overall distribution of diseases

In total, over all age groups, about 316 million DALYs (95 per cent Uncertainty Interval [UI]: 292-342 million) were lost in China (complete Chinese population) in 2010 which results in an age-standardized DALY rate of 22,806 (95 per cent UI: 21,125-24,630) per 100,000 population. About 10.1 per cent are due to communicable, maternal neonatal and nutritional disorders (group I), 77 per cent due to non-communicable diseases (group II), and 12.9 per cent due to injuries (group III).

The proportion of DALYs attributed to the three main disease groups stratified by age groups is shown in figure 1. Group I conditions mainly contribute to the burden of disease in the age groups below 15 years. The DALYs attributable to non-communicable diseases rise with increasing age. Injuries reach their peak in the 20-24 age group (30 per cent) and a steady decline can be observed with increasing age.

Figure 1: DALYs by disease groups and age groups, China, 2010



Source: IHME 2013.

The total crude DALY rate for the Chinese population aged 15-49 years in the sum of all three disease groups is 15,598 DALYs per 100,000 (95 per cent UI: 14,026-17,193). The rate for this age group is lower as compared to the region of Southeast Asia, East Asia and Oceania (18,159 DALYs per 100,000; 95 per cent UI: 16,533-19,872). Most DALYs in China and the selected age group are currently due to non-communicable diseases (11,092 DALYs per 100,000; 95 per cent UI: 9,859-12,438), followed by injuries (3,243 DALYs per 100,000; 95 per cent UI: 2,856-3,899) and infectious diseases (1,261 DALYs per 100,000; 95 per cent UI: 1,041-1,601). The DALY rates for women are lower as compared to men for all disease groups, especially for injuries (table 1).

Table 1: DALYs per 100,000 in China (95 per cent UI), 15-49 age group, 2010

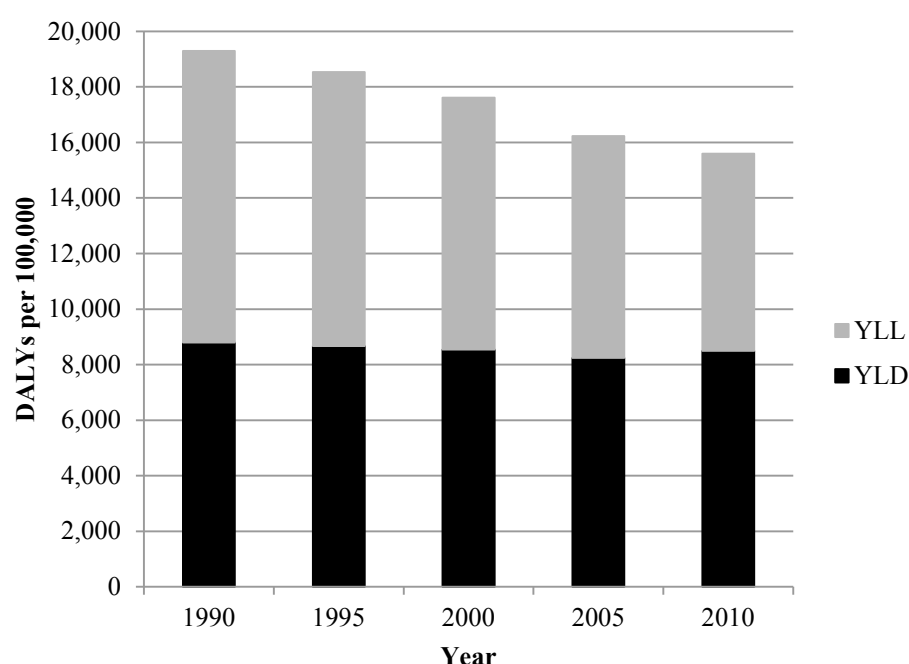
	Total	Male	Female
All causes	15,598 (14,026-17,193)	17,833 (16,122-19,708)	13,201 (11,681-14,912)
Group I	1,261 (1,041-1,601)	1,405 (1,153-1,924)	1,107 (871-1,500)
Group II	11,092 (9,859-12,438)	11,676 (10,406-13,011)	10,467 (9,200-11,904)
Group III	3,243 (2,856-3,899)	4,751 (4,087-5,763)	1,627 (1,364-2,115)

Source: IHME 2013.

The DALY rates declined in the observed period between 1990 (34,627 age-standardized DALYs per 100,000; 95 per cent UI: 32,546-36,964) and 2010 (22,805

age-standardized DALYs per 100,000; 95 per cent UI: 21,125-24,630), indicating a median decline of 34.2 per cent for age-standardized DALY rate. This decrease is the result of the rapid health transition in China, which is characterized by demographic and epidemiological changes in the past decades. One can observe declines in fertility, child mortality (decline of under-5 mortality rates between 1990 and 2010 of 70 per cent [95 per cent UI: 61.3-77.9 per cent]) as well as adult mortality. Additionally, an increase in life expectancy took place with a 6.4 years increase at birth for both sexes combined (from 69.3 years to 75.7 years). This transition was already described and illustrated with results from the GBD 2010 study by Yang et al. (2013). The decline in DALY rates is mainly the result of decreasing rates of YLLs. The YLDs remained almost constant. Therefore, the contribution of years lived with disability to the overall burden increased over time (figure 2).

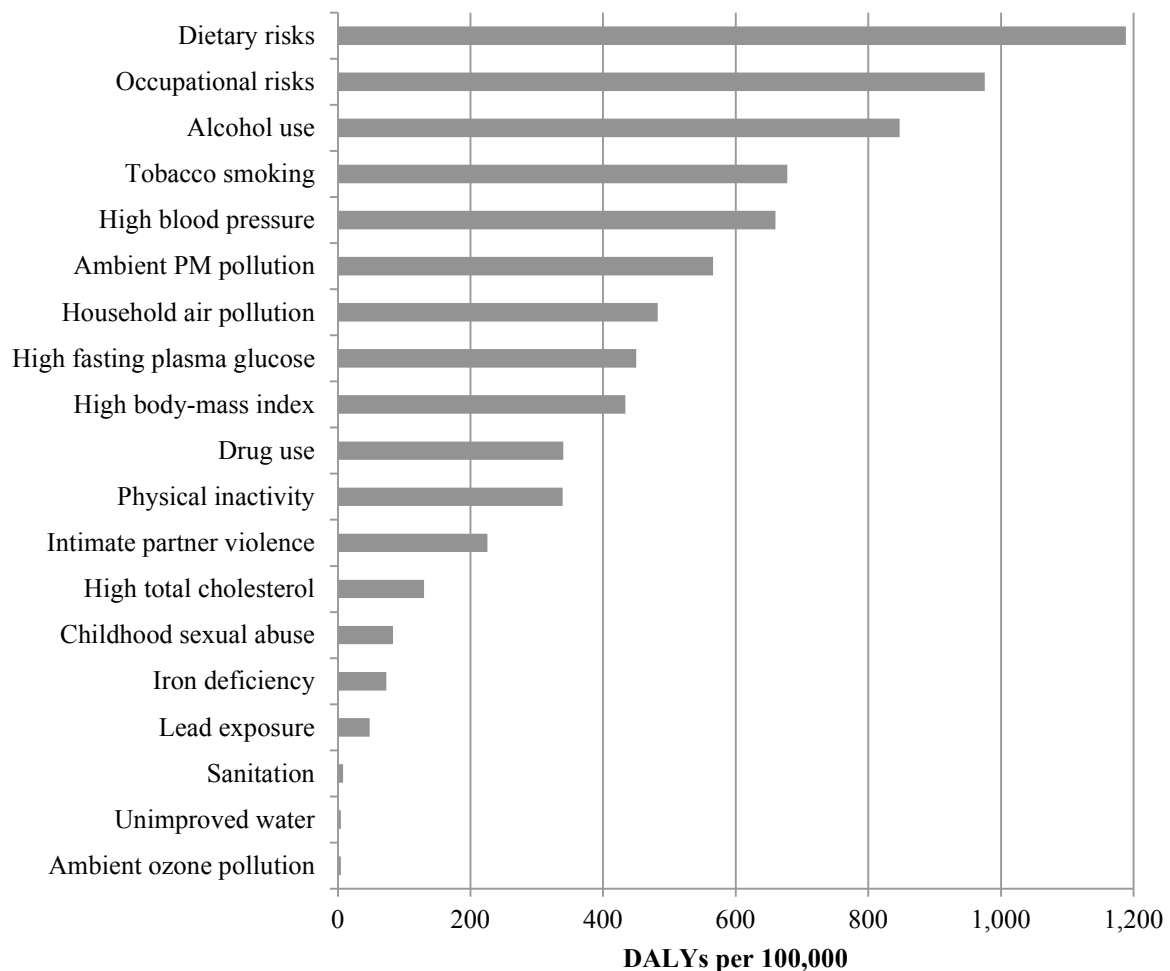
Fig. 2: Contribution of YLDs and YLLs to burden of disease in China, 15-49 age group, 1990-2010



Source: IHME 2013.

Figure 3 shows the DALYs per 100,000 attributable to major risk factors in China in the 15-49 age group in 2010. The ranking of risk factors particularly highlights the importance of dietary risks, which comprise 14 different dietary components (Lim et al. 2012), as well as occupational risk factors (occupational exposure to carcinogens, asthmagens, particulate matter, gases, fumes, noise and occupational risk factors for injuries and low back pain) (Lim et al. 2012) for the burden of disease in this age group. Further risk factors, such as behavioural factors (for example, alcohol use, smoking and drug use), unhealthy socioeconomic conditions and adverse environmental exposures (ambient air pollution, household air pollution and exposure to lead and radon), may elevate the spread of and vulnerability to different health outcomes. This is especially true for cardiovascular and circulatory diseases, musculoskeletal disorders, neoplasms and different forms of injuries (figure 3).

Figure 3: Risk factors for DALYs in China, 15-49 age group, 2010



Source: IHME 2013.

The main groups of causes and single disease entities and their contribution to the disease burden will be described in more detail in the following sections.

Distribution of group I conditions: Communicable diseases

Despite the decreasing trend of group I conditions, these disease entities still play an important role for the health of the Chinese population. Sexually transmitted infections (STI), especially HIV/AIDS are an important driver of the disease burden among the Chinese population. STIs, excluding HIV/AIDS, account for 3.5 per cent of the group I disease burden in China. However, HIV/AIDS alone accounts for 15.6 per cent of the infectious disease burden in China with 15.6 per cent. The proportion of DALYs caused by HIV/AIDS in the 15-49 age group is much higher for men (20 per cent) than for women (9.5 per cent). The relevance of tuberculosis (TB) decreased in the past decades: in 1990 TB accounted for 18.8 per cent of group I disease burden in the 15-49 age group, in 2010 it accounted for 8.5 per cent, again with higher proportions for men (10.6 per cent) than for women (5.6 per cent).

Nutritional deficiencies are mainly found in the female population (16.8 per cent of group I disease burden) and contribute only to a small amount to the DALYs of group I

diseases for male population (2.7 per cent). Further important infectious diseases in this age group are food-borne trematodiasis (7.0 per cent), hepatitis A, B, C and E (including liver cancer and cirrhosis of the liver secondary to hepatitis B and C) (6.7 per cent) and lower respiratory infections (5.8 per cent).

Distribution of group II conditions: Non-communicable diseases

Due to the epidemiologic transition, group II conditions continuously account for rising disease burden in China. Non-communicable diseases accounted for nearly three-quarter of disease burden in 2010 for the 15-49 age group. Most of these diseases are chronic and non-fatal and thus have an adverse impact on the health status of an individual over a long period of time. Group II diseases comprise a wide range of different disease entities (for example, malignant neoplasms, cardiovascular diseases and neurological disorders).

The leading causes of group II disease burden in the 15-49 age group in China are mental and behavioural disorders (2,720 DALYs per 100,000 [95 per cent UI: 2,206-3,264]; 24.5 per cent of group II DALYs) and musculoskeletal disorders (2,250 DALYs per 100,000 [95 per cent UI: 1,690-2,867]; 20.3 per cent of group II DALYs). This is emphasized by the high relevance of single disease entities such as low back pain (1,082 DALYs per 100,000 [95 per cent UI: 731-1,481]; 9.8 per cent of group II DALYs) and neck pain (546 DALYs per 100,000 [95 per cent UI: 379-747]; 4.9 per cent of group II DALYs). Also major depressive disorder is a highly relevant disease, because 7 per cent of group II DALYs (779 DALYs per 100,000 [95 per cent UI: 543-1,043]) in this age group can be attributed to this condition. Additionally, alcohol use disorders (351 DALYs per 100,000 [95 per cent UI: 224-519]; 3.2 per cent of group II DALYs), schizophrenia (305 DALYs [95 per cent UI: 200-415]; 2.7 per cent of group II DALYs), bipolar affective disorders (297 DALYs per 100,000 [95 per cent UI: 183-435]; 2.7 per cent of group II DALYs), drug use disorders (286 DALYs per 100,000 [95 per cent UI: 183-429]; 2.6 per cent of group II DALYs) and anxiety disorders (264 DALYs per 100,000 [95 per cent UI: 174-379]; 2.4 per cent of group II DALYs) can be identified as important diseases belonging to the cause group of mental and behavioural disorders.

All neoplasms lead to 1,893 DALYs per 100,000 (95 per cent UI: 1,720-2,187; 17.1 per cent of group II DALYs) in the 15-49 age group, with higher rates for men (2,235 DALYs per 100,000 [95 per cent UI: 1,976-2,679]; 19.1 per cent of group II DALYs) than for women (1,526 DALYs per 100,000 [95 per cent UI: 1,324-1,796]; 14.6 per cent of group II DALYs). The main entities of neoplasms are liver cancer (456 DALYs per 100,000 [95 per cent UI: 361-668]; 4.1 per cent of group II DALYs), trachea, bronchus, and lung cancer (248 DALYs per 100,000 [95 per cent UI: 174-307]; 2.2 per cent of group II DALYs) and stomach cancer (166 DALYs per 100,000 [95 per cent UI: 124-248]; 1.5 per cent of group II DALYs).

Cardiovascular and circulatory diseases also have a considerable impact on the burden of disease. In the 15-49 age group, cerebrovascular diseases account for 4.6 per cent of group II DALYs (505 DALYs per 100,000 [95 per cent UI: 371-589]) and ischemic heart diseases for 3.8 per cent of group II DALYs (425 DALYs per 100,000 [95 per cent UI: 360-476]). Furthermore, chronic obstructive pulmonary diseases (COPD) are responsible for 295 DALYs per 100,000 in the 15-49 age group (95 per cent UI: 198-425; 2.7 per cent of group II DALYs).

Distribution of group III conditions: Injuries

As already mentioned, the burden of disease caused by injuries is almost three times higher for men (4,751 DALYs per 100,000 [95 per cent UI: 4,087-5,763]; 26.6 per cent of total DALYs) than for women (1,627 DALYs per 100,000 [95 per cent UI: 1,364-2,115]; 12.3 per cent of total DALYs). The group III conditions are subdivided into four major groups of causes: (i) transport injuries, (ii) unintentional injuries, (iii) intentional injuries and (iv) injuries caused by war and disaster. The fourth cause group did not account for any DALYs in China in 2010.

The most important group is transport injuries, accounting for almost half of total group III DALYs in China in the 15-49 age group (1,463 DALYs per 100,000 [95 per cent UI: 1,093-1,943]; 45.1 per cent of group III DALYs). For men the DALYs caused by transport injuries are much higher (2,223 DALYs per 100,000 [95 per cent UI: 1,548-3,075]; 46.8 per cent of group III DALYs) than for women (648 DALYs per 100,000 [95 per cent UI: 450-895]; 39.8 per cent of group III DALYs).

All unintentional injuries such as falls, drowning, fire and poisonings cause 35.0 per cent of group III DALYs (1,135 DALYs per 100,000 [95 per cent UI: 972-1,284]). Self-harm accounted for 15.5 per cent of group III DALYs (501 DALYs per 100,000 [95 per cent UI: 382-834]) and 4.4 per cent by interpersonal violence as factors of intentional injuries (143 DALYs per 100,000 [95 per cent UI: 110-218]). Although the proportion of intentional injuries is much lower than for unintentional injuries, the disease group of self-inflicted injuries in particular contributed substantially to the overall DALYs. The impact of self-inflicted injuries might even be higher, because there are several limitations to the assessment of China's suicide mortality rate due to missing data or misclassification of suicides as other accidents (Wang et al. 2003).

Ranking of leading causes of DALYs

Figure 4 shows a ranking of leading causes of DALYs for the population aged 15-49 years in China and its changes from 1990 to 2010. The ranking of DALYs illustrates the impact of non-communicable diseases and injuries for both sexes. Only group II and group III entities are listed in the ten leading causes of DALYs for the 15-49 age group in 2010. In particular, entities associated with the musculoskeletal system are included in the ranking in 2010 (low back pain: rank 2; neck pain: rank 4; other musculoskeletal disorders: rank 8). Furthermore, the burden attributable to stroke and ischemic heart diseases has increased in this age group.

None of group I conditions can be found in the top ten ranking, which is a sign of the advancing epidemiologic transition in China. Tuberculosis is the only disease entity from group I diseases which can be found in the ranking in 1990 (rank 9), but its impact has declined since it has reached rank 34 in 2010. Road injuries are ranked first, and other kinds of injuries such as self-harm (rank 6) and falls (rank 10) also show a high relevance for the burden of disease in the 15-49 age group.

Figure 4: Ranking of DALYs, China, 15-49 age group, 1990 and 2010

Rank	Cause	DALYs 1990 (95% UI)	Rank	DALYs 2010 (95% UI)	Change % (95% UI)
1 (1-5)	Self-harm	7,087,210 (4,083,170-8,861,480)	1 (1-2)	10,505,100 (7,922,920-13,914,500)	58 (-7 to 141)
2 (1-4)	Road injury	7,039,120 (5,307,140-9,974,770)	2 (1-3)	8,159,000 (5,515,950-11,166,400)	30 (15 to 45)
3 (1-4)	Low back pain	6,289,990 (4,226,830-8,730,820)	3 (2-5)	5,877,600 (4,100,030-7,859,100)	13 (-16 to 49)
4 (2-6)	Major depressive disorder	5,220,180 (3,590,270-6,952,390)	4 (3-10)	4,122,220 (2,863,620-5,631,680)	29 (18 to 41)
5 (4-9)	COPD	3,675,620 (2,986,760-4,536,220)	5 (4-10)	3,811,320 (2,804,070-4,437,580)	34 (-34 to 57)
6 (5-12)	Liver cancer	3,368,990 (2,558,370-4,102,160)	6 (3-11)	3,779,010 (2,886,860-6,289,910)	-56 (-65 to 20)
7 (4-11)	Stroke	3,314,580 (2,735,500-4,631,620)	7 (4-12)	3,440,560 (2,722,970-5,036,640)	-1 (-23 to 61)
8 (5-16)	Neck pain	3,192,790 (2,215,090-4,385,570)	8 (5-12)	3,248,310 (2,682,880-3,713,380)	29 (16 to 45)
9 (6-12)	Tuberculosis	3,021,030 (2,584,070-3,524,760)	9 (6-11)	3,204,340 (2,717,350-3,590,080)	25 (-3 to 41)
10 (8-16)	Ischemic heart disease	2,605,070 (2,329,880-3,142,060)	10 (6-14)	2,877,760 (2,226,580-3,552,750)	18 (-14 to 42)
12 (9-18)	Other musculo-skeletal disorders	2,513,170 (2,047,600-2,898,840)	14 (9-21)	2,224,340 (1,499,840-3,202,790)	-40 (-55 to -22)
14 (8-18)	Falls	2,482,300 (1,995,690-3,212,390)	34 (29-43)	810,142 (623,602-1,026,060)	-73 (-79 to -67)

Notes: group I conditions in dark grey, group II conditions in light grey and group III conditions in grey. Source: IHME 2013.

The disease patterns indicate that China is in a transitional phase: there is already a large non-communicable diseases burden but group I and III conditions still play an important role. Group I conditions contribute to a comparably low amount of DALYs. The following section will focus more on the health of migrant workers and associated living and working conditions, and later in this paper the migrants' role in influencing the epidemiological patterns of the general population will be elucidated.

4. Rural-to-Urban Migrant Workers in Urban China and their Health-Related Characteristics

According to the official statistics, there are about 230 million internal migrants in China accounting for about 17 per cent of the Chinese population (National Bureau of Statistics in China 2012) and this amount is expected to rise up to 400 million people within the next 20 years (China Development Report 2010). In this paper, we focus on internal rural-to-urban migrants (also referred to as migrant or peasant workers or floating population (Li 2007) that account for about 80 per cent of the total migrant population in China (Ling et al. 2011)). Officially, the China National Bureau of Statistics defines rural-to-urban migrant workers or floating population as individuals “who move from rural areas to urban areas for jobs and better lives without obtaining permanent urban residency” (Li et al. 2006: 14). In contrast, migration with local urban residency (not discussed in this paper), also called “hukou migration” (Chan 2008:4), is considered as permanent migration that is “official, orderly, and ‘within state plan’” (Fan 2002:108).

Although Chinese internal migrants are heterogeneous population, the rural-to-urban migrant workers in particular “are a special group in urban cities in China” (Wong et al.

2007:33) sharing common characteristics. Usually, they are relatively young, around the age of 15 to 39 years (Zheng and Lian 2006) and despite an increase of young unmarried migrant women, the majority of migrants is still male. According to the China 2000 census, 75.6 per cent of the migrant workers were married (Wong et al. 2007) and better educated as compared to rural settlers. Further, migrants strongly suffer from low-income employment (Huang and Pieke 2003).

Internal migration in China is strongly linked to the Chinese household registration (*hukou*) system and it needs to be taken into account when analysing internal migration processes and health in China (Chan 2008). Not holding a local urban hukou means having only restricted access to state-provided services like health care services, education and employment (Huang and Pieke 2003; Ling et al. 2011). Special migrant health insurance schemes do exist in cities (Liang 2009), and migrant workers might also be insured by their employer. However, not all employers provide these insurances and employees therefore often have to pay out of pocket in case of health problems. Despite several efforts to improve this situation, the socioeconomically underprivileged rural-to-urban migrant workers are still disadvantaged in the urban destinations as compared to the urban residents holding a local urban hukou (Chan and Buckingham 2008).

Due to their low socioeconomic status, migrant workers are frequently forced to live in low-standard, crowded conditions often accompanied by poor hygiene increasing the risk of (infectious) diseases (Fan 2006; Zheng and Lian 2006). Additionally, they are typically engaged in the dirtiest and most dangerous jobs (Ling et al. 2011) and work longer hours as compared to the local urban residents (Wong et al. 2007). Migrants also risk psychological problems brought on by stress, discrimination or exclusion in the cities because many urban residents do not consider migrants as being part of urban society.⁴

Migrants commonly lack health education, for example, about sexual and reproductive health and they often do not have information about health care facilities in their neighbourhoods (Amnesty International 2007). Furthermore, they are more likely to engage in risky behaviour, such as having multiple sex partners or providing and utilizing commercial sex (Zhu et al. 2005), increasing their risk of severe health consequences.

Excursus: Internal migration and its effects on the sending areas

Besides the effects in the urban areas, migration also has strong influences on the sending areas. The migrant workers usually send money back to their relatives left behind in the rural areas, and this huge inflow of remittances has a positive effect on rural development (Huang and Zhan 2008).

However, migration is a highly selective process: primarily the young and better educated people, mostly men, are leaving their hometowns (Wong et al. 2007). This can strongly influence the age and sex structure in the sending area with an imbalanced distribution with more females, children and older people remaining in the rural areas.

⁴ Wong et al. 2007; Huang and Pieke 2003; Wong et al. 2008.

Health care services in remote areas may also be affected by rural-to-urban migration. The young and better educated people leave their hometowns in order to receive further education or better jobs in the large cities and may not return to work in the rural health care service. Additionally, already trained health personnel may also migrate, leaving a gap in the remote health care service provision.

5. Health Risks and Disease Patterns of the Migrant Population in China

The importance of the Chinese migrant populations and their disease patterns becomes obvious when taking into account the large number of migrants. As mentioned before, there is no burden of disease assessment for this subpopulation available yet. Therefore, the next parts of the paper focus on key literature identifying the main aspects and influencing factors that have an impact on the health status of the Chinese migrant population, thus elucidating the role of migration for potential increases and decreases of the burden of disease in China. To describe the burden of disease of Chinese migrants, the following section provides some examples of selected diseases stratified according to the GBD disease classification and the risk factor smoking as an important contributor to non-communicable diseases.

Migrants and group I conditions

Several studies highlight the impact of migration on the health status and health behaviour of migrant subpopulations in China. In general, migration creates a greater mix of people, living under very dense circumstances and thus providing an ideal environment for transmission of communicable diseases. Furthermore, travel activities to areas with different endemic infectious diseases offer a vehicle for the spread of diseases (Yang et al. 2007).

For the description of the impact of migration on group I diseases, tuberculosis, sexually transmitted infections and HIV/AIDS were chosen for case studies.

Tuberculosis

The proportion of Chinese TB patients with a migratory background has increased since the TB registration system was extended to include migrants in 1993 (Zhang et al. 2006). A study in Beijing showed that since the introduction of directly observed therapy (DOT) in 1978, the prevalence rates of smear positive cases decreased from 127 per 100,000 (in 1978) to 16 per 100,000 population in 1990 (Zhang et al. 2000). The DOT strategy in China was further intensified in 1991 with a 10-year project—the Endemic Disease Project—that included 12 Chinese provinces. During this project, DOT coverage rates of more than 90 per cent of the target population were reached. Overall cure rates of 95 and 90 per cent, for new and previously treated cases, respectively, were observed (Xianyi et al. 2002). Nevertheless, the prevalence and the rate of treatment vary between the resident and migrant populations. Several studies have emphasized the relation between migration and prevalence of TB. According to Dye et al. (2002), migration itself increases immigrants' vulnerability to TB. A spatial analysis of TB cases in migrants in comparison to permanent residents in Beijing for the time period 2000–2006 using data from the Beijing Institute for Tuberculosis Control, showed that migrants from any region in China had a significantly higher risk of being infected by TB, compared to the urban permanent residents (Jia et al. 2008). One of the reasons for this higher risk could be seen in the limited knowledge about TB among migrants (Wei et al. 2009).

Since the liberalization of population movement in China, the proportion of TB cases among migrants in Beijing rose from 10.5 to 37.5 per cent. Rates of cases treated under DOT were higher in permanent residents (84 per cent) as compared to the migrants (56.9 per cent). The percentage of TB cases cured was 90.6 per cent among permanent residents but only 37 per cent for internal migrants. It was stated that providing DOT to a strongly mobile group and sustaining it is hardly manageable (Zhang et al. 2006).

The impact of migration on the spread of (drug-resistant) TB was highlighted by several studies. Zhang et al. (2006) claimed that internal rural-to-urban migration appeared to be a major factor for the spread of drug-resistant TB. In a study by Shen et al. (2009), dealing with drug-resistant TB in Shanghai during 2000-2006, the authors hypothesized that the increasing internal migration might promote transmission of drug-resistant TB in cities. The results of a facility-based epidemiological study of all TB patients in two districts each of Shanghai and Ningbo showed that the rural-to-urban migrants had a lower TB drug-resistance rate compared to the residents, although a relatively high level of drug-resistance was found in rural areas. Therefore, Wang et al. (2011) concluded that migrants did not a priori contribute to TB drug-resistance rates in urban areas, but that they may subsequently play a role for transmission of drug-resistant TB in cities due to their mobility and lower adherence to TB treatment.

These contradictory results of high TB prevalence and lower prevalence of drug-resistant TB in migrants may be explained by the migrants' restricted access to the health care system. Considering their hukou status and—maybe even more important—their low socioeconomic status, they are less likely to seek medical treatment, possibly reducing the risk of TB drug-resistance (Wang et al. 2011). However, the overall higher prevalence of TB among migrants in combination with a decreased perception of TB and high mobility emphasizes the importance of TB among rural-to-urban migrants in China (Wang et al. 2007).

Sexually transmitted infections

Migration itself is not a factor influencing the spread of STIs like chlamydia, gonorrhoea, hepatitis B, genital herpes, human papilloma virus (HPV) infection or syphilis. Instead, an increased risk of acquiring or transmitting STIs is associated with risky behaviours (Yang et al. 2007) that could be different among internal migrant populations as compared to non-migrants. According to several studies, rural-to-urban migrants in China seem to be more likely to engage in risk-taking behaviour that carry a risk of contracting STIs after moving to urban areas. It was shown that male migrants are more likely to have multiple sexual partners and/or seek commercial sex (Biao 2003), whereas female migrants are more likely to offer commercial sex in case they face financial problems in the urban destinations as compared to the rural or urban residents.⁵ Other studies indicated that 70-95 per cent of the female sex workers in China were reported to be migrants from rural areas.⁶ Another aspect that may increase the risk-taking behaviour is that migrant workers perceive less social control since their former social network is usually disrupted or impaired, and the anonymity in the cities facilitates breaking social norms like utilizing commercial sex workers or drug use (Yang et al. 2007).

⁵ Zheng et al. 2000; Rogers et al. 2002; van den Hoek et al. 2001; Qian et al. 2005; Zhu et al. 2005; Yang 2004.

⁶ Yang, Li, Stanton, Liu et al. 2005; Zhou et al. 2010; Lau et al. 2002; Liao et al 2003; Liao et al. 2006; Yang, Li, Stanton, Fang et al. 2005; Hong and Li 2008.

A recent analysis of survey data comparing the health-risk behaviours of migrants to rural and urban residents in China using age-standardized rates and multivariable logistic regression analysis confirmed that the migrant population was significantly more likely to use illegal drugs (1.1 vs. 0.5 per cent), to share needles while injecting drugs (1.2 vs. 0.3 per cent), to engage in casual sex (0.5 vs. 0.1 per cent), and to have multiple sex partners (11.2 vs. 2.2 per cent) (Chen et al. 2009). Similar results were found in a cross-sectional study conducted among 605 marriage licence applicants in China. The results showed significantly higher proportions of people having premarital sex (62 vs. 52 per cent) and multiple sexual partners (12 vs. 6 per cent) in the group of migrants compared to non-migrants. Among those who had multiple sexual partners, only 9 per cent of migrants and even fewer non-migrants (8 per cent) reported that they always or often used condoms with sexual partners other than their spouse. Therefore, overall migrants are at greater risk of acquiring and transmitting HIV than the non-migrant population (Hu et al. 2006). In comparison migrants scored significantly higher on the measure of lax social control than non-migrants (Yang et al. 2007).

A study based on a nationally representative sample from the Chinese Health and Family Life Survey—conducted in 1999–2000—showed that the prevalence of *Chlamydia trachomatis* infection among migrant women was three times higher than the rate among rural non-migrant women (Wang et al. 2010). Another study in a rural Chinese county (Guangxi Province) on a sample of 454 female sex workers showed that the group of sex workers who were not from Guangxi had significantly higher rates of pregnancies (83 vs. 53 per cent, $p < 0.001$) and reported not using condoms frequently (56 vs. 69 per cent, $p < 0.05$) (Fang et al. 2007). This is another indicator for a higher risk for STIs in migrants. For these reasons the internal rural-to-urban migration was declared to be a major factor in the spread of STIs (Wang et al. 2010).

However, the focus on migration and risky behaviour responsible for the spread of STIs is too narrow. There are many additional factors that may be even more important than migration. Wang et al. (2010), for instance, emphasized socioeconomic and socio-demographic characteristics such as gender, education and income as being potentially associated with HIV acquisition and transmission risk behaviours. This was also confirmed by a study from Mantell et al. (2011) of 724 employees of an entertainment centre in Kunshan, Jiangsu Province (eastern China). The authors pointed out that the risky sexual behaviour might be related to numerous factors besides migration, such as sex, marital status, employment status, income or education. They stated that broad generalizations about the risky behaviour of migrant populations could lead to their increased stigmatization. Nevertheless, many factors were closely related to the migration process and the living conditions of rural-to-urban migrants (Mantell et al. 2011).

Human immunodeficiency virus (HIV)

In 2009, approximately 740,000 Chinese were estimated to be HIV positive, representing about 0.057 per cent of the total population (UNGASS 2010). Studies showed inconclusive results concerning the HIV prevalence among different migrant groups with large variations between 0 to 2.59 per cent.⁷ In the past, the majority (80 per cent) of HIV-infected persons were rural residents (Wu et al. 2004). However, recent studies showed that epidemiological patterns in China have substantially changed, and HIV is increasingly an infection of urban areas and does not only affect

⁷ Fu et al. 2005; Dai et al 2007; Hu et al. 2003; Lu et al. 2006.

high-risk behaviour groups such as injecting drug users as in the beginning of the epidemic. Instead, in recent years the main transmission mode of HIV was heterosexual activity (Jia et al. 2011; UNGASS 2010). Studies on internal migration in China and HIV showed similar results with respect to migrants' risk patterns of HIV infection compared to other STIs. This seems reasonable because many risk factors and transmission routes are similar.

One major additional risk factor, however, is parenteral transmission caused by needle sharing among intravenous drug users. A recent analysis comparing health-risk behaviours of migrants with the ones of non-migrant rural and urban residents in China confirmed that the migrant population was significantly more likely to use illegal drugs (1.1 vs. 0.5 per cent) and to share needles while injecting drugs (1.2 vs. 0.3 per cent) (Chen et al. 2009). Injecting drug use was the main transmission mode in China until 2006 (MOH China and UNAIDS 2007) and is still of major importance in terms of HIV spread in China. Besides the high risks for HIV transmission due to unsafe injection practices, injecting drug users are likely to engage in high risk sexual behaviour, often associated with commercial sex work. This creates a strongly increased risk profile in this group (Zhu et al. 2005) and establishes a direct link to the general population and particularly to migrant workers, who are known to more frequently utilize commercial sex than non-migrants (Yang 2004).

Besides the migrants' risk behaviour patterns, the main role of spreading diseases within China is the high mobility of the migrant workers. This was identified to be one of the major risk factors for the spread of HIV (Zhang and Ma 2002; MOH China, et al. 2010). The frequent shifts between their work places and the regular visits of rural areas suggest risk of HIV transmission to people at other occupational sites and back home (Qian et al. 2005; Yang et al. 2007).

All these characteristics of rural-to-urban migrant workers suggest that this group plays an important role as a "bridging population" in facilitating the spread of HIV and STIs in China (Jia et al. 2011; Wang et al. 2010).

Migrants and group II conditions

We present data from the literature for this disease group regarding smoking, a major risk factor for many chronic diseases, and also discuss the important dimension of mental health.

Impact of smoking

Smoking is not only a risk factor for malignant neoplasms, because it also promotes other diseases of high frequency in the population, such as respiratory and cardiovascular diseases, which have a major impact on overall DALYs. Active smoking was observed as one of the leading causes of disease burden in China. Due to the high smoking rates and China's very large population, the burden of disease from tobacco smoking is highest among all countries of the world (Finch et al. 2010; Gan et al. 2007). A global burden of disease study by WHO projected that by 2030 tobacco smoking is expected to kill 10 million people globally. This would result in more deaths than from any other single disease, even surpassing the mortality from the HIV epidemic. Of these 10 million tobacco-attributable deaths, 70 per cent will occur in developing countries, and about 2 million deaths are expected in China alone (Bui and Markle 2007). Smoking is closely related to the migration status. Several studies

showed that during the migration process the prevalence of smoking increased. One study investigated smoking patterns among over 4,000 rural-to-urban migrant workers, aged 18 years or older, residing in one of three Chinese cities (Chengdu in south-west China, Shanghai in south-east China and Beijing in north China). The overall result was that smoking prevalence was higher subsequent to migration (28.4 per cent) in comparison with before migration (20.8 per cent) ($p < 0.01$) (Yang et al. 2009). Acculturation and migratory status emerged as the most important determinants of smoking behaviour in migrant populations (Niaura et al. 2002; Baluja et al. 2003). In line with that, another study on cigarette smoking among migrants in Beijing also showed that smoking prevalence increased after migration. Furthermore, it was pointed out that due to solitude, stress and higher income, migrants were more likely to start smoking, either daily or occasionally (Chen et al. 2004). Another cross-sectional study of 206 rural-to-urban migrant women in Beijing investigating knowledge of and attitudes to smoking, as well as smoking behaviour showed similar results. Young female migrants were more susceptible to start smoking, compared with Chinese women nationally (Finch et al. 2010).

Mental health

Neuropsychiatric conditions account for a high amount of overall DALYs in China as well as in other countries. The migration process seems to be a major determinant for an increase of different kinds of mental health impairments. Migrants often move without their family and friends and thereby lose social networks and social support. Furthermore, difficulties in their new environment, such as cultural differences and language barriers burden mental well-being. This complex constellation of psychological demands can lead to impaired mental health (Jahn et al. 2011).

Chinese rural-to-urban migrants face the same challenges. Stress during the settlement period (Wong and Chang 2010) and stress caused by economic pressure, work load, family separation, discrimination and acculturation in their daily lives were emphasized as potential risk factors for poor mental health outcomes within the migrant population (Li, Zhang et al. 2007; Lin et al. 2011). Wong et al. (2008) reported that in their study 25 per cent of male migrant workers suffered from poor mental health due to stress because of financial and employment difficulties. Unpublished results of a study conducted by Wong and Lee (2003) showed that 63 per cent of the examined migrants were at risk of developing mental health problems.⁸ Another study by Li et al. (2006) indicated an association between migrants' mental health status and the social stigmatization and discrimination often faced by migrants in urban areas.

Migrant workers as well as college graduate students from rural areas have to cope with fluctuating labour demands in urban areas. They often change their work place, either within a city or moving to another city. This requires a high level of psychological adaptation to new workplaces, which may also be a threat for mental health. Migration stress—which includes the stress resulting from exposure to challenges in handling all issues related to migration (for example, employment and financial difficulties, losses and cultural differences)—during the settlement period was therefore emphasized as a potential risk factor for poor mental health outcomes within this population (Wong and Chang 2010).

⁸ Wong and Lee 2003: unpublished work, cited in Wong et al. 2007.

Migrants and group III conditions

For the description of the impact of migration on group III conditions, the main focus was set to occupational health and road traffic injuries that are assumed to be the key drivers of the disease burden of this condition group.

Occupational health

In 2004, 136,000 work-related deaths were reported in China (Wen 2005). In 2005, 15,000 people died in the industrial sector due to work-related accidents (Pareles 2005) and injuries are common in many factories. Crushed or amputated fingers are the most frequent types of injuries. In Shenzhen and the surrounding Pearl River Delta, which has a large industrial zone, 40,000 fingers are severed annually due to work-related injuries. Beside accidents, mental and physical exhaustion from overwork may cause severe health problems as well (Wen 2005). The most vulnerable group are migrant workers. They are often low-skilled and lack sufficient work place safety training (Pareles 2005; Wen 2005). They are usually less educated than urban residents (Hesketh et al. 2008), and therefore a large proportion of migrants are more often engaged in low-skill dangerous and lower paid jobs than the urban residents. For this reason, less educated rural-to-urban migrants in particular suffer from unhealthy or dangerous working conditions responsible for severe injuries (Human Rights in China 2002; Wen 2006). Besides injuries, these working conditions may also lead to cardiovascular and musculoskeletal diseases and mental illness (Zhang et al. 2010).

Road traffic injuries

The reasons for the high number of injuries related to road traffic accidents are associated with the rapid economic development and increasing motorization in China. Most of the traffic-related injuries occur in poor rural areas, but the reasons are not yet well understood. Possible explanations are the poor road quality, less traffic regulation and supervision, not well trained drivers, insufficient medical emergency care and a higher level of drunk driving as compared to urban areas (Wang et al. 2008). Although the numbers of traffic-related accidents officially reported by the police are high, they are likely to underestimate the real situation (Alcorn 2011). A study comparing the death rates from road traffic injuries in China between the years 2002 to 2007 showed that the death rate based on the death registration system was about twice as high as the rate reported by the police (Hu et al. 2011). It is plausible that road traffic safety plays a very important role for the migrant population, because they are highly mobile travelling back and forth between their rural origin and the cities where they work. Unfortunately, data availability is insufficient to better estimate the traffic-related burden of disease among Chinese rural-to-urban migrant workers.

6. Burden of disease in Chinese Cities Influenced by Internal Migration

Considering DALYs for the 15-49 age group and the literature review conducted, it is very likely that the rural-to-urban migration has an appreciable effect on the disease burden of the general population in China, because migrants suffer more from several health risks (paragraph 2.5). The results show that the specific demographic and behavioural characteristics deviating from the general Chinese population in the focused age group can lead to an increasing burden of disease. This is particularly true for diseases and injuries related to the migrants' low socioeconomic status, the kinds of typical occupations and behaviours.

For example, the distribution of infectious diseases, especially HIV/AIDS and TB needs increased attention, because migrants may serve as a bridging population. Therefore, migration can lead to a spread of infectious diseases and may also lead to a transmission from high-risk groups to the general population (Pan et al. 2013).

A study from Jiang and colleagues showed that highest death rates for cerebrovascular diseases in China (2004-2005) were observed in people aged above 39 years (35-39, 55-59, 85+; 10.6, 177.6, and 4051.4 per 100,000, respectively) (Jiang et al. 2010). Migrants are mainly in the 15-39 age group and thus the occurrence of cerebrovascular diseases can be assumed to be low, and the effect on the overall disease burden is relatively small. However, this may change when the migrant population ages. For COPD, we assume a considerable impact on the overall disease burden, because migrants show higher rates of smoking and are also prone to unhealthy working conditions (such as inhalation of dust, chemicals, vapours and fumes during labour). Migrants may develop this disease in a later stage of life after being exposed to the risk factors for a long time period, and we assume that the impact on the current disease burden as presented by the top ten ranking is considerably lower as compared to conditions such as depressive disorders or work-related injuries. We suppose that the overall burden of mental disorders, such as major depressive disorders, but also alcohol use disorders and transport injuries and other unintentional injuries are strongly affected by migration.

High mobility of migrants may lead to increased rates of road traffic accidents, which thus have a considerable impact on the overall disease burden of this condition group. Migration largely affects the overall work-related injury burden (as part of unintentional injuries) because migrant workers are often less well paid and employed in more dangerous jobs as compared to the local population.

7. Limitations

Several limitations have to be considered when interpreting the presented data. Internal migrants are highly mobile, and it is therefore difficult to continuously and comprehensively collect reliable data to obtain accurate estimates about the burden of disease in this subpopulation. Furthermore, their lack of local hukou and their low income leads to restricted access to affordable formal health care services in cities with accurate health status documentation. The majority of rural-to-urban migrant workers have out-of-pocket expenses for health care services. They are forced to consult pharmacies, to treat themselves or to utilize informal health care services. A sound documentation of health problems and proper diagnostics among internal migrants therefore largely fails, causing gaps in municipal routine health data for migrants. Additionally, the amount and quality of the literature addressing the disease pattern in Chinese migrants is limited. Furthermore, there is a major bias for disease summaries from literature, because so far no systematic burden of disease analysis for the migrant population is available in China.

Because of the lack of systematically collected secondary data, we reviewed the available literature to obtain a comprehensive insight into the health problems and health risks that are characteristic of migrant workers in China. Additionally, we contrasted such adversities (described in section 2.5) with the well-reported BoD patterns of the general population provided by the GBD 2010 study in an age group that is typical for the migrant workers, namely 15-49 years.

Due to the higher health risks among migrants compared to the general population, the GBD 2010 study results of the general population's disease burden would underestimate the disease burden of migrants.

However, also the use of information collected from published studies show some limitations. The validity can be limited due to selection bias. The pre-selection of young, healthy and self-confident people before migration ("healthy migrant effect") and the possible return of migrants to their hometowns in case of disease after migration can lead to an underestimation of the real health problems among migrants. On the other hand, publication bias should be taken into account while analysing the available literature. It is likely that noteworthy results, such as those concerning big differences in health status between subgroups, are more frequently published and cited as compared to less significant differences, for instance between migrant populations and host populations in cities. Furthermore, many publications report results from small samples. Such findings should be assessed with caution since they may lack representativeness and precision.

8. Conclusions and Implications for Health Policy

By contrasting the BoD of the total population in the 15-49 age group with literature-based results on disease patterns of the migrant population, our results highlight the impact of migration on burden of disease trends in China. Although the rural-to-urban migrant workers represent a large share of the Chinese population and thus have a substantial influence on the health of the Chinese society, there is no particular assessment of the burden of disease for this subgroup available yet.

Taking into account the migrants' vulnerability in terms of the various health threats, further efforts in terms of public health interventions should be invested to prevent an increase of disease burden in China related to the ongoing rural-to-urban migration. Even though BoD data as presented in 2.3 indicate that China overall is in a fairly advanced stage of epidemiologic and demographic (and economic) transition, it can be assumed that progress of both the demographic and epidemiologic transition varies regionally, with some (urban) regions being at a later and some (rural) regions being at an earlier stage (Mou et al. 2013). For instance, people living in rural areas are still more prone to infectious diseases that are more common in populations in an early stage of epidemiologic transition, whereas chronic diseases play a more important role in the large urban centres. These diverging trends in the disease profiles pose serious threats to overall population health when people, carrying different risk and disease profiles, mix. This occurs as rural-to-urban migrants are considered to be a bridging population connecting the populations of rural and urban areas.

Infectious disease prevention

Many studies suggest that rural-to-urban migrants in particular are at higher risk of acquiring and transmitting communicable diseases as compared to non-migrant urban populations. This is related to risky behaviour after migrating into the urban areas. Migrants are more frequently engaged in drug use, using and offering commercial sex, and commonly live in unhealthy and crowded housing conditions, compared to urban residents. They are on average less educated concerning the risk of transmission of infectious diseases including STIs, and are therefore not able to adequately take

preventive measures, which leads to STIs posing a risk to their sex partners, colleagues and families.

For reducing the risk of spread of STIs, including HIV, in China, specific preventive measures need to be established for migrants. Female but also male migrant workers, which are very often single men, need to be targeted for preventive health education because of their low level of education and their risk behaviour (Li, Morrow and Kermode 2007). For instance, based on the results of a cross-sectional survey of 2,821 adolescents (9 per cent migrant workers vs. 91 per cent local residents), Li et al. (2009) advocated targeting adolescent and young migrant workers. This group has generally shown a higher level of sexual exposure, lower socioeconomic status, inadequate information regarding reproductive health and HIV/AIDS and are therefore highly vulnerable to HIV and other STIs.

Preventive intervention programmes will only be efficient if they are user-oriented. First of all, public health measures should easily reach the (potential) migrant groups taking into account their particular characteristics and demands (such as age, sex, educational level, language/dialect and income). Health education should already start in rural junior middle schools and should provide gender-sensitive basic knowledge about typical health threats related to rural-to-urban migration. Furthermore, preventive measures like condom provision, the provision of health information and information about supporting institutions like labour rights authorities, health care providers for migrants or non-governmental organizations supporting migrants in urban areas should be provided at employment agencies in rural and urban areas, at main train and bus stations used by migrant workers, at employers and so forth. Additionally, vaccination strategies and early diagnosis may strongly reduce infectious disease threats. Such measures should be conducted in collaboration with the local rural (preceding migration) and urban (subsequent to migration) authorities, as well as employers in an outreach health service so that a large share of migrants can be reached.

Since there are no overall data available for comparing different risk groups for different kinds of communicable diseases, there is a need to further improve surveillance systems by collecting detailed data on the most important infectious diseases. As far as possible, such measures should aim at the possibility of distinguishing between resident and migrant populations and also between different migrant populations regarding their kind of work, working and living conditions, educational level, socioeconomic background and migratory history in terms of temporal and geographical course.

Road traffic safety

Although some results show that road traffic injuries occur mainly in rural areas, this does not necessarily result in decreasing DALYs for the rural-to-urban migrants. Besides the under-reporting of road traffic injuries, the higher mobility of the migrant population has to be considered. A reduction of these injuries can be achieved by establishing interventions like those implemented in high-income countries (Stevenson et al. 2008).

A widely implemented strategy is traffic calming in towns and cities that aims to reduce injuries caused by road traffic accidents. In a systematic literature review by Bunn et al. (2003), it was pointed out that those interventions need further evaluation, especially in low- and middle-income countries. One example is a study by Stevenson et al. (2008), in which interventions from high-income countries were adapted and implemented in

Guangzhou. Those interventions were implemented over a 12-month period and included enhanced training and raising public awareness. In this study it was observed that the seat belt use increased from 50 per cent before to 62 per cent after the intervention (Stevenson et al. 2008).

Hukou, labour legislation and (gender) equality

Despite substantial efforts to reform the hukou system, there are still institutional disadvantages for migrants as compared to the local urban hukou holders (Chan and Buckingham 2008). Similar to many changes of the hukou regulations, various laws were enacted for the benefit of migrant workers, such as laws regulating the minimum wage and standard working hours, a law for occupational safety, a law for maternity leave, and so on. Nevertheless, these laws are still ignored by many employers (Magnani and Zhu 2012; Scheineson 2009). Hence, policy makers should improve control mechanisms to effectively inspect the implementation of labour legislations and should be ensured that employers who do not comply with these laws would face severe penalties.

Besides better access to health care services and rigorous implementation of labour legislations, specific workplace health promotion interventions could help to decrease the burden of disease, particularly when taking into account the fact that most migrants are young and healthy when coming to the cities. Gender inequality is also an issue that needs to be considered by policy makers. Migrant women usually have fewer job opportunities and lower incomes than migrant men (Magnani and Zhu 2012). Therefore, a policy focusing on eliminating discrimination among female migrants is needed to ensure equal job opportunities and income for them.

Data availability and demand

The literature indicates that the Chinese migrant populations are exposed to a variety of risk factors for diseases that differ from those of non-migrants. Although several data systems have been implemented to provide information on levels and trends in China, a comprehensive and comparable assessment of populations' health status and its changes over time is not yet available (Yang et al. 2013). There is a lack of data on the health status of migrants, so we cannot get a full picture of disease patterns in this heterogeneous population. Another reason for the health data gap is the institutional barrier for internal migrants to receive affordable formal health care in the cities because they lack local urban hukou. This barrier also reduces the ability to systematically collect data on this population's health status. A better access to the formal health care service sector, namely the institutional inclusion into state-provided health care provision regardless of the hukou status, would also facilitate the systematic collecting of the needed health data. If this hurdle could be removed, a comprehensive picture of the health status and needs of internal rural-to-urban migrant workers could be drawn.

Therefore, in the future, national burden of disease studies in China's general and migrant population will be of great importance for disease surveillance, monitoring and the implementation and evaluation for public health interventions of different population groups including migrants.

The improvement of surveillance strategies is also indispensable and should be handled in a coordinated and cooperative manner. A systematic and detailed burden of disease

analysis for the migrant subpopulation would be an important source of information that allows the implementation of efficient intervention policies to reduce the burden of disease in the migrant population and to prevent a further development of diseases. Further public health and epidemiological research is needed to more comprehensively and accurately characterize the disease burden, as well as the equally important and large health potentials of the diverse Chinese migrant populations and their impacts on the health of the whole Chinese population.

References

- Alcorn, Ted. 2011. Uncertainty clouds China's road-traffic fatality data. *Lancet* 378 (9788):305-6.
- Amnesty International. 2007. *People's Republic of China. Internal migrants: Discrimination and Abuse. The Human Cost Of An Economic 'Miracle'*. London: Amnesty International
- Anand, Sudhir, and Kara Hanson. 1997. Disability-adjusted life years: A critical review. *J Health Econ* 16 (6):685-702.
- Baluja, Kaari Flagstad, Julie Park, and Dowell Myers. 2003. Inclusion of immigrant status in smoking prevalence statistics. *Am J Public Health* 93 (4):642-6.
- Biao, Xiang. 2003. Migration and Health in China: Problems, Obstacles and Solutions. In *Asian MetaCentre for Population and Sustainable Development. Analysis Research paper, No. 17*.
- Bui, T. D., and William H. Markle. 2007. The Global Burden of Disease. In *Understanding Global Health*, edited by W. H. Markle, M. A. Fisher and R. A. Smego. New York: McGrawHill.
- Bunn, F., T. Collier, C. Frost, K. Ker, I. Roberts, and R. Wentz. 2003. Traffic calming for the prevention of road traffic injuries: Systematic review and meta-analysis. *Inj Prev* 9 (3):200-4.
- Chai, Joseph C. H., and B. Karin Chai. 1997. Chinas's floating population and its implications. *International Journal of Social Economics* 24:1038-1051.
- Chan, Kam Wing. 2008. Internal labour migration in China: Trends, geographical distribution and policies. New York: United Nations.
- Chan, Kam Wing, and Will Buckingham. 2008. Is China abolishing the hukou system? *The China Quarterly* 195:582-606.
- Chen, X., X. Li, B. Stanton, X. Fang, D. Lin, M. Cole, H. Liu, and H. Yang. 2004. Cigarette smoking among rural-to-urban migrants in Beijing, China. *Prev Med* 39 (4):666-73.
- Chen, X., B. Stanton, X. Li, X. Fang, D. Lin, and Q. Xiong. 2009. A comparison of health-risk behaviors of rural migrants with rural residents and urban residents in China. *Am J Health Behav* 33 (1):15-25.
- China Development Report. 2010. China Statistics Press.
- Cook, Ian G., and Trevor J. B. Dummer. 2004. Changing health in China: Re-evaluating the epidemiological transition model. *Health Policy* 67 (3):329-343.
- Cui, Zhaohui, Rachel Huxley, Yangfeng Wu, and Michael J. Dibley. 2010. Temporal trends in overweight and obesity of children and adolescents from nine provinces in China from 1991-2006. *International Journal of Pediatric Obesity* 5 (5):365-374.
- Dai, Dong Mei, Xia Liu, and Zeng Mei Xun. 2007. [Investigation and Analysis on AIDS Epidemiology of Immigratory Women in Certain County of YIMENG Mountains Area]. *Medical Laboratory Science and Clinics* 18 (4):36-38.
- Dye, C., C. J. Watt, and D. Bleed. 2002. Low access to a highly effective therapy: A challenge for international tuberculosis control. *Bull World Health Organ* 80 (6):437-44.
- Fan, Cindy C. 2002. The Elite, the Natives, and the Outsiders: Migration and Labor Market Segmentation in Urban China. *Annals of the Association of American Geographers* 92 (1):103-124.

- Fan, Yingying. 2006. Achievements and challenges of the rural migrant workers in access to healthcare service in urban China - A case study of Nanjing. Master thesis, Centre for East and South-East Asian Studies Lund University, Sweden, Lund.
- Fang, X., X. Li, H. Yang, Y. Hong, R. Zhao, B. Dong, W. Liu, Y. Zhou, S. Liang, and B. Stanton. 2007. Profile of female sex workers in a Chinese county: Does it differ by where they came from and where they work? *World Health Popul* 9 (1):46-64.
- Finch, K., T. E. Novotny, S. Ma, D. Qin, W. Xia, and G. Xin. 2010. Smoking knowledge, attitudes, and behaviors among rural-to-urban migrant women in Beijing, China. *Asia Pac J Public Health* 22 (3):342-53.
- Fu, Ji Hua, Xue Zhen Liu, Dian Min Kang, Yue Sheng Qian, Xiao Fei Zhang, Jing Zhang, and Cui Xia Lu. 2005. [A survey on HIV infections among immigrant women in rural areas of Shandong province] (in Chinese). *Chin J AIDS STD* 11 (6):403-405.
- Gan, Q., K. R. Smith, S. K. Hammond, and T. W. Hu. 2007. Disease burden of adult lung cancer and ischaemic heart disease from passive tobacco smoking in China. *Tob Control* 16 (6):417-22.
- Haagsma, J. A., A. H. Havelaar, B. M. Janssen, and G. J. Bonsel. 2008. Disability adjusted life years and minimal disease: Application of a preference-based relevance criterion to rank enteric pathogens. *Popul Health Metr* 6:7.
- He, Jiang, Michael J. Klag, Paul K. Whelton, Jun-Yun Chen, Jing-Ping Mo, Ming-Chu Qian, Pei-Sheng Mo, and Guan-Qing He. 1991. Migration, blood pressure pattern, and hypertension: The Yi Migrant Study. *American Journal of Epidemiology* 134 (10):1085-1101.
- Hesketh, T., X. J. Ye, L. Li, and H. M. Wang. 2008. Health status and access to health care of migrant workers in China. *Public Health Rep* 123 (2):189-97.
- Hong, Y., and X. Li. 2008. Behavioral studies of female sex workers in China: A literature review and recommendation for future research. *AIDS Behav* 12 (4):623-36.
- Hu, G., T. Baker, and S. P. Baker. 2011. Comparing road traffic mortality rates from police-reported data and death registration data in China. *Bull World Health Organ* 89 (1):41-5.
- Hu, Shao Yuan, Fei Yuan, Shi Guang Lei, Qiao Ying Jiang, Jin Zhi Yang, Jian Zhang, and Shu Quang Lei. 2003. [An intervention study of the status of HIV infection and preventing AIDS dangerous behavior in the floating population of Guiyang] (in Chinese). *Guizhou Medical Journal* 27 (2):120-122.
- Hu, Z., H. Liu, X. Li, B. Stanton, and X. Chen. 2006. HIV-related sexual behaviour among migrants and non-migrants in a rural area of China: Role of rural-to-urban migration. *Public Health* 120 (4):339-45.
- Huang, Ping, and Frank N Pieke. 2003. China Migration Country Study. Paper read at Regional Conference on Migration, Development and Pro-Poor Policy Choices in Asia, 22-24 June, at Dhaka, Bangladesh.
- Huang, Ping, and Shaohua Zhan. 2008. Migrant Workers' Remittances and Rural Development in China. In *Migration and Development Within and Across Borders: Research and Policy Perspectives on Internal and International Migration*, edited by Josh de Wind and Jennifer Holdaway. Geneva: International Organization for Migration and Social Science Research Council.
- Human Rights in China. 2002. *Institutionalized exclusion: The tenuous legal status of internal migrants in China's major cities*. Available from <http://www.hrichina.org/en/publications/hric-report/institutionalized-exclusion-tenuous-legal-status-internal-migrants-chinas>.
- IHME (Institute for Health Metrics and Evaluation). *Institute for Health Metrics and Evaluation - Global Burden of Disease (GBD) Visualizations* 2013. Available from <http://www.healthmetricsandevaluation.org/gbd/visualizations/country>.

- Jahn, Heiko Juergen, Li Ling, Lu Han, Yinghua Xia, and Alexander Krämer. 2011. Migration and Health in Megacities—A Chinese Example from Guangzhou, China. In *Health in Megacities and Urban Areas*, edited by A. Krämer, M. M. H. Khan and F. Kraas. Berlin, Heidelberg: Physica-Verlag.
- Jia, Z. W., X. W. Jia, Y. X. Liu, C. Dye, F. Chen, C. S. Chen, W. Y. Zhang, X. W. Li, W. C. Cao, and H. L. Liu. 2008. Spatial analysis of tuberculosis cases in migrants and permanent residents, Beijing, 2000-2006. *Emerg Infect Dis* 14 (9):1413-9.
- Jia, Z., L. Wang, R. Y. Chen, D. Li, Q. Qin, Z. Ding, G. Ding, C. Zang, and N. Wang. 2011. Tracking the evolution of HIV/AIDS in China from 1989-2009 to inform future prevention and control efforts. *PLoS One* 6 (10):e25671.
- Jiang, Y., X. Y. Li, N. Hu, Z. J. Huang, and F. Wu. 2010. [Epidemiologic characteristics of cerebrovascular disease mortality in China, 2004-2005] (in Chinese). *Zhonghua Yu Fang Yi Xue Za Zhi* 44 (4):293-7.
- Lai, T., J. Habicht, and R. A. Kiivet. 2009. Measuring burden of disease in Estonia to support public health policy. *Eur J Public Health* 19 (5):541-7.
- Lau, J. T., H. Y. Tsui, P. C. Siah, and K. L. Zhang. 2002. A study on female sex workers in southern China (Shenzhen): HIV-related knowledge, condom use and STD history. *AIDS Care* 14 (2):219-33.
- Li, L., M. Morrow, and M. Kermode. 2007. Vulnerable but feeling safe: HIV risk among male rural-to-urban migrant workers in Chengdu, China. *AIDS Care* 19 (10):1288-95.
- Li, S., H. Huang, Y. Cai, G. Xu, F. Huang, and X. Shen. 2009. Characteristics and determinants of sexual behavior among adolescents of migrant workers in Shanghai (China). *BMC Public Health* 9:195.
- Li, X., L. Zhang, X. Fang, Q. Xiong, X. Chen, D. Lin, A. Mathur, and B. Stanton. 2007. Stigmatization experienced by rural-to-urban migrant workers in China: Findings from a qualitative study. *World Health Popul* 9 (4):29-43.
- Li, Xiaoming, Bonita Stanton, Xiaoyi Fang, and Danhua Lin. 2006. Social stigma and mental health among rural-to-urban migrants in China: A conceptual framework and future research needs. *World Health Popul* 8 (3):14-31.
- Li, Yongning. 2007. *Migration and Spatial Development. Cases from the Coastal and Interior Regions in Contemporary China*. Guandong Province: Shantou University Press.
- Liang, Qiwen. 2009. Guangzhou to provide cheaper medical insurance for migrant workers. *China Daily* March 19, 2009.
- Liao, S. S., Q. Y. He, K. H. Choi, E. S. Hudes, J. F. Liao, X. C. Wang, M. Liu, W. L. Pan, and J. S. Mandel. 2006. Working to prevent HIV/STIs among women in the sex industry in a rural town of Hainan, China. *AIDS Behav* 10 (4 Suppl):S35-45.
- Liao, S. S., J. Schensul, and I. Wolffers. 2003. Sex-related health risks and implications for interventions with hospitality women in Hainan, China. *AIDS Educ Prev* 15 (2):109-21.
- Lim, S. S., T. Vos, A. D. Flaxman, G. Danaei, K. Shibuya, H. et al. 2012. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990-2010: A systematic analysis for the Global Burden of Disease Study 2010. *Lancet* 380 (9859):2224-60.
- Lin, D., X. Li, B. Wang, Y. Hong, X. Fang, X. Qin, and B. Stanton. 2011. Discrimination, perceived social inequity, and mental health among rural-to-urban migrants in China. *Community Ment Health J* 47 (2):171-80.

- Ling, L., J. Yue, and Z. Jun. 2011. *Report on the Status Quo of Public Health of Migrants in China*. Guangzhou: Zhongshan University.
- Lopez, A. D., C. D. Mathers, M. Ezzati, D. T. Jamison, and C. J. L. Murray. 2006. Global and regional burden of disease and risk factors, 2001: Systematic analysis of population health data. *The Lancet* 367:1747-1757.
- Lu, Fan, Ji Hua Zhang, Rui Fu Zhang, Ian Wang, Xue Zhen Liu, Lu Wang, Li Yan Wang, Cui Xia Lu, Jing Chen, Yan He Wang, Xiao Fei Zhang, and Cheng Yi Qu. 2006. [Analysis of HIV epidemic situation and immigrant population] (in Chinese). *Infectious Disease Information* 19 (05):259-261.
- Magnani, Elisabetta, and Rong Zhu. 2012. Gender wage differentials among rural–urban migrants in China. *Regional Science and Urban Economics* 42 (5):779-793.
- Mantell, J. E., E. A. Kelvin, X. Sun, J. Zhou, T. M. Exner, S. Hoffman, F. Zhou, T. G. Sandfort, and C. S. Leu. 2011. HIV/STI risk by migrant status among workers in an urban high-end entertainment centre in Eastern China. *Health Educ Res* 26 (2):283-95.
- Mathers, C. D., T. Vos, A. D. Lopez, J. Salomon, and M. Ezzati, eds. 2001. *National Burden Of Disease Studies: A Practical Guide. Edition 2.0*. Geneva: World Health Organization.
- MOH China, and UNAIDS. 2007. *A Joint Assessment of HIV/AIDS Prevention, Treatment and Care in China (2007)*. Beijing: Ministry of Health of the Peoples Republic of China, United Nations Programme on HIV/AIDS.
- MOH (Ministry of Health of the People's Republic of China), UNAIDS (Joint United Nations Programme on HIV/AIDS) and WHO (World Health Organization). 2010. *Estimates for the HIV/AIDS Epidemic in China*. Beijing, China: Ministry of Health of the People's Republic of China, Joint United Nations Programme on HIV/AIDS, World Health Organization.
- Mou, J., S. M. Griffiths, H. Fong, and M. G. Dawes. 2013. Health of China's rural-urban migrants and their families: A review of literature from 2000 to 2012. *Br Med Bull* 106:19-43.
- Murray, C. J. 1994. Quantifying the burden of disease: The technical basis for disability-adjusted life years. *Bull World Health Organ* 72 (3):429-45.
- . 2007. Towards good practice for health statistics: Lessons from the Millennium Development Goal health indicators. *Lancet* 369 (9564):862-73.
- Murray, Christopher J. L., Majid Ezzati, Abraham D. Flaxman, Stephen Lim, Rafael Lozano, Catherine Michaud, Mohsen Naghavi, Joshua A. Salomon, Kenji Shibuya, Theo Vos, Daniel Wikler, and Alan D. Lopez. 2012a. GBD 2010: Design, definitions, and metrics. *The Lancet* 380 (9859):2063-2066.
- . 2012b. Supplementary appendix to: Comprehensive systematic analysis of global epidemiology: Definitions, methods, simplification of DALYs, and comparative results from the Global Burden of Disease Study 2010. *The Lancet* 380 (5859).
- Murray, C. J. L., and A. D. Lopez. 1996. *The Global Burden of Disease: A Comprehensive Assessment of Mortality and Disability from Diseases, Injuries, and Risk Factors in 1990 and Projected to 2020*. Cambridge: Harvard University Press.
- Murray, C. J. L., J. A. Salomon, C. D. Mathers, and A. D. Lopez. 2002. *Summary Measures of Population Health: Concepts, Ethics, Measurements and Applications*. Geneva: World Health Organization.
- Murray, C. J. L., T. Vos, R. Lozano, M. Naghavi, A. D. Flaxman, C. Michaud, M. Ezzati, K. Shibuya, J. A. Salomon et al. 2012. Disability-adjusted life years (DALYs) for 291 diseases and injuries in 21 regions, 1990-2010: A systematic analysis for the Global Burden of Disease Study 2010. *Lancet* 380 (9859):2197-223.

- National Bureau of Statistics in China. 2012. *China's Total Population and Structural Changes in 2011*. National Bureau of Statistics in China,, 20.01.2012 2012 [cited January, 25 2012]. Available from http://www.stats.gov.cn/was40/gjtjj_en_detail.jsp?searchword=population&channelid=9528&record=2.
- Niaura, R., W. G. Shadel, D. M. Britt, and D. B. Abrams. 2002. Response to social stress, urge to smoke, and smoking cessation. *Addict Behav* 27 (2):241-50.
- Pan, X., Y. Zhu, Q. Wang, H. Zheng, X. Chen, J. Su, Z. Peng, R. Yu, and N. Wang. 2013. Prevalence of HIV, syphilis, HCV and their high risk behaviors among migrant workers in eastern China. *PLoS One* 8 (2):e57258.
- Pareles, Michael. 2005. *Crushed. A Survey of Work Injuries and Treatment in the Pearl River Delta*. New York: China Labor Watch.
- Pinheiro, Paulo, Dietrich Plass, and Alexander Krämer. 2011. The burden of disease approach for measuring population health. In *Health in Megacities and Urban Areas*, edited by A. Krämer, M. M. H. Khan and F. Kraas. Berlin, Heidelberg: Physica-Verlag.
- Qian, H. Z., S. H. Vermund, and N. Wang. 2005. Risk of HIV/AIDS in China: Subpopulations of special importance. *Sex Transm Infect* 81 (6):442-7.
- Rogers, S. J., L. Ying, Y. T. Xin, K. Fung, and J. Kaufman. 2002. Reaching and identifying the STD/HIV risk of sex workers in Beijing. *AIDS Educ Prev* 14 (3):217-27.
- Salomon, Joshua A., Theo Vos, Daniel R. Hogan, Michael Gagnon, Mohsen Naghavi, Ali Mokdad, Nazma Begum, Razibuzzaman Shah, Muhammad Karyana, Soewarta Kosen, Mario Reyna Farje, Gilberto Moncada, Arup Dutta, Sunil Sazawal, Andrew Dyer, Jason Seiler et al. 2012a. Common values in assessing health outcomes from disease and injury: disability weights measurement study for the Global Burden of Disease Study 2010. *The Lancet* 380 (9859):2129-2143.
- . 2012b. Supplementary appendix to: Common values in assessing health outcomes from disease and injury: disability weights measurement study for the Global Burden of Disease Study 2010 *The Lancet* 380:25.
- Scheineson, A. *China's Internal Migrants*. Council on Foreign Relations 2009. Available from <http://www.cfr.org/china/chinas-internal-migrants/p12943>.
- Shen, X., K. DeRiemer, Z. A. Yuan, M. Shen, Z. Xia, X. Gui, L. Wang, Q. Gao, and J. Mei. 2009. Drug-resistant tuberculosis in Shanghai, China, 2000-2006: Prevalence, trends and risk factors. *Int J Tuberc Lung Dis* 13 (2):253-9.
- Stevenson, M., J. Yu, D. Hendrie, L. P. Li, R. Ivers, Y. Zhou, S. Su, and R. Norton. 2008. Reducing the burden of road traffic injury: Translating high-income country interventions to middle-income and low-income countries. *Inj Prev* 14 (5):284-9.
- Stouthard, M. E. A., M. L. Essink-Bot, and G. J.onsel. 2000. Disability weights for diseases: A modified protocol and results for a Western European region. *Eur J Public Health* 10 (1):24-30.
- UNGASS (United Nations General Assembly Special Session on Drugs). 2010. China 2010 UNGASS Country Progress Report (2008 - 2009). In *UNGASS Country Progress Report*, edited by UNGASS: Ministry of Health of the People's Republic of China.
- van den Hoek, A., F. Yuliang, N. H. Dukers, C. Zhiheng, F. Jiangting, Z. Lina, and Z. Xiuxing. 2001. High prevalence of syphilis and other sexually transmitted diseases among sex workers in China: Potential for fast spread of HIV. *AIDS* 15 (6):753-9.

- Wang, L. J., M. Phillips, Z. J. Huang, Y. P. Zhang, Y. X. Zhao, and G. H. Yang. 2003. [Evaluation on the accuracy of reported suicides in the Chinese population]. *Zhonghua Liu Xing Bing Xue Za Zhi* 24 (10):889-92.
- Wang, S. Y., Y. H. Li, G. B. Chi, S. Y. Xiao, J. Ozanne-Smith, M. Stevenson, and M. R. Phillips. 2008. Injury-related fatalities in China: An under-recognised public-health problem. *Lancet* 372 (9651):1765-73.
- Wang, W., J. Wang, Q. Zhao, N. D. Darling, M. Yu, B. Zhou, and B. Xu. 2011. Contribution of rural-to-urban migration in the prevalence of drug resistant tuberculosis in China. *Eur J Clin Microbiol Infect Dis* 30 (4):581-6.
- Wang, W., C. Wei, M. E. Buchholz, M. C. Martin, B. D. Smith, Z. J. Huang, and F. Y. Wong. 2010. Prevalence and risks for sexually transmitted infections among a national sample of migrants versus non-migrants in China. *Int J STD AIDS* 21 (6):410-5.
- Wang, Weibing, Qingwu Jiang, Abu Saleh M. Abdullah, and Biao Xu. 2007. Barriers in accessing to tuberculosis care among non-residents in Shanghai: A descriptive study of delays in diagnosis. *The European Journal of Public Health* 17 (5):419-423.
- Wei, X., J. Chen, P. Chen, J. N. Newell, H. Li, C. Sun, J. Mei, and J. D. Walley. 2009. Barriers to TB care for rural-to-urban migrant TB patients in Shanghai: A qualitative study. *Trop Med Int Health* 14 (7):754-60.
- Wen, D. 2006. *China Copes with Globalization*. San Francisco: The International Forum on Globalization (IFG).
- Wen, Dale. 2005. *China Copes with Globalization. A Mixed Review*. San Francisco: The International Forum on Globalization (IFG).
- WHO (World Health Organization). 2008. *The Global Burden of Disease: 2004 Update*. edited by WHO. Geneva: WHO.
- Wong, Daniel Fu Keung, and Ying-Li Chang. 2010. Mental health of Chinese migrant workers in factories in Shenzhen, China: Effects of migration stress and social competence. *Social Work in Mental Health* 8 (4):305-318.
- Wong, Daniel Fu Keung, Yingli Chang, and Xuesong He. 2007. Rural migrant workers in urban China: Living a marginalised life. *International Journal of Social Welfare* 16:32-40.
- Wong, Daniel Fu Keung, Xuesong He, Grace Leung, Ying Lau, and Yingli Chang. 2008. Mental health of migrant workers in China: prevalence and correlates. *Soc Psychiatry Psychiatr Epidemiol* 43 (6):483-9.
- Wong, Daniel Fu Keung, and D. C. M. Lee. 2003. China Blue Collar Workers: Work Stress, Coping and Mental Health. Unpublished work. Hong Kong: Department of Social Work and Social Administration, University of Hong Kong.
- Wu, Z., K. Rou, and H. Cui. 2004. The HIV/AIDS epidemic in China: History, current strategies and future challenges. *AIDS Educ Prev* 16 (3 Suppl A):7-17.
- Xianyi, C., Z. Fengzeng, D. Hongjin, W. Liya, W. Lixia, D. Xin, and D. P. Chin. 2002. The DOTS strategy in China: Results and lessons after 10 years. *Bull World Health Organ* 80 (6):430-6.
- Yang, G., Y. Wang, Y. Zeng, G. F. Gao, X. Liang, M. Zhou, X. Wan, S. Yu, Y. Jiang, M. Naghavi, T. Vos, H. Wang, A. D. Lopez, and C. J. Murray. 2013. Rapid health transition in China, 1990-2010: Findings from the Global Burden of Disease Study 2010. *Lancet* 381 (9882):1987-2015.
- Yang, Gonghuan, Lingzhi Kong, Wenhua Zhao, Xia Wan, Yi Zhai, Lincoln C. Chen, and Jeffrey P. Koplan. 2008. Emergence of chronic non-communicable diseases in China. *The Lancet* 372 (9650):1697-1705.

- Yang, H., X. Li, B. Stanton, X. Fang, R. Zhao, B. Dong, W. Liu, S. Liang, Y. Zhou, and Y. Hong. 2005. Condom use among female sex workers in China: Role of gatekeepers. *Sex Transm Dis* 32 (9):572-80.
- Yang, H., X. Li, B. Stanton, H. Liu, N. Wang, X. Fang, D. Lin, and X. Chen. 2005. Heterosexual transmission of HIV in China: A systematic review of behavioral studies in the past two decades. *Sex Transm Dis* 32 (5):270-80.
- Yang, T., J. Wu, I. R. Rockett, A. S. Abdullah, J. Beard, and J. Ye. 2009. Smoking patterns among Chinese rural-urban migrant workers. *Public Health* 123 (11):743-9.
- Yang, X., V. J. Derlega, and H. Luo. 2007. Migration, behaviour change and HIV/STD risks in China. *AIDS Care* 19 (2):282-8.
- Yang, Xiushi. 2004. Temporary migration and the spread of STDs/HIV in China: Is there a link? *International Migration Review* 38 (1):212-235.
- Zhang, Kevin Honglin, and Shunfeng Song. 2003. Rural–urban migration and urbanization in China: Evidence from time-series and cross-section analyses. *China Economic Review* 14:386-400.
- Zhang, Kong-lai , and Shao-Jun Ma. 2002. Epidemiology of HIV in China. *BMJ* 324 (7341):803-804.
- Zhang, L. X., D. H. Tu, Y. S. An, and D. A. Enarson. 2006. The impact of migrants on the epidemiology of tuberculosis in Beijing, China. *Int J Tuberc Lung Dis* 10 (9):959-62.
- Zhang, L. X., D. H. Tu, and D. A. Enarson. 2000. The impact of directly-observed treatment on the epidemiology of tuberculosis in Beijing. *Int J Tuberc Lung Dis* 4 (10):904-10.
- Zhang, X., Z. Wang, and T. Li. 2010. The current status of occupational health in China. *Environ Health Prev Med* 15 (5):263-70.
- Zheng, L., J. Zhu, P. Tian, Y. Chen, Y. Song, and YS. Chen. 2000. Sexual behaviors and associated factors among unmarried female migratory workers in Guangzhou. *Chinese Journal of Family Planning* 60:162-164.
- Zheng, Zhenzhen, and Pengling Lian. 2006. Health vulnerability among temporary migrants in urban China. In *Global Change, Urbanization and Health*, edited by W. Wuyi, T. Krafft and F. Kraas. Beijing: China Meteorological Press.
- Zhou, Xiao Lan, Li Ling, Hui Fang Xu, Ci Yong Lu, Jie Wu, Xue Qing Deng, and Hui Wang. 2010. [Knowledge and behavior about AIDS/STD among female sex workers] (in Chinese). *Chinese Journal of Public Health* 26 (8):954-956.
- Zhu, Tuo Fu, Chun Hui Wang, Peng Lin, and Na He. 2005. High risk populations and HIV-1 infection in China. *Cell Res* 15 (11-12):852-7.