

Dengue and development: a critical political ecology

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DENGUE AND DEVELOPMENT: A CRITICAL POLITICAL ECOLOGY

DENGUE AND DEVELOPMENT: A CRITICAL POLITICAL ECOLOGY

By KATHLEEN MULLIGAN, M.A., B. ARTS SC.

A Thesis Submitted to the School of Graduate Studies in Partial Fulfilment of the
Requirements for the Degree Doctor of Philosophy

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Abstract

Policies for the control of dengue fever often construct the mosquito-borne virus as a disease of poverty, and call for disease control through “development” to meet the needs of poor populations and impoverished or unsanitary spaces. However, exceptions to the narrative of a rich/poor dengue divide persist in non-poor urban environments across the world. One example is Malaysia's new administrative capital city of Putrajaya – a wealthy and centrally planned new city with among the highest rates of dengue in the country.

This dissertation drew on theories of ecosocial epidemiology and urban political ecology to investigate and contextualize the geography of dengue and development in Putrajaya. Key informant interviews and critical discourse analysis found that infectious disease control fell well below other urban priorities for the city, and that globally dominant dengue control strategies targeted toward poor populations were inappropriately transferred to Putrajaya's non-poor local environment. A systematic review of the research literature found no clear evidence showing an association between dengue and conditions of poverty. These findings challenge conventional thinking by policy makers about epidemiological transition and the social determinants of health.

The dissertation addresses the dearth of research into the world's neglected tropical diseases (NTDs); in particular, gaps in our understanding of the

biopolitical and socioecological contexts (sites of urban governance, sites of health policy development and implementation, and sites of academic research) in which policies for NTDs like dengue are determined, enacted and justified. The dissertation further identifies non-poor urban environments – in particular those undergoing rapid development, such as Putrajaya – as key spaces for future geographic and political ecological research related to epidemiological transition, economic development and the social and environmental determinants of health.

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Kate Mulligan

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Preface

This thesis includes previously published material and material submitted for publication. Each of the three research papers included here follows the stylistic and referencing conventions of the associated journal. For all papers included in this thesis, Kate Mulligan devised the research instruments, analyzed the data and wrote the papers. Kate conducted all key informant interviews (presented in Chapters Two and Three) and both supervised and participated in undertaking the systematic review (presented in Chapter Four). For Chapters Two and Three, the additional authors on the papers adopted a supervisory role, providing suggestions on the research directions, data collection and analysis techniques, and providing comments on paper drafts. For Chapter Four, S.J. Elliott acted in a supervisory role while C.J. Sinn provided research assistance. S.J. Elliott, as the primary supervisor, provided significant supervisory assistance throughout.

*It would appear that diseases predominantly afflicting the poor
are unlikely to garner funding for research and drug development –
unless they begin to 'emerge' into the consciousness and space of the nonpoor.*

- Paul Farmer (2001), Infections and Inequalities: The Modern Plagues

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CHAPTER ONE

Introduction

Introduction

Policies for the control of dengue fever, a mosquito-borne virus prevalent in tropical and subtropical cities around the world, tend to consider the disease one of poverty. These policies focus on “development” to meet the needs of poor populations living in impoverished or unsanitary spaces. However, evidence to support the dengue-poverty narrative is scarce, and exceptions to the narrative of a rich/poor dengue divide persist in non-poor urban environments across the world. One example is Malaysia's new administrative capital city of Putrajaya – a wealthy and centrally planned new city with dengue rates that are among the highest in the country. If dengue is a disease of poverty and unplanned urbanization, why is the disease so prevalent in Putrajaya? How have hegemonic ideas about dengue and development affected population health in this emerging city? And what research evidence supports the hegemonic construction of dengue as a disease of underdevelopment? This dissertation contributes to our understanding of the geography of health by investigating and situating the political ecology of dengue fever in Putrajaya in the contexts of urban governance, global health policy, and academic research.

Research context

Dengue fever is the most rapidly advancing vector-borne disease in the world and a major public health issue for tropical and subtropical countries worldwide. Up to forty percent of the world's population – 2.5 billion people in over 100 countries – live at risk of infection and over 50 million infections are reported each year (Farrar et al. 2007, Morens and Fauci 2008, Gómez-Dantés and Willoquet 2009, WHO 2009). In urban areas, the water-related infectious disease is transmitted primarily by the *Aedes aegypti* mosquito, a container-breeding and day-biting mosquito adapted to the conditions of city life.

Despite its global importance, dengue fever (together with its more severe symptomatic manifestations in dengue hemorrhagic fever and dengue shock syndrome – throughout this dissertation referred to as “dengue”) has been under-prioritized in public health research and policy. For example, dengue research and control receives less than fifteen percent of the global funding allocated to malaria (Moran 2012), even though dengue is more common worldwide and measures combining both morbidity and mortality have shown the two diseases to have comparable impacts (Schwartz 2009). There is no vaccine or cure for the flu-like illness, which accounts for 25 to 30 thousand fatalities each year and 0.7 million lost Disability-Adjusted Life Years (DALYs) worldwide (Canyon 2008, Hotez et al. 2009). In response to the lack of attention to dengue, global health

organizations including the World Health Organization (WHO 2010) have included the disease in their emerging lists of the world's “neglected tropical diseases” (NTDs) – diseases that affect millions across the world and yet have been under-prioritized for public health research and action. Since 2003, the WHO has been purposefully moving toward an integrated approach to global health in which “attention and action are given to the health needs of populations affected by neglected tropical diseases rather than to their individual diseases” (WHO 2010, p. 7).

However, questions remain as to whether dengue should be categorized alongside the poverty-related diseases that the WHO claims act as “a proxy for poverty and disadvantage” (2010, p. 7) and are caused by “unplanned urban development, poor water storage and unsatisfactory sanitary conditions” (2008, p. x). Evidence of endemic dengue in wealthy households, neighbourhoods and cities across the global South and developed spaces in Australia, Europe and North America appears to run counter to the categorization of dengue as a disease of poverty (Wilder-Smith et al. 2004, Caprara et al. 2009). In addition, global trends including widespread urbanization and a growing middle class (now a majority of the population of the Global South) indicate that the infectious disease will be of increasing relevance for non-poor people and places in the near future (Adams 2011).

One such place is Malaysia's newly-emerging administrative capital city, Putrajaya. Despite being a planned and relatively wealthy city with excellent water quality standards and efficient public services, Putrajaya has among the highest rates of dengue in the country: roughly 359 per 100,000 population in 2008 – well above that year's national average of 182.72 per 100 000 population and Malaysia's goal rate of 50 per 100,000 (Ministry of Health Malaysia, 2011, 2008). By contrast, Singapore's dengue incidence during its major dengue outbreak of 2007 was 192.3 cases per 100 000 residents (Ler et al. 2011) and the 2008 national-level average across the WHO's Western Pacific Asian subregion was just 11.78/100,000 (WPRO 2010).

Home to approximately 70,000 people – almost exclusively ethnically Malay civil servants and their families – Putrajaya is a high-tech “intelligent garden city” which aims to be a model of the country's ambition to become a “fully developed,” high-income country by the year 2020 (Bunnell 2002, King 2008, Moser 2010). The expression of dengue in Putrajaya is not well predicted by global health discourses linking the disease to poverty and poor planning (WHO 2008, 2010) or by theories of “epidemiological transition” (Omran 1971) that suggest infectious disease considerations will give way to growing rates of chronic diseases as a region undergoes a linear path to economic development. A planned, wealthy and socially exclusionary space, the city of Putrajaya provides a

unique geographic location from which to examine the connections between urban planning, globalization and environment-related infectious disease.

Research objectives

Little research has investigated the materiality or the discourse relating dengue to poverty and unplanned urbanization. The potential mechanisms of these relationships are poorly understood. In addition, little research has investigated the epidemiology, determinants or control of dengue in non-poor spaces and populations, including the world's emerging cities and transitional economies. In fact, little social research of any kind has been conducted into the world's “Neglected Tropical Diseases” (Reidpath et al. 2011), despite recent calls for research into infectious diseases like dengue in urban areas as cities grow in size and importance worldwide – “partly driven by economic changes, but also by environmental and climate change, resulting in changed patterns of land use and residence, and changes in vector habitat and behavior” (Manderson et al. 2009). Since countries undergoing rapid urbanization, neoliberalization and economic growth illustrate potential future pathways of development for less-developed countries – pathways that are at times explicitly emulated by other countries in an era of inter-urban competition and policy transfer (Bunnell and Das 2010, Moser 2010) – health research that takes place in transitional economies and growing

elite urban centres may prove highly useful to understanding the complex connections between development and health.

This dissertation addresses the need to better understand the complex linkages between urban governance and infectious disease in emerging markets, and in particular the material and discursive links between dengue, poverty, and urban planning. It does so through an investigation of the materiality of dengue in the planned administrative capital city of Putrajaya, Malaysia. The thesis contextualizes Putrajaya's expression of dengue in the contexts of local urban development, global health policy and the current body of academic research. The objectives of this research were:

1. To analyze the connections between the epidemiology of dengue and the political ecology of urban governance in Putrajaya, Malaysia.
2. To locate the political ecology of dengue in Putrajaya within local and global-level discourses linking dengue to poverty.
3. To identify and assess the current academic research evidence that poverty is a determinant of dengue.

Theoretical framework

Dengue fever, and indeed all human health, is expressed, experienced and exchanged at the nexus between social and environmental systems. To understand

this complex nexus, this research takes a *political ecology of health* approach, seeking to look beyond dominant medical and behavioural approaches to health and illness to consider local and global ecological and political-economic conditions as fundamental determinants of individual and social health (Birn et al. 2009). Research into the political ecology of health has three main agendas; to:

generate new insights into the political economy of disease, interrogate health discourses produced by actors and institutions, and show how health is shaped through the relationships between social and environmental systems (King 2010, p. 40).

In this dissertation, political ecology of health is also used as a linking concept that bridges the fields of ecosocial epidemiology and urban political ecology by interrogating the expression of health conditions in human bodies and/in their urban environmental context(s). Each of these theoretical traditions understands human-environment relations to be dialectical and co-determining, but each has traditionally taken a different interest in the material manifestation of power relations.

The unit of interest for urban political ecology is the city. Political ecologists investigate the politics of urban environments by identifying the connections “between the materiality of nature and the sociopolitical processes embedded within it” (Budds 2004). Urban political ecology understands cities as complex socio-ecological entities (Heynen et al. 2005, Keil 2005) whose material and social metabolisms serve as manifestation expressions of urban power

relations (Bakker 2003, 2005; Budds 2004; Swyngedouw 2004).

For ecosocial epidemiologists, human bodies also manifest – literally, *embody* – social and environmental relations. For ecosocial epidemiologists, human bodies are biological expressions of social, material, and ecological contexts that “tell stories about – and cannot be studied divorced from – the conditions of our existence” (Krieger 2005, p. 350). Bodies are the biological incorporation by human populations of their material and social worlds. In integrating these research traditions, this dissertation traces the geography of health to the relationships between people in/and their urban environments, and to the pathways by which disease becomes literally incorporated in human bodies. Further, the dissertation addresses the material-discursive processes that link the local expression and control of dengue in Putrajaya with current trends in global health policy and research.

Research design

Informed by political ecology's three main agendas [to interrogate health discourses, to understand health-environment interactions, and to understand the political economy of disease (King 2010)], this dissertation draws upon a multiple methods approach to understanding the political ecology of dengue fever. Each of the three papers represents research from one of three analytical perspectives and

scales: a bottom-up, theory-building case study of the relationship between social and environmental systems in Putrajaya; a top-down systematic review of the academic research evidence that poverty is a determinant of dengue fever; and an integrative, materialist discourse analysis that links the two by interrogating the operationalization of global health discourses at the local level in Putrajaya. Taken together, the multiple-methods approach creates a multi-layered, contextualized case study of dengue's political ecology in local and global, discursive and material, academic and applied, and general and particular contexts.

Following political ecology's case study tradition (Bakker 2003, 2005; Budds 2004; Swyngedouw 2004), the research program began by constructing a theoretically-informed case study – “an evolving structure of argument sensitive to encounters with the complex ways in which social processes are materially embedded in the web of life” (Harvey 2006, p. 78-79). Such case studies are uniquely useful in exploring and understanding new or complex human situations (Flyvbjerg 2006). They are critical to urban political ecology as a means of bottom-up theorizing – understanding underlying, guiding social forces in relation to material historical and geographic processes (Harvey 2006). The case study drew primarily on key informant interviews conducted with central figures in Malaysian public health, urban planning and design, community leadership and governance at local, regional and federal levels. The interview data were

supplemented by textual sources including planning documents from government and private sources, archival records, and media reports, along with direct observation. This last activity includes the consideration of physical artifacts such as buildings, landscapes, and dengue-fogging equipment, understanding these material entities to serve both as “discourse materialized” and as agents in themselves (Schein 1997).

The interview transcripts, taken to represent local discourse, were then analyzed in comparison with the World Health Organization's *Working to overcome the global impact of neglected tropical diseases: First WHO report on Neglected Tropical Diseases* (WHO 2010), a text broadly representative of the current global consensus on global and national-level health policy approaches to dengue fever. The texts were analyzed for both manifest and latent content, with a view toward understanding the ways in which discourse, as social practice, is materialized and operationalized in the local context (Fairclough 2005, 2009; Wodak and Meyer 2009).

Finally, a systematic critical review of the academic research literature was undertaken, seeking all types of empirical studies that directly assessed the correlation between poverty or its indicators on dengue or vector rates. Following a systematic search of six electronic databases across the biomedical sciences, physical and natural sciences, social sciences, and international health disciplines,

articles meeting eligibility criteria were assessed for relevance and quality and were analyzed and compared according to a predetermined set of evaluative criteria.

Chapter outline

The majority of this thesis is a collection of works published in, or submitted to, scholarly journals. Chapter Two draws on key informant interviews, direct observation and document analysis to present a case study of the relationships between the local expression of dengue fever and the pursuit of other urban priorities in the city of Putrajaya, Malaysia. The research addresses the connections between the epidemiology of dengue and the political ecology of urban governance in Putrajaya (Objective 1) by asking: how is the expression of dengue fever shaped at the interface between environmental health and urban governance?

Chapter Three treats the key informant interview transcripts, along with a recent document from the World Health Organization's Neglected Tropical Diseases initiative, as textual sources for a critical discourse analysis. The chapter considers the dialectical relationship between global dengue discourse and/as material and social practice in the city (Objective 2), asking: how are globally hegemonic discourses relating to dengue fever and poverty recontextualized and

operationalized in Putrajaya, Malaysia?

Chapter Four is the result of a systematic review of academic literature investigating the correlations between dengue and poverty. The chapter is driven by the key findings of the previous chapters: that dengue is not always a disease of poor populations or poor places (Chapter Two); and that currently hegemonic global health policy purposefully identifies poor populations and environments as determinants of dengue (Chapter Three). The review identifies and assesses the current academic research evidence for poverty as a determinant of dengue (Objective 3) through a systematic search for and analysis of academic studies investigating poverty and its indicators as determinants of dengue fever. The chapter asks: what is the research evidence that poverty is a determinant of dengue?

Chapter Five draws together the three substantive papers, addressing the dissertation's material, theoretical and methodological contributions to the study of urban political ecology of health. This chapter identifies the results from each paper that make the greatest contribution to the literature. The chapter also elaborates on the implications and contributions of the thesis by evaluating the multiple-methods research approach and considering both policy implications and potential areas of future research.

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CHAPTER TWO

The place of health and the health of place:

Dengue fever and urban governance in Putrajaya, Malaysia

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Mulligan K., Elliott, S.J. & Schuster-Wallace, C. 2012. The Place of Health and the Health of Place: Dengue Fever and Urban Governance in Putrajaya, Malaysia. *Health & Place* 18(3), 613–620

Abstract: This case study investigates the connections between urban planning, governance and dengue fever in an emerging market context in the Global South. Key informant interviews were conducted with leading figures in public health, urban planning and governance in the planned city of Putrajaya, Malaysia. Drawing on theories of urban political ecology and ecosocial epidemiology, the qualitative study found the health of place – expressed as dengue-bearing mosquitoes and dengue fever in human bodies in the urban environment – was influenced by the place of health in a hierarchy of urban priorities.

Research Highlights: > Key informant interviews addressed connections between urban governance and health > Putrajaya prioritized rapid growth, neoliberalization, model intelligent garden city > Action on these urban priorities affected dengue outcomes in Putrajaya > Emerging markets and planned cities not immune from environmental infectious disease > Place of health in hierarchy of urban priorities affects health of place

Keywords: dengue, urban, governance, political ecology, Putrajaya, Malaysia

1. Introduction

1.1 Dengue, urban planning and emerging economies

Dengue fever is a highly prevalent and globally neglected tropical disease strongly associated with urbanization. Cities provide ideal habitats for its urban vector, the *Aedes aegypti* mosquito, which depends on anthropogenic water sources for propagation. Dengue (including its more severe manifestations in dengue hemorrhagic fever and dengue shock syndrome) is the most rapidly advancing vector-borne disease in the world. It has no vaccine or cure – making the environmental control of the virus and its host mosquitoes a major public health challenge for the 2.5 billion people – forty percent of the world’s population at risk of infection in tropical countries worldwide (Farrar et al., 2007; Gomez-Dantes and Willoquet, 2009; Morens and Fauci, 2008; WHO, 2009).

Because dengue-bearing *Aedes* mosquitoes breed in water-filled small containers, puddles and refuse common in high-density urban areas, it is no surprise that one of dengue’s most frequently cited environmental determinants is rapid urban development coupled with poor or nonexistent urban planning (Kyle and Harris, 2008; Snowden, 2008; Campbell-Lendrum and Corvalan 2007, Stephenson, 2005). According to the World Health Organization’s (2008) Dengue

Strategic Plan for The Asia Pacific Region 2008–2015, for example

the progressive worsening of dengue in the Asia Pacific Region is attributed to unplanned urban development, poor water storage and unsatisfactory sanitary conditions, all of which contribute to the proliferation of the main vector, the *Aedes aegypti* mosquito (p. 1).

More surprising, however, is the dearth of research evidence to support this connection: few research studies have directly investigated the role of urban governance, planning or design in the spread and the control of dengue fever; policy prescriptions for dengue and planning tend to focus on the absence or presence of planning measures rather than the substance of planning processes, policies or outcomes (cf. WHO, 2008). In research and in policy, insufficient attention has been paid to the details of how planning relates to dengue fever and which planning measures might mitigate the spread of the infectious disease. The lack of research studies represents a serious gap in our collective knowledge about how dengue may be affected by urban planning and municipal services: although dengue control policies may be rooted in this presumed connection between dengue and urban environments, the details and direction of this relationship are poorly understood. Also poorly understood is the relationship between the urban planning and urban governance sectors—and not only the health sector—in preventing and managing this infectious disease.

Intertwined with the construal of dengue as a disease of poor urban

planning is its construal as a disease of poverty. The *First WHO Report On Neglected Tropical Diseases* (WHO, 2010b), for example, classifies dengue as one of sixteen globally neglected diseases so “strongly associated with poverty” that they serve as “prox(ies) for poverty and disadvantage” (pp. 3, 5). This characterization runs counter to the experience of dengue in many wealthy and middle-income urban areas. For example, almost half of surveyed adults in Singapore—one of the wealthiest countries in the world—show evidence of previous dengue infection (Wilder-Smith et al., 2004). In addition, as infectious vector-borne diseases, including dengue, re-emerge and expand their ranges in the context of globalization—through both the material global flows of people and products, and the changing environmental conditions brought on by urbanization and climate change—the demographics of dengue risk appear to be changing. Global trends, including widespread urbanization and a growing middle class (now a majority of the population of the Global South), indicate that the infectious disease will be of increasing relevance for non-poor people and places in so-called “emerging markets” (Adams, 2011).

Little research has considered the expression or control of dengue in the world’s emerging cities and transitional economies. In fact, little social scientific research of any kind has been conducted into the world’s neglected tropical diseases (Reidpath et al., 2011). The multilateral Special Programme (<http://www.>

who.int/tdr/about/en/) for Research and Training in Tropical Diseases (TDR) has called for more social scientific research at the interface between globalization and disease control, with increasing concern for research into infectious disease prevalence in urban areas as cities grow in size and importance worldwide (Manderson et al., 2009). Countries undergoing rapid urbanization, neoliberalization and economic growth illustrate potential future pathways of development for less-developed countries—pathways that are at times explicitly emulated by other countries in an era of inter-urban competition and policy transfer. Health research that takes place in transitional economies and growing elite urban centers may therefore prove highly useful to understanding the complex connections between development and health.

One such emerging city is Putrajaya, Malaysia, a new and planned “administrative capital” that has undergone a rapid transition from oil palm and rubber plantation to would-be global city over the past 15 years. Centrally planned and relatively well-off, with showpiece architecture and public services, Putrajaya does not appear to demonstrate the “unplanned urban development, poor water storage and unsatisfactory sanitary conditions” held by the WHO (2008, p.2) to be driving dengue’s re-emergence in Asia. Surprisingly, however, the population of Malaysia’s “intelligent garden city” has very high rates of dengue (Ministry of Health Malaysia, 2011). Dengue incidence is rising rapidly across Malaysia

(WHO, 2010a; Ministry of Health Malaysia, 2008). In Putrajaya, 237 cases of dengue were reported in 2008 – an estimated case rate of 395 per 100,000 in the roughly 60,000-strong city that year – well above both the national average and the national goal to be below 50 cases per 100,000 population (Ministry of Health Malaysia, 2011, 2008). Putrajaya provides a unique geographic location from which to examine the connections between rapid development, urban planning and public health: if poverty and planning are important determinants of dengue, what explains the expression of the disease in this prosperous and planned region?

1.2 Theoretical framework: the political ecology of urban health

Dengue fever, and indeed all human health, is expressed, experienced and exchanged at the nexus between social and environmental systems. To understand this complex nexus, this research takes a political ecology of health approach, seeking to look beyond dominant medical and behavioral approaches to health and illness to consider local and global ecological and political–economic conditions as fundamental determinants of individual and social health (Birn et al., 2009). Research into the political ecology of health has three main agendas; to:

generate new insights into the political economy of disease, interrogate health discourses produced by actors and institutions, and show how health is shaped through the relationships between social and environmental systems. (King, 2010, p. 40).

In this paper, political ecology of urban health is used as a linking concept that bridges ecosocial epidemiology and urban political ecology by interrogating the expression of health conditions in human bodies and their urban environmental context(s). Both theoretical traditions understand human–environment relations to be dialectical and co-determining, but each takes a different interest in the material manifestation of power relations.

For urban political ecology the unit of interest is the city; for ecosocial epidemiology it is the human body. Political ecology is primarily concerned with the connection “between the materiality of nature and the sociopolitical processes embedded within it” (Budds, 2004, p. 325), regarding cities as complex socioecological entities (Heynen et al., 2005; Keil, 2005). The material and social metabolism of cities, including the changing meanings and socioenvironmental roles of water in the urban hydrosocial cycle, is of particular interest as a manifestation of urban power relations (Swyngedouw, 2004; Bakker, 2003, 2005; Budds, 2004). For ecosocial epidemiologists, human bodies are biological expressions of social, material and ecological contexts that “tell stories about – and cannot be studied divorced from – the conditions of our existence” (Krieger 2005, p. 350) – literally, the biological incorporation by human populations of their material and social worlds (Krieger, 2006; Krieger and Davey Smith, 2004; Yamada and Palmer, 2007). In integrating these research traditions,

this investigation of the political ecology of dengue in Putrajaya will address the inter-development of urban policies, the biophysical environment, and human health. The paper asks, in other words, how a human population – biological beings in connection with their lived environments (social, political and environmental) – comes to embody endemic dengue. In particular, which urban policies promote or prevent this disease-state in the municipal population? The focus of this paper is therefore not on the appropriateness of the full breadth of health sector policies for disease control (clinical methods, pharmaceutical development and health promotion activities) but on environmental and vector control at the nexus between planning, development, governance and health.

1.3 Context

The city of Putrajaya sits midway between Malaysia's capital city of Kuala Lumpur and the Kuala Lumpur International Airport. The city was conceptualized in the early 1990s as part of former Prime Minister Tun Mahathir's 1991 development plan, *Wawasan 2020* (Vision 2020), which aimed to make Malaysia a "fully developed", high-income country by the year 2020. Alongside the high-tech IT city of Cyberjaya, Putrajaya forms the urban heart of the Multimedia Super Corridor (MSC), a 50-km mega-project literally and symbolically linking the Kuala Lumpur metropolitan region to the international airport and to the

world. Putrajaya was designed to form Malaysia's new administrative capital, anchored by grand-scale federal government offices and housing up to 300,000 civil servants and their families in government-sponsored highrise apartments, bungalows and townhouses. The new city would represent the ultimate in high-tech and orderly modern governance, free from the traffic chaos, haphazard design and colonial baggage of Kuala Lumpur (KL), "a move that would distance Malaysia from its colonial past while emphasizing its new identity as a sovereign nation" (Moser, 2010, p, 289). As a government administrative center, Putrajaya would also represent the ideal expression of Malay Muslim ethnic and economic identity within Malaysia's multicultural society (King, 2008).

Built on a former oil palm plantation, Putrajaya rapidly and dramatically altered land use and population patterns from low-density plantation agriculture to higher density and higher-tech urban governance. Imagined as an "intelligent garden city", Putrajaya's landscape includes 38% green space and depends on a complex system of artificial lakes and wetlands to service the city's water needs. The city is also characterized by large-scale 'fantasy Islamic' and "high-tech" architecture (Moser, 2010, p. 292), which concretizes a particular political vision of Malaysia as a modern Islamic state whose future faces the Middle East (King, 2008). These concretizations of urban priorities and dreams demonstrate what Yeoh (2005) calls a particularly Southeast Asian version of "spatial

Imagineering”, in which urban areas intentionally aestheticize local landscapes as part of planning, branding and marketing strategies.

Surrounded by the urban state of Selangor, Putrajaya is officially an independent Federal Territory planned and governed by the federally mandated Putrajaya Corporation rather than an elected town council. The primary developer is the government-linked corporation Putrajaya Holdings, itself a subsidiary of government-owned energy giant Petronas. There is little private industry or commercial development in the city and only a small fraction of households are privately owned. The current population of Putrajaya is approximately 70,000. Because of the historic conflation between ethnicity and job function in Malaysia, the inhabitants are almost exclusively Malay. Most residents are middle-income or upper-middle income civil servants living in government-subsidized housing quarters. Other inhabitants of the city include the domestic servants and construction workers (usually immigrants, often illegal or temporary workers) who live outside the city and commute to their workplaces each day. To date, the small community lacks the social cohesion and sense of place its planners envisioned: many civil servants continue to live outside Putrajaya and commute to work, while others return to their home communities on weekends (Ismail et al., 2008). Construction of the city began in the late 1990s, proceeded rapidly for the next decade and continues at a slower pace today.

2. Methods

2.1 Research design

This paper draws from broader case study research into the development of dengue in Putrajaya. Informed by political ecology's case study tradition (Bakker, 2003, 2005; Budds, 2004; Swyngedouw, 2004), the research aims to construct, from interview data and other empirical evidence, a theoretically informed case study—"an evolving structure of argument sensitive to encounters with the complex ways in which social processes are materially embedded in the web of life" (Harvey, 2006, pp. 78–79). Such case studies are uniquely useful in exploring and understanding new or complex human situations (Flyvbjerg, 2006). They are critical to urban political ecology as a means of bottom-up theorizing—understanding underlying, guiding social forces in relation to material historical and geographic processes (Harvey, 2006).

The study relied on multiple sources of evidence, drawing primarily on key informant interviews ($n=14$) conducted with central figures in public health, urban planning and design, community leadership and governance at local, regional and federal levels. The interview data are supplemented by textual sources, including planning documents from government and private sources, archival records and media reports, along with direct observation—the consideration of physical artifacts such as buildings, landscapes and dengue-

fogging equipment, understanding these material entities serving both as “discourse materialized” and as agents in themselves (Schein, 1997). The study received ethics clearance from the McMaster University Research Ethics Board, the Research Ethics Committee of the Universiti Kebangsaan Malaysia and the Malaysian Ministry of Health.

2.2. Data collection

A purposeful sample of key informants was identified from Internet searches of local databases, conference proceedings and government and agency directories. Key informants were then contacted by email with a joint formal letter from the local and international research partners. The formal letter included details of the study’s purpose, methods, confidentiality measures and procedures for informed consent. Additional, potential participants were identified by key informants themselves (snowball sampling) throughout the interview period. Of thirty-two individuals contacted throughout the research process, fourteen agreed to an interview or designated a delegate to be interviewed; two refused (one because the interview was deemed not relevant to the individual’s work, and one because the individual was denied permission from superiors to participate); and there were sixteen non-responses. Recruitment was considered complete on the basis of theoretical saturation and the inclusion of more than one

representative of each key sector (public health, governance, planning and development, community and academia). The key informant interviews, each approximately one hour in duration, took place in Malaysia in September and October 2011 and followed a theory-driven interview schedule guided by questions derived from an extensive literature review. Direct observation took place over a series of visits to Putrajaya between March 2010 and November 2011 and included residence in Putrajaya by the lead author between September and November 2011. Documents for analysis were identified through academic literature reviews, Internet searches, government archival searches and the suggestions of key informants.

2.3. Analysis

Interviews were recorded and transcribed, with permission, and coded with the assistance of NVivo 8 qualitative analysis software. An initial set of thematic codes, derived from the literature and theoretical framework, was applied to the interviews and refined throughout the analysis. Reliability of the initial coding and its application to the data were assessed using both qualitative comparisons and quantitative tests of inter-rater reliability. First, one coder applied a set of theory-derived thematic codes to two transcripts while an independent coder reviewed the transcripts using an inductive, grounded approach. The arising themes were

then qualitatively compared; a high degree of qualitatively assessed consistency was found between raters. In areas of disagreement between raters, new dialogs emerged, which helped to clarify the coding scheme and to identify further analytical directions. A revised set of theme codes was then developed collaboratively and applied to two interview transcripts by both the lead author and a new independent reviewer. Inter-rater reliability for the resulting coded transcripts, compared on the basis of percentage agreement (Miles and Huberman, 1994), was found to be over 93%.

Respondent validation and feedback were solicited at two points during the research process. During interviews, some responses were restated or summarized to the participants, who were then questioned about the accuracy of the summarized or restated responses. Following the interviews, each participant was also invited to respond in writing to the accuracy and completeness of a written summary of key findings. Participation in the member-checking exercise was optional. Checks and balances on the lead researcher's own position, possible bias and influence on the research took the form of ongoing discussions with the research team and with research staff at UNU-IIGH, as well as the creation of a separate, independently accessible evidence database and research diary (using NVivo 8).

3. Key findings

It is not about lack of planning. We do have very good planning, but I don't think when it comes to the health aspect, it is not that sufficient, because they are very much putting emphasis on architecture, landscape, you know, to make it look grand and beautiful, but when it comes to health, it's not the top priority for them. So I won't say lack of planning. I would say different priorities.

- Public health official

The key informants interviewed for this study were asked about a wide range of urban governance issues, including infectious disease management. The following discussion focuses on the four most commonly identified urban priorities and the ways in which each intertwined with emergent dengue in the city. These priorities were: rapid construction and development; the development of a neoliberal city administered by a modernized public service in the Malaysia, Inc. model; the creation of an “intelligent garden city” with high standards for environmental services, parks and recreation; and the establishment of an exemplary “model city” whose structures and citizens would demonstrate a particular vision of Malaysian *boleh* (can-do spirit) to the country and to the world.

3.1 Rapid development

Putrajaya is a planned city, and we are developing very fast...the number of dengue cases is very high, and our incidence is also very high compared to the other local authorities or the other townships, because of the rapid development.

- Public health official

A key priority for Putrajaya was rapid development to meet Mahathir's 2020 deadline for Malaysia's economic transformation. Key informants reported that in the rush to build, considerations of dengue fever were neglected. At the design stage, architects and project managers working under the authority of their government client did not question the local appropriateness of the borrowed architectural forms employed in Putrajaya. One architectural expert stated:

With Mahathir's very fast industrialization, you have a situation where you can build, build, and build and build very fast...it's like shoot first and ask questions later. So it is like build first and never really ask any questions at all.

The result was impressive-looking buildings with major design flaws that created semi-permanent areas for *Aedes* breeding. Homes were designed with unreachable rain gutters under leafy tree canopies, making checking and cleaning for mosquito breeding in clogged gutters impossible for local residents. Unscreened windows allowed mosquitoes to enter living quarters, and poorly sloped storm drains left standing water in households and neighborhoods during less-rainy seasons.

According to one construction expert, "Putrajaya, although it's a showcase, we

are in a very fast track project, so project managers have overlooked those things”.

During construction, inspection and enforcement of mosquito breeding regulations on construction sites was inconsistent. One public health expert noted, “the construction sites are not really being looked into for the breeding sites by the developer,” putting construction workers – usually foreign (and often illegal) workers – as well as nearby residents at high risk of exposure to the dengue virus. Following construction, some of the rapidly constructed buildings were completed long before government workers were prepared to move in. These went unoccupied and locked for long periods of time, creating opportunities for mosquito breeding in unflushed toilets and unmaintained areas. One public health official stated, “If there is empty quarters for a long period of time, the stagnant water in the toilets and the water tanks will be a problem for dengue, *Aedes* breeding”.

3.2 Malaysia, Inc.

Malaysia is very ambitious. Vision 2020, new economic model – what it means is they want to have a better quality of life. At the same time they want to protect and safeguard the environment, at the same time they want high income. But this is as you know very difficult...

- Environment expert

In aiming for the latest in “fully developed” governance for the intelligent city,

Putrajaya represented a uniquely Malaysian effort at drawing on neoliberal thinking by involving public–private partnerships. In part under a model known as *Malaysia, Inc.*, public services were subcontracted to private companies and government-linked corporations (GLCs) were prioritized in national development plans to promote ethnic Malay participation in the country’s Chinese-dominated economy. While key informants generally expressed pride in this economic transformation, they also identified several ways in which neoliberal-inspired strategies contributed to rising rates of dengue in the city.

Because GLCs were considered integral to national development, they were issued special rules and exemptions. In Putrajaya, the city’s chief developer (the GLC Putrajaya Holdings) was issued a rushed construction schedule coupled with a special extended liability period to cover potential building and design flaws. This policy facilitated the city’s rush to construction and may have contributed to a failure to inspect fully for mosquito breeding. One development official remarked:

A normal contract for buildings is eighteen months, but outside it is normally twenty-four months. Then again our liability period here is more than outside...I think it is more of a quality issue, where drains are not inspected properly, and they do allow for stagnant spots.

The city’s government – the unelected *Perbadanan Putrajaya* (Putrajaya Corporation) – also followed neoliberal thinking by subcontracting many public services to smaller private companies. These efforts decentralized responsibility

for delivery of essential services, including those related to landscaping, building maintenance and sanitation. Subcontracted companies at times refused to pick up rubbish in wrongly labeled containers, for example, or argued about which company was responsible for waste pickup in different areas of the city.

According to one official:

The contractors blame each other, they also want to reduce their expenditure, so they are quarreling every day. The rubbish is not collected, so stays on the ground, so when the rains come, sometimes this rubbish becomes collection for water, and also becomes a breeding ground.

Rather than clarifying roles, the city periodically rewarded this confusion by paying extra for a single company to clean up all waste in a particular area.

In addition, with the federal government serving in a mix of officially public or private capacities such as landlord, tenant, resident, government and chief developer, enforcing monetary fines (“compounds”) for failing to comply with breeding regulations – a key strategy and operating-income generator for public health officials elsewhere in the country – was ineffective in Putrajaya. Front-line enforcement officers found it difficult to challenge their public service counterparts over dengue-related infractions. As one health official observed:

Here more of the houses are government quarters, so it’s quite difficult to issue compounds here. They will say, I’m a government servant, you’re a government servant, why do you want to issue a compound? ... Enforcement-wise it’s quite difficult, because normally we issue the compound to the government. We cannot do that, because we are the government.

3.3 The intelligent garden city

When they designed the city, bringing some kind of natural element to the city was a priority. The whole idea about integrating nature into the urban fabric is very much implemented here...The whole idea, the sacredness of the water being introduced, translated into urban planning. I mean in general that is how we see water, and that can ultimately create problems like dengue.

- Urban planner

From the early planning stages, Putrajaya's goal was to earn its name as Malaysia's "intelligent garden city". The smoothly run "city in a garden" would necessitate a highly engineered biophysical environment featuring the highest standards for environmental services, including water provision and waste collection. According to several key informants, the major emphasis on the cultural importance of landscape rendered other considerations, including public health, as secondary. As one public health official noted, "They are very much putting emphasis on architecture, landscape, you know, to make it look grand and beautiful, but when it comes to health, it's not the top priority for them".

Planners also emphasized the importance of the garden city for maintaining healthy citizens by providing opportunities for recreation and physical activity. However, although Putrajaya subscribed to the WHO's "Healthy Cities" model, the initiative was seen as more of a branding exercise than a serious consideration of urban health. One urban planner noted, "Probably it is just a, I don't know, a lip service...it is a known program, but I do not think, the

healthy city program, I don't think it is taken seriously". While parks featuring the breadth of Malaysia's flora were designed to encourage residents and visitors to be active in the outdoors, and bicycle lanes were constructed throughout the neighborhoods, the city's lack of shade created urban heat problems. As the population grew, the city's open plazas, wide streets and gardens remained largely empty of pedestrians, who preferred to drive from one air-conditioned destination to another.

The majority of residents proved less than willing to participate in community activities, including *gotong-royong* (community cleanups) in the garden city. As one public health expert observed, "People in Putrajaya are busy. How many people would want to go and clean up their surrounding areas, or how often do they have time to even do that?" At home, Putrajaya's residents were encouraged to beautify their homes and neighbourhoods through *bumi hijau* (gardening), but the water features and plant pots used in their household and neighborhood gardens created potential *Aedes* breeding sites. The public health expert noted:

Malaysians like pots with lots of water in the gardens...and you get a lot of that, thinking it's very beautiful. You also get people collecting rain water, and more often than not, the dengue mosquito.

Water, in particular, was intended to play important symbolic, religious, ecosystemic and public health roles in the garden city. One urban official stated:

We have been branded by our Prime Minister to be the green city. So we are working towards that. So these are the things that are related, water quality must be good, bottled water must be good, the waste water must be clean, and we must have a healthy city.

Artificial lakes and wetlands were constructed on the formerly dry oil palm plantation to serve the city's urban metabolism; water features predominate in community and household gardens; and clean, piped drinking water circulates throughout the city, reducing the need for stored water which creates dengue problems in water-insecure environments. The purpose-built Putrajaya Lake, created to serve as a recreational hub in the city and to enable the city to host international caliber aquatic events, had strict standards for body-contact-level water quality: sand traps and gross pollutant traps were installed outside homes and other buildings throughout the city to prevent polluted stormwater from entering the lake. However, efforts to maintain high water quality in the city had an unexpected outcome: the traps became key breeding grounds for dengue-bearing mosquitoes. One health official described the effects:

The purpose of the sand traps...is to prevent all of the sands, the grease, all the rubbish to enter the lake...but however it also causes stagnant water. So initially there were lots of sand traps built [and] after a few years, the dengue cases began to rise.

3.4 The model city

Ultimately the government is spending this amount of money. I think we have to make it work. It has to be the model city. There is no choice about it.

- Urban planner

Putrajaya was designed as a model city, an opportunity to demonstrate Malaysia's modernity and its potential – its *boleh* – to the country's own citizens and to the world. Planners, government workers and residents faced considerable pressure to portray a story of Malay success, not only in urban style but in urban governance and civic behavior. One environment expert described Putrajaya's pressures and opportunities:

Putrajaya is really important. It has to portray that good. Green building must be demonstrated in Putrajaya first. Any systematic system about lifestyle would be possible if people in Putrajaya demonstrate it first.

Key informants pointed to several ways in which the pressure to perform contributed to rising dengue rates in the city. Despite the emphasis on creating a “good community with good values” as a key part of what one government official described as the overall “mission to make Putrajaya an example to the other cities in Malaysia,” the actual community of Putrajaya demonstrated little interest in civic participation. While some key informants found this outcome surprising – “It is so surprising that here in Putrajaya, where the majority are public servants...we have attitude problems in so many aspects”,

– others linked the lack of social cohesion to the historically inferior social status of Malaysia's civil servants: "I do not think in general government servants are highly respected...there is no identification that government servants have to perform in certain ways, because they are menially paid". In addition, despite common narratives linking poor attitudes about dengue to poverty, health officials stated that those in higher income brackets were the least likely to participate in health promotion campaigns:

The dengue epidemic is longer in the upper class area, because the participation of the upper class people is less. They do not allow us to go into their house to check their premises...they say fogging will damage the value of their property.

Although rising rates of the disease meant dengue was eventually recognized as a major public health issue in Putrajaya, public health continued to face competing interests from a range of other government stakeholders and sectors. According to one government worker:

Putrajaya is the place where we assemble all the big guys: the politicians, the ministers, and the senior government heads of departments. Many of them stay in Putrajaya, and these people have their own perceptions and perspective, so everybody has a different opinion in the sense of what they want to have, so the stakeholders are too many.

Despite the general consensus that dengue fever had become the city's top public health priority, for example, the health sector was not included in major planning committees, processes or decisions. There was no formal role for health or vector control in final building inspections; health officials were not

represented on the One Stop Committee overseeing building and development plans. The committee comprises a long list of government representatives and stakeholders, including representatives of utility companies, telecommunications, electricity, sewage, irrigation, public works and the fire brigades, but excludes the health sector.

In part because of intense pressure on Putrajaya to be Malaysia's model city, there was little official tolerance for high dengue rates or mosquito-promoting behaviors that might embarrass the government or detract from Putrajaya's exemplary image. As one health expert described it:

They do recognize dengue as a very high risk in Putrajaya, because to them Putrajaya should be the example city. There should be no cases of dengue, because it is a planned city, so it should be a model city.

The culture of secrecy in the Malaysian bureaucracy, coupled with the desire to project a positive image of Putrajaya as a national urban leader, led health and planning officials to downplay any dengue outbreaks and try to keep them out of the spotlight. Putrajaya's dengue case data were reported monthly by the Ministry of Health, but in general only after being aggregated with those of neighboring (and much larger) Kuala Lumpur—rendering the public results meaningless for interpreting the scale of Putrajaya's epidemic. In addition, residents were discouraged from speaking to the media about dengue. As one health official reported:

we are very near to the headquarters, then people, normally they will go to the press to report. We don't want that to happen. We want them to tell us, not to tell the press, because when they tell the press, then our big bosses, they will jump. So very [much] pressure.

4. Discussion

This paper has applied a political ecology of health framework to understand the ways in which dengue is shaped at the interface between environmental health and urban governance in the city of Putrajaya. The case of dengue in Putrajaya provides some evidence of the ways in which health, and in particular infectious disease management, is systematically excluded from mainstream urban planning and governance. Despite widespread knowledge of the dengue virus and its vectors, there is little consideration of environmental health in urban policy and even less formalized interaction between public health officials and the planners and policy makers responsible for urban development. The case of dengue in Putrajaya also serves as a reminder that all urban development takes place in a particular biopolitical context. In prioritizing a symbolic city over a material one, Putrajaya's planners failed to consider either the city's ecology or the likely uses of the city by its middle-class inhabitants. Despite aims to transcend local conditions through urban development symbolizing a new, modern, Islamic Malaysia, Putrajaya's planners were unable to escape the complex interactions between urban governance and environmental

health in their local socioecological system.

The geographic expression of dengue in Putrajaya is shaped much differently than might have been predicted from global health discourses and biomedical research linking the disease to poverty and poor planning. In Putrajaya, dengue fever emerged not in spite of the existence of relative wealth, high quality public services and a centralized urban planning strategy, but in some ways because of these urban characteristics and processes. In locally situated ways, the relative prioritization of dengue control and infectious disease in Putrajaya became embedded in the everyday structures and processes of urban governance, affecting both the urban environment and human health outcomes in the city. The city's most important urban priorities—rapid development, neoliberalization, “intelligent garden” ecology and model city status—represented not infectious disease control but a broader material and symbolic effort to create a new city-space divorced from its socioecological context. The emergence of dengue in Putrajaya reflects some of the key ways in which the *health of place* is influenced by the *place of health* (and in particular infectious disease) in the complex local hierarchy of priorities for urban governance and planning.

Although dengue is often characterized as a disease of poverty and poor planning, the case of endemic dengue in Putrajaya demonstrates that urban

populations in tropical environments, no matter how “elite”, do encounter dengue fever and *Aedes* mosquitoes in their daily lives. However, theories of “epidemiological transition” (Omran, 1971) – which presume that infectious disease considerations will give way to growing rates of chronic diseases as a region undergoes a linear path to economic development – continue to pervade global health discourse about dengue fever, underpinning global constructions of dengue as a disease of poverty and poor planning (WHO, 2008, 2010a). This thinking may go some way toward explaining the lack of concern for dengue fever shown in Putrajaya’s early development and planning stages.

The introduction of health evidence grounds political ecological analysis of urban power relations in the biological necessities of population health. The political ecology of urban health perspective calls attention not only to power relations in their environmental context – the production of “neoliberal nature” in an urban environment (Bakker 2003, 2005; Keil, 2005) – but also to the particular pathways by which human social relations become literally, biologically embodied—the production and reproduction of endemic disease. The approach illuminates not only the non-linear relationship between human health and economic and urban development in Putrajaya, but also the particular vulnerabilities of a population living under a political and spatial Imagineering project (Yeoh, 2005) focused on non-health priorities for urban development.

In Putrajaya, the state rushed to create a city to embody the modern, Islamic Malaysia—overlooking public health in favor of neoliberal public policy and aspirational public space. This state-directed approach rendered population health secondary to particular politically and ethnically nationalist urban aspirations, producing a “neoliberal nature” under which the environmental, political and social conditions for endemic dengue were created and reproduced. The city’s goals were reinforced in political structure (through the installation of an unelected municipal government, the use of state contractors and funds, and the systematic exclusion of public health experts from urban planning), in process (the emphasis on rapid development, the segregation of populations by race and class, and the contracting out of essential public services) in architecture and urban design (the focus on urban beautification, the creation of an artificial wetland city and the desire to appear both modern and Islamic) and in civic messaging (the pressure on civil servants to represent the model city, model services and model citizenry). Within this context, Putrajaya’s civil servants – compelled to populate the new city, subject to its “neoliberal nature” as a condition of their employment, and housed according to employment rank – became vulnerable to the disease.

5. Conclusions

This research represents one of the first empirical examinations of the complex connections between urban planning and dengue fever in a planned city or emerging market context. Given the evident dearth of social research into neglected tropical diseases like dengue fever, such a contribution is significant. However, much further research is needed. In Putrajaya, more detailed epidemiological analysis could further determine the causal pathways at work in the broadly identified areas of planning's importance to dengue fever. In addition, a more participatory approach to policy might identify particular policy or planning changes appropriate to the local context. At the local level, further research into the policy pathways and barriers to interaction between public health and urban planning could illuminate potential areas for policy change and collaboration, both formal and informal. In the broader context of research into neglected tropical diseases, more social research is required to understand the discursive-material relationships between historic and contemporary constructions of “diseases of poverty”, particularly as they relate to the growing middle class in the world's burgeoning cities and emerging economies.

An immediate practical lesson from Putrajaya is clearly the importance of mainstreaming public health officials in urban planning and governance. Despite considerable understanding of dengue and its causes among urban officials and

citizens in Putrajaya, public health concerns were not raised systematically. Under Malaysia's rigid social and political hierarchies, public health officials who lack an official venue for inclusion are unlikely either to speak up or to be heard.

Beyond Putrajaya's borders, there are two major potential implications of this research. Firstly, the emergence of dengue in Putrajaya suggests that dengue may never have been an exclusively poverty-related disease, and that its social construction in dominant scientific and planning paradigms may have led wealth-seeking emerging markets to ignore its importance in new, planned and middle-income environments. Secondly, it is possible that emerging cities like Putrajaya may constitute new biopolitical spaces in which the epidemiology of the disease is changing in the face of changing urban trends. In either case, or in any combination of the two, the growing wealthy segments of the cities of the Global South are clearly not immune to environment-related infectious disease. Researchers, planners and policy makers should, in the future, pay close attention to the social aspects of disease emergence across diverse local contexts, and in particular to the relationship between urban planning priorities and infectious disease in emerging economies.

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CHAPTER THREE

Global public health policy transfer and dengue fever in Putrajaya,

Malaysia:

a critical discourse analysis

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Abstract

This study critically analyzed the operationalization and materialization of globally hegemonic dengue fever discourse at the local level in the city of Putrajaya, Malaysia. Textual analysis of the World Health Organization's First report on neglected tropical diseases (NTDs) (2010) identified three discursive strategies in the WHO's effort to set the agenda for research and action on neglected diseases: the nomination of dengue fever as a disease of the impoverished and voiceless other; the predication of neglected disease status on environmental and behavioural uncleanness; and the framing of so-called 'pro-poor' neglected tropical disease discourse as a new paradigm under which targeting these othered people, behaviours and environments is a key strategy for NTD management and control. Further analysis of the transcripts of 14 key informant interviews conducted with experts in public health, governance and urban development in Putrajaya found that discursive links between dengue and poverty contributed to the inappropriate transfer of globally dominant dengue control strategies to Putrajaya's non-poor local environment. These findings indicate that endemic dengue emerged in Putrajaya in part because planners, health officials and residents reproduced in their plans, policies and behaviours the construction of the disease as one of the other. The findings call into question the characterization of dengue fever as a disease of poor people,unclean spaces

and unsanitary behaviours, and raise new questions about the appropriateness of targeting NTD initiatives to the poor. The findings also highlight the need for locally appropriate public health policies for infectious disease control in non-poor environments.

Keywords: healthy public policy; illness; critique

Introduction

Dengue fever is the most rapidly advancing vector-borne disease in the world and a major public health issue for tropical countries worldwide. Up to 40% of the world's population – 2.5 billion people in over 100 countries – live at risk of infection and over 50 million infections are reported each year (Farrar et al. 2007, Morens and Fauci 2008, Gomez-Dantes and Willoquet 2009, WHO 2009). In urban areas, the water-related infectious disease is transmitted primarily by the *Aedes aegypti*, a container-breeding and day-biting mosquito adapted to living conditions in and around human settlements.

Despite its global importance, dengue (along with its more severe symptomatic manifestations in dengue hemorrhagic fever and dengue shock syndrome) has been under-prioritized in public health research and policy. For example, dengue research and control receives less than 5% of the global funding allocated to malaria, even though dengue is more common worldwide and measures combining both morbidity and mortality have shown the two diseases to have comparable impacts (Gubler 2002, Schwartz 2010). There is no vaccine or cure for the flu-like illness, which accounts for 25,000–30,000 fatalities each year and 0.7 million lost Disability- Adjusted Life Years (DALYs) worldwide (Canyon 2008, Hotez et al. 2009). '

In response to the lack of attention to dengue, global health organizations

including the World Health Organization (WHO 2010) have included the disease in their emerging lists of the world's 'neglected tropical diseases' (NTDs) – diseases that affect millions across the world and yet have been under-prioritized for public health research and action. Since 2003, the WHO has been purposefully moving toward an integrated approach to global health in which 'attention and action are given to the health needs of populations affected by neglected tropical diseases rather than to their individual diseases' (WHO 2010, p. 7).

However, questions remain as to whether dengue belongs in a group of diseases that, as claimed by the WHO, act as 'a proxy for poverty and disadvantage' (2010, p. 7). Evidence of endemic dengue in wealthy households, neighbourhoods and cities from Brazil to Singapore (Wilder-Smith et al. 2004, Caprara et al. 2009), and in developed country contexts including Australia (Canyon 2008) and the southern United States (Morens and Fauci 2008), appears to run counter to the categorization of dengue as a disease of poverty. Little academic research has interrogated the dengue-poverty connection – a research gap that may reflect particular research biases, including an entomological bias toward areas of known *Aedes* prevalence and a bias toward researching the disease in poorer places and populations. In addition, global trends including widespread urbanization, global environmental change (that may broaden the dengue vector's range) (Campbell-Lendrum and Corvalan 2007) and a growing

middle class (now a majority of the population of the Global South) indicate that the infectious disease will be of increasing relevance for non-poor people and places (Adams 2011).

Regardless, health policies in wealthy spaces and emerging economies continue to draw on the apparent global consensus that dengue is both a neglected tropical disease and a disease of poverty. In Southeast Asia, for example, many national and local dengue strategies draw from the WHO's Dengue Strategic Plan for the Asia Pacific Region 2008–2015, which blames the regional spread of dengue on 'unplanned urbanization, poor water storage, and unsatisfactory sanitary conditions' (WHO 2008, p. 1). Countries from across the WHO's Western Pacific and Southeast Asian Regional Offices – from wealthy Singapore to poorer countries such as the Philippines – are signatories to the plan. Regardless of their relative wealth or poverty, signatory countries strive to follow the Strategic Plan's prescriptions for vector control, disease surveillance, health promotion and clinical case management.

In Malaysia, a transitional economy striving to be 'fully developed' by the year 2020 (Bunnell 2002, King 2008, Moser 2010), dengue control policies also follow the WHO model. However, dengue has continued to grow as a public health problem in both poor and non-poor populations (Ashencaen Crabtree et al. 2001, Hussin et al. 2005, Umor et al. 2007, Norli and Azmi 2008). In the newly

developed administrative capital city of Putrajaya – a relatively wealthy and high-tech ‘intelligent garden city’ aiming to be a model of the country’s ambitions for development – dengue rates are among the highest in the country. Despite strong central planning, relative wealth, high water quality and accessible public services, Putrajaya had 359 new cases of dengue per 100,000 population in 2008 – well above both the national average of 146 per 100,000 and Malaysia’s goal incidence rate of 50 per 100,000 (Ministry of Health Malaysia 2008, 2011).

The emergence of endemic dengue among Putrajaya’s middle and upper-middle income civil servant population calls into question the appropriateness, particularly for relatively wealthy communities, of public health policies that construe dengue as a disease of poverty. For the rapidly urbanizing and growing middle class communities of the global South, this is a pressing problem: what relevance does global dengue policies have for these communities? What are the risks of applying poverty-targeted health policies to non-poor people and places? Are there more appropriate health policies for these communities, or more accurate ways of characterizing diseases like dengue?

This article begins to address these questions by interrogating the role of global health discourse in managing dengue fever in the city of Putrajaya. We employ dialectical-relational critical discourse analysis (Fairclough 2005, 2009) to consider the relationship between global dengue discourse and/as material and

social practice in the city. This form of analysis seeks to understand the dialectical, mutually constitutive relationships between materiality and discourse through a comparison between discursive texts and material outcomes. We ask: how are globally hegemonic discourses relating to dengue fever and poverty recontextualised or operationalized in health policy and practice in Putrajaya, Malaysia? Drawing from a broader case study of the emergence of endemic dengue in Putrajaya from 1995 to 2010, we aim to understand the processes by which Putrajaya's local health conditions, policies and procedures reflect, reinforce or reshape a global dengue discourse that links the disease to conditions of poverty. In addition, we aim to understand the ecological, biological, social and political consequences of this dialectical relationship for the future of dengue as a socially constructed neglected 'tropical disease'.

Theoretical framework

We situate this work as part of ongoing research into the political ecology of health, a body of research that considers local and global political economic and ecological conditions to be fundamental determinants of individual and social health (Birn et al. 2009). The subfield aims not only to interrogate health discourses, but to understand the ways in which these discourses are embedded in a political economy and ecology of disease, part of a dialectical material process

in which ‘health is shaped through the relationships between social and environmental systems’ (King 2010, p. 40). While political ecology is typically concerned with fundamental questions about the production of nature and therefore stresses ‘the need for political rather than “technical” or “policy” solutions’ (Budds 2004, p. 325), our analysis also concerns itself with the details of policy and practice; in particular, to accountability and agency for the ways in which health inequalities are monitored, analyzed and addressed (Krieger and Davey Smith 2004). We therefore supplement our political ecological framework with ecosocial epidemiology, which uses health research evidence to interrogate human bodies themselves as embodied socioecological relations. This methodology draws on epidemiological evidence – health outcomes and patterns of human health and illness in individuals and populations, understood in their environmental and social contexts – to investigate both macro- and micro-level mechanisms through which social inequalities are manifested in population health (Krieger and Davey Smith 2004, Krieger 2006, Birn et al. 2009).

Methods

Following the method articulated by Fairclough (2005, 2009) for using textual analysis to understand discourse as a social practice, and influenced by the discourse-historical approach used by Wodak and Meyer (2009) in identifying

particular linguistic–discursive strategies, we consider both manifest and latent content in two sources of textual data. After an extensive review of current policy literature, the text *Working to Overcome the Global Impact of Neglected Tropical Diseases: First WHO Report on Neglected Tropical Diseases* (WHO 2010) was chosen as broadly representative of the current consensus on global and national-level public health policy approaches to dengue fever. Local-level texts selected for analysis are transcripts of a series of key informant interviews ($n=14$) conducted with experts in public health, planning, community leadership and governance – including front-line staff – at local, regional and federal levels in Putrajaya and the Kuala Lumpur Metropolitan Region of Malaysia in 2010. Key informants were identified using a purposeful sampling strategy supplemented by snowball sampling. With liaison assistance from the United Nations University International Institute for Global Health (UNU-IIGH) in Malaysia, the lead author contacted each key informant and provided details of the study’s purpose, methods, confidentiality measures and procedures for informed consent. Recruitment was considered complete when theoretical saturation was reached.

One-hour semi-structured interviews were conducted in English (the country's language of business, widely spoken as a second language by Malaysia’s civil servants) at a location of the key informant’s choosing. The interviews followed a theory-driven interview schedule guided by questions derived from an

extensive literature review. Interviews were recorded and transcribed, with permission, and coded with the assistance of NVivo 8 qualitative analysis software. Compared on the basis of percentage agreement (Miles and Huberman 1994), inter-rater reliability for the resulting coded transcripts was found to be over 93%. Following the analysis, participant feedback and validation was solicited by the research team through an invitation to each key informant to respond to a written summary of key findings. In addition, ongoing discussions with the research team, the maintenance of a research diary and the creation of a separate, independently accessible evidence database assisted retroductability (transparency and reproducibility) (Wodak and Meyer 2009) and the ongoing assessment of the lead author's reflexivity (position, possible bias and influence on the research) throughout the research process. The study received ethics clearance from the McMaster University Research Ethics Board, the Research Ethics Committee of the Universiti Kebangsaan Malaysia and the Malaysian Ministry of Health.

Dengue, poverty and 'neglected tropical disease': three discursive strategies

The WHO's Working to Overcome the Global Impact of Neglected Tropical Diseases (2010) represents the culmination of a global public health policy effort over the past several years to categorize and target diseases that,

despite affecting millions across the world, have been under-prioritized for public health research and action. The text employs three primary discursive strategies in its effort to set the agenda for research and action on the diseases it describes: the nomination of dengue and other neglected tropical diseases as diseases of poor populations, the predication of neglected diseases on the unsanitary environments and behaviours of poor people, and the framing of neglected disease discourse as 'pro-poor' in its strategic targeting of poor people and places. The following discussion describes the ways in which each of these discursive strategies is materialized, operationalized and/or re-shaped with respect to dengue fever in the complex interplay between social and environmental systems in the city of Putrajaya, Malaysia.

Nomination: dengue as a disease of the impoverished and voiceless 'other'

Working to Overcome the Global Impact of Neglected Tropical Diseases (WHO 2010) argues that neglected tropical diseases are neglected because they primarily affect an impoverished and voiceless *other*:

This group of diseases largely affects low-income and often politically marginalized people living in isolated rural and underserved urban areas. Such people cannot readily influence administrative and governmental decisions that affect their health, and often seem to have no constituency that speaks on their behalf. Diseases associated with rural and urban poverty may have little impact on decision-makers in capital cities and their expanding populations (p. 7).

The Director-General's message, which prefaces the official document, further nominates or categorizes dengue fever as part of this new group of 'neglected tropical disease' that affect the poor: 'Dengue has emerged as a rapidly spreading vector-borne disease affecting mostly poor, urban populations . . .'

(WHO 2010, p. iv). Although the document does not argue that dengue is *exclusive* to poor communities – employing qualifiers such as *largely*, *often*, *mostly*, *seem* and *may* – the categorization serves, through repetition and intensification, to connect the disease to populations primarily comprising the poor and the powerless.

Texts of interviews with health officials in Putrajaya provide a counterpoint to this construction of dengue. One health official reported little evidence of poverty in the city: 'I don't think too many live below the poverty line in Putrajaya. Maybe none at all. It is well organized'. There are no slums within the city, and certain classes of workers who might be at risk of dengue are politically and socially excluded. Construction workers, for example (often foreign or illegal workers), are not permitted to live in the city or on construction sites – a break with common practice in the rest of the country – and are not counted in the city's dengue statistics.

One health official stated:

They are not staying here, they will stay in their neighbourhood districts. If they become, they caught dengue, their case will be registered in their respective district . . . So most of the time we can suspect them to get the infection not in Putrajaya.

Putrajaya's population consists almost exclusively of ethnically Malay civil servants and their families. In contrast to the politically voiceless communities described by the WHO, those at high risk of dengue in Putrajaya live and work at the heart of Malaysian governance and decision-making. However, the absence of a politically marginalized community in Putrajaya has not resulted in an increased focus on neglected diseases like dengue, but rather in competition for funding amongst a range of powerful government stakeholders. One government official described the effect:

Putrajaya is the place where we assemble all the big guys: the politicians, the ministers, and the senior government heads of departments. Many of them stay in Putrajaya, and these people have their own perceptions and perspective, so everybody has a different opinion in the sense of what they want to have, so the stakeholders are too many.

Among these priorities is the promotion of Putrajaya as a model city, meaning that Putrajaya is not an 'underserved urban area' as described by the WHO but rather one uniquely endowed with government and public-private funding for lifestyle and architectural initiatives that demonstrate Malaysian *boleh* (capability and potential). One health official stated that health ranked low on the government's

list of priorities: ‘. . . they are very much putting emphasis on architecture, landscape, you know, to make it look grand and beautiful, but when it comes to health, it’s not the top priority for them’.

Despite the local counter-evidence, key informants do not dispute hegemonic discourses linking dengue with poverty. Instead, they see Putrajaya as the exception to the rule, blaming rapid urbanization and building design for the city’s dengue problem while seeing poverty as a key determinant of dengue for other people and other places in the country. When asked what causes dengue fever, one health expert stated:

You see a lot of dengue cases in Malaysia . . . I think it is several factors. You know, you get people who are poor, staying in very close, densely populated, squatters, where you have got pools of water accumulating, becoming a fantastic place for dengue mosquitoes to breed.

When asked what causes dengue in Putrajaya, the same expert stated: ‘You still get cases [of dengue fever in Putrajaya], throughout the process of becoming a city in itself, the way planning has been done, urbanization has been ongoing’.

Predication: neglected tropical diseases as diseases of poor environments and behaviours

Related to the categorization of dengue as a disease of poor people is the predication of its neglected disease status on poor spaces characterized by environmental and behavioural uncleanness. According to the Director-General’s

message:

Today, neglected tropical diseases have their breeding grounds in the places left furthest behind by socioeconomic progress, where substandard housing, lack of access to safe water and sanitation, filthy environments, and abundant insects and other vectors contribute to efficient transmission of infection. Close companions of poverty, these diseases also anchor large populations in poverty (WHO 2010, p. iv).

In this passage, the WHO text finds a reason for the global neglect of widespread diseases not in the decision-making processes of global health funders and national health programs, but in the unhealthy spaces themselves, which render diseases ‘close companions of poverty’ through environmental neglect.

There is a long history of discursively connecting poverty with poor sanitary practice (and therefore poor health). In the bacteriological city of the colonial era (Gandy 2005), technocratic public interventions (including water and sewer systems) aimed to reduce or eliminate disease outbreaks by using hygienism – the separation of the clean and the dirty and the promotion of cleanliness as a social goal – as a strategy for economic development and demographic growth (Keil and Ali 2007). Piped water systems created material and symbolic separation between clean, healthy populations and an unclean, unhealthy, unsanitary underclass – an association that perpetuates inequalities in water access and use in many post-colonial cities to this day (Swyngedouw 2004, Kooy and Bakker 2008).

Putrajaya did not inherit this colonial infrastructure, however, and its

living environments do not match this description. Instead, the new urban development explicitly draws on the modernist garden city (Gandy 2005) that aimed to re-introduce 'nature' to urban communities for beautification and outdoor recreation. Putrajaya's new apartment, townhouse and bungalow developments are well served by public services including water, sewage, communications and electricity; they face few of the hygiene problems associated with under-served urban slums. As one health official noted, 'Sanitation conditions here, sanitary is wonderful, so not a problem here. Here sanitation is centralized and monitored'. However, even the effort to create and control a 'clean' environment has had implications for the development of dengue in the city. Efforts to engineer high urban water quality, for example, created mosquito breeding grounds throughout the city. As one health official described it: 'So basically it is a new city. It was planned carefully to the point that we have the water is too clean to the point where you cause a problem with dengue'. Another health official blamed dengue rates on the use of stormwater sand traps to keep the city's artificial lake clean:

The purpose of the sand traps . . . is to prevent all of the sands, the grease, all the rubbish to enter the lake . . . but however it also causes stagnant water. So initially there were lots of sand traps built [and] after a few years, the dengue cases began to rise.

At the same time, dengue prevention and surveillance in the city continue to echo the hygienist arguments of the bacteriological city, using the words 'sanitary' and

‘clean’ to describe dengue-free spaces and behaviours. Although they recognize that design problems beyond individual control – including the sand traps, along with hard-to-reach household rain gutters and closed monsoon drains – are key determinants of dengue transmission in the city, health officials are excluded from formal participation in urban planning and development strategies. Instead, they continue to focus on Communication for Behavioural Impact (COMBI), a community participation strategy heavily favoured by the WHO in the Asia-Pacific region (WHO 2008). As one health expert noted, ‘Of course what is really important is you get the community to participate, and ensure that the surroundings are clean’.

Framing: neglected tropical disease discourse as ‘pro-poor’ policy targeting

Finally, the WHO’s First Report on Neglected Tropical Diseases frames its discourse as a new, ‘pro-poor’ paradigm that sees the strategic act of targeting poor people, behaviours and environments as a key strategy for NTD management and control:

The paradigm shift towards an integrated approach to the control of neglected tropical diseases has enabled Member States and partners to find innovative solutions to enable weak health systems to target the people most in need: the poorest sectors of the population with limited or non-existent financial means (WHO 2010, p. 4).

In Putrajaya, however, targeting lower income neighbourhoods has not resulted in

a reduction in dengue rates. In fact, key informants reported that dengue outbreaks are worse in wealthier neighbourhoods. One health official stated:

The dengue epidemic is longer in the upper class area, because the participation of the upper class people is less. They don't allow us to go into their house to check their premises . . . they say fogging [spraying pesticides] will damage the value of their property.

Rather than adapt COMBI to meet the needs of the higher income neighbourhoods, however, health officials responded by continuing to target COMBI to low- and middle-income neighbourhoods. In wealthy neighbourhoods, health officials abandoned COMBI and took on more government responsibility for dengue control. One health official observed:

For the higher income, they are normally not that cooperative . . . I think they think dengue is a local authority job, and everything they do on the local authority basis, so the upper class they think like that because maybe they have no time, and maybe their workload in their offices are so much, that they cannot entertain us. That is the wrong concept.

The medium and low income they are cooperative. They understand our role, and also they understand what role they are going to do. For the upper class they are a bit reluctant. We do anything on the community basis, they don't turn up. Only one or two will turn up, so most of the programs, we do on our own in the upper class level.

Although 'pro-poor' targeting proved ineffective in Putrajaya, officials were slow to deviate from the approach recommended by the WHO and others. However, in recent years health officials have implemented some important adaptations to target new and different populations. One health official described a new health

promotion campaign to check for mosquito breeding:

Previously the message was generally, let's say, inspect your house every week. But for Putrajaya, we modify it to, inspect every Friday afternoon. Why Friday afternoon? Because, according to the housing authority, about forty to sixty percent of Putrajaya residents will go back to their home town at the weekend . . . so we ask them to inspect before they go back, and I believe this kind of more straightforward and more specific message will go to the target easier.

According to health officials, anecdotal evidence suggests that this message was more readily adopted by residents and may have contributed to a decrease in dengue cases over the prior year. The apparent success of the new approach inspired health officials to re-think the ways in which they identify and target at-risk communities. Said one health official: 'Actually dengue control is that all the people in the community have to participate. You don't go by classes or anything. Everything has to go'.

Summary of key findings

The WHO's First Report on Neglected Tropical Diseases employs three discursive strategies in its effort to set the agenda for research and action on the diseases it describes: the nomination of dengue fever as a disease of the impoverished and voiceless other; the predication of neglected disease status on environmental and behavioural uncleanness; and the framing of so-called 'pro-poor' neglected tropical disease discourse as a new paradigm that sees the strategic act of targeting

these othered people, behaviours and environments as a key strategy for NTD management and control. This study suggests that the operationalization and materialization of these discursive links between dengue and poverty contributed to the de-prioritization and inappropriate targeting of dengue control strategies – and therefore to the exacerbation of endemic dengue – in the city of Putrajaya, Malaysia. Planners, health officials and residents reproduced, in their plans, policies and behaviours, the construction of the disease as one of the other: poor people, unplanned spaces and unsanitary behaviours. In each case, despite local dissonances, health officials maintained the hegemonic discourse: that dengue is a disease of poor populations (except in Putrajaya), that dengue is a disease of unclean places (except where it is caused by building defects and rapid urbanization), and that dengue control should target the poor (even when the wealthy face longer dengue outbreaks due to non-participation in health-promoting activities).

Because of these dissonances, health and environment officials have struggled to fit their experience of dengue fever in planned, sanitary and even wealthy urban spaces – often those outside the control of resident behaviour change – into the prescribed discursive frame. Over time, officials responsible for vector control have begun to adapt and modify dengue control initiatives to meet local political, ecological and cultural conditions; that is, for all community

members (for *us* rather than for the *other*). While the first steps toward local adaptation have been partial, and the hegemonic discourse continues to predominate, over time local adaptations to local determinants and conditions may have an impact on dengue control in the city and may, in turn, influence global dengue discourse.

Conclusions

In integrating approaches from political ecology and ecosocial epidemiology, our analysis has illuminated how some of the complex relationships between discourse, public health practice and material health outcomes opens up possibilities for specific policy and prioritization changes. In particular, our findings suggest that it is a mistake to see dengue primarily as a disease of the poor. Without incorporating public health input into all policies related to living situations in tropical settings, the disease may be just as likely to afflict the wealthy as the poor. For rapidly developing countries such as Malaysia, where governmental priorities favour the creation of new and ‘fully developed’ spaces rather the improvement of public health in poor environments, decision-makers may be more likely to invest in control strategies for a disease that is understood to affect middle-income citizens and spaces. Investing in better urban planning to prevent dengue outbreaks in middle-income spaces, for example, may leave

countries with more health resources to address the conditions in poorer urban spaces supportive of the disease. For the WHO, reconsidering dengue-poverty connections may also mean revisiting the question of why dengue is a neglected tropical disease, shifting responsibility for dengue from the characteristics of poor populations and communities themselves to the political decisions that have resulted in under-investment in this rapidly spreading infectious disease.

It is possible that Putrajaya is simply an outlier, a community with a uniquely homogeneous population and history of centralized urban planning. However, as noted by Guha-Sapir and Schimmer (2005), persistent ‘anomalies’ in the narrative of a rich/poor dengue divide occur in non-poor urban environments across the world. Coupled with the lack of strong research evidence supporting dengue-poverty connections, these apparent anomalies warrant further research to better establish the nature and strength of the relationship between wealth, public health policy discourse and dengue outcomes in non-poor settings.

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CHAPTER FOUR

Is Dengue a Disease of Poverty? A Systematic Critical Review

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Abstract

Dengue fever is the most rapidly advancing vector-borne disease in the world, affecting up to forty percent of the world's population. Poverty has long been considered a determinant of dengue, and policy prescriptions for combating the disease tend to focus on alleviating conditions of poverty at the population level. However, the breadth and depth of the research evidence for connections between conditions of poverty and rates of dengue have not been well established. We conducted a systematic review of the research literature with the aim of identifying and assessing the current state of dengue-poverty research and further elucidating the relationships between dengue and a variety of poverty indicators. Of 260 articles referencing dengue-poverty relationships, only 12 English-language studies empirically assessed these relationships. The small size of this sample, and the heterogeneity of measures and scales used to capture conditions of poverty, made it difficult to assess the strength and consistency of associations between various poverty indicators and dengue outcomes. Our analysis of separate poverty indicators covering various social and economic conditions of poverty showed no clear associations with dengue rates: 35% (15) of all study-level associations between measures of dengue and poverty were found to be positive while 41% (17) were null associations. With respect to individual indicators of poverty, low income and poorer physical housing condition reported

positive associations more often than other poverty indicators, while education, household overcrowding and access to water and sanitation did not demonstrate consistent correlations with dengue rates. However, at present, the global body of eligible English-language literature investigating dengue-poverty relationships is too small to support conclusions regarding a relationship between dengue and poverty. There is a need for more research, particularly at supra-household levels and using standardized measures, to help guide evidence-based policy and planning interventions.

1. Introduction

Dengue fever is frequently called a disease of impoverished people and places. The World Health Organization, for example, classifies dengue as one of sixteen global Neglected Tropical Diseases (NTDs), diseases so strongly associated with poverty that they serve as “prox(ies) for poverty and disadvantage” [1]. However, there has been some debate in the academic literature regarding the nature and strength of the relationship between dengue and poverty. Reviews of dengue by Gómez-Dantés and Willoquet [2] and Guha-Sapir and Schimmer [3], and of climate and environmental health by Campbell-Lendrum and Corvalán [4], note that while certain improvements to hygiene, housing conditions, literacy and local intervention programs have been demonstrated to reduce rates of dengue, the

disease also affects wealthy neighbourhoods, developed countries, and regions with advanced health systems – including Puerto Rico and the wealthier countries of Southeast Asia. Further, greater individual susceptibility to dengue has been observed “among upper and middle-class communities than impoverished ones” [3].

There are also notable gaps in the empirical research literature regarding dengue and poverty. There is an overall dearth of social scientific research into NTDs: according to a study by Reidpath et al. (2011), social scientific or interdisciplinary research represented less than 4% of surveyed dengue research literature while 96.8% came from the biomedical sciences. Within the limited social sciences literature, greater attention is paid “to communities who are vulnerable to disease, and less to institutions involved in disease prevention and control” [5] – a potential bias toward researching those communities perceived as most vulnerable. There is also a paucity of studies investigating socio-economic determinants of exposure to dengue at community, and not just individual, levels [3].

The debate over dengue's association with poverty takes place in the context of a growing research and policy agenda regarding the social determinants of health: the economic, environmental and social conditions that “shape the health of individuals, communities, and jurisdictions as a whole” [6]. This agenda

is represented at the global level by the WHO's Commission on Social Determinants of Health [7]. Research into the social determinants of health interprets poverty in several ways: the daily living conditions of individuals and communities (social, ecological and economic environments); inequalities in the distribution of power, money and resources (a comparative measure of poverty as inequity); and differences in individual and community-level socioeconomic characteristics (levels of education, literacy, income and so on).

At the same time, there has been growing concern for emerging and re-emerging infectious diseases, particularly in poor and urbanizing areas [8, 5]. At the global level, the Millennium Development Goals (MDGs) highlighted multilateral agreement that poverty reduction programs should address the social determinants of infectious diseases, with a particular emphasis on HIV/AIDs, malaria and tuberculosis. Not long after, policy prioritization efforts emerged to draw attention to infectious diseases not mentioned by the MDGs. These lobbying efforts crystallized at the global level under, *inter alia*, the WHO's Neglected Tropical Disease programs, which have become a locus for global initiatives to target funding to diseases that have been under-prioritized for research and action. Dengue is among the NTDs: research and control efforts for the disease receive less than five percent of the global funding allocated to malaria, even though dengue is more common worldwide and measures combining both morbidity and

mortality have shown the two diseases to have comparable impacts [9,10]

Dengue is the most rapidly advancing vector-borne disease in the world and a major global public health issue, particularly in tropical and sub-tropical environments. Up to forty percent of the world's population – 2.5 billion people in over 100 countries – live at risk of infection and over 50 million infections are reported each year [2, 11, 12, 13]. In urban areas, the water-related infectious disease is transmitted primarily by the *Aedes aegypti*, a container-breeding and day-biting mosquito adapted to the conditions of city life. At present, there is no vaccine or cure for the flu-like illness, which accounts for 25 to 30 thousand fatalities each year and 0.7 million lost Disability-Adjusted Life Years (DALYs) worldwide [14, 15]. Environmental factors such as conditions of poverty, which may mediate human exposure to the vector mosquitoes, are therefore critical to disease transmission, prevention and control.

The debate over dengue's association with poverty is important for dengue control initiatives at different policy and geographic scales. At local levels, public health policy and practice have a clear interest in understanding the socioecological determinants of dengue in order to decide how, where and to whom disease control initiatives should be targeted. Globally, NTD policy initiatives have increasingly linked globally-neglected diseases with poor populations and places and argue for population-specific, rather than disease-

specific, interventions [1, 16]. At national and regional levels, particularly in developed and rapidly developing contexts, policy actors and institutions also risk de-prioritizing the disease as one irrelevant to wealthy and middle-income communities [17, 18].

Given the debates over the contributions of poverty to the distribution and diffusion of dengue, the noted gaps in the research literature, the policy impetus given to these debates by global NTD initiatives, and the relevance of findings for control initiatives for this rapidly-spreading disease, we carried out a systematic review of the literature with two main objectives. The first was to identify and assess the body of research into dengue-poverty associations. The second was to further elucidate the relationships between dengue and a variety of poverty indicators. Although dengue's characterization as a disease of poverty may include the degree to which the disease can be construed as poverty-promoting (i.e., incurs economic costs or burden-of-illness), this review focuses on poverty as a determinant, rather than an outcome, of the incidence or prevalence of dengue infection.

Because of the apparently embryonic state of dengue-poverty research, we decided to proceed with analysis even in the case of a small or heterogeneous sample of included articles. Although a small and heterogeneous sample poses clear limitations to analysis (discussed later in this article), the exercise remains

worthwhile as a first step toward identifying not only the (limited) evidence base for constructions of dengue as a disease of poverty, but also which poverty indicators have been associated with dengue in the limited literature to date.

2. Methods

2.1 Searching

We searched six electronic databases across the biomedical sciences, physical and natural sciences, social sciences, and international health disciplines (MEDLINE, EMBASE, Web of Science – Social Sciences Citation Index, Web of Science – Science Citation Index, Popline, and Global Health) for English-language articles. We did not apply restrictions on time period or geographic scope in the search or in the selection process. All search terms were used as keywords and subject headings, where possible. Possible measures of dengue and vector rates were captured using “dengue” and “aedes”. Terms used to retrieve articles relating to poverty measures or their indicators included: “poverty”, “income”, “social class”, “population density”, “economics”, “socioeconomic factors”, “housing”, “employment”, “unemployment”, “public health practice”, and “community health services”. The reference lists of relevant retrieved articles were also searched with the same inclusion criteria.

2.2 Selection and Study Characteristics

In order to capture the widest possible sample, we began with an open approach to inclusion of articles: all types of quantitative studies that empirically assessed the relationship between poverty or its indicators and dengue or *Ae. aegypti* vector rates, using original data analysis or novel analysis of secondary data, were eligible for this systematic review. However, we excluded studies if their authors did not link possible indicators (for example, housing condition) with poverty or socioeconomic status in any section of the article. We also excluded studies that assessed dengue risk without directly measuring the presence of vector mosquitoes or dengue cases (e.g. risk indices based on presence of household water containers). We further excluded studies of the economic impact of dengue (e.g. burden of disease studies). Only full articles that were peer-reviewed and published (or in-press) were included. The search followed Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines for reporting in systematic reviews [19] and the model used by Lund et al. [20] in their review of the associations between poverty and common mental disorders.

2.3 Validity Assessment

The initial electronic search and manual search of the reference lists yielded 260 unique articles. All titles and abstracts of identified articles were independently assessed for relevance by two reviewers (Cohen's kappa = 0.77,

good inter-rater agreement). Full text articles for 66 potentially relevant abstracts were obtained. A further 53 articles were excluded using the exclusion criteria set out in Figure 1 (Cohen's kappa = 0.88, very good inter-rater agreement). At the end of each stage, the two reviewers discussed all discordant or uncertain results until agreement was reached.

Thirteen articles representing twelve studies were included for analysis. Quality assessments of the thirteen articles were carried out independently by two reviewers. Following Lund et al. [20], we applied a set of pre-determined criteria based on SIGN50 guidelines. Each study was assigned an overall rating of “++”, “+”, or “–” based on the number of fulfilled criteria, and the likelihood that any unfulfilled criteria would alter the study's conclusions. Cohen's kappa coefficient measured 0.63 for study quality for good inter-rater agreement.

2.4 Data abstraction

Two reviewers extracted data from the thirteen articles to be included into a spreadsheet, which included five dimensions (cf. Lund et al.[20]): (1) study characteristics: year(s), study purpose, study design, sampling method, randomization method, allocation method, estimated and actual sample size, sample inclusion and exclusion criteria, definition of cases and controls, response rate, follow-up, world region, geographic location, setting, unit of analysis, age, gender, ethnicity, potential confounders; (2) poverty measures (as listed above)

and instruments used; (3) dengue/vector measures (as listed above) and instruments used; (4) analysis: variables adjusted for, interactions tested, type of statistical analysis, missing data, dengue outcomes by poverty measure, crude odds ratios (OR) (95% confidence intervals) for poverty measures, adjusted OR (95% confidence intervals) for poverty measures, associations between dengue and poverty; and (5) quality assessment.

2.5 Quantitative Data Synthesis

In order to avoid over- or under-counting single studies published in multiple articles, our review took the study, rather than the article, as the unit of analysis. Given the small sample size and heterogeneity of the studies' design, measurement, and analysis, it was not feasible to pool the data for a meta-analysis. Instead, we stratified the eligible studies by poverty indicator and by those that conducted univariate and multivariate analyses. We generated ten categories of poverty indicators for use during data extraction: income, employment, education, housing/living environment (structural), housing/living environment (household overcrowding), social class, socioeconomic status (SES), health care access, and other (Table 1). To explore specific hypotheses, we grouped studies by poverty indicator, dengue indicator, study design, study quality, scale of poverty indicator, poverty data source, setting, and geographic location. Using these stratifications, we calculated proportions of studies that demonstrated positive, null, negative, or

mixed associations at the variable level and at the study level. If a study found a positive association with one measure of income and a null association with a second measure of income, we reported the study-level association as mixed and recorded each variable-level result separately. We reported a positive, null, or negative association at the study level only if all measures of a given poverty indicator (e.g. overcrowding) yielded the same conclusion. A mixed association at the study level was defined as the report of both significant and non-significant findings for a single poverty variable (e.g. significant association with overcrowding in rich, but not significant in poor areas), or the report of conflicting associations across two or more poverty variables representing a single poverty indicator (e.g., for measures of household overcrowding, finding significant association with persons per bedroom, but not finding significant association with persons per residence).

3. Results

3.1. Study Characteristics

Overview of studies

A total of thirteen articles representing twelve studies were included in the final analysis. Table 1 shows study characteristics. The majority of studies were conducted in South America (others were undertaken in Southeast Asia, North

America, and the Caribbean) and were undertaken in urban community settings.

The number of eligible studies published per year remained small over the review period (1998-2010).

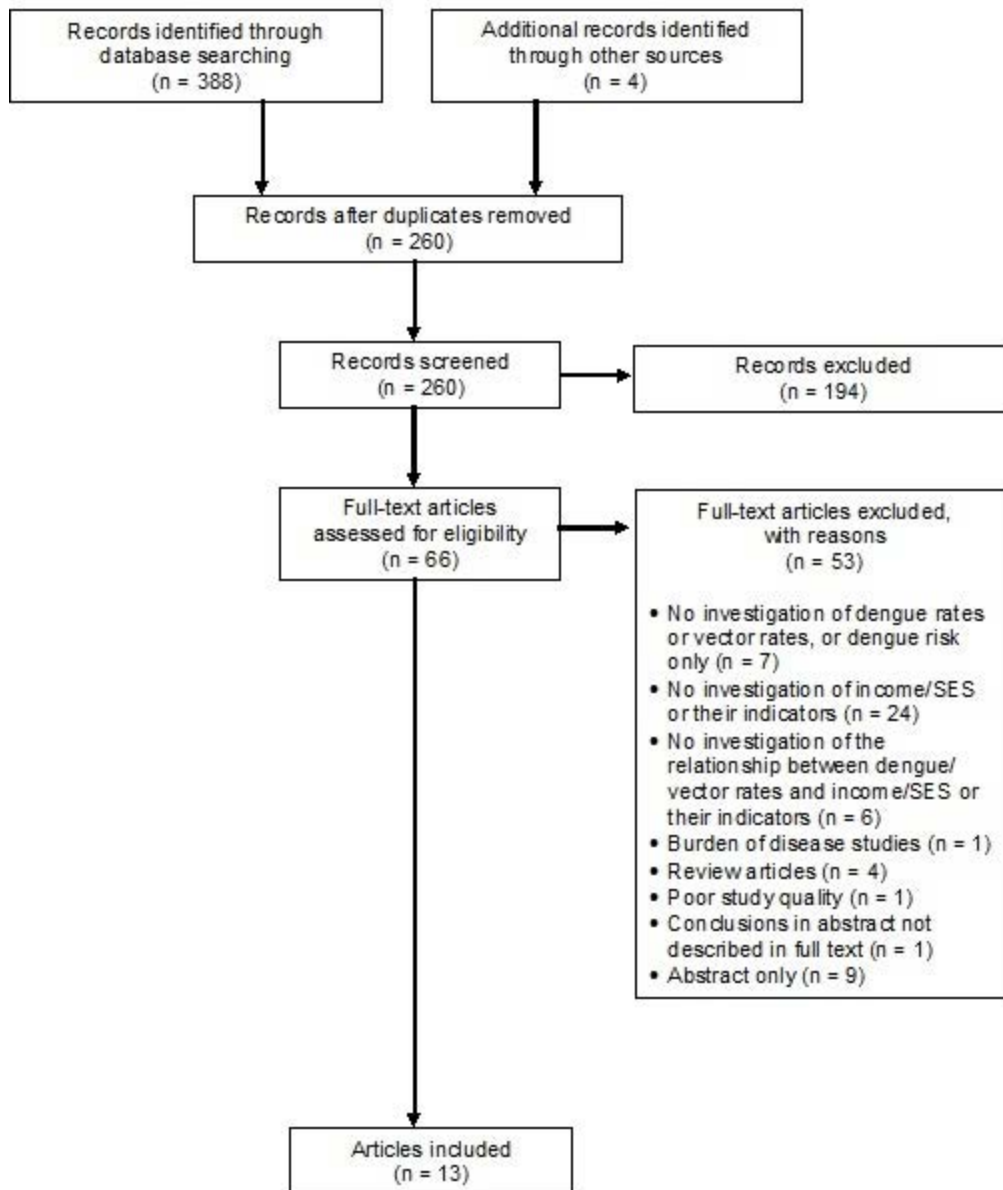


FIGURE 1: Flow of Included Studies

TABLE 1: Study Characteristics

Variable	Number of studies ^a	%
<i>Setting</i>		
Community-based	9	75%
Health facility-based	1	8%
Registries or secondary data	2	17%
<i>World region</i>		
North America + Caribbean	2	17%
South America	7	58%
Southeast Asia	3	25%
<i>Geographic location</i>		
Rural	1	8%
Urban	9	75%
Both	2	17%
<i>Study design</i>		
Case-control	2	17%
Cohort	3	25%
Cross-sectional	7	58%
<i>Sampling procedure</i>		
Consecutive	0	0%
Random	5	42%
Selective	4	33%
Other ^b	3	25%
<i>Poverty measure^{c,d}</i>		
Income	8	
Education	11	
Housing/living environment (structural)	5	
Housing/living environment (overcrowding) ^e	7	
Access to water and sanitation	5	
Socioeconomic status	6	
<i>Source of poverty measure</i>		
Primary	6	50%
Secondary	2	17%
Both	4	33%

Variable	Number of studies ^a	%
<i>Scale of analysis by poverty measure^c</i>		
Individual	9	
Household	22	
Neighbourhood	7	
Region	4	
<i>Dengue measure^c</i>		
Vector	5	
Clinical case/laboratory	10	
Self-report	3	
<i>Source of dengue measure</i>		
Primary	8	67%
Secondary	3	25%
Both	1	8%
<i>Scale of analysis by dengue measure^c</i>		
Individual	8	
Household	4	
Neighbourhood	4	
Region	2	
<i>Quality</i>		
++	5	42%
+	7	58%
<i>Sample sizes^{a,f}</i>		
Minimum value	68	
First quartile (25th percentile)	408	
Median (50th percentile)	1173	
Third quartile (75th percentile)	2511	
Maximum value	5975	

^a Except in the case of sample sizes, where number of participants are given.

^b Two of the three "Other" studies sampled the full population. One did not describe the sampling method.

^c Percentages are not given for poverty measures and dengue measures as some studies examined more than one category.

^d No studies analyzed employment, social class, or health care access, so these poverty variables are not included in this or subsequent tables.

^e Household overcrowding, not population density.

^f Two studies did not report sample sizes, but sampled the full population.

Poverty measures

Poverty variables were rarely standardized or comparable among studies. Some variables and their methods of measurement were not explicitly defined or explained. The most common poverty indicators used were education and income, of which the most common standardized poverty measure (one that consistently measured the same dimension of poverty and therefore allowed for direct comparisons) was years of formal education. Household overcrowding, defined as persons per room or persons per residence, was also a common standardized poverty measure. The most common poorly defined poverty measure was the structural condition of housing and living environment, whose variables ranged widely across studies – from a subjective analysis of house condition to the presence of an air-cooling system.

The included studies captured poverty indicators using a range of scales of measurement and analysis, of which individual and household were the most common. Ten of the twelve studies used multiple poverty measures in their analyses. No eligible studies analyzed employment, social class (as distinct from SES), or health care access, despite evidence for their importance in models of social determinants of health [21, 22, 23]. Primary data were used more frequently to measure and analyze education, structural housing conditions, and overcrowding. Both primary and secondary data sources were frequently

consulted for income and SES data.

Dengue measures

Various tools and methods were used to assess dengue and vector rates. Vector rates were determined from entomological surveys of *Ae. aegypti* pupae or larvae. We grouped clinical case and laboratory data into a single category measuring dengue infection, in contrast to vector studies that measured risk vis-à-vis mosquito prevalence. All clinical measures of serum anti-dengue immunoglobins (IgG or IgM) used commercial enzyme-linked immunosorbent assay (ELISA) kits. Some studies also included additional laboratory tests. Several studies used clinical diagnoses from secondary data sources (25%). Only four of the twelve studies used multiple dengue measures. Overall, clinical case and laboratory assessments were the most common (83% of studies) – of which serum IgG was the most common measure (50%). Vector measures accounted for 28% of all dengue measures, while self-reported dengue was recorded in three studies. For the most part, dengue indicators were well-defined.

3.2 Quantitative Data Synthesis

Associations by poverty measure

Global associations

Our review of the twelve eligible studies showed no clear association between poverty and dengue (odds ratios (OR) with 95% CI > 1, or $p < 0.05$). Using univariate and multivariate analyses respectively, 43% and 26% of studies reported positive associations between a variety of poverty and dengue indicators, 33% and 41% reported null associations, and 3% and 0% reported negative associations (Table 2). 21% and 33% of studies, using more than one poverty measure, reported mixed associations. Trends for variable-level associations were similar to the study-level associations. Using univariate and multivariate analyses respectively, 47% and 26% reported positive associations, 43% and 51% reported null associations, 2% and 0% reported negative associations, and 8% and 22% reported mixed associations (Table 3).

TABLE 2: Study-level associations between poverty and dengue

Poverty measure	Analysis	Association with dengue measure								Total
		Positive		Null		Negative		Mixed		
		n	%	n	%	n	%	n	%	
Lower income	Univariate	3	60%	2	40%	0	0%	0	0%	5
	Multivariate	2	67%	1	33%	0	0%	0	0%	3
Lower education	Univariate	2	33%	1	17%	1	17%	2	33%	6
	Multivariate	2	40%	3	60%	0	0%	0	0%	5
Poorer housing/living environment (structural)	Univariate	2	67%	0	0%	0	0%	1	33%	3
	Multivariate	1	50%	0	0%	0	0%	1	50%	2
Poorer housing/living environment (overcrowding)	Univariate	0	0%	4	67%	0	0%	2	33%	6
	Multivariate	0	0%	0	0%	0	0%	1	100%	1
Poorer access to water and sanitation	Univariate	0	0%	3	75%	0	0%	1	25%	4
	Multivariate	0	0%	1	100%	0	0%	0	0%	1
Lower SES/wealth	Univariate	3	100%	0	0%	0	0%	0	0%	3
	Multivariate	0	0%	1	50%	0	0%	1	50%	2
	Spatial	0	0%	1	100%	0	0%	0	0%	1
Mean	Univariate	1.7	43%	1.7	33%	0.2	3%	1.0	21%	
	Multivariate	0.8	26%	1.0	41%	0.0	0%	0.5	33%	

TABLE 3: Variable-level associations between poverty and dengue

Poverty measure	Analysis	Association with dengue measure								Total
		Positive		Null		Negative		Mixed		
		n	%	n	%	n	%	n	%	
Lower income	Univariate	3	50%	3	50%	0	0%	0	0%	6
	Multivariate	2	67%	1	33%	0	0%	0	0%	3
Lower education	Univariate	3	43%	2	29%	1	14%	1	14%	7
	Multivariate	2	33%	4	67%	0	0%	0	0%	6
Poorer housing/living environment (structural)	Univariate	4	67%	2	33%	0	0%	0	0%	6
	Multivariate	1	33%	0	0%	0	0%	2	67%	3
Poorer housing/living environment (overcrowding)	Univariate	2	22%	6	67%	0	0%	1	11%	9
	Multivariate	0	0%	1	33%	0	0%	2	67%	3
Poorer access to water and sanitation	Univariate	0	0%	4	80%	0	0%	1	20%	5
	Multivariate	0	0%	1	100%	0	0%	0	0%	1
Lower SES/wealth	Univariate	3	100%	0	0%	0	0%	0	0%	3
	Multivariate	1	25%	3	75%	0	0%	0	0%	4
	Spatial	0	0%	1	100%	0	0%	0	0%	1
Mean	Univariate	2.5	47%	2.8	43%	0.2	2%	0.5	8%	
	Multivariate	1.0	26%	1.7	51%	0.0	0%	0.7	22%	
	Spatial	0.0	0%	1.0	100%	0.0	0%	0.0	0%	

Income

This review did not find any clear association between low income and dengue rates. Five studies that measured income reported positive associations, and three studies found null associations; however, the small sample size makes it difficult to draw firm conclusions about these findings. All income-related studies defined income either as family income or head-of-household income, with the exception of one cross-sectional study that compared proportional costs of air-conditioning in using the per capita Gross Domestic Products of Texas, USA and Taumalipas, Mexico [24].

Only three of the eight income-related studies used multivariate analysis. Siqueira et al.'s 2004 study [25] found seroprevalence to be significantly associated with low income (OR: 1.32, 95% CI: 1.02-1.71) in one of the largest urban settings in central Brazil. Spiegel et al. [26] also noted a 12% reduction in risk of *Ae. aegypti* infestation for a 10 Cuban peso increase in monthly family income, although the relationship was not statistically significant after adjustment for other variables. Cross-sectional designs, studies using neighbourhood-level income variables, and studies using secondary income data were more likely to find positive associations between dengue and poverty. Notably, all four studies using secondary income data reported positive associations, while three of four studies using primary income data reported null associations.

Education

Overall, there was no clear association between low education and dengue measures across the eleven studies that investigated education-related variables. Four studies reported positive associations, four studies reported null associations, one study reported negative associations, and two studies reported mixed associations. Two studies maintained a positive association after multivariate analysis. Siqueira et al. (2004)[25] compared seroprevalence and illiteracy (OR: 3.45, 95% CI: 1.82-6.55) and elementary school-level education (OR: 2.02; 95% CI: 1.24-3.28). The other study, a follow-up study by Siqueira et al. (2008)[27], did not present odds ratios. The cohort study by Penna et al. [28] in the Amazon region of Brazil was the only study that noted a negative association between any poverty measure and dengue measure. This study reported the annual incidence rates of dengue fever by years of formal education, and observed, without calculating any probabilities or odds ratios, “an illness pattern that affected the middle and upper classes more than other socio-economic groups,” particularly in urban areas [28].

Housing

Five studies investigated the relationship between structural housing conditions and dengue. Of these, three found positive associations and two found mixed associations. Honório et al. [29] compared three neighbourhoods within the city of

Rio de Janeiro that differed in their structural environments, among other factors, and found the highest rate of IgM seropositivity in the slum where “household conditions were the best for promoting contact between hosts and vectors” (p. e545). Spiegel et al. [26] labelled visited houses as “good/in repair” or “poor condition”, and found significant associations with positive larval inspections in both univariate and multivariate analyses (OR: 1.64, 95% CI: 1.15-2.32). Reiter et al. [24] defined structural housing condition as the absence of air-conditioning and the number of room air conditioners in homes. This study found positive associations of both IgM and IgG seropositivity with the absence of air-conditioning (OR: 2.6, 95% CI: 1.2-5.6 and OR: 2.4, 95% CI: 1.5-4.0) and null associations with the number of room air conditioners.

Several studies assessed the relationship between household overcrowding and dengue measures. Four studies reported null associations and three studies reported mixed associations. All three case-control studies reported null associations, and three of four cross-sectional studies reported mixed associations. Braga et al. [30] found a mixed variable-level association where persons per room predicted greater seropositivity in intermediate (OR: 3.00, 95% CI: 3.21-7.37) and rich (OR: 1.81, 95% CI: 1.07-3.04) areas, but not in the deprived neighbourhood studied.

Access to water and sanitation

All studies relating to access to water and sanitation investigated the presence of a regular water supply. Four of the five studies found null associations between access to water and sanitation and dengue rates; one study found a mixed association. Braga et al. [30] found a significant positive univariate association between seropositivity and irregular water supply in the richest of its three study areas (OR: 2.8, 95% CI: 1.5-5.3), but this association neither extended to the less wealthy areas nor remained significant in multivariate analysis in any geographic area.

Socio-economic status (SES)

Of the six studies that examined SES, half found that lower SES or wealth was associated with higher rates of dengue; however, all of these were univariate analyses. Of the remaining studies, the two multivariate analyses yielded one null and one mixed association, while spatial analysis yielded a null association. The only multivariate variable-level association between low SES and dengue rates that remained positively associated found seroprevalence, but not seroincidence, to be significant ($\chi^2 = 8.386$, $p = 0.004$) after adjusting by age and total composition of the study sample [31]. We reported SES as it was defined by the authors of the studies. Studies that detected positive associations defined SES by multiples of minimum wage, total assets, and self-assessed economic situation.

Studies that reported null or mixed associations defined SES by census-derived household income and sanitation, family income, and ownership of premises belongings.

3.3 Associations by dengue measure

Clinical case and laboratory studies were the least likely to find positive associations (19% (3)) compared to vector (31% (4)) or combined (33% (8)) studies. Even so, null associations were more common than positive associations across all types of dengue indicators. Both vector and clinical case/laboratory studies reported an equal split in the percentage of positive and null associations of lower income on dengue rates; similarly, both types of studies consistently reported null associations for lower education and for poorer access to water and sanitation. Still, there were some disparities: vector studies were more likely to find positive associations with poorer structural housing conditions, and clinical case and laboratory studies were more likely to find mixed associations with household-level overcrowding.

3.4 Associations by scale and setting

Most studies investigated poverty at the household level, followed by individual, neighbourhood and regional levels. A greater proportion of studies using poverty

measures at higher scales reported positive study-level associations. Community-based studies, which represented 75% of all eligible studies in this review, were the only studies that reported positive or mixed associations. Facility-based studies consistently found null associations. Urban neighbourhoods, which represented the study population in 75% of all eligible studies in this review, reported 35% (13) positive associations, 40% (16) null associations, and 25% (9) mixed associations. The only rural study found a positive association between dengue and lower asset-based SES [32].

4. Discussion

4.1 Summary of Key Findings

Despite the relatively high volume of academic literature making some reference to relationships between dengue and poverty (260 unique articles found in this review), very few have assessed this relationship empirically. Thirteen articles (representing twelve studies) retrieved by systematic database searching and hand searching were included in the final review; this small sample makes it difficult to draw conclusions about dengue-poverty relationships and illustrates the need for more research in this area. Within the small sample of studies, our analysis of separate poverty indicators covering various social and economic conditions of poverty showed no clear associations with dengue rates. 35% (15) of all study-

level associations between measures of dengue and poverty were found to be positive while 41% (17) were null associations. At the level of individual variables, our review again found no clear association between poverty and dengue: 36% of all measures of poverty showed positive associations with dengue and 51% showed null associations (only 1% showed negative associations while 12% showed mixed associations). However, there are important differences in the consistency and strength of the poverty-dengue association across poverty indicators. Some poverty indicators, namely low income and poorer physical housing condition, were somewhat more consistently associated with dengue. Household overcrowding and poorer access to water and sanitation, on the other hand, exhibited a relatively consistent null association with dengue outcomes.

These findings provide weak support for previous narrative reviews of dengue by Gómez-Dantés and Willoquet [2] and Guha-Sapir and Schimmer [3], and of climate and environmental health by Campbell-Lendrum and Corvalán [4], which point to housing conditions in particular as important poverty-related dengue determinants. Although the strength of the association was not well established by this review, low income and poor physical housing conditions were somewhat more consistently correlated with dengue outcomes than were several other poverty indicators. Further investigations are needed to determine the nature and strength of these associations. In particular, detailed studies are needed that

will further investigate which physical housing conditions are most relevant for dengue transmission. In addition, future research into dengue-poverty connections should be geared toward the use or development of standardized measures of both physical housing conditions and income.

Surprisingly, although income is often incorporated into definitions of socioeconomic status, and the majority of income studies reported positive associations even after multivariate analysis, none of the multivariate and spatial studies reported positive associations with SES. It may be the case that the direction and strength of the poverty-dengue relationship are affected by whether a single variable is used as a proxy for SES, or a broad definition of SES is applied [33]. Given that household hygiene was also listed by these narrative reviews as an important determinant of dengue, it is also surprising that our analysis did not find either access to water and sanitation or level of education to be more strongly correlated with dengue outcomes. One study found significantly greater seroprevalence in both a well-serviced urban area as well as an underserviced slum, but not in a suburban residential area – suggesting that other factors such as population density or mobility may be more important than access to water and sanitation services in the household [29].

4.2 Measuring Poverty

The heterogeneity of poverty indicators and measures posed challenges to assessing the consistency and strength of the poverty-dengue associations. Scale was also an important factor: individual-scale analyses were much less likely to report positive associations than were analyses undertaken at household and neighbourhood scales. However, since most poverty measures were taken at the household level, it is not clear whether these trends are significant. Although dengue may be contracted outside the home (making human mobility within and beyond cities and neighbourhoods an important factor in disease transmission), few studies investigated dengue-poverty relationships at scales higher than that of the household. Our findings support Guha-Sapir and Schimmer's [3] call for more research on dengue-poverty associations at supra-household levels.

There were also differences in the poverty-dengue association by type of analysis: univariate analyses reported positive associations more frequently than did multivariate analyses. Nevertheless, caution should be exercised in the interpretation of null associations that are found only after multivariate analyses. The weakening of an association may indicate that variables such as income and physical housing condition are possible mediators of the poverty-dengue relationship; these variables may exert their effects through these other dimensions of deprivation.

4.3 Measuring Dengue

Dengue measures were reported as a combination of vector rates, clinical case and laboratory assessments, and self-reports. A number of studies in the dengue literature use vector rates as a proxy for dengue risk and prevalence, suggesting a connection between high *Ae. aegypti* density and high seroprevalence. However, it is possible for transmission to be maintained at high levels even in situations of low vector density [34]. Further, the Breteau Index and all other conventional indices for vector surveillance focus on immature stages and no specific index has been developed for the *Ae. aegypti* adult population that is involved in actual dengue transmission [35]. Studies that used a combination of dengue measures, such as either vector and laboratory assessment, or clinical diagnosis and self-report, were more likely to report positive associations between dengue and poverty. Contrastingly, vector-only studies were nearly twice as likely to report null associations. Additional research is required regarding the suitability of vector density alone as a measure of dengue risk and dengue outcomes.

4.4 Limitations

We have emphasized throughout this review that potential associations identified could not be assessed with confidence due to the small sample size of eligible studies. First, the review focused only on peer-reviewed journal articles. A systematic review of grey literature was not undertaken, and it is possible that

more evidence supporting particular dengue-poverty relationships is available in this body of literature. Second, eligible studies were English-language only; research in other languages used across the Global South (in particular, a significant body of research in Portuguese from Brazil) was excluded. Third, although we observed many null associations across poverty indicators, publication bias (in which studies showing a positive association are more likely to be published than those that show a null association) may have limited the conclusiveness of this review. Fourth, although no restrictions were placed on geographic scope, the studies in this review were conducted mostly in South America; the findings may have limited generalizability to other continents where dengue is prevalent. Fifth, the sample was limited by the exclusion of articles using social or ecological measures of dengue risk, rather than direct measures of dengue or its vectors. Finally, only one-third of study-level associations used multivariate analyses. Especially in the case of studies studying several poverty indicators separately by univariate analysis, there is the effect of possibly overstating the strength of associations. The PRISMA method for systematic review is clearly restrictive at this stage of the global body of research on dengue – leading to a sample combining studies with differences in dengue epidemiology, environment, scale, and methods. However, the method does enable a more detailed review of poverty-dengue relationships (however provisional) than is

afforded by qualitative analysis – for example, by identifying individual poverty indicators of particular interest for future research.

The review also reveals an absence of dengue-poverty research from China, India and sub-Saharan Africa, where dengue prevalence is poorly documented but the disease is presumed endemic [36, 37], and a dearth of literature exploring the impact of macro-economic factors on the relationship between poverty and dengue.

5. Conclusion

The objectives of this systematic review were twofold. First, we aimed to identify and assess the body of research into the associations between dengue and poverty. We found that, despite a substantial body of research *mentioning* or *asserting* that poverty and/or its component indicators (income, housing condition, access to water and sanitation, and so on) are determinants of the disease, few empirical research studies directly assessed the nature and strength of these associations. Of these, few measured dengue-poverty connections beyond the household level. These findings are particularly surprising because of the current policy push linking the causes of (and policy prescriptions for) dengue and other Neglected Tropical Diseases with poor populations and underserved environments.

The second objective of this review was to further elucidate the relationship

between dengue and a variety of poverty indicators. Given the small sample size (thirteen articles representing twelve studies) and the wide variety of approaches, scales and measures represented within the sample, few firm conclusions could be drawn from this analysis. However, some notable trends were identified. First, no conclusive evidence exists to support the assertion that dengue is a disease of poverty *per se*: similar numbers of studies found positive and null connections between measures of dengue and poverty. That said, very few studies found negative associations between dengue and poverty; it remains possible that increases in wealth, however measured, may contribute to resilience to the disease. With respect to individual poverty indicators, this review found that low income and poor physical housing condition were slightly more consistent indicators of a dengue-poverty relationship. Surprisingly, aggregated measures of SES did not maintain this relationship, nor did measures of household or neighbourhood access to water and sanitation services – both of which are commonly presumed to mediate the dengue-poverty relationship as measures of social inequality and impoverished or underserviced environments. Household overcrowding, education and poorer access to water and sanitation were less likely to demonstrate a relationship between dengue and poverty.

There are several important implications of this review. For researchers, it is clear that further studies are required in order to more conclusively determine the

nature, strength and dimensions of the association between poverty and dengue. More research is required to elucidate which poverty indicators are most relevant to dengue transmission, and in which socioenvironmental contexts. In particular, future research should consider the role and importance of scale in measuring and reporting dengue-poverty connections. The use of standardized measures of dengue and the indicators of poverty would also assist in future comparability of studies.

For policy and decision-makers, the dearth of conclusive studies means that current dengue policies and interventions rooted in "pro-poor" rhetoric have, to date, little basis in the research evidence. Population-targeted interventions may miss important environmental or social conditions affecting both poor and non-poor neighbourhoods and individuals, or may fail to address the specific socioenvironmental conditions most relevant to dengue transmission and control. Health policies such as the Neglected Tropical Disease initiatives, that call for poor-targeted health interventions and presume causal links between poverty and dengue, may miss important contextual factors in the social and environmental determination of the disease. Environmental prescriptions for dengue control, for example, tend to include calls for better urban planning or fairer distribution of city services; in particular, the provision of consistent water and sanitation services. While such services confer many social and environmental benefits in

underserviced urban areas, our review suggests that a reduction in dengue rates may not be among them.

It is important to note that our review does not suggest there is *no* relationship between dengue and poverty; rather, the review demonstrates the need for future research to better determine what relationship, if any, exists, and which elements or indicators of environmental, social or economic poverty are most relevant to promoting vulnerability or resilience to the disease. In the meantime, public health policy makers should exercise caution in asserting a relationship between dengue and poverty and should pay closer attention to more specific risk factors in combating this rapidly spreading disease.

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CHAPTER FIVE

Conclusions

Summary of key findings

This dissertation had three substantive chapters. Chapter Two investigated the relationship between urban governance and the environmental determinants of dengue fever in the emerging city of Putrajaya, Malaysia. Based on key informant interviews with leading figures in public health, urban planning and governance in the planned city of Putrajaya, Malaysia, and drawing on theories of urban political ecology and ecosocial epidemiology, the case study found that the *health of place* – expressed as dengue fever in human bodies and dengue-bearing mosquitoes in the urban environment – was influenced by the *place of health* in a hierarchy of urban priorities. The study further found that the pursuit of a particular set of urban priorities for Putrajaya – rapid development, neoliberalization, the creation of an “intelligent garden city” and the pressure to be a “model city – affected the development of endemic dengue in the region.

Chapter Three focused on the discursive context of health policy implementation in Putrajaya. Critical discourse analysis of the transcripts of key informant interviews in Putrajaya, set against the backdrop of the World Health Organization's *Working to overcome the global impact of neglected tropical*

diseases: First Report on Neglected Tropical Diseases (NTDs) (2010), found that discursive links between dengue and poverty contributed to the inappropriate transfer of globally dominant dengue control strategies to Putrajaya's unique local environment. The study concluded that endemic dengue emerged in Putrajaya in part because rather than managing dengue according to local needs and developments, planners, health officials and residents reproduced in their health plans, policies and behaviours the construal of the disease as one of the impoverished, voiceless and unclean *other*.

Chapter Four reported on a systematic review of the research literature into dengue's associations with poverty. The review found no clear association between poverty and dengue. With respect to individual conditions or indicators of poverty, the review found that low income and poorer physical housing condition were somewhat more likely to be linked with dengue while education, household overcrowding and access to water and sanitation did not demonstrate consistent correlations with dengue rates. However, the small sample size precluded conclusive analysis regarding any relationship between dengue and poverty. The exercise demonstrates the lack of a solid evidence base for current dengue control strategies targeting poor communities and populations.

Substantive contributions

This dissertation addresses the research gap associated with the world's Neglected Tropical Diseases – an under-researched thematic area for all disciplines, particularly the social sciences (Manderson et al. 2009, Reidpath et al. 2011). In particular, the research addresses gaps in our understanding of the biopolitical and socioecological contexts (sites of urban governance, sites of health policy development and implementation, and sites of academic research) in which health policies for NTDs are determined, enacted and justified. The dissertation further identifies Putrajaya as among non-poor spaces in the rapidly developing cities of the Global South – key spaces for further research into the geography and political ecology of health. These spaces, which are becoming more prevalent, more populous, and more powerful, are of epidemiological importance for understanding and testing theories related to epidemiological transition, economic development and the social and environmental determinants of health.

The dissertation makes several specific contributions to our understanding of the relationships between urban development and environment-related infectious disease. The dissertation identifies urban governance, and in particular the place of health as an urban priority, as important determinants of the health of a particular place. The thesis entailed empirically researching urban governance as a social determinant of health – among the “‘non-health’ policies and programs

with social justice implications” for health (Krieger 2005). In so doing, the dissertation takes up Manderson et al.’s (2009) moral and intellectual challenge to employ social scientific perspectives to address issues of governance and disease control for neglected tropical diseases. Further, it uses empirical research evidence to ensure social and political economic analysis of the “causes of the causes” is not just a value but a judgement derived from research (Marmot & Friel 2008).

The dissertation identifies and addresses the dearth of empirical research supporting widespread claims that dengue rates are linked to poverty and unplanned urbanization. The case study of Putrajaya, Malaysia (Chapters Two and Three) serves to counter common claims about dengue's social and environmental determinants. Its findings highlight the lack of interaction between health and planning sectors. It challenges the health sector's presumptions about the role of planning (for example, that urban planning will reduce rates of the disease without specifying which urban planning measures and relationships are required). It also challenges the planning sector's assumptions about health (notably, that in developed spaces chronic disease management is more important than infectious disease management). The findings demonstrate that the details of urban planning policies, processes and power relations are more important than the simple presence or absence of planning for urban developments. The findings further demonstrate that dengue fever can be as prevalent in wealthy, politically-

connected and ecologically-sensitive communities as it is in impoverished, marginalized and environmentally degraded communities. Chapter Four systematically reviews the research evidence for dengue's link with poverty and finds major gaps in the research that forestall, for the present time, our ability to conclude that dengue is a disease of poverty, poor socioenvironmental conditions, or the characteristics and behaviours of poor populations.

Methodological contributions

A diverse methodological toolkit is required in order to address the three major agendas of research into the political ecology of health [to “generate new insights into the political economy of disease, interrogate health discourses produced by actors and institutions, and show how health is shaped through the relationships between social and environmental systems” (King, 2010, p. 40)]. The multiple methods employed in this study acknowledge and respond to this requirement and further serve to situate the thesis as a multi-scalar investigation. The local-level case study (Chapter Two) and the global-level review of research literature (Chapter Four) are integrated empirically and conceptually by a critical discourse analysis of the operationalization of global policy discourse at the local level (Chapter Three). The cumulative impact of integrating these methods into a single dissertation serves to broaden the epistemological foci of academic inquiry.

It addresses concerns about political ecology's policy relevance, political relevance, and ecological relevance (Walker 2005, 2006, 2007) in three ways. It takes dengue seriously in varied contexts (applied public health, urban and global health policy, and academic research). It broadens the objects of dengue research beyond the biomedical to include social, environmental, discursive and policy determinants of disease. It also brings empirical rigour to debates about the role and power of dominant discourses about dengue in the research and policy literature.

According to a recent bibliographical analysis (Reidpath et al. 2011), ninety-six percent of current published academic research into dengue fever derives from the biomedical sciences– only four percent of studies represent either social scientific studies or interdisciplinary research. Social scientific and interdisciplinary investigations of dengue like those represented in this dissertation serve to counter the privileging of biomedical knowledge. They take up under-used methodologies and epistemological perspectives to understand this disease and its social, cultural, political, ecological and economic contexts. The use of such methods answers Manderson et al.'s (2009) call for more social scientific perspectives in researching neglected diseases. It also responds to Gatrell and Elliott's (2009) call for health geographers to engage with the growing literature on global social, economic and environmental processes and their links

to human health; to contribute to empirical health geography research in developing country contexts, particularly in Asia; to address cultural relationships between place, landscape and health; and to engage in interdisciplinary research.

Finally, the dissertation fieldwork highlights some challenges and opportunities of interdisciplinary field research in one of Asia's emerging economies. As the first fieldwork for a potential multidisciplinary and multi-partner study into the complexities of dengue fever in Malaysia (involving UNU-INWEH, UNU-IIGH, Malaysian government partners and an international research team), the dissertation navigated the methodological challenges, responsibilities and opportunities of working in Malaysia's quasi-democratic context. For example, a major challenge for anyone wishing to conduct political or policy research in Malaysia is access to government documents and key informants. Malaysian state secrets and practices are closely guarded and government workers are generally reluctant to speak about their work without official approval. Membership in an interdisciplinary team of researchers, including local researchers and Malaysian government officials, facilitated unprecedented access to key informants in Malaysia. The approval of Malaysia's Ministry of Health, the UKM, and the willingness of UNU-IIGH local officials to include their names on letters of introduction (Appendix A) may have been given in part because of the range of research proposed by the research team, from

health to natural and social sciences, to improve knowledge about the dengue situation in Malaysia. This approval facilitated access to key informants who, upon agreeing to participate, were highly forthcoming about their experiences and analyses of dengue and governance in Putrajaya and across Malaysia. This approval and access may not have been granted for a critical social science research project unconnected to the more powerful and “traditional” health and natural sciences. The research therefore provides a rare glimpse into the workings and perspectives of the Malaysian civil service.

Theoretical contributions

This dissertation theorizes the political ecology of health at the nexus between ecosocial epidemiology and political ecology, understanding ecosocial epidemiology's insistence on attention to particular policies and pathways of disease as an invaluable layer to political ecology's “thick description” of political processes at the socio-environmental interface (Peet and Watts 2004). Political ecologists such as Budds (2004) argue that political ecology is concerned with fundamental questions about the production of nature and therefore stresses “the need for political rather than ‘technical’ or ‘policy’ solutions.” However, ecosocial epidemiologists, including Krieger (2001), argue that political ecology should indeed concern itself with the details of policy, contending that a purely

descriptive and political perspective does not offer principles for “thinking through, systematically, whether—and if so, which—specific public health and policy interventions are needed.” A political ecology of health drawing from both traditions can critique *and* contribute, acting as both “the hatchet and seed” (Robbins 2004). By addressing not only the political, policy and academic research contexts in which power relations and policies regarding dengue and urban development are played out, but also the details of our knowledge regarding the pathways of embodiment in a detailed systematic review of scientific research evidence, the thesis integrates the two traditions and strengthens the empirical basis for analysis. In so doing, the thesis highlights specific policy and prioritization changes that may be used to better address dengue and reduce rates of the disease in under-researched and under-acknowledged spaces.

The dissertation also identifies material challenges to theories of epidemiological transition and the social determinants of health. Chapters Two and Three describe socioenvironmental relations in a geographic region where economic development has not resulted in a linear epidemiological transition away from infectious disease and toward primarily chronic disease considerations (cf. Omran, 1971). Chapter Four identifies gaps in our knowledge of dengue-poverty relationships and suggests the categorization of dengue as a “disease of poverty” has been at best premature. The thesis papers draw attention to the policy

and public health risks – to both poor and non-poor communities – of categorizing particular illnesses as “diseases of poverty” without sufficient evidence to support the claim. In addition, the chapters serve to highlight the importance of empirical specificity and theoretical complexity in understanding and applying broad theories of epidemiological transition and social determinants of health.

Implications for policy and planning

Taken together, the three papers in this dissertation pose two major challenges to conventional thinking about policy for health and development. First, the papers challenge conventional conceptions of the epidemiological transition (Omran 1971). The case study analysis of the ongoing importance of dengue in wealthy environments like Putrajaya – taken together with the emergence and re-emergence of infectious diseases like H1N1, West Nile virus, and SARS in developed country contexts around the world – suggests that infectious diseases do not wane in importance as societies undergo economic development. However, where contemporary urban planning considers health at all – for example, through the WHO's “Healthy Cities” movement (Barton 2004) – it tends to focus on chronic disease management. Urban planners, including those in Putrajaya, strive to reduce rates of chronic disease by creating opportunities for physical activity, active transport and recreation; however, their plans and policies rarely consider

the importance of managing infectious diseases like dengue fever. The implications for urban planning are clear: urban planning should consider health, and should not discount in their health considerations the potential for infectious diseases to emerge or re-emerge in wealthy and wealth-seeking environments. Formalized relationships and dialogues between health and planning sectors are required in order to plan better for urban health in the context of these emerging and re-emerging infectious diseases.

Second, the papers challenge conventional interpretations of the social determinants of health. While there can be little doubt that broad social factors related to daily living conditions and income inequality have tangible effects on human health, policies arising from presumed (rather than established) health determinants carry significant risks for population health. The trend in global health policy away from disease-specific health interventions and toward population-targeted health policies, as demonstrated in the WHO's Neglected Tropical Diseases initiative, carries some notable risks. Policies emerging from the WHO's shift from disease-specific interventions to population-targeted interventions (WHO 2011) may miss important environmental or social determinants of dengue that affect both poor and non-poor neighbourhoods and individuals. Environmental prescriptions for dengue control, for example, tend to include calls for better urban planning or fairer distribution of city services; in

particular, the provision of consistent water and sanitation services. While these may serve equity and health in other important ways, our review suggests that the use of such policies as dengue control strategies lacks a strong foundation in the research literature.

Policy makers, public health officials and researchers working in local dengue control may intuitively understand the disease as one that affects more than just poor populations. However, this understanding has not yet translated into meaningful changes in praxis: interventions targeted toward poor communities continue to predominate despite the dearth of conclusive studies to support them. Health policies that conflate politically neglected, under-prioritized diseases with diseases caused by or related to poverty risk further entrenching longstanding stereotypes linking infectious disease with poverty and poverty with uncleanness and ignorance. This approach also risks ignoring or glossing over the specificities of disease transmission in diverse contexts. While policy efforts to focus attention on previously-ignored but high-impact diseases are well meaning, prescriptions for disease control must continue to strive for biological specificity based on research evidence.

Furthermore, it remains possible that discursive associations between dengue and poverty could actually cause well-meaning NTD initiatives to backfire. As Paul Farmer (2001, p.201) has pointed out, diseases that are

understood to predominantly afflict the poor “are unlikely to garner funding for research and drug development – unless they begin to 'emerge' into the consciousness and space of the nonpoor.” Policy and decision makers should exercise caution in asserting a relationship between dengue and poverty and should pay closer attention to more specific risk factors – including those faced by non-poor communities – in combating this rapidly spreading disease.

Future research directions

This study relied on key informant interviews and direct observation to formulate a case study of dengue and development in the city of Putrajaya. Further epidemiological research in Putrajaya would benefit from primary data collection and the direct comparison of dengue and vector rates with the potential socioeconomic and environmental determinants of dengue in the city (for example, income and education levels, household structural conditions, neighbourhood design, household dengue control behaviours and local public service practices) and from comparisons between Putrajaya and other communities in Malaysia. However, major barriers to data access in Malaysia remain: over a three-year period, the collaborative efforts of UNU-INWEH and UNU-IIGH, even with project partners from the Malaysia Ministry of Health, the Putrajaya Health Unit, and several national-level government research agencies,

have not resulted in the full release of useable dengue case, vector prevalence and demographic data from the Ministry of Health.

More broadly, there is a clear mandate to expand research into the relationships between urbanization, planning/governance and dengue fever to other geopolitical locations and biophysical environments. Across Southeast Asia and many other parts of the Global South, newly-constructed and planned communities – in particular the “edge cities” which strive to provide a homogenized and “globalized” living environment for growing middle classes – provide ample opportunity for such investigations. Further research could help identify determinants of dengue in the built environment, along with potential policy fixes or interventions, as well as understanding the local adaptations, specificity and politics at work in each biopolitical environment. As identified above, the political ecology of health in emerging markets is an under-researched area deserving more research attention as these spaces grow in population, size and economic importance worldwide.

Policy associations between poverty and dengue abound, and are repeated in the preambles to research studies into dengue. However, it appears that little research has directly considered the nature, strength and dimensions of the association between poverty and dengue. If dengue-poverty connections become a priority for the research community – a goal of the NTD initiatives – future

studies are required in order to elucidate which poverty indicators are most relevant to dengue transmission, and in which socioenvironmental contexts. These future studies would benefit from the use of standardized measures of the indicators of poverty (to assist in comparability of studies) and from consideration of supra-household scales in measuring and reporting dengue-poverty connections.

Given the questions that the example of dengue has raised about the categorization of politically neglected diseases as diseases of poverty, there is also room for ongoing research into the links between poverty and other NTDs. Further case studies and systematic reviews of the research literature into the links between each NTD and poverty indicators are warranted. In addition, evaluative research into the impacts of NTD initiatives in poor and non-poor spaces would help bring empirical evidence to bear on the value of targeting poor communities for NTD interventions and research, as well as on the particular strategies favoured by NTD funders (private investment in research and drug development, for example). Beyond the NTDs, other population-targeted health policies rooted in “social determinants of health” discourses merit further investigation.

The complex relationships between dengue, poverty and urbanization raise serious questions for priority-setting in global health policy. Should policy makers wait for scientific evidence to be established before categorizing diseases of

poverty, or do the urgent and complex health needs of poor populations mean policy makers should act first and ask questions later? Does policy rhetoric linking certain diseases with poverty further marginalize efforts to address NTDs, or counter neglect by the global health community? How should actors at local scales interpret and implement global health policies and directives for their unique contexts? The NTDs initiative is well placed to move beyond simple identification of the NTDs toward incorporating a diversity of research approaches that address these global diseases in their embodied biological, ecological, political, cultural and economic contexts. The political ecology of health framework used in this paper provides one avenue for addressing not only the causes and contexts of the NTDs themselves, but also the reasons for their ongoing neglect.

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APPENDIX A: Letter of Invitation



September 2010

Dear Colleagues,

We are writing to invite you to participate in a research study being conducted by the United Nations University's International Institute for Global Health (UNU-IIGH) and International Network on Water, Environment and Health (UNU-INWEH). The purpose of this study is to investigate the connections between infectious diseases and urban planning policies. In this study, we would like to interview you, in your professional role, about public health and urban governance in the city of Putrajaya, including what can be done to prevent and control dengue fever in Putrajaya. We hope to schedule the interview on a date between September 15 – October 15, 2010.

Should you choose to participate, our researcher, Ms. Kate Mulligan, will contact you to set up a convenient time and place for a one-on-one interview, which will take approximately 1 hour of your time. The interview will focus on your role in and your knowledge of public health or urban development in Malaysia and/or Putrajaya. You do not need to be knowledgeable in both areas to participate in this research study.

Your identity will be kept confidential unless you request otherwise. If you decide to participate confidentially, every effort will be made to protect your privacy. If your preferred language for the interview is not English, please identify your preferred language and an interpreter will be present to translate the interview. Upon completion of the study, you will be invited to review and respond to a written summary of key findings.

We hope to use the information gathered to better understand the current linkages between dengue fever and urban planning in Putrajaya. This knowledge will contribute to our understanding of infectious diseases in urban settings and will empower future interventions to prevent and control dengue fever. This study is part of a larger research project conducted by the United Nations University. The international project will produce a suite of tools which can be used by decisions makers like you to map, predict and prevent water-related infectious diseases in Malaysia and globally. This study has received ethics clearance from the McMaster University Research Ethics Board, the Research Ethics Committee of the Universiti Kebangsaan Malaysia, and the Malaysian Ministry of Health.

Please respond to mulligkm@mcmaster.ca or call Kate Mulligan at 016-9162945 as soon as possible to indicate your willingness to participate in an interview. For more information, please

feel free to contact the research team. Full contact information follows below.

Thank you very much for your consideration.

Sincerely,

Ms. Kate Mulligan, McMaster University
Dr. Jamal Hisham Hashim, UNU-IIGH (research supervisor)
Dr. Susan Elliott, UNU-INWEH (research supervisor)

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If you have concerns or questions about your rights as a participant or about the way the study is conducted, please contact:

McMaster Research Ethics Secretariat
Tel.: (905) 525-9140 ext. 23142
c/o Office of Research Services
E-mail: ethicsoffice@mcmaster.ca

APPENDIX B: Letter of Consent



UNITED NATIONS
UNIVERSITY



Inspiring Innovation and Discovery

LETTER OF CONSENT

Dengue Fever in the Multimedia Super Corridor

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Research Sponsor:

United Nations University International Network on
Water, Environment and Health
175 Longwood Road South, Suite 204
Hamilton, Ontario, Canada

Purpose of the Study

The purpose of this study is to investigate the connections between infectious diseases and urban planning policies. In this study, we would like to talk to you, in your professional role, about public health and urban governance in the city of Putrajaya, including what can be done to prevent and control dengue fever in Putrajaya.

What will happen during the study?

You are invited to be part of a one-on-one interview at a time and place convenient to you. Participation is voluntary. The interview will take approximately 1 hour of your time and will focus on your role in and your knowledge of public health or urban development.

There are no other tasks required for this study. However, upon completion of the study, you will be invited to review and respond to a written summary of key findings. This response is voluntary.

Are there any risks to doing study?

There are few risks associated with participation in this study. However, there is the chance that you may feel uncomfortable answering some questions within the interview. Please note that you do not have to answer any questions within the interview that you feel uncomfortable with, or any others that you wish to leave unanswered. Any person participating in the interviews may withdraw at anytime without penalty.

Are there any benefits to doing this study?

We hope to use the information gathered to better understand the current linkages between dengue fever and urban planning in Putrajaya. This knowledge will contribute to our understanding of infectious diseases in urban settings and will empower future interventions to prevent and control dengue fever. This study is part of a larger research project conducted by the United Nations University International Institute for Global Health (UNU-IIGH) in Kuala Lumpur, Malaysia, and the United Nations University International Network for Water, Environment and Health (UNU-INWEH) in Hamilton, Canada. The international project will produce a suite of tools which can be

used by decisions makers like you to map, predict and prevent water-related infectious diseases in Malaysia and globally.

Who will know what I said or did in the study?

Your identity will be kept confidential unless you request otherwise. If you decide to participate confidentially, every effort will be made to protect your privacy. We will not use your name nor any identifying information in our reports. However, as you can appreciate, we are sometimes recognizable through the references we make and the experiences we share. Please keep this in mind through the interview.

The information obtained by will be kept private, stored in a locked cabinet at McMaster University, and only available to the research team. Any digital data will be kept on a secure server protected by a password, with only us having access to it. Once the study is over, all the information will be destroyed.

What if I change my mind about being in the study?

It is your choice as to whether you wish to participate in this study. If you do so choose to participate, you have the right to stop participating within the study, even after signing the consent form or within the middle of the study. If you do decide to stop your participation, no consequences will occur to you. If you choose to stop your participation, information gathered within the interview will be destroyed unless you indicate otherwise. If you do not wish to answer some of the questions, you may decline from answering them, but still participate in the rest of the study.

How do I find out what was learned in this study?

You will have the option of reviewing the general research findings. The research team will return to the UNU-IIGH in 2011 to make the overall research findings available to participants for your review.

Questions about the Study

You are encouraged to ask any questions that occur to you before, during, or after the time of participation within the study. You will be given a copy of this agreement for your own information. If you desire more information at a later date please contact Kate Mulligan at mulligkm@mcmaster.ca.

If you have questions or require more information about the study itself, please contact us.

This study has been reviewed by the McMaster University Research Ethics Board and received ethics clearance.

If you have concerns or questions about your rights as a participant or about the way the study is conducted, please contact:

McMaster Research Ethics Secretariat
Telephone: (905) 525-9140 ext. 23142
c/o Office of Research Services
E-mail: ethicsoffice@mcmaster.ca

APPENDIX C: Key Informant Interview Schedule

The political ecology of dengue fever in Putrajaya, Malaysia		
Purpose of Checklist: This checklist will guide in the conduct of key informant interviews related to the development of dengue fever in Putrajaya, Malaysia		
Construct	Question	Probes/cues
1. Context	<ol style="list-style-type: none"> 1. Tell me about (your agency or workplace) and your professional role. 2. What would you say are the most important responsibilities and issues facing you in this role? 3. How did you come to be in this role? 	<p>Length of tenure</p> <p>Prior employment</p> <p>Educational background</p>
2. Putrajaya	<ol style="list-style-type: none"> 1. What can you tell me about the city of Putrajaya? 2. In your opinion, what is Putrajaya best known for? 3. What lessons can other places learn from the development of Putrajaya? 	<p>History and builders</p> <p>Planning and population characteristics</p> <p>Global/regional significance</p> <p>Is Putrajaya a well-known city? Known for what, among whom?</p>

3. Public Health in Putrajaya and Malaysia	<ol style="list-style-type: none"> 1. What would you say are some of the most important health issues in Putrajaya today? 2. What would you say are some of the most important health issues across Malaysia today? 	Are there any major differences in health issues between Putrajaya and the rest of Malaysia?
4. Dengue Governance in Malaysia	<ol style="list-style-type: none"> 1. What can you tell me about dengue fever in Malaysia? 2. In your experience, what are some of the causes of dengue fever in Malaysia? 3. In your view, what are some of the ways dengue can be prevented? 4. What can you tell me about how dengue is controlled in Malaysia? 	What are some of the strategies, plans, laws or regulations? How (well) are these enforced?
5. Dengue Governance in Putrajaya	<ol style="list-style-type: none"> 1. To your knowledge, what is the dengue situation like in Putrajaya? 2. What can you tell me about how dengue fever is controlled in Putrajaya? 3. In your experience, what is the relationship between dengue control and other city services? 4. ...What about urban planning? 	<p>Are there any major differences in dengue fever between Putrajaya and the rest of Malaysia? Other services, eg.: water, waste management, housing, education...?</p> <p>Ie, how was health/dengue considered in the planning and development of the city?</p>

6. Social Epidemiology of Dengue	<ol style="list-style-type: none"> 1. In your view, who is most at risk for dengue fever? 2. What can you tell me about public education campaigns for dengue fever? 3. ...in Putrajaya? 	<p>How effective are these campaigns? ... for example, the new “Jom Ganyang Aedes” campaign?</p> <p>Are campaigns in Putrajaya different from campaigns in other communities? Do people participate?</p>
7. WHO Determinants of Dengue Fever	<ol style="list-style-type: none"> 1. The World Health Organization says dengue is worsening across the Asia Pacific Region because of “unplanned urban development, poor water storage, unsatisfactory sanitary conditions” and “increased trade and travel.” In your opinion, how well does this capture the experience of dengue in Malaysia? 2. What about in Putrajaya? 	<p>What is the relevance of each determinant in Malaysia and Putrajaya?</p> <p>Are any important causes of dengue not mentioned?</p>
9. UNU Tool	<ol style="list-style-type: none"> 1. We are working to develop a software tool to help predict places at risk of dengue fever (dengue hotspots). Do you think such a tool would be helpful to you in your work? 2. What features would make such a tool useful to you or your agency? 3. What other resources do you wish you had to help you in your professional role? 	<p>What information should such a tool include? What should the tool be able to do? Who should be able to use it?</p> <p>Staff, equipment, money, information, collaboration...?</p>
10. Other	<ol style="list-style-type: none"> 1. Is there anything else you’d like to add? 	

APPENDIX D: Data Extraction Tool

Name of reviewer:

Date of review:

Instructions: Please indicate your selection(s) by changing [] to [x].

Guidelines for Quality Assessment:

- ⤴ Well-covered
- ⤴ Adequately addressed
- ⤴ Poorly addressed
- ⤴ Not addressed (i.e. not mentioned, or indicates that this aspect of study design was ignored)
- ⤴ Not reported (i.e. mentioned, but insufficient detail to allow assessment to be made)
- ⤴ Not applicable

First author:

Title:

Year of publication:

Country of corresponding author:

Journal title:

Volume (Issue):

Pages:

(A) Study Characteristics

<i>Year(s)</i>	
<i>Study purpose: A primary purpose of the study is to investigate the effect of income/SES or their indicators on dengue/vector rates.</i>	<input type="checkbox"/> Yes <input type="checkbox"/> No
<i>Study design</i>	<input type="checkbox"/> Case-control <input type="checkbox"/> Cohort <input type="checkbox"/> Cross-sectional <input type="checkbox"/> RCT <input type="checkbox"/> Other:
<i>Study design: A control population was used.</i>	<input type="checkbox"/> Yes <input type="checkbox"/> No
<i>Sampling method</i>	<input type="checkbox"/> Consecutive <input type="checkbox"/> Random <input type="checkbox"/> Selective <input type="checkbox"/> Other:
<i>Randomization method</i>	

<i>Allocation method</i>	<input type="checkbox"/> Quasi-randomization <input type="checkbox"/> Time differences <input type="checkbox"/> Location differences <input type="checkbox"/> Treatment decisions <input type="checkbox"/> Participants' preferences <input type="checkbox"/> On the basis of outcome <input type="checkbox"/> Other:
<i>Estimated sample size</i>	
<i>Actual sample size</i>	
<i>Sample inclusion criteria</i>	
<i>Sample exclusion criteria</i>	
<i>Definition of cases</i>	
<i>Definition of controls</i>	
<i>Response rate</i>	
<i>Loss to follow-up</i>	
<i>World region</i>	<input type="checkbox"/> South America <input type="checkbox"/> Caribbean <input type="checkbox"/> Southeast Asia <input type="checkbox"/> South Asia <input type="checkbox"/> Other:
<i>Geographic location</i> (select all that apply if combination)	<input type="checkbox"/> Rural <input type="checkbox"/> Urban <input type="checkbox"/> Sub-/peri-urban
<i>Setting</i>	<input type="checkbox"/> Community <input type="checkbox"/> Health facility <input type="checkbox"/> Registry/secondary data <input type="checkbox"/> Other:
<i>Unit of analysis</i> (select all that apply if multi-level)	<input type="checkbox"/> Individual <input type="checkbox"/> Household <input type="checkbox"/> Neighbourhood <input type="checkbox"/> Community/city <input type="checkbox"/> Region <input type="checkbox"/> Country
<i>Age of respondents</i> (range and mean/median)	
<i>Gender of respondents</i> (% male/female)	
<i>Ethnicity of respondents</i>	
<i>Potential statistical confounders</i> (list all specified)	

(B) Poverty measures and instruments used

<i>Poverty measure</i> (select all that apply; only if authors have explicitly linked these variables to poverty)	<input type="checkbox"/> Income <input type="checkbox"/> Employment <input type="checkbox"/> Education <input type="checkbox"/> Housing and living environment (structural) <input type="checkbox"/> Physical condition of housing and living environment <input type="checkbox"/> Access to water and sanitation <input type="checkbox"/> Housing and living environment (overcrowding) <input type="checkbox"/> Social class <input type="checkbox"/> Socioeconomic status <input type="checkbox"/> Health care access <input type="checkbox"/> Other:
<i>Scale of poverty measure</i>	<input type="checkbox"/> Individual <input type="checkbox"/> Household <input type="checkbox"/> Neighbourhood <input type="checkbox"/> Community/city <input type="checkbox"/> Region <input type="checkbox"/> Country
<i>Source of poverty data</i>	<input type="checkbox"/> Primary <input type="checkbox"/> Secondary

(C) Dengue/vector measures and instruments used

<i>Dengue measure</i> (select all that apply)	<input type="checkbox"/> Vector <input type="checkbox"/> Clinical case/laboratory <input type="checkbox"/> Self-report
<i>Scale of dengue measure (refer to Unit of analysis)</i>	<input type="checkbox"/> Individual <input type="checkbox"/> Household <input type="checkbox"/> Neighbourhood <input type="checkbox"/> Community/city <input type="checkbox"/> Region <input type="checkbox"/> Country
<i>Source of dengue data</i>	<input type="checkbox"/> Primary <input type="checkbox"/> Secondary

(D) Analysis

<i>Variables adjusted for</i> (list all specified)	
<i>Interactions tested</i> (list all specified)	

<i>Type of statistical analysis</i>	<input type="checkbox"/> Univariate <input type="checkbox"/> Bivariate <input type="checkbox"/> Multivariate
<i>Missing/incomplete data</i>	
<i>Dengue outcomes by poverty measure (list all reported rates/ percentages)</i>	
<i>Crude odds ratios (OR) (95% CI) for poverty measures</i>	
<i>Adjusted OR (95% CI) for poverty measures</i>	
<i>Association(s) between dengue and poverty (list by poverty measure)</i>	<input type="checkbox"/> Positive: <input type="checkbox"/> Null: <input type="checkbox"/> Negative:

(E) Quality Assessment

SECTION 1: All study designs		
1.1	The study presents a clearly focused question that is appropriate for its objectives.	<input type="checkbox"/> Well-covered <input type="checkbox"/> Adequately addressed <input type="checkbox"/> Not reported <input type="checkbox"/> Poorly addressed <input type="checkbox"/> Not applicable Comments:
1.2	The sampling method is appropriate.	<input type="checkbox"/> Well-covered <input type="checkbox"/> Adequately addressed <input type="checkbox"/> Not reported <input type="checkbox"/> Poorly addressed <input type="checkbox"/> Not applicable Comments:
1.3	The study reports confidence intervals.	<input type="checkbox"/> Well-covered <input type="checkbox"/> Adequately addressed <input type="checkbox"/> Not reported <input type="checkbox"/> Poorly addressed <input type="checkbox"/> Not applicable Comments:
1.4	The study uses reliable (standardized) poverty measures and instruments.	<input type="checkbox"/> Well-covered <input type="checkbox"/> Adequately addressed <input type="checkbox"/> Not reported

		<input type="checkbox"/> Poorly addressed <input type="checkbox"/> Not applicable Comments:
1.5	The study uses reliable (standardized) dengue measures and instruments.	<input type="checkbox"/> Well-covered <input type="checkbox"/> Adequately addressed <input type="checkbox"/> Not reported <input type="checkbox"/> Poorly addressed <input type="checkbox"/> Not applicable Comments:
1.6	The main potential confounders are identified and taken into account in the design and analysis.	<input type="checkbox"/> Well-covered <input type="checkbox"/> Adequately addressed <input type="checkbox"/> Not reported <input type="checkbox"/> Poorly addressed <input type="checkbox"/> Not applicable Comments:
SECTION 2: Case-control studies		
2.1	The cases and controls are taken from comparable populations.	<input type="checkbox"/> Well-covered <input type="checkbox"/> Adequately addressed <input type="checkbox"/> Not reported <input type="checkbox"/> Poorly addressed <input type="checkbox"/> Not applicable Comments:
2.2	The same exclusion criteria are used for both cases and controls.	<input type="checkbox"/> Well-covered <input type="checkbox"/> Adequately addressed <input type="checkbox"/> Not reported <input type="checkbox"/> Poorly addressed <input type="checkbox"/> Not applicable Comments:
2.3	What percentage of each group (cases and controls) participated in the study?	
2.4	Comparison is made between participants and non-participants to establish their similarities or differences.	<input type="checkbox"/> Well-covered <input type="checkbox"/> Adequately addressed <input type="checkbox"/> Not reported <input type="checkbox"/> Poorly addressed <input type="checkbox"/> Not applicable Comments:
2.5	Cases are clearly defined and differentiated from controls.	<input type="checkbox"/> Well-covered <input type="checkbox"/> Adequately

		addressed <input type="checkbox"/> Not reported <input type="checkbox"/> Poorly addressed <input type="checkbox"/> Not applicable Comments:
2.6	It is clearly established that controls are non-cases.	<input type="checkbox"/> Well-covered <input type="checkbox"/> Adequately addressed <input type="checkbox"/> Not reported <input type="checkbox"/> Poorly addressed <input type="checkbox"/> Not applicable Comments:
2.7	Measures will have been taken to prevent the researchers' knowledge of primary exposure influencing case ascertainment.	<input type="checkbox"/> Well-covered <input type="checkbox"/> Adequately addressed <input type="checkbox"/> Not reported <input type="checkbox"/> Poorly addressed <input type="checkbox"/> Not applicable Comments:
2.8	The study uses sensitivity analysis (solve model for outcome measures for each discrete scenario individually, or for all combinations of discrete scenarios, at each parameter's minimum and maximum value).	<input type="checkbox"/> Well-covered <input type="checkbox"/> Adequately addressed <input type="checkbox"/> Not reported <input type="checkbox"/> Poorly addressed <input type="checkbox"/> Not applicable Comments:
SECTION 3: Cross-sectional studies		
3.1	What percentage of each group participated in the study (i.e. non-response rate, refusal rate)?	
3.2	Measures will have been taken to prevent the researchers' knowledge of primary exposure influencing group ascertainment.	<input type="checkbox"/> Well-covered <input type="checkbox"/> Adequately addressed <input type="checkbox"/> Not reported <input type="checkbox"/> Poorly addressed <input type="checkbox"/> Not applicable Comments:
3.3	The study uses sensitivity analysis (solve model for outcome measures for each discrete scenario individually, or for all combinations of discrete scenarios, at each parameter's minimum and maximum value).	<input type="checkbox"/> Well-covered <input type="checkbox"/> Adequately addressed <input type="checkbox"/> Not reported <input type="checkbox"/> Poorly addressed <input type="checkbox"/> Not applicable Comments:
SECTION 4: Cohort studies		
4.1	The two groups being studied	<input type="checkbox"/> Well-covered

	are selected from source populations that are comparable in all respects other than the factor under investigation.	<input type="checkbox"/> Adequately addressed <input type="checkbox"/> Not reported <input type="checkbox"/> Poorly addressed <input type="checkbox"/> Not applicable Comments:
4.2	The study indicates how many of the people asked to take part did so, in each of the groups being studied.	<input type="checkbox"/> Well-covered <input type="checkbox"/> Adequately addressed <input type="checkbox"/> Not reported <input type="checkbox"/> Poorly addressed <input type="checkbox"/> Not applicable Comments:
4.3	The likelihood that some eligible subjects might have the outcome at the time of enrolment is assessed and taken into account in the analysis.	<input type="checkbox"/> Well-covered <input type="checkbox"/> Adequately addressed <input type="checkbox"/> Not reported <input type="checkbox"/> Poorly addressed <input type="checkbox"/> Not applicable Comments:
4.4	What percentage of individuals or clusters recruited into each arm of the study dropped out before the study was completed?	
4.5	Comparison is made between full participants and those lost to follow up, by exposure status.	<input type="checkbox"/> Well-covered <input type="checkbox"/> Adequately addressed <input type="checkbox"/> Not reported <input type="checkbox"/> Poorly addressed <input type="checkbox"/> Not applicable Comments:
4.6	The outcomes are clearly defined.	<input type="checkbox"/> Well-covered <input type="checkbox"/> Adequately addressed <input type="checkbox"/> Not reported <input type="checkbox"/> Poorly addressed <input type="checkbox"/> Not applicable Comments:

4.7	The assessment of outcome is made blind to exposure status.	<input type="checkbox"/> Well-covered <input type="checkbox"/> Adequately addressed <input type="checkbox"/> Not reported <input type="checkbox"/> Poorly addressed <input type="checkbox"/> Not applicable Comments:
4.8	Where blinding was not possible, there is some recognition that knowledge of exposure status could have influenced the assessment of outcome.	<input type="checkbox"/> Well-covered <input type="checkbox"/> Adequately addressed <input type="checkbox"/> Not reported <input type="checkbox"/> Poorly addressed <input type="checkbox"/> Not applicable Comments:
4.9	The measure of assessment of exposure is reliable.	<input type="checkbox"/> Well-covered <input type="checkbox"/> Adequately addressed <input type="checkbox"/> Not reported <input type="checkbox"/> Poorly addressed <input type="checkbox"/> Not applicable Comments:
4.10	Evidence from other sources is used to demonstrate that the method of outcome assessment is valid and reliable.	<input type="checkbox"/> Well-covered <input type="checkbox"/> Adequately addressed <input type="checkbox"/> Not reported <input type="checkbox"/> Poorly addressed <input type="checkbox"/> Not applicable Comments:
4.11	Exposure level of prognostic factor is assessed more than once.	<input type="checkbox"/> Well-covered <input type="checkbox"/> Adequately addressed <input type="checkbox"/> Not reported <input type="checkbox"/> Poorly addressed

		[] Not applicable Comments:
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OVERALL ASSESSMENT OF THE STUDY	
How well was the study done to minimize the risk of bias or confounding, and to establish a causal relationship between exposure and effect?	<p>[] ++: All or almost all of the above quality assessment criteria were fulfilled, and those criteria that were not fulfilled were thought unlikely to alter the conclusions of the study.</p> <p>[] +: Some of the above quality assessment criteria were fulfilled, and those criteria that were not fulfilled were thought unlikely to alter the conclusions of the study.</p> <p>[] -: Few or no criteria were fulfilled, and the conclusions of the study were thought likely or very likely to alter the conclusions of the study with their inclusion.</p>

Quality assessment based on a set of pre-determined criteria outlined by SIGN50 guidelines (<http://www.sign.ac.uk/guidelines/fulltext/50/annexc.html>) with minor adjustments.