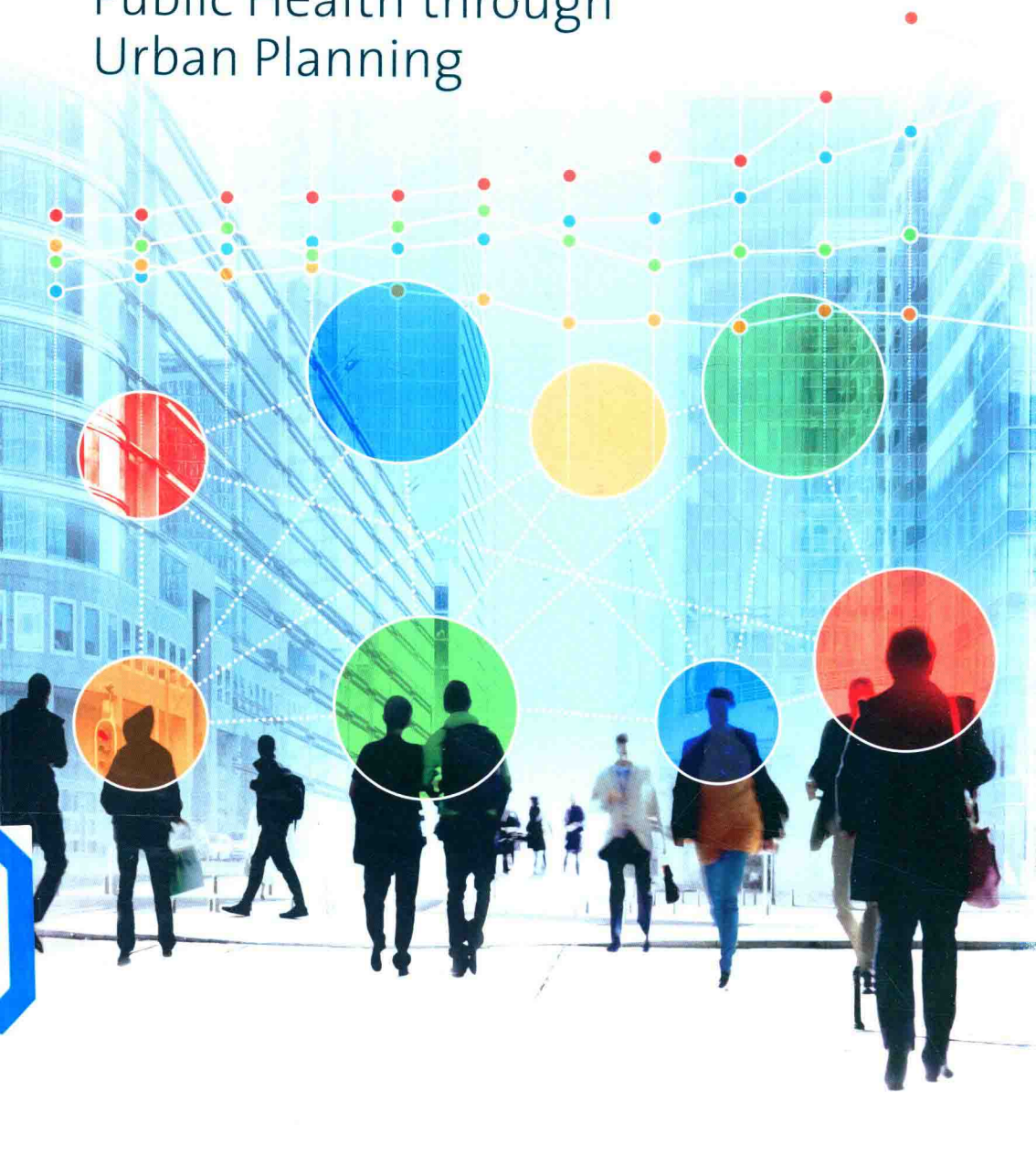
Chinmoy Sarkar
Chris Webster
John Gallacher

EE

HEALTHY CITIES

Public Health through Urban Planning



Healthy Cities

Public Health through Urban Planning

Chinmoy Sarkar

School of Medicine and School of Planning and Geography, Cardiff University, UK

Chris Webster

Faculty of Architecture, University of Hong Kong

John Gallacher

School of Medicine, Cardiff University, UK

Edward Elgar
Cheltenham, UK • Northampton, MA, USA

Published by
Edward Elgar Publishing Limited
The Lypiatts
15 Lansdown Road
Cheltenham
Glos GL50 2JA
UK

Edward Elgar Publishing, Inc.
William Pratt House
9 Dewey Court
Northampton
Massachusetts 01060
USA

A catalogue record for this book
is available from the British Library

Library of Congress Control Number: 2013954347

This book is available electronically in the ElgarOnline.com
Social and Political Science Subject Collection, E-ISBN 978 1 78195 572 7

ISBN 978 1 78195 571 0 (cased)

Typeset by Servis Filmsetting Ltd, Stockport, Cheshire
Printed and bound in Great Britain by T.J. International Ltd, Padstow

Healthy Cities

To Tapas, Ratna, Sarika, Rini and Angelina;
Maggie, Chloe and Sam;
Anne, David, Owen and Daniel.
We are each indebted to, supported by and made wise by our families.

Foreword

> And now let doctors leave the centre stage
> And usher in the prophylactic phase.
>
> (From 'Superfluous Doctors', a poem written in prisoner-of-war camp by Archie Cochrane)

In the privileged West we have come a long way since Edwin Chadwick and Southwood Smith challenged the authorities in the 1840s about the living conditions and the lack of sanitary provision for 'the labouring population'. Their work led to the formation of the Health of Towns Association in 1844, and to the passing of the Public Health Act 1848 under which the collection of sewage, the supply of water and the cleansing of streets became a statutory duty of the local authorities. We have come a long way from these, and from the surveys of Charles Booth in the 1890s in which streets were classified on a scale from 'lowest class, vicious and semi-criminal', through 'very poor, casual, chronic want' to 'fairly comfortable, good ordinary earnings' and 'upper classes, wealthy'.

While one could argue that these major battles have been largely won in the West in relation to infectious disease, there are still substantial differences in chronic disease incidence and death rates attributable to social class and to area of residence. Furthermore, as McKeown argued, after the early successes public policy on health in Britain and in many other countries became dominated by a treatment rather than a prevention orientation. Indeed it could be argued that, in the UK at any rate, the major objective in many departments of public health has become the monitoring and evaluation of therapeutic services, rather than a focus on the preservation of health and prevention of disease.

Nevertheless, the Healthy Cities Initiative in 1986 by the World Health Organization has provided a framework for what some have termed 'the New Public Health', in that it brings together environmental changes and personal preventive measures, with a focus on public policy and individual lifestyle. This recognition of the built environment as a 'first cause' (alongside genetics and the socio-economic environment) of chronic disease has profound implications, as it brings into context the foundational importance of the built environment and urban planning. To be able to design environments, including redesigning and retrofitting parts of cities

in the West that are past their due date and creating brand new cities in developing countries, which promote health across chronic as well as infectious disease will affect global health for generations to come, just as the reshaping of cities since the first Public Health Acts did over a century ago.

Against this background this work of Sarkar, Webster and Gallacher is highly opportune. Their application of objective built environment assessment to cohort data represents a step-change in rigour. It is an essential step towards quantifying the effect of the built environment on chronic disease in individuals over the life course. It is also a modern milestone in the construction of an evidence base for healthy town planning. The empirical part of the book draws on results from a small town, but one that has become one of the best international epidemiologic laboratories. It is rather remarkable that significant urban design effects have been found in such a small town and population. The Caerphilly study results are encouraging, therefore, but more data await the analysis of this team. The automation of their methods has allowed their application to large-scale data sets, and work is under way to apply their built environment metrics to the UK Biobank (a flagship UK epidemiology study of half a million people) and other cohorts. This work holds enormous promise.

The records of the Health of Towns Association of late-nineteenth-century England show that the Association members argued and debated and the early medical officers of health were branded as troublemakers. A new round of debate is upon us with very different types of urban public health concerns, notably obesity, mental health and an ageing population. Therefore – let the work continue and the evidence-based arguments begin.

Peter Elwood
Cardiff University
July 2013

Preface

Mounting scientific evidence generated over the past decade points to the significant role played by the myriad attributes of our cities' built environments in shaping our health and well-being. Nonetheless, the attainment of healthy cities still remains a massive unmet challenge to urban societies at all levels of development. The production and socio-spatial distribution of health originate as a result of a complex interplay between contextual socio-economic, built and natural environmental as well as individual- and population-level factors; and this complexity is tricky to unravel. We undertook to write this book with this challenge in mind. In particular, we wanted to bring together the disciplines of urban planning, public health and epidemiology and show how once again in the modern history of urban planning they have need of each other. The modern era of urban planning in the UK, and the West as a whole, started under the influence of public health studies and policy concerns. We believe that it is time to reunite the two fields in more than a rhetorical manner.

To decipher the impact of healthy (or unhealthy) places upon health outcomes, the book hypothesizes that the constituent components of the built environment, especially the configuration and design of land uses and street networks, govern the distribution of resources and services and configure neighbourhood activity space. They thereby influence individual physical activity behaviour, social interactions, general well-being and specific health such as weight outcomes and mental health. The underlying causal hypothesis in the book, and in the field of studies that it reviews and extends, is that the configuration of urban space and the distribution of opportunities within its subspaces influence physical activity and influence exposure to health-enhancing and -subtracting factors.

The transport networks of a city, particularly its road grid, can be thought of as distributing the benefits and costs of living together in a city. For this reason, property prices are highly correlated with the accessibility conferred by the grid. The urban grid also distributes health risks. If this is so, then it should be possible to use urban accessibility measured from the road network to both explain and predict individual health variations within cities.

Chapters 1–4 conceptualize the *urban health niche* as a novel holistic and spatially explicit paradigm in health-related urban planning and public health planning, and propose a method for empirically modelling the healthy city. Chapters 5–8 demonstrate how this paradigm, informed by accumulated research evidence, can be used to structure empirical studies and provide scientific evidence much needed to support healthy-city policy and planning. These empirical chapters show how we have created and integrated multi-level data sets pertaining to health, socio-economic, built and natural environments to constitute a high-resolution health niche database. We call this a *spatial Design Network Analysis for Urban Health* model (*sDNA-UH*) after the sDNA spatial network analysis tool that conceptually and empirically underlies the implemented health niche model (http://www.cardiff.ac.uk/sdna/). The sDNA-UH model reported in this book has been developed for the assembly constituency of Caerphilly, an assembly constituency of South Wales in the UK.

State-of-the-art spatial and network analysis performed on UK Ordnance Survey MasterMap data layers creates objective measurements of urban built environment accessibility (morphological metrics – *morphometrics*). These are used to investigate fine-scale associations between urban configuration and individual health. We employ health data from the Caerphilly Prospective Study, a long-standing and internationally prominent cohort study of adult men. Using the morphometrics and the health data, we construct a series of multi-level cross-sectional and longitudinal models in Chapters 5–8 to examine the association between built environment configuration and individual health outcomes.

The conceptual and empirical chapters (Chapters 1–4 and 5–8 respectively) are intended to point to a more focused and evidence-based approach to investigating and designing for healthy cities. We hope that the book will encourage a new generation of scholars to pursue the new opportunities now available through innovations in data and spatial and network data analysis methods and technology.

The book is intended to be of interest to an interdisciplinary body of scholars, practitioners and policy makers within the domains of urban planning, spatial epidemiology, health geography, sociology, public health and psychology. The empirical studies in Chapters 5–8 are especially intended for advanced undergraduate and postgraduate scholars and urban health researchers who may want to integrate readily accessible spatial data with health data in constructing robust spatial epidemiological and public health models.

We wish to thank several individuals who helped us in the writing of this book. Our ideas for the book have been refined over time under the influence of contributions from many scholars, including some of the works

cited in the References. In particular we would like to thank Professor Peter Elwood, Professor Stephen Palmer and Professor Lawrence Frank for their encouragement during the course of the project. Professor Elwood's influence goes back to the start of the careers of two members of the authoring team (Chris Webster and John Gallacher), and this is a good opportunity to thank him for shaping our respective intellectual journeys. We also thank our students and colleagues at Cardiff University for being a constant source of challenge and renewal in our academic pursuits. Special thanks are due to the anonymous respondents of the Caerphilly Prospective Study, whose health we study in this book. We further wish to thank the UK Ordnance Survey for the MasterMap data layers that formed the base for the construction of built environment metrics in this project. Thanks are also due to the UK Economic and Social Research Council and UK Biobank for their support of the authors' WHealth modelling project (ESRC grant reference: ES/L003201/1 under its Transformative Research Programme) and UK Biobank Built Environment project (entitled Morphometric Analysis of the Built Environment in UK Biobank). The work presented in this book provided a pilot run for the scaled-up version in these research projects. At the same time, the ESRC project provided resources towards the completion of the book, which contains the fullest statement in print of the methodology underlying the WHealth modelling paradigm. We express our thanks to Jo Betteridge, Caroline Cornish, Emily Neukomm and Alex Pettifer at Edward Elgar for their patient help with the editing of the original manuscript. Last but not the least, we owe special gratitude to our families for their constant encouragement and support, as well as for patiently enduring this project with us.

Chinmoy Sarkar
Chris Webster
John Gallacher

Abbreviations

ACEs	active community environments
AIC	Akaike information criterion
APGAR	adaptation, partnership, growth, affection, resolve
ARI	acute respiratory infections
ARIC	Atherosclerosis Risk in Communities
ASA	angular segment analysis
BALTS	Baltimore Active Living Teens Study
BATS	Bay Area Travel Survey
BE	built environment
BEAT	Built Environment Assessment Tool
BEPAS	Belgian Environmental Physical Activity Study
BESSC	Built Environment Site Survey Checklist
BG	block group
BIC	Bayesian information criterion
BMI	body mass index
BRFSS	Behavioural Risk Factor Surveillance System
CAAL	Child/Adolescent Activity Log
CaPS	Caerphilly Prospective Study
CAS	complex adaptive systems
CATI	computer-assisted telephone interview
CBD	central business district
CCD	census collection district
CCHS	Canadian Community Health Survey
CDC	Centers for Disease Control and Prevention
CES-D	Center for Epidemiologic Studies Depression Scale
CHD	coronary heart disease
CHS	Community Health Survey (New York City)
CI	confidence interval
CIS-R	Revised Clinical Interview Schedule
CMSA	consolidated metropolitan statistical area
CO	carbon monoxide
CO_2	carbon dioxide
COPD	chronic obstructive pulmonary disease
Cred.I	credible interval

CVD	cardiovascular disease
DALYs	disability-adjusted life-years
DHAs	district health authorities
DSSI	Duke Social Support Index
DTM	digital terrain model
DZ	data zone
ETS	environmental tobacco smoke
FAR	floor area ratio
GDP	gross domestic product
G–E	gene–environment
GGHB	Greater Glasgow Health Board
GHQ	General Health Questionnaire
GIS	geographic information system
GLLAMM	generalized linear latent and mixed models
GP	general practitioner
GWAS	genome-wide association studies
HADS	Hospital Anxiety and Depression Scale
HANAH	Housing and Neighbourhood and Health
HCl	hydrogen chloride
HHI	Herfindahl–Hirschman Index
HIMS	Health in Men Study
HIV	human immunodeficiency virus
HNC	household–neighbourhood–city
HNO_2	nitrous acid
HNO_3	nitric acid
HRQoL	health-related quality of life
HSE	Health Survey for England
ICSU	International Council for Science
IHD	ischaemic heart disease
IPAQ	International Physical Activity Questionnaire
IPS	International Physical Activity Prevalence Study
ITN	Integrated Transport Network
LA	local authority
L.A.FANS	Los Angeles Family and Neighborhood Study
LARES	Review of European Housing and Health Status
LGA	local governing area
LSOA	lower super output area
LU	land use
LUM	land use mix
MCMC	Markov Chain Monte Carlo
MESA	Multi-Ethnic Study of Atherosclerosis
METS	metabolic syndrome

MI	myocardial infarction
MoNAT	Montreal Neighbourhood Assessment Tool
MSOA	middle super output area
MVPA	moderate to vigorous physical activity
NALP	Neighbourhood Active Living Potential
NBZ	network buffer zone
NDVI	Normalized Difference Vegetation Index
NEWS	Neighbourhood Environment Walkability Scale
NHANES	National Health and Nutrition Examination Survey
NHS	National Health Service
NHTS	National Household Travel Survey
NICE	National Institute for Health and Clinical Excellence
NIHL	noise-induced hearing loss
NO_2	nitrogen dioxide
NOx	oxides of nitrogen
NPAQ	Neighbourhood Physical Activity Questionnaire
NPTS	National Personal Transportation Survey
NQLS	Neighbourhood Quality of Life Study
O_3	ozone
OPCS	Office of Population Censuses and Surveys
OR	odds ratio
OS	Ordnance Survey
OSM	Ordnance Survey MasterMap
PA	physical activity
PACW	physically active commuting to work
PANES	Physical Activity Neighbourhood Environment Survey
PCS	postcode sector
PEDS	Pedestrian Environmental Data Scan
PERI	Psychiatric Epidemiological Research Instrument
PLACE	Physical Activity in Localities and Community Environments
PM	particulate matter
POR	prevalence odds ratio
ppm	parts per million
PR	prevalence ratio
QoL	quality of life
REAT	Residential Environment Assessment Tool
RESIDE	RESIDential Environment project
SAD	seasonal affective disorder
SAR	sample of anonymized records
SD	standard deviation
sDNA	spatial Design Network Analysis

sDNA-UH	spatial Design Network Analysis for Urban Health
SE	standard error
SEAs	state economic areas
SEID1	Study of Environmental and Individual Determinants
SES	socio-economic status
SHAPE	Senior Health and Physical Exercise
SMARTRAQ	Strategies for Metropolitan Atlanta's Regional Transportation and Air Quality
SofC	sense of community
SOV	single-occupant vehicle
SPACES	Systematic Pedestrian and Cycling Environmental Scan
spc	standardized path coefficient
SVOCs	semi-volatile organic compounds
SWAT	Scottish Walkability Assessment Tool
SWEAT	Senior Walking Environmental Assessment Tool
TAZ	traffic analysis zone
TIA	transient ischaemic attack
TREC-IDEA	Trans-disciplinary Research on Energetics and Cancer – Identifying Determinants of Eating and Activity
UMBECS	University of Miami Built Environment Coding System
USEPA	US Environmental Protection Agency
VHT	vehicle hours of travel
VIFs	variance inflation factors
VOCs	volatile organic compounds
WBC	Walkable and Bikeable Communities
WHO	World Health Organization
WIMD	Welsh Index of Multiple Deprivation
WOMAN	Women on the Move through Activity and Nutrition
WPS	Walkable Places Survey

Contents

1. Introduction

> For in general you will find assimilated to the nature of the land both the physique and the characteristics of the inhabitants.
>
> (Hippocrates, 1948: 137)

The first decade of the twenty-first century was for British urban planning something of a rerun of the first decade of the twentieth century: planning was heralded as a powerful new antidote to urban public health problems. A hundred years ago, the cause was the abysmal conditions in cities that had emerged by the middle of the nineteenth century and the consequent successive waves of public health-related legislation that eventually gave rise to the modern British planning system at the dawn of the new century. This time around, it was an epidemic in obesity allied with growing concerns over the health outcomes of unequal cities, marginalized groups and problem neighbourhoods and a shift in perspective amongst epidemiologists that favoured a holistic view of health, health problems and interventions and led them to view urban planning as the ultimate public health intervention:

> Understanding the urban factors that are risk or protective factors for health can capitalize on the positive aspects of urban living and lead to the development of appropriate interventions and preventive measures. Given the growing predominance of the urban living, interventions that take into account features of the urban environment have the potential to be widely applicable and to influence the health of vast number of people. (Vlahov and Galea, 2003)

In the United Kingdom, the relationship between urban planning and public health has come under renewed focus by medical and planning academics (H. Barton and Tsourou, 2000; Kidd, 2007; H. Barton, 2009; Herrick, 2009; Townshend and Lake, 2009; B. Evans et al., 2012) and public health and planning policy makers (National Heart Forum, 2007; Department of Health, 2008; NICE, 2008; RTPI, 2009). Britain is not alone in this: the same connections are being made across Europe, Australia, New Zealand (National Heart Foundation of Australia, 2004; Public Health Advisory Committee, 2008; Healthy Spaces and Places, 2009; WHO Europe, 2010) and the USA (Greenberg et al., 1994; Diez Roux, 2001, 2002; Dannenberg et al., 2003; Frank et al., 2003; Corburn,

2004; Sallis et al., 2012). The developed world has been rediscovering one of the forgotten fundamental purposes of city planning. The modern scholarship picks up from that of the early pioneering ecological health studies aimed at deciphering the disparities in health and mortality. The earliest studies were conducted in the seventeenth century; John Graunt ([1662] 1939) reported on the social distribution of death from plague in London, while William Petty enumerated the costs of mortality (Petty and Hull, 1899). Towards the late nineteenth century (1886–91), Charles Booth (1889), a social reformer, conducted a detailed survey to measure and map the incidence and causes of poverty in inner London, which formed the basis of the contemporary Registrar General's social class scheme.

The relationship between health and urban development pattern has not had to be rediscovered in countries at a less advanced stage of economic and urban development. Cities in developing countries, as with European cities 150 years ago, have always been intrinsically unhealthy. The proportion of urban population increased from slightly below 20 per cent to 36 per cent over the period 1960–2000 in both Asia and Africa (Bloom et al., 2008). Increasing competition for space in the cities results in socio-spatial stratifications wherein residents of the poorer neighbourhoods typically experience inadequate housing and sanitation, lack of access to potable water, overcrowding, pollution, substance use, crime and the associated health costs. Induced behavioural changes result in sedentary lifestyles manifested by physical inactivity, psychosocial stress, increased dependence on junk or otherwise poor-quality food, and tobacco use: potential precursors for chronic non-communicable diseases. For example, the estimated mortality from cardiovascular disease in 1990 was 70 per cent higher in the developing countries (at 8–9 million fatalities) relative to developed countries at 5.3 million deaths over the same period (A.D. Lopez, 1993). A study found comparatively higher incidence rates of hypertension in the urban areas of India and sub-Saharan Africa than in the rural areas (Srinath Reddy et al., 2005; Addo et al., 2007). Another study, conducted in China, indicates that the propensity to report poor health increases with increasing degree of urbanization. Incidence rates of obesity and hypertension were also comparatively higher in urban populations than their rural counterparts (Van de Poel et al., 2012). Another longitudinal study, conducted in eight provinces of China, reported a 14 per cent increase in car ownership between 1989 and 1997 and an associated 1.8 kilogram greater weight gain, while the likelihood of becoming obese during that time period doubled (A.C. Bell et al., 2002; F.B. Hu, 2011). The world's slum population is increasing despite the rapid progress in urban environmental quality made in some parts of the developing world. The population of slum dwellers has risen from 0.75 billion in 1990 to 1 billion today, and this