Health & Place 42 (2016) 19–29

Contents lists available at ScienceDirect

Health & Place

journal homepage: www.elsevier.com/locate/healthplace

The effects of built environment attributes on physical activity-related health and health care costs outcomes in Australia

Belen Zapata-Diomedi*, Ana Maria Mantilla Herrera, J. Lennert Veerman

The University of Queensland, School of Public Health, Herston, Queensland 4006, Australia

ARTICLE INFO

Article history:
Received 29 February 2016
Received in revised form
2 August 2016
Accepted 24 August 2016

Keywords:
Built environment
Physical activity
Health
Economic evaluation
Health impact assessment

ABSTRACT

Attributes of the built environment can positively influence physical activity of urban populations, which results in health and economic benefits. In this study, we derived scenarios from the literature for the association built environment-physical activity and used a mathematical model to translate improvements in physical activity to health-adjusted life years and health care costs. We modelled 28 scenarios representing a diverse range of built environment attributes including density, diversity of land use, availability of destinations, distance to transit, design and neighbourhood walkability. Our results indicated potential health gains in 24 of the 28 modelled built environment attributes. Health care cost savings due to prevented physical activity-related diseases ranged between A$1300 to A$105,355 per 100,000 adults per year. On the other hand, additional health care costs of prolonged life years attributable to improvements in physical activity were nearly 50% higher than the estimated health care costs savings. Our results give an indication of the potential health benefits of investing in physical activity-friendly built environments.

1. Introduction

In Australia, just over half of the adult population meets the recommended physical activity (PA) guidelines (Australian Bureau of Statistics, 2015b). This is a public health concern, given the strong evidence of a causal association between low levels of physical activity and ischaemic heart disease, stroke, colon cancer, breast cancer in women, and type 2 diabetes (Bull et al., 2004). The high prevalence of physical inactivity in Australia is taking its toll with nearly 10,000 premature deaths and 31,000 years lived with disability annually (Institute for Health Metrics and Evaluation, 2015a). A physically inactive population also represents an economic burden for the society by means of high health care costs and loss of productivity (Pratt et al., 2012).

Population levels of physical activity could be increased via multilevel approaches that include the individual, institutional, community, and built and policy environments (Sallis et al., 2012). The built environment (BE), defined as those elements of the environment that are man-made, including transportation systems, urban planning, and individual buildings (World Health Organization, 2009 p. 28), has drawn increasing attention to its effect on health. This is reflected in the exponential growth over recent years of studies investigating the links between physical activity and built environment attributes (Eichinger et al., 2015; Grasser et al., 2013; Kramer et al., 2013; McCormack and Shiell, 2011; Van Holle et al., 2012). These studies have shed light on the effect of the built environment on levels of physical activity. However, demonstrating the potential health value of built environments that facilitate physical activity may help to convince policy makers to consider health impacts in project appraisals.

In recent years, a number of quantitative studies have been conducted to predict health and economic outcomes of built environment interventions. Health impact assessment (HIA) studies mostly investigated hypothetical or policy scenarios, including health impacts via physical activity, air pollution, and road injuries. For example, Woodcock and colleagues developed the Integrated Transport and Health Impact Modelling (ITHIM) tool and applied it to assess transport and urban form scenarios in the United Kingdom (UK), Europe, India and the United States (Centre for Diet and Activity Research, 2015). In one of the applications of ITHIM, three alternative urban land transport scenarios (low-carbon emission motor vehicles, increased active travel and a combination of both) were assessed for London, UK and Delhi, India (Woodcock et al., 2009). The findings from this study indicated that decreased use of motor vehicles and more active travel produced the highest health benefits with 7,332 averted disability-adjusted life years in London and 12,516 in Delhi on average per year per million population. A recent systematic review of HIAs and economic evaluations assessing mode shifts towards active transport found that in most of

* Corresponding author.
E-mail addresses: b.zapatadiomedi@uq.edu.au (B. Zapata-Diomedi), ana.mantillaherrera@uqconnect.edu.au (A.M.M. Herrera), l.veerman@uq.edu.au (J.L. Veerman).

http://dx.doi.org/10.1016/j.healthplace.2016.08.010
1353-8292/

the included studies, health benefits from physical activity outweighed other potential health harms of active transport (e.g. road injuries and greater exposure to air pollution) (Mueller et al., 2015). The literature in the field is now advancing towards more specific scenarios linking built environment to physical activity, followed by health impact assessments and economic evaluations as opposed to basing prediction on hypothetical scenarios. For instance, a recent study conducted cost-benefit analyses (CBAs) of proposed built environment changes designed to improve walkability in three different communities: one urban, one suburban, and one rural (Mansfield and Gibson, 2015). In this study estimates for the association between a walkability score and sidewalk density were used to predict changes in walking for transport. The study found that the health benefits of the built environment projects exceeded the project costs in the urban area and the rural town, with benefit-cost ratios of 20.2 (95% CI: 8.7–30.6) and 4.7 (95% CI: 2.1–7.1). The suburban project's costs exceeded benefits by 40% (benefit-cost ratio = 0.6, 95% CI 0.3–0.9). Unlike the urban and rural projects, the suburban project involved only the installation of sidewalks, without other improvements such as addition of walking destinations, in an area that was lacking in destinations. Gibson et al. (2015) recently developed a simulation model linking changes in the built environment to time spent walking which was translated into health and economic outcomes (2015). The study results indicated potential economic benefits of US$ 234 million (95% CI: US$53–US$393 million) attributable to decreased mortality and diseases prevalence. A benefit-cost ratio of 29 (95% CI: 6.5–48) was estimated including only the cost of sidewalk infrastructure.

In Australia, building and maintaining healthy places has become a priority given the rising levels of chronic diseases (National Preventative Health Taskforce, 2009). Creating healthy built environments is already on the agenda of health professionals, who are working closely with urban planners to influence city designs that support healthy lifestyles (Thompson et al., 2014). However, for the inclusion of physical activity in urban and transport projects, context specific estimates for the association built environment-physical activity, in combination with agreed methods to determine the health benefits of physical activity are required.

In this study, we quantified physical activity-related improvements in mortality and morbidity measured in health-adjusted life years (HALYs) associated with specific built environment attributes along with potential savings/increases in health care costs for the Australian context. The results can serve as a reference for the inclusion of physical activity-related health outcomes in the appraisal of built environment projects. This research originated as an initiative from the Centre for Population Health, Government of New South Wales (NSW), to demonstrate the potential costs and benefits of changes in urban form (built environment).

2. Methods

We reviewed the Australian literature assessing the association BE-PA for the adult population and used reported effect estimates to quantify the potential health benefits and health care costs associated with improving population levels of PA attributable to the BE. There are three sections to our analysis: (1) selection of BE attributes; (2) estimation of change in PA attributable to the BE expressed as average minutes of PA per week across the population; and (3) translation of changes in population levels of PA into HALYs gained and health care costs, using a mathematical model. We explain each step in turn (Fig. 1).

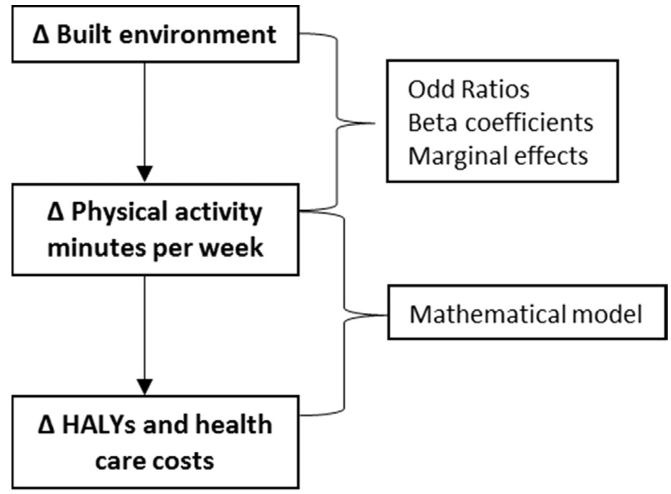

Fig. 1. Analytical framework of the process of quantifying HALYs and health care costs of changes in exposure to selected built environment attributes.

2.1. Selection of built environment attributes

We reviewed the current Australian literature for the association BE-PA for the adult population (18 years +) (For complete review see Zapata-Diomedi and Veerman (2016)). Given the wide diversity of BE attributes reported, we grouped them in seven categories, including five of the six "D's" from Ewing and Cervero (2010) (density, diversity of land use, availability of destinations, distance to transit, and design) plus measures of safety and neighbourhood walkability. We assessed studies for the quality of their design, representativeness of the data, and control for confounding variables using tools applied for similar purposes (Grasser et al., 2013). We only modelled attributes from studies of good and fair quality that measured the BE objectively and were based on samples of over 1,000 individuals.

2.2. Estimation of changes in physical activity

Three types of measures for the association BE-PA were used in the source literature: (1) odds ratios for the likelihood of doing PA for a given BE exposure (Christian et al., 2011; Knuiman et al., 2014; Learnihan et al., 2011; Owen et al., 2010; Wilson et al., 2011); (2) beta coefficients for the additional time or sessions of PA for a given BE exposure (Giles-Corti et al., 2013; Koohsari et al., 2014; McCormack et al., 2012) and (3) marginal probabilities of doing PA for those exposed compared to non-exposed to a given BE attribute (McCormack et al., 2012). Given the diversity of reporting styles we applied different methods to translate effect estimates into average population change in minutes of PA per week.

Two steps were required to translate OR into average additional minutes of PA across the population. Firstly, we converted OR into relative risks (RR) to estimate the additional proportion doing PA if exposed to an alternative BE. We used the formula proposed by Grant (2014) which was developed by Zhang and Yu (1998) to convert OR to RR (Formula 1).

$$RelativeRisk = \frac{Oddsratio}{(1-p_0 + (p_0{*}Oddsratio))} \quad (1)$$

Here, p_0 is the incidence of the outcome of interest in the non-exposed group (physical activity among those not exposed to the built environment of interest). None of the source studies provided information for p_0, hence we assumed that this was equivalent to the prevalence of PA for the sample under consideration (sample prevalence physical activity in Table 4 in Results section). Our