Forest Policy and Economics 54 (2015) 11–17

Contents lists available at ScienceDirect

Forest Policy and Economics

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

Do forests help to keep my body mass index low?

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A R T I C L E   I N F O

Article history:
Received 3 June 2014
Received in revised form 25 November 2014
Accepted 18 February 2015
Available online 5 March 2015

Keywords:
Forest
Recreational activity
Obesogenic environments
Multilevel modelling

A B S T R A C T

Increasing importance has been placed on understanding how the environment in which people live can help anti-obesity behaviour and policy. This tendency represents a shift away from a model characterised by individual responsibility in favour of one that focuses on so-called 'obesogenic environments'. Although an extensive body of literature stresses the importance of urban design in helping to eradicate obesity, there is, nevertheless, significant uncertainty in the science surrounding the relationship between body size and broad geographic areas. In this paper, we therefore widen the perspective from urban area planning to land planning. Specifically, we outline the incidence of forests helping to create an environment more favourable to outdoor physical activities, which at least improve health by lowering body mass index. The results demonstrate a relationship between forests and lower average body mass index (BMI); in other words, a reduction in the risk of being overweight. There is, however, no impact on obesity.

1. Introduction

Overweight and obesity are conditions where weight is greater than what is optimally considered healthy for a given height. These conditions are one of the most important health problems in the USA and Europe. According to World Health Organization (2008), 69.4% of American and 54.8% of European adults are overweight, of whom 31.8% and 21.9%, respectively, are obese. Overweight increases the likelihood of several diseases and the direct and indirect costs lie with government and household budgets. As an example, Finkelstein et al. (2003) estimate average annual medical expenditures to be substantially higher for obese than for normal-weight individuals. In addition, Bhattacharya and Bundorf (2009) demonstrate that the obese have lower wages than the non-obese. Furthermore, Michaelowa and Dransfeld (2008) find that fiscal and regulatory measures to reduce obesity could help greenhouse emissions.

The emergence of obesity has become an increasing concern, including in middle income countries as a result of the quick shift in nutritional habits and sedentary working conditions (Popkin and Ng, 2007). The 'geography of obesity' exhibits an enormous variety of incidences of obesity around the world. However, as Etilé (2008) notes, geographic differences cannot be ascribed to differences in national eating patterns when within-country comparisons reveal different patterns between socio-demographic or socio-economic groups. In addition, different patterns emerge between regions of the same country (Ford et al., 2005; Holtgrave and Crosby, 2006; Mokdad et al., 2001, 2003).

Obesity is the outcome of long periods of imbalance between energy intake and energy expenditures during daily activities. Three causes of obesity arise from this definition: incorrect food choice, insufficient physical activity or both. Many authors stress the importance of socio-economic determinants of the pathological status, such as age (Chang et al., 2006; Miljkovic et al., 2008), gender (Miljkovic et al., 2008), race (Lakdawalla and Philipson, 2002), income (Drewnowski et al., 2007) and occupational status (Drewnowski and Darmon, 2005; Loureiro and Nayga, 2005). Others emphasise how lifestyle and habits, an inclination for sport (Lakdawalla and Philipson, 2002), smoking (Huffman and Rizov, 2008) and educating oneself about nutritional facts (Loureiro et al., 2012) have a significant impact on daily physical activities, food choice behaviour and consequently, on individual weight.

According to Lakdawalla and Philipson (2002), one of the main reasons for increasing obesity among adults is the growing prevalence of sedentary jobs and leisure. Therefore, an emphasis on methods promoting physical activities emerges. Lake and Townshend (2006) define the 'obesogenic environment' as a model for understanding the external factors that may influence individual weight, which is to say the way in which the built environment provides the individual with opportunities or barriers to food intake and physical activity. Many researchers have concentrated their efforts on the influence of contextual factors on behaviour incentives for weight gain, such as sugar and fat prices (Miljkovic and Nganje, 2008), availability of food stores (Wang et al., 2006; White, 2007) and urban planning (Frank et al., 2004; Lopez, 2004).

The aim of this paper is to understand, in the context of the obesogenic environment model, the positive impact of forests on

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http://dx.doi.org/10.1016/j.forpol.2015.02.003
1389-9341/

the development of less obesogenic communities. A multilevel regression model has been applied for the purpose of combining the effects of individual factors (gender, age, education) and contextual determinants such as land use of population centres.

This paper is organised as follows: in Section 2, a literature review of the influence of land use on weight and the importance of forest-centric recreational functions has been performed; in Section 3, the empirical model and its data source are introduced; in Section 4, results are provided; finally, Section 5 is dedicated to conclusions.

2. Environment and weight

An extensive body of literature has established a relationship between urban features, land use and obesity. Frank et al.'s (2004) paper is one of the first works to emphasise the link between land use and the Body Mass Index (BMI). The authors stress the association of high mix use areas (residential, commercial, office and institutional) with a lower probability for obesity as a consequence of an increasing willingness to engage in outdoor activities. In contrast, Lopez (2004), which focuses on urban planning, finds that urban sprawl increases obesity because of increased commuting time and the reliance on car and public transportation for daily transfers. Many other authors have found similar results (Smith et al., 2008; Rundle et al., 2007; Li et al., 2008; Wakefield, 2004).

In general, these papers stress the role that walkability of space in urban areas and neighbourhoods plays in encouraging outdoor activities for more than just recreational purposes. The presence of recreational activities in urban areas is often found to be positively associated with more physical activity and with healthier weights (Cohen et al., 2007; Fan and Jin, 2013; Giles-Corti et al., 2005). Yamada et al. (2012), starting from an extensive literature review on this issue, stress that the walkability of space is one of the key factors preventing obesity and encouraging healthy weight. In addition, they underscore the capacity of these results to be generalized for different geographic scales or for methods of measuring land use. The general conclusion of the literature is that a built environment offering more opportunities for outdoor activities reduces average weight and the willingness to be overweight or obese.

One shortcoming of the previous studies is the limitation of the analysis to the opportunities an individual finds in neighbourhoods or urban areas. Farther afield, recreational opportunities are available in areas other than the proximity. From a broader geographic perspective, the forest offers a wide variety of energy intensive activities.

The primary function of forests has changed in recent years, transitioning away from economic functions such as timber production to more social and environmental dimensions. In terms of the latter aspects, much research has investigated and assessed the benefits of forests.

In general, natural resources are multifunctional and provide a wealth of goods and services with socioeconomic and environmental value. Several authors (see among others Pearce, 2001; Zhongwei et al., 2001) have identified five primary benefits of forests: hydrogeological security and soil conservation, production of timber or other forest products (i.e., mushrooms, truffles, chestnuts), carbon sequestration and mitigation of climate change, naturalistic functions (biodiversity preservation) and tourist and recreational functions.

The present paper focuses on the touristic and recreational functions of forests that are directly connected to the quality of life of users. The recreational function is based on a wide range of energy intensive activities, including sports and hobbies such as hiking, bird watching, mountain biking, the collection of non-forest products (mushrooms, chestnuts, blueberries), and hunting.

An extensive body of literature has tried to estimate the recreational value of forest (see Aragón et al., 2011; Voces González et al., 2010; Wang, 2013) and formulate models for recreation demand (Smirnov and Egan, 2012). The previous papers underline the high value of the recreational function of forests, without depending on intrinsic (spruce forest, oak forest, etc.) or extrinsic (type of soil, average temperature, etc.) characteristics of case studies; that is, many different types of forests are important for recreational purposes. Furthermore, many studies demonstrate the preference on the part of recreational users for certain forest attributes (Bestard and Font, 2009; Dhakal et al., 2012; Edwards et al., 2012; Horne et al., 2005; Koo et al., 2013; Nielsen et al., 2007), such as biodiversity, good mix of stand types, age and health of trees and landscape variety. As Termansen et al. (2013) noted, each of the following attributes are positively correlated with the extension of forests since large forest has a higher degree of animal and vegetable biodiversity, a greater mix of stand types, age and health of trees, a wider range of landscapes and greater recreational attractiveness. Particularly for recreational purposes, biophysical factors are crucial in determining the preferences of users (Edwards et al., 2012).

The hypothesis of this paper originates from two facts: (*i*) average individual weight is influenced by opportunities for outdoor activities afforded by land use; and (*ii*) forests provide a forum for energy intensive activities. Hence, does any relationship between individual weight and forests emerge?

To demonstrate this relation is crucial in the context of an obesogenic environment model, since a large percentage of literature has focused on physical activities of daily life such as walking to grocery stores or to bus stops, while the role of recreational activities as opportunities for spending energy has received less attention. This is relevant in light of obesity and overweight concerns that unequally burden lower income populations. Previous empirical studies have found a weak effect of income on recreational demand where parks are concerned (Amoako-Tuffour and Martínez-Espiñeira, 2012; Loomis, 2003). Liston-Heyes and Heyes (1999) even found recreation to be an inferior good. In general, the cost for leisure time is greater for the wealthy than for the poor (Feather and Shaw, 1999; Jara-Díaz et al., 2008). Therefore, the most vulnerable socioeconomic groups will be able to benefit more from an increase of recreational opportunities in parks.

In addition, analysing the connection between individual weight and forests helps in providing a solution for the concerns highlighted by Plantinga and Bernell (2005) and Fan and Jin (2013). These authors, in light of conclusions yielded by previous studies about obesogenic environment, identified a potential weakness of causal relationships between obesity and neighbourhood amenities due to the possibilities of self-selection. In other words, more active individuals (from a physical point of view) may tend to live in areas that promote physical activities. These concerns are not presented in this paper, since the hypothesis that residential location is chosen based on individual preferences for the recreational use of forests was tested and rejected by Abildtrup et al. (2013). Indeed, Abildtrup et al. (2013) found no relation between the preference for recreational amenities such as hiking routes and the residential locations of users. Therefore, the relation between the presence of forests and the lower likelihood to be overweight or obese does not appear to depend on residential location choice.

3. Empirical models

The dependent variable of the empirical models is the BMI of adults, the most widely used measurement of human body shape, applied by both epidemiologists and scientists in population research. The BMI is calculated as weight/height^2 (in units kg/m^2) and classifies people as overweight (BMI $\geq$ 25) or obese (BMI $\geq$ 30). In this paper, individual BMI was associated with the amount of forest acreage in the region where an individual lived. The regions comprised the second NUTS administrative level of the European Union (henceforth referred to as regions').

To test the hypothesis, a simple two-level multilevel model was applied to separately estimate individual determinants from contextual