



Short report

An ecological study of the relationship between social and environmental determinants of obesity

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Abstract

There is growing concern with the increasing prevalence of obesity in industrialised countries, a trend that is more apparent in the poor than in the rich. In an ecological study, the relationship between an area measure of socioeconomic status (SES) and the density of fast-food outlets was examined as one possible explanation for the phenomenon. It was found that there was a dose-response between SES and the density of fast-food outlets, with people living in areas from the poorest SES category having 2.5 times the exposure to outlets than people in the wealthiest category. The findings are discussed. © 2002 Elsevier Science Ltd. All rights reserved.

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Introduction

The prevalence of obesity in industrialised countries is high and rising (World Health Organization, 1998). In Australia, for instance, it is estimated that more than half the population is overweight or obese (ABS, 1995) and this is paralleled in other industrialised settings (Birmingham et al., 1999; Must et al., 1999; Seidell, 1997). This “obesity epidemic” carries with it the associated problems of the rising rates of its comorbidities (World Health Organization, 1998). Obesity-related diseases include non-insulin-dependent diabetes mellitus, coronary heart disease, hypertension, and various cancers including breast, cervical, ovarian, gall bladder, prostate, and colon cancer (Colditz, 1992; Must et al., 1999; Segal et al., 1994).

In trying to develop an understanding of the causes of obesity, two complementary themes are currently in the public health research. These themes relate to the social

determinants of obesity (Goodman, 1999; Molarius et al., 2000) and to the environmental determinants (Egger and Swinburn, 1997; Swinburn et al., 1999). These themes reflect a broader interest in the social and environmental determinants of health that have looked at area-level influences on health (often controlling for individual influences) such as income inequality (Kahn et al., 1999), social capital (Kawachi, 1999), social cohesion (Wilkinson, 1996), and environmental quality (Joshi et al., 2000; Subramanian et al., 2001).

A number of recent studies around the social determinants of obesity have focussed on the socioeconomic status (SES) as a determinant, generally finding a negative association between obesity and SES (Jeffery et al., 1989; Martikainen and Marmot, 1999; McMurray et al., 2000; Reijneveld, 1998; Sundquist and Johansson, 1998; Sundquist et al., 1999). Thus, as SES declines, the risk of obesity increases. One possible explanation for the association between SES and obesity is that the poor, unlike the rich, “behave poorly” (Lynch et al., 1997). The differential consumption of energy-dense “fast food” has been suggested as one possible contributor to the increasing prevalence of obesity

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(World Health Organization, 1998), and if the poor were more inclined than the rich to eat fast food, this could explain some of the relationship between SES and obesity.

The other side of the discussion in the literature is around the notion of obesogenic environments (Hill and Peters, 1998). Obesogenic environments are essentially environments that encourage the consumption of food and/or discourage physical activity. The environmentally induced change in the energy balance results in an increased risk of obesity (Chisholm et al., 1998; Price and Gottesman, 1991; Stunkard, 1991; Weinsier et al., 1998).

A number of recent studies examining area-level effects and obesity have found strong associations between factors such as income inequality, neighbourhood deprivation, and obesity (Ellaway et al., 1997; Kahn et al., 1998; Sundquist et al., 1999). These effects were apparent even after accounting for individual-level effects such as age, gender, and level of education. Although the area-level effects are significant, the actual mechanism by which such factors as area deprivation may affect weight gain is still at the level of speculation.

One could readily imagine situations in which social and environmental determinants interact to increase the risk of obesity in some groups. For example, if the environment in low-SES areas were structurally different from those in high-SES areas, such that they promoted the consumption of fast food and discouraged physical activity, this could explain part of the association between SES and obesity.

In an ecological study, the association between an area measure of SES and the density of fast-food outlets was examined. It was expected that (a) there would be a higher density of outlets in areas of lower SES, and (b) there would be a dose–response relationship between SES and the density of outlets such that as SES increased, the density of outlets decreased.

Methods

The relationship between an area measure of SES and the density of franchise fast-food outlets per head of population was studied in postal districts in Australia's second largest city, Melbourne. There were 269 postal districts initially included in the study.

A franchise fast-food outlet was defined as a retail outlet belonging to one of the largest five fast-food chains in Australia (Global market intelligence and forecasting, 1995): "Pizza Hut" (pizzas), "MacDonalds" (hamburgers), "Hungry Jacks" (hamburgers), "KFC" (fried chicken), and "Red Rooster" (chicken). The location of each retail outlet was identified by searching the telephone service directory on-line in 2000 (<http://www.yellowpages.com.au>). The on-line directory listed

the street address and postal district for each outlet. Some of the franchise outlets had home delivery or dine-in facilities available from the same location as the fast-food facilities and these were double-listed in directory. An outlet was treated as double-listed if the same franchise appeared twice at the same street address or an adjacent street address. Double-listed franchises were only counted once. There were 19 outlets listed in the postal district "3000". This is the central business district for the State's capital city—Melbourne. These outlets were also excluded from the analysis because they serve a population much greater than their resident (or adjacent resident) population. Similarly, the postal district "3045" was excluded because the single-franchise outlet is located at the Melbourne International Airport as a service to workers and travellers rather than the small ($n = 258$) resident population. This left 267 postal districts in the study.

The population of each postal district (excluding "3000" and "3045") was obtained from the Australian Bureau of Statistics' 1996 Census data available on CD-ROM (Australian Bureau of Statistics, 1999).

The net median individual income for each postal district was used as the area measure of SES. These data were also obtained from the 1996 Census (Australian Bureau of Statistics, 1999). Data on a postal district's median individual weekly income were available in six ordered categories for metropolitan Melbourne (\$160–\$199, \$200–\$299, \$300–\$399, \$400–\$499, \$600–\$699, \$800–\$899). There were only five postal districts in the top two income categories and none of them had a franchise fast-food outlet. These categories were collapsed, therefore, with the third highest income category. The final income categories were median individual weekly incomes of \$160–\$199 (SES 4), \$200–\$299 (SES 3), \$300–\$399 (SES 2), and \$400–\$899 (SES 1).

The density of fast-food outlets within an income category was defined as the combined population of all the postal districts in that income category divided by the total number of fast-food franchises within those same districts.

Results

There were 331 unique franchise fast-food outlets listed in the on-line telephone service directory distributed across the 267 postal districts included in the study.

Table 1 shows the distribution of the population and number of outlets disaggregated by the income categories. The right-most column of Table 1 indicates that the density of outlets decreases as the income category improves from SES 4, through, to SES 1. Thus, in the lowest income category (SES 4), there is approximately one outlet per 5641 head of population and this drops in

Table 1

The number of fast-food outlets, population, and population per fast-food outlet by the median weekly income category from the lowest income group (SES 4), through, to the highest (SES 1)

Income category	Postal districts	Fast-food outlets	Population	Population per fast-food outlet
SES 4	12	29	1,63,589	5641
SES 3	71	109	9,41,527	8638
SES 2	156	171	1,74,442	10196
SES 1	28	22	2,91,093	14256
Total	267	331	31,62,198	9553

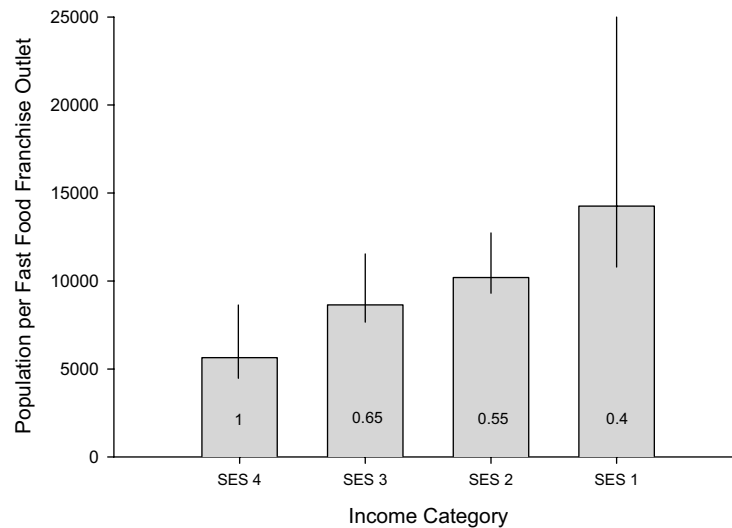


Fig. 1. The population per fast-food outlet (with approximate 95% confidence intervals) by median individual weekly income. The density of fast-food outlets relative to the lowest income group (SES 4) is also shown.

the highest income category (SES 1) to approximately one outlet per 14,256 heads of population.

This relationship is shown graphically in Fig. 1. The relative density of outlets using the lowest income category as the reference group is also shown as a number within each bar of the histogram. Approximate 95% confidence intervals around the estimates were determined using the BCa variant of the bootstrap confidence intervals (Efron and Tibshirani, 1993). Postal district was used as the unit of randomisation in the bootstrap.

It should be noted that BCa confidence intervals are generally not symmetrical. This is particularly obvious in the SES 1 category where the point estimate of the density is 14,256 and the 95% confidence interval lies between 10,197 and 23,566.

A dose–response relationship can be observed between income category and the density of outlets. The second lowest income category (SES 3) has a relative density of outlets of 0.65; the next wealthiest income

category (SES 2) has a relative density of 0.55 and this drops to 0.4 in the wealthiest income category (SES 1).

As a single test of the difference in the density of outlets by income category, the densities in SES 4 and SES 1 were examined. The difference in outlet densities between the income categories was 8614. A permutation test (Good, 1994), using postal district as the unit of randomisation, showed the difference to be significant ($p < 0.01$). Similarly, SES 3 was significantly different from SES 1 ($p < 0.05$), and SES 4 was significantly different from SES 2 ($p < 0.01$). However, there was no significant difference between SES 4 and SES 3, or SES 2 and SES 1.

Discussion

This study suggests that the social determinants (in this case, SES) and environmental determinants (in this case, the density of fast-food outlets) interact to create

environments in which the poor have increased exposure to energy-dense foods. Indeed, those living in areas with the lowest individual median weekly incomes have 2.5 times the exposure to fast-food outlets compared to those living in areas with the highest individual median weekly incomes. The effect is actually starker than that portrayed here. In the analysis of the data, the two highest income categories were collapsed into the third highest income category because there were no fast-food outlets in the five postal districts in the two highest categories. Thus, those living in the very richest areas actually have no exposure to fast-food outlets within their postal districts.

This confluence of environmental factors and socio-economic factors promoting obesity provides a plausible example of the link between the social and the environmental determinants of obesity. Whether increased exposure actually carries an increased individual risk of obesity is a question that highlights the limitations of the study. The limitations relate to (a) the ecological nature of the study, and (b) the existence of possible confounders. The ecological nature of the study means that one cannot conclude that the greater density of fast-food outlets in lower SES areas is the cause of the observed obesity in individuals of lower personal SES. The lack of individual level measures, and specifically the lack of individual data on body weight (and height) limits the explanatory power of the study and the inclusion of the individual data may reveal alternative explanations for the observations.

This leaves open some obvious and interesting questions such as whether the appearance of fast-food franchises in lower SES areas is in response to local demand, or whether their appearance drives demand, and whether it is the poor who tend to visit the outlets frequently. In either case, it would appear that lower SES areas are potentially more obesogenic.

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