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Do 'environmental bads' such as alcohol, fast food, tobacco, and gambling outlets cluster and co-locate in more deprived areas in Glasgow City, Scotland?

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ABSTRACT

This study utilised an innovative application of spatial cluster analysis to examine the socio-spatial patterning of outlets selling potentially health-damaging goods/services, such as alcohol, fast food, tobacco and gambling, within Glasgow City, Scotland. For all categories of outlets combined, numbers of clusters increased linearly from the *least* to the *most* income deprived areas (i.e. one cluster within the least deprived quintile to ten within the most deprived quintile). Co-location of individual types of outlets (alcohol, fast food, tobacco and gambling) within similar geographical areas was also evident. This type of research could influence interventions to tackle the co-occurrence of unhealthy behaviours and contribute to policies tackling higher numbers of *'environmental bads'* within deprived areas.

1. Introduction

Health-related behaviours, such as smoking, heavy drinking and poor diet, can lead to higher risk of chronic disease, multi-morbidity, and shortened life span (Cawley and Ruhm, 2011; Fortin et al., 2014). The drivers of such behaviours are multifactorial and recent work has acknowledged that health behaviours are influenced, not just by personal attributes, but also by features of the broader physical, social, economic and cultural environments (Shortt et al., 2014). Most recently there has been a focus on the retail environment specifically, and the ways in which it may contribute to the health 'chances' afforded to the population (Thomas and Frohlich, 2012). With a focus on inequalities, research has begun to explore the relationship between such environmental risk factors and area level deprivation.

Recent research has explored the distribution of each of these outlet types in isolation: tobacco (Shortt et al., 2015; Chaiton et al., 2013), alcohol (Hay et al., 2009; Ellaway et al., 2010), fast food (Fraser et al., 2010; Macdonald et al., 2007), and gambling outlets (Robitaille and Herjean, 2008; Wardle et al., 2014). It has been reported that an increased availability of each is related to an increase in related unhealthy behaviours; for smoking (Reitzel et al., 2011; Novak et al., 2006; Shortt et al., 2016), increased alcohol consumption (and related violence) (Connor et al., 2010; Livingston, 2008; Young et al., 2013), increased consumption of fast food and increased obesity rates (Bodicoat et al., 2015; Moore et al., 2009) and increased likelihood of problem gambling (Pearce et al., 2008; Young et al., 2012). Whilst the health consequences of smoking, excess alcohol consumption and an unhealthy diet are well established, for gambling the association with health is under-researched (Lancet Editorial, 2017). Problem gambling has however been linked to several health outcomes, such as increased alcohol consumption, obesity, smoking, mental health problems, and suicide (Barnes et al., 2015a; Black et al., 2013), as well as intimate partner violence (Afifi et al., 2010). Although the majority of work in this area has focussed on features of the environment in isolation, unhealthy behaviours do interact (such as alcohol misuse and smoking) (Buck and Frosini, 2012; Meader et al., 2016; Room, 2004) and individuals do not experience one type of retail outlet in isolation from the others.

Strong socioeconomic gradients in retailer presence exist within the UK and further afield, and it has been suggested that the overprovision of a range of health damaging outlets in deprived areas is a form of *'environmental injustice'* (Mennis et al., 2016; Romley et al., 2007). Within Scotland, compared to more affluent areas, deprived areas showed greater densities of alcohol, tobacco and gambling outlets (Shortt et al., 2015; Wardle et al., 2014); in Canada tobacco outlet and gambling outlet densities were higher within deprived areas (Chaiton

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et al., 2013; Wilson et al., 2006); and deprived areas in New Zealand and Australia showed higher densities of alcohol outlets and fast food outlets respectively (Hay et al., 2009; Thornton et al., 2016). Such gradients may contribute to the wider social gradient in health related outcomes. This association is not always clear-cut and findings vary by geographical region. For example, earlier Glasgow-based studies found no clear socio-spatial patterning in the distribution of fast food or alcohol outlets by deprivation (Ellaway et al., 2010; Macintyre et al., 2008).

Limited work looks at the availability of a variety of categories. One study explored the availability of three types of retailer, tobacco, alcohol and takeaway outlets in four districts in Cologne, Germany (Schneider and Gruber, 2012), while other research calculated the density of alcohol and tobacco outlets in small neighbourhoods across Scotland (Shortt et al., 2015); both studies compared access between areas with varying levels of income deprivation. We go beyond previous work by exploring four categories of outlets offering potentially harmful products/services (both individually and in combined analysis), recognising that people are exposed to multiple characteristics day-to-day. We focus specifically on locating 'clusters' of outlets (i.e. occur closely together) and explore whether these 'co-locate' (i.e. different categories of outlet found in similar areas) within poorer neighbourhoods. Previous research used a more traditional approach of comparing densities across geographical areas (Chaiton et al., 2013; Ellaway et al., 2010; Thornton et al., 2016; Wiggins et al., 2010; Shortt et al., 2016; Hay et al., 2009; Wardle et al., 2014; Wilson et al., 2006). Within these studies densities of outlets were generally calculated for pre-defined geographical and administrative boundaries e.g. density of alcohol outlets across Scottish 'Data Zones' (Ellaway et al., 2010), fast food outlet density at Australian 'Local Government Area' (Thornton et al., 2016), density of tobacco outlets at Canadian 'Public Health Unit' level (Chaiton et al., 2013), or gambling outlet density within US 'Census Tracts' (Wiggins et al., 2010). The benefit of this approach was the potential to link these boundaries to additional key data such as poverty rates (Ellaway et al., 2010; Thornton et al., 2016), indicators of urbanicity/rurality (Thornton et al., 2016), population ethnicity (Wiggins et al., 2010), or number of smokers (Chaiton et al., 2013). The cluster analysis approach applied within our paper has previously been used to detect geographic disparities in the incidence of disease cases, e.g. cancer (Goungounga et al., 2016), tuberculosis (Roth et al., 2016) and HIV (Zhang et al., 2017; Goungounga et al., 2016; Roth et al., 2016) and to explore socio-economic distribution of road traffic accident cluster locations following the construction of a new motorway (Olsen et al., 2017). Spatial cluster analysis has rarely been used to identify concentrations of retail outlets (Han and Gorman, 2014) but lends itself well to this type of study for a number of reasons. Primarily, it is a form of dynamic mapping which is not restricted by pre-defined boundaries but locates natural concentrations of outlets. In doing so it provides objective, robust detection of potential retail clusters. Furthermore, it enables the detection of small area levels of groups of outlets containing higher than expected cases rather than applying a smoothed density surface to a pre-defined geographical area such as a census tract.

We examine the distribution of alcohol, tobacco, fast food and gambling outlets within the geographical context of Glasgow because the city contains areas of stark contrast, consisting of the most and least deprived areas in Scotland with nearly half (48%) of neighbourhoods falling within the 20% most income deprived areas in Scotland (The Scottish Government, 2016a). Glasgow displays an adverse health profile in comparison to the rest of Scotland (Gray, 2008), and compared to those residing within similar cities with similarly high levels of socio-economic deprivation (Walsh et al., 2010). The current study furthers our previous work on the socio-spatial patterning of retail outlets and other amenities within Glasgow City and across Scotland by using a novel application of cluster detection to advance the field. Our earlier work looked at the density of food outlets and alcohol outlets across pre-defined geographical boundaries (i.e. small area level geography known as data zones), linking this geography to deprivation scores and comparing more or less deprived areas within Scotland (for fast food chains such as McDonald's (Cummins et al., 2005) Burger King, KFC and Pizza Hut (Macdonald et al., 2007)), and Glasgow (for various out of home food outlets (Macintyre et al., 2005), food retailers (Macdonald et al., 2009), amenities (e.g. schools, leisure centres, hospitals) (Macintyre et al., 2008), and alcohol outlets ((Ellaway et al., 2010), (Young et al., 2013)).

The main objectives of this research are to explore whether particular areas are subject to excess access to potentially health damaging retailers and whether these types of retailers co-locate within these areas. We do this by examining the socio-spatial patterning of a range of retail outlets which sell potentially health damaging products (alcohol, tobacco, fast food) or services (gambling) in combination and separately; utilising an innovative application of cluster analysis to detect if geographic clusters of these outlets exist (i.e. outlets locate closely together) and co-locate (i.e. different categories of outlet found in similar areas) within poorer neighbourhoods.

2. Methods

2.1. Outlet data

Address data for all outlets were obtained from Glasgow City Council (i.e. the local government body for the City of Glasgow), for 2012 (tobacco and fast food), and 2013 (alcohol and gambling). Although we did not validate address information for every outlet, due to the number of premises, the data held is deemed as comprehensive as information on the various premises is required to be held by Glasgow City Council for inspection, planning and licensing purposes (see Ellaway et al., 2010, 2012) (e.g. food premise/standards inspection, planning permission for gambling outlets, alcohol premise licensing, tobacco retailers register).

The types of outlets in the current analysis included: 1) alcohol outlets (including off-sales (off licence stores, convenience stores, and supermarkets) and on-sales (restaurants, cafes, public houses, hotels, nightclubs, entertainment venues, social and sports clubs)); 2) fast food outlets: fast food chains, premises selling fast food (e.g. Chinese food, Indian food, burgers, kebabs, fish and chips, pizza etc.); 3) tobacco outlets: convenience stores, newsagents, supermarkets, petrol stations, off licence stores; and 4) gambling outlets: betting shops, lottery vendor, bingo halls, casinos, gambling machines. The postal codes for the outlets were linked to precise geo-coordinates via the Office for National Statistics Postcode Directory (for August 2011) which contains British National Grid coordinates for address-weighted unit postcode centroids (Office For National Statistics, 2016). Data cleaning included checking for duplicates and correcting postcodes which did not map.

2.2. Analysis

2.2.1. Detection of outlet clusters

SaTScan™ is a well-established cluster analysis tool that allows for a variety of spatiotemporal cluster analyses based on various probability models. The procedure can identify geographically defined clustered areas of high risk, low risk, or both, for the occurrence of retail outlets, within a defined geographical boundary, enabling each individual cluster to be compared to the whole geographical area in question (Kulldorff, 2010). The software constructs a large number of different sized circular frames (from zero to an imposed upper limit, *specified below*) with varying location and radii across the study area and then makes a comparison of occurrence of outlets within each frame and the occurrence outside the frame. The close location of frames with apparently higher rates of outlets is used to identify the location and size of a cluster, and its statistical significance is then