



## Accessibility of fast food outlets is associated with fast food intake. A study in the Capital Region of Denmark



Kamille Almer Bernsdorf<sup>a,\*</sup>, Cathrine Juel Lau<sup>a</sup>, Anne Helms Andreasen<sup>a</sup>, Ulla Toft<sup>a</sup>, Maja Lykke<sup>a</sup>, Charlotte Glümer<sup>a,b,1</sup>

<sup>a</sup> Research Centre for Prevention and Health, Capital Region of Denmark, Rigshospitalet – Glostrup, Nordre Ringvej 57, Section 84/85, 2600 Glostrup, Denmark

<sup>b</sup> Department of Health Sciences and Technology, Aalborg University, Fredrik Bayers vej 7D2, DK-9220 Aalborg, Denmark

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### ABSTRACT

Literature suggests that people living in areas with a wealth of unhealthy fast food options may show higher levels of fast food intake. Multilevel logistic regression analyses were applied to examine the association between GIS-located fast food outlets (FFOs) and self-reported fast food intake among adults (+ 16 years) in the Capital Region of Denmark (N = 48,305). Accessibility of FFOs was measured both as proximity (distance to nearest FFO) and density (number of FFOs within a 1 km network buffer around home). Odds of fast food intake  $\geq 1$ /week increased significantly with increasing FFO density and decreased significantly with increasing distance to the nearest FFO for distances  $\leq 4$  km. For long distances ( $> 4$  km), odds increased with increasing distance, although this applied only for car owners. Results suggest that Danish health promotion strategies need to consider the contribution of the built environment to unhealthy eating.

### 1. Background

Food environments are built environments described by the location of food outlets (FOs), and access to these environments is theorized to influence individual dietary patterns and, ultimately, risk of obesity and chronic diseases (Caspi et al., 2012). The accessibility of food is often defined by geographical measures from home to FOs. Specific measures hypothesized to be important contributors to eating patterns are proximity and density of different types of FOs (Boone-Heinonen et al., 2011b; Cobb et al., 2015; Dunn et al., 2012; Fraser et al., 2010; Gamba et al., 2014; Longacre et al., 2012; Moore et al., 2009; Oexle et al., 2015; Richardson et al., 2011; Thornton et al., 2009; Turrell and Giskes, 2008).

Fast food outlets (FFOs) generally tend to serve foods with a higher energy density and poorer nutritional quality than foods prepared at home (Moore et al., 2009; Powell et al., 2012). Eating fast food has been associated with poor dietary habits, such as higher intakes of energy, fat, sodium, added sugars and sugar-sweetened beverages, and lower intakes of fruit, vegetables, fibre and milk (Bowman and Vinyard, 2004; Fraser et al., 2010; Lachat et al., 2012; Orfanos et al., 2009; Richardson et al., 2015). Furthermore, eating fast food has been associated with an

increased risk of obesity and other health-related factors such as insulin resistance (Laxy et al., 2015; Pereira et al., 2005; Richardson et al., 2015). Consequently, there is increasing interest to assess the influence of accessibility of FFOs on health-related parameters.

High accessibility of FFOs in a neighbourhood has been associated with high fast food intake (Boone-Heinonen et al., 2011b; Longacre et al., 2012; Moore et al., 2009; Richardson et al., 2015; Thornton et al., 2009), unhealthy dietary habits (He et al., 2012; Moore et al., 2009; Richardson et al., 2015) and a higher prevalence of obesity (Burgoine et al., 2016; Cobb et al., 2015; Dunn et al., 2012; Gamba et al., 2014). However, research has reported conflicting findings. Several reviews have highlighted considerable heterogeneity in measures and techniques within the geographical information system (GIS) research, which is commonly used to describe accessibility (Caspi et al., 2012; Charreire et al., 2010; Cobb et al., 2015; Gamba et al., 2014; McKinnon et al., 2009; Wilkins et al., 2017). According to Wilkins et al. (2017), there are commonly five dimensions of methodological diversity: the choice of FO data, the methods used to extract FO data of interest, the ways that FOs are defined, the geocoding methods used and the ways that FO access is operationalized. Wilkins et al. (2017) state that “while most authors acknowledge these limitations, an

\* Corresponding author.

E-mail addresses: [knie0421@regionh.dk](mailto:knie0421@regionh.dk) (K.A. Bernsdorf), [cathrine.juel.lau@regionh.dk](mailto:cathrine.juel.lau@regionh.dk) (C.J. Lau), [anne.helms.andreasen@regionh.dk](mailto:anne.helms.andreasen@regionh.dk) (A.H. Andreasen), [ulla.toft@regionh.dk](mailto:ulla.toft@regionh.dk) (U. Toft), [maja.lykke@regionh.dk](mailto:maja.lykke@regionh.dk) (M. Lykke), [FS0H@SUF.kk.dk](mailto:FS0H@SUF.kk.dk) (C. Glümer).

<sup>1</sup> Present address: Center for diabetes, Municipality of Copenhagen, Vesterbrogade 121, 3rd floor, 1620 Copenhagen V, Denmark.

absence of best practices means the problems look set to persist. With such diversity in methods, accurate and transparent reporting is essential". Another issue potentially contributing to the conflicting findings is that evidence mainly stems from the US and Australia. European and specifically Danish studies are sparse. While Denmark may share some similarities with the US and Australia, there are distinct geographical, political, economic, commercial, social and cultural differences between the continents in relation to planning, distribution and usage of FOs. In the US, for example, the food environment often consists of rural or urban low-income areas with limited access to affordable and nutritious food, i.e. 'food deserts' (Beaulac et al., 2009). Such differences make it difficult to translate international findings into a Danish context.

The food environment can be associated with the socioeconomic status (SES) of an area in several ways, e.g. by grouping of specific types of people, FOs and facilities. Furthermore, the social position of an individual may influence the choice of residential location and as such the potential environment and its built characteristics, such as accessibility of food (Sushil et al., 2017; Voigtländer et al., 2013). Studies in the US, Canada, Australia and the UK have shown that the accessibility of FFOs is higher in deprived areas than in non-deprived areas (Black et al., 2014a, 2014b; Fraser et al., 2010; Laxy et al., 2015; Mozaffarian et al., 2012; Richardson et al., 2015; Rummo et al., 2017). Access to food may also vary with urban-rural residence in Denmark. Particularly in rural and frontier areas FFOs may be limited, while greater access may be found in urban areas (Pearce et al., 2007; Powell et al., 2007; Thornton et al., 2016). In Denmark, access to convenience stores has been positively associated with unhealthy diet only in non-metropolitan areas, suggesting a role for urbanicity in the potential association between access and intake of fast food (Lind et al., 2016). Whether these conditions are mirrored in Denmark has not been examined, but such associations could have great importance for the persistence of health inequalities that we see across place of residence in Denmark (Christensen et al., 2014a; Lau et al., 2015; Macintyre et al., 2002; Mendis and Banerjee, 2010; Robinson et al., 2014).

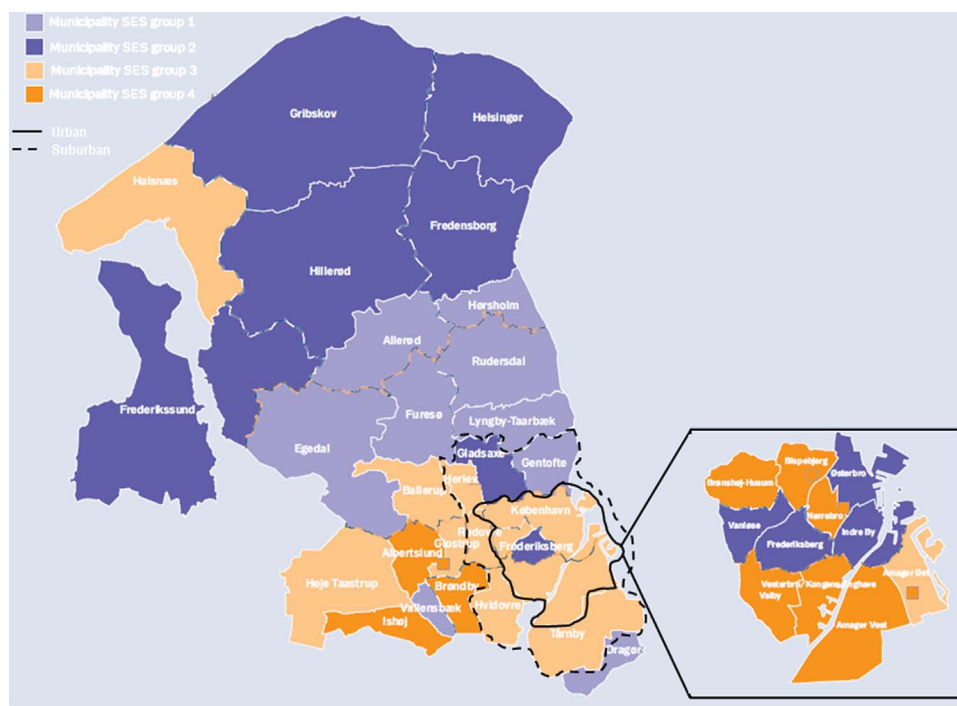
To ensure that preventive efforts and Danish public health policies can focus on the built environments, geographical areas and population sub-groups where most benefit can be expected, it is essential to identify which characteristics may promote health-related behaviour (e.g. fast food intake) among the Danish population. GIS is widely used by researchers for measuring food environments and by town planners and local authorities in developing policy and making planning decisions (Glanz et al., 2016). Consequently, this makes GIS-based research particularly relevant to policy development. Thus, in order to facilitate an effective translation of research into practice, the present study seeks to be transparent regarding choices within the GIS technology used to analyse the two aims of this study: 1) to examine the association between FFO accessibility and fast food intake, and 2) to examine whether this association is modified by area SES and urbanicity.

## 2. Methods

### 2.1. The Danish Capital Region Health Survey

The present study is based on data from the Danish Capital Region Health Survey, a cross-sectional survey conducted in the 29 municipalities of the Capital Region of Denmark (Christensen et al., 2012; Hammer-Helmich et al., 2011). The survey was conducted from February to May 2010. A random sample of individuals was drawn from the Danish Civil Registration System (CRS). CRS identifies all inhabitants in Denmark by a unique 10-digit personal identification (CPR) number that allows record linkage on an individual level of data to national registers.

The survey sample included 95,150 individuals. Copenhagen Municipality was divided into ten areas according to official administrative districts (Fig. 1), and these were treated as individual municipalities in the sampling process, resulting in a total of 38 municipalities. A random sample of 2450 individuals aged 16 years or older was drawn from each municipality. Due to differences in population size, the sample size in Frederiksberg Municipality was 4500 individuals. Each individual received a mailed invitation and a paper questionnaire



**Fig. 1.** The Capital Region of Denmark in 2010 divided into four municipality SES groups and urbanicity. Light purple - Municipality SES group 1 (Most affluent); purple - Municipality SES group 2; light orange - Municipality SES group 3; orange - Municipality SES group 4 (Less affluent). Municipalities within the solid line comprise the Copenhagen inner-city area defined as urban. This area comprises ten official administrative districts and Frederiksberg Municipality, which are highlighted in the box to the right. Municipalities between the dotted and solid line comprise six municipalities of Greater Copenhagen defined as suburban areas. Remaining municipalities are defined as rural. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

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