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Alternative measures to BMI: Exploring income-related inequalities in adiposity in Great Britain

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ABSTRACT

Socio-economic inequalities in adiposity are of particular interest themselves but also because they may be associated with inequalities in overall health status. Using cross-sectional representative data from Great Britain (1/2010-3/2012) for 13,138 adults (5652 males and 7486 females) over age 20, we aimed to explore the presence of income-related inequalities in alternative adiposity measures by gender and to identify the underlying factors contributing to these inequalities. For this reason, we employed concentration indexes and regression-based decomposition techniques. To control for non-homogeneity in body composition, we employed a variety of adiposity measures including body fat (absolute and percentage) and central adiposity (waist circumference) in addition to the conventional body mass index (BMI). The body fat measures allowed us to distinguish between the fat- and lean-mass components of BMI. We found that the absence of income-related obesity inequalities for males in the existing literature may be attributed to their focus on BMI-based measures. Pro-rich inequalities were evident for the fat-mass and central adiposity measures for males, while this was not the case for BMI. Irrespective of the adiposity measure applied, pro-rich inequalities were evident for females. The decomposition analysis showed that these inequalities were mainly attributable to subjective financial well-being measures (perceptions of financial strain and material deprivation) and education, with the relative contribution of the former being more evident in females. Our findings have important implications for the measurement of socio-economic inequalities in adiposity and indicate that central adiposity and body composition measures should be included health policy agendas. Psycho-social mechanisms, linked to subjective financial well-being, and education -rather than income itself-are more relevant for tackling inequalities.

1. Introduction

The prevalence of obesity is an increasing worldwide concern (OECD, 2014). Obesity can be defined using different adiposity measures, such as the conventional Body Mass Index (BMI), body composition (for example, body fat, muscles), waist-circumference (WC) and body-shape measures (for example, the "A Body Shape Index" (ABSI)) (O'Neill, 2015). Recent evidence has shown that the United Kingdom (UK) not only has one of the highest obesity prevalence rates in Western Europe and the eighth highest among all OECD member countries (OECD, 2014) but is one of the countries with the highest obesity growth rates in the past three decades (OECD, 2014). If the increasing obesity trends are not stemmed, there could be 11 million more obese adults in the UK by 2030 than in 2011 (Wang et al., 2011). Obesity is associated with increased mortality and morbidity risks (WHO, 2000) and places a significant burden on health care systems worldwide (Lehnert et al., 2013; OECD, 2014); the estimated proportion of health expenditures attributed to obesity in the United States (9%) and UK (5%) is among the highest worldwide (Allender and Rayner, 2007; Lehnert et al., 2013). It is no surprising therefore that obesity is considered a global public health concern and that a growing number of countries and the World Health Organization have established policies and strategies to reduce obesity levels (WHO, 2013). More specifically, UK governments have identified tackling obesity as a key priority (for example, Gilman, 2015; House of Commons Health Select Committee, 2015).

The existing literature on socio-economic determinants of adiposity showed negative associations between BMI (or BMI-

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based obesity measures) and education (Chou et al., 2004; Rashad, 2006), income (Chou et al., 2004; Lakdawalla and Philipson, 2009) and childhood socio-economic position (Baum and Ruhm, 2009). A review of several biomedical studies revealed that socio-economic position was, in general, negatively associated with adiposity measures; the findings were more evident in women and varied by the socio-economic measure employed (McLaren, 2007). However, most of these studies applied regression techniques to identify the existence of a "socio-economic gradient in adiposity". They did not take into account the whole distribution of the socio-economic measures and, more generally, did not quantify the extent of socio-economic inequality in adiposity (Wagstaff et al., 1991; Zhang and Wang, 2004). The degree of socio-economic inequality depends on both the association of adiposity with the chosen socio-economic measure and the dispersion of the adiposity measure itself. This is important because similar associations can imply different inequalities, depending on the variability of the adiposity measures (O'Donnell et al., 2008). For example, for a given negative association between income and body weight, the degree of the inequality should be higher when the inequality in the distribution of the body weight measure itself is higher (i.e., the magnitude of the differences in body weight within the society).

Excess adiposity is viewed, to a large extent, as a preventable condition (Ljungvall and Gerdtham, 2010). Given its association with several health conditions and its uneven distribution across socioeconomic groups, inequalities in adiposity are likely to be reflected in socio-economic inequalities in overall health status (Borg and Kristensen, 2000). Therefore, socio-economic inequalities in adiposity are of particular interest themselves, but also because they may be associated with inequalities in overall health status. However, studies that do quantify socio-economic inequalities in adiposity are limited and restricted to BMI-based obesity measures that are often self-reported. These studies suggest that inequalities in obesity favour the less disadvantaged females, while the evidence for males is mixed (Costa-Font et al., 2014; Costa-Font and Gil, 2008; Hajizadeh et al., 2014; Ljungvall and Gerdtham, 2010; Madden, 2013; Zhang and Wang, 2004). A few of these studies investigate the underlying factors that contribute to such inequalities; however, the evidence to date has not reached consensus (Costa-Font and Gil, 2008; Hajizadeh et al., 2014; Ljungvall and Gerdtham, 2010; Madden, 2013).

Employing nationally representative data from Great Britain, the aim of this paper is twofold: a) to explore the presence of income-related inequalities in a number of alternative adiposity measures by gender and b) to identify what factors contribute to these inequalities. Concentration indexes (CIs) were used to quantify income-related inequalities in adiposity. These are widely used inequality measures (Erreygers and Van Ourti, 2011) that capture the socio-economic dimension of health inequalities using information from the whole distribution of the socio-economic measure rather than just the extremes (Wagstaff et al., 1991). Given the advantages of the methodology, regression-based decomposition techniques were then implemented to explore the contribution of the variables underpinning the observed income-related adiposity inequalities. We particularly focused on the role of more intermediate mechanisms linked to psycho-social processes, such as subjective financial well-being (SFW), as opposed to the impact of "structural" factors (such as income and education) and health behaviours.

Measures of SFW have been shown to be associated with health as independent correlates and as mediators between income and health (Arber et al., 2014; Gunasekara et al., 2013). Income and SFW measures, although related, should be viewed as distinct measures, with the latter mainly capturing individual *perceptions* of financial condition and to lesser extent actual indebtedness/budget problems (Arber et al., 2014; Zyphur et al., 2015). For example, people with similar levels of (low) income may make different judgements about adequacy of their income, potentially as a result of the role of expectations or social comparisons (Arber et al., 2014; Mirowsky and Ross, 1999; Zyphur et al., 2015). Measures of SFW have been found to be associated with adiposity (Averett and Smith, 2014; Conklin et al., 2013; Laaksonen et al., 2004) and weight gain (Loman et al., 2013). These associations can be theorized through two generally distinguishable mechanisms, following a similar framework to Arber et al. (2014). First, perceptions of financial strain, i.e. feeling unable to manage on their income, may involve stressful psychological processes that may result in people overeating and excess adiposity (Averett and Smith, 2014; Wardle et al., 2011). Second, SFW measures may be linked to adiposity through "perceived relative material deprivation" pathways, which reflect the extent to which individuals feel that their income is insufficient to participate in ways considered customary within the community (Conklin et al., 2013); this mechanism is related to the reference group theory and the role of social comparisons (Arber et al., 2014). However, the impact of SFW on socio-economic inequalities in adiposity remains unknown.

In this study, alternative measures of adiposity were used. In addition to the conventional BMI, we employed body fat and WC measures. Body mass index (and consequently BMI-related obesity measures) is a noisy adiposity measure because it does not distinguish fat from lean body mass (Schutz et al., 2002; Burkhauser and Cawley, 2008). In particular, disentangling fat- from lean-mass is important for obesity research because these two components have distinct health consequences (Burkhauser and Cawley, 2008). Recent evidence has shown that different adiposity measures may result in different levels of obesity (Burkhauser and Cawley, 2008; O'Neill, 2015), different effects on outcomes (Burkhauser and Cawley, 2008) and different socio-economic patterns (Ljungvall et al., 2015). It is important therefore to examine a range of adiposity measures to better identify potential intervention points for tackling inequalities in adiposity.

Based on the existing literature we hypothesized that: income-related inequalities in adiposity will favour the rich; these inequalities will differ between alternative adiposity measures and by gender; and SFW measures will considerably contribute to the income-related inequalities in adiposity after accounting for demographic, socio-economic and lifestyle factors.

This study contributes to the literature in a number of ways. This is the first study, to our knowledge, that explores income-related inequalities in alternative adiposity measures employing CI techniques; conventional BMI-based measures, body composition (fat- and lean-mass components of BMI; percentage body fat, BF%) and central adiposity measures (WC) are used. These adiposity measures are treated as continuous and discrete obesity indicators. Second, in contrast to many of the previous studies, we employ clinically obtained adiposity measures. It has been shown that reporting errors in body weight (or BMI) are non-classical (Cawley et al., 2015; O'Neill and Sweetman, 2013) and they systematically differ by socio-economic status (Ljungvall et al., 2015). Hence, socio-economic inequalities in BMI-based measures may be biased when self-reported measures are employed (Ljungvall et al., 2015; O'Neill and Sweetman, 2013). Previous attempts to correct for bias in self-reported BMI data using a priori information on reporting behaviour (Costa-Font et al., 2014) were criticized regarding the ability of their methods to fully eliminate reporting error (Cawley et al., 2015). Measured anthropometric data are therefore preferable (Cawley et al., 2015). Finally, this is the first attempt to quantify the contribution of SFW, after accounting for demographic, socio-economic and lifestyle factors, to income-related inequalities in adiposity.