Industrial restructuring and physical activity in England

Esther Christiane Rind

A thesis submitted for the degree of Doctor of Philosophy

School of Environmental Sciences,

University of East Anglia, UK

May 2012

To my father Ferdinand Rind

Abstract

In recent decades, the prevalence of physical activity has declined considerably in many high-income countries, and this has been linked to rising levels of obesity and several weight-related medical conditions such as coronary heart disease, diabetes and cancer. There is some evidence that areas experiencing the lowest levels of physical activity tend to be those which have undergone a particularly strong transition away from employment in physically demanding occupations. It is proposed that such processes of industrial restructuring may be causally linked to unexplained geographical variations in activity patterns. Although the socio-cultural correlates of activity behaviours have been well studied, none have explicitly attempted to identify components of industrial change that may impact physical activity.

This thesis addresses the gap in knowledge surrounding the socio-cultural context of industrial restructuring by investigating where, how and why dimensions of industrial change may impact current levels of physical activity in England. The research applies a mixed methods approach using GIS techniques, multilevel modelling and qualitative research interviewing. Firstly, the current literature on socio-cultural correlates of health behaviours is reviewed to present a novel conceptual framework that hypothesises how processes between physical activity and industrial restructuring may be linked in context. Subsequently, measures of industrial restructuring as well as physical activity are developed to analyse spatial variations in activity patterns across England. The analyses focus on how employment decline in physically demanding occupations may affect current levels of physical activity across different activity domains and relevant macro-economic time periods. Finally, this research aims to get an insight in the mechanisms underlying the relationship between physical activity and industrial restructuring.

Results from this research showed geographical variations with distinctive urban-rural disparities in levels of predominantly recreational physical activity across England. Processes of industrial restructuring appeared to be associated with patterns of physical activity, although the nature of the association differed across areas, time periods and employment types. The results also highlighted the plausible impact of inherited cultures and regional identities on health-related behaviours. Socio-cultural factors relevant in the context of industrial restructuring are likely to provide valuable context in activity-related research.

Declaration

The research reported in this thesis is my own original work which was carried out in collaboration with others as follows:

Chapter 1 was written by Esther Rind. Parts of the introduction are based on

Rind, E. and Jones, A., (accepted for publication). Obesity and overweight in the United Kingdom - Overcoming obesogenic environments. Berichte zur deutschen Landeskunde, Special Issue: Therapeutic Landscapes.

Chapter 2 Esther Rind was the lead author. She reviewed the literature, designed the framework and wrote the manuscript. Andy Jones contributed to and advised on the design of the framework and reviewed manuscript drafts.

Chapter 2 is to be submitted as

Rind, E. and Jones, A. Declining physical activity and the socio-cultural context of the geography of industrial restructuring: A novel conceptual framework.

Chapters 3 and 5 Esther Rind was the lead author. She designed the studies, was responsible for the data acquisition, carried out statistical analyses and wrote the manuscripts. Andy Jones contributed to the design of the studies and reviewed drafts of the manuscripts. Humphrey Southall provided data on which the studies are based and reviewed drafts of the manuscripts.

Chapter 3 is to be submitted as:

Rind, E., Jones, A., Southall, H. Assessing associations between industrial restructuring and domains of physical activity in England.

Chapter 5 is to be submitted as:

Rind, E., Jones, A., Southall, H. Assessing urban/rural differences in associations between industrial restructuring and recreational physical activity and walking in England.

Chapter 4 Esther Rind was the lead author. She was responsible for the study design, data acquisition, carried out statistical analyses and wrote the manuscript. Andy Jones contributed to the design of the study and reviewed drafts of the manuscripts.

Chapter 4 has been published as

Rind, E. and Jones, A., 2011. The geography of recreational physical activity in England. Health & Place, 17(1), 157-165.

Chapter 6 Esther Rind was the lead author. She was responsible for the study design, data collection, transcription, carried out the analysis and wrote the manuscript. Andy Jones contributed to the design of the study and reviewed drafts of the manuscripts.

Chapter 6 is to be submitted as

Rind, E. and Jones, A. 'I used to be as strong as a horse and fit as a linnet' – Changing physical activity in former coalfield areas in the North-East of England.

Chapter 7 was written by Esther Rind.

Acknowledgements

Thanks to my supervisory team including Andy Jones, David Ogilvie, Graham Bentham, and Robin Haynes, who have all provided valuable support and guidance over the last years. A special thanks to my primary supervisor Andy for his statistical advice, meticulous and swift manuscript revisions, including encouraging and invaluable comments and suggestions. From a linguistic point of view, I really appreciated his ability to translate my sometimes rhapsodic and convoluted sentences into comprehensible English. From this, I believe, I have learned quite a bit over the last years. Thank you!

Thanks to the MRC/ESRC and the School of Environmental Sciences for funding my studentship. This study was also supported by the Centre for Diet and Activity Research (CEDAR). This offered additional networking opportunities as well as the funding for my fieldwork, which provided the exciting opportunity to leave the world of statistical analyses. I am grateful to all study participants for their warm welcome, time and contributions. A special thanks to Brian Young, Secretary of the Durham Branch of the Working Men's Club and Institute Union as well as to both of the club secretaries who helped with the organisation of the focus groups.

I also very much appreciate competent advice from the research managers who helped with my data requests concerning the *Health Survey for England* and the *Active People Survey*. Humphrey Southall from the University of Portsmouth provided valuable support with data from the *Great Britain Historical GIS Project*.

Finally a very big thank you to my friends and family who kept everything in perspective: the “Norwich-Girls-Support-Team” including Karen, Helen, and Lauren, my fellow PhD-students, my music friends from the University Orchestra who kept me sane, the “Zicer-colleagues” for their friendly welcome and continuous support, and my friends who kept me “in the loop” with news from abroad. A very special thanks to my mother, Friedemann, my brother and sisters who continuously support and share my life outside the “Vaterland”. Ben, you have shared all of the ups and downs. Thank you!

Contents

Chapter 1

General Introduction

Obesity levels in the UK are among the highest in Europe (Eurostat, 2011: 121). In England for example, 66% of men and 57% of women were overweight or obese[1] in 2008, and the percentage of obese adults has increased by about 10% since 1993 (Craig et al., 2009). As in other high-income countries, the proliferation of the obesity epidemic has been related to social and economic deprivation (Wilkinson et al., 2010). Although there has been a steady increase in levels of obesity among adults in each social class since the mid-1990s, this has been highest amongst those at the lower end of the socio-economic strata (Marmot, 2010). This development causes significant costs to the National Health Service; in 2002, the direct costs for the treatment of diseases related to overweight and obesity were estimated to be £3.23 billion, the largest proportion being due to stroke (£983 million), coronary heart disease (£773 million), hypertensive diseases (£576 million) and diabetes mellitus (£533 million) (Allender et al., 2007).

Increasing prevalence in overweight and obesity is linked to an imbalance between energy intake and expenditure which, given the rapidity of the epidemic, cannot be driven by genetic or biological factors (Pearce et al., 2010). Rapid societal change over recent decades has resulted in the development of 'obesogenic' environments which promote unhealthy eating patterns and insufficient physical activity[2] levels in a considerable proportion of the UK population. Swinburn et al. (1999, 564) define these environments as *"the sum of influences that the surroundings, opportunities, or conditions of life have on promoting obesity in individuals or populations"*.

[1]Overweight is defined as body mass index (BMI) $\geq$ 25kg/m^2. Obesity is defined as BMI $\geq$ 30kg/m^2 (WHO 2005).

[2]In this thesis "physical activity" is defined "as any bodily movement produced by contraction of skeletal muscle that substantially increases energy expenditure" (Howley 2001, 364).

On the one hand, there have been significant changes in the food environment leading to modifications in eating behaviours. Data for the United Kingdom suggests an increase in mean daily caloric intake by 63 kcal from 1970 to 1984 and by 190 kcal from 1985 to 2002 (Bleich et al., 2008). On the other hand, there has been a general decrease in energy expenditure. It has been estimated that the overall mean reduction in energy expenditure over the past 50 years is 250 - 500 kcal/d^{-1} (Fox et al., 2007). Fox and Hillsdon (2007, 116) list 5 reasons for this reduction, including domains of occupational, domestic, transport-related and leisure time activities:

1. fewer jobs requiring physical work as the UK has changed from an industrial to service-based economy;
2. increased labour-saving technology in the home, work and retail environments;
3. changes in work and shopping patterns – from local to distant – that have resulted in greater reliance on motorised transport;
4. increased self-sufficiency in the home, including entertainment, food storage and preparation, controlled climates and greater comfort;
5. reductions in walking and cycling.

Within the literature, there has been an ongoing debate on the specific relevance of factors related to diet and physical activity. The obesity system map, presented as part of the 2007 Foresight Report 'Tackling Obesities: Future Choices', highlighted that the reasons for imbalances of the energy equilibrium are multicausal and interrelated (Butland et al., 2007). The system map links 108 variables that directly or indirectly influence energy balance to four key determinants of obesity, including the level of primary appetite control, the force of dietary habits, the level of psychological ambivalence, and the level of physical activity. Although the map provides a comprehensive picture of several dimensions and multiple factors impacting obesity, the underlying mechanisms for many of the pathways described have not been well understood.

A relatively young and emerging research field within the broader discipline is the study of associations between the environment and physical activity (Jones et al., 2007). In particular, there remains a lack of evidence on the effects of the environment on overall physical activity levels, including activity domains related to leisure, work, transportation and the domestic environment.

Physical activity and health

There is a wealth of evidence that physical activity is beneficial to health. Warburton et al. (2006), for example, summarise how regular physical activity contributes to the prevention of several chronic diseases (e.g., cardiovascular disease, diabetes, cancer, hypertension, obesity, depression and osteoporosis) and premature death. Within different physical activity domains, however, some activities have been described as more beneficial to health than others. For example, certain forms of heavy occupational activity in the manufacturing and mining industry have been shown to have negative health impacts which, in turn, may limit physical abilities over the life course (Leino-Arjas et al., 2004; Ross et al., 2004). Although leisure time activities may entail health risks (Hartog et al., 2011), they have generally not only been associated with physical benefits, but also with improved mental health and a better quality of life (Cameron et al., 2012; Lee et al., 2008).

Insufficient levels of physical activity in a large proportion of the population are, however, of increasing concern for policy makers and health professionals. Physical inactivity is the fourth leading risk factor for mortality in high-income countries (WHO, 2009). It is noteworthy that socio-demographic factors are well-established correlates of physical activity (Gidlow et al., 2006; Trost et al., 2002). For example, activity usually decreases with age, is lower in women than men, lower in non-White compared to White ethnicities, and higher in those at the top versus the bottom end of the socio-economic strata. Prior research has also observed distinctive geographical variations in physical activity across high-income countries, reflected by the particularly low levels of activity in the UK (Sjöström et al., 2006). In England, for example, based on accelerometry, an objective measurement of activity, only 6% of men and 4% of women met the government's recommendation for sufficient physical exercise of at least 30 minutes of moderate physical activity on 5 days per week in 2008 (Craig et al., 2009)[3]. Although temporal trends in physical activity in England suggest an upward trend in recreational sports participation since the early 1990s (Stamatakis et al., 2007), this increase is small, occurs mainly across higher socio-economic classes and remains insufficient to close the energy gap.

[3]Moderate intensity activity has been defined as activity undertaken at 3-6 times the intensity of that of resting, whereby a person experiences increased heart rate, breathing rate, transpiration and muscle fatigue (Sallis and Owen 1999).

Understanding physical activity behaviours

Prior research has identified a range of factors influencing activity behaviours. Broadly, they may be divided into those associated with individuals themselves and those related to the broader context in which individual behaviour takes place. Theories applied in activity-related research have traditionally been applied to explain and understand individual attitudes and behaviours towards physical activity (Glanz et al., 2008). Social cognitive theory, for example, emphasises individual abilities to influence and regulate health behaviours such as physical activity, whereas the theory of planned behaviour is concerned with individual motivational factors linking health attitudes and behaviours. In the late 1980s, these models were criticised for paying little attention to contextual factors on activity behaviours, and there has since been a rediscovery of ecological and social concepts in activity-related research (McLeroy et al., 1988; Stokols, 1992). This has also resulted into an increased study of how characteristics of the physical environment impact physical activity. Recent evidence, however, suggests that the effects of the environment, including for example dimensions of walkability or accessibility of recreational places, on activity behaviours are relatively small (Jones et al., 2007; Zenk, 2011). This indicates that other large scale drivers such as societal conditions may play an important role in understanding activity patterns.

Since the mid-1990s, ecosocial theory has contributed to a better understanding of social determinants of health within populations. The theory explicitly considers how individual characteristics as well as physical, social and cultural conditions and changes impact population patterns of health (Krieger, 2001). Macintyre et al. (2002, 129), however, have suggested that there is a lack of *"clear theorising about the mechanisms which might link area of residence and [health outcomes]"*. The authors proposed a new framework for unpacking *"the black box of places"* which is based on compositional (characteristics of individuals), contextual (opportunity structures in the local physical and social environment) and collective explanations. The latter add characteristics which are concerned with socio-cultural and historical features of places and offers an additional perspective to explore area effects on health (Macintyre et al., 2002; Stafford et al., 2007).

Socio-cultural context and physical activity

The range of socio-cultural factors that have been identified in the literature have been classified into social roles and relationships (marital status, care giving role, motherhood), ethnicity and cultural factors (ethnic background), and socio-economic status (work role, income, education level, occupation) (Ball et al., 2005). The socio-cultural context of a neighbourhood is known to play an important role in influencing physical activity (Berger et al., 2009; Mavoa et al., 2008) and comprises *"the political, economic, ethnic and religious history of a community [which includes] norms and values, the degree of community integration, levels of crime, incivilities and other threats to personal safety, and networks of community support"* (Macintyre et al., 2002, 131).

There is some evidence from the UK that levels of physical activity might be related to factors associated with socio-cultural change. One of the most incisive large scale drivers that impacted political, economic, demographic and social dimensions of community life has been the transformation of occupational structures over recent decades. This particularly includes the transition from employment in industrial occupations towards a service-based and information-orientated society. This development did not only drive considerable socio-cultural changes (Altena et al., 2002), but also the widening of income and health inequalities. These inequalities are not only persistent, but much higher today compared to the 1960s and show a significant increase from 2000 to 2008 (Government Equalities Office, 2010; Hacking et al., 2011). Furthermore, there are distinct social and spatial variations in health outcomes that mirror those of socio-economic developments. For example, a relative deterioration in health has been shown particularly in areas of the UK experiencing effects of industrial decline during the 1980s (Mitchell et al., 2000). In terms of physical activity, Ellis et al. (2007) reported particularly low activity levels for residents of more northern industrial towns in England. However, the underlying mechanisms for the plausible relationship between socio-cultural factors relevant in the context of industrial restructuring and physical activity have not been well documented and remain largely unexplained.

Aims and objectives

This thesis investigates how the socio-cultural context of industrial restructuring may impact current levels of physical activity for adults in England. The main research question is therefore concerned with geographical patterns as well as socio-cultural dimensions of physical activity and industrial restructuring: *"How does physical activity vary across England, and how may this be related to patterns of industrial restructuring?"*

To meet the aims of the thesis, five main objectives are pursued:

1. To review the current literature on socio-cultural correlates of health behaviours, and to develop a novel conceptual framework that hypothesises how processes associated with industrial restructuring and physical activity may be linked in context (chapter 2).

2. To develop a measure of industrial restructuring and study how geographical variations in this measure may be associated with current levels of physical activity (chapter 3).

3. To develop a direct measure of aggregate population physical activity and use this measure to investigate geographical variations in recreational activity and walking patterns (chapter 4).

4. To assess urban/rural differences in associations between industrial restructuring and recreational physical activity (chapter 5).

5. To obtain an insight into the potential causal mechanisms underlying any relationship between physical activity and industrial restructuring (chapter 6).

Methodological overview

This thesis applies a mixed methods approach using geographic information system (GIS) techniques, statistical analyses including multilevel modelling, and focus group interviewing. Spatial analyses, including mapping and GIS techniques, as well as multilevel modelling have a well-recognised history in health-related research (Blossom et al., 2011; Pickett et al., 2001; William et al., 2009). For example, a combined approach using accelerometry, global position system (GPS) and GIS techniques have been used to follow, map and evaluate activity behaviours in school children (Jones et al., 2009). Multilevel modelling is a broadly applied method in health-related research and provides the tools to separately assess group level effects on individual health within hierarchically structured data (Pickett et al., 2001). With respect to activity related research, numerous studies have used this technique to analyse data where, for example, individuals are nested within administrative areas of local government (e.g. Yu et al., 2011). These types of analysis have contributed to a better understanding of social and environmental determinants of health and health-related behaviours (Berkman et al., 2000).

Focus group methodologies have been widely applied to investigate public understanding of and attitudes towards health behaviours (Kitzinger, 1995). Focus group discussions have been defined as *"[…] a one-off meeting of between four and eight individuals who are brought together to discuss a particular topic chosen by the researcher(s) who moderate or structure the discussion."* (Bedford et al., 2001: 121). Hoebeke et al. (2008), for example, have recently used group discussions to explore and understand barriers towards physical activity in socio-economically deprived women. In comparison to other methods such as in-depth interviewing, focus group research reveals the participants' attitudes, beliefs and experiences in a collective way within a setting where behaviour takes place (Gibbs, 1997). Within the context of this thesis, the group discussions focussed on particular community settings where participants were encouraged to discuss day-to-day activities and experiences which could not have been explored through the application of individual interviews. Dependent on the sensitivity of the topic, group dynamics have furthermore the advantage to encourage discussions amongst participants who would be reluctant to participate in one-to-one interview

situations or feel that they have nothing to contribute on their own (Hopkins, 2007; Kitzinger, 1995). Group processes can therefore help respondents to articulate their experiences in relation to others, elaborate on ideas and opinions facilitated through contributions from others, highlight community priorities, and identify group norms and cultural values.

Due to the relatively small number of participants, one concern related to the application of focus group research is the transferability of the results to the wider population (Cameron, 2005). A well-established way of dealing with this is the combination of quantitative and qualitative methods which can provide a more comprehensive means to study a complex research question than each method on its own (Creswell et al., 2007). The value of mixed methods approaches has been well demonstrated in health-related research (Mitchell et al., 2009; Trochim et al., 2005), as they can provide a better understanding of how and why particular local contexts shape key health behaviours of interest. Focussing on particular health behaviours, Park et al. (2011) applied qualitative interviewing and generalised estimation equations to investigate dietary beliefs, preferences, and practices regarding healthy foods within ethnic minority groups. Lebel et al. (2011) used concept mapping, including focus group research, multidimensional scaling and cluster analysis, to investigate stakeholders' perceptions of factors associated with physical activity and diet. Their findings aim to provide a better understanding of how and why particular local contexts shape weight-related behaviours.

In terms of knowledge-generation, the combination of quantitative and qualitative methods does not only provide a better understanding of more general trends and associations relevant for a large study sample which can be representative for the whole of the population, but the material generated from focus groups can add specific and place-related meaning to the quantitative patterns observed. Based on survey responses, the quantitative analysis of this thesis aims to provide a better understanding of where and how activity patterns may vary across space, place and populations. The subsequent focus group analysis adds to these findings by providing a deeper understanding of why these patterns occur. All analyses presented are based either on secondary data sources or data collected during field work.

Secondary data sources

This thesis uses data from three main data sources; the Health Survey for England, the Active People Survey, and the Great Britain Historical GIS project. The analyses are undertaken at the scale of Local Authority Districts (LADs). LADs are basic units of local government in England with an average population of 139,000 residents. In 2001, England was divided into 354 LADs, including non-metropolitan districts, metropolitan districts, unitary authorities and London boroughs (Office for National Statistics, 2001). LADs are widely used units in health-related research as they provide adequate study power and have responsibilities for local services including economic development, public health and leisure facilities (Doran et al., 2006). Further, they have been shown to provide a meaningful scale to represent industrial structures and labour market characteristics (Chevan et al., 2000; Mitchell et al., 2000). A brief introduction is now provided to each of the main data sources.

The Health Survey for England

Undertaken since 1991, the Health Survey for England (HSE) comprises a series of annual surveys that include information on various aspects of population health (NHS Information Centre, 2011). A representative number of randomly selected adults aged 16+ who are interviewed at their homes are surveyed each year. Methods of recruitment, the full sampling strategy and the derivation of the activity outcomes are described elsewhere (Craig et al., 2008 & 2009; NHS Information Centre, 2011). This thesis uses data from the 2006 and 2008 HSE. As both surveys include comparable core questions on self-reported total, occupational, domestic, recreational and walking activities, it was possible to pool the datasets to increase the sample size for subsequent analyses.

Active People Survey

Covering the whole of England, the Active People Survey (APS) comprises the largest series of annual surveys on sport and recreational activities in Europe, undertaken since 2005 (Sport England, 2011). The (telephone) survey was designed to identify spatial variations in activity participation as well as different population groups. The full sampling and recruitment strategy is described elsewhere (Ipsos Mori, 2006). This thesis uses data from the 2005/2006 APS, the first and largest survey of the series, including

more than 360,000 randomly selected participants aged 16+. The survey provides information on frequency, duration and effort level of self-reported recreational activities and walking as well as a broad range of socio-demographic characteristics.

The Great Britain Historical GIS project

The Great Britain Historical GIS project integrates data from a range of surveys in Britain including, for example, census data since 1801, election results since 1833 and historical maps from the 19th and 20th century (Gregory et al., 1998; Southall, 2011; Southall et al., 2009). Some of these data were re-organised to standardised reporting areas (Gilbert et al., 2000) which allows comparisons of areas over long periods and provides the possibility to link the data to other surveys using the same reporting areas. For the analyses of this thesis, long-term trends in employment data for three economic sectors, including manufacturing, mining and agriculture, were obtained for the period 1841 - 2001.

Field work

The fieldwork for this research took place in the North-East of England where a series of focus group discussions was conducted during August 2011. Subsequent analysis is based on transcribed interview material and on a short survey collecting socio-demographic information on all participants. Ethical approval for the research project was obtained from the School of Environmental Sciences University Research Ethics Committee.

Thesis structure

The subsequent thesis is presented as a series of papers that build upon each other. This work therefore does not include a formal methods chapter, but in addition to the preceding methods overview, each chapter will separately consider the approaches and analytical tools applied, present and discuss the results, and provide a critical appraisal of strength and limitations.

Chapter 2 provides the conceptual background for this thesis. Focussing on the United Kingdom, relevant theoretical context and empirical evidence is reviewed to develop a new conceptual framework linking physical activity to the socio-cultural context of industrial restructuring. Also discussed is the framework's transferability to other settings than the UK as well as implications and recommendations for future work. Analyses of subsequent chapters aim to test different pathways presented in this new framework.

Chapter 3 sets out to develop a measure of industrial restructuring and analyses how variations in outcomes related to employment decline in physically demanding occupations may affect current levels of physical activity across different activity domains and relevant macro-economic time periods between 1841 - 2001. The study considers long-term trends in employment for three economic sectors, comprising manufacturing, mining and agriculture. The analysis is stratified for sex and includes the domains of total, occupational, domestic, recreational and walking activities.

Chapter 4 focuses on the geography of recreational physical activity. The study develops a direct measure of physical activity based on energy expenditure and investigates spatial variations in activity patterns across England. The analysis includes measures of recreational activity, walking as well as a measure of non-active recreational behaviour. All results are presented separately for both men and women.

Chapter 5 links previous findings to investigate specifically urban/rural differences in associations between industrial restructuring and recreational activities as well as those for walking.

Chapter 6 obtains an insight into the mechanisms underlying the plausible relationship between physical activity and industrial restructuring. The study focuses on the particular socio-economic and cultural context of communities with a history of mining employment. Within the context of industrial decline, changes in individual as well as community choices and opportunities towards physical activity are explored, discussed and evaluated.

Chapter 7 summarises the principle findings from this thesis, discusses strengths and limitations as well as the wider implications for policy and practice, and highlights areas for future research.

Chapter 2

Declining physical activity and the socio-cultural context of the geography of industrial restructuring: A novel conceptual framework

Introduction

This chapter provides the conceptual and theoretical background for the whole of the thesis which sets out to get a better understanding of how physical activity varies across England, and how observed variations may be related to patterns of industrial restructuring. First, the current literature on socio-cultural correlates of health is reviewed; subsequently, a case study centred on the United Kingdom is used to present a novel framework that hypothesises how the processes between physical activity and the socio-cultural context of industrial restructuring may be linked in context.

Background

In recent decades, levels of physical activity (PA) have declined considerably throughout many developed countries (WHO, 2006). In Europe, for example, over 65% of the adult population does not exercise sufficiently. Low levels of overall PA have been related to rising levels of overweight and obesity which are in turn associated with health risks such as coronary heart disease, type 2 diabetes, and several forms of cancer (Kopelman, 2007).

In the UK, which we focus upon as a case study in this manuscript, the prevalence of sufficient PA and walking is significantly lower than the European average, whilst the prevalence of sedentariness is higher (Sjöström et al., 2006). The 2008 Health Survey for England suggests that based on self-reported PA, only 39% of men and 29% of women

aged 16 and over met the government's recommendations of at least 30 minutes of moderate or vigorous activity on not less than five days a week (Craig et al., 2009). Based on objective accelerometer-based measurements of PA, activity levels are even lower; just 6% of men and 4% of women achieved the recommended levels in 2008.

In the 1990s, conceptual work coined the term *"obesogenic environments"* to describe physical and social conditions hampering opportunities for a healthy lifestyle around dietary and activity behaviours (Swinburn et al., 1999). Since then, numerous studies have shown that features of the physical environment such as neighbourhood aesthetics, safety from traffic, or access to parks and other recreational facilities are associated with PA (Jones et al., 2009). However, rather little attention has been paid to the role of social and cultural factors as potential drivers of PA. This is despite the fact that the evidence from the environmental correlates literature suggests that the influence of the physical environment on activity levels is rather small (Jones et al., 2007; Zenk, 2011). This indicates that large scale drivers such as societal circumstances may have an important role in explaining disparities in PA behaviours.

The concept that declines in PA may in part be associated with large scale shifts in social and cultural environments is perhaps unsurprising given that many countries exhibit distinct gradients in health and health-related behaviours that have been repeatedly associated with socio-economic inequalities. Wilkinson and Pickett (2010) recently provided clear evidence that health is inversely associated with income inequality. In the UK, much prior research has described a persistent and widening geographical gradient in health and health-related behaviours (Department of Health and Social Security, 1980; Marmot, 2010). Patterns of health have been generally worse in the more deprived northern regions compared to the more affluent south, in particular for men and women working in manual occupations (Blaxter, 1990; Smith, 1989). Mitchell et al. (2000) found that respondents living in areas that were highly dependent on industrial employment and that have experienced high job losses due to industrial decline showed significantly increased odds of reporting ill-health compared to those where the effects of job loss were less severe. More recently, Bambra and Popham (2010) report that employment rates may attenuate inequalities in health within English regions by as much as 60%. They further suggest that health inequalities are associated with macro-

economic change and are likely to persist, particularly in those areas where high levels of unemployment and poor economic recovery remain a major challenge.

The transformation of occupational structures is one of the most incisive large scale drivers of social change in modern history and has been related to multiple interrelated processes including the implementation of neoliberal agendas, the globalisation and liberalisation of economies, technical innovations, as well as the shift from goods to knowledge production and service provision (Castells et al., 1994). The process set about the Industrial Revolution followed by a period of deindustrialisation and industrial restructuring. Here, we define the term *'deindustrialisation'* as a pronounced employment decline in industries associated with manual work such as the manufacturing and mining sectors. *'Industrial restructuring'* describes the transition from a manufacturing based industry to a high technology, service based and information orientated economy (Bazen et al., 1997). This economic cycle is a global phenomenon and has resulted in substantial social and economic change in areas such as Europe and the USA (Altena et al., 2002).

Centuries ago, England was the first country to introduce major reforms to the agricultural sector which resulted in a considerable growth in productivity, yet made parts of the agricultural workforce redundant (Bazen et al., 1997). Such changes have been mirrored by a substantial employment decline, primarily in the manufacturing sector, with an overall loss of 5 million jobs between the late 1960s and the early 1990s (Castells et al., 1994). In particular, during the 1980s, many of the older structurally disadvantaged northern industrial conurbations were challenged by the effects of severe deindustrialisation, characterised mainly by considerable economic decline (Frost et al., 1991). Indeed, industrial restructuring has been described as *"the single most powerful and direct cause of growing income inequality and the declining fortunes of the working classes"* (Chevan et al., 2000, 365).

Apart from economic aspects, industrial restructuring also triggered a variety of other social and cultural changes to personal circumstances and overall living conditions that we suggest have potential relevance to PA. Taking the definition of Macintyre et al. (2002, 131), the socio-cultural context of a neighbourhood comprises *"the political,*

economic, ethnic and religious history of a community [including] norms and values, the degree of community integration, levels of crime, threats to individual safety, and the level of existing neighbourhood support." Such socio-cultural contexts have undoubtedly been reshaped by industrial restructuring. For example, life-changing events such as a change in employment status or residence can modify the persistence of key community structures and the consequences have been related to patterns of living, including participation in PA (Allender et al., 2008).

There is further evidence from resilience studies for the explanatory value of considering socio-cultural dimensions in the context of deindustrialisation and health-related behaviours. Resilience research is primarily concerned with the question as to why some areas excel compared to others in terms of health outcomes despite similar histories of economic adversity. It investigates the mechanisms which underlie different processes of adaption (Mitchell et al., 2009). Tunstall et al. (2007), for example, illustrated how English cities such as Birmingham, Nottingham and Liverpool have mortality rates that indicate the presence of protective mechanisms that may mitigate adverse effects from poverty and material deprivation. They showed that these areas were particularly successful in retaining population or attracting new residents, possibly preventing social erosion and consolidating community structures. Other studies from Britain also concluded that socio-cultural factors such as social cohesion may be important in explaining why some areas have been more resilient than others (Doran et al., 2006; Ellaway et al., 2001; Mitchell et al., 2009; Walsh et al., 2009).

There is some direct empirical evidence from England suggesting a relationship between declining levels of PA and industrial restructuring. Stamatakis (2007) et al. found a statistically significant decline in occupational PA since the early 1990s for both men and women. Furthermore, there is evidence that participation in leisure-time PA across those employed in physically demanding jobs is relatively low (e.g. Mäkinen et al., 2009). Jones and Bentham (2009) hypothesise this non-participation could persist even after a transition to less physically demanding occupations, which would make the former manual workforce particularly susceptible to low levels of overall PA. Other studies have investigated spatial variations in PA participation. Early work, based on body mass index, blood pressure, and respiratory function, showed that residents of the

West and the Midlands Regions, both areas which have experienced substantial industrial decline, had relatively poor fitness (Blaxter, 1990). Ellis et al. (2007) recently investigated variations in levels of recreational PA across 39 socio-economically deprived English communities and reported lowest levels of PA amongst residents of more northern industrial towns. Several of the localities they identify have suffered between 40% and 70% declines in manufacturing employment between 1971 and 2001 (Southall et al., 2009). Rind and Jones (2011) investigated spatial variations in levels of recreational PA across English Local Authorities. They found that overall PA and walking activity was relatively low in more northerly urban districts which were, again, those showing manufacturing declines.

Despite these observations, the underlying mechanisms for this plausible relationship between PA and industrial restructuring have not been well documented. Nevertheless, well-established conceptional traditions in the behavioural and social sciences, summarised amongst others by McAlister et al. (2008) and Montaño and Danuta (2008), have facilitated the understanding of individual behaviour (e.g. theory of planned behaviour) or guided behavioural interventions (e.g. social cognitive theory). Many elements of these theories relate to concepts that encompass both social and ecological or area contexts, and these have become increasingly popular as a means of providing a conceptual background to activity-related research (Ball et al., 2010; Sallis et al., 2008); hence, we draw upon them here.

The relevance of ecosocial theory within health-related research

Ecosocial theory provides a useful framework for this thesis as it considers explicitly how present and historical physical, social, and cultural conditions and shifts impact population patterns of health and well-being (Krieger, 2001; McLaren et al., 2005). The term was introduced in the 1990s by Nancy Krieger, emphasising the necessity to develop multi-level frameworks integrating a dynamic, historical, ecological and social perspective on population health (Krieger, 2001). This theoretical approach stems from four centuries of epidemiologic research, including basic descriptions of disease mortality (1600s), specific causal pathways of diseases (1700s), comprehensive approaches revolutionising ideas and practises of sanitation (1800s), broader causal

models explaining the distribution of communicable diseases such as cholera, tuberculosis, diphtheria, and flu (1900s), as well as an emphasis on the specific, multiple causes of increasing morbidity and mortality rates related to non-communicable diseases (1950s) (McMichael, 1999). The central theme for ecosocial theory is concerned with population patterns of health and ill-health, including a better understanding of health inequalities affecting individuals and populations over the life course. A life course perspective highlights the importance of considering how population health is shaped by the historical period in which individuals live, including social, economic, political and ecological contexts. Early research concerned with these contexts root back to Louis René Villermé (1782-1863) who linked population health to the political and economic environment, or Friedrich Engels (1820-1895) who emphasised the impact of childhood deprivation on adult health (Krieger, 2001). This early research generally stressed that context matters in getting a better understanding of existing socio-economic gradients in health.

In the late 1990s, Anthony McMichael highlighted that a particular gap in knowledge is related to the understanding of the specific consequences of large-scale, social and environmental changes on health (McMichael, 1999). The author emphasised the increasing pressure of economic activity and overexploiting life-styles on the broader environment, including social and environmental systems which are directly related to human health. Increasing health risks are associated with the fragmentation and weakening of labour markets which increasingly adversely affect the health of workers and their families through declining economic security, and the unequally greater exposure to occupational health risks and physically as well as socially deprived neighbourhoods (McMichael et al., 2000). Specific risks to health include, for example, diseases related to dietary excesses and sedentary lifestyles resulting in increasing rates of obesity and weight-related diseases. McMichael suggested that research concerned with population health needs to address *"two larger-scale dimensions: the reduction of social and health inequalities and the striving for health-sustaining environments."* (McMichael et al., 2000: 495).

The growing interest in theories and conceptual models addressing ecological as well as social environments has been related to its valuable contribution to the development of multilevel public health interventions (Sallis et al., 2006). Health and health-related behaviours take place within multiple intertwined environments which need to be considered when developing strategies and programmes to improve population health and tackle health inequalities. Current research stresses persisting health inequalities across long-term socio-economically deprived areas (Riva et al., 2011) and that tackling these inequalities needs to be embedded in the life-course experience of individuals as well as in the broader historical context of the areas under study (Curtis et al., 2004; Ellaway et al., 2011). A classic example of integrating historical and contemporary measures associated with health is the study by Dorling et al. (2000) who showed that contextual patterns of poverty across different parts of London have remained persistent across a century and have associations with contemporary patterns of diseases such as stroke and stomach cancer. The study exemplifies persisting inequalities in health which highlights the necessity to apply integrative frameworks in order to successfully address patterns of inequality.

There has been an increasing interest in not only focussing on how aspects of the physical or socio-economic environment impact health and health-related behaviours, but on a better understanding of area effects related to the broader social environment (Popay, 2000). According to Berkman et al. (2000), prior research has shown that the social environment can influence behaviour by shaping norms, enforcing patterns of social control, or influence choices and opportunities for specific behaviours. In particular, it has been claimed that factors related to social forces within the family and community environment may play an equally or even more important role in explaining variations in health outcomes than those related to the physical environment or characteristics and life-styles of individuals (Lomas, 1998). Within health-related research, studies related to social capital have contributed to a better understanding of how and why the social environment affects the health of populations and individuals. Before developing an ecosocial perspective on changing levels of physical activity, the next section therefore outlines broader concepts related to social capital and their relevance within health-related research.

Concepts related to social capital and their relevance within health-related research

In its broadest sense, social capital has been defined as an important dimension of the social environment (Kim et al., 2011) and is concerned with how shared social resources may be assets for groups as well as individuals (Elgar et al., 2011). For over two decades, this idea has been conceptualised in sociology (Bourdieu, 1986; Coleman, 1990), economics (Putnam, 1993) and political sciences (Loury, 1992). In comparison, its application within health-related research is relatively new, with a significant increase of studies on the relationship between social capital and health in the early 2000s (Kawachi et al., 2008).

Defining social capital within health-related research has been challenging due to a lack of consensus concerning incorporated dimensions of the social environment and their empirical assessment. Recently, Kawachi et al. (2008) described two different dimensions in the conceptualisation of social capital emphasising either group or individual attributes. On the one hand, the "social-cohesion-school" refers to social capital as resources (e.g. trust, norms) available within particular groups (e.g. a community), and this "group-asset" can have positive effects for individuals. Social cohesion has been described as "a product of the adequacy of physical and social structure in the community" (Lomas, 1998: 1182). On the other hand, the "network theory" refers to social capital as resources that are part of an individual's social network (e.g. social support). This approach conceptualises social capital as a group asset (e.g. the social network operating within the working or home environment) as well as an individual attribute (e.g. individual reputation).

Elgar et al. (2011) recently summarised three types of social connections embedded in the conceptual context of social capital. *Bonding social capital* links people who share, for example, similar socio-economic histories and experiences which in turn reinforce social identities and solidarity among specific groups and communities. Particularly in socio-economically deprived areas, high levels of social support through community networks have been shown to explain why some communities are more resilient than others, despite similar socio-economic circumstances (Gilbertson et al., 2006; Mitchell et al., 2009). Bonding social capital has been measured through indicators such as

membership in religious, art, musical or charitable organisations as well as sport or recreational clubs. However, adverse physical and mental health effects have been observed for those continuously providing mental, physical or financial support for others (Mitchell et al., 2002), and it has been argued that an important factor for promoting health within deprived communities may be related to *bridging social capital* or resources beyond those related to similar social identities (Kawachi et al., 2008). This refers, for example, to co-operative connections between people across different social classes or race, fostering social inclusion and equality across the whole of the society. Bridging social capital has been measured through indicators representing trust crossing ethnic, religious or cultural boundaries. The final conceptualisation of *linking social capital* describes differences in power relationships, comprising residents' trust in formal authorities, including political, governmental or health organisations. Individuals and communities with high levels of linking social capital can, for example, access resources from formal institutions which are beyond the communities own financial capacity (e.g. community grants for health which aim to support marginalised and disadvantaged communities through activities reducing the gap in health inequalities) (Nottingham City Council, 2012).

Social capital is linked to health through a variety of mechanism such as the establishment of healthy norms within groups, knowledge diffusion about health behaviours, the promotion of healthy behaviours through informal social control and a decrease in psychosocial stress (Kawachi et al., 2000). Prior research has shown that an increase in social capital, conceptualised as overall trust across citizens and group membership, was significantly associated with lower total mortality rates as well as deaths from coronary heart disease and certain forms of cancer (Kawachi et al., 1997, all models adjusted for poverty). Social capital has also been linked to a variety of health-related behaviours including smoking, alcohol consumption, physical activity, dietary factors and sexual behaviour. A recent review on social capital and health-related behaviours has highlighted that the social context in peer groups can influence smoking as well as alcohol consumption, and that low social cohesion across neighbourhoods was significantly associated with increased public disorder (Lindström, 2008). Public disorder has also been related to decreasing levels of recreational physical activity, whereas participation in social activities has been associated with healthy diets. In terms

of sexual behaviours, norms and values established within peer groups have been shown to increase/decrease the risk of acquiring sexually transmitted infections which remain a considerable public health risk.

Social capital is a valuable concept to operationalise plausible relationships between the social environment and health. It has also been used as a public health strategy aiming to reduce health inequalities across persistently socio-economically deprived areas (Lomas, 1998). For example, structural improvements within communities have not only targeted physical environments or institutional facilities, but also aspects of social capital such as the reinforcement of social cohesion through the provision and maintenance of safe physical environments, attractive public meeting spaces or the promotion of social and recreational activities for the whole of the community. Nevertheless, interventions designed to improve dimensions of social capital have been critiqued for shifting governmental responsibilities towards communities. This "blaming approach" makes communities responsible for their own local problems such as high crime and morbidity rates, without acknowledging power differentials created by broader structural and political forces (Muntaner et al., 2001). As mentioned previously, social as well as health behaviours take place in multiple intertwined environments, and programmes designed to tackle particular community issues in isolation are most likely to fail (Mackenbach, 2010).

As Kawachi et al. (2008: 18) summarise *"[…]social capital does not arise in a vacuum or magically rain down from the sky on a few selected (and lucky communities); but rather, social capital is itself shaped by broader structural forces operating at the level of communities, such as historical patterns of residential mobility (e.g. influx of immigrants, shifts in local labour markets), municipal investment in housing and local infrastructure, as well as policies that perpetuate residential segregation or the planned shrinkage of services and amenities."* The dimensions described above can be linked directly to socio-economic, demographic, migrational, cultural and political aspects related to industrial restructuring and patterns of deindustrialisation. In the remainder of this chapter, we therefore provide a deeper evaluation of how socio-cultural factors relevant in the context of industrial restructuring can be integrated within an ecosocial perspective on changing levels of physical activity.

Developing an ecosocial perspective on changing levels of physical activity

An ecosocial perspective on changing levels of PA not only considers individual characteristics and responsibilities for a sufficiently active lifestyle, but explicitly examines how economic, political and socio-cultural factors impact structural and social barriers that in turn impede the achievement of sufficient levels of PA across whole populations.

Based on the ecological model for health promotion (McLeroy et al., 1988), in Figure 1 we therefore propose three tiers of consequences of industrial restructuring which we suggest may directly or indirectly be associated with declines in PA. The tiers we have identified are based around compositional and contextual socio-cultural concepts and we therefore present those changes related primarily to individuals and families separately from those affecting entire areas, although several of the processes are interrelated. In the figure we depict individuals and families dependent on manual labour as being particularly adversely affected by the impact of industrial restructuring, being forced frequently to find new sources of income, sometimes in different areas (tier1). This impacts gender relations and family structures since women increasingly contribute to family incomes. The loss of consolidated economic and social structures could also have adverse consequences on an individual's psychological mind-set and general well-being, or may change former political beliefs (Altena et al., 2002). For example, a change in voting outcomes (tier 2) can affect the political climate of entire areas and impact political strategies to promote environmental and social improvements (tier 3) (Hobbs, 1992). Neighbourhoods affected by deindustrialisation may experience impoverishment, and significant changes in their socio-demographic composition (tier 2). Subsequent economic decline and migration can increase social fragmentation and aggravate the well-being of populations (Altena et al., 2002).

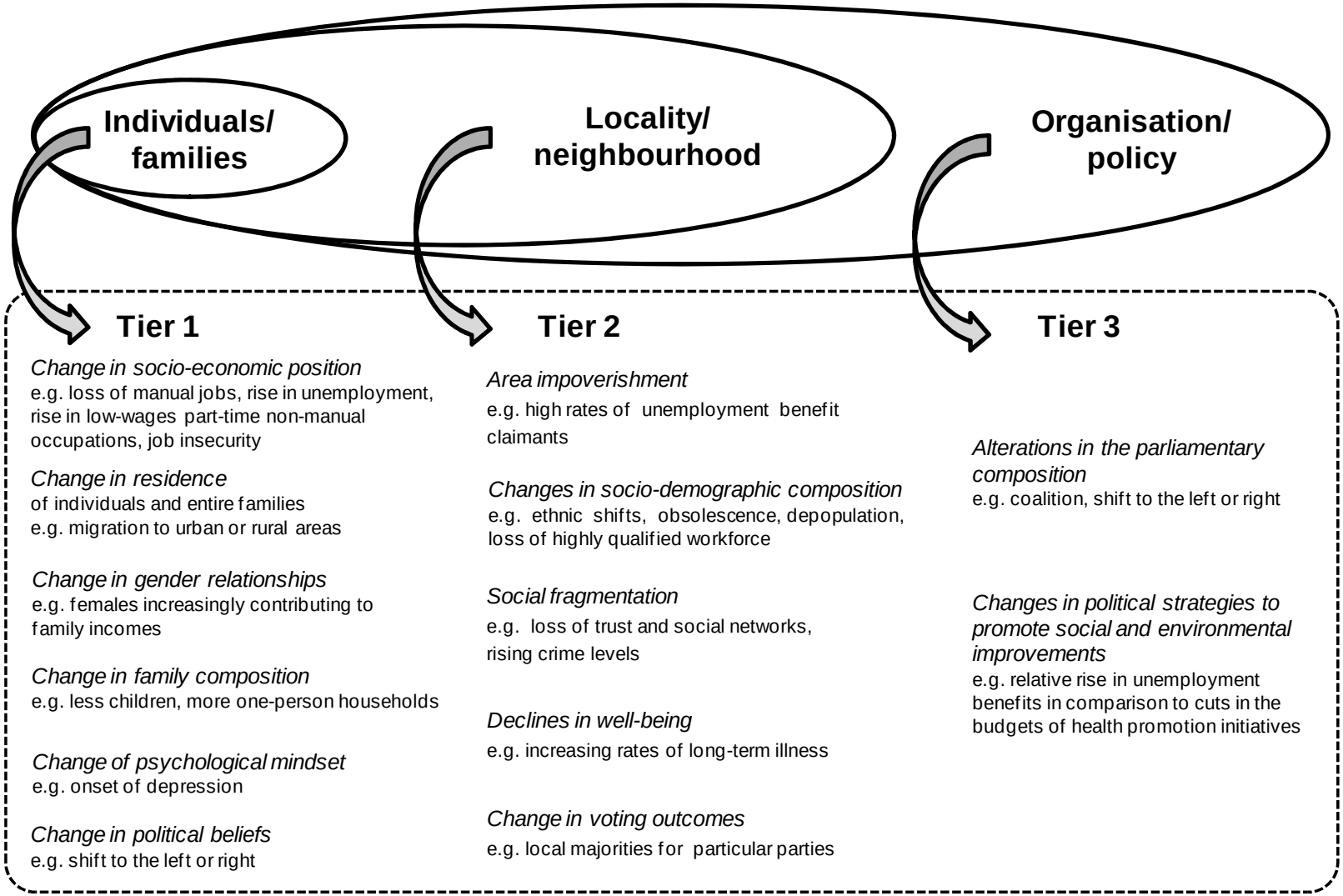


Figure 1 Examples of socio-cultural changes related to industrial restructuring

Prior research has investigated the relationship between socio-cultural factors and PA within certain population groups (Mavoa et al., 2008), or for adolescents and children (Goncalves et al., 2007). Yet we believe the ways in which particular socio-cultural characteristics of a post-industrial society may be related to variations in PA is an under-researched question. Based on the impacts identified in Figure 1, we present in this paper a theoretical framework in order to depict how the socio-cultural context of industrial restructuring may be related to the distinctive geography of PA. Our focus is on the UK for two reasons: compared to many other countries, the process of deindustrialisation has been particularly pronounced (Bazen et al., 1997), and the UK has significantly lower levels of overall PA compared to the European average (Sjöström et al., 2006). Nevertheless, we believe our framework is applicable to all societies that experience Subsequently, we briefly review existing theoretical perspectives and frameworks within the context of ecosocial theory that have attempted to relate socio-cultural processes to health. We then move on to present our own framework linking PA to industrial restructuring which provides the conceptual background for the empirical analyses of this thesis.

Previous frameworks integrating socio-cultural contexts and health

Prior research has developed models integrating socio-cultural environments into broader frameworks linked to health. This provides a basis to identify dimensions which are likely to impact levels of PA and which are relevant in the context of industrial restructuring. The interdisciplinary ecological model of four domains of active living developed by Sallis et al. (2006), for example, provides a comprehensive model summarising multi-dimensional influences on PA. The model includes socio-cultural aspects and was designed to synthesise contributions of various disciplines such as public health or urban planning to activity-related research. Other models focus on policy (Schmid et al., 2006) or economic aspects (Cawley, 2004), as well as on specific causal pathways and mechanisms (Panter et al., 2008). We, however, subsequently focus on four models which directly link socio-cultural dimensions to health-related behaviours and have thus provided relevant context for the development of our framework.

In their early work, Stokols (1992) listed a comprehensive set of socio-cultural factors related to both personal and environmental factors in health and illness, including the socio-economic status of individuals or groups, economic changes, social cohesion and support, cultural and religious practices, political attitudes, and health promotion in communities. The main purpose of this framework was the identification of various factors being related to personal and environmental considerations in health and illness, but linkages were postulated, and the author suggested the confirmation of linking mechanisms was a need for future research.

The ANGELO framework (ANalysis Grid for Environments Linked to Obesity) encompasses physical, economic, political and socio-cultural environments (Swinburn et al., 1999). These are related to food intake and PA for both the individual/family environment and the wider population. In terms of PA, the socio-cultural macro-environment includes factors such as a society's attitude towards recreation (e.g. a participating versus 'watching' culture) whereas the socio-cultural micro-environment comprises attitudes related to peers' activities, family recreation, school sports and safety. The framework has been used primarily as a classification scheme for various

systematic reviews including environmental correlates of PA (Ferreira et al., 2007), and interventions to promote PA among teenagers (De Meester et al., 2009).

Although earlier conceptual work identified a variety of socio-cultural factors relevant to the context of health and illness, only recently have these been directly related to PA and associated behaviours. Stafford et al. (2007) developed a framework linking social and physical environmental characteristics to weight-related behaviours and obesity. The model includes a variety of correlates of PA, but the socio-cultural aspects considered are confined to contexts representing social disorder, for example high crime levels, which is linked inversely to PA. A comprehensive model conceptualising socio-cultural influences on obesity was developed by Ball and Crawford (2005). They classify a variety of socio-cultural factors into social roles and relationships (marital status, care-giving role, motherhood), cultural background (ethnicity), and socio-economic status (work role, income, education level, occupation), arguing that those factors incorporate different behavioural pathways. The framework postulates that, within different cultures, values and beliefs about food, eating, PA and body image vary, resulting in different behavioural outcomes which in turn influence the energy balance and weight outcome of individuals. The authors clearly position socio-cultural factors as major determinants of weight-related behaviours and weight outcomes. In summary, prior work has suggested that future research needs to further develop creative and comprehensive methodologies to better understand the socio-cultural dimension of PA. The importance of identifying those factors relevant in the context of the society studied is particularly emphasised and we thus build upon these prior conceptual frameworks.

Linking physical activity to socio-cultural dimensions of industrial restructuring

Our new conceptual framework is presented in Figure 2. Our main outcome is current levels of overall PA. The framework applies to adults across the age spectrum and highlights three main moderators, age, gender and ethnicity, as well as general health status, which alter the strength of the association between PA and the dimensions of the socio-cultural environment considered. We believe these moderators are important because PA is known to be higher in males than in females, decreases with age or physical limitations such as long-term illnesses and varies between ethnicities (Craig et al., 2009; Fischbacher et al., 2004).

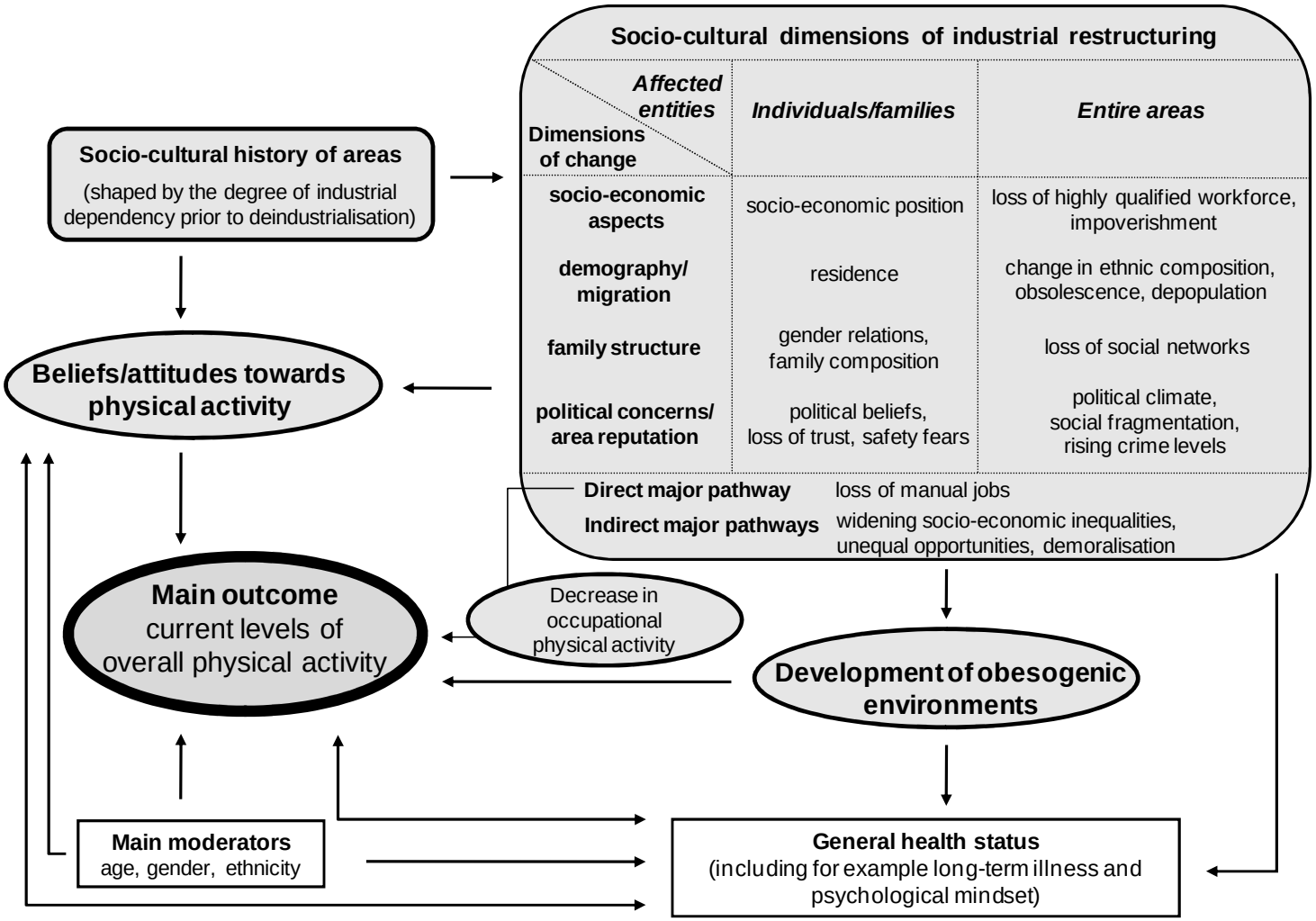


Figure 2 Framework linking physical activity to socio-cultural dimensions of industrial restructuring

We hypothesise that the socio-cultural environment in the context of industrial restructuring impacts levels of PA in two key ways. Firstly, the decrease in occupational PA is directly related to current levels of overall PA. Secondly, two additional mechanisms operate. On the one hand, overall exercise levels are shaped by beliefs and attitudes towards PA. These are related to the socio-cultural history of individuals and communities prior to the period of deindustrialisation, and to the dimensions of industrial restructuring. Peer, friend and family networks establish role models, social norms and support which vary across different cultures (Berger et al., 2009; Story et al., 2008). This affects social environments of individuals and communities and encourages either active or non-active behaviours. Indeed, research focussing on low income groups and poor neighbourhood environments has highlighted cultural backgrounds and local social environments as key dimensions to understand barriers to PA (e.g. Warr et al., 2007). On the other hand, rapid socio-cultural change, including significant shifts in employment patterns and cultural mixes within societies, results in the development of obesogenic environments which promote insufficient PA. Widening socio-economic inequalities, unequal opportunities and demoralisation are major pathways linking beliefs and attitudes towards PA and the development of obesogenic environments to overall levels of PA.

Our framework incorporates four interrelated key socio-cultural dimensions of industrial restructuring which may have a plausible impact on individuals, families and entire areas: socio-economic aspects, demography and migration, family structure, and political concerns and area reputation. Based on recent systematic reviews on correlates of PA and drawing upon literature from the broader health research, we explore explicitly how these dimensions may be related to patterns of PA. We acknowledge that many of the processes described below are interrelated, yet for the sake of simplicity we consider them successively.

Socio-economic aspects and physical activity

Industrial restructuring impacts the socio-economic circumstances of individuals, families and entire areas. Most notably, the manual workforce frequently experiences a shift towards the bottom of the socio-economic ladder, and areas of considerable economic decline become unattractive for those who are highly qualified (Altena et al., 2002). As a consequence, impoverishment as well as demoralisation can proliferate, and socio-economic differences increase. This further weakens economic and social structures for both individuals and areas (Wilkinson et al., 2010).

Indicators of socio-economic status (SES) such as high occupational class, education and income are known to shape beliefs and attitudes towards PA and show predominantly positive associations with activity levels (Gidlow et al., 2006). Increases in socio-economic deprivation have been associated with the development of obesogenic environments via mechanisms such as the likelihood of having poor access to recreational facilities, thus reducing opportunities to engage in PA (Giles-Corti et al., 2003). Further, low SES has been related to living and working in physically, mentally and emotionally stressful environments. For the UK, Haynes et al. (1997) and Beatty et al. (2005) have shown that adverse labour market conditions are associated with increased rates of long-term illness and permanent sickness. This may eventually reduce the opportunity for a predominantly active lifestyle. It has also been suggested that lifestyles involving recreational PA and other health promoting behaviours are seen as luxury goods and therefore play a minor role for lower occupational classes (Candib, 2007; Smith, 1989).

International studies report that participation in recreational PA is generally lower in manual compared to non-manual workers (e.g. CDC, 2000; Mäkinen et al., 2009). Total PA, however, appears to be relatively similar across race, ethnicity and education subgroups (He et al., 2005). Since industrial restructuring results in a considerable decline in physically demanding jobs there is a need to compensate for the loss of occupational PA by increasing levels of active travel and recreational PA. However, there is little evidence to suggest this occurs.

In England, Stamatakis et al. investigated temporal trends in PA between 1991 and 2004 (Stamatakis et al., 2007), and sports participation between 1997 and 2006 (Stamatakis & Chaudhury, 2008). Although their results indicate a small upwards trend in sports participation, this does not generally contribute sufficiently to the recommended levels of PA, occurs predominantly amongst White adults aged 45+ belonging to non-manual, higher income households, and takes place in gyms and fitness clubs. We believe the absence of evidence for compensatory mechanisms may be associated with the persistence of cultures of non-participation in recreational PA that developed in communities where high levels of occupation PA were once prevalent. Disparities may be amplified as the majority of low income households are unlikely to invest significantly in cost-related PA.

Demography, migration and physical activity

Deindustrialisation often results in downsizing and frequently forces individuals and families to take up work elsewhere. Selective migration consequently impacts the demographic and ethnic composition of areas and can result in depopulation and obsolescence of entire regions (Altena et al., 2002). At the global level, labour migration has increased significantly since the 1980s due to the need of many countries to fill gaps in their labour markets. Within the UK, work-related migration has fluctuated since 1946, with peaks in the 1970s and the early 2000s. Not only does this have an impact on domestic labour markets, but also on the demographic composition of populations, as migrants are usually younger and healthier than the overall population (Sriskandarajah et al., 2004).

In England, there has been a considerable change in the demographic and ethnic composition of the population since 1971. During this period, the population grew by 6.5% (Sly, 2009), gaining a considerable proportion of new residents due to labour migration within an enlarged EU (Kancs, 2010). Currently, the North East has the highest proportion of White British origin, the second oldest population next to the South West, the highest population losses and the slowest growing number of residents over the last 20 years. The North West also has a high proportion of White British residents, recorded high population losses during 1980s and 1990s, but a population growth since

2001, with Yorkshire and Humberside having the fastest growing Asian population (Sly, 2009).

There is evidence that these demographic patterns are reflected in geographical patterns of PA. For example, Ellis et al. (2007) showed that all but one communities exhibiting statistically significantly insufficient levels of PA are located within the North East, the North West, and Yorkshire and the Humber. It has also been shown that levels of PA in South Asian residents are relatively low compared to the general population (Fischbacher et al., 2004).

Despite these observations, some of the most deprived London boroughs and neighbourhoods in Birmingham actually show relatively high levels of PA in comparison to other areas of the cities (Ellis et al., 2007). Since the early 1990s, governmental initiatives, such as the conversion of former industrial and commercial buildings into new attractive properties, have had a considerable impact on demographic as well as socio-economic patterns in these areas. A high proportion of the new population is male, in their 20's, economically active or studying, and of high social status (Bromley et al., 2007), all characteristics associated with a relatively active lifestyle. This provides evidence for how the capacity of retaining residents and attracting new populations is likely to impact positively on an area's health profile (Tunstall et al., 2007). It also illustrates how components of our framework, in this case those associated with policy, can positively impact PA if the pathways allow the development of environments that are conducive to PA.

Family structure and physical activity

Between 1971 and 2001 the proportion of married couples declined by 15%, the proportion of single people increased by 9%, while the proportion divorced rose by 7% in the UK (Office for National Statistics, 2009). Industrial restructuring can impact family structures, change gender relations, family composition and the cohesiveness of consolidated social networks. This has consequences for levels of PA for both sexes. Indicators of changes in family structure also show spatial variations: London and the North West, for example, have the smallest proportion of married couples, and the North West also has the highest proportion of lone-parent households with dependent children (Office for National Statistics, 2003). These patterns may be associated with reported low levels of PA (Ellis et al., 2007).

The mechanisms by which these associations may be generated are complex. Current evidence suggests that major life events such as marriage, having children and divorce can lead to decreases in PA (Allender et al., 2008; Brown et al., 2003). Reductions in PA may result from particular strains on lone-parent households who are more likely to be women, of lower SES, unemployed, work part-time, be less physically and mentally healthy, and also tend to engage more often in high risk behaviours (e.g. smoking, poor diet, low levels of PA) (O'Neill, 2002). With a declining labour market for men, women may also start to more actively contribute to the family income which can impact the traditional division of work between the genders, give women financial independence and invert entrenched power relationships (Joshi, 2002). Nevertheless, there is little indication that this results in higher levels of total PA. Indeed, there is evidence from Australia of PA declines amongst women taking up work (Brown et al., 2003), suggesting that former homemakers do not compensate time lost in domestic activities or childcare with other forms of PA. For men, loss of work results not only in reduced levels of occupational PA, but can also be associated with decreasing authority within the family and neighbourhood. This may adversely impact psychological well-being which, in turn, has been associated with decreased PA (Whitelaw et al., 2008).

Political concerns, area reputation and physical activity

The final dimensions of socio-cultural change encompassed in our framework are related to political concerns and area reputation. Industrial restructuring can influence voting behaviours of individuals which determines the political climate of regions. This may be associated with the structure and provision of health-related resources. Periods of economic decline can adversely affect strategies to promote environmental and social improvements which are in turn related to the reputation of entire areas (Hobbs, 1992).

Few studies have investigated associations between political aspects and health or health-related behaviours. However, there is some national and international evidence that political climate is related to more general aspects of health (Beckfield et al., 2009; Doran et al., 2003; Subramanian et al., 2009) as well as to PA (Cummins et al., 2005). Many associations between the political history of areas and PA are unlikely to be directly causal; yet voting behaviours can act to shape regional political profiles and are themselves strongly shaped by socio-demographic and socio-economic factors which may influence patterns of PA. For example, Thomson et al. (2003) assessed health effects of the closure of a public swimming pool in a deprived area in Glasgow where political restrictions on local council resources meant that insufficient funds were available to maintain the facility. They showed that the closure of the pool was strongly related to adverse health impacts including reduced PA, as well as increased mental health problems linked to the loss of safe activity environments and social space for stress relief.

Social cohesion and social capital play an important role in shaping the reputation of areas. Both have been shown to have a positive effect on health-related behaviours as they contribute to the prevention of neighbourhood social disorder, consolidate trust, contribute to knowledge diffusion about health promotion, and strengthen informal social control (Jen et al., 2010; Kim et al., 2010; Popay et al., 2003). There is some evidence from England that some of the socio-cultural features integrated in our framework are likely to contribute to variations in health and health-related behaviours in areas considerably affected by industrial decline. Outcomes like individual safety fears and crime rates have been used as indicators to measure the effect of area

reputation on PA, and prior studies provide evidence that safety concerns in particular may be a considerable barrier to PA (Harrison et al., 2007). It is noteworthy that areas showing relatively high crime rates (London, Yorkshire and the Humber, the North West and the East Midlands) (Walker et al., 2009; Yu et al., 2011) are also those where levels of PA are relatively low (Ellis et al., 2007).

Finally, the reputation of places is shaped through public opinion and how residents perceive the decline of their neighbourhoods (Popay, 2000). Tunstall et al. (2007) hypothesise that aspects such as a similar history of economic decline, long-cherished community ties and facilities formed in relation to former industries (e.g. Working Men's Clubs), and shared ethnic and religious identities are important aspects of determining a community's level of social cohesion. However, high unemployment, the loss of highly qualified workforce or depopulation undermine these established structures, contribute to social fragmentation, increase economic and social insecurity and stigmatise the reputation of deindustrialised areas (Gourlay, 2007).

Discussion

Whilst prior studies have investigated how components of socio-cultural contexts may relate to broader aspects of health, the novel conceptual framework we present has been developed to facilitate a comprehensive assessment of plausible direct and indirect pathways linking socio-cultural context of industrial restructuring to PA. In particular, our framework aims to provide a conceptual background to identify those risks and protective factors which are not related to socio-economic deprivation alone. We consider how the steep decline of employment in occupations associated with heavy manual work will directly impact overall levels of PA. We also summarise evidence for distinct geographical variations in activity levels which are likely not only to be associated with individual socio-demographic and economic factors, but which are also related to the particular socio-cultural context of industrial restructuring and decline. We suggest it is important to focus on these socio-cultural dimensions to add to the already well-established correlates of PA. We also believe a better understanding of activity levels across populations within a particular socio-cultural context could contribute to

the development of effective PA interventions, and eventually to a decrease in the adverse health consequences of increasingly inactive lifestyles.

The post-industrial political pathways adopted by many affluent countries, including the UK and the USA, have tended to create socio-economically unequal societies, and problems associated with inequality have been found to exhibit distinct social gradients (Government Equalities Office, 2010; Wilkinson et al., 2010). Although this may impact PA across the whole of the society our framework shows how it may be most severe at the lower end of the socio-economic strata where protective mechanisms such as better job opportunities or safer and more trusting environments are less likely to operate. Indeed, Wilkinson and Pickett (2010) have recently described how health differences within societies are rooted primarily in unequal socio-economic conditions. It is notable that Subramanian and Kawachi (2004) report a 10 - 15 year lag between the development of inequalities in income and those in health. In the UK, the processes we have described occurred particularly since the late 1960s and we suggest that they have contributed to the declines in PA observed since.

This review focussed on the UK, but other countries have experienced similar developments. In the USA, for example, the percentage of people employed in farming or other blue-collar jobs decreased by almost 60% between 1870 and 1990 (Sobek, 2006), and overall PA has declined considerably since 1950 (Brownson et al., 2005). Although the major pathways which impact declining levels of PA may be similar across countries experiencing industrial restructuring our framework does focus mainly on western orientated literature. Within radically different socio-cultural settings and histories, the mechanisms through which these pathways impact levels of PA may well have other focal points. Furthermore, we recognise that when obesity is considered, changes in dietary intakes associated with industrial restructuring, such as the movement away from traditional foods and increasing intakes of convenience food (Carrigan et al., 2006), are important. The integration of these broader obesity-related considerations was, however, outside the scope of our framework.

We have shown that there is a plausible link between dimensions of industrial restructuring and PA, but there is currently a lack of empirical research investigating

many of the mechanisms described in this wider context. Hence, we also relied on evidence which was not exclusively specific to PA. Several aspects of our framework could therefore be applied to other health behaviours, a well-discussed general weakness of socio-ecological approaches (e.g. Sallis et al., 2008). However, our framework links all of the evidence discussed clearly to PA and considers relevant previous and current literature for that field. To further explore the processes conceptualised in the framework, it may be of particular interest to consider individual and contextual effects of changes in employment status, type of occupation and different local histories of industrial restructuring. This may be useful to elucidate and link some of the key socio-cultural features that might distinguish areas with different histories of industrial decline, thus helping to shed further light on the question as to why strategies to reduce health inequalities have largely failed to affect health outcomes such as PA (Mackenbach, 2010; Whitehead et al., 2010). There is also potential for reverse-causation in some of the associations observed, whereby prior levels of poor health in deprived areas result in job losses may be driving subsequent low levels of PA. This potential process, known as the "Healthy Worker Effect" (Wen et al., 1983), is well-documented, and it is therefore of future interest to disentangle the causal directions of relationships that have been reported thus far.

To enhance our understanding of causal mechanisms, calls for comprehensive longitudinal data and more longitudinal studies have also been made (Subramanian et al., 2004). Longitudinal datasets such as the *Health Survey for England* (NHS Information Centre, 2011) or the *Active People Survey* (Sport England, 2011) allow the investigation of extending temporal as well as geographical changes in PA across England (e.g. Rind et al., 2011; Stamatakis et al., 2008). Projects such as the *Great Britain Historical GIS* (Southall et al., 2009) also provide detailed longitudinal data on historical changes in employment patterns that will allow conceptual theories to be tested. Qualitative work may further help to obtain a better insight into key causal mechanisms. Hanibuchi et al. (2011) recently suggested that community resources are more associated with broader long-term historical and geographical characteristics of areas than with contemporary features of the built environment. In this context, it may be particularly relevant to focus on intergenerational aspects associated with changes in PA behaviour such as the transformation of traditional family environments.

From a policy perspective, prior research has highlighted the importance of developing complex long-term solutions to improve economic recovery and reduce health inequalities, and the necessity to relate health interventions to particular local issues and needs (Shucksmith et al., 2010). Hence, a better understanding of socio-cultural processes might be particularly helpful for the development of successful interventions to increase levels of PA in areas characterised by industrial decline. Over the last decade, a variety of interventions have been proposed to increase levels of PA in individuals and across populations (Butland et al., 2007; Williams, 2009). However, evidence suggests that the majority of attempts to increase PA amongst the wider population have been unsuccessful, at least based on the limited evaluation work that has been undertaken. Whatever interventions may be proposed in the future, it is important that they are implemented within a political climate that favours their effectiveness and sustainability.

We emphasise that creating accessible and affordable environments which promote PA requires approaches that address both individual behaviours and the context in which people live. The promotion of healthy environments for the whole of the society instead of the expansion of obesogenic environments for those who are most socio-economically disadvantaged remains a major challenge for policy and practice. Nevertheless, our framework suggests that environmental modification alone may not suffice, and that ways will need to be identified to overcome social barriers and attitudes if we are to achieve a more physically active population. We propose a focus on ameliorating the consequences of employment decline in communities that have experienced substantial loses of manual employment may be one fruitful avenue of work. In the remainder of the thesis, proposed pathways and mechanisms of the framework are empirically tested.

Chapter 3

Assessing associations between industrial restructuring and domains of physical activity in England

Introduction

The first empirical chapter of this thesis sets out to investigate how geographical variations in deindustrialisation may be associated with current levels of physical activity across different activity domains and relevant macro-economic time periods in England. With respect to the proposed framework, it is explored how the loss of manual jobs and a subsequent decrease in occupational physical activity over the last centuries may be associated with current levels of physical activity. This understanding could provide new evidence for the hypothesised impact of socio-cultural historical developments on shaping beliefs and attitudes towards physical activity which may influence activity patterns till today.

Background

Achieving a health-promoting weekly energy expenditure from physical activity (PA) of about 1,000 kcal equates to just one hour of moderate walking five days a week (Warburton et al., 2006a). However, in Europe more than 65% of the adult population is insufficiently active, and this has been related to increasing levels of obesity and related diseases such as diabetes, heart disease and several forms of cancer (WHO, 2006). Compared to many other European countries, the proportion of sedentary residents in the UK is relatively high, and the proportion of the population being sufficiently active is low (Sjöström et al., 2006). The average person walks less than a mile per day, and between 1975 and 2009 the average annual walking distance decreased by 68 miles, a decline of 26% (Department for Transport, 2010; Fox et al., 2007).

Recently, Stamatakis et al. (2007) investigated temporal trends in PA in England and showed that levels of occupational PA have decreased significantly between 1991 and 2004. There was a small increase in recreational PA across the country during this period, but this was not pronounced in men from manual social classes, lower income households, and those from non-White ethnic backgrounds (Stamatakis et al., 2008). This is of particular concern given that these groups are the ones who are most vulnerable to the loss of PA from their occupation (Popham et al., 2007).

Using data from the Health Survey for England (HSE) 2003, Allender et al. (2008) showed that occupational activity significantly contributes to overall PA in English adults. Further, the contribution of occupational activity has been shown to be socially patterned, with both men and women in manual occupations being more likely to meet the government's recommended PA guidelines than their non-manual counterparts. Those in manual occupations, however, show lower levels of recreational activity (Kirk et al., 2011).

It has been argued that the lower prevalence of recreational activity in manual classes could persist even after a transition to less physically demanding occupations (Jones et al., 2009), resulting in low levels of overall PA in individuals and communities who have been particularly affected by industrial transitions. Observed decreases in occupational PA in England, along with many other European countries, have been related to industrial decline and technological progress, including processes of automatisation and computerisation. A consequence has been a considerably reduced need for heavy manual work, even in areas where employment in heavy industries has remained relatively high (Bazen et al., 1997). In England, the demand for manual employment has long been in decline and over the last century this has been particularly so in the agricultural sector (-92%), manufacturing (-51%) and the mining industry (-90%) (Southall et al., 2009).

There is overwhelming evidence that health outcomes and health behaviours, including PA, mirror levels of socio-economic deprivation and inequality in ways that cannot be solely explained by the individual characteristics of the population under study (e.g. Cleland et al., 2010; Doran et al., 2004; Krieger, 2001). Doran et al. (2006), for example, showed that mining, manufacturing and other industrial areas had lower life expectancies

than predicted by their level of deprivation. Related to such observations, there is some evidence that processes associated with industrial restructuring may directly impact health and health-related behaviours. For example, Mitchell et al. (2000) investigated the effect of deindustrialisation on self-reported physical health in Great Britain between 1981 and 1991. They found that residents living in areas that were highly dependent on industrial employment and that had experienced high levels of employment decline were more likely to report physical ill-health compared to those where the effects of industrial restructuring were less severe.

In terms of PA, prior research has shown that residents of more northerly and urban districts that have undergone a particular strong transition from industrial to postindustrial economies are more likely to report low levels of PA than their more southerly and rural counterparts (Blaxter, 1990; Ellis et al., 2007; Rind et al., 2011). We have previously suggested that such disparities may be associated with loss of occupation PA that has not been compensated for by increases in other activity domains (Rind et al., 2011).

Industrial restructuring catalysed the transformation of occupational structures, the widening of health inequalities and has been one of the most incisive contextual large scale drivers of social change in modern history. However, there has been rather little research attempting to assess how patterns of industrial restructuring may affect observed variations in the prevalence of PA across the different activity domains. This study has been undertaken to investigate associations between individual and contextual correlates of PA related to the context of industrial restructuring. We hypothesise that levels of PA are likely to be lower in areas where there has been a history of high employment as well as high decline in occupations associated with heavy manual work. We further hypothesise the relationship between industrial restructuring and PA to vary according to macro-economic change. We hope that the outcomes of this study will contribute to a better understanding of where and how factors related to changes in socio-economic conditions affect levels of PA across the different activity domains.

Methods

Data

The primary data sources for this study were the Health Surveys for England (HSE) 2006 and 2008 (NHS Information Centre, 2011), as well as the Great Britain Historical GIS project (Gregory et al., 1998; Southall, 2011). Subsequently, the use of these sources, which provide the outcomes and exposure measures analysed, is described.

Physical activity

The HSE is an annual survey drawn from a nationally representative general population sample that includes data on several indicators of health and health-related behaviours. The full sampling methodology and the derivation of the PA variables is described elsewhere (Craig et al., 2008; Craig et al., 2009). Briefly, a random sample of core addresses are selected from the Postcode Address File and households are sampled proportionately across the nine Government Office regions of England. For the survey conducted in 2006, 14,142 adults aged 16 and over were interviewed at their homes, whilst 15,102 were interviewed for the HSE 2008. All PA measures recorded and used for this study were based on self-report. The HSE samples for 2006 and 2008 include comparable measurements of total, occupational, domestic, recreational, and walking activities, and these two years were combined to provide the outcome dataset for this analysis. For this study, all participants aged 16 and above providing information for the five activity domains were identified, and individual records including information on these self-reported activity measures as well as relevant socio-demographic characteristics of each participant were extracted from both survey years. These records were compiled in a database which was the basis for subsequent statistical analyses.

The outcome variables provided in the HSE dataset covered the frequency and intensity of activity undertaken in five different domains of PA (total PA, walking, occupational, domestic, and recreational PA) based on reported activity spells of at least 30 minutes duration. Total PA in both HSE surveys was measured as the number of days per week of any moderate and vigorous activity. Overall activity levels for each respondent were

categorised as 'less active' (<1 day/week), 'moderately active' (1 to 4 days/week), or 'highly active' (5 or more days/week). Levels of walking activity were classified accordingly based on the reported number of days over the last 4 weeks respondents walked at a fast or brisk pace.

The intensity of reported activities for the other three domains was classified based on MET (metabolic equivalent) intensities categorised by the Compendium of Physical Activities (Ainsworth et al., 2000). One MET is considered a resting metabolic rate obtained during quiet sitting. If respondents did not report any activity of at least 30 minutes duration in a domain they were categorised as 'inactive'. The classification of occupational activity levels included consideration of the respondents' reported working status, perceived intensity levels and the type of occupation according to the Standard Occupational Classification (Office for National Statistics, 1990). For domestic activities, participants were given examples of light, moderate and heavy housework, gardening, and home-improvement activities, and were asked to select those which equated most closely to their own participation. The intensity levels of recreational activities considered the type and perceived effort level. A low or high perceived effort level was defined according to not being or being out of breath during exercise. Based on estimated MET-values, each respondent's activity level is classified as 'light' (< 3 METs), 'moderate' (3-6 METs) or 'vigorous' (> 6 METs) for these three domains in the HSE dataset (Craig et al., 2009). For clarity and comparison with the domains of total PA as well as levels of walking activity, we renamed these original HSE headings into 'non-active, 'less active', 'moderately active' and 'highly active' in this article. In the two surveys utilised, there were only 70 men and 2 women who reported 'high' occupational PA. Hence, these cases were combined with those reporting moderate activities.

Each HSE record included a year 2001 Local Authority District (LAD) of residence identifier. LADs are administrative areas of local government in England, with an average population of 139,000 residents. In 2001, there were 354 English Local Authorities, including non-metropolitan districts, metropolitan districts, unitary authorities and London boroughs (Office for National Statistics, 2001). The HSE excluded any respondents from the City of London (in 2008), the Isles of Scilly and Berwick-upon Tweed (both 2006 and 2008) due to the small residential populations of

these LADs. In England, LADs provide a suitable scale to study variations in health outcomes as they are large enough to provide adequate study power, and can be used to represent labour market attributes such as employment change (Chevan et al., 2000; Mitchell et al., 2000). The LAD identifier allowed the record to be supplemented with area-based data on industrial restructuring from the Great Britain Historical GIS project.

Industrial restructuring

The Great Britain Historical GIS project was instigated to integrate data from a range of surveys in Britain including travel writing, census results and historical maps (Southall, 2007 & 2011). The project aimed not simply to assemble a diverse range of statistical data from the full range of censuses 1841 to 2001, but also to enable comparisons of areas to be made over long periods by re-organising data to standardised reporting areas and topics (Gilbert et al., 2000). Given the wide range of classifications used by the census, standardisation by topic generally means assembling historical categories into simplified aggregate categories (Southall, 2011), and even then caveats are needed, such as miners not being separately identifiable in the 1981 Small Area Statistics.

Standardisation by area involved three distinct strategies. Firstly, 2001 "Key Statistics" were used unchanged, covering Great Britain using 408 districts and unitary authorities. Secondly, for 1971, 1981 and 1991 ward-level Small Area Statistics were assembled into the same 408 LADs using the Linking Censuses through Time system, which assigns all data for a ward to the 2001 LAD containing its geometric centre (Pateman, 2011). Thirdly, for all earlier census dates, geography conversion tables (Simpson, 2002) were constructed using parish-level census population data and detailed parish boundary mapping constructed by the project Geographical Information System (GIS) to estimate what proportion of each historical district's population should be assigned to each 2001 LAD. The geographical standardisation of the historical census data permitted the analysis of spatial change in economic outcomes across different time periods in relation to individual PA outcomes.

For this study we used data comprising, for each LAD in England, long-term trends in employment data for several economic sectors, including manufacturing, mining, and agriculture for the period 1841 to 2001 (Southall et al., 2009). Following a similar

methodology to that applied by Mitchell et al. (2000) in their analysis of industrial change and self-rated health, we developed a suite of variables representing industrial restructuring. Prior research has shown that occupation characteristics have relatively strong associations with PA (Kirk et al., 2011). Therefore, our measures were based on employment change in employment types associated with heavy manual work. Employment in manufacturing, mining and agriculture was selected as PA from these activities is likely to have moderate to vigorous intensities; the average intensity of agricultural activities is 4.3 METs, that of coal mining is 6.5 METs, and work intensities related to the manufacturing sector, such as working in a steel mill, have 7.3 METs (Ainsworth et al., 2000).

To investigate whether different macro-economic periods have a different relationship with current levels of PA we chose three different time periods to measure changes in employment. The first period, 1841 to 2001, encompassed employment change in each sector over the whole timescale for which data was available. For employment in manufacturing and mining the years from 1841 - 1971 capture employment change prior to severe industrial decline, including the closure of most of England's coal mines in the 1980s, whilst for agricultural employment that transition occurred earlier (Castells et al., 1994). Hence, the second time period covered 1841-1971 for manufacturing and mining, with 1971 - 2001 comprising the third. For agriculture the second period was 1841 – 1931, and the third 1931 - 2001.

Across all three employment sectors, the measurements of industrial restructuring used in analysis combined the level of initial employment, defined as the percentage of the LAD population employed in each of the three employment types at a particular year, with the level of subsequent employment change. As may be expected, for most LADs, employment change in manufacturing, mining and agriculture was dominated by decline. There were, however, some areas of growth. For manufacturing (1971 – 2001) growth was recorded for just 6 LADs, containing a total of 296 HSE respondents and for agriculture (1931 – 2001) there were 384 HSE respondents in 5 LADs. For all other measurements of industrial restructuring, the number of respondents in areas of growth ranged from 870 in 16 LADs (mining 1841 – 2001) to 18,285 in 251 LADs (manufacturing 1841 – 1971).

For the purposes of analysis, we classified each LAD using a 5-category variable for each employment type: 'high initial employment/high decline', 'high initial employment/low decline', 'low initial employment/high decline', 'low initial employment/low decline', and 'growth'. 'High' or 'low' initial employment was defined according to whether each LAD was above or below the median initial employment level for each period. Employment change was measured by calculating the percentage change during each time period, and again 'high decline' and 'low decline' were based on whether a LAD fell above or below the median. The resulting values were mapped using the ArcGIS 9.3 Geographical Information System (ESRI Inc.).

Individual covariates

Information on a range of individual covariates that may be associated with PA (Gidlow et al., 2006; Trost et al., 2002) were available from the HSE and those included in the analyses were age in years, gender, ethnicity (White vs. non-White), presence of long-term limiting illness (yes vs. no), and self-assessed general health (very good/good vs. fair vs. bad/very bad).

Analysis

Rank correlation [Spearman's rho (ρ)] was used to explore associations between levels of total PA and the other activity domains. Including a measure of effect direction (gamma coefficient), we calculated Pearson's Chi-square tests to test unadjusted associations between levels of PA and the magnitude of employment change in each sector. Results were stratified by gender as it was anticipated that employment decline in heavy manual work may have a stronger effect on men than on women.

To investigate the relationship between PA and industrial restructuring, we fitted multilevel ordinal regression models. Ordered proportional odds models applying a logit link function were used since this procedure allows the derivation of interpretable odds ratios (Garson, 2009). The coding of the outcome variables was ascending (e.g. total PA: 1 = low, 2 = medium, 3 = high), so we modelled the log odds of low PA versus medium and high PA.

The modelling procedure comprised two steps. For each of the five PA outcomes, the first model included the full suite of individual covariates and in the next stage we added our measurement of industrial restructuring for each employment type at each of the three time periods. Although energy expenditure from employment differs by sex, the fitting of the interaction terms in the regression models showed no consistent differences in association by gender, and therefore the models were not stratified by sex. In null models, where no explanatory variables were added, there was a statistically significant variation in outcomes between LADs at the $p < 0.05$ level. Therefore, the models were fitted using a 2-level multilevel structure of individuals (level 1) nested within LADs (level 2). All regression models were fitted in MLwiN 2.23 (Rasbash et al., 2011), whilst other analyses were undertaken in SPSS version 16 (SPSS Inc).

Results

In total, the records of 29,244 respondents to the 2006 and 2008 HSE were obtained. Of these, 1,830 (6.3%) were excluded due to missing data on one or more domains of PA. Hence, the final sample analysed included 27,414 adults. Of the included sample, 45% were male (compared to 49% in the mid-year 2007 population estimates for England (Office for National Statistics, 2010), 27% were aged under 35 (compared to 24%), and 18% were aged over 64 (compared to 19%). Some 90% (compared to 88%) gave their ethnic origin as White. In total, 24% reported some limiting long-term illness, and 75% reported their health as 'very good' or 'good'. Just 7% reported their health as 'poor'.

Table 1 summarises the PA and individual characteristics of the included sample.

Table 1

Health Survey for England 2006 and 2008 – descriptive statistics for the physical activity outcomes

		men		women	
		n = 12,255		n = 15,159	
Outcome variables		**n**	**%**	**n**	**%**
Total physical activity	less active	3,767	30.7	5,537	36.5
	moderately active	3,632	29.6	5,102	33.7
	highly active	4,856	39.6	4,520	29.8
Occupational activity	non-active	7,209	58.8	10,275	67.8
	less active	2,722	22.2	3,221	21.2
	moderately active	2,324	19.0	1,663	11.0
Domestic activity	non-active	3,541	28.9	4,401	29.0
	less active	1,503	12.3	1,074	7.1
	moderately active	7,211	58.8	9,684	63.9
Recreational activity	non-active	5,841	47.7	8,259	54.5
	less active	615	5.0	833	5.5
	moderately active	1,403	11.4	2,234	14.7
	highly active	4,396	35.9	3,833	25.3
Walking activity	less active	8,820	72.0	11,407	75.2
	moderately active	1,682	13.7	1,722	11.4
	highly active	1,753	14.3	2,030	13.4

All of the PA domains were positively associated with each other. For men, levels of total PA showed the strongest association with levels of walking (ρ = .514), followed by

occupational (ρ = .434), recreational (ρ = .380) and domestic activities (ρ = .301). For women, levels of total PA also had the strongest association with levels of walking (ρ = .585), followed by domestic (ρ = .397), recreational (ρ = .387) and occupational activities (ρ = .324) (all $p < 0.01$).

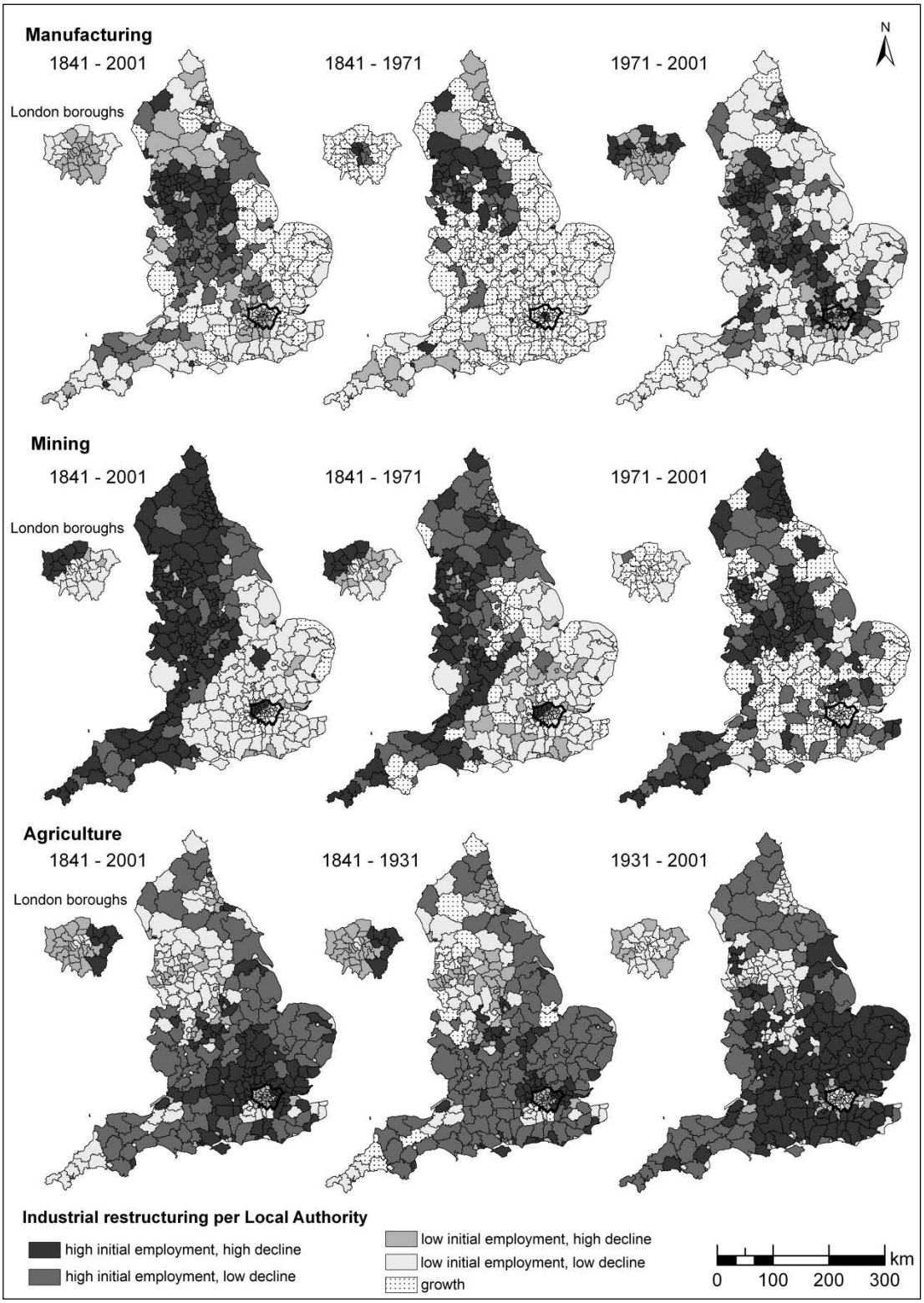
Table 2 shows changes in employment across the time periods studied. There was an overall decline for all sectors and across all time periods, except for manufacturing between 1841 and 1971 which reflects the growth in prosperity between the 1950s and early 1970s.

Table 2

Initial employment and employment change in manufacturing, mining and agriculture, England 1841 - 2001

Employment type	Year (baseline)	% employment in baseline year	Period of change	% change
Manufacturing	1841	31.6	1841 - 2001	-50.6
	1971	35.0	1841 - 1971	10.8
	2001	15.6	1971 - 2001	-55.4
Mining	1841	3.1	1841 - 2001	-90.3
	1971	1.5	1841 - 1971	-51.6
	2001	0.3	1971 - 2001	-80.0
Agriculture	1841	20.7	1841 - 2001	-92.3
	1931	6.8	1841 - 1931	-67.1
	2001	1.6	1931 - 2001	-76.5

Figure 1 maps the derived measures of industrial restructuring. Across all time periods, areas with high initial employment in manufacturing and high declines in this sector are particularly concentrated in the North West and partly in the Midlands regions. High initial employment and high decline in mining was particularly prominent in the North, and partly in the Midlands and the South West. Agricultural employment particularly declined in more southerly districts.



Data source: Statistical Atlas - Great Britain Historical GIS project, 1841 – 2001

Figure 1

The spatial distribution of industrial restructuring across English Local Authorities, 1841 – 2001

Table 3 summarises the direction of effect of unadjusted associations between individual levels of PA and employment change per district. Most associations indicated lower levels of PA to be associated with higher employment decline, with the majority of the results being statistically significant for domestic and recreational PA. Contrary to expectations, there was little evidence of the strength or direction of relationships differing by gender.

Table 3

Direction of associations between levels of physical activity and industrial restructuring across English Local Authorities

		Results of the Pearson Chi-square tests (X^2-value, level of significance, direction of effect [γ]†)				
		Physical activity domain				
Period of employment	**sex**	**total**	**occupational**	**domestic**	**recreational**	**walking**
% change in manufacturing employment						
1841 - 2001	male	7.8 +	22.0** -	32.6** -	21.9** +	15.0** +
	female	1.9 -	5.5 -	30.6** -	14.9* -	2.3 +
1841 - 1971	male	5.7 +	2.8 -	11.2* -	5.0 -	10.7* +
	female	2.1 -	1.9 -	11.7* +	7.7 -	8.3 +
1971 - 2001	male	7.6 -	13.4** -	79.0** -	35.8** +	5.3 -
	female	4.5 -	14.0** -	37.5** -	26.6** -	2.3 +
% change in mining employment						
1841 - 2001	male	14.3** -	2.1 -	9.4 -	34.4** -	21.1** -
	female	20.8** -	5.3 -	5.3 +	76.6** -	27.8** -
1841 - 1971	male	4.8 -	12.3* -	30.2** -	10.2 +	2.5 +
	female	1.4 -	9.1 -	18.9** -	8.0 -	5.7 -
1971 - 2001	male	3.1 -	5.6 +	13.0* +	30.8** -	10.5* -
	female	11.0* -	4.4 -	17.1** +	10.3 -	18.9** -
% change in agricultural employment						
1841 - 2001	male	0.5 -	0.5 -	10.6** -	14.2** +	2.3 -
	female	2.3 -	<0.1 -	2.2 -	9.6* -	3.3 -
1841 - 1931	male	12.1* -	5.9 -	61.3** -	20.5** +	9.5* -
	female	9.3 -	3.7 -	42.0** -	50.8** -	8.1 -
1931 - 2001	male	12.4* +	3.1 -	76.9** +	27.6** +	14.9** +
	female	18.8** +	3.4 +	55.6** +	43.7** +	19.2** +

†Pearson chi-square: $**p < .01$, $*p < .05$;

direction of the gamma coefficient: - indicates lower physical activity associated with higher employment decline; + indicates higher physical activity associated with higher employment decline.

In regression modelling, all of the individual covariates showed associations with the PA outcomes, with PA being lower amongst older participants, women (except for domestic PA), non-White ethnicities, those reporting limiting long-term illness, and those assessing their health as either 'bad or very bad' or 'poor' compared to good. After adjustment for these covariates, the associations with industrial restructuring from the regression models are presented in Table 4.

Table 4

Summary of odds ratios from multilevel ordinal regression predicting low physical activity[†] for five physical activity domains by types and periods of industrial restructuring

	Total physical activity			Occupational physical activity			Domestic physical activity			Recreational physical activity			Walking activity		
Odds ratio (OR)[‡]	OR (n = 27,414)			OR (n = 27,414)			OR (n = 27,414)			OR (n = 27,414)			OR (n = 27,414)		
	Time period														
Manufacturing[¥]	**1841-2001**	**1841-1971**	**1971-2001**	**1841-2001**	**1841-1971**	**1971-2001**	**1841-2001**	**1841-1971**	**1971-2001**	**1841-2001**	**1841-1971**	**1971-2001**	**1841-2001**	**1841-1971**	**1971-2001**
high initial employment, high decline	1.12*	0.96	1.13	1.16*	1.09	1.25	1.09	1.03	1.07	1.13	1.08	1.04	1.07	0.89	1.07
high initial employment, low decline	1.08	1.09*	1.07	1.13	1.09	1.03	1.01	1.02	0.90	1.00	1.14*	1.08	1.05	1.04	1.09
low initial employment, high decline	0.98	0.81*	0.99	1.35**	0.91	1.37	1.25**	0.91	1.19	0.87*	0.87	0.84	0.76**	0.61**	0.83
low initial employment, low decline	0.99	0.84*	0.95	1.15*	0.87	1.04	1.22**	0.82	0.95	0.90	0.97	0.91	0.88*	0.87	0.93
Mining[¥]															
high initial employment, high decline	1.13	1.07	1.03	0.87	0.99	0.92	0.87	1.09	0.87**	1.49**	1.10	1.17**	1.19	1.03	1.17**
high initial employment, low decline	1.04	1.07	1.00	0.84	0.91	1.02	0.79*	1.05	0.94	1.32*	1.17*	0.91	1.09	1.10	1.04
low initial employment, high decline	1.10	1.03	nd	0.94	1.04	nd	0.89	1.17*	nd	1.53**	1.05	nd	1.13	0.94	nd
low initial employment, low decline	1.04	1.00	1.04	0.88	0.94	0.94	0.96	1.18**	1.05	1.25*	0.95	1.07	1.04	0.98	1.09
	Time period														
Agriculture[¥]	**1841-2001**	**1841-1931**	**1931-2001**	**1841-2001**	**1841-1931**	**1931-2001**	**1841-2001**	**1841-1931**	**1931-2001**	**1841-2001**	**1841-1931**	**1931-2001**	**1841-2001**	**1841-1931**	**1931-2001**
high initial employment, high decline	1.02	1.07	0.95	0.95	0.95	0.70*	1.00	1.14	0.63**	0.93	0.99	0.77	1.11	1.12	1.40*
high initial employment, low decline	0.93	1.06	0.83	0.87*	0.92	0.55**	0.90	1.07	0.52**	0.97	0.92	0.77	1.09	1.07	1.30
low initial employment, high decline	1.05	1.13	0.97	1.05	1.05	0.73*	1.07	1.17	0.68*	1.03	1.08	0.76	1.06	1.06	1.30
low initial employment, low decline	baseline	1.03	1.03	baseline	0.97	0.73*	baseline	1.12	0.67**	baseline	0.92	0.93	baseline	0.95	1.44*

[†]Coding for the outcome variables:

Total physical activity and walking activity: 1 = less active, 2 = moderately active, 3 = highly active; occupational and domestic activity: 1 = non-active, 2 = less active, 3 = moderately active; recreational activity (sport): 1 = non-active, 2 = less active, 3 = moderately active, 4 = highly active.

[‡]$^{**}p < 0.01, ^{*}p < 0.05$.

[¥]Baseline: employment growth; exception: models "Agriculture 1841 – 2001": low initial employment, low decline as basline since there were no areas of growth; nd = no districts observed in cell.

Although many of the associations did not reach statistical significance, Table 4 shows that in comparison to areas of growth, there were generally higher odds for lower total PA in LADs with high initial employment, followed by employment declines in manufacturing and mining. In areas characterised by declines in manufacturing employment, residents were generally more likely to report lower levels of occupational PA for all time periods, irrespective of whether initial employment was high or low. There were few associations between occupational PA and change in mining employment, whilst participants living in areas with declines in agricultural employment between 1931 and 2001 were actually less likely to report lower levels of occupational PA. The odds of reporting lower domestic activity were generally increased for participants in areas with employment decline in the manufacturing sector between 1841 and 2001, and across the manufacturing as well as the mining sector between 1841 and 1971. Participants living in areas with declines in agricultural employment between 1931 and 2001 were however significantly less likely to report lower levels of domestic activity.

For the recreational PA and walking domains, declines coupled with high initial employment in manufacturing were associated with higher odds of reporting lower PA. Again for both domains, respondents living in areas where employment in mining had declined were more likely to report lower PA, with this association particularly strong for recreational activity and employment change between 1841 and 2001. In comparison to areas of growth, residents of districts characterised by agricultural employment decline showed predominantly reduced odds for reporting lower recreational activity, but increased odds for reporting lower walking activity. Many of these associations were, however, not statistically significant.

Discussion

To our knowledge this is the first study linking different activity domains from a large national health survey to the historical context of industrial restructuring. Although, partly as a result of the number of tests we undertook, our findings were somewhat equivocal, they provide some evidence that a history of industrial decline in an area may be associated with lower levels of PA. In particular, residents of districts characterised by high employment in the manufacturing sector during the period of strong industrialisation in the mid-19th century were more likely to report lower PA across all five activity domains and over the time periods studied. Declining mining employment was generally associated with a decreased likelihood of high total, recreational and walking activity. Residents in areas of agricultural decline were particularly prone to reporting lower walking activity.

Since all of the PA domains were positively related with each other, our findings suggested that there was no evidence of a compensatory effect between the different types of PA. We also found the nature of the relationships to be generally similar for men and women. This is interesting insofar as the decline in occupational PA associated with heavy manual work primarily concerns men. Perhaps living in an area with an industrial heritage may promote non-active behaviours for the whole of the population, and factors related to the socio-cultural history of areas may shape beliefs and attitudes towards PA. Certainly social and cultural backgrounds of individuals and families are known to establish PA related norms and role models which affect social environments of communities as well as those of entire areas (Berger et al., 2009; Fischbacher et al., 2004). Furthermore, widening socio-economic inequalities and unequal opportunities may promote the development of environments which increasingly hamper sufficiently active lifestyles. Although declining levels of PA and their adverse effects on health are found across the whole of the society, they become more common at the lower end of the socio-economic strata because here protective factors such as better job opportunities and living conditions are less obtainable for both men and women (Ball et al., 2010; Wilkinson et al., 2010).

This study has a number of strengths and weaknesses. Strengths include the large, nationally representative and geographically heterogeneous samples of the HSE (Craig et

al., 2008; Craig et al., 2009), and the fact that the HSE includes information on five key domains of PA. Since our health outcome was measured across multiple domains and related to different macro-economic time periods we were also able to extend earlier work on the impact of industrial restructuring on population health (Mitchell et al., 2000). In particular the availability of data from the Great Britain Historical GIS project allowed us to analyse population census data collected over a period of a century and a half, yet standardised to a set of modern day units.

In terms of weaknesses, our outcome variables did not include information on changes in levels of PA over time. The information on the PA outcomes is largely based on self-report and several assumptions underlying the intensity level classification which make the outcomes susceptible to error (Adams et al., 2005). As the study sample generally compared well to the general population, we decided not to impute the missing values. The data did not provide specific information on incomplete responses, and imputation could have resulted in biasing the confidence intervals around the estimate (Vogl et al., 2012). Furthermore, all PA measures collected in the HSE considered only bouts of at least 30 minutes' duration, which will have resulted in an underestimation of activity for respondents who undertook many shorter activities. Most transport-related walks, for example, do not amount to 30 minutes; yet even 10 minutes of activity have beneficial effects for health (Warburton et al., 2006b). Research from Canada provides evidence that walking to transit can account for 25% of the recommended volume of PA per day (Morency et al., 2011).

In comparison to White ethnicities, non-White respondents are known to be more likely to report lower levels of PA (Fischbacher et al., 2004; Trost et al., 2002). Although the focus of this analysis was on variations of PA in relation to employment change over historical time periods, it would have been interesting to further investigate associations between PA and the diversity of different ethnic groups. This would have resulted in a more differentiated picture of who may be most likely to report relatively low PA across the study sample. Due to the relatively small number of non-White respondents it was, however, not possible to stratify the analysis for ethnicity or consider a different categorisation of ethnicities than the dichotomised variable (White/non-White) included. We therefore decided to adjust our analysis for ethnicity which allowed the inclusion of a more comprehensive and larger study sample.

One limitation of the data provided by the Great Britain Historical GIS project is that the standardisation of economic data covering a period of 160 years required the matching of different occupational classifications which resulted in relatively simple categorisation of the employment sectors. Further, estimates of employment change in several LADs in the 1960s were most likely severely understated due to the conversion of population counts between different geographical units, and mining did not exist as a separate category in the 1981 census. Both factors meant we were not able to look at change for time points in the decade before and after 1971. Since the data we analysed did not comprise information on unemployment rates across the three sectors of interest, we did not consider issues related to the potential impact of hidden unemployment (Beatty et al., 1996). For example, it has been argued that pre-1997 governments were using incapacity benefits to exclude former miners from the unemployment total (Beatty et al., 1996; Haynes et al., 1997), even though many may have been healthy enough to undertake light industrial work. It would have been interesting to explore whether the relationship between unemployment rates, incapacity benefits, and PA show comparable associations to those reported here.

Our modelling approach involved many comparisons and is therefore susceptible to the problems of multiple hypotheses testing where the probability of detecting statistically significant false positive or negative effects increases with each additional test (Shaffer, 1995). Furthermore, we chose not to include a measure of respondent occupational social class or income in our regression models. When we tested our models for the effects of adding a measure of individual income, some of the associations observed with our area-based measures were attenuated. However, income was also statistically significantly associated with all our area-based measures representing industrial restructuring ($p < 0.01$). Due to the cross-sectional nature of our outcome variable, it was not possible to determine if the causal mechanisms underlying the associations with industrial change that we have observed may be mediated by present-day socio-economic circumstances, but the theory underlying our analysis did not require this. Hence, we did not attempt to adjust for individual socio-economic position here.

This study focuses on England, and the results may not be applicable to other settings. However, the country provides a good case study as activity levels are relatively low and processes of deindustrialisation have been particularly pronounced (Bazen et al., 1997;

Sjöström et al., 2006). It is well known that other countries have experienced a similar history of declining levels of PA and industrial decline (Brownson et al., 2005; Muntner et al., 2005; Sobek, 2006), and replication of our analysis in these other settings is required.

In line with prior research we conclude that industrial restructuring may be an important factor in explaining inequalities in health and health-related behaviours such as PA, and that there is some evidence that processes of deindustrialisation may be contributing to observed disparities in PA. In our framework, we hypothesised a direct relationship between current levels of PA and industrial restructuring. With respect to our results, we conclude that there is some evidence that patterns of industrial restructuring, such as a decrease in occupational physical activity, are likely to be associated with current levels of PA, but that differs across the PA domains included in this analysis. However, our research cannot determine what the mechanisms leading to this observation may be. We suggest qualitative research may help to deepen our understanding of ways by which local physical, social, cultural, political and economic conditions shaped by a history of industrial decline may influence PA behaviours. This work should focus on socio-cultural factors relevant in the context of industrial restructuring as this may facilitate the development of effective interventions to increase population levels of PA in areas with an industrial heritage.

Chapter 4

The geography of recreational physical activity in England

Introduction

The previous chapter provided evidence for associations between patterns of industrial restructuring and physical activity, but the relationships varied across different activity domains. Recreational physical activity is an important domain of physical activity providing opportunities to counterbalance the decrease in overall physical activity (Stamatakis et al., 2007). Walking has been shown to be a particularly health beneficial activity for large parts of the population (Andrews et al., 2012). Therefore, this chapter sets out to develop a direct measure of recreational physical activity and investigates variations in activity patterns across English Local Authorities. With respect to the proposed framework, this chapter will provide an detailed description and analysis of where current levels of recreational physical activity and walking are particularly high or low.

Background

A physical activity related energy expenditure of 1000 kcal per week has been linked with a fall in all-cause mortality risk of approximately 30% (Kesaniemi et al., 2001) and is associated with a reduction in the incidence of diseases such as coronary heart disease and type 2 diabetes (Department of Health, 2004). In England, however, there is evidence that average levels of energy expenditure from physical activity (PA) have declined in recent decades by as much as 800 kcal/day (James, 1995). For example, the mean distance walked has fallen by approximately 26% and that cycled by 24%, whilst employment in manual occupations involving heavy PA has reduced considerably (Butland et al., 2007). A decline in overall PA is one reason behind an increasing

prevalence of obesity, which rose by approximately 10% in adults between 1993 and 2007 (The Health and Social Care Information Centre, 2008).

Studies of the geography of health outcomes can provide new evidence on the role of population demographics as well as on aspects of the physical and social environment as drivers of health-related behaviours. Prior conceptual work has shown that spatial variations in health outcomes result from compositional, contextual, and collective effects (Macintyre et al., 2002). Compositional effects refer to characteristics of individuals in particular areas and comprise, for example, individual demographic characteristics or individual-level socio-economic status. These factors have been linked to activity patterns. For example, men are generally more active than women (Livingstone et al., 2001, 2003), and there is a distinct gradient in levels of PA across the socio-economic strata (Gidlow et al., 2006). In contrast to compositional effects, contextual effects refer to characteristics of places where people live and work. For example, attributes such as safety or attractiveness of green spaces have been associated with activity patterns, independent of compositional effects (Trost et al., 2002; Wendel-Vos et al., 2007). Collective effects comprise factors that are concerned with social, cultural, and historical features of places. For example, various studies have shown that cultural background impacts attitudes towards exercise behaviours and affects levels of PA (Fischbacher et al., 2004; Mavoa et al., 2008; Sarrafzadegan et al., 2008). Therefore, collective factors offer an additional perspective on the socio-economic, psychological, and epidemiological angles of the exploration of area effects on health and health-related behaviours (Macintyre et al., 2002).

Although individual and area characteristics have been linked to activity patterns, studies on geographical variations in PA over large areas are scarce. There is some evidence from the US that regional differences in activity and inactivity patterns might be related to urban and rural settings, respectively (Martin et al., 2005). Earlier work from the UK suggested that levels of unfitness, based on BMI, blood pressure, and respiratory function, were high in the West and the Midlands compared to the South and East (Blaxter, 1990). But to our knowledge there is only one recent study of the geography of PA in England. Ellis et al. (2007) investigated variations in activity levels across just 39 deprived towns and cities, highlighting low levels of PA, particularly amongst residents of more northern industrialised towns. Their findings suggested that inequalities related

to social, economic, historical, and physical environments remained an important public health issue with respect to PA.

With the publication of the Black Report in 1980 by the former UK Department of Health and Social Security (1980), spatial disparities in health obtained a widely accepted political platform. The report emphasised that inequalities in health were both persistent and widening, in particular for those at the lower end of the socio-economic ladder living in the northern regions of England. Similar gradients have subsequently been shown for other countries including Germany (Voigtländer et al., 2010) and Italy (Mangano, 2010). Thirty years after the publication of the Black Report, the message has lost none of its topicality; Wilkinson and Pickett (2010) recently described significant inter- and intranational differences in 23 of the richest countries in the world for obesity and weight-related behaviours.

Due to the paucity of comprehensive datasets on health and health-related behaviours, research investigating health disparities frequently depends on the production of synthetic estimates when patterns are being analysed for small geographical units of analysis. Synthetic estimates have been produced and validated for a variety of health behaviours and outcomes including the prevalence of smoking, fruit and vegetable intake, drinking, diabetes, and obesity (Moon et al., 2007; Scarborough et al., 2009; Scholes et al., 2007; Twigg et al., 2000). Based on the Health Survey for England, Dibben et al. (2004) produced two sets of synthetic estimates of physical inactivity (proportion doing under 5h of PA per week) for English Local Authority Districts for the years 2001 and 2003. The results show distinct variations between some of the districts, partly differing for males and females (maps available from British Hearth Foundation, 2008).

Synthetic estimates of health and health-related behaviours appear attractive for small area analyses by facilitating the comparison of particular localities with national averages. Indeed, it has been shown that synthetic estimates can be more accurate than underpowered national survey estimates (EURAREA Consortium, 2004). However, limitations of synthetic estimation include the fact that they are based on deterministic model outputs rather than objective measurements in local areas. Therefore, they are solely a function of the population prevalence of those characteristics used to estimate

them. This is limiting as it is often the areas that do not conform to expectations from population demographics that are interesting from a research perspective. A related limitation is that it is not possible to further separate estimates for specific population subgroups, and confidence intervals surrounding the estimates can be wide, hindering geographical comparisons (Scholes et al., 2007). Scarborough et al. (2009) recently highlighted problems with the estimates of Dibben et al. (2004) related to model misspecification and invalid predictive validity due to the statistical dominance of age and sex. The authors concluded that public health policy and health interventions should not be based on results derived from these estimates.

Whilst the development of synthetic estimates for small geographical units can be useful if there are no other robust data available, the use of original measurements provides the possibility to understand actual patterns of health and health-related behaviours for local areas. In England, Local Authority Districts provide a suitable scale for comparison of health behaviours and outcomes as they are large enough to provide adequate study power (mean population per local authority in 2001: 138,810) (Office for National Statistics, 2001), but relatively environmentally homogeneous due to the fact that they do not mix large urban and rural areas within their boundaries. A number of studies executed at this scale have provided new insights into the aetiology of a range of health outcomes (Jones et al., 2008; Jones and Bentham, 1997, 2009; McLeod et al., 2000).

Recently, outputs from the Sport England Active People Survey (APS) have become available at the Local Authority District scale in England (Sport England, 2011). The sample size of the APS is large, with over 350,000 responses from adults. For the first time, this provides the potential for the development of a set of comprehensive measures of geographical variations in PA covering the whole of England that are not based on synthetic estimates. Using data from the 2006 APS, this study has thus been undertaken to provide new evidence on geographical variations in PA and associated energy expenditure, with a focus on that undertaken for recreation.

Methods

Developing a measure of physical activity

Our measures of PA were based on data from the 2006 APS, a telephone survey of 363,724 adults (aged 16 to 85+) commissioned by Sport England and conducted between 2005 and 2006 across 354 English Local Authorities (Ipsos Mori, 2006). To achieve a nationally representative sample Random Digit Dialling was used with one respondent randomly selected from the eligible household members. On average, 250 telephone interviews were conducted with the residents of each Local Authority in each quarter of the study period.

The APS provided information on the frequency and duration of self-reported recreational PA and the number of days respondents walked at moderate intensity for 30 minutes or more within the 28 days preceding the interview. Those reporting walking were asked on how many of those days they were walking particularly for the purpose of health or recreation. No information was collected on occupational PA. APS participants were excluded from our study when they failed to provide full enough information for their PA to be determined, or when they reported over 16 hours of mean daily activity (Howley, 2001; Masse et al., 2005).

The primary PA measure was energy expenditure. The intensity level of a particular activity can be defined as the rate of energy expenditure related to body mass, expressed as metabolic rate. The resting metabolic rate equals an energy expenditure of approximately 1 kcal/kg/h. Metabolic equivalents (METs) are multiples of the resting metabolic rate, and for adults METs can be taken as numerical equivalents to energy expenditure (Howley, 2001; Masse et al., 2005).

In order to calculate a measure of energy expenditure for each participant, the Compendium of Physical Activities was used (Ainsworth et al., 2000). It provides look-up tables for activities according to their respective MET intensity level, with a range of 0.9 METs (sleeping) to 18 METs (running at 10.9 mph). The appropriate MET-level provided by the Compendium of Physical Activities was assigned to each of the 237 activities mentioned by participants in the APS. In rare cases where particular activities

were not listed in the Compendium of Physical Activities, the MET-level of a similarly patterned activity was assigned. In a few cases (e.g. for ‘‘modern pentathlon’’) it was necessary to calculate the median of several activities involved (pistol shooting, fencing, freestyle swimming, horse-jumping, cross-country run). The PA measure generated, expressed as MET-min/week, is based on the methodology applied by Ball et al. (2003):

MET-min/week = $\sum$ (number of days undertaken the activity x time per session x MET-level of activity).

From this, an additional measure of more sedentary behaviour, an identifier of non-active respondents, was assigned to those who reported no PA (MET-min/week = 0).

Analysing geographical patterns

To investigate the geography of PA in England, the indicator of the Local Authority within which each APS respondent resided was used to compute directly age-standardised average MET-min/week (standard population: English adults aged 16 to 85+ (Office for National Statistics, 2001)), as well as rates of non-activity. As there is considerable evidence that levels of PA differ between men and women (Livingstone et al., 2001, 2003) analyses were stratified by sex. Maps were produced across Local Authorities for total PA energy expenditure, which were associated with walking, and for rates of non-activity. To explore the existence of spatial clustering in the mapped outputs, Moran’s I statistics were calculated.

To provide context to the observed geographical patterns, the Government Office Region in which each Local Authority fell was identified. In addition, the urban–rural status of each Local Authority was ascertained using a published classification (Defra, 2005), as was whether the Local Authority fell in the North or South of England (Scarborough et al., 2008). Differences in the ranking of outcomes by these categorisations were tested using Kruskal–Wallis tests (Monte Carlo method) and the highest and lowest scoring Local Authorities were identified. Preliminary analysis showed that walking prevalence was particularly high in London boroughs, so these were treated as a third category in the tests. Due to the small number of interviews (< 200) obtained in each, the Isles of Scilly and the City of London were excluded from analysis. All analyses were undertaken in SPSS 16.0.

Results

From the original dataset, 3401 (<1%) individuals were excluded either due to incomplete questionnaires (3380) or reporting >16 hours/day PA (21), leaving 360323 participants. Table 1 summarises the PA characteristics of the included sample, of which 42% were male (compared to 48% in the 2001 Census in England), 24% were aged under 35 (compared to 32%), and 20% were aged over 64 (compared to 19%). Some 93% (compared to 92%) of participants gave their ethnic origin as White.

Table 1
Active People Survey 1 – descriptive statistics for the physical activity outcomes.
Data source: Sport England, Active People Survey 1, 2005 - 2006

	Total		**Males**		**Females**	
	Frequency	**%**	**Frequency**	**%**	**Frequency**	**%**
Total physical activity (PA)[a]						
Inactive respondents (PA = 0 MET-min/week)	154 649	42.9	57 429	38.4	97 220	46.2
Active respondents (PA > 0 MET-min/week)	205 674	57.1	92 296	61.6	113 378	53.8
Respondents excercising ≥ 675 MET-min/week[b]	104 270	28.9	52 741	35.2	51 529	24.5
Walking (W)						
Non-walkers (W = 0 MET-min/week)[c]	261 657	72.6	106 349	71.0	155 308	73.7
Walkers (W > 0 MET-min/week)	98 666	27.4	43 376	29.0	55 290	26.3
recreational walkers	*72 823*	*73.8*	*30 557*	*70.4*	*42 266*	*76.4*
non-recreational walkers	*47 811*	*48.5*	*22 225*	*51.2*	*25 586*	*46.3*

[a]Including recreational activities and non-recreational walks at a moderate pace ≥ 30 minutes.
[b]Government recommendation for moderate physical activity = 4.5 METs x 30 minutes x 5 days.
[c]No walking at moderate pace in 5 days ≥ 30 minutes.

The mean total PA energy expenditure reported for men was 839 MET-min/week (750 excluding walking) and for women 483 MET-min/week (394 excluding walking). The mean total energy expenditure for indoor swimming was 70 MET-min/week (13% of the respondents), 178 MET-min/week for going to the gym (10% of the respondents), and for recreational cycling 41 MET-min/week (8% of the respondents). Mean total walking-associated energy expenditure was 89 MET-min/week for both men and women, whilst that for recreational walking was 53 MET-min/week for men and 58 MET-min/week for women. The mean ratio of reported PA energy expenditure, excluding walking, to overall walking was 8.1 for men and 4.6 for women.

Figure 1 maps between-district variations in total physical activity energy expenditure across England. There is evidence of a general trend of higher physical activity in more southerly districts. Spatial clustering in the mapped pattern is low but statistically significant for both males (Moran's I = 0.06, $p < 0.01$) and females (Moran's I = 0.07, $p < 0.01$).

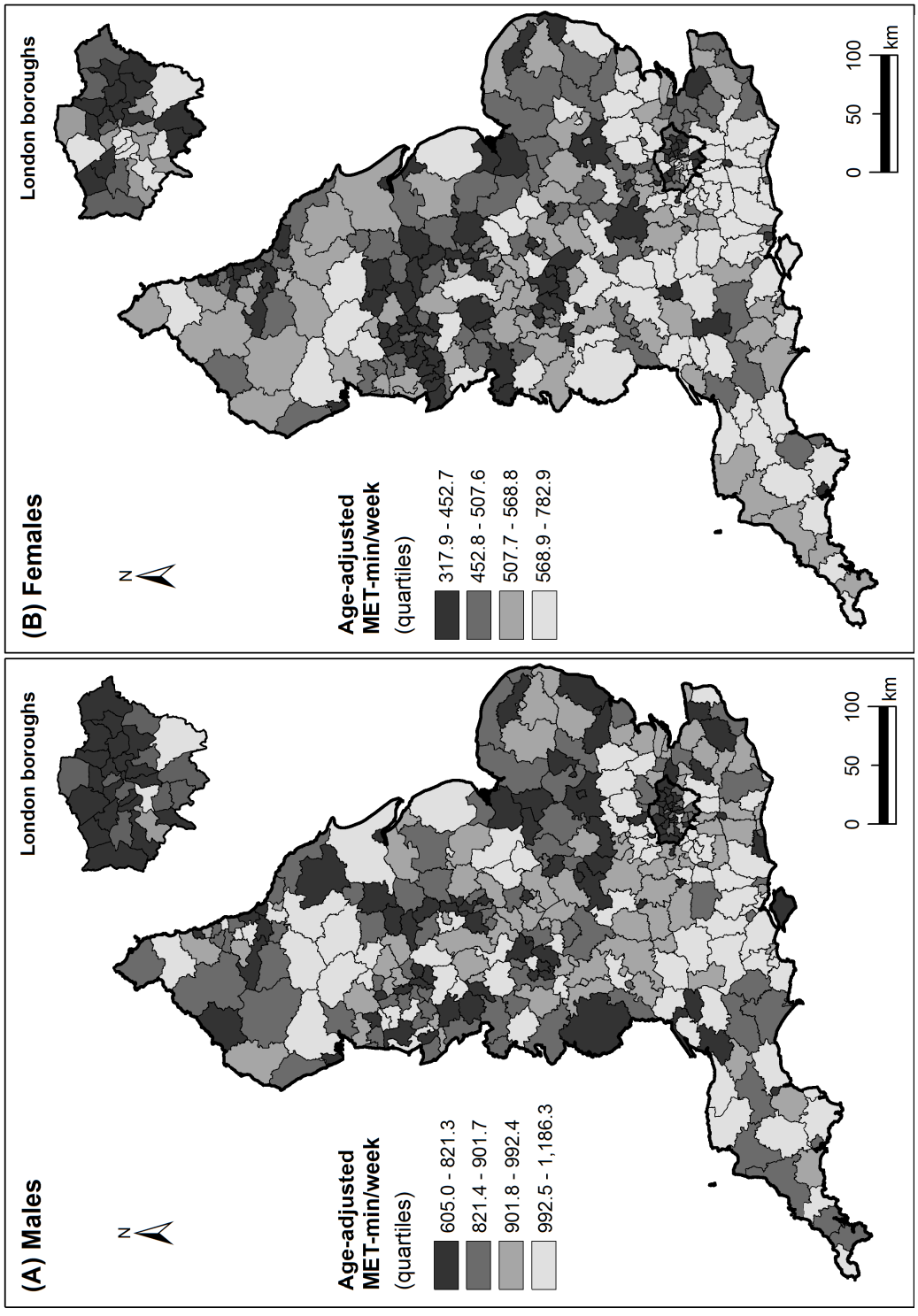
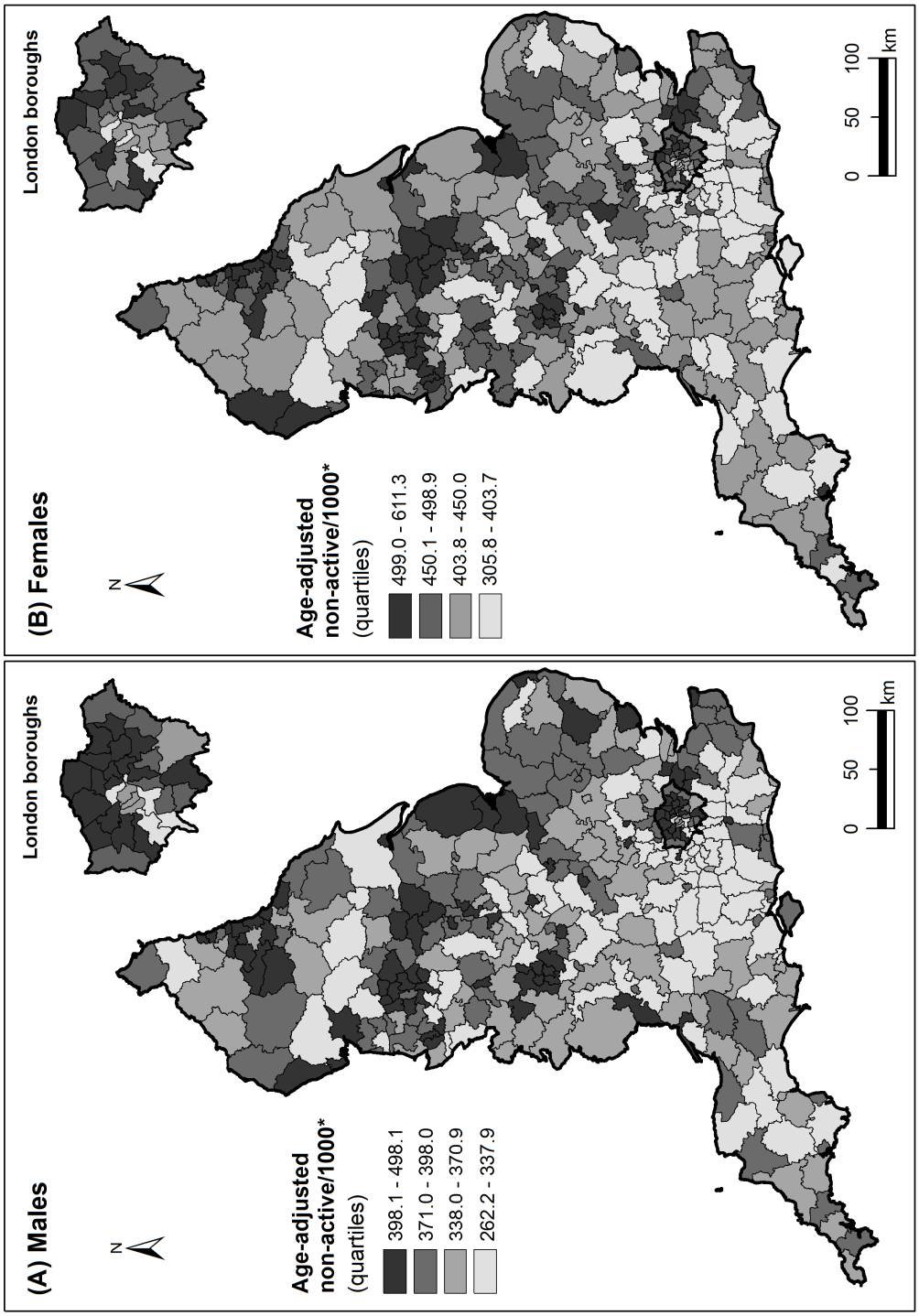


Figure 1 Age-adjusted total physical activity across English Local Authorities, 2005-2006.

Figure 2 highlights variations in rates of non-activity, which generally mirror that of physical activity. Spatial clustering was again relatively low, but statistically significant for both males (Moran's I = 0.07, $p < 0.01$) and females (Moran's I = 0.09, $p < 0.01$).



*MET-min/week = 0

Figure 2 Age-adjusted non-active population across English Local Authorities, 2005 – 2006.

Figure 3 depicts between district variations in total walking associated energy expenditure. A similar north-south gradient is apparent to that observed for overall physical activity, with again relatively low but statistically significant clustering for both males (Moran's I = 0.03, $p < 0.01$) and females (Moran's I = 0.14, $p < 0.01$).

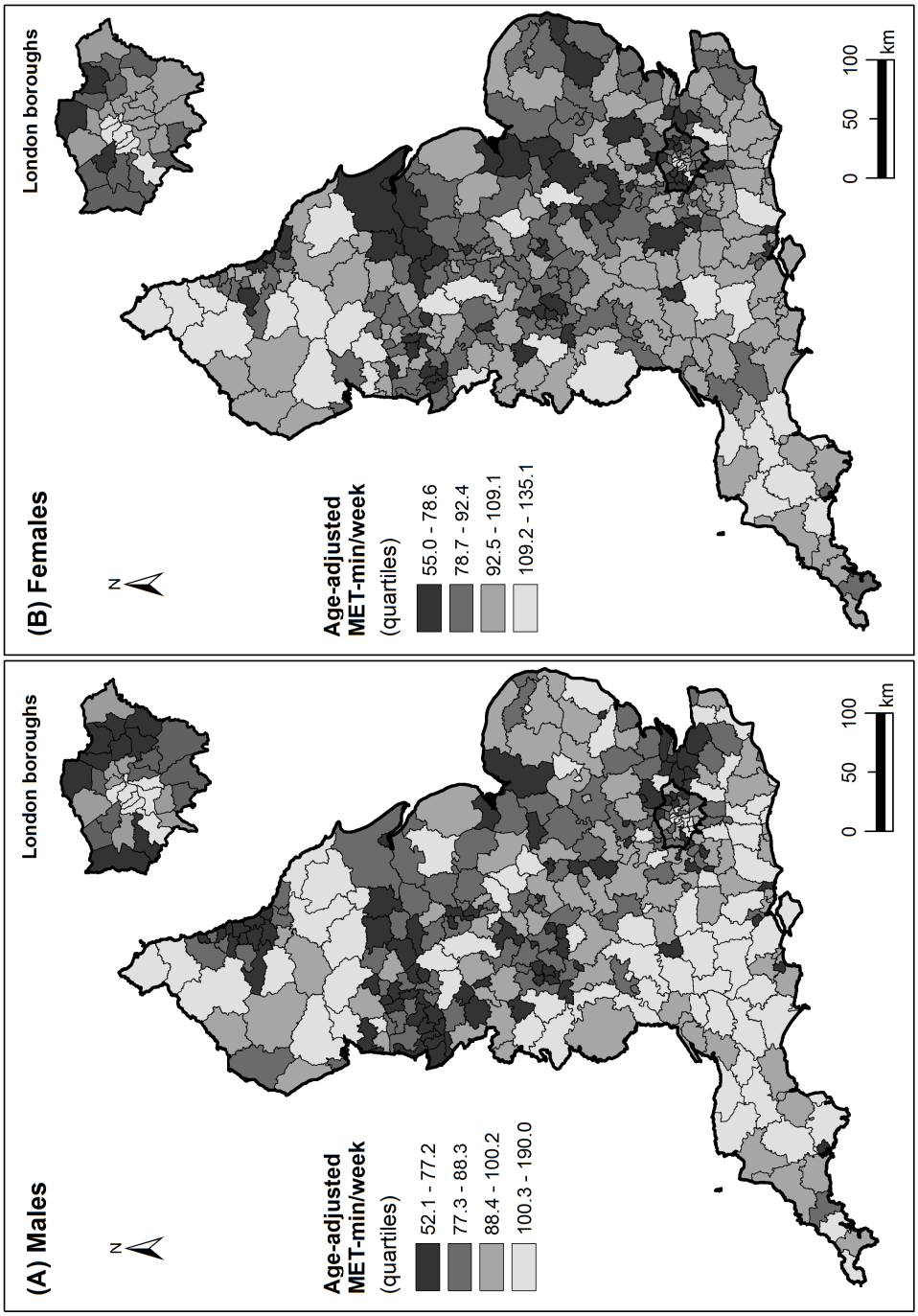
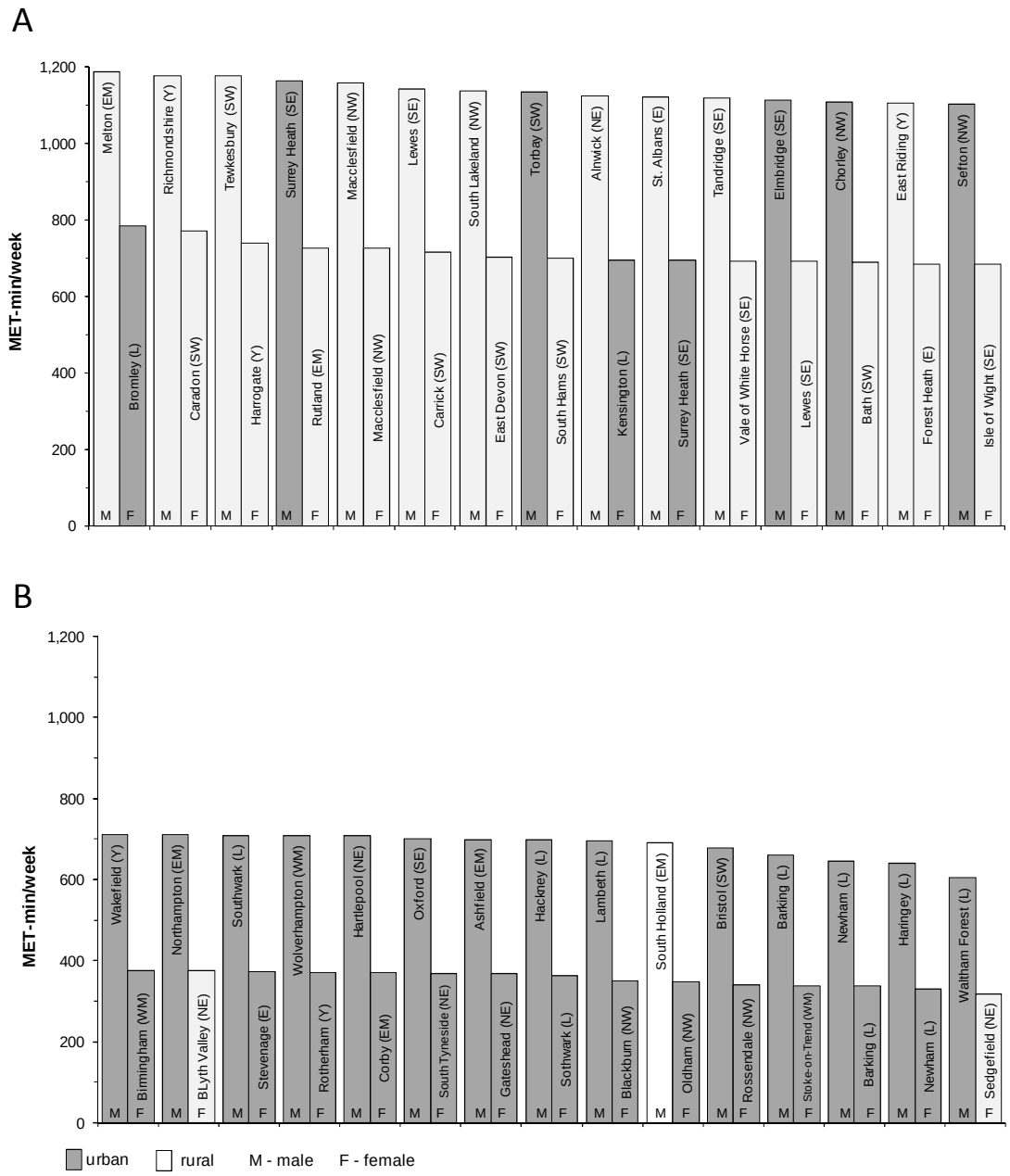


Figure 3 Age-adjusted total walking across English Local Authorities, 2005 – 2006.

Figure 4 shows the urban-rural status and Government Office Regions of the 30 (15 for males and 15 for females) Local Authorities ranked with the highest and lowest overall MET-min/week.

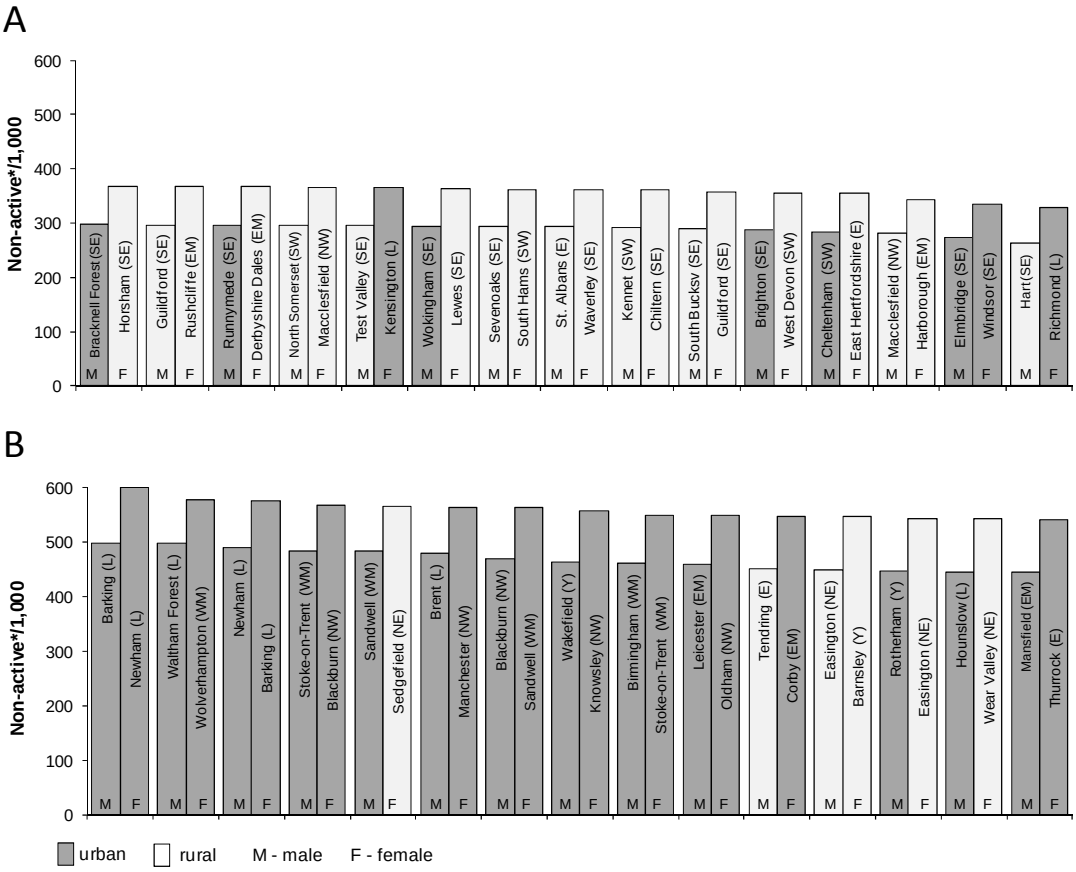


Government Office Regions: NE – North East, NW – North West, Y – Yorkshire, E – East, WM – West Midlands, EM – East Midlands, SW – South West, SE – South East, L – London.

Figure 4 Local Authorities with the (A) highest and (B) lowest age-adjusted MET-min/week of total recreational physical activity, 2005 – 2006.

It is noteworthy that 22 (73%) of the highest PA Local Authorities are rural, whilst 27 (90%) of the lowest are urban. Although the broad geographical patterns are similar, the districts with the highest and lowest PA differ for men and women. Although both high and low PA districts are found in northern and southern Government Office Regions, 10 (33%) of the lowest PA Local Authorities are in London.

Figure 5 shows the Local Authorities with the lowest and highest rates of non-active respondents.



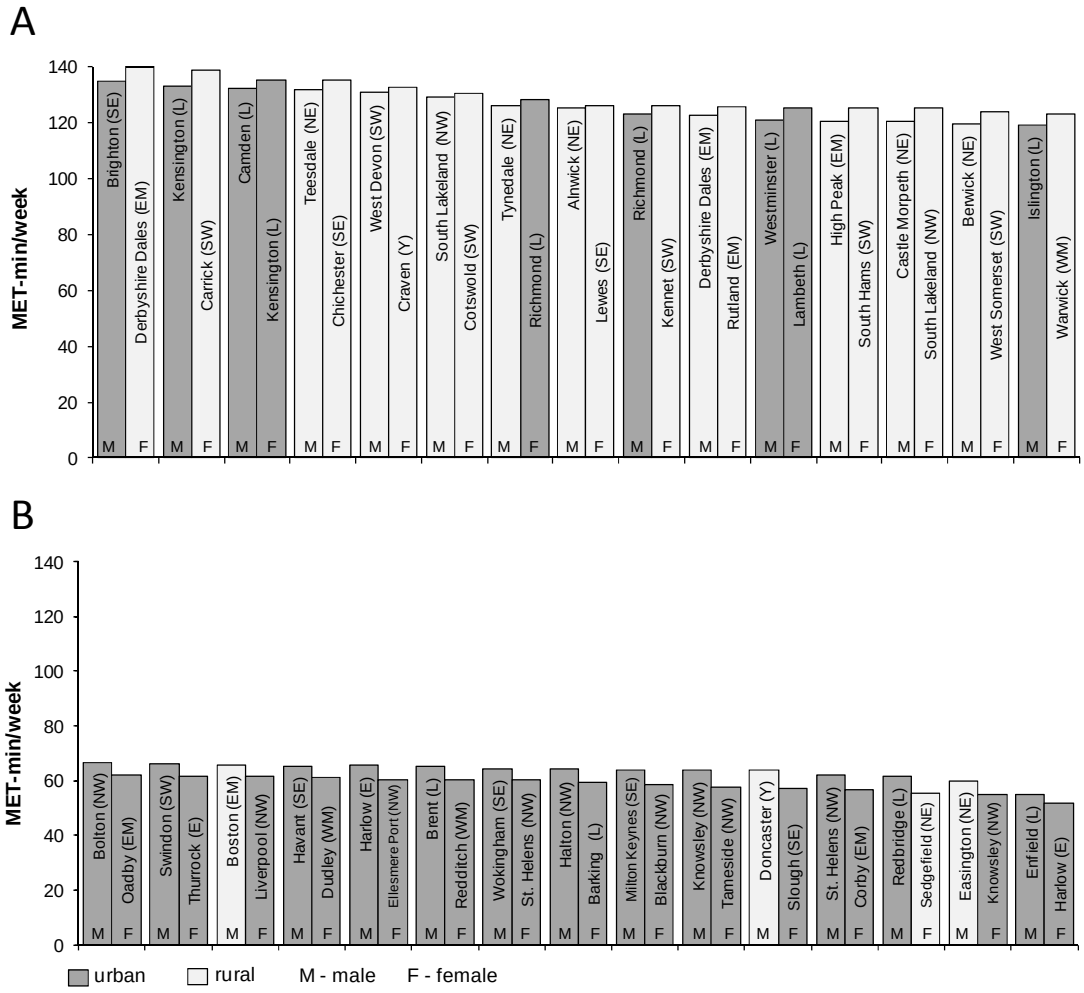
Government Office Regions: NE – North East, NW – North West, Y – Yorkshire, E – East, WM – West Midlands, EM – East Midlands, SW – South West, SE – South East, L – London.

Figure 5 Local Authorities with the (A) lowest and (B) highest age-adjusted rate of non-active people, 2005 – 2006 [*MET-min/week = 0].

The pattern is generally the inverse of that for overall PA, with the 70% of the districts with low levels of non-active respondents being rural, although the disparities between males and females are much smaller than for overall PA. Twenty-one (70%) of the Local

Authorities with the fewest non-active respondents also fell within the southeast or the southwest Government Office Regions.

In terms of walking, there are particularly distinctive urban-rural disparities, with 26 of the 30 (87%) of districts with the lowest levels of walking associated energy expenditure being urban (Figure 6). With the exception of Brighton, all of the urban Local Authorities with high walking associated energy expenditure were London boroughs. Again, disparities between males and females were relatively low.



Government Office Regions: NE – North East, NW – North West, Y – Yorkshire, E – East, WM – West Midlands, EM – East Midlands, SW – South West, SE – South East, L – London.

Figure 6 Local Authorities with the (A) highest and (B) lowest age-adjusted MET-min/week of total walking, 2005 – 2006.

For females there were highly statistically significant differences ($p < 0.001$) for all outcomes when comparing the urban-rural and north-south status of districts. For males, this was also the case for north-south status (all $p < 0.001$) and, for urban-rural status, for all outcomes except overall PA ($p = 0.450$).

Discussion

Overall PA, walking, and non-active behaviours show a divide of lower levels of PA amongst residents of more northerly districts compared to those of the south, yet it is the urban–rural disparities that are particularly striking. Residents of urban districts generally reported less overall PA and walking energy expenditures compared to their rural counterparts, and were also more likely to report non-participation in any of the PA behaviours measured.

To our knowledge, this study is unique in being the first to examine the geography of PA for the whole of England without resorting to synthetic estimates. Other strengths include the very large sample size of the APS, representing approximately 1% of the total adult population in 2006 (Office for National Statistics, 2010). Compared to the general population, the sample comprised a slightly higher percentage of males and adults aged under 35, but was generally comparable. The large sample size allowed us to examine disparities by sex, geographical region, and urban–rural status. The APS also provided information on participation in a very wide range of PA and this allowed a rigorous methodology to be applied in order to estimate energy expenditures for every participant.

In terms of weaknesses, the MET-values in the Compendium of Physical Activities are derived from young, college-age men and thus do not account for individual differences in energy expenditure associated with age, gender, ethnicity, or weight status. The outcomes studied were based on self-report, and the PA questions, although similar to those used elsewhere, have not been subjected to validation. Self-report measures of PA can be susceptible to bias whereby some respondents, particularly the least active, may overestimate the frequency and intensity of their PA (Adams et al., 2005; Masse et al., 2005; Wilcox et al., 2001), although this may not influence the geographical disparities

depicted. Furthermore, overall walking was recorded, but our findings show a particular emphasis on recreational PA. Compared to recent self-report data from Stoke on Trent, England, our calculated total average MET-min/ week for recreational PA are particularly high for men (839 vs. 604), although similar for women (483 vs. 501) (Cochrane et al., 2009).

It is noteworthy that the APS only records energy expenditure associated with walks lasting 30 minutes or more, and many transport-related walks would not reach that threshold. This is most likely one reason why METs associated with walking in our sample are small compared with those from other recreational PA, which is at odds to the known low levels of participation in sport (Lader et al., 2006; Uitenbroek et al., 1991). It has been suggested that bouts of PA as short as 10 minutes have beneficial effects for health (Warburton et al., 2006), and thus even relatively short transport-related walking or cycling trips may accumulate to contribute to the overall health benefits of PA. A further limitation is that the APS recorded no information on PA associated with employment or incidental activities such as housework or gardening. This means that overall levels of energy expenditure will be underestimated, and the contribution of recreation overestimated.

Although prior research has highlighted high car use in rural areas and poorer accessibility to facilities for health and recreation (Moseley et al., 2008) our results show these areas to have higher recreational PA and, in particular, higher levels of recreational walking compared to urban areas. Thus, our findings illustrate the supportiveness of the rural environment for certain forms of recreation. In terms of urban areas, only residents of districts in London reported high mean total walking-associated energy expenditure, most likely reflecting a combination of the restrictions on car use, the developed public transport system, and the generally good walkability of environments within the city.

With respect to the observed north–south gradients, low levels of PA in some areas may be associated with the socio-cultural context of deindustrialisation, whereby cultures of non-participation in PA outside work may have developed in places where levels of employment in physically demanding occupations were historically high. In England, the period of most rapid industrial change occurred in the 1970s and had a particular impact in the Midlands and the North (Imrie, 1991; Jarvis et al., 2001) where residents are now

more likely to report poor health (Mitchell et al., 2000). It is noteworthy that we found districts in the Midlands and the North to have generally lower levels of PA and higher levels of non-activity, and it is possible that cultures of non-participation in PA persist in these places despite the decline in physically demanding jobs. We suggest this possible context of deindustrialisation is a rather unexplored dimension of the obesity epidemic for which putative mechanisms merit further research.

In conclusion, we have described distinctive geographical variations in levels of predominantly recreational PA across England which links to the research question of how PA varies across England. Our findings have implications for interventions to encourage PA. For example, Gidlow et al. (2007) have shown uptake and adherence in Physical Activity Referral Schemes in primary care to be poorest amongst rural residents. Such schemes are often facility based, yet our results highlight the importance of recreational walking amongst rural populations. Taken together this evidence suggests that an increased focus on non-facility based interventions might improve adherence, especially amongst populations living further from facilities. Certainly, the distinct patterns that we reveal suggest that more effective interventions may be those that are designed with their social and geographical setting in mind. The subsequent chapter directly links the findings of the previous chapters to further explore how PA may be related to patterns of industrial restructuring.

Chapter 5

Assessing urban-rural differences in associations between industrial restructuring and recreational physical activity and walking in England

Introduction

This analysis investigates plausible associations between recreational activities, including walking, and industrial restructuring with a focus on urban/rural disparities. This chapter will therefore provide further analysis of how current levels of recreational physical activity may be related to patterns of industrial restructuring.

Background

According to the World Health Organisation (WHO), physical inactivity is the fourth leading risk factor for mortality in high income countries, causing 7.7% of all deaths in 2004 (Chau et al., 2012; Mahmood et al., 2012). Yet in many post-industrial societies, levels of physical activity (PA) have declined considerably in recent decades (WHO, 2006). In England for example, levels of PA are particularly low compared to other European countries (Sjöström et al., 2006), and more than 60% of men and 70% of women did not achieve the recommended levels of at least 30 minutes moderate activity on five days per week in 2008 (Craig et al., 2009).

In previous chapters we have reviewed how the socio-cultural context of industrial restructuring may be linked to declining levels of PA in England. One of the major pathways driving this development may be the loss of heavy manual work which particularly affects areas with a strong industrial heritage. Using data from the Health Survey for England (HSE), we previously found some evidence that processes of industrial restructuring may be associated with patterns of PA, including those in the

occupational, domestic, recreational and walking domains. Our findings indicated that the relationship between industrial restructuring and PA varied across key macro-economic time periods and different activity domains, with relatively strong associations for recreational activities. Interestingly, we did not observe strong differences in associations for males and females, but we have demonstrated that there are spatial variations in recreational PA across English Local Authorities with distinct urban-rural differences in activity patterns (Rind et al., 2011). In comparison to their rural counterparts, residents of more northern urban districts were particularly likely to report lower levels of recreational as well as walking activities.

This study specifically investigates associations between industrial restructuring and recreational PA, including walking, using data from the 2006 Sport England Active People Survey (APS) (Sport England, 2011), the largest survey of sport and recreation participation in any country in Europe. The sample size of the APS (over 350,000 participants in 2006) provided a unique opportunity to stratify the sample for urban/rural status. Further, both PA outcomes adopted for this analysis were based on the frequency, duration and intensity of more than 230 recreational activities and walking. This provided a more precise estimation of energy expenditure (MET-min/week) compared to that which was available from the HSE dataset. From this measure, it was therefore possible to derive a 4-category variable ("highly active", "moderately active", "less active", "non-active") describing recreational as well as walking activity. With respect to walking, the latter category was not available from the HSE data, so the use of the APS data provided the opportunity to include a measure of non-participation (activity below a low threshold) for both of the PA outcomes.

Methods

Data sources

For this study we used data from the 2006 APS, a telephone survey collecting nationally representative self-reported information on recreational PA and walking from 363,724 English adults aged 16 to 75+. Participants were randomly selected using random digit telephone dialling. Each APS record included a year 2001 Local Authority district (LAD) of residence identifier (Ipsos Mori, 2006). LADs are administrative areas of local government in England. In 2001 there were 354 LADs including 170 non-metropolitan (rural) and 105 metropolitan (urban) districts, as well as 38 urban and 8 rural unitary authorities, and 33 London boroughs (Office for National Statistics, 2001). On average, 250 telephone interviews were conducted per LAD in each quarter of the study period.

The urban/rural classification for each 2001 LAD was introduced in 2005 by the Department for Environment, Food and Rural Affairs (Defra, 2005). The classification is based on six settlement types. Preliminary analysis showed that the stratification of the sample into more than two categories resulted in an insufficient number of observations in several of the subgroups, so we used a 2-category variable that distinguished predominantly urban from rural districts.

The measures of industrial restructuring were based on data from the Great Britain Historical GIS project (Gregory et al., 1998; Southall, 2011). The project integrates data from a range of surveys in Britain and provides, for each LAD, long-term trends in employment data for several economic sectors from the period 1841 to 2001 (Southall et al., 2009).

Physical activity outcomes

The APS provided information on the frequency and duration of 237 recreational activities, plus walks of at least 30 minutes duration at moderate intensity. Although the nature of the walks was not recorded, the majority of this duration will be recreational in nature. The full methodology used with the APS to measure levels of recreational PA and walking is described in the previous chapter. Briefly, for each participant we calculated a measures of energy expenditure associated with recreational PA and walking which were expressed in metabolic equivalents [MET-min/week] comprising

the sum of the frequency multiplied by duration and intensity level of each activity reported (Ainsworth et al., 2000; Ball et al., 2003). For the purpose of this study we divided the individual PA outcomes into four categories summarised in Table 1, with terciles being used to delineate the groupings of activity above 0 MET-min/week.

Table 1 Classification of the physical activity outcomes

Categorisation of the outcome variables	**Recreational PA** [MET-min/week]		**Walking activity** [MET-min/week]	
	men	**women**	**men**	**women**
non-active	0	0	0	0
less active	> 0 - 525	> 0 - 360	> 0 - 124	> 0 - 149
moderately active	> 525 - 1410	> 360 - 840	> 124 - 371	> 149 - 495
highly active	> 1410	> 840	> 371	> 495

Measuring industrial restructuring

To develop a range of variables representing industrial change in each LAD, we followed a similar methodology to that applied by Mitchell et al. (2000) who analysed associations between self-rated health and industrial decline. The full methodology is described in the penultimate chapter of the thesis. In short, since prior research has documented a relatively strong association between occupations characteristics and PA (Kirk et al., 2011), we based our measurements of industrial restructuring on employment change in the agricultural, manufacturing and mining sectors, where levels of work are likely to have moderate to vigorous intensities (Ainsworth et al., 2000). Further, we chose three different time periods to explore potential variations in PA across changing macro-economic conditions. The first period comprised the entire period (1841 - 2001) for which data was available. For manufacturing and mining, the second (1841 - 1971) and third (1971 - 2001) periods captured employment change before and after the advent of severe industrial decline, including the closure of most of England's coalmines in the 1980s. For agricultural employment, decline occurred before the 1970s; hence, the cut-off point for the second and third period was 1931. For analytical purposes, we classified each LAD using a 5-category typology for each employment type: 'high initial employment, high decline', 'high initial employment, low decline', 'low initial employment, high decline', 'low initial employment, low decline', and employment growth.

Individual covariates

A set of covariates that may be associated with PA (Trost et al., 2002) were available from the APS including categorical measures of age (age groups 18 - 34, 35 - 54, 55 - 74, 75+), gender, ethnicity (White vs. Non-White), and the presence of long-term limiting illness (yes vs. no).

Analysis

To test associations between PA and industrial restructuring, we fitted multilevel ordinal regression models. To obtain interpretable odds ratios, we applied ordered proportional odds models with a logit link function (Garson, 2009). The coding of the outcome variables was ascending (1= non-active, 2 = less active, 3 = moderately active, 4 = highly active), so we predicted the likelihood of non-activity versus more active behaviours. In order to test for urban/rural differences in both of the activity outcomes, all analyses were stratified by the LAD urban/rural classification. Our modelling approach comprised two steps. For both PA outcomes, a base model included the individual covariates, whereas a full model added the measurement of industrial change for each employment type at each of the three time periods. In null models with no explanatory variables added, there was a statistically significant variation in outcomes between LADs at the $p < 0.05$ level. Therefore models were fitted using a 2-level multilevel structure of individuals (level 1) nested within LADs (level 2). All models were fitted using MLwiN 2.23 (Rasbash et al., 2011).

Results

This study included female 360,323 APS respondents, which matched the demographic structure of the 2006 total adult population in England (Office for National Statistics, 2010). All of the individual covariates showed statistically significant associations with both of the PA outcomes ($p < 0.01$). Older respondents, non-White ethnicities, those reporting limiting long-term illness and those living in urban LADs were more likely to report lower levels of recreational and walking activity. The final models were therefore adjusted for those covariates, and the results are presented in Table 2.

Table 2 Summary of odds ratios from multilevel ordinal regression predicting non-active behaviour[†] for recreational physical activity and walking domains by types and periods of industrial restructuring

	Recreational physical activity						**Walking activity**					
Odds ratio (OR)[‡]	OR (urban: n = 180,558 urban; rural: n = 179,478)						OR (urban: n = 180,558 urban; rural: n = 179,478)					
Manufacturing[¥]	**1841-2001**		**1841-1971**		**1971-2001**		**1841-2001**		**1841-1971**		**1971-2001**	
	urban	**rural**	**urban**	**rural**	**urban**	**rural**	**urban**	**rural**	**urban**	**rural**	**urban**	**rural**
high initial employment, high decline	1.07	0.96	1.05	0.98	1.09**	0.93	0.92	0.99	0.91*	0.92*	1.15**	0.99
high initial employment, low decline	1.06	0.97	1.07*	0.99	1.14**	0.99	0.94	0.95	0.97	0.99	1.18**	1.05
low initial employment, high decline	0.93	0.87**	0.78	0.98	0.94	0.85*	0.73**	0.83**	0.51**	0.85**	0.89**	0.96
low initial employment, low decline	0.94	0.89**	0.96	0.99	baseline	0.93	0.89**	0.87**	0.87	0.87**	baseline	0.94
Mining[¥]												
high initial employment, high decline	1.25**	0.95	1.00	0.95	1.11**	1.09**	1.39**	0.91	1.14*	0.89**	1.16**	1.03
high initial employment, low decline	1.24**	0.95	1.02	0.99	0.97	0.97	1.49**	0.92	1.14*	0.92*	1.03	0.94*
low initial employment, high decline	1.23*	0.93	0.94	0.92*	nd	nd	1.38**	1.01	1.01	0.96	nd	nd
low initial employment, low decline	1.14*	0.89	0.90*	0.93*	1.05	1.07	1.22**	0.93	1.00	0.95	1.09	1.04
Agriculture[¥]	**1841-2001**		**1841-1931**		**1931-2001**		**1841-2001**		**1841-1931**		**1931-2001**	
	urban	**rural**	**urban**	**rural**	**urban**	**rural**	**urban**	**rural**	**urban**	**rural**	**urban**	**rural**
high initial employment, high decline	0.97	0.93**	0.94	0.95	0.90	0.83**	1.14**	1.02	0.97	1.05	1.55**	0.87**
high initial employment, low decline	0.93	0.98	0.89	0.93	0.91	0.90**	0.93	0.96	1.03	0.98	1.29	0.81**
low initial employment, high decline	1.01	1.18**	0.99	1.12*	0.89	0.85**	1.05	1.21**	0.91	1.21**	1.49**	0.88*
low initial employment, low decline	baseline	baseline	0.88	0.98	1.03	baseline	baseline	baseline	0.82*	0.99	1.48**	baseline

[†]Coding for the outcome variables (all activities included were executed for at least 30 min/session):
1 = non-active, 2 = less active, 3 = moderately active, 4 = highly active

[‡]**$p < 0.01$,*$p < 0.05$

[¥]Baseline: employment growth; exception: models "Manufacturing/urban 1971 – 2001", "Agriculture 1841 – 2001", "Agriculture/rural 1931 – 2001": the basline is low initial employment, low decline since there were no areas of growth

nd = no districts observed in cell

Although many of the associations did not reach statistical significance, there were differences in associations between urban and rural areas according to employment sector. Urban/rural differences were more distinct for areas characterised by employment decline in the mining sector, particularly between 1841 - 2001 and 1841 - 1971. Residents of urban areas characterised by employment decline in mining employment were statistically significantly more likely to report lower levels of recreational PA compared to residents in areas of employment growth. Although the effect did not reach statistical significance, their rural counterparts were less likely to report lower levels of PA. For manufacturing, there was no strong evidence of urban-rural disparities. For districts with declines in agricultural employment between 1931 - 2001, however, there was a notable urban/rural difference in walking activity whereby residents of more urban districts were more likely to report low walking activity, compared to a lower likelihood amongst their rural counterparts.

Discussion

We investigated associations with industrial restructuring covering a period of 160 years, and current levels of recreational PA and walking, focussing on urban/rural differences in associations with activity patterns. For some time periods, our results indicate that compared to their rural counterparts, employment decline in the sectors studied amongst urban residents appears to be associated with lower reporting of recreational PA and walking, particularly in areas with a history of mining employment.

We suggest the urban/rural differences observed may be associated with fewer opportunities for outdoor activities in urban areas in combination with a higher dependency on cost-related activity environments such as gyms or swimming pools. This may mean that that the processes that could be driving an association between employment loss in manual work and lower overall PA may manifest particularly strongly in urban communities where the barriers to recreational PA may be greater. For example, prior research from England has shown that the availability of safe and attractive green spaces tends to be poorer in socio-economically deprived urban areas (CABE, 2010; Pateman, 2011). Furthermore, whilst participation in organised activity sessions has been shown to be relatively high amongst deprived residents, there is evidence that this is only so if those activities are organised through community

members, address special interests and manage to raise awareness through word-of-mouth distribution (Withall et al., 2010). Whilst functioning social networks and support have been related to increased leisure time PA (Yu et al., 2011), it can be particularly difficult to implement these mechanisms in urban environments where social interaction and support may be relatively low (Thivierge-Rikard et al., 2010). We further suggest that the particularly strong associations observed for urban areas with a history of mining employment may be related to the particular context of social cohesion in mining communities (Mellor et al., 2005).

In terms of strengths, the PA outcomes included in this study were derived from a large, nationally representative dataset and reflect energy expenditure based on an extensive set of activities. This provided the opportunity to extend previous analysis and further explore aspects of geographical variations in recreational PA and walking related to the socio-cultural context of industrial restructuring. Weaknesses include the cross-sectional nature of our outcome variables which did not allow the consideration of changes in PA over time. Further, both of the PA outcomes were based on self-report where participants are likely to overestimate their actual activity levels (Adams et al., 2005). The 2006 APS did also not provide information on gardening activities which is likely to have resulted in an underestimation of overall recreation PA. There is recent evidence from England that rural residents are significantly more likely to participate in at least three times of 30 minutes moderate gardening per week than their urban counterparts (Ipsos Mori, 2011). In comparison to previous analysis, we could not adjust this analysis for self-reported general health which is a well-known correlate of PA because this variable was not available from the Active People Survey. The inclusion of this covariate would have resulted in a refined model as presented in chapter 3. The analysis presented here had, however, the advantage of providing an enhanced understanding of urban/rural differences in relation to activity patterns. Further limitations are related to the fact we undertook a large number of statistical tests and therefore some of the associations we observed may be due to chance, the conceptual issue of not adjusting this analysis for individual measures of socio-economic deprivation, the relatively simple categorisation underlying our measurement representing employment change, and the transferability of the results to other settings than the UK. These issues are discussed in detail in chapter 3.

In line with prior research we suggest that socio-cultural factors are likely to provide valuable context in understanding determinants of activity patterns (Martin et al., 2005), particularly in areas adversely affected by the consequences of industrial decline. As proposed in our framework presented in chapter 1, we hypothesise that the particular industrial heritage of communities may impact recreational opportunities as well as beliefs and attitudes towards PA. We believe that the consideration of these aspects is important because local authority driven PA initiatives in communities with high levels of socio-economic deprivation have been shown to have low levels of participation (Withall et al., 2010). Considering particular geographical as well as socio-cultural settings may contribute to the development of interventions that effectively tackle insufficient activity levels across populations in most disadvantaged communities. Yet, within the context of industrial restructuring little research has considered causal mechanisms underlying the plausible relationship between the socio-economic history of places and PA. To better understand these mechanisms, our next study applies focus group methodology in an area characterised by a complete demise of the mining industry since the 1980s.

Chapter 6

'I used to be as strong as a horse and fit as a linnet' – Changing physical activity in former mining areas in the North-East of England

Introduction

Previous chapters provided new evidence and a better understanding of where and how across England patterns of industrial decline may be associated with physical activity. This study is based on previous findings and investigates mechanisms linking physical activity to socio-cultural and environmental dimensions of industrial decline. With respect to the proposed framework, this chapter focuses on the wider impact of socio-cultural dimensions of industrial restructuring on PA, including socio-economic aspects, demography and migration, family structure, as well as political concerns and area reputation. In comparison to the previous chapters, this study not only provides further evidence for associations between PA and industrial decline, but aims to unpack how wider changes associated with industrial decline affect beliefs and attitudes towards PA as well as the development of obesogenic environments.

Background

Moderate to vigorous intensity physical activity (PA) undertaken for around 30 minutes at least 5 times a week has been related to a reduced risk of all-cause mortality of about 30% (Kesaniemi et al., 2001; Warburton et al., 2006). This recommended level of PA can be achieved through a wide range of activities associated with work, travel, housework, and leisure. In recent decades, however, levels of PA have declined considerably throughout many European countries (WHO, 2006). In England, activity participation is particularly low, and in 2008 65% of the population did not achieve the recommended levels of PA (Craig et al., 2009).

Declines in population levels of PA may at least in part be associated with broader effects of industrial decline and restructuring, which includes the transition from a heavy labour-based industry to a service-based and information-orientated society (Bazen et al.,

1997). Indeed, a wealth of research has linked socio-economic decline and increasing inequalities to declines in both health-promoting behaviours and positive health outcomes. For example, a recent study on population health across Europe (White et al., 2011) found that men living in adverse material and social conditions had an increased risk of engaging in high risk behaviours such as excessive drinking, smoking, unhealthy eating and insufficient exercising. Considering PA specifically, a key issue may be the loss of opportunities to be physically active in the workplace, which if not counterbalanced by an increase of PA within other activity domains will lead to overall population declines in those areas affected. It is noteworthy that Ellis et al. (2007) showed that activity levels were particularly low in English northern industrial towns where there have been high job losses in manual occupations such as manufacturing and mining, although they were not able to identify the mechanisms generating this disparity. If activity declines are to be reversed at a population level, we suggest an important first step is to identify the mechanisms leading to such present-day disparities.

Living in an area with a history of mining has generally been associated with a relatively high risk of poor health (Riva et al., 2011; Shucksmith et al., 2010) which is, in turn, likely to directly impact levels of PA. A number of recent studies have identified individual (e.g. lack of time and money, cultural background, health problems, social isolation, safety fears) as well as contextual factors (e.g. neighbourhood support, community participation, physical environment) as important barriers to reaching sufficient levels of PA (Allender et al., 2006; Hoebeke, 2008; e.g. McNeill et al., 2006; Wendel-Vos et al., 2007). The particular causal mechanisms linking socio-cultural characteristics of the post-industrial society to PA are, however, not well understood. Based on ecosocial theory (Krieger, 2001), which considers how present and historical physical, social and cultural conditions impact population patterns of health, a conceptual framework linking PA to socio-cultural dimensions of industrial restructuring was developed in Chapter 2. It considers the decline of labour-intensive jobs as a direct pathway to reduced overall PA. Furthermore, the framework incorporates ways through which the socio-cultural history of areas may shape beliefs and attitudes towards PA, and how the progressive development of obesogenic environments may reduce opportunities for a sufficiently active lifestyle. For example, activity behaviours are influenced through role models established by peer, friend, family and community networks which are, in

turn, related to socio-cultural background (Legh-Jones et al., 2012; Yu et al., 2011). However, industrial decline and increasing socio-economic inequalities may have weakened old established community and family structures through high unemployment, demoralisation, obsolescence and movement of labour (Altena et al., 2002). Individuals and families were frequently forced to find new sources of income in other areas, and this form of selective migration makes it difficult to maintain community facilities important for education, health, recreation and local business.

A further issue is that financial insecurities, loss of control, and adjusting to new working environments may adversely affect mental well-being through increased stress levels and depression. This has, in turn, been associated with reduced participation in PA (e.g. Allender et al., 2008; Phongsavan et al., 2004). Another important issue that has implications for PA within areas of industrial decline may be related to inherited cultures and regional identities. In the late 1940s Ferdynand Zweig (1948) published a detailed portrayal of English pitmen. He wrote that *"The force of habit is nowhere stronger than in the colliery and the mining village. A change of habits is most difficult to accomplish, even if the change proves beneficial and the habit has no longer a functional value."* (Zweig, 1948: 8).

In Chapters 3 - 5 we then tested our framework empirically and showed that declines in occupations associated with heavy manual work appear to have relatively strong associations with the reporting of lower participation in recreational activities, particularly in urban areas with a history of mining employment. The purpose of this study is to explore mechanisms that may underlie the relationship between PA and industrial decline in the particular context of areas with a history of mining employment. The study aims to understand how the process of employment decline in the physically demanding mining industry may have led to structural, socio-cultural and environmental changes in former pit communities, and whether this may have contributed to the generation of cultures of non-participation in PA. We argue that gaining such understandings by talking to those who have direct experience of the process and consequences of industrial decline will not only refine the theoretical models that underpin work relating cultures to health behaviours, but will also contribute to a better understanding of the specific mechanisms underlying spatial variations in PA and will thus aid the development of effective PA interventions.

Methods

Research design

This research focuses on socio-cultural and environmental changes in former mining communities and how this has impacted community life as well as health-related behaviours, including PA. The main aim is to get a better understanding of causal mechanisms between PA and industrial restructuring. We therefore used a case study applying focus group methodology which did not only allow to explore individual narrative accounts of individual lives and experiences (Elliott, 2005), but to get a better understanding of how the participants understand changes in their community in relation to others. Particularly in health research, focus groups have been found useful to provide an understanding of how the relationships between people and places affect practices of everyday life (Kitzinger, 1994; Rabiee, 2004), and Khan and Manderson explicitly highlight the value of focus group research to get a better understanding of health and illness in village settings (Khan et al., 1992).

Study area

This study took place in the North-East of England across the Durham and Northumberland Coalfields which have a significant history of employment decline in the mining sector. In terms of several indicators of deprivation, including employment, education and health, the region performs poorly compared with national trends (O'Donnell et al., 2008; Walsh et al., 2008). Within the region, two case study communities were selected; one was a semi-rural area within the Derwentside District (population 89,191) and the other a semi-urban area within the Sunderland District (population 283,509) (Office for National Statistics, 2010). Both localities have a history of coalmining, but since the 1980s all mining-related activity ceased, and the sector no longer provides local employment (Beatty et al., 2005). In terms of PA, previous analysis showed that both areas have relatively low levels of recreational PA and walking, as well as a high prevalence of non-active residents (chapter 4).

Selection of participants and procedure

The discussions were conducted with participants who had lived in the area for at least 30 years to ensure that they were able to provide information on potential environmental, socio-economic and health-related changes since the 1980s. Further, this allowed the discussions to take place within familiar social networks and environments where participants spontaneously explored and discussed issues and concerns related to changes in community life. In order to aid participant recruitment, we offered to pay each focus group attendee £25 to cover their time and travel expenses. All participants were recruited via flyers from a local Working Men's Club in each study location. The clubs were founded in the 19th century and are historically rooted in the areas' industrial past (Bulmer, 1978). They are owned by its members and provide education, social entertainment and opportunities for recreation. Initial contact with the clubs was made through the Durham Branch of the Working Men's Club and Institute Union, which is a voluntary association representing and supporting affiliated clubs and its members (WMCIU, 2011).

During August 2011, four 1-1.5 hour group discussions with a total of 19 participants were conducted. The discussions were organised separately for men and women to specifically explore male and female attitudes and beliefs towards community life and health-related behaviours. All sessions took place in the clubs. Before the closure of each session, participants completed a short questionnaire providing socio-demographic and health-related background (additional material A). Additionally, there was the opportunity to explore the areas' industrial past over a two week fieldwork period that included informal discussions with local residents and members of several other Working Men's Clubs. Field notes taken over the period of study were used to assist with interpretation of the information gained from the focus groups.

Questioning route

To drive the discussion, a questioning route (additional material B) was developed following the methodology of Krueger et al. (2000). The introductory theme explored general aspects of community life (e.g. *"In what sort of things do you get involved in your community?"*). The transition theme covered residents' perceptions and opinions on health differences between places generally and specifically within their communities (e.g. *"In some places people have worse health than in others. Can you think of any reason for that?"*). This provided insight about local health issues and conditions which may have changed over time.

The key theme targeted perceptions and opinions of participants on health behaviours in their community, with a focus on PA. In order to initiate and facilitate this discussion, the participants were asked to choose from a range of 20 newspaper headlines, which had an even number of positive as well as negative connotations related to health and PA (e.g. positive: *"Gardening for health"*, negative: *"Local park needs makeover"*), and they were asked to present their thoughts. This required the participants to establish individual priorities and provided insight whether these were shared throughout the group. The closing theme summarised the discussion and provided an opportunity for the participants to add yet undiscussed areas of concern.

Data management and analysis

The focus groups were recorded and transcribed verbatim using f4, version 4.2 (Dresing & Pehl GmbH, 2010). To protect the participants' confidentiality, we used pseudonyms and omitted local place names. The transcripts were analysed following Krueger's (2000) framework of data analysis, incorporating key stages of framework analysis by Ritchie & Spencer (1994). This approach follows a continuous and overlapping analysis sequence including familiarisation with the data, identifying a thematic framework, managing and coding the data, and linking individual quotes to put identified core issues into context (Krueger et al., 2000; Rabiee, 2004; Ritchie et al., 1994).

Findings

Ten men (M) and nine women (W) attended the focus group (G1 – G4) discussions. Characteristics of the study sample are summarised in Table 1.

Table 1 Characteristics of the study sample

	Group 1	**Group 2**	**Group 3**	**Group 4**
Number of participants	4	6	4	5
Gender	female	male	male	female
Average age	70	73	77	67
Working status				
retired	4	4	4	5
not in paid employment	0	2	0	0
Number of participants with a working history directly related to the mining industry	0	6	3	0
Self-reported health status				
good	2	0	0	2
fair	1	3	4	3
bad	1	3	0	0
Average years of residence in the current community (at least 30 years)	59	66	59	48
Community classification	town	town	village	village

The average age of the participants was 72 years, and all were of a White ethnic background. All but two were retired, and nine out of the ten men had a working history related to the mining industry. Most participants characterised their health status as "fair", with only women reporting "good health". Only residents of the more urban area characterised their health status as "bad".

We identified and subsequently present two main themes that evolved from the focus group discussions. Firstly, we report the participants' opinions on how industrial change directly impacted different PA domains, including those of occupational, domestic, and leisure time activities. Subsequently, we present how participants discussed activity-related changes in social and physical environments, including impacts on family and community life, as well as on the physical environment.

Direct impact of industrial restructuring on different activity domains

Occupational and domestic activities

All participants discussed the mining industry's physically demanding working environment, summarised by one of the male attendees who also discussed broader contexts of industrial restructuring such as the development of a service and information orientated society (G2 transcript lines: 572-584):

> *M2: [...] you can never explain to people, what you might call modern day things like school teachers and work places that make little telephones and things like that, you know, with the greatest respect, trying to tell these people what being in the mining industry or heavy engineering, what it meant on a day to day basis. And some of the things you had to do, just to get the job done, [...], to produce coal, [...], just to produce, it was so hard, the work, and trying to explain that to people.*

For most of the male participants, working life started at an early age, there was not much choice and several stayed in manual occupations until retirement (G3:238-244):

> *M3: There was the colliery. Coal, that was it.*
>
> *M1: I left school on a Friday, and my father said you are coming to the pit on the Saturday. [...]. 15 years old, and I started the pit, on a Monday. [...]. That was where you [were] born into.*

For whole regions, the demise of the industry resulted in a direct loss of occupational PA. Although some of the miners found work in alternative industries such as the shipyards, factories or building work, most of these jobs had gone by the end of the 1980s (G1:480-502; G3:123-141).

Changing jobs and adjusting to new working environments also had psychological effects through increased stress levels resulting from losing the security of familiar working environments (G2:785-875):

M3: The difference in working down the pits when you say the word "marrer" [work mate], you were marrers because you had to depend on each other. But when you are not in the pits, but in factories they stab you in the back the whole weekend. It wasn't like that down the pits. [...].

M1: But it was very difficult for the lads. I mean, they were paid off, and made redundant and things like that. [...].

M3: Your whole lifestyle changed, didn't it?

M1: Some of the lads went into stress mode because they were doing jobs that was out of their kind of style. [...].

M2: Invariably people went on what you might call heavy engineering into a lighter type of facility. [...]. [T]here was no way you could go into what you might call a new industry and expect to work as hard as you were because somebody would stop you and say, hang on, this is the way we do it here. [...] and a lot of the places you were going to, you weren't allowed to lift anything. That was a crime to do that, you know. So, really, it wasn't something you control, you were controlled by the system that you fit into, you know. [...].

M2: The men were different. And the more, the more collieries issued redundancy, the more you moved on, the more you moved on. [...].

M1: They were industrial gypsies, that's what they were, they just moved from one pit to another.

Today, most of the participants report suffering from long-term illnesses associated with heavy manual work and a dangerous working and living environment (G2:588-590). A female participant clearly linked particular diseases to local pollution (G1:389-394):

F3: Yes, [around here] there is lots of people who've got asbestosis, silicosis, all the, how can I say it, all the diseases that's not curable. They've all got that, where anywhere down London or Devon or places like that they haven't got it. Because they're not breathing the dust air. That's round about here you know.

Another female participant who worked in the local hospital summarised (G4:455-463):

> *F2: Well, a lot of mining injuries it was, mainly, you know, a lot of you know broken bones and falls and dust and things like that. Heavy work, these men have worked hard. [...]. Their knees, with crawling in the low, that was a lot of the injuries that they came in with. Mining injuries and their backs. And I think that is where most of the men suffer now. And then their chest with the dust.*

The women also emphasised that many of their relatives who worked in the collieries died before or shortly after retirement (G1:602-610).

Although none of the female participants were actively involved in occupations related to the mining industry, most of them used to work in environments that required them to be physically active (e.g. factory, commercial kitchen, health care facility, market trade). Furthermore, all of the women have been responsible for most of the domestic activities such as baking, shopping, washing or ironing (G1:64-71). In the past, these activities required more physical strength than nowadays (G4:271-282):

> *F2: [...] I was strong as a horse when I was young [...]. And then we used to have a big ton of coal, the coalman was coming and empty the coal outside your gate.*
>
> *F1: You had to fill those buckets.*
>
> *F2: [...]. You did things like that. You wouldn't dream doing anything like that nowadays, would you? God, no no. You have got any amenity now, you see, and an easier life.*

However, they also discussed how, in particular for younger residents, changing lifestyles may act as a barrier to continue long-established activities such as having an allotment (G4:572-576):

> *F3: [Hannah] had an allotment down the road. And then [her partner] went to [...] work [further away]. And she sets it on for years, but then it got too much for her. Too much for her, working and then having the three kids to look after and the house and that. So she packed it in. [...].*

Leisure, recreation and sport

Although most of the participants described their working life as physically challenging, they also talked about being relatively active during leisure time. Coping with the hard working environment required physical fitness (G1:558-564):

> *F2: My dad had to go on a diet because he was big and the seam was that low, he couldn't get in [...].*
>
> *Moderator: So they were all pretty fit when they used to work in the pit?*
>
> *F2: Oh yes. You had to be. It was hard work.*

The colliery environment was directly related to the provision and maintenance of recreational opportunities (G2:1025-1030):

> *M1: [...]. [Around here] the provision for football pitches, cricket pitches, bowling greens, meeting places, and all that was provided by the miners by the reduction of their pay code. The city or the district councils they provided nothing in terms of leisure facilities or anything, they didn't, nothing. [...].*

The closure of the pits had therefore a direct effect on opportunities for leisure and recreation (G3:45-51):

> *M3: Oh, Tuesdays used to be enormous. That's the biggest loss in this village. We had a tennis court. We had a bowling green. We had two football teams and we weren't any down* [short of players].
>
> *M4: There is no sport and activity since the colliery ceased. [...].*

Several of the participants repeatedly highlighted the importance of walking for pleasure and gardening in their allotments (G3:355-399). However, for most of the participants, long-term illness was a severe impairment to maintain an active lifestyle throughout retirement (G3:290-294). Although mining activity-related health impairments particularly concern men, many women have been affected by dust exposure and environmental pollution.

Other activities, mostly attended by female pensioners, were classes provided by the local community centre, including dancing, day trips or weekend getaways, whereas golf was a popular activity for the men (G4:825-844; G3:74-78). Voluntary and charity work provide further opportunities for PA, such as DIY work including painting, grass cutting, or the distribution of weekly flyers in the neighbourhood (G2:1051-1069). However, the participants also worried about difficulties to motivate new and younger residents to participate in voluntary community work. Most participants regarded their local Working Men's Club as the focal facility within their community as here many of the social activities were organised and also took place (e.g. G3:63-65). However, with the closure of the pits and declining memberships many clubs had to close or struggle to remain open which resulted in a severe loss of sociability for the affected communities (e.g. G3:113-119). The participants also discussed tedious bureaucratic processes and costly construction works as constraints to improve the local park environment (G3:565-591). Another important issue was the lack of recreational opportunities for the younger generation (G3:644-662):

M2: Sport and recreation that is the main thing. There is nothing here for the kids.

M3: We have the football field, but they didn't play.

M4: You can get these things but you have got to get someone to organise them. Someone who'll be dedicated to the job. It's hard to come by to get some people [...], in days gone by they were there, you could pull them off a tree, but now, you have just got to find them. And if you are involved with young children and the youth, the police, you know, you have to have a certificate to see you can do this. It's very, very difficult. 'Cause, you know, if something goes wrong when you are dealing with the younger generation, it's very bad trouble on. Very bad, you know.

M2: [...]. And there is health and safety.

M3: That's a killer.

Changes in social and physical environments

Family and community life

All focus groups discussed the loss of social networks and how this altered community and family life over the past decades. With the progressive closure of the pits, several of the old-established families were forced to take up work in other areas (G3:551-557):

> *M1: [...]. People went to Yorkshire, Nottingham and Wales. The miners, you know. I had five cousins, have never seen [them] since 1962.*
>
> *M2: Years ago it was all miners that lived here, wasn't it, mostly. I would say 90% worked down the pit [...].*

The collieries played a pivotal role, not only in providing employment, but also in shaping close-knit relationships between the pit families. The decline of the industry and continuous migration dissolved consolidated socio-economic structures (G2:20-37):

> *M2: So, it's not as if, in the olden days you would be talking about a family arrangement, collieries and colliery villages you might call a family village, or a family pit, this kind of thing. It doesn't happen now because there has been an influx of so many people from so many places [...]. So, to me it's completely changed from the days when it was what you might call a family pit village type scenario. Completely changed.*

Even though several of the participants were relatively happy with their current neighbourhood settings, they emphasised how the situation has changed compared to the times when the mines were still running (G2:10-13):

> *M1: No, the mix [of people] is quite well. Not as well as they did when the mines were going. You live together, you eat together, you stay together, you work together, you know and that was it.*

Another group elaborated the issue of increasing anonymity (G1:361-369):

> *F3: Well, in the olden days the community was community people; they loved one another. Now, where I am living, I am ok, but some people don't even know the next door neighbours, you know, that is changed, because you're frightened for who you're gonna get next door. Whether you're going to get a nice quiet family or a rowdy family or what. For when we were little, we were excited what we were going to get, 'cause we were all sitting in the same boat.*

"Sitting in the same boat" was later referred to as experiencing economic equality (G1:1167-1169):

> *F2: Everybody was poor. Everybody was the same. But now there are people that are poor and people that have a lot of money, you know. It separates.*

Increasing socio-economic inequalities were directly related to changes in family life, and the rural participants described families outside their village being increasingly confronted with unstable economic as well as social instabilities (G4:396-410 and 929-937). All groups were particularly concerned about the loss of community spirit (e.g. G2:328-336):

> *M6: There is a lot of them [local residents] that don't do self and look after number one. I think that was preached by one of our old esteemed prime ministers, wasn't it?*
>
> *M3: Maggie Thatcher.* [Expletive deleted.]
>
> *M6: Maggie Thatcher, look after number one. And a lot of it, a lot of it is still what we [do], we just look after themselves and that's it.*

The physical environment and access to health care facilities

The closure of the pits had effects on the physical environment in both study areas. All participants discussed the disappearance of coal heaps and the reduction of air pollution which they feel impacted positively on health (G2:982-994; G4:195-199). They also discussed how the improvement of health services may relate to the health of residents (G3:255-276):

> *M3: I think the generation coming is a lot healthier than what we are.*
>
> *M2: Well, I think when you look around and keep notes in general, see people from our age and [younger people] going by, those are quite a big lad, and us three, we are on a smaller statue. Seeing the young lads, they are all bloody giants.*
>
> *Moderator: And why do you think is that?*
>
> *M3: Well, because they haven't got the dust, [...], the heaps is gone, everything is gone.*
>
> *M2: Well, and the NHS [National Health Service] is one of the more brilliant things. Without the NHS the best part of us wouldn't have been here [...].*
>
> *M1: Yes, I wouldn't be sitting here.*

Participants further discussed that the "greener environment" (G1:412), including the decommissioning of an old railway line, has resulted in increased participation of cycling and walking throughout the area, which was seen as being particularly important for younger families (G2:640-656; G3:581-603).

Another participant summarised changes which impact mobility within local communities (G2:390-407):

> *M2: [...]. The speed of things changed. The facilities to account for that also change. You couldn't have narrow little roads to get from A to B, like you used to. A, the transport system wasn't required [...]. You didn't travel very far, you know. Everything evolved around where you were at. The village you were in and the next neighbour village that was a night out. [...], technology has speeded everybody up, [...], you have got motor race, you have got wide roads, you have got improved traffic, cars are better, buses are better, more reliability, more numbers of them, you know. [...].*

Discussion

The results of our study give insight into how and why structural, socio-cultural and environmental changes in former mining communities may have impacted activity behaviours through to today. There was evidence of a direct impact of industrial decline on several activity domains as well as activity-related changes in social and physical environments that were closely intertwined with the communities' economic history. Many of the issues discussed crossed rigid categories which highlighted the interrelationship between multiple dimensions of the areas' industrial past and PA.

In our theoretical framework we hypothesised that the loss of manual jobs are directly related to current levels of PA. The results of this chapter emphasise how the complete disappearance of the mining industry has not only affected levels of occupational PA throughout the area, but has left a legacy particularly affecting the activity potential of the older generation. The demise of the mining industry was found to be directly related to the closing and deterioration of recreational structures and facilities. Furthermore, the necessity to pursue physically demanding leisure-time activities has shifted from the requirement to be physically fit, so as to be able to undertake the requirements of paid jobs, to a more laissez-faire attitude regarding the need to be fit to live a quality life. Whilst participants also emphasised how environmental change has positively affected general aspects of health, the more urban residents in particular did not associate this with increased opportunities for activities such as recreational walking, because long-term illness and safety fears regarding traffic and crime limited their activity potential and motivation in the first place. Our results also showed that issues related to health and safety (such as the need for a criminal records bureau check), maintenance (difficulties in recruitment of volunteers), and bureaucratic barriers (lack of monetary support) are important factors influencing PA opportunities, partly also affecting children and adolescents.

The central theme throughout all discussions was the loss of trust and social networks in both of the communities which has been described as important dimensions of the proposed theoretical framework in chapter 1. Several participants recalled former community and family life according to the sociological models of the mining

community (Bulmer, 1975) which describe work, family life and recreation in the traditional pit communities as closely intertwined. In terms of social structure, working and living environments in mining communities were largely homogeneous and collectively organised. All of the families shared the same experiences, gender roles were clearly defined and everyday life and leisure time were organised around the colliery. This promoted social cohesion and mitigated against the exceptionally hard working and living conditions affecting both men and women (Carr, 2001). Although all participants discussed increasing individualism, loss of identity, migration, and increasing socio-economic inequalities as factors that undermine community life, compared to the more urban participants, residents of the rural area were less distinctive in applying these concerns directly to their community. We believe that this is partly related to the village's committed local partnership which organised and implemented intergenerational projects aiming to encourage community involvement, as well as projects related to regeneration and renewal such as the continuing improvement of the local park environment. Fan et al. (2011), for example, emphasised the positive interrelation between park spaces, PA, stress mitigation and social support. They highlighted that the opportunity to socialise in public green spaces strengthens their health benefits if they are accessible and multifunctional. Furthermore, the urban area had undergone a considerable structural change as the closure of several collieries dissolved former communities with particular pit identities, and subsequent town expansion created relatively anonymous urban neighbourhoods.

Our findings also illustrate how gardening has remained a popular activity which is directly related to the industrial past of the areas (Bulmer, 1978; Zweig, 1948). For many pit families, allotments provided an essential food supply and an opportunity to experience social recognition. This is different from other findings where most of the participants who were very active in their jobs did not engage in physically demanding leisure-time activities because they were either too tired or had other priorities (Wandel et al., 2005). Today, however, limited access to and availability of allotments, particularly in more urban areas, as well as a tendency to more sedentary lifestyles has influenced former activity patterns, and the original purpose of gardening has shifted from being a food-producing and socio-cultural necessity towards a more exclusive leisure-time activity.

Since this research was dependent on the co-operation of the working men's clubs and their members, it was challenging to recruit an appropriate study sample, and similar to other research projects applying focus group methodology (Hoebeke, 2008), this study is limited in size. Women were particularly hesitant to participate which may partly reflect the intrinsic male-dominated environment of the clubs. As our study focussed on change related to the communities' socio-economic history, the participants were relatively homogenous in age. Further, the attendees were highly motivated, very active community members and partly experienced in fundraising and communicating community issues to stakeholders. The transferability of our results must therefore be considered in the context that they reflect attitudes and perceptions of a particular group in a particular socio-cultural setting.

Earlier studies have investigated socio-cultural change in mining areas from a primarily social perspective (Bulmer, 1978; Waddington et al., 2001), have focused on health inequalities (Riva et al., 2011; Shucksmith et al., 2010) or have emphasised the importance of social capital in relation to health (Gilbertson et al., 2005; Gilbertson et al., 2006). To our knowledge, the present study is the first to attempt to link several dimensions known to impact PA within a particular historical context and defined community setting. This provides an in-depth picture of changes in activity-related environments in ex-mining communities where adverse socio-economic and other legacies persist to lead to what may be worse ramifications compared to other areas with an industrial past. These include a persisting health burden resulting from exceptionally hard working conditions, and the closing and deterioration of, as well as the loss of control over formerly owned recreational structures and facilities. Our findings suggest that these factors directly impact levels of PA, whereas other processes have indirectly shaped activity behaviours through declining community cohesion, including increasing individualism and safety fears, aspects of migration, widening socio-economic inequalities, bureaucratic, organisational and monetary barriers, increasingly hectic lifestyles and a loss of identity. In combination, these factors have contributed to the development of both socially and physically driven obesogenic environments which particularly affect those at the lower end of the socio-economic strata.

Prior research has highlighted the particular challenge to reach and motivate residents of low-income communities to participate in health enhancing programmes and activities

(Withall et al., 2010; Yancey et al., 2006). We therefore believe that our findings have implications for policy and practice. As the historically hard working conditions in ex-mining communities have limited particularly older residents' physical abilities, the development and availability of programmes that adequately consider age, health status and accessibility could facilitate the participation of those who may believe that their personal circumstances and living conditions exclude them from pursuing a sufficiently active lifestyle. There are some promising examples for health enhancing community programmes for senior residents such as the implementation of healthy living networks which support and encourage residents to take and keep control over their independence and well-being (Henderson, 2011; Thomson, 2010). Time banking, for example, is a reciprocal skill and service exchange which encourages neighbourly help and builds trust within communities through the generation of social capital and the reduction of social exclusion. The availability of these programmes is, however, limited and their continuity frequently uncertain. Further, the reinforcement of family and community support would mitigate factors related to increasingly hectic and taxing living conditions. The important role of community organisation for health education and practice has previously been highlighted (Minkler et al., 2008). Our participants discussed available resources that benefit the whole of the community which could be enhanced through structural, organisational and monetary support.

We suggest it could be beneficial to focus further investigations on intergenerational factors that impact PA behaviours across different age-groups in deprived neighbourhoods. This could help to develop interventions where political as well as family and community structures complement and consolidate each other. Furthermore, our participants emphasised that local projects such as the re-development of public green spaces as well as recreational country parks representing industrial history have recently gained an increase in users and visitors (Joint Committee of Beamish Museum, 2011), and similar success has been reported from other areas facing post-industrial structural change (Goch, 2002). The emotional link to the socio-cultural history of areas has been shown to be a strong motivator for communities to tackle adverse effects of industrial decline and evaluate future needs (Mellor et al., 2005). We believe that this potential is a relatively unexplored but invaluable source to enhance PA in areas characterised by persisting post-industrial decline.

Additional material

A. Questionnaire group discussion

Would you please fill in this short questionnaire? It will provide some background information about the characteristics of the people who are here today. All of your answers will remain anonymous in any reports.

Date_____

Time_____

Name

Are you

- o male or
- o female?

What is your ethnic background?

- o White
- o Mixed
- o Asian or Asian British
- o Black or Black British
- o Chinese
- o Other_____

What is your current work status?

- o In full-time paid employment
- o In part-time paid employment
- o Not in paid employment
- o Looking after home/family
- o Retired
- o Permanently sick
- o Other_____

How would you describe your health?

- o good
- o fair
- o bad

Have you ever worked in the mining industry?

- o No
- o Yes
- o If yes, what was your job? _____

Which community do you live in? _____

For how many years have you lived in this community? _____

What is your year of birth? _____

B. Questioning route

Opening

Welcome and thanks for taking the time to join our discussion today. My name is Esther and I am from Norwich. I work at the University of East Anglia, and I am trying to learn more about health in your community and how health may have changed over the last 30 years or so. I am interested in what you think and there are no right or wrong answers. I expect that you will have differing points of view. Please feel free to share your point of view even if it differs from what others have said. I am recording the session because I do not want to miss any of your comments. However, everything that is said will be anonymous, and I will not use your names in anything I write based on our discussion today. Keep in mind that we are just as interested in negative comments as positive comments, and at times the negative comments are the most helpful. If you want to follow up on something that someone has said, you want to agree, or disagree, or give an example, feel free to do that. Don't feel like you have to respond to me all the time. Feel free to have a conversation with one another. I am here to ask questions, to listen, and to make sure everyone has a chance to share. I am interested in hearing from each of you.

Thank you very much for your cooperation, and feel free to enjoy the refreshments if you like. Let's begin.

[Introduction of participants, exchange of names]

Introductory theme

Q1 Do people know each other in your neighbourhood?

Q2 In what sort of things do you get involved in your community?

Q3 Are there things you particularly like or dislike about your community as a place to live?

Transition theme

Q4 In some places people have worse health than in others. Can you think of any reason for that?

Q5 Which of those are particularly important in your community?

Q6 If you think about your community, would you say that the health of the residents has changed over the last 30 years?

Q7 What factors would you say have led to those changes?

Q8 What about the closure of the Collieries in this area? Would you say that has anything to do with health in your community?

Key questions theme

[Choosing of newspaper headlines; "+ positive" or "- negative" connotation.]

Q9 Please let us know why you chose this headline.

+ District Council helps communities to live healthier and more fulfilling lives
+ District Council helps residents to take greater personal responsibility for their health
+ Join a fun packed programme of fitness and healthy eating sessions
+ Gardening for health – nature's own fitness centre
+ Be cool, walk to school
+ Golf your way to a longer life
+ Good fitness offers hope for fatigue and depression
+ Get a dog and walk for health
+ It is never too late to start
+ Regular walking slashes risk of stroke dramatically
– Poor people are less healthy than rich people
– Cyclist run over by car
– Running is bad for your knees
– Local park needs makeover
– Potholes everywhere
– Greatest health risk isn't cancer or heart disease - it's lack of exercise
– Eating, drinking and watching TV cause more deaths than smoking
– High crime rates upset local residents
– Smoking and drinking for comfort
– Drug use increased dramatically over the last years

Q10 People in some places do more walking, gardening, or other things that doctors say are good for health than people from other places. Do you have any ideas what the reasons for that may be?

Q11 How important are activities like walking and gardening in your life?

Ending questions

Q12 If you were in a discussion with local politicians or health experts: what would be the most important thing that you would suggest to them that needs to change to improve health in your community?

Q13 I needed your help to learn more about health in your community and where things are particularly good or bad. I wanted to know what helps you to do something for your health and what your council and politics in general could do to support your needs better. Is there anything that we missed? Is there anything that you came wanting to say that you did not get a chance to say?

Chapter 7

General Discussion

This thesis was concerned with issues that relate to the broader context of ecosocial theory which addresses the central question of "*who and what is responsible for population patterns of health, disease, and wellbeing, as manifested in present, past, and changing social inequalities in health*?" (Krieger, 2001: 694). The progressive development of obesogenic environments is strongly intertwined with the persistence of social inequalities in health. This includes both dietary as well as activity-related components, and the main focus of this thesis addressed the understanding of low physical activity in areas with a history of industrial decline.

The main research question was concerned with geographical patterns as well as socio-cultural dimensions of industrial restructuring: "*How does physical activity vary across England, and how may this be related to patterns of industrial restructuring*?" In particular, the thesis examined associations between physical activity and the socio-cultural context of industrial restructuring in England. After reviewing relevant theoretical and empirical evidence, a new conceptual framework linking the proposed pathways was presented and subsequently tested. Measures of physical activity and industrial restructuring were developed to analyse spatial variations in activity patterns and to examine how variations in outcomes related to industrial decline may be associated with current levels of activity across several activity domains. Furthermore, the thesis investigated mechanisms underlying the relationship between physical activity and socio-cultural factors that are relevant in the context of industrial restructuring. This final chapter summarises principal findings from the previous chapters and discusses the wider implications of the results for physical activity promotion in areas particularly affected by persisting socio-economic decline. It also provides a critical appraisal of issues related to broader conceptual challenges that shaped the development of this research and outlines areas for future research.

Summary of principal findings

Chapter 2 developed a new conceptual framework based on theoretical and empirical evidence, mainly from the UK, linking societal change to physical activity within the broader context of industrial restructuring and decline. The framework did not only consider economic dimensions, but linked a variety of related social and cultural changes to individual and contextual factors that were suggested to have a plausible effect on physical activity in adults. It was hypothesised that the observed decrease in occupational activities is directly related to current levels of overall activity. Furthermore, the framework related activity levels to the socio-cultural background of individuals and areas, as well as to the progressive development of obesogenic environments. This provided the conceptual background for the thesis, and subsequent chapters aimed to test mechanisms described in the framework.

Chapters 3 to 5 analysed how and in which areas across England variations in indicators related to considerable employment change in physically demanding occupations may be associated with different physical activity domains. Analyses included employment change in occupations related to the manufacturing, mining and agricultural sector as well as the domains of total, occupational, domestic, recreational and walking activity. With respect to the proposed framework, these chapters focused in particular on the pathway that linked the loss of manual jobs through the decline occupational physical activity to current levels of overall physical activity.

In particular, *Chapter 3* set out to develop a measure of industrial restructuring based on employment change in occupations which have been affected by severe employment decline over the past 160 years. This period was subdivided into relevant macro-economic eras to explore whether these have different relationships with current levels of physical activity. Results showed differences in levels of employment declines, which were highest across the agricultural and mining sector. There were geographical variations in employment losses between the different sectors as well as between time periods. Subsequently, it was tested whether these variations had associations with levels of physical activity. Interestingly, the effects observed were generally similar for men and women, but they differed across areas, time periods and employment types. Residents of areas with a history of high manufacturing employment during the mid-19th

century had increased odds of reporting lower activity levels across all activity domains and macro-economic time periods. Residents in agricultural areas reported relatively low walking activity. Declining mining employment was associated with an increased likelihood of reporting lower total, recreational and walking activities. Particularly within the recreational and walking domain, there was evidence of relatively strong associations between employment declines and lower physical activity.

In order to further explore these associations, C*hapter 4* aimed to provide new evidence on geographical variations in recreational physical activity and walking for the whole of England. Based on a previously unavailable sample size as well as a comprehensive range of activities it was possible to develop a direct measure of physical activity based on energy expenditure. From this, an additional measure of non-active behaviour was derived from participants who reported activity below a low threshold in any of the activities included. The subsequent analysis showed relatively low activity levels as well as high levels of non-participation in recreational physical activity amongst residents of more urban districts in the Midlands and the North where employment declines in manual occupations were particularly high.

Chapter 5 links previous findings to assess specifically associations between recreational activities, walking, and industrial restructuring. The analysis was stratified by urban/rural status and showed that urban residents living in areas with a history of employment decline in the mining sector had particularly high odds of reporting lower levels of recreational as well as walking activity.

Taken together, these analyses provided evidence for a relationship between socio-economic factors associated with the context of industrial decline and physical activity. With regards to lower levels of physical activity, the findings indicated that living in an area with industrial decline may affect a large proportion of the population, and certainly beyond those directly affected by the loss of their jobs, and this may be because factors related to the socio-cultural history of areas may shape attitudes and beliefs towards physical activity. The focus of the subsequent analysis shifted from an explanatory nature towards an understanding of how and why socio-cultural factors relevant in the context of industrial restructuring may shape activity behaviours and opportunities which consequently impacts levels of physical activity.

According to the proposed framework, *Chapter 6* examined mechanisms linking socio-cultural dimensions of industrial restructuring, including socio-economic, demographic and family-related factors, as well as the development of obesogenic environments driving physical activity behaviours. Since the associations observed in previous analyses suggested that residents of areas with a history of mining employment were likely to report relatively low levels of PA, this study took place in the North-East of England, an area with a strong historical tradition of mining, and included both a more urban and a more rural area where this industry completely ceased to exist. The results from this study provided evidence for a causal relationship between lower levels of physical activity and industrial decline and restructuring that appears to operate through the loss of occupational physical activity as well as the progressive development of obesogenic environments. Based on the four focus groups conducted, attitudes and beliefs directly related to the areas' industrial past were also shown to affect current activity behaviour. This somewhat differed for urban and rural areas, as well as the genders and also exhibited intergenerational differences. One of the main factors that changed activity patterns resulting directly from the closing of the collieries was related to the subsequent loss of recreational facilities, public green spaces and organised sport events. It was suggested that the development of interventions considering the socio-cultural history and socio-economic reality of communities could be a promising route to encourage more active lifestyles in areas with particularly low levels of physical activity.

Implications for promoting physical activity in areas of persisting socio-economic decline

The Marmot Review (2010) recently collated comprehensive evidence for persisting health inequalities in the UK. One of the key messages of the review is that health inequalities result from social inequalities. Furthermore, the report addressed three main reasons for the failure of government policies to reduce health inequalities. These included policies that have not addressed the underlying factors of inequality, did not reach the most deprived, and pursued inappropriate targets that have failed to consider the complex patterns of the social gradient in health (Mackenbach, 2010). With respect to increasing costs resulting from obesity-related diseases this remains a concerning development for health professionals and policy makers. Current policies in the UK,

however, do not provide a sustainable environment neither for tackling socio-economic nor health inequalities, as recently summarised by a publication evaluating why social inequalities persist (Dorling, 2011). The main concerns of that author include the reinforced exclusion of young adults from working-class areas to pursue a higher academic education in combination with increased youth unemployment, the progressive development of an economic environment that is based on low-paid and short-term contracts, and the introduction of spending cuts that mainly affect the well-being of already marginalised populations. This development underlines the necessity to target physical activity interventions to the right people in the right place with the right objectives.

It is hoped that this thesis has contributed to a better understanding of where across England levels of physical activity are particularly low, and how this may be related to variations in employment declines across different macro-economic settings. The results may inform health researchers aiming to increase levels of physical activity in areas of persisting socio-economic decline. Increasing occupational and domestic physical activity appears to have a limited scope (Fox et al., 2007), and prior research has shown that it has been difficult to reach and motivate residents of low-income communities to participate in health-enhancing recreational programmes and activities (Withall et al., 2010; Yancey et al., 2006). Bottom-down approaches in health policy have largely failed to reduce health inequalities and improve health behaviours (Bauld et al., 2007). According to Minkler et al. (2008), the creation of sustainable environments that include high-level participation in community-driven projects is based on the concepts of empowerment, critical consciousness, community capacity, social capital, issue selection, participation and relevance. The results of this thesis indicated that community-based health initiatives, which consider a comprehensive range of barriers towards physical activity and enforce existing community resources, may be a promising path to pursue. This could include interventions targeting both sides of the energy equation which are related to specific community settings, aiming to link place, space and network activities within specific physical, social and cultural environments to health and well-being (Smyth 2005).

This thesis indeed highlighted the importance of gardening, which is directly related to the industrial history of the study area. In a recent review of the contribution of domestic

gardens to urban green infrastructure, Cameron et al. (2012) specifically addressed the relevance of gardens in terms of their cultural, health-related and therapeutic context. Many aspects of gardening, including the cultivation of allotments and small holdings, have been shown to positively impact well-being and health. Numerous studies have also related gardening activities to increased physical activity, a better understanding of healthy food environments, stress relief and the development of social networks (e.g. Milligan et al. 2004; Park et al. 2009; Hale et al. 2011). Although the results from this thesis indicated that gardening was highly valued, the fact remained that health, time, availability and monetary constraints frequently limited residents' participation in this activity. This further highlights the fact that interventions need to specifically target the demands of a particular community in order to reduce barriers that prevent participation in activities that were otherwise likely to be undertaken more frequently.

The findings of this thesis also showed how some residents have explicit ideas and capacities to encourage, promote and support health and more active lifestyles in their communities. It was, however, highlighted that several of the projects required highly motivated "key players" who are able and willing to designate a considerable amount of time into community work. A reconsideration of how our society values voluntary engagement as well as organisational and monetary support may not only encourage more residents to get involved into community life and work, but also ensure the continuation of initiatives that benefit the whole of the community.

Finally, this research showed that there is indeed a demand for sport and exercise environments that encourage participation in recreational activities through the provision and organisation of adequate facilities and events. The promotion of physical activity as a primarily leisure-time pursuit is, however, unlikely to increase activity levels across the majority of the population. Instead, the reduction of sedentary time through increasing energy-expenditure of non-exercise activity thermogenesis (NEAT), including for example walking, cycling or climbing stairs, can result in burning an extra 500 to 1,000 kcal/day (Kotz et al., 2005; Levine et al., 2011). However, the findings from this thesis highlighted that walking activity was relatively low amongst residents in several areas of industrial decline, which was partly related to residents' perceptions of unattractive and unsafe activity spaces. This emphasises the importance to not only promote interventions

that directly address low levels of physical activity, but also the broader social and physical environments where activity behaviour takes place.

Promoting physical activity in areas of industrial decline remains challenging and involves the interplay of a broad range of factors that include the support of individual choices and the provision of adequate environmental conditions. Lang and Rayner (2007) have highlighted that the obesity epidemic is not just the result of insufficient physical activity and unhealthy diets, but a systemic failure of several interrelated dimensions, including material, physical, social and cognitive environments. They urge a substantial policy shift which needs to overcome political vanities and provide more equality across the whole of the population. Reducing social inequalities through the improvement of living conditions, particularly for those at the lower end of the socio-economic strata, combined with community-based projects addressing specific needs of residents appears to be a promising path to reduce health inequalities. This may eventually result into the development of more successful interventions to improve health-related behaviours such as physical activity across the whole of the population.

Strengths and limitations

As already evaluated throughout previous chapters of this thesis, the work presented here has a number of strengths and weaknesses. The subsequent discussion is therefore mainly concerned with a critical appraisal of issues related to broader conceptual challenges that shaped the development of the whole of the thesis.

A particular strength included the development of a new conceptual framework that links several dimensions of industrial restructuring to declines in population levels of physical activity. The setting of the framework, however, was based mainly on social, cultural, and economic developments within the UK, and, although related to the broader context of obesity-related research, puts physical activity in the centre of interest. Further, the scope of this work did not allow the testing of all of the pathways suggested by the framework. For example, the conceptual work highlighted the transformation of traditional family environments as an important determinant of physical activity, but here it was not possible to explore explicitly how industrial decline impacts physical activity in children, or how the presence of children may mediate activity behaviours of

adults. Furthermore, the framework addressed socio-cultural dimensions of industrial restructuring related to changes in the ethnic composition of populations; however, there was a lack of cultural diversity, particularly within the focus group participants, so it was not possible to extensively explore the effect of ethnicity on physical activity.

The linkage of nationally representative data samples allowed the analysis of physical activity measures in relation to historical context likely to impact health-related behaviours today. Using data from the *Health Survey for England* and the *Great Britain Historical GIS project* made it possible to assess associations between physical activity and industrial decline across multiple activity domains, including that of total, occupational, domestic, recreational and walking activity. The availability of data from the *Active People Survey* allowed for the development of physical activity measures based on energy expenditure, a subsequent geographical analysis of variations in measures of physical activity for the whole of England, as well as the stratification of the sample for urban/rural status. In combination, this provided the possibility to undertake a comprehensive analysis of how physical activity varies amongst residents of areas characterised by different types and levels of industrial decline for the whole of the country.

One of the main challenges throughout this work was the question of whether or not to adjust the analyses for measures representing individual-level socio-economic deprivation. On the one hand, factors such as individual income or social class were conceptually as well as empirically significantly associated with the area-based measurement representing industrial change. On the other hand, the nature of the physical activity measurements was cross-sectional; therefore, it was not possible to assess whether the associations observed were mediated by current individual socio-economic position. However, the theory underlying this work did not require this as the focus was on the evaluation of whether different macro-economic changes and employment characteristics of areas have different effects on present-day population levels of physical activity. Adjustment for individual-level measures may have inappropriately attenuated the magnitude of area effects, and therefore adjustment was not attempted.

Despite the question of individual-level adjustment, it is hoped that the thesis made a contribution towards the literature on associations between the social environment and physical activity by integrating a measure of macro-economic context which provided further evidence that health behaviours may be shaped by socio-cultural and historical context. The conclusions were, however, based on ecological associations which do not allow the inference of causality from the relationships observed. Subsequent research accounted for this weakness and applied focus group research to study mechanisms that may underlie prior observations. However, within the scope of the thesis it was not possible to extend the qualitative analysis beyond the particular setting of areas characterised by employment declines in the mining industry and to attempt similar investigations for areas with losses in manufacturing or agricultural employment.

In conclusion, it is hoped that the analysis strategy mitigated some of the limitations that arise from applying either quantitative or qualitative methodologies alone. According to Kessel et al. (2008: 6) the approach applied here attached 'meaning' to *"relationships that had been predetermined by existing categories"* through subsequent qualitative analysis. Although this contributed to a better understanding of how and why broader socio-cultural dimensions of industrial restructuring may shape attitudes and beliefs towards physical activity as well as the development of obesogenic environments, the qualitative component of the thesis followed deductive reasoning. A primarily inductive approach may have had the advantage to uncover more symbolic or "less practical" barriers or facilitating forces towards physical activity within the context of industrial decline, including, for example, themes framing deeper meanings and implications of powerlessness, discrimination, racism, loss of identity or the stigmatisation of places (Joshi, 2002; Popay, 2000; Popay et al., 2003).

Practical and theoretical recommendations for future work

Reducing health inequalities and increasing population levels of physical activity are two sides of the same coin, and the development of effective interventions needs to be based on the best available evidence. From a quantitative point of view, strong evidence comes from well-designed cohort or case control studies, multiple time series and randomised controlled trials (RCT). In assessing some of the criteria established by Hill (1965),

RCTs provide a particular potential to study causal relationships; the study design is, however, time-consuming, relatively costly and for ethical considerations frequently not applicable when studying environmental effects on health-related outcomes. A relatively young field addressing this issue applies natural experiments to study the effect of changes in the environment (e.g. changing transportation infrastructure) on particular health outcomes (e.g. active travelling) (Fitzhugh et al., 2010; Ogilvie et al., 2012). Frequently, this study design applies a mixed methods approach in combining quantitative and qualitative survey data with data from accelerometers and Global Positioning Systems (GPS), which are used to accurately track the location, frequency, and effort level of movement. It would be interesting to apply this methodology in areas of industrial decline where PA interventions such as free outdoor gyms or particular fitness programmes have been introduced, as well as in areas without specific health programmes for residents. A comparative analysis between and within these areas could provide a better understanding of how and why particular populations may or may not benefit from specific health interventions.

Another important issue across the current research field is related to the validation and evaluation of established physical activity guidelines across different populations and age-groups. For adults, the current guidelines recommend at least 150 minutes of moderate-intensity activity or 75 minutes of vigorous-intensity activity per week (Craig et al., 2009). However, these guidelines may not be appropriate for the increasing number of adults being overweight, obese or aiming to keep their weight status after a substantial weight loss. For example, current research indicates that the average time of moderate activity spend by successful weight-loss maintainers is 40 - 60 minutes per day (Catenacci et al., 2011; Catenacci et al., 2008) and comprises a variety of moderate to vigorous recreational as well as non-recreational activities (Bond et al., 2012). In the light of this evidence, increasing levels of activity in low-income communities becomes even more challenging and needs strong public support, political will and rigorous evaluation procedures (Howden-Chapman, 2010). The findings of this thesis showed that residents of areas with a history of mining employment were particularly likely to report relatively low participation in recreational PA and walking. It would be interesting to relate these findings to weight-related outcomes and investigate whether and how the

implementation of PA interventions affect health-related behaviours and outcomes in areas that are most affected by health as well as socio-economic inequalities.

From a theoretical point of view, our framework contributes to the field of ecosocial conceptualisation, and the whole of the thesis provides a new focus on the plausible relationship between physical activity and industrial restructuring, a relatively unexplored dimension within activity-related research. In comparison to previous research applying ecosocial frameworks within this field (e.g. Sallis et al., 2006; Sallis et al., 2008), our conceptual model as well as subsequent analyses integrate interrelations between individuals and their environment, particularly focusing on socio-cultural dimensions of industrial restructuring, including historically relevant aspects of employment change covering a period of 160 years. This provides a comprehensive, in-depth analysis of how and why changes in the broader environment related to the transformation of occupational structures may be particularly relevant in the context of activity-related research.

The theoretical challenge within an ecosocial framework relates to its positivistic tradition, summarised by Dunn (2012: 26-27). Key points outlined include the unity of science and its methods, the generation of knowledge through empirical means, explanation and prediction as main objectives of scientific research, and the claim of scientific knowledge being value neutral. It is hoped that this thesis contributed to a broader field of knowledge-generation than outlined in positivistic principles. The empirical analyses of the thesis are based on the development of a new, comprehensive conceptual framework, and the application of a mixed methods approach provided the opportunity to not only focus the analysis on explanation and prediction, but also obtain a deeper understanding of specific pathways linking physical activity to the socio-cultural context of industrial restructuring.

With respect to future developments within this theoretical and conceptual background, the framework of environmental justice has recently been used to address the disproportionate exposure of marginalised populations to obesogenic environments (Taylor et al., 2006). The movement roots back to protests in US communities during the early 1980s, and according to Bryant (1995: 6) environmental justice *"is served when people can realize their highest potential"*. This also includes the integration of social

justice which has been described as the foundation of public health (Krieger et al., 1998). Health as well as ill-health are indeed a public matter and directly related to social and political environments which greatly differ across more or less equal societies (Wilkinson et al., 2010). This is reflected through social systems determining health outcomes and privileging some parts of the population more than others (Lomas, 1998). Social justice has recently been linked to the ecologic milieu of physical activity which hypothesises the direct impact of the environment on physical activity (Lee et al., 2009; Spence et al., 2003). Within these contexts, it has been suggested that the development of future studies should aim to develop transdisciplinary projects and research networks that aim to analyse environmental changes in relation to obesity rates, population levels of physical activity as well as dietary factors (Taylor et al., 2006).

In practice, understanding the complexity of obesogenic environments requires the development of measures that capture multiple factors that impact obesity and obesity-related health behaviours. This also includes a better understanding of what residents perceive to be health-enhancing or adverse for their community in combination with objective needs established through evidence-based research. Although composite measures have been criticised for oversimplifying complex phenomena (Briggs, 2000), their application has been useful to identify variations in environmental adversity across populations. In England, the Index of Multiple Deprivation captures several domains of socio-economic deprivation (e.g. employment, income, health) for relatively small areas (David McLennan et al., 2011). Similar indices exist for constituent countries, and the development of an adjusted UK-wide index has been announced (Payne et al., 2012). Only recently, research has developed two small-area measures of health-related multiple physical environmental deprivation for the UK (Richardson et al., 2010). The integration of these measures with small-area data from survey series such as the *Health Survey for England* or the *Active People Survey* could provide a more complex picture of 'triple jeopardy', comprising environmental, social, and health-related inequalities (Pearce et al., 2011).

Overall conclusion

Levels of physical activity in England are low, and this is in part related to the progressive development of obesogenic environments to which those at the lower end of the socio-economic strata are unequally more exposed than others. This thesis highlights the importance of a range of factors which contribute to the understanding of observed geographical variations in levels of physical activity in adults. The results emphasise the importance of considering socio-cultural and historical dimensions for the development of physical activity interventions within communities with a particular industrial past. Promising initiatives, even in the most challenging environments, may be those that reinforce community structures and developments by pursuing a holistic approach towards a sustainable and active living environment.

References

Adams, S. A., Matthews, C. E., Ebbeling, C. B., et al. (2005). The Effect of Social Desirability and Social Approval on Self-Reports of Physical Activity. *American Journal of Epidemiology,* 161(4), 389-398.

Ainsworth, B. E., Haskell, W. L., Whitt, M. C., et al. (2000). Compendium of physical activities: an update of activity codes and MET intensities. *Medicine and Science in Sports and Exercise,* 32(9 Suppl), 498-504.

Allender, S., Cowburn, G. & Foster, C. (2006). Understanding participation in sport and physical activity among children and adults: A review of qualitative studies. *Health Education Research,* 21(6), 826-835.

Allender, S., Foster, C. & Boxer, A. (2008). Occupational and nonoccupational physical activity and the social determinants of physical activity: results from the Health Survey for England. *Journal of physical activity & health,* 5(1), 104-116.

Allender, S., Hutchinson, L. & Foster, C. (2008). Life-change events and participation in physical activity: a systematic review. *Health Promotion International,* 23(2), 160-172.

Allender, S. & Rayner, M. (2007). The burden of overweight and obesity-related ill health in the UK. *Obesity Reviews,* 8(5), 467-473.

Altena, B. & van der Linden, M. (2002). Preface. In B. Altena & M. van der Linden (Eds.), *De-industrialization: Social, Cultural, and Political Aspects* (pp. 1-2). Cambridge, New York, Melbourne: Press Syndicate of the University of Cambridge.

Altena, B. & van der Linden, M. (Eds.) (2002). *De-industrialisation: Social, Cultural, and Political Aspects*. Cambridge, New York: Press Syndicate of the University of Cambridge.

Andrews, G. J., Hall, E., Evans, B., et al. (2012). Moving beyond walkability: On the potential of health geography. *Social Science & Medicine,* 75(11), 1925-1932.

Ball, K., Cleland, V. J., Timperio, A. F., et al. (2010). Love thy neighbour? Associations of social capital and crime with physical activity amongst women. *Social Science & Medicine,* 71(4), 807-814.

Ball, K. & Crawford, D. (2005). The role of socio-cultural factors in the obesity epidemic. In D. Crawford & R. W. Jeffery (Eds.), *Obesity Prevention and Public Health* (pp. 37-53). Oxford, New York: Oxford University Press.

Ball, K., Mishra, G. D. & Crawford, D. (2003). Social factors and obesity: an investigation of the role of health behaviours. *International Journal of Obesity and Related Metabolic Disorders,* 27(3), 394-403.

Bambra, C. & Popham, F. (2010). Worklessness and regional differences in the social gradient in general health: Evidence from the 2001 English census. *Health & Place,* 16(5), 1014-1021.

Bauld, L., Judge, K. & Platt, S. (2007). Assessing the impact of smoking cessation services on reducing health inequalities in England: observational study. *Tobacco Control,* 16(6), 400-404.

Bazen, S. & Thirlwall, A. P. (Eds.) (1997). *UK industrialization and deindustrialization*. Oxford: Heinemann.

Beatty, C. & Fothergill, S. (1996). Labour Market Adjustment in Areas of Chronic Industrial Decline: The Case of the UK Coalfields. *Regional Studies,* 30(7), 627-640.

Beatty, C. & Fothergill, S. (2005). The diversion from 'unemployment' to 'sickness' across British regions and districts. *Regional Studies,* 39(7), 837 - 854.

Beatty, C., Fothergill, S. & Powell, R. (2005). *Twenty years on: Has the economy of the coalfields recovered?* Sheffield Hallam University: Centre for Regional Economic and Social Research.

Beckfield, J. & Krieger, N. (2009). Epi + demos + cracy: Linking Political Systems and Priorities to the Magnitude of Health Inequities - Evidence, Gaps, and a Research Agenda. *Epidemiologic Reviews,* 31(1), 152-177.

Bedford, T. & Burgess, J. (2001). The focus group experience In L. M & D. C (Eds.), *Qualitative methodologies for geographers: issues and debates* (pp. 121-135). New York: Arnold.

Berger, G. & Peerson, A. (2009). Giving young Emirati women a voice: Participatory action research on physical activity. *Health & Place,* 15(1), 117-124.

Berkman, L. F. & Kawachi, I. (2000). A Historical Framework for Social Epidemiology. In L. F. Berkman & I. o. Kawachi (Eds.), *Social epidemiology* (pp. 3-12). New York: Oxford University Press.

Blaxter, M. (1990). *Health and Lifestyles*. London, New York: Tavistock/Routledge.

Bleich, S., Cutler, D., Murray, C., et al. (2008). Why is the developed world obese? *Annual Review of Public Health,* 29, 273-295.

Blossom, J. C., Finkelstein, J. L., Guan, W. W., et al. (2011). Applying GIS Methods to Public Health Research at Harvard University. *Journal of Map & Geography Libraries,* 7(3), 349-376.

Bond, D. S., Raynor, H. A., Phelan, S., et al. (2012). The Relationship between Physical Activity Variety and Objectively Measured Moderate-to-Vigorous Physical Activity Levels in Weight Loss Maintainers and Normal-Weight Individuals. *Journal of Obesity,* 2012, 1-6.

Bourdieu, P. (1986). The forms of capital. In J. Richardson (Ed.), *Handbook of Theory and Research for the Sociology of Education* (pp. 241-258). New York: Greenwood.

Briggs, D. (2000). Decision-making in environmental health: from evidence to action. In C. Corvalan, D. Briggs & G. Zielhuis (Eds.), *Methods for building environmental health indicators* (pp. 57-75). London: SPON Routledge.

British Hearth Foundation, 2008. Synthetic estimates of the prevalence of CHD risk factors in England. Available at: <http://www.heartstats.org/datapage.asp?id=6964> (Accessed 08 December 2009).

Bromley, R. D. F., Tallon, A. R. & Roberts, A. J. (2007). New populations in the British city centre: Evidence of social change from the census and household surveys. *Geoforum*, 38(1), 138-154.

Brown, W. J. & Trost, S. G. (2003). Life transitions and changing physical activity patterns in young women. *American Journal of Preventive Medicine*, 25(2), 140-143.

Brownson, R. C., Boehmer, T. K. & Luke, D. A. (2005). Declining rates of physical activity in the United States: What are the contributors? *Annual Review of Public Health*, 26(1), 421-443.

Bryant, B. (1995). *Environmental Justice*. Washington: Island Press.

Bulmer, M. (Ed.) (1978). *Mining and social change*. London: Croom Helm Ltd.

Bulmer, M. I. A. (1975). Sociological models of the mining community. *The Sociological Review*, 23(1), 61-92.

Butland, B., Jebb, S., Kopelman, P., et al., 2007. Foresight. Tackling Obesities: Future Choices - Project Report, 2nd Edition. Available at: <http://www.foresight.gov.uk/Obesity/obesity_final/17.pdf> (Accessed 27 October 2008).

CABE, 2010. Urban green nation: Building the evidence base. Available at: <http://webarchive.nationalarchives.gov.uk/20110118095356/http://www.cabe.org.uk/files/urban-green-nation.pdf> (Accessed 13 March 2012).

Cameron, J. (2005). Focussing on the Focus Group. In I. Hay (Ed.), *Qualitative Research Methods in Human Geography, 2nd ed.* Melbourne: Oxford University Press.

Cameron, R. W. F., Blanuša, T., Taylor, J. E., et al. (2012). The domestic garden – Its contribution to urban green infrastructure. *Urban Forestry & Urban Greening*, 11(2), 129–137.

Candib, L. M. (2007). Obesity and Diabetes in Vulnerable Populations: Reflection on Proximal and Distal Causes. *Annals of Family Medicine*, 5(6), 547-556.

Carr, G. (2001). *Pit women: coal communities in Northern England in the early twentieth century*. London: Merlin.

Carrigan, M., Szmigin, I. & Leek, S. (2006). Managing routine food choices in UK families: The role of convenience consumption. *Appetite*, 47(3), 372-383.

Castells, M. & Aoyama, Y. (1994). Paths towards the Informational Society: Employment Structure in G-7 Countries, 1920-90. *International Labour Review*, 133(1), 5-33.

Catenacci, V. A., Grunwald, G. K., Ingebrigtsen, J. P., et al. (2011). Physical activity patterns using accelerometry in the National Weight Control Registry. *Obesity (Silver Spring),* 19(6), 1163-1170.

Catenacci, V. A., Ogden, L. G., Stuht, J., et al. (2008). Physical Activity Patterns in the National Weight Control Registry. *Obesity,* 16(1), 153-161.

Cawley, J. (2004). An economic framework for understanding physical activity and eating behaviors. *American Journal of Preventive Medicine,* 27(3 SUPPL.), 117-125.

CDC (2000). Prevalence of leisure-time and occupational physical activity among employed adults - United States, 1990. *Journal of the American Medical Association,* 283(23), 3064-3065.

Chau, J. Y., van der Ploeg, H. P., Merom, D., et al. (2012). Cross-sectional associations between occupational and leisure-time sitting, physical activity and obesity in working adults. *Preventive Medicine,* 54(3-4), 195–200.

Chevan, A. & Stokes, R. (2000). Growth in family income inequality, 1970-1990: Industrial restructuring and demographic change. *Demography,* 37(3), 365-380.

Cleland, V., Ball, K., Hume, C., et al. (2010). Individual, social and environmental correlates of physical activity among women living in socioeconomically disadvantaged neighbourhoods. *Social Science & Medicine,* 70(12), 2011-2018.

Cochrane, T., Davey, R. C., Gidlow, C., et al. (2009). Small area and individual level predictors of physical activity in urban communities: a multi-level study in Stoke on Trent, England. *International Journal of Environmental Research and Public Health,* 6(2), 654-677.

Coleman, J. S. (1990). *Foundations of social theory*. Cambridge: MA: Harvard University Press.

Craig, R. & Mindell, J. (Eds.) (2008). *The Health Survey for England 2006. Volume 1 - Cardiovascular disease and risk factors in adults*. London: The NHS Information Centre.

Craig, R., Mindell, J. & Hirani, V. (Eds.) (2009). *The Health Survey for England 2008. Volume 1 - Physical Activity and Fitness*. London: The NHS Information Centre.

Creswell, J. W. & Plano Clark, V. L. (2007). *Designing and conducting mixed methods research*. Thousand Oaks, California: Sage Publications, Inc.

Cummins, S., Stafford, M., Macintyre, S., et al. (2005). Neighbourhood environment and its association with self rated health: evidence from Scotland and England. *Journal of Epidemiology and Community Health,* 59(3), 207-213.

Curtis, S., Southall, H., Congdon, P., et al. (2004). Area effects on health variation over the life-course: analysis of the longitudinal study sample in England using new data on area of residence in childhood. *Social Science & Medicine,* 58(1), 57-74.

David McLennan, Barnes, H., Michael Noble, et al. (2011). *The English Indices of Deprivation 2010*. London: Department for Communities and Local Government.

De Meester, F., van Lenthe, F. J., Spittaels, H., et al. (2009). Interventions for promoting physical activity among European teenagers: A systematic review. *International Journal of Behavioral Nutrition and Physical Activity,* 6:82 doi:10.1186/1479-5868-6-82.

Defra, 2005. Rural Definition and Local Authority Classification. Available at: <http://archive.defra.gov.uk/evidence/statistics/rural/rural-definition.htm> (Accessed 16 August 2011).

Department for Transport (2010). *National Travel Survey 2009*. London: Office for National Statistics.

Department of Health, 2004. At least five a week. Evidence on the impact of physical activity and its relationship to health. A report from the Chief Medical Officer. Available at: <http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_4080994> (Accessed 27 October 2008).

Department of Health and Social Security (1980). *Inequalities in Health: Report of a Working Group Chaired by Sir Douglas Black*. London: DHSS.

Dibben, C., Sims, A., Watson, J., et al., 2004. The Health Poverty Index. South East Public Health Observatory, Oxford. Available at: <http://www.hpi2.org.uk/> (Accessed 3 March 2010).

Doran, T., Drever, F. & Whitehead, M. (2004). Is there a north-south divide in social class inequalities in health in Great Britain? Cross sectional study using data from the 2001 census. *BMJ (Clinical Research Ed.),* 328(7447), 1043-1045.

Doran, T., Drever, F. & Whitehead, M. (2006). Health underachievement and overachievement in English local authorities. *Journal of Epidemiology and Community Health,* 60(8), 686-693.

Doran, T. & Whitehead, M. (2003). Do social policies and political context matter for health in the United Kingdom? *International Journal of Health Services,* 33(3), 495-522.

Dorling, D. (2011). *Injustice. Why social inequality persists*. Bristol: The Policy Press.

Dorling, D., Mitchell, R., Shaw, M., et al. (2000). The Ghost of Christmas Past: health effects of poverty in London in 1896 and 1991. *BMJ (Clinical Research Ed.),* 321(7276), 1547-1551.

Dresing & Pehl GmbH, 2010. f4 audiotranskription. Available at: <http://www.audiotranskription.de/english/f4.htm> (Accessed 13 July 2011).

Dunn, J. R. (2012). "Explanation," Philosophy and Theory in Health Inequalities Research: Towards a Critical Realist Approach. In J. R. Dunn & P. O'Campo (Eds.), *Rethinking social epidemiology towards a science of change* (pp. 23-42). Dordrecht ; New York: Springer Science+Business Media B.V.

Elgar, F. J., Davis, C. G., Wohl, M. J., et al. (2011). Social capital, health and life satisfaction in 50 countries. *Health & Place,* 17(5), 1044-1053.

Ellaway, A., Benzeval, M., Green, M., et al. (2011). "Getting sicker quicker": Does living in a more deprived neighbourhood mean your health deteriorates faster? *Health & Place,* 18(2), 132-137.

Ellaway, A., Macintyre, S. & Kearns, A. (2001). Perceptions of Place and Health in Socially Contrasting Neighbourhoods. *Urban Stud,* 38(12), 2299-2316.

Elliott, J. (2005). *Using Narrative in Social Research. Qualitative and Quantitative Approaches*. London: Sage Publications, Inc.

Ellis, E., Grimsley, M., Goyder, E., et al. (2007). Physical activity and health: evidence from a study of deprived communities in England. *Journal of Physical Activity and Health,* 29(1), 27-34.

EURAREA Consortium (2004). *Enhancing small area estimation techniques to meet European needs. Final Project Report*. London: Office for National Statistics.

Eurostat, 2011. Overweight and obesity - BMI statistics. Available at: <http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Overweight_and_obesity_-_BMI_statistics> (Accessed 13 March 2012).

Fan, Y., Das, K. V. & Chen, Q. (2011). Neighborhood green, social support, physical activity, and stress: Assessing the cumulative impact. *Health & Place,* 17(6), 1202–1211.

Ferreira, I., Horst, K. v. d., Wendel-Vos, W., et al. (2007). Environmental correlates of physical activity in youth - a review and update. *Obesity Reviews,* 8(2), 129-154.

Fischbacher, C. M., Hunt, S. & Alexander, L. (2004). How physically active are South Asians in the United Kingdom? A literature review. *Journal of Physical Activity and Health,* 26(3), 250-258.

Fitzhugh, E. C., Bassett, D. R. & Evans, M. F. (2010). Urban Trails and Physical Activity: A Natural Experiment. *American Journal of Preventive Medicine,* 39(3), 259-262.

Fox, K. R. & Hillsdon, M. (2007). Physical activity and obesity. *Obesity Reviews,* 8 Suppl 1, 115-121.

Frost, M. & Spence, N. (1991). British employment in the eighties: The spatial, structural and compositional change of the workforce. *Progress in Planning,* 35(Part 2), 77-168.

Garson, D., 2009. Ordinal Regression. Available at: <http://faculty.chass.ncsu.edu/garson/PA765/ordinalreg.htm> (Accessed 18 December 2010).

Gibbs, A. (1997). *Focus groups. Social Research Update 19*. University of Surrey, England: Department of Sociology.

Gidlow, C., Johnston, L. H., Crone, D., et al. (2006). A systematic review of the relationship between socio-economic position and physical activity. *Health Education Journal,* 65(4), 338-367.

Gidlow, C., Johnston, L. H., Crone, D., et al. (2007). Socio-demographic patterning of referral, uptake and attendance in Physical Activity Referral Schemes. *Journal of Public Health,* 29(2), 107-113.

Gilbert, D. & Southall, H. (2000). The urban labour market. In M. Daunton (Ed.), *The Cambridge Urban History of Britain, Vol. III c. 1840-1950* (pp. 593-628). Cambridge: Cambridge University Press.

Gilbertson, J., Green, G., Grimsley, M., et al. (2005). *The Dynamic of Social Capital, Health and Economy: the impact of regeneration in South Yorkshire coalfield communities*. Sheffield Hallam University: Centre for Regional Economic and Social Research.

Gilbertson, J. & Manning, J. (2006). Social participation and social capital in South Yorkshire Coalfield Communities. *Voluntary action,* 8(1), 22-38.

Giles-Corti, B., Macintyre, S., Clarkson, J. P., et al. (2003). Environmental and lifestyle factors associated with overweight and obesity in Perth, Australia. *American Journal of Health Promotion,* 18(1), 93-102.

Glanz, K., Rimer, B. K. & Viswanath, K. (Eds.) (2008). *Health behavior and health education theory, research, and practice*. Hoboken: John Wiley & Sons Inc.

Goch, S. (2002). Betterment without Airs: Social, Cultural, and Political Consequences of De-industrialization in the Ruhr. In B. Altena & M. van der Linden (Eds.), *De-industrialisation: Social, Cultural, and Political Aspects*. Cambridge, New York: Press Syndicate of the University of Cambridge.

Goncalves, H., Hallal, P. C., Amorim, T. C., et al. (2007). Sociocultural factors and physical activity level in early adolescence. *Pan American journal of public health,* 22(4), 246-253.

Gourlay, G., 2007. 'It's got a bad name and it sticks…' Approaching stigma as a distinct focus of neighbourhood regeneration initiatives. Paper presented at the EURA Conference, 'The Vital City', 12-14 September 2007, Glasgow. Available at: <http://www.gla.ac.uk/media/media_47940_en.pdf> (Accessed 22 August 2010).

Government Equalities Office (2010). *An anatomy of economic inequality in the UK: Report of the national equality panel (The Hills Report)*. London: Centre for Analysis of Social Exclusion.

Gregory, I. N. & Southall, H. (1998). Putting the Past in Its Place: the Great Britain Historical GIS. In S. Carver (Ed.), *Innovations in GIS 5* (pp. 210-221): Taylor & Francis.

Hacking, J. M., Muller, S. & Buchan, I. E. (2011). Trends in mortality from 1965 to 2008 across the English north-south divide: comparative observational study. *BMJ (Clinical Research Ed.),* 342.

Hanibuchi, T., Kondo, K., Nakaya, T., et al. (2011). Does walkable mean sociable? Neighborhood determinants of social capital among older adults in Japan. *Health & Place,* 18(2), 229–239.

Harrison, R. A., Gemmell, I. & Heller, R. F. (2007). The population effect of crime and neighbourhood on physical activity: an analysis of 15 461 adults. *Journal of Epidemiology and Community Health,* 61:, 34-39.

Hartog, J. J., Boogaard, H., Nijland, H., et al. (2011). Do the health benefits of cycling outweigh the risks? *Cien Saude Colet,* 16(12), 4731-4744.

Haynes, R., Bentham, G., Lovett, A., et al. (1997). Effect of labour market conditions on reporting of limiting long-term illness and permanent sickness in England and Wales. *Journal of Epidemiology and Community Health,* 51(3), 283-288.

He, X. Z. & Baker, D. W. (2005). Differences in leisure-time, household, and work-related physical activity by race, ethnicity, and education. *Journal of General Internal Medicine,* 20(3), 259-266.

Henderson, J., 2011. Breaking through. Community-led health Organisations: Removing Barriers to Wellbeing. Community Health Exchange (CHEX). Available at: <http://www.chex.org.uk/media/resources/publications/briefings/Breaking%20Through%20%282nd%20edition%29.pdf> (Accessed 13 March 2012).

Hill, A. B. (1965). THE ENVIRONMENT AND DISEASE: ASSOCIATION OR CAUSATION? *Proceedings of the Royal Society of Medicine,* 58, 295-300.

Hobbs, P. (1992). The economic determinants of post-war British town planning. *Progress in Planning,* 38(Part 3), 185-300.

Hoebeke, R. (2008). Low-income women's perceived barriers to physical activity: focus group results. *Applied Nursing Research,* 21(2), 60-65.

Hopkins, P. E. (2007). Thinking critically and creatively about focus groups. *Area,* 39(4), 528-535.

Howden-Chapman, P. (2010). Evidence-based politics: How successful have government reviews been as policy instruments to reduce health inequalities in England? *Social Science & Medicine,* 71(7), 1240-1243.

Howley, E. T. (2001). Type of activity: resistance, aerobic and leisure versus occupational physical activity. *Medicine and Science in Sports and Exercise,* 33(6 Suppl), 364-369.

Imrie, R. (1991). Industrial change and local economic fragmentation: the case of Stoke-on-Trent. *Geoforum,* 22(4), 433-453.

Ipsos Mori, 2006. Active People Diagnostic. User Guide Manual. Version 1.5. Available at: <http://www.data-archive.ac.uk/doc/5767%5Cmrdoc%5Cpdf%5C5767technicalreport.pdf> (Accessed 20 October 2008).

Ipsos Mori, 2011. Active People Surveys 2, 3 and 4 and DCMS culture boost. Technical Report Final Version. Available at: <http://www.sportengland.org/search.aspx?query=active+people+technical+report> (Accessed 12 February 2012).

James, W. P. (1995). A public health approach to the problem of obesity. *International Journal of Obesity and Related Metabolic Disorders*, 19 Suppl 3, 37-45.

Jarvis, D., Dunham, P. & Ilbery, B. (2001). Rural industrialisation in a declining coalfield region: the case of north Warwickshire. *Geoforum*, 32(2), 271-283.

Jen, M. H., Sund, E. R., Johnston, R., et al. (2010). Trustful societies, trustful individuals, and health: An analysis of self-rated health and social trust using the World Value Survey. *Health & Place*, 16(5), 1022-1029.

Joint Committee of Beamish Museum, 2011. Report. Available at: <http://democracy.durham.gov.uk/documents/s1825/Item%202%20JC%20March%202011%20Museum%20Directors%20Report.pdf> (Accessed 20 November 2011).

Jones, A., Bentham, G., Foster, C., et al. (2007). *Foresight. Tackling Obesities: Future Choices – Obesogenic Environments – Evidence Review*. London.

Jones, A. P. & Bentham, G. (1997). Health service accessibility and deaths from asthma in 401 local authority districts in England and Wales, 1988-92. *Thorax*, 52(3), 218-222.

Jones, A. P. & Bentham, G. (2009). Obesity and the environment. In P. G. Kopelman, I. D. Caterson & W. H. Dietz (Eds.), *Clinical Obesity in Adults and Children* (pp. 440-451). Oxfordshire: Wiley-Blackwell Publishing.

Jones, A. P. & Bentham, G. (2009). Particulate air pollution and mortality from lung cancer in local authority districts in England and Wales. *Cancer Research Journal*, 2(4), 287-299.

Jones, A. P., Coombes, E. G., Griffin, S. J., et al. (2009). Environmental supportiveness for physical activity in English schoolchildren: a study using Global Positioning Systems. *International Journal of Behavioral Nutrition and Physical Activity*, 6, doi:10.1186/1479-5868-1186-1142.

Jones, A. P., Haynes, R., Kennedy, V., et al. (2008). Geographical variations in mortality and morbidity from road traffic accidents in England and Wales. *Health & Place*, 14(3), 519-535.

Joshi, C. (2002). On "De-industrialization" and the Crisis of Male Identities. In B. Altena & M. v. d. Linden (Eds.), *De-Industrialization: Social, Cultural, and Political Aspects* (pp. 159-175). Cambridge, New York: Press Syndicate of the University of Cambridge.

Kancs, d. A. (2010). The Economic Geography of Labour Migration: Competition, Competitiveness and Development. *Applied Geography*, 31(1), 191–200.

Kawachi, I. & Berkman, L. F. (2000). Social cohesion, social capital and health. In L. F. Berkman & I. Kawachi (Eds.), *Social epidemiology* (pp. 174-190). New York: Oxford University Press.

Kawachi, I., Kennedy, B. P., Lochner, K., et al. (1997). Social capital, income inequality, and mortality. *American Journal of Public Health,* 87(9), 1491-1498.

Kawachi, I., Subramanian, S. V. & Kim, D. (2008). Social Capital and Health. A Decade of Progress and Beyond. In I. Kawachi, D. Kim & S. V. Subramanian (Eds.), *Social Capital and Health* (pp. 1-26). New York: Springer Science + Business Media.

Kesaniemi, Y. A., Danforth Jr E, Jensen, M. D., et al. (2001). Dose-response issues concerning physical activity and health: An evidence-based symposium. *Medicine and Science in Sports and Exercise,* 33(6 SUPPL.), 351-358.

Kessel, A., Green, J., Pinder, R., et al. (2008). Multidisciplinary research in public health: A case study of research on access to green space. *Public Health,* 123(1), 32–38.

Khan, M. E. & Manderson, L. (1992). Focus groups in tropical diseases research. *Health Policy and Planning,* 7(1), 56-66.

Kim, D., Baum, C. F., Ganz, M., et al. (2011). The contextual effects of social capital on health: a cross-national instrumental variable analysis. *Social Science & Medicine,* 73(12), 1689-1697.

Kim, D. & Kawachi, I. (2010). Contextual Determinants of Obesity: An Overview. In J. Pearce & K. Witten (Eds.), *Geographies of Obesity. Environmental Understanding of the Obesity Epidemic* (pp. 39-54). Farnham, Burlington: Ashgate.

Kirk, M. A. & Rhodes, R. E. (2011). Occupation Correlates of Adults' Participation in Leisure-Time Physical Activity: A Systematic Review. *American Journal of Preventive Medicine,* 40(4), 476-485.

Kitzinger, J. (1994). The methodology of Focus Groups: the importance of interaction between research participants. *Sociology of Health & Illness,* 16(1), 103-121.

Kitzinger, J. (1995). Qualitative research. Introducing focus groups. *BMJ (Clinical Research Ed.),* 311(7000), 299-302.

Kopelman, P. (2007). Health risks associated with overweight and obesity. *Obesity Reviews,* 8 Suppl 1, 13-17.

Kotz, C. M. & Levine, J. A. (2005). Role of nonexercise activity thermogenesis (NEAT) in obesity. *Minnesota Medicine,* 88(9), 54-57.

Krieger, N. (2001). A glossary for social epidemiology. *Journal of Epidemiology and Community Health,* 55(10), 693-700.

Krieger, N. (2001). Historical roots of social epidemiology: socioeconomic gradients in health and contextual analysis. *International Journal of Epidemiology,* 30(4), 899-900.

Krieger, N. (2001). Theories for social epidemiology in the 21st century: an ecosocial perspective. *International Journal of Epidemiology,* 30(4), 668-677.

Krieger, N. & Birn, A. E. (1998). A vision of social justice as the foundation of public health: commemorating 150 years of the spirit of 1848. *American Journal of Public Health,* 88(11), 1603-1606.

Krueger, R. A. & Casey, M. A. (2000). *Focus Groups - 3rd Edition. A practical guide for applied research*. Thousand Oaks, London, New Delhi: Sage Publications, Inc.

Lader, D., Short, S. & Gershuny, J., 2006. The Time Use Survey, 2005. How we spend our time. Available at: <http://www.statistics.gov.uk/articles/nojournal/time_use_2005.pdf> (Accessed 09 December 2009).

Lang, T. & Rayner, G. (2007). Overcoming policy cacophony on obesity: an ecological public health framework for policymakers. *Obesity Reviews,* 8 Suppl 1, 165-181.

Lebel, A., Cantinotti, M., Pampalon, R., et al. (2011). Concept mapping of diet and physical activity: Uncovering local stakeholders perception in the Quebec City region. *Social Science & Medicine,* 72(3), 439-445.

Lee, I. M. & Buchner, D. M. (2008). The importance of walking to public health. *Medicine and Science in Sports and Exercise,* 40(7 Suppl), S512-518.

Lee, R. E. & Cubbin, C. (2009). Striding Toward Social Justice: the Ecologic Milieu of Physical Activity. *Exercise and Sport Sciences Reviews,* 37(1), 10-17.

Legh-Jones, H. & Moore, S. (2012). Network social capital, social participation, and physical inactivity in an urban adult population. *Social Science & Medicine,* 74(9), 1362–1367.

Leino-Arjas, P., Solovieva, S., Riihimäki, H., et al. (2004). Leisure time physical activity and strenuousness of work as predictors of physical functioning: a 28 year follow up of a cohort of industrial employees. *Occupational and Environmental Medicine,* 61(12), 1032-1038.

Levine, J. A., McCrady, S. K., Boyne, S., et al. (2011). Non-exercise physical activity in agricultural and urban people. *Urban Stud,* 48(11), 2417-2427.

Lindström, M. (2008). Social Capital and health-Related Behaviors. In I. Kawachi, D. Kim & S. V. Subramanian (Eds.), *Social Capital and Health* (pp. 215-238). New York: Springer Science + Business Media.

Livingstone, M., Robson, P., McCarthy, S., et al. (2001). Physical activity patterns in a nationally representative sample of adults in Ireland. *Public Health Nutrition,* 4(5A), 1107-1116.

Livingstone, M. B. E., Robson, P. J., Wallace, J. M. W., et al. (2003). How active are we? Levels of routine physical activity in children and adults. *Proceedings of the Nutrition Society,* 62(3), 681-701.

Lomas, J. (1998). Social capital and health: Implications for public health and epidemiology. *Social Science & Medicine,* 47(9), 1181-1188.

Loury, G. (1992). The economics of discrimination: getting to the core of the problem. *Harvard journal of African American Public Policy,* 1, 91-110.

Macintyre, S., Ellaway, A. & Cummins, S. (2002). Place effects on health: how can we conceptualise, operationalise and measure them? *Social Science & Medicine,* 55(1), 125-139.

Mackenbach, J. P. (2010). Has the English strategy to reduce health inequalities failed? *Social Science & Medicine,* 71(7), 1249-1253.

Mahmood, A., Chaudhury, H., Michael, Y., et al. (2012). A Photovoice Documentation of the Role of Neighborhood Physical and Social Environments in Older Adults' Physical Activity in two Metropolitan Areas in North America. *Social Science & Medicine,* 74(8), 1180-1192.

Mäkinen, T., Kestilä, L., Borodulin, K., et al. (2009). Occupational class differences in leisure-time physical inactivity - contribution of past and current physical workload and other working conditions. *Scandinavian Journal of Work, Environment and Health,* 36(1), 62-70.

Mangano, A. (2010). An analysis of the regional differences in health care utilization in Italy. *Health & Place,* 16(2), 301-308.

Marmot, M., 2010. Fair society, healthy lives. Strategic review of health inequalities in England post-2010. Available at: <http://www.marmotreview.org/AssetLibrary/pdfs/Reports/FairSocietyHealthyLives.pdf> (Accessed 07/09/2010).

Martin, S., L., Gregory, J. K., Kelly, M., et al. (2005). Urban, Rural, and Regional Variations in Physical Activity. *The Journal of Rural Health,* 21(3), 239-244.

Masse, L. C., Eason, K. E., Tortolero, S. R., et al. (2005). Comparing Participants' Rating and Compendium Coding to Estimate Physical Activity Intensities. *Measurement in Physical Education and Exercise Science,* 9(1), 1-20.

Mavoa, H. M. & McCabe, M. (2008). Sociocultural factors relating to Tongans' and Indigenous Fijians' patterns of eating, physical activity and body size. *Asia Pacific Journal of Clinical Nutrition,* 17(3), 375-384.

McAlister, A. L., Perry, C. L. & Parcel, G. S. (2008). How individuals, environments, and health behaviors interact. Social cognitive theory. In K. Glanz, B. K. Rimer & K. Viswanath (Eds.), *Health behavior and health education theory, research, and practice* (pp. 169-188). Hoboken: John Wiley & Sons Inc.

McLaren, L. & Hawe, P. (2005). Ecological perspectives in health research. *Journal of Epidemiology and Community Health,* 59(1), 6-14.

McLeod, H., Langford, I. H., Jones, A. P., et al. (2000). The relationship between socio-economic indicators and air pollution in England and Wales: implications for environmental justice. *Regional Environmental Change,* 1(2), 78-85.

McLeroy, K. R., Bibeau, D., Steckler, A., et al. (1988). An ecological perspective on health promotion programs. *Health Education Quarterly,* 15(4), 351-377.

McMichael, A. J. (1999). Prisoners of the Proximate: Loosening the Constraints on Epidemiology in an Age of Change. *American Journal of Epidemiology,* 149(10), 887-897.

McMichael, A. J. & Beaglehole, R. (2000). The changing global context of public health. *The Lancet,* 356(9228), 495-499.

McNeill, L. H., Kreuter, M. W. & Subramanian, S. V. (2006). Social Environment and Physical activity: A review of concepts and evidence. *Social Science & Medicine,* 63(4), 1011-1022.

Mellor, M. & Stephenson, C. (2005). The Durham Miners' Gala and the spirit of community. *Community Development Journal,* 40(3), 343-351.

Minkler, M., Wallerstein, N. & Wilson, N. (2008). Improving health through community organization and community building. In K. Glanz, B. K. Rimer & K. Viswanath (Eds.), *Health behavior and health education theory, research, and practice* (pp. 287-312). Hoboken: John Wiley & Sons Inc.

Mitchell, C. U. & LaGory, M. (2002). Social capital and mental distress in an impoverished community. *City & Community,* 1, 195-215.

Mitchell, R., Gibbs, J., Tunstall, H., et al. (2009). Factors which nurture geographical resilience in Britain: a mixed methods study. *Journal of Epidemiology and Community Health,* 63(1), 18-23.

Mitchell, R., Gleave, S., Bartley, M., et al. (2000). Do attitude and area influence health? A multilevel approach to health inequalities. *Health & Place,* 6(2), 67-79.

Montaño, D. E. & Danuta, K. (2008). Theory of reasoned action, theory of planned behavior, and the integrated behavioral models. In K. Glanz, B. K. Rimer & K. Viswanath (Eds.), *Health behavior and health education theory, research, and practice* (pp. 67-96). Hoboken: John Wiley & Sons Inc.

Moon, G., Quarendon, G., Barnard, S., et al. (2007). Fat nation: Deciphering the distinctive geographies of obesity in England. *Social Science & Medicine*, 65(1), 20-31.

Morency, C., Trépanier, M. & Demers, M. (2011). Walking to transit: An unexpected source of physical activity. *Transport Policy,* 18(6), 800–806.

Moseley, M. J. & Owen, S. (2008). The future of services in rural England: The drivers of change and a scenario for 2015. *Progress in Planning,* 69(3), 93-130.

Muntaner, C., Lynch, J. & Smith, G. D. (2001). Social capital, disorganized communities, and the third way: understanding the retreat from structural inequalities in epidemiology and public health. *International Journal of Health Services*, 31(2), 213-237.

Muntner, P., Gu, D., Wildman, R. P., et al. (2005). Prevalence of physical activity among Chinese adults: results from the International Collaborative Study of Cardiovascular Disease in Asia. *American Journal of Public Health*, 95(9), 1631-1636.

NHS Information Centre, 2011. The Health Survey for England. Available at: <http://www.dh.gov.uk/en/Publicationsandstatistics/PublishedSurvey/HealthSurveyForEngland/index.htm> (Accessed 31 October 2011).

Nottingham City Council, 2012. Communities for Health - Small Grants. Available at: <http://www.nottinghamcity.gov.uk/earlyyears/index.aspx?articleid=13590> (Accessed 13 October 2012).

O'Donnell, A., Welamedage, L. & Lambie, E., 2008. Equality and Diversity in the North East: a statistical profile. Available at: <http://www.equality-ne.co.uk/downloads/267_EandDstat.pdf> (Accessed 29 September 2011).

O'Neill, R., 2002. Experiments in living: the fatherless family. Available at: <http://www.civitas.org.uk/pdf/Experiments.pdf> (Accessed 07 June 2010).

Office for National Statistics, 1990. Standard Occupational Classification (SOC 1990). Available at: <http://www.statistics.gov.uk/STATBASE/Product.asp?vlnk=956&More=Y> (Accessed 13 May 2010).

Office for National Statistics, 2001. Census 2001. Available at: <http://www.statistics.gov.uk/census2001/pop2001/england_ages.asp> (Accessed 14 October 2009).

Office for National Statistics, 2001. England & Wales: Counties, Unitary Authorities and Local Authority Districts, 2001. Available at: <http://www.statistics.gov.uk/census2001/downloads/ewmap.pdf> (Accessed 12 November 2009).

Office for National Statistics, 2001. Neighbourhood Statistics: 2001 Census: Census Area Statistics: Population. Available at: <http://neighbourhood.statistics.gov.uk/dissemination/Download1.do> (Accessed 15 June 2010).

Office for National Statistics, 2003. Census 2001 - Families of England and Wales. Available at: <http://www.statistics.gov.uk/census2001/profiles/commentaries/family.asp> (Accessed 07 June 2010).

Office for National Statistics, 2009. Population: age, sex and legal marital status, 1971 onwards (England and Wales): Population Trends. Available at: <http://www.statistics.gov.uk/STATBASE/ssdataset.asp?vlnk=9540> (Accessed 10 August 2010).

Office for National Statistics, 2010. Mid Year Population Estimates 2006. Available at: <http://www.statistics.gov.uk/statbase/Product.asp?vlnk=15106> (Accessed 14 October 2009).

Office for National Statistics, 2010. Mid Year Population Estimates 2007. Available at: <http://www.statistics.gov.uk/statbase/product.asp?vlnk=15106> (Accessed 14 November 2010).

Ogilvie, D., Bull, F., Cooper, A., et al. (2012). Evaluating the travel, physical activity and carbon impacts of a 'natural experiment' in the provision of new walking and cycling infrastructure: methods for the core module of the iConnect study. *BMJ Open,* 2:e000694. doi:10.1136/bmjopen-2011-000694.

Panter, J. R., Jones, A. P. & van Sluijs, E. M. (2008). Environmental determinants of active travel in youth: A review and framework for future research. *International Journal of Behavioral Nutrition and Physical Activity,* 5:34, doi:10.1186/1479-5868-1185-1134.

Park, Y., Quinn, J., Florez, K., et al. (2011). Hispanic immigrant women's perspective on healthy foods and the New York City retail food environment: A mixed-method study. *Social Science & Medicine,* 73(1), 13-21.

Pateman, T., 2011. Rural and urban areas: comparing lives using rural/urban classifications. Regional Trends 43. Office for National Statistics. Available at: <http://www.ons.gov.uk/ons/rel/regional-trends/regional-trends/no--43--2011-edition/index.html> (Accessed 14 March 2012).

Payne, R. A. & Abel, G. A. (2012). UK indices of multiple deprivation – a way to make comparisons across constituent countries easier. *Health Statistics Quarterly,* 53, 22-37.

Pearce, J. & Witten, K. (2010). *Geographies of obesity: environmental understandings of the obesity epidemic*. Farnham, Surrey ; Burlington, VT: Ashgate.

Pearce, J. R., Richardson, E. A., Mitchell, R. J., et al. (2011). Environmental justice and health: A study of multiple environmental deprivation and geographical inequalities in health in New Zealand. *Social Science & Medicine,* 73(3), 410-420.

Phongsavan, P., Merom, D., Marshall, A., et al. (2004). Estimating physical activity level: the role of domestic activities. *Journal of Epidemiology and Community Health,* 58(6), 466-467.

Pickett, K. E. & Pearl, M. (2001). Multilevel analyses of neighbourhood socioeconomic context and health outcomes: a critical review. *Journal of Epidemiology and Community Health,* 55(2), 111-122.

Popay, J. (2000). Social capital: the role of narrative and historical research. *Journal of Epidemiology and Community Health,* 54(6), 401.

Popay, J., Thomas, C., Williams, G., et al. (2003). A proper place to live: health inequalities, agency and the normative dimensions of space. *Social Science & Medicine,* 57(1), 55-69.

Popham, F. & Mitchell, R. (2007). Relation of employment status to socioeconomic position and physical activity types. *Preventive Medicine,* 45(2-3), 182-188.

Putnam, R. D. (1993). *Making democracy work: Civic traditions in modern Italy*. Princeton, NJ: Princeton University Press.

Rabiee, F. (2004). Focus-group interview and data analysis. *Proceedings of the Nutrition Society,* 63(4), 655-660.

Rasbash, J., Charlton, C., Browne, W., et al. (2011). MLwiN, Version 2.23. *Centre for Multilevel Modelling, University of Bristol*.

Richardson, E. A., Mitchell, R., Shortt, N. K., et al. (2010). Developing summary measures of health-related multiple physical environmental deprivation for epidemiological research. *Environment and Planning A,* 42(7), 1650-1668.

Rind, E. & Jones, A. P. (2011). The geography of recreational physical activity in England. *Health & Place,* 17(1), 157-165.

Ritchie, J. & Spencer, L. (1994). Qualitative data analysis for applied policy research. In A. Bryman & R. G. Burgess (Eds.), *Analysing Qualitative Data* (pp. 173-194). London: Routledge.

Riva, M., Terashima, M., Curtis, S., et al. (2011). Coalfield health effects: Variation in health across former coalfield areas in England. *Health & Place,* 17(2), 588-597.

Ross, M. H. & Murray, J. (2004). Occupational respiratory disease in mining. *Occupational Medicine,* 54(5), 304-310.

Sallis, J. F., Cervero, R. B., Ascher, W., et al. (2006). An ecological approach to creating active living communities. *Annual Review of Public Health,* 27, 297-322.

Sallis, J. F. & Owen, N. (1999). *Physical activity and behavioral medicine*. Thousand Oaks, CA: Sage Publications, Inc.

Sallis, J. F., Owen, N. & Fisher, E. B. (2008). Ecological models of health behaviour. In K. Glanz, B. K. Rimer & K. Viswanath (Eds.), *Health behavior and health education theory, research, and practice* (pp. 465-485). Hoboken: John Wiley & Sons Inc.

Sarrafzadegan, N., Kelishadi, R., Abdulmehdi, B., et al. (2008). Metabolic syndrome: An emerging public health problem in Iranian Women: Isfahan Healthy Heart Program. *International Journal of Cardiology,* 131(1), 90-96.

Scarborough, P. & Allender, S. (2008). The North-South gap in overweight and obesity in England. *British Journal of Nutrition,* 100(3), 677-684.

Scarborough, P., Allender, S., Rayner, M., et al. (2009). Validation of model-based estimates (synthetic estimates) of the prevalence of risk factors for coronary heart disease for wards in England. *Health & Place,* 15(2), 596-605.

Schmid, T. L., Pratt, M. & Witmer, L. (2006). A Framework for Physical Activity Policy Research. *Journal of Physical Activity and Health,* 3(Suppl 1), S20-S29.

Scholes, S., Pickering, K. & Rayat, P., 2007. Healthy Lifestyle Behaviours: Model Based Estimates for Middle Layer Super Output Areas and Local Authorities in England, 2003-2005: User Guide. Available at: <http://www.ic.nhs.uk/webfiles/Popgeog/MSOA%20and%20LA%20User%20Guide.pdf> (Accessed 26 February 2010).

Shaffer, J. P. (1995). Multiple hypothesis testing. *Annual Review of Psychology*, 1(46), 561-584.

Shucksmith, J., Carlebach, S., Riva, M., et al. (2010). *Health Inequalities in Ex-Coalfield/Industrial Communities*. London: Improvement and Development Agency.

Simpson, L. (2002). Geography conversion tables: a framework for conversion of data between geographical units. *International Journal of Population Geography*, 8(1), 69-82.

Sjöström, M., Oja, P., Hagströmer, M., et al. (2006). Health-enhancing physical activity across European Union countries: the Eurobarometer study. *Journal of Public Health*, 14(5), 291-300.

Sly, F. (Ed.) (2009). *Regional Trends 41*. Basingstoke, New York: Office for National Statistics and Palgrave Macmillan.

Smith, D. (1989). *North and South: Britain's economic, social and political divide*. London: London : Penguin.

Sobek, M. (2006). Occupations. In S. B. Carter, S. S. Gartner, M. R. Haines, A. L. Olmstead, R. Sutch & G. Wright (Eds.), *Historical Statistics of the United States. Earliest Times to the Present* (pp. 2–35-32–40). New York: Cambridge University Press.

Southall, H. (2007). A vision of Britain through time: online access to “statistical heritage”. *Significance*, 4(2), 67-70.

Southall, H. (2011). Rebuilding the Great Britain Historical GIS, Part 1: Building an Indefinitely Scalable Statistical Database. *Historical Methods: A Journal of Quantitative and Interdisciplinary History*, 44(3), 149-159.

Southall, H. & Great Britain Historical GIS Project, 2009. A vision of Britain through time. Available at: <http://www.visionofbritain.org.uk/index.jsp> (Accessed 14 October 2010).

Southall, H. & Great Britain Historical GIS Project, 2009. A vision of Britain through time. Statistical Atlas. Available at: <http://www.visionofbritain.org.uk/atlas/index.jsp> (Accessed 13 March 2010).

Spence, J. C. & Lee, R. E. (2003). Toward a comprehensive model of physical activity. *Psychology of Sport and Exercise*, 4(1), 7-24.

Sport England, 2011. The Active People Survey. Available at: <http://www.sportengland.org/research/active_people_survey.aspx> (Accessed 18 October 2011).

Sriskandarajah, D., Crawley, H., Dhudwar, A., et al. (2004). *Labour migration to the UK - an ippr FactFile*. London: Institute for Public Policy Research.

Stafford, M., Cummins, S., Ellaway, A., et al. (2007). Pathways to obesity: Identifying local, modifiable determinants of physical activity and diet. *Social Science & Medicine,* 65(9), 1882-1897.

Stamatakis, E. & Chaudhury, M. (2008). Temporal trends in adults' sports participation patterns in England between 1997 and 2006: the Health Survey for England. *British Journal of Sports Medicine,* 42(11), 901-908.

Stamatakis, E., Ekelund, U. & Wareham, N. J. (2007). Temporal trends in physical activity in England: The Health Survey for England 1991 to 2004. *Preventive Medicine,* 45(6), 416-423.

Stokols, D. (1992). Establishing and maintaining healthy environments. Toward a social ecology of health promotion. *American Psychologist,* 47(1), 6-22.

Story, M., Kaphingst, K. M., Robinson-O'Brien, R., et al. (2008). Creating healthy food and eating environments: policy and environmental approaches. *Annual Review of Public Health,* 29, 253-272.

Subramanian, S. V., Huijts, T. & Perkins, J. M. (2009). Association between political ideology and health in Europe. *The European Journal of Public Health,* 19(5), 455-457.

Subramanian, S. V. & Kawachi, I. (2004). Income Inequality and Health: What Have We Learned So Far? *Epidemiologic Reviews,* 26(1), 78-91.

Swinburn, B., Egger, G. & Raza, F. (1999). Dissecting Obesogenic Environments: The Development and Application of a Framework for Identifying and Prioritizing Environmental Interventions for Obesity. *Preventive Medicine,* 29(6), 563-570.

Taylor, W. C., Poston, W. S. C., Jones, L., et al. (2006). Environmental Justice: Obesity, Physical Activity, and Healthy Eating. *Journal of Physical Activity and Health,* 3(Suppl 1), S30-S54.

The Health and Social Care Information Centre (2008). *The Health Survey for England 2007. Latest Trends*. London.

Thivierge-Rikard, R. V. & Mair, C. A. (2010). The Strength of Strong Ties for Older Rural Adults: Regional Distinctions in the Relationship between Social Interaction and Subjective Well-Being. *The International Journal of Aging and Human Development,* 70(2), 119-143.

Thomson, H., Kearns, A. & Petticrew, M. (2003). Assessing the health impact of local amenities: a qualitative study of contrasting experiences of local swimming pool and leisure provision in two areas of Glasgow. *Journal of Epidemiology and Community Health,* 57(9), 663-667.

Thomson, K., 2010. Breaking through. Healthy Living Centres: Removing Barriers to Wellbeing. Community Health Exchange (CHEX). Available at: <http://www.chex.org.uk/media/resources/publications/briefings/Breaking%20Through.pdf> (Accessed 14 March 2012).

Trochim, W. & Kane, M. (2005). Concept mapping: an introduction to structured conceptualization in health care. *International Journal for Quality in Health Care,* 17(3), 187-191.

Trost, S. G., Owen, N., Bauman, A. E., et al. (2002). Correlates of adults' participation in physical activity: review and update. *Medicine and Science in Sports and Exercise,* 34(12), 1996-2001.

Tunstall, H., Mitchell, R., Gibbs, J., et al. (2007). Is economic adversity always a killer? Disadvantaged areas with relatively low mortality rates. *Journal of Epidemiology and Community Health,* 61(4), 337-343.

Twigg, L., Moon, G. & Jones, K. (2000). Predicting small-area health-related behaviour: a comparison of smoking and drinking indicators. *Social Science & Medicine,* 50(7-8), 1109-1120.

Uitenbroek, D. G. & McQueen, D. V. (1991). Leisure time physical activity behavior in three British cities. *Sozial- und Präventivmedizin,* 36(6), 307-314.

Vogl, M., Wenig, C. M., Leidl, R., et al. (2012). Smoking and health-related quality of life in English general population: implications for economic evaluations. *BMC Public Health,* 12, 203.

Voigtländer, S., Berger, U. & Razum, O. (2010). Increasing regional disparities in living conditions in Germany and their role in the explanation of health inequalities. *Gesundheitswesen,* 72(5), 301-308.

Waddington, D., Critcher, C., Dicks, B., et al. (2001). *Out of the Ashes? The Social Impact of Industrial Contraction and Regeneration on Britain's Mining Communities.* Norwich: The Stationery Office Limited.

Walker, A., Flatley, J., Kershaw, C., et al. (Eds.) (2009). *Crime in England and Wales 2008/2009. Volume 1. Findings from the British Crime Survey and police recorded crime*. London: Home Office.

Walsh, D., Taulbut, M. & Hanlon, P. (2008). *The Aftershock of Deindustrialisation. Trends in mortality in Scotland and other parts of post-industrial Europe*. Glasgow: Glasgow Centre for Population Health.

Walsh, D., Taulbut, M. & Hanlon, P. (2009). The aftershock of deindustrialization - trends in mortality in Scotland and other parts of post-industrial Europe. *The European Journal of Public Health,* 20(1), 58-64.

Wandel, M. & Roos, G. (2005). Work, food and physical activity. A qualitative study of coping strategies among men in three occupations. *Appetite,* 44(1), 93-102.

Warburton, D. E., Nicol, C. W. & Bredin, S. S. (2006). Health benefits of physical activity: the evidence. *Canadian Medical Association Journal,* 174(6), 801-809.

Warburton, D. E., Nicol, C. W. & Bredin, S. S. (2006). Prescribing exercise as preventive therapy. *Canadian Medical Association Journal,* 174(7), 961-974.

Warr, D. J., Tacticos, T., Kelaher, M., et al. (2007). `Money, stress, jobs': Residents' perceptions of health-impairing factors in `poor' neighbourhoods. *Health & Place,* 13(3), 743-756.

Wen, C. P., Tsai, S. P. & Gibson, R. L. (1983). Anatomy of the healthy worker effect: a critical review. *Journal of Occupational Medicine,* 25(4), 283-289.

Wendel-Vos, W., Droomers, M., Kremers, S., et al. (2007). Potential environmental determinants of physical activity in adults: a systematic review. *Obesity Reviews,* 8(5), 425-440.

White, A., De Sousa, B., De Visser, R., et al. (2011). Men's health in Europe. *Journal of Men's Health,* 8(3), 192-201.

Whitehead, M. & Popay, J. (2010). Swimming upstream? Taking action on the social determinants of health inequalities. *Social Science & Medicine,* 71(7), 1234-1236.

Whitelaw, S., Swift, J., Goodwin, A., et al. (2008). *Physical Activity and Mental Health: the role of physical activity in promoting mental wellbeing and preventing mental health problems. An Evidence Briefing*. Edinburgh: NHS Health Scotland.

WHO (2005). *The SuRF Report 2. Surveillance of chronic disease risk factors*. Geneva: WHO.

WHO, 2006. Physical activity and health in Europe: Evidence for action. Available at: <http://www.euro.who.int/document/e89490.pdf> (Accessed 14 October 2008).

WHO (2009). *Global health risks. Mortality and burden of disease attributable to selected major risks*. Geneva: WHO Press.

Wilcox, S., Irwin, M. L., Addy, C., et al. (2001). Agreement between participant-rated and compendium-coded intensity of daily activities in a triethnic sample of women ages 40 years and older. *Annals of Behavioral Medicine,* 23(4), 253-262.

Wilkinson, R. & Pickett, K. (2010). *The Spirit level. Why Equality is Better for Everyone*. London: Penguin Books.

William, F. W. & Alan, M. D. (2009). Geographic information systems. *Wiley Interdisciplinary Reviews: Computational Statistics,* 1(2), 167-186.

Williams, N. H. (2009). "The wise, for cure, on exercise depend": physical activity interventions in primary care in Wales. *British Journal of Sports Medicine,* 43(2), 106-108.

Withall, J., Jago, R. & Fox, K. R. (2010). Who attends physical activity programmes in deprived neighbourhoods? *Health Education Journal,* 70(2), 206-216.

WMCIU, 2011. The Working Men's Club & Institute Union. Available at: <http://www.wmciu.org.uk/> (Accessed 23 May 2011).

Yancey, A. K., Ory, M. G. & Davis, S. M. (2006). Dissemination of physical activity promotion interventions in underserved populations. *American Journal of Preventive Medicine,* 31(4 Suppl), S82-91.

Yu, G., Renton, A., Schmidt, E., et al. (2011). A multilevel analysis of the association between social networks and support on leisure time physical activity: evidence from 40 disadvantaged areas in London. *Health & Place,* 17(5), 1023-1029.

Zenk, S. N. (2011). Activity space environment and dietary and physical activity behaviors: A pilot study. *Health & Place,* 17(5), 1150–1161.

Zweig, F. (1948). *Men in the pits*. London: Gollancz.

Rind, E. & Jones, A. P. (2011). The geography of recreational physical activity in England. *Health & Place*, 17(1), 157-165.

The geography of recreational physical activity in England

Abstract

Levels of physical activity have declined considerably over recent decades in England, and there is evidence that activity patterns vary across areas. Previous studies of the geography of physical activity have frequently relied on model based synthetic estimates. Using data from a large population survey, this study develops a direct measure of recreational physical activity and investigates variations in activity patterns across English Local Authorities. For both sexes the results show a distinct geography of recreational physical activity associated with north/south variations and urban/rural status. The environmental and behavioural factors driving those patterns are still poorly understood. We conclude that the variations observed might reflect recreational opportunities and the socio-cultural context of areas.

Introduction

A physical activity related energy expenditure of 1000 kcal per week has been linked with a fall in all-cause mortality risk of approximately 30% (Kesaniemi et al., 2001) and is associated with a reduction in the incidence of diseases such as coronary heart disease and type 2 diabetes (Department of Health, 2004). In England, however, there is evidence that average levels of energy expenditure from physical activity (PA) have declined in recent decades by as much as 800 kcal/day (James, 1995). For example, the mean distance walked has fallen by approximately 26% and that cycled by 24%, whilst employment in manual occupations involving heavy PA has reduced considerably (Butland et al., 2007). A decline in overall PA is one reason behind an increasing prevalence of obesity, which rose by approximately 10% in adults between 1993 and 2007 ((The Health and Social Care Information Centre, 2008).

Studies of the geography of health outcomes can provide new evidence on the role of population demographics as aspects of the physical and social environment as drivers of health-related behaviours. Prior conceptual work has shown that spatial variations in health outcomes result from compositional, contextual, and collective effects ((Macintyre et al., 2002). Compositional effects refer to characteristics of individuals in particular areas and comprise, for example, individual demographic characteristics or individual-level socio-economic status. These factors have been linked to activity patterns. For example, men are more active than women (Livingstone et al., 2001, 2003), and there is a distinct gradient in levels of PA across the socio-economic strata (Gidlow et al., 2006). In contrast to compositional effects, contextual effects refer to characteristics of places where people live and work. For example, attributes such as safety or attractiveness of green spaces have been associated with activity patterns, independent of compositional effects (Trost et al., 2002; Wendel-Vos et al., 2007). Collective effects comprise factors that are concerned with social, cultural, and historical features of places. For example, various studies have shown that cultural background impacts on attitudes towards exercise behaviours and affects levels of PA (Fischbacher et al., 2004; Mavoa et al., 2008; Sarrafzadegan et al., 2008). Therefore, collective factors offer an additional perspective on the socio-economic, psychological, and

epidemiological angles of the exploration of area effects on health and health-related behaviours (Macintyre et al., 2002).

Although individual and area characteristics have been linked to activity patterns, studies on geographical variations in PA over large areas are scarce. There is some evidence from the US that regional differences in activity and inactivity patterns might be related to urban and rural settings, respectively (Martin et al., 2005). Earlier work from the UK suggested that levels of unfitness, based on BMI, blood pressure, and respiratory function, were high in the West and the Midlands compared to the South and East (Blaxter, 1990). But to our knowledge there is only one recent study of the geography of PA in England. Ellis et al. (2007) investigated variations in activity levels across just 39 deprived towns and cities, highlighting low levels of PA, particularly amongst residents of more northern industrialised towns. Their findings suggested that inequalities related to social, economic, historical, and physical environments remained an important public health issue with respect to PA.

With the publication of the Black Report in 1980 by the former UK Department of Health and Social Security (1980), spatial disparities in health obtained a widely accepted political platform. The report emphasised that inequalities in health were both persistent and widening, in particular for those at the lower end of the socio-economic ladder living in the northern regions of England. Similar gradients have subsequently been shown for other countries including Germany (Voigtländer et al., 2010) and Italy (Mangano, 2010). Thirty years after the publication of the Black Report, the message has lost none of its topicality; Wilkinson and Pickett (2010) recently described significant inter- and intranational differences in 23 of the richest countries in the world for obesity and weight-related behaviours.

Due to the paucity of comprehensive datasets on health and health-related behaviours, research investigating health disparities frequently depends on the production of synthetic estimates when patterns are being analysed for small geographical units of analysis. Synthetic estimates have been produced and validated for a variety of health behaviours and outcomes including the prevalence of smoking, fruit and vegetable intake, drinking, diabetes, and obesity (Moon et al., 2007; Scarborough et al., 2009; Scholes et al., 2007; Twigg et al., 2000). Based on the Health Survey for England,

Dibben et al. (2004) produced two sets of synthetic estimates of physical inactivity (proportion doing under 5h of PA per week) for English Local Authority Districts for the years 2001 and 2003. The results show distinct variations between some of the districts, partly differing for males and females (maps available from British Hearth Foundation, 2008).

Synthetic estimates of health and health-related behaviours appear attractive for small area analyses by facilitating the comparison of particular localities with national averages. Indeed, it has been shown that synthetic estimates can be more accurate than underpowered national survey estimates (EURAREA Consortium, 2004). However, limitations of synthetic estimation include the fact that they are based on deterministic model outputs rather than objective measurements in local areas. Therefore, they are solely a function of the population prevalence of those characteristics used to estimate them. This is limiting as it is often the areas that do not conform to expectations from population demographics that are interesting from a research perspective. A related limitation is that it is not possible to further separate estimates for specific population subgroups, and confidence intervals surrounding the estimates can be wide, hindering geographical comparisons (Scholes et al., 2007). Scarborough et al. (2009) recently highlighted problems with the estimates of Dibben et al. (2004) related to model misspecification and invalid predictive validity due to the statistical dominance of age and sex. The authors concluded that public health policy and health interventions should not be based on results derived from these estimates.

Whilst the development of synthetic estimates for small geographical units can be useful if there are no other robust data available, the use of original measurements provides the possibility to understand actual patterns of health and health-related behaviours for local areas. In England, Local Authority Districts provide a suitable scale for comparison of health behaviours and outcomes as they are large enough to provide adequate study power (mean population per local authority in 2001: 138,810) (Office for National Statistics, 2001), but relatively environmentally homogeneous due to the fact that they do not mix large urban and rural areas within their boundaries. A number of studies executed at this scale have provided new insights into the aetiology of a range of health outcomes (Jones et al., 2008; Jones and Bentham, 1997, 2009; McLeod et al., 2000).

Recently, outputs from the Sport England Active People Survey (APS) have become available at the Local Authority District scale in England (Sport England, 2011). The sample size of the APS is large, with over 350,000 responses from adults. For the first time this provides the potential for the development of a set of comprehensive measures of geographical variations in PA covering the whole of England that are not based on synthetic estimates. Using data from the 2006 APS, this study has thus been undertaken to provide new evidence on geographical variations in PA and associated energy expenditure, with a focus on that undertaken for recreation.

Methods

Developing a measure of physical activity

Our measures of PA were based on data from the 2006 APS, a telephone survey of 363,724 adults (aged 16 to 85+) commissioned by Sport England and conducted between 2005 and 2006 across 354 English Local Authorities (Ipsos Mori, 2006). To achieve a nationally representative sample Random Digit Dialling was used with one respondent randomly selected from the eligible household members. On average, 250 telephone interviews were conducted with the residents of each Local Authority in each quarter of the study period.

The APS provided information on the frequency and duration of self-reported recreational PA and the number of days respondents walked at moderate intensity for 30 minutes or more within the 28 days preceding the interview. Those reporting walking were asked on how many of those days they were walking particularly for the purpose of health or recreation. No information was collected on occupational PA. APS participants were excluded from our study when they failed to provide full enough information for their PA to be determined, or when they reported over 16 hours of mean daily activity (Howley, 2001; Masse et al., 2005).

The primary PA measure was energy expenditure. The intensity level of a particular activity can be defined as the rate of energy expenditure related to body mass, expressed as metabolic rate. The resting metabolic rate equals an energy expenditure of approximately 1 kcal/kg/h. Metabolic equivalents (METs) are multiples of the resting

metabolic rate, and for adults METs can be taken as numerical equivalents to energy expenditure (Howley, 2001; Masse et al., 2005).

In order to calculate a measure of energy expenditure for each participant, the Compendium of Physical Activities was used (Ainsworth et al., 2000). It provides look-up tables for activities according to their respective MET intensity level, with a range of 0.9 METs (sleeping) to 18 METs (running at 10.9 mph). The appropriate MET-level provided by the Compendium of Physical Activities was assigned to each of the 237 activities mentioned by participants in the APS. In rare cases where particular activities were not listed in the Compendium of Physical Activities, the MET-level of a similarly patterned activity was assigned. In a few cases (e.g. for ‘‘modern pentathlon’’) it was necessary to calculate the median of several activities involved (pistol shooting, fencing, freestyle swimming, jumping, cross-country run). The PA measure generated, expressed as MET-min/week, is based on the methodology applied by Ball et al. (2003):

MET-min/week = $\sum$ (number of days undertaken the activity x time per session x MET-level of activity).

From this, an additional measure of more sedentary behaviour, an identifier of non-active respondents, was assigned to those who reported no PA (MET-min/week = 0).

Analysing geographical patterns

To investigate the geography of PA in England, the indicator of the Local Authority within which each APS respondent resided was used to compute directly age-standardised average MET-min/week (standard population: English adults aged 16 to 85+ (Office for National Statistics, 2001)), as well as rates of non-activity. As there is considerable evidence that levels of PA differ between men and women (Livingstone et al., 2001, 2003) analyses were stratified by sex. Maps were produced across Local Authorities for total PA energy expenditure, which were associated with walking, and for rates of non-activity. To explore the existence of spatial clustering in the mapped outputs, Moran's I statistics were calculated.

To provide context to the observed geographical patterns, the Government Office Region in which each Local Authority fell was identified. In addition, the urban–rural status of each Local Authority was ascertained using a published classification (Defra, 2005), as was whether the Local Authority fell in the North or South of England (Scarborough et al., 2008). Differences in the ranking of outcomes by these categorisations were tested using Kruskal–Wallis tests (Monte Carlo method) and the highest and lowest scoring Local Authorities were identified. Preliminary analysis showed that walking prevalence was particularly high in London boroughs, so these were treated as a third category in the tests. Due to the small number of interviews (< 200) obtained in each, the Isles of Scilly and the City of London were excluded from analysis. All analyses were undertaken in SPSS 16.0.

Results

From the original dataset, 3401 (<1%) individuals were excluded either due to incomplete questionnaires (3380) or reporting >16 hours/day PA (21), leaving 360323 participants. Table 1 summarises the PA characteristics of the included sample, of which 42% were male (compared to 48% in the 2001 Census in England), 24% were aged under 35 (compared to 32%), and 20% were aged over 64 (compared to 19%). Some 93% (compared to 92%) of participants gave their ethnic origin as White.

Table 1
Active People Survey 1 – descriptive statistics for the physical activity outcomes.
Data source: Sport England, Active People Survey 1, 2005 - 2006

	Total		**Males**		**Females**	
	Frequency	**%**	**Frequency**	**%**	**Frequency**	**%**
Total physical activity (PA)[a]						
Inactive respondents (PA = 0 MET-min/week)	154 649	42.9	57 429	38.4	97 220	46.2
Active respondents (PA > 0 MET-min/week)	205 674	57.1	92 296	61.6	113 378	53.8
Respondents excercising ≥ 675 MET-min/week[b]	104 270	28.9	52 741	35.2	51 529	24.5
Walking (W)						
Non-walkers (W = 0 MET-min/week)[c]	261 657	72.6	106 349	71.0	155 308	73.7
Walkers (W > 0 MET-min/week)	98 666	27.4	43 376	29.0	55 290	26.3
recreational walkers	*72 823*	*73.8*	*30 557*	*70.4*	*42 266*	*76.4*
non-recreational walkers	*47 811*	*48.5*	*22 225*	*51.2*	*25 586*	*46.3*

[a]Including recreational activities and non-recreational walks at a moderate pace ≥ 30 minutes.
[b]Government recommendation for moderate physical activity = 4.5 METs x 30 minutes x 5 days.
[c]No walking at moderate pace in 5 days ≥ 30 minutes.

The mean total PA energy expenditure reported for men was 839 MET-min/week (750 excluding walking) and for women 483 MET-min/week (394 excluding walking). The mean total energy expenditure for indoor swimming was 70 MET-min/week (13% of the respondents), 178 MET-min/week for going to the gym (10% of the respondents), and for recreational cycling 41 MET-min/week (8% of the respondents). Mean total walking-associated energy expenditure was 89 MET-min/week for both men and women, whilst that for recreational walking was 53 MET-min/week for men and 58 MET-min/week for women. The mean ratio of reported PA energy expenditure, excluding walking, to overall walking was 8.1 for men and 4.6 for women.

Figure 1 maps between-district variations in total physical activity energy expenditure across England. There is evidence of a general trend of higher physical activity in more southerly districts. Spatial clustering in the mapped pattern is low but statistically significant for both males (Moran's I = 0.06, $p < 0.01$) and females (Moran's I = 0.07, $p < 0.01$).

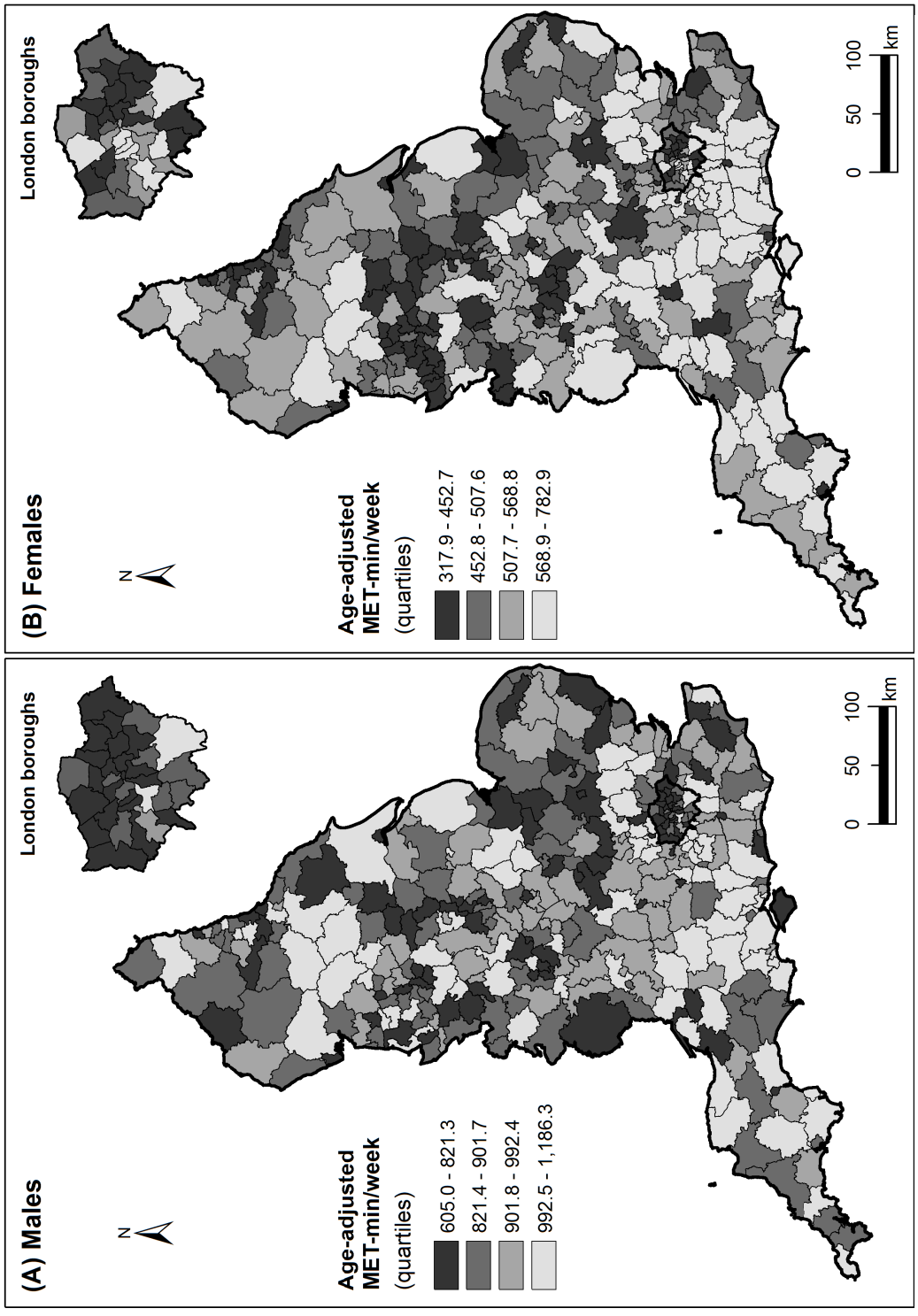
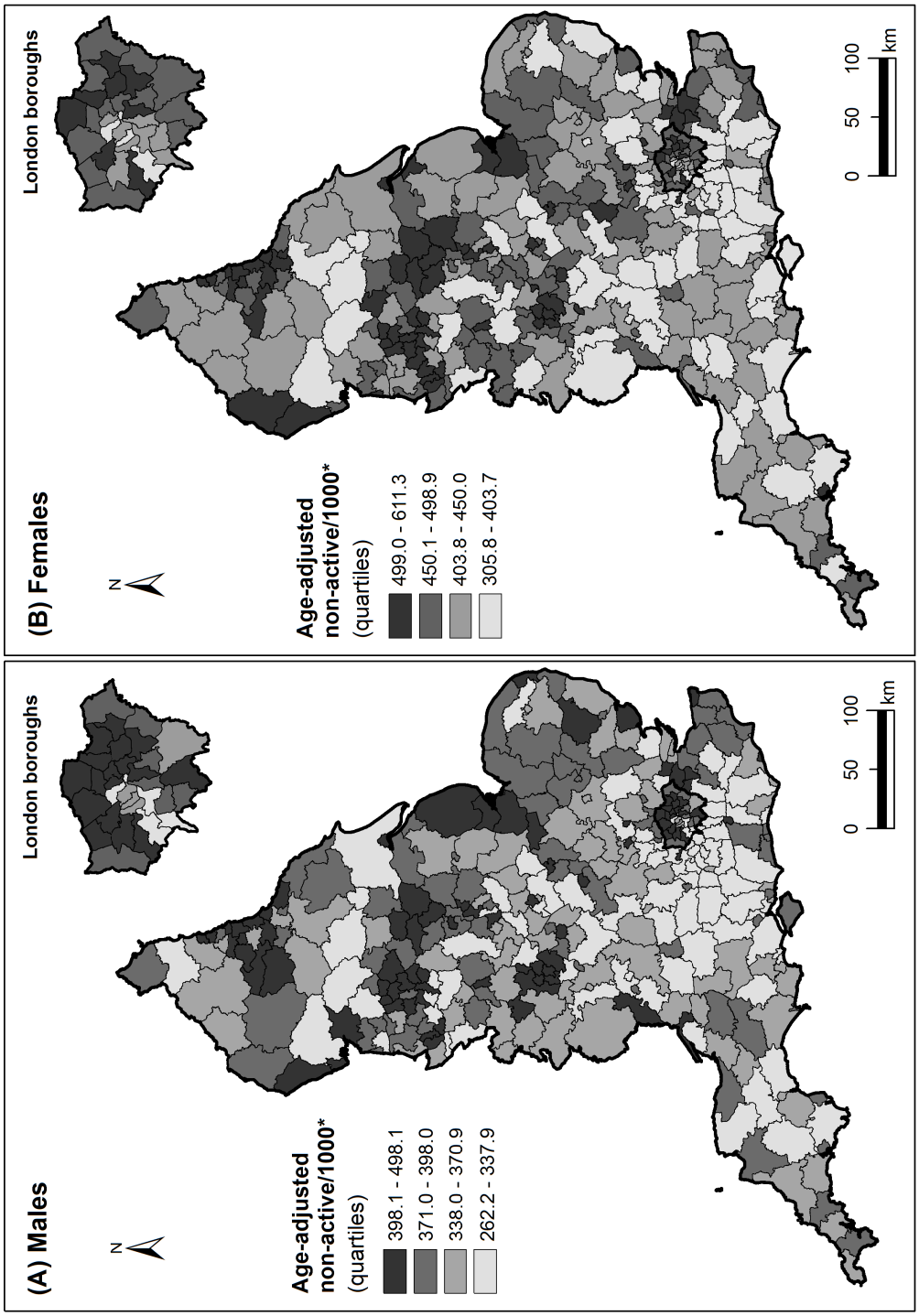


Figure 1 Age-adjusted total physical activity across English Local Authorities, 2005-2006.

Figure 2 highlights variations in rates of non-activity, which generally mirror that of physical activity. Spatial clustering was again relatively low, but statistically significant for both males (Moran's I = 0.07, $p < 0.01$) and females (Moran's I = 0.09, $p < 0.01$).



*MET-min/week = 0

Figure 2 Age-adjusted non-active population across English Local Authorities, 2005 – 2006.

Figure 3 depicts between district variations in total walking associated energy expenditure. A similar north-south gradient is apparent to that observed for overall physical activity, with again relatively low but statistically significant clustering for both males (Moran's I = 0.03, $p < 0.01$) and females (Moran's I = 0.14, $p < 0.01$).

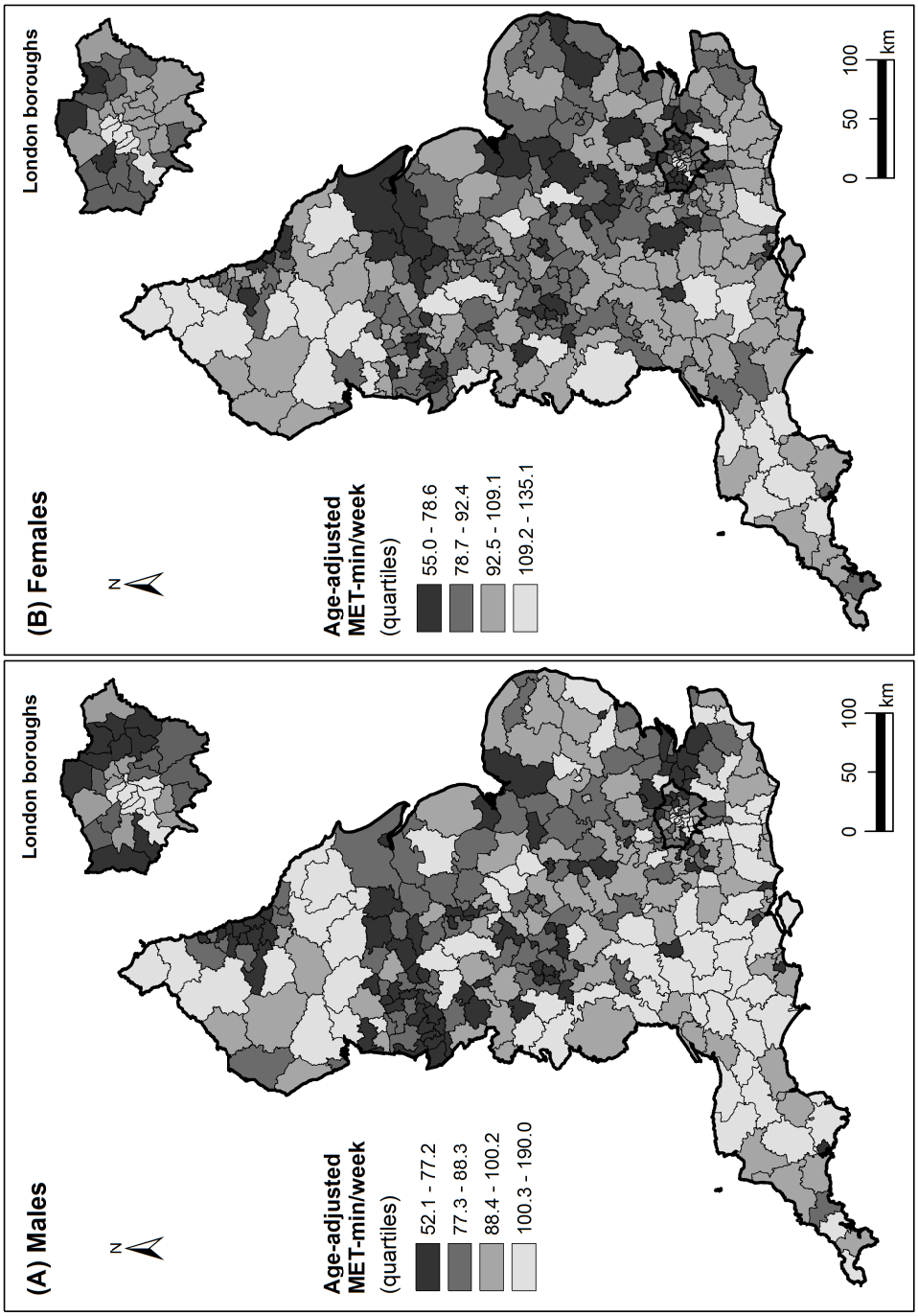
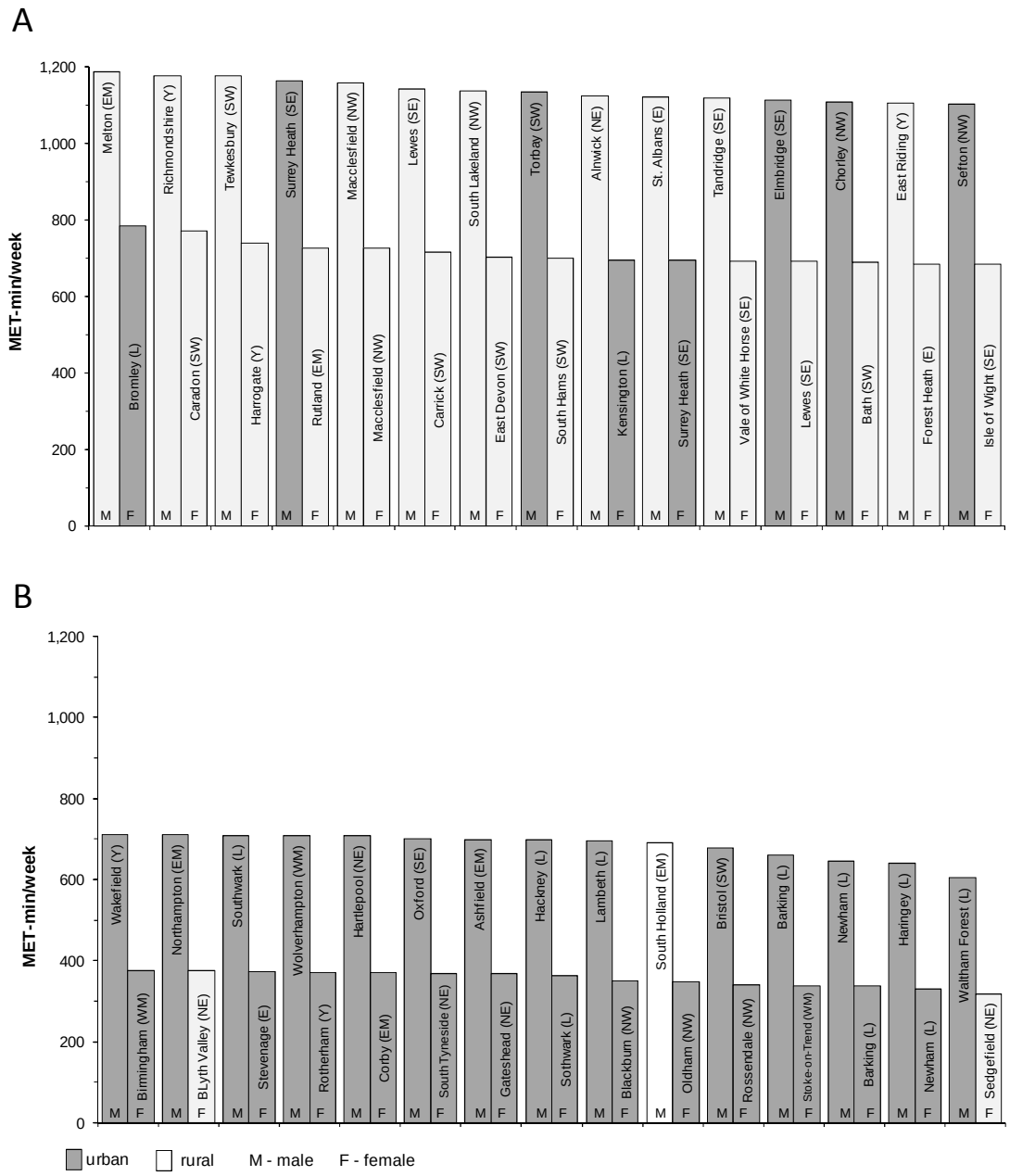


Figure 3 Age-adjusted total walking across English Local Authorities, 2005 – 2006.

Figure 4 shows the urban-rural status and Government Office Regions of the 30 (15 for males and 15 for females) Local Authorities ranked with the highest and lowest overall MET-min/week.

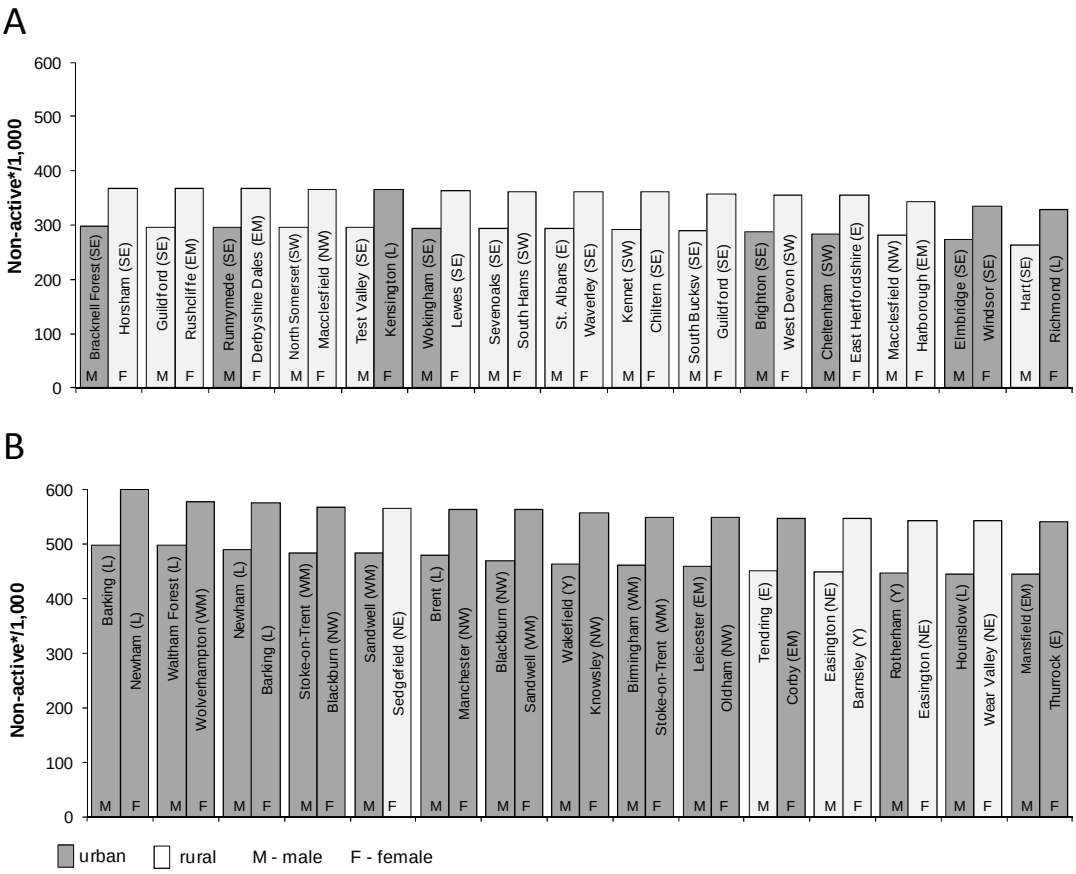


Government Office Regions: NE – North East, NW – North West, Y – Yorkshire, E – East, WM – West Midlands, EM – East Midlands, SW – South West, SE – South East, L – London.

Figure 4 Local Authorities with the (A) highest and (B) lowest age-adjusted MET-min/week of total recreational physical activity, 2005 – 2006.

It is noteworthy that 22 (73%) of the highest PA Local Authorities are rural, whilst 27 (90%) of the lowest are urban. Although the broad geographical patterns are similar, the districts with the highest and lowest PA differ for men and women. Although both high and low PA districts are found in northern and southern Government Office Regions, 10 (33%) of the lowest PA Local Authorities are in London.

Figure 5 shows the Local Authorities with the lowest and highest rates of non-active respondents.



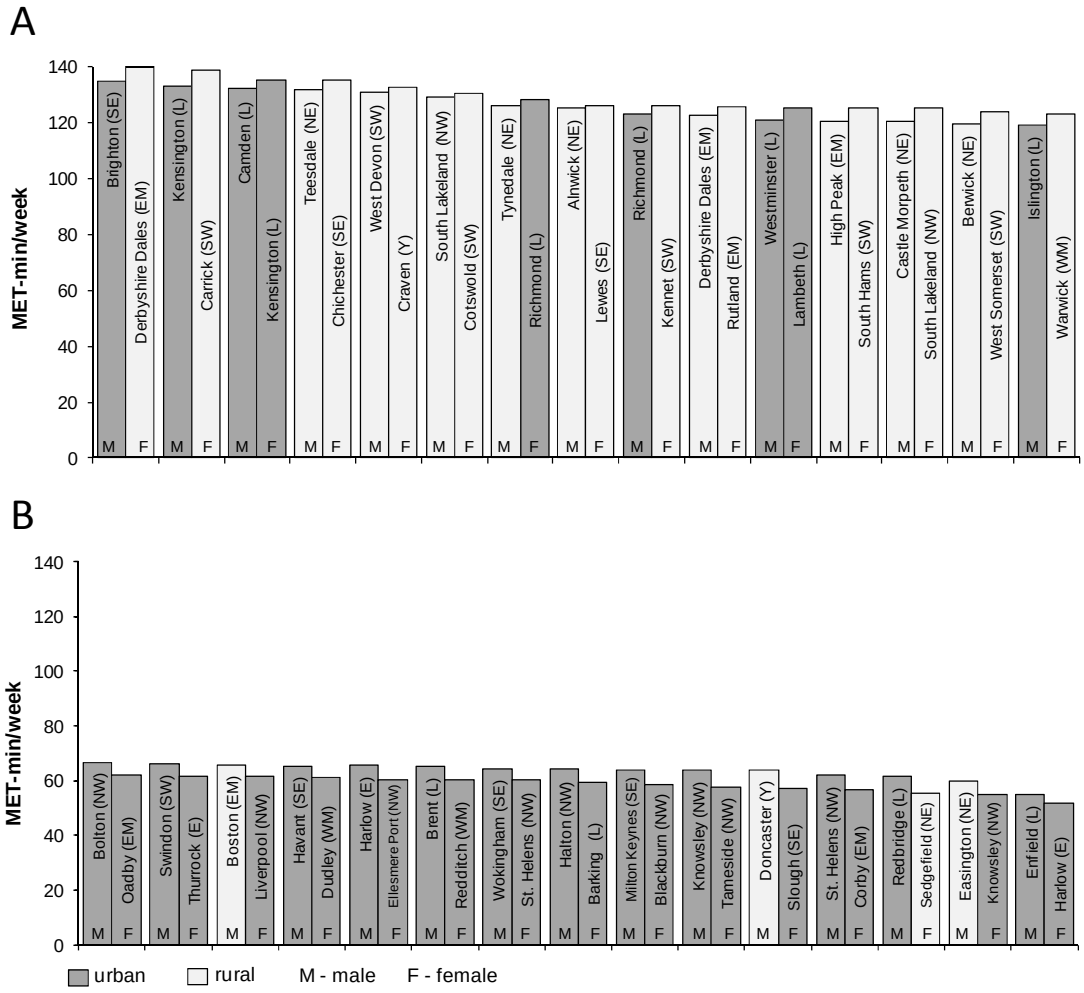
Government Office Regions: NE – North East, NW – North West, Y – Yorkshire, E – East, WM – West Midlands, EM – East Midlands, SW – South West, SE – South East, L – London.

Figure 5 Local Authorities with the (A) lowest and (B) highest age-adjusted rate of non-active people, 2005 – 2006 [*MET-min/week = 0].

The pattern is generally the inverse of that for overall PA, with the 70% of the districts with low levels of non-active respondents being rural, although the disparities between males and females are much smaller than for overall PA. Twenty-one (70%) of the Local

Authorities with the fewest non-active respondents also fell within the southeast or the southwest Government Office Regions.

In terms of walking, there are particularly distinctive urban-rural disparities, with 26 of the 30 (87%) of districts with the lowest levels of walking associated energy expenditure being urban (Figure 6). With the exception of Brighton, all of the urban Local Authorities with high walking associated energy expenditure were London boroughs. Again, disparities between males and females were relatively low.



Government Office Regions: NE – North East, NW – North West, Y – Yorkshire, E – East, WM – West Midlands, EM – East Midlands, SW – South West, SE – South East, L – London.

Figure 6 Local Authorities with the (A) highest and (B) lowest age-adjusted MET-min/week of total walking, 2005 – 2006.

For females there were highly statistically significant differences ($p < 0.001$) for all outcomes when comparing the urban-rural and north-south status of districts. For males, this was also the case for north-south status (all $p < 0.001$) and, for urban-rural status, for all outcomes except overall PA ($p = 0.450$).

Discussion

Overall PA, walking, and non-active behaviours show a divide of lower levels of PA amongst residents of more northerly districts compared to those of the south, yet it is the urban–rural disparities that are particularly striking. Residents of urban districts generally reported less overall PA and walking energy expenditures compared to their rural counterparts, and were also more likely to report non-participation in any of the PA behaviours measured.

To our knowledge, this study is unique in being the first to examine the geography of PA for the whole of England without resorting to synthetic estimates. Other strengths include the very large sample size of the APS, representing approximately 1% of the total adult population in 2006 (Office for National Statistics, 2010). Compared to the general population, the sample comprised a slightly higher percentage of males and adults aged under 35, but was generally comparable. The large sample size allowed us to examine disparities by sex, geographical region, and urban–rural status. The APS also provided information on participation in a very wide range of PA and this allowed a rigorous methodology to be applied in order to estimate energy expenditures for every participant.

In terms of weaknesses, the MET-values in the Compendium of Physical Activities are derived from young, college-age men and thus do not account for individual differences in energy expenditure associated with age, gender, ethnicity, or weight status. The outcomes studied were based on self-report, and the PA questions, although similar to those used elsewhere, have not been subjected to validation. Self-report measures of PA can be susceptible to bias whereby some respondents, particularly the least active, may overestimate the frequency and intensity of their PA (Adams et al., 2005; Masse et al., 2005; Wilcox et al., 2001), although this may not influence the geographical disparities

depicted. Furthermore, overall walking was recorded, but our findings show a particular emphasis on recreational PA. Compared to recent self-report data from Stoke on Trent, England, our calculated total average MET-min/ week for recreational PA are particularly high for men (839 vs. 604), although similar for women (483 vs. 501) (Cochrane et al., 2009).

It is noteworthy that the APS only records energy expenditure associated with walks lasting 30 minutes or more, and many transport-related walks would not reach that threshold. This is most likely one reason why METs associated with walking in our sample are small compared with those from other recreational PA, which is at odds to the known low levels of participation in sport (Lader et al., 2006; Uitenbroek et al., 1991). It has been suggested that bouts of PA as short as 10 minutes have beneficial effects for health (Warburton et al., 2006), and thus even relatively short transport-related walking or cycling trips may accumulate to contribute to the overall health benefits of PA. A further limitation is that the APS recorded no information on PA associated with employment or incidental activities such as housework or gardening. This means that overall levels of energy expenditure will be underestimated, and the contribution of recreation overestimated.

Although prior research has highlighted high car use in rural areas and poorer accessibility to facilities for health and recreation (Moseley et al., 2008) our results show these areas to have higher recreational PA and, in particular, higher levels of recreational walking compared to urban areas. Thus, our findings illustrate the supportiveness of the rural environment for certain forms of recreation. In terms of urban areas, only residents of districts in London reported high mean total walking-associated energy expenditure, most likely reflecting a combination of the restrictions on car use, the developed public transport system, and the generally good walkability of environments within the city.

With respect to the observed north–south gradients, low levels of PA in some areas may be associated with the socio-cultural context of deindustrialisation, whereby cultures of non-participation in PA outside work may have developed in places where levels of employment in physically demanding occupations were historically high. In England, the period of most rapid industrial change occurred in the 1970s and had a particular impact in the Midlands and the North (Imrie, 1991; Jarvis et al., 2001) where residents are now

more likely to report poor health (Mitchell et al., 2000). It is noteworthy that we found districts in the Midlands and the North to have generally lower levels of PA and higher levels of non-activity, and it is possible that cultures of non-participation in PA persist in these places despite the decline in physically demanding jobs. We suggest this possible context of deindustrialisation is a rather unexplored dimension of the obesity epidemic for which putative mechanisms merit further research.

In conclusion, we have described distinctive geographical variations in levels of predominantly recreational PA across England. Our findings have implications for interventions to encourage PA. For example, Gidlow et al. (2007) have shown uptake and adherence in Physical Activity Referral Schemes in primary care to be poorest amongst rural residents. Such schemes are often facility based, yet our results highlight the importance of recreational walking amongst rural populations. Taken together this evidence suggests that an increased focus on non-facility based interventions might improve adherence, especially amongst populations living further from facilities. Certainly, the distinct patterns that we reveal suggest that more effective interventions may be those that are designed with their social and geographical setting in mind.

References

Adams, S. A., Matthews, C. E., Ebbeling, C. B., et al. (2005). The Effect of Social Desirability and Social Approval on Self-Reports of Physical Activity. *American Journal of Epidemiology*, 161(4), 389-398.

Ainsworth, B. E., Haskell, W. L., Whitt, M. C., et al. (2000). Compendium of physical activities: an update of activity codes and MET intensities. *Medicine and Science in Sports and Exercise*, 32(9 Suppl), 498-504.

Ball, K., Mishra, G. D. & Crawford, D. (2003). Social factors and obesity: an investigation of the role of health behaviours. *International Journal of Obesity and Related Metabolic Disorders*, 27(3), 394-403.

Blaxter, M. (1990). *Health and Lifestyles*. London, New York: Tavistock/Routledge.

British Hearth Foundation, 2008. Synthetic estimates of the prevalence of CHD risk factors in England. Available at: <http://www.heartstats.org/datapage.asp?id=6964> (Accessed 08 December 2009).

Butland, B., Jebb, S., Kopelman, P., et al., 2007. Foresight. Tackling Obesities: Future Choices - Project Report, 2nd Edition. Available at: <http://www.foresight.gov.uk/Obesity/obesity_final/17.pdf> (Accessed 27 October 2008).

Cochrane, T., Davey, R. C., Gidlow, C., et al. (2009). Small area and individual level predictors of physical activity in urban communities: a multi-level study in Stoke on Trent, England. *International Journal of Environmental Research and Public Health*, 6(2), 654-677.

Defra, 2005. Rural Definition and Local Authority Classification. Available at: <http://archive.defra.gov.uk/evidence/statistics/rural/rural-definition.htm> (Accessed 16 August 2011).

Department of Health, 2004. At least five a week. Evidence on the impact of physical activity and its relationship to health. A report from the Chief Medical Officer. Available at: <http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_4080994> (Accessed 27 October 2008).

Department of Health and Social Security (1980). *Inequalities in Health: Report of a Working Group Chaired by Sir Douglas Black*. London: DHSS.

Dibben, C., Sims, A., Watson, J., et al., 2004. The Health Poverty Index. South East Public Health Observatory, Oxford. Available at: <http://www.hpi2.org.uk/> (Accessed 3 March 2010).

Ellis, E., Grimsley, M., Goyder, E., et al. (2007). Physical activity and health: evidence from a study of deprived communities in England. *Journal of Physical Activity and Health*, 29(1), 27-34.

Fischbacher, C. M., Hunt, S. & Alexander, L. (2004). How physically active are South Asians in the United Kingdom? A literature review. *Journal of Physical Activity and Health,* 26(3), 250-258.

Gidlow, C., Johnston, L. H., Crone, D., et al. (2006). A systematic review of the relationship between socio-economic position and physical activity. *Health Education Journal,* 65(4), 338-367.

Gidlow, C., Johnston, L. H., Crone, D., et al. (2007). Socio-demographic patterning of referral, uptake and attendance in Physical Activity Referral Schemes. *Journal of Public Health,* 29(2), 107-113.

Howley, E. T. (2001). Type of activity: resistance, aerobic and leisure versus occupational physical activity. *Medicine and Science in Sports and Exercise,* 33(6 Suppl), 364-369.

Imrie, R. (1991). Industrial change and local economic fragmentation: the case of Stoke-on-Trent. *Geoforum,* 22(4), 433-453.

Ipsos Mori, 2006. Active People Diagnostic. User Guide Manual. Version 1.5. Available at: <http://www.data-archive.ac.uk/doc/5767%5Cmrdoc%5Cpdf%5C5767technicalreport.pdf> (Accessed 20 October 2008).

James, W. P. (1995). A public health approach to the problem of obesity. *International Journal of Obesity and Related Metabolic Disorders,* 19 Suppl 3, 37-45.

Jarvis, D., Dunham, P. & Ilbery, B. (2001). Rural industrialisation in a declining coalfield region: the case of north Warwickshire. *Geoforum,* 32(2), 271-283.

Jones, A. P. & Bentham, G. (1997). Health service accessibility and deaths from asthma in 401 local authority districts in England and Wales, 1988-92. *Thorax,* 52(3), 218-222.

Jones, A. P. & Bentham, G. (2009). Particulate air pollution and mortality from lung cancer in local authority districts in England and Wales. *Cancer Research Journal,* 2(4), 287-299.

Jones, A. P., Haynes, R., Kennedy, V., et al. (2008). Geographical variations in mortality and morbidity from road traffic accidents in England and Wales. *Health & Place,* 14(3), 519-535.

Kesaniemi, Y. A., Danforth Jr E, Jensen, M. D., et al. (2001). Dose-response issues concerning physical activity and health: An evidence-based symposium. *Medicine and Science in Sports and Exercise,* 33(6 SUPPL.), 351-358.

Lader, D., Short, S. & Gershuny, J., 2006. The Time Use Survey, 2005. How we spend our time. Available at: <http://www.statistics.gov.uk/articles/nojournal/time_use_2005.pdf> (Accessed 09 December 2009).

Livingstone, M., Robson, P., McCarthy, S., et al. (2001). Physical activity patterns in a nationally representative sample of adults in Ireland. *Public Health Nutrition,* 4(5A), 1107-1116.

Livingstone, M. B. E., Robson, P. J., Wallace, J. M. W., et al. (2003). How active are we? Levels of routine physical activity in children and adults. *Proceedings of the Nutrition Society,* 62(3), 681-701.

Macintyre, S., Ellaway, A. & Cummins, S. (2002). Place effects on health: how can we conceptualise, operationalise and measure them? *Social Science & Medicine,* 55(1), 125-139.

Mangano, A. (2010). An analysis of the regional differences in health care utilization in Italy. *Health & Place,* 16(2), 301-308.

Martin, S., L., Gregory, J. K., Kelly, M., et al. (2005). Urban, Rural, and Regional Variations in Physical Activity. *The Journal of Rural Health,* 21(3), 239-244.

Masse, L. C., Eason, K. E., Tortolero, S. R., et al. (2005). Comparing Participants' Rating and Compendium Coding to Estimate Physical Activity Intensities. *Measurement in Physical Education and Exercise Science,* 9(1), 1-20.

Mavoa, H. M. & McCabe, M. (2008). Sociocultural factors relating to Tongans' and Indigenous Fijians' patterns of eating, physical activity and body size. *Asia Pacific Journal of Clinical Nutrition,* 17(3), 375-384.

McLeod, H., Langford, I. H., Jones, A. P., et al. (2000). The relationship between socio-economic indicators and air pollution in England and Wales: implications for environmental justice. *Regional Environmental Change,* 1(2), 78-85.

Mitchell, R., Gleave, S., Bartley, M., et al. (2000). Do attitude and area influence health? A multilevel approach to health inequalities. *Health & Place,* 6(2), 67-79.

Moon, G., Quarendon, G., Barnard, S., et al. (2007). Fat nation: Deciphering the distinctive geographies of obesity in England. *Social Science & Medicine,* 65(1), 20-31.

Moseley, M. J. & Owen, S. (2008). The future of services in rural England: The drivers of change and a scenario for 2015. *Progress in Planning,* 69(3), 93-130.

Office for National Statistics, 2001. Census 2001. Available at: <http://www.statistics.gov.uk/census2001/pop2001/england_ages.asp> (Accessed 14 October 2009).

Office for National Statistics, 2001. Neighbourhood Statistics: 2001 Census: Census Area Statistics: Population. Available at: <http://neighbourhood.statistics.gov.uk/dissemination/Download1.do> (Accessed 15 June 2010).

Office for National Statistics, 2010. Mid Year Population Estimates 2006. Available at: <http://www.statistics.gov.uk/statbase/Product.asp?vlnk=15106> (Accessed 14 October 2009).

Sarrafzadegan, N., Kelishadi, R., Abdulmehdi, B., et al. (2008). Metabolic syndrome: An emerging public health problem in Iranian Women: Isfahan Healthy Heart Program. *International Journal of Cardiology*, 131(1), 90-96.

Scarborough, P. & Allender, S. (2008). The North-South gap in overweight and obesity in England. *British Journal of Nutrition*, 100(3), 677-684.

Scarborough, P., Allender, S., Rayner, M., et al. (2009). Validation of model-based estimates (synthetic estimates) of the prevalence of risk factors for coronary heart disease for wards in England. *Health & Place*, 15(2), 596-605.

Scholes, S., Pickering, K. & Rayat, P., 2007. Healthy Lifestyle Behaviours: Model Based Estimates for Middle Layer Super Output Areas and Local Authorities in England, 2003-2005: User Guide. Available at: <http://www.ic.nhs.uk/webfiles/Popgeog/MSOA%20and%20LA%20User%20Guide.pdf> (Accessed 26 February 2010).

The EURAREA Consortium (2004). *Enhancing small area estimation techniques to meet European needs. Final Project Report*. London: Office for National Statistics.

The Health and Social Care Information Centre (2008). *The Health Survey for England 2007. Latest Trends*. London.

Trost, S. G., Owen, N., Bauman, A. E., et al. (2002). Correlates of adults' participation in physical activity: review and update. *Medicine and Science in Sports and Exercise*, 34(12), 1996-2001.

Twigg, L., Moon, G. & Jones, K. (2000). Predicting small-area health-related behaviour: a comparison of smoking and drinking indicators. *Social Science & Medicine*, 50(7-8), 1109-1120.

Uitenbroek, D. G. & McQueen, D. V. (1991). Leisure time physical activity behavior in three British cities. *Sozial- und Präventivmedizin*, 36(6), 307-314.

Voigtländer, S., Berger, U. & Razum, O. (2010). Increasing regional disparities in living conditions in Germany and their role in the explanation of health inequalities. *Gesundheitswesen*, 72(5), 301-308.

Warburton, D. E., Nicol, C. W. & Bredin, S. S. (2006). Prescribing exercise as preventive therapy. *Canadian Medical Association Journal*, 174(7), 961-974.

Wendel-Vos, W., Droomers, M., Kremers, S., et al. (2007). Potential environmental determinants of physical activity in adults: a systematic review. *Obesity Reviews*, 8(5), 425-440.

Wilcox, S., Irwin, M. L., Addy, C., et al. (2001). Agreement between participant-rated and compendium-coded intensity of daily activities in a triethnic sample of women ages 40 years and older. *Annals of Behavioral Medicine*, 23(4), 253-262.

Wilkinson, R. & Pickett, K. (2010). *The Spirit level. Why Equality is Better for Everyone*. London: Penguin Books.