

**STRATEGIC INSIGHT PAPER FOR SPORT ENGLAND:  
'CALORIE MAPPING' SPORTS PARTICIPATION IN ENGLAND**

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**ABSTRACT**

The Active People Survey is a nationwide project commissioned by Sport England to investigate the sport and physical activity habits of the general population. The results of this survey provide valuable data to inform health-related Government strategy. The aim of this investigation was to provide a preliminary regional 'calorie map' of sport and physical activity. Utilising mode, frequency, duration and intensity of sport/physical activity data, energy expenditure values were ascribed to the 7 most popular sports/physical activities in the Active People Survey 2. The activities selected were: walking, cycling, swimming/diving, gym, football, golf and road running. Energy expenditure ( $\text{kcal}\cdot\text{week}^{-1}$ ) was calculated using standard metabolic equations. Results revealed that, for much of the population, energy expenditure from walking, cycling, swimming/diving, and gym activities, was insufficient to provide a positive impact on health. However, more vigorous, high-impact pursuits, such as football and road running, or those performed over a long duration, such as golf, appear to provide a more beneficial stimulus for positive health adaptations. Males tended to expend more calories than females, although energy expenditure was higher in females for walking activity. These results suggest that further work is required to educate the public about the types and levels of sport and physical activity required to promote health and fitness. A general understanding of issues related to calorie expenditure would necessarily lead to an awareness of the important link between energy intake and energy expenditure. Sport and physical activity promotion activities should also encourage those who are already physically active to increase the frequency, intensity and/or duration of their activity bouts. Those who currently rely on walking as their sole form of exercise should supplement this with more deliberate forms of physical activity. Sport provides an excellent range of such activities. In order to maximise the health benefits of sport and physical activity, individuals should seek to incorporate both moderate (e.g. walking) and vigorous intensity (e.g. football) activities into their weekly routines. Future calorie mapping exercises should evaluate all sports/physical activities reported in the Active People Surveys, should compare successive surveys, and should provide a comprehensive evaluation of the impact of population demographics on sport and physical activity energy expenditure.

Key words: sport, physical activity, energy expenditure, health, METs, Active People Survey.

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**TABLE OF CONTENTS**

	<b>PAGE</b>
<b>ABSTRACT</b> .....	i.
<b>LIST OF TABLES</b> .....	iv.
<b>LIST OF FIGURES</b> .....	vi.
<b>1.0 INTRODUCTION</b>	<b>1-7</b>
1.1    WHY PHYSICAL ACTIVITY?.....	1
1.2    RECOMMENDATIONS FOR MINIMUM LEVELS OF PHYSICAL ACTIVITY.....	2
1.3    PHYSICAL ACTIVITY AND ENERGY EXPENDITURE.....	3
1.4    PHYSICAL ACTIVITY AND ENERGY EXPENDITURE RECOMMENDATIONS.....	5
1.5    AIMS OF INVESTIGATION.....	7
<b>2.0 METHODS</b>	<b>8-9</b>
2.1    SOURCE DATA.....	8
2.2    CALCULATING ENERGY/CALORIE EXPENDITURE.....	8
2.3    DATA ANALYSIS.....	9
<b>3.0 RESULTS</b>	<b>10-19</b>
3.1    REGIONAL ENERGY EXPENDITURE.....	10
3.2    SPORTS/PHYSICAL ACTIVITY ENERGY EXPENDITURE COMPARISONS.....	16
3.3    PRELIMINARY SOCIAL-DEMOGRAPHIC ANALYSIS.....	17
<b>4.0 DISCUSSION</b>	<b>20-23</b>
4.1    THE FEASIBILITY OF CALORIE MAPPING.....	20
4.2    HOW EFFECTIVE ARE THE MOST POPULAR SPORTS/PHYSICAL ACTIVITIES.....	20
4.3    REGIONAL VARIATION IN SPORT AND PHYSICAL ACTIVITY ENERGY EXPENDITURE.....	22
4.4    SOCIO-DEMOGRAPHIC VARIATIONS.....	22
<b>5.0 STUDY LIMITATIONS</b>	<b>24-25</b>
5.1    SURVEY DATA.....	24
5.2    PHYSICAL ACTIVITY COMPENDIA.....	24

5.3	DATA HANDLING AND PROCESSING.....	24
<b>6.0</b>	<b>RECOMMENDATIONS AND DIRECTIONS FOR FUTURE RESEARCH</b>	<b>26-29</b>
6.1	RECOMMENDATIONS.....	26
6.2	DIRECTIONS FOR FUTURE RESEARCH.....	28
<b>7.0</b>	<b>CONCLUSIONS</b>	<b>30</b>
<b>8.0</b>	<b>REFERENCES</b>	<b>31-32</b>
<b>APPENDICES</b>		<b>33-42</b>
APPENDIX I:	LOCAL AUTHORITY ENERGY EXPENDITURE.....	33
APPENDIX II:	HEALTH PROFILE OF ENGLAND.....	42

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**LIST OF TABLES**

	<b>PAGE</b>
<b>3.0 RESULTS</b>	
<b>Table 3.1</b> Regional weekly energy expenditure for walking	<b>11</b>
<b>Table 3.2</b> Regional weekly energy expenditure for swimming	<b>11</b>
<b>Table 3.3</b> Regional weekly energy expenditure for cycling	<b>12</b>
<b>Table 3.4</b> Regional weekly energy expenditure for gym	<b>13</b>
<b>Table 3.5</b> Regional weekly energy expenditure for football	<b>14</b>
<b>Table 3.6</b> Regional weekly energy expenditure for golf	<b>15</b>
<b>Table 3.7</b> Regional weekly energy expenditure for road running	<b>15</b>
<b>Table 3.8</b> Regional levels of participation in 7 most popular sports/physical activities	<b>16</b>
<b>Table 3.9</b> Weekly calorie expenditure for 7 most popular sports/physical activities	<b>17</b>
<b>Table 3.10</b> Weekly calorie expenditure for 7 sports/physical activities for males and females	<b>18</b>
<b>A.1 APPENDIX</b>	
<b>Table A1.1</b> Weekly calorie expenditure for top 7 sports/physical activities for all Local Authorities	<b>33</b>

**LIST OF FIGURES**

	<b>PAGE</b>
<b>1.0 INTRODUCTION</b>	
<b>Figure 1.1</b> Methods of summarising physical activity data	<b>6</b>
<b>3.0 RESULTS</b>	
<b>Figure 3.1</b> Regional calorie map for walking	<b>10</b>
<b>Figure 3.2</b> Regional calorie map for cycling	<b>13</b>
<b>APPENDIX II</b>	
<b>Figure A2.1</b> Excerpt from Health Profile of England 2008	<b>42</b>

## **1.0 INTRODUCTION**

Sport makes a significant contribution to the wider health agenda, providing economic and social benefits to the community (Sport England, 2008). The “Choosing Health” White Paper, published in 2004, set out the UK Government agenda for supporting the public to make more informed choices about their health. The Government pledged to provide information, practical support and access to services, such that ‘healthy choices’ could be more easily taken.

The approaching 2012 Olympic Games in London has given sport and health a fresh impetus, and moved it higher up the Government’s public health agenda. Sport England is committing 15% of its investment to increase regular participation in sport by 200,000 adults per annum, working towards a target of 1 million more sports participants by 2012-2013 (Sport England, 2008). This key performance indicator will be monitored through the Active People Survey.

The collection of data in the Active People Survey on population activity habits, particularly exercise duration, frequency, intensity, and type of sport or physical activity undertaken, makes it possible to estimate the calories (energy) expended during sport and physical activity. By carrying out a calorie mapping exercise, the key aim of this investigation was to quantify the contribution that sport participation makes to health. Key global public health agencies, such as the American College of Sports Medicine, recommend minimum weekly calorie expenditure targets that should be achieved through bouts of physical activity.

### **1.1 WHY PHYSICAL ACTIVITY?**

It is recognised that sport and physical activity, along with a healthy diet, are key determinants of health (Department of Health, 2009a). Compared to those with a sedentary lifestyle, physically active individuals are at approximately half the risk of developing coronary heart disease (Department of Health, 2004a). Regular physical activity is also associated with improved mental health and a reduced risk of diabetes, obesity, osteoporosis and colon cancer. In older adults, physical activity is associated with increased functional capacity (Mazzeo & Tanaka, 2001). In September 2009 the UK Government

announced details of a new sports and physical activity scheme as part of the 'Change4Life' initiative. This scheme includes a Dance Champions Group, to promote dance participation in the lead up to the 2012 London Olympic Games, and the new 'Swim4Life' campaign to complement the existing free swimming scheme. These new initiatives will complement other such activities (e.g. Bike4Life), to comprise a comprehensive Change4Life social marketing campaign. The National Health Service (NHS) will have a key role in this promotion of physical activity, placing physical activity at the forefront of policy decisions and at the heart of the health service. These activities demonstrate national recognition for the importance of sport and physical activity. For the first time, sport and physical activity is being seen as a clinical need, rather than just a lifestyle choice.

Despite this, there is evidence that general physical activity levels are declining as lifestyles change (Department of Health, 2004a). However, whilst the distance travelled per year on foot and bicycle has fallen in the last three decades, there is evidence to suggest an increase in the proportion of people who choose to be active in their leisure time (Department for Transport, 2001).

Cancer and cardiovascular disease (heart disease and stroke) are the major causes of death in England, together accounting for almost 60% of premature deaths (Department of Health, 2004a). Increasing physical activity in the adult population would reduce the prevalence of these major lifestyle diseases, as well as reducing the risk of osteoporosis, back pain and osteoarthritis. Physical activity has also been shown to have positive effects on psychological wellbeing and mental health (Paluska & Schwenk, 2000).

## **1.2 RECOMMENDATIONS FOR MINIMUM LEVELS OF PHYSICAL ACTIVITY**

The Chief Medical Officer has recommended that the adult population (i.e. ages 16 years and over) should achieve 30 minutes of physical activity of at least moderate intensity on 5 days per week ("5x30") (Department of Health, 2004a). Whilst agreeing that moderate intensity activity should be encouraged, Haskell *et al.* (2007) also emphasised the need for vigorous intensity physical activity. Moderate and vigorous intensity tasks performed as part of everyday life (e.g. brisk walk, gardening, DIY tasks) can be counted towards the 5x30 target. However, the recommended amount of physical activity (whether moderate or



vigorous) should be in addition to the routine, light intensity, activities of daily living (e.g. casual walking, shopping, domestic chores).

Although it is widely acknowledged that an active lifestyle leads to better health, estimates suggest that only 31% of the adult population are sufficiently active to experience the health benefits (Department of Health, 2009). Data from the most recent Health Profile of England shows that 40% of the adult male population and just 28% of the adult female population achieve the minimum recommended level of physical activity (Department of Health, 2009a). It has been reported that levels of sport and physical activity decline significantly with age for both sexes, whilst higher academic achievement has been associated with greater engagement in physical activity (Department of Health, 2004a).

One function of the Choosing Health consultation (Department of Health, 2004b) was to develop an activity plan for the UK population that would contribute to the delivery of 'Game Plan', the strategy for delivering the Government's sport and physical activity objectives. Game Plan set out a vision for increasing physical activity participation, to get 70% of the population performing 30 minutes of moderate exercise five times a week by 2020 (Strategy Unit, 2002). The 2012 London Olympic Games provides a vital opportunity to encourage the UK population to become more physically active and could stimulate a golden age of sport and physical activity. Using this global celebration of sport as an inspiration, it is hoped that the London Olympics will provide sufficient momentum to achieve the Government's ambitious targets for sport and physical activity participation.

### **1.3 PHYSICAL ACTIVITY AND ENERGY EXPENDITURE**

Physical activity includes many different forms of 'everyday' activity. Thus, walking to work, working out in a gym, attending a dance class, and informal family play activities are all forms of physical activity (Department of Health, 2009b). What is intrinsic to each of these forms of physical activity is the effect that movement has on the body, raising heart rate and breathing rate, eventually bringing about beneficial physiological adaptations. These are usually accompanied by an improvement in overall sense of wellbeing (Paluska & Schwenk, 2000). The simple concept of increased movement underpins the Change4Life health strategy discussed above (Department of Health, 2009c).

The energy cost of many physical activities has been established. Activities that are vigorous and involve large muscle groups require greater energy expenditure than do moderate or low intensity activities that utilise small muscle groups. For this reason, most health agencies (American College of Sports Medicine, 2006; Department of Health, 2004; Haskell *et al.*, 2007) recommend activities that require large rhythmical contraction of muscle groups, performed at a moderate intensity (enough to raise breathing rate) over a prolonged period of time (10-90 minutes).

The energy expenditure of a wide range of physical activities have been obtained by directly measuring the oxygen cost of these activities in an adult population (Ainsworth *et al.*, 1993, 2000; Montoye, 2000; Montoye *et al.*, 1996; Olson *et al.*, 1991; Zeni *et al.*, 1996). The term metabolic equivalent (MET) is often used to describe exercise intensity (Ainsworth *et al.*, 2000; Department of Health, 2004a). One MET is equivalent to the amount of energy expended during one minute of seated rest. Therefore, exercise performed at a level of intensity five times that of resting oxygen uptake ( $VO_2$ ) is equivalent to 5 METs. An example of a 5 METs activity is walking at 4.0 miles·hour<sup>-1</sup> on a level firm surface (Ainsworth, *et al.*, 2000). Exercise of light intensity will usually have a MET value <3, moderate intensity 3-6 METs, and vigorous exercise >6 METs (Haskell *et al.*, 2007).

Whilst providing a valuable tool, the MET approach has a number of limitations. The absolute energy expended during exercise at a 5-MET intensity depends on an individual's body size (i.e. a large person is likely to have a larger  $VO_2$  than a small person) and their body fat percentage (Howell *et al.*, 1999). As a result, the estimation of energy expenditure for weight-bearing activities may be underestimated when using MET tables and over-estimated for non-weight bearing activities (American College of Sports Medicine, 2010). Similarly, differences in age, cardiorespiratory fitness, exercise efficiency, and environmental conditions may impact on the accuracy of standardised MET values (Ainsworth *et al.*, 1993, 2000).

In a public health setting, the MET approach is valuable as it provides a physiologically valid method to evaluate the contribution of various types of physical activity to overall daily and weekly energy expenditure. It also facilitates comparisons of energy expended between

different modes of activities. As an example, an adult walking at an average pace of 3 miles·hour<sup>-1</sup> on a flat hard surface would be working at an intensity of 3.3 METs. If this is performed for the recommended 30 minutes, then the total accumulated energy expenditure would be 99 METs (3.3 METs x 30 min = 99 METs). If this individual began jogging at 5 miles·hour<sup>-1</sup> (12 min·mile<sup>-1</sup>), they would then be exercising at a metabolic rate that was 8 times that of resting metabolic rate, or 8 METs. Jogging for 20 minutes, accumulated energy expenditure would be 160 METs (8 METs x 20 min = 160 METs). If an adult is to achieve the Chief Medical Officer's "5x30" target, they should achieve a weekly value in the range of 450-900 MET·week<sup>-1</sup> (based upon the MET range of 3-6 METs for moderate intensity effort and 5x30 min = 150 mins·week<sup>-1</sup>; 3 METs x 150 min·week<sup>-1</sup> = 450 MET·week<sup>-1</sup>; 6 METs x 150 mins·week<sup>-1</sup> = 900 MET·week<sup>-1</sup>).

In order to accumulate the recommended weekly energy expenditure targets outlined, a person would need to engage in moderate intensity activity for a longer duration (i.e. more minutes), or shorter bouts of vigorous intensity activity (i.e. higher MET values). Haskell *et al.* (2007) suggested that vigorous intensity physical activity leads to a greater health benefit; hence the encouragement from public health agencies to mix moderate and vigorous intensity efforts.

#### **1.4 PHYSICAL ACTIVITY AND ENERGY EXPENDITURE RECOMMENDATIONS**

The specific physiological adaptations (e.g. weight loss, cholesterol reduction, enhanced maximal aerobic capacity) that result from physical activity are dependent upon the level of energy expenditure (American College of Sports Medicine, 2006). It is the interaction of intensity, duration and frequency of physical activity performed that will determine the net caloric expenditure.

Common methods to express sport and physical activity data include: duration (total minutes spent in activity [number of sessions\*session time]); metabolic equivalents (METs; a MET is an estimate of intensity based on the ratio of working metabolic rate to resting metabolic rate); and kilocalories (kcal). A progression of the three methods for calculating energy expenditure during activity is illustrated in Figure 1.1.

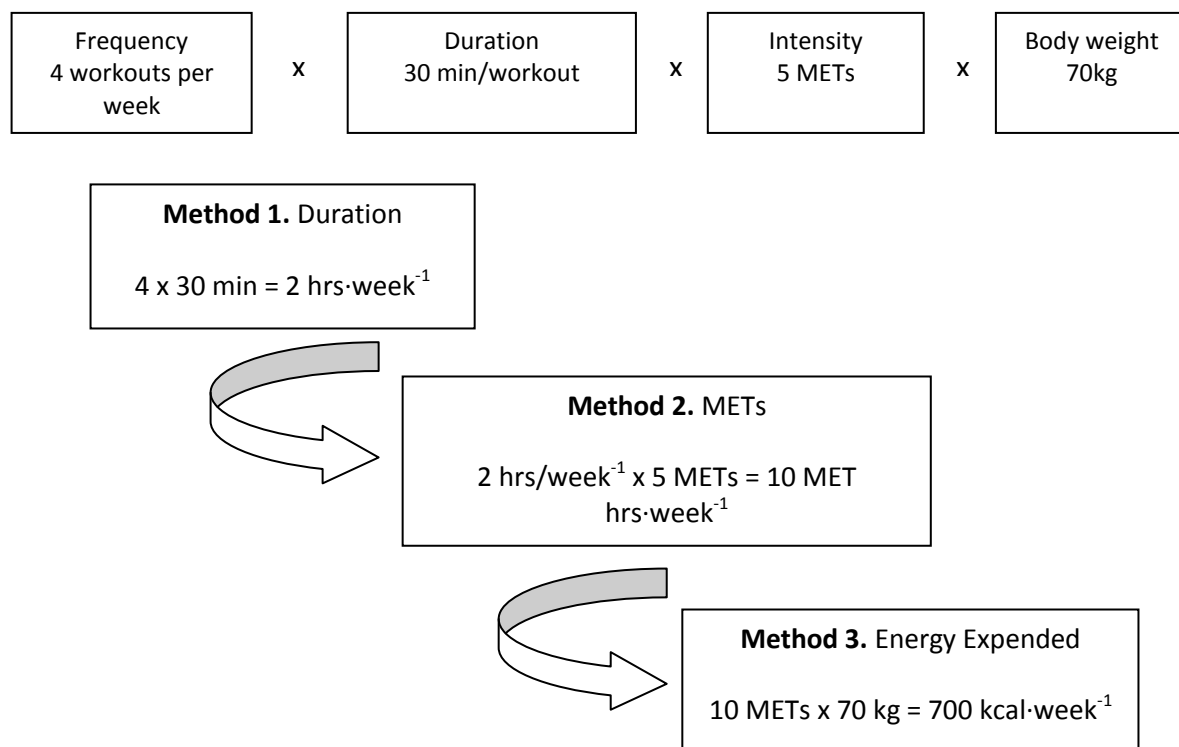


Figure 1.1 Methods of summarising physical activity data (American College of Sports Medicine, 2010)

When using these calculations the assumption is made that MET values are representative of the way an activity is performed, regardless of the skill level of the individual or the pace of the activity. Furthermore, it is assumed that the metabolic cost of performing activities (in METs) is constant among individuals, regardless of body weight (American College of Sports Medicine, 2010).

For simplicity, individual differences in resting energy expenditure are often overlooked; 1 MET is considered to be equivalent to a  $\text{VO}_2$  of  $3.5 \text{ ml}\cdot\text{O}_2\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ . Expressed as caloric expenditure, 1 MET represents an energy expenditure of approximately  $1.2 \text{ kcal}\cdot\text{min}^{-1}$  for a 70kg individual (American College of Sports Medicine, 2010).

All adults should expend 150-400 kcal of energy per day through sport and/or physical activity (American College of Sports Medicine, 2006). The lower end of this range represents a minimal caloric threshold of approximately  $1000 \text{ kcal}\cdot\text{week}^{-1}$ . This level of activity has been shown to reduce the risk of all-cause mortality by 20-30% (Nelson *et al.*, 2007). Because

there is a strong dose-response relationship between physical activity and health and fitness, there should be progression toward the upper end of the recommended range of 300-400 kcal·day<sup>-1</sup> (2100-2800 kcal·week<sup>-1</sup>), particularly if weight loss is a target outcome. Indeed, recent recommendations from the Chief Medical Officer suggest that a minimum of 60 min·day<sup>-1</sup> of activity is required for weight loss or healthy weight maintenance (Department of Health, 2004a). Ross & Janssen (2001) suggested that physical activity energy expenditure in excess of 2000 kcal·week<sup>-1</sup> is required for short and long-term weight control.

### **1.5 AIMS OF INVESTIGATION**

The primary aim of this investigation was to provide a preliminary calorie map of sport and physical activity in England using data from the Active People Survey 2. Survey questions relating to the mode, frequency, duration and intensity of physical activity performed were utilised. A secondary aim was to investigate energy expenditure from a range of sports and physical activities, to establish those activities that provide the highest and the lowest levels of energy expenditure. The results of this investigation will illustrate whether or not the sport and physical activity being performed by the sampled population is sufficient to have a positive impact on health. Whilst the target 5x30 minutes of weekly activity might be achieved by a substantial fraction of the population, this does not necessarily mean that activity levels are sufficient to promote positive health adaptations. The calculation of physical activity caloric expenditure provides valuable information on the potential health-promoting benefits of the sport and physical activity performed by adults in England.

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## 2.0 METHODS

### 2.1 SOURCE DATA

A key aim of the Active People Survey (APS) is to establish how much of the adult population of England (% of respondents) are active at the recommended levels. However, as questions relating to the frequency, duration, and intensity of activity are included, the APS surveys also provide a valuable opportunity to quantify the energy expended through sport and physical activity.

The Active People Survey 2 (APS 2) identified 256 sports and physical activities. The preliminary investigation carried out here considered the 7 most popular sports/physical activities: walking (134,920 participants), swimming/diving [indoors] (23,769 participants), cycling (20,280 participants), gym (18,615 participants), football (7,247 participants), golf (7,098 participants), and road running (5,243 participants). This selection includes 3 out of the 4 activities promoted by the UK Government in the Change4Life health campaign. Dance was not included due to the low number of dance participants recorded in APS 2.

### 2.2 CALCULATING ENERGY/CALORIE EXPENDITURE

Standard metabolic calculations and MET values were used to calculate energy expenditure for each day of sport/physical activity completed (Q11: “Number of days in last 4 weeks”). The compendium tables of Ainsworth *et al.* (2000) were used to prescribe metabolic equivalents (METs) for each sport/physical activity at 3 intensities (Q13, negative response: ‘raised breathing rate?’; Q13, positive response: ‘raised breathing rate?’; and Q14, positive response: ‘out of breath or sweaty?’). These compendium tables have been used previously by Haskell *et al.* (2007) and the UK Chief Medical Officer (Department of Health, 2004a).

Using a range of nested logic functions in Microsoft Excel, caloric expenditure was calculated for each sport/physical activity session as (Ainsworth, 2009; American College of Sports Medicine, 2006):

$$\text{kcal}\cdot\text{session}^{-1} = (\text{METs} \times \text{body weight [kg]}) / 60 \times \text{session duration (min)}$$

Taking account of the number of sessions completed in the previous 4 weeks, this data was averaged to produce monthly, weekly, and daily calorie expenditure values. (Note: Walking

and cycling calculations utilised a 30-minute session duration. This was because 'average session duration' data was not available for these activities.)

It was beyond the scope of this analysis to accommodate all variables that might impact on the energy cost of movement. Ideally a correction factor would be available for different physical activities. However, no such correction is currently available. The only variable that could be accounted for was body weight. However, actual body weight data was not available. Therefore, body weight was factored into the calorie mapping calculations using a range of weights (10kg increments between 60-100kg) to accommodate for variation in the UK adult population.

Establishing caloric expenditure during exercise is problematic due to the many variables that can influence it. These include factors such as inter-individual differences in skill, co-ordination, exercise efficiency (VO<sub>2</sub> per unit workload), and the variation in exercise intensity within an activity. Further error is introduced when asking an individual to report their 'usual' level of effort/intensity during sport and physical activity. Therefore, these analyses/data should be used with caution. Indeed, even direct attempts to establish energy expenditure through methods such as accelerometry have identified a variety of limitations (American College of Sports Medicine, 2006).

### **2.3 DATA ANALYSIS**

Caloric expenditure and demographic data were prepared using Microsoft Excel pivot tables. Data were reported as means for sport, region, local authority, and sex.

Preliminary statistical analyses were carried out to evaluate differences between sports and ethnic groups (walking only). One-way ANOVA and Tukey post-hoc tests were performed using the SPSS statistical software package (versions 16 and 17). The alpha level was set at  $P < 0.05$ . An adjustment was made to the ethnic group data to accommodate 5,109 blank responses. These were converted to category 5, classified as 'Other'.

### 3.0 RESULTS

#### 3.1 REGIONAL ENERGY EXPENDITURE

Regional weekly energy expenditure values for the 7 most popular activities recorded in the Active People Survey 2 are reported in Tables 3.1-3.7. As body weight data was not collected in APS 2, average values are reported for the illustrative range 60kg-100kg. Values for each weight category are not qualitatively different. Therefore, it is appropriate to consider values for a reference individual of 70kg, this representing an 'average' adult.

The most popular physical activity reported in the Active People Survey 2 was walking (APS 2 Question 2). 134,920 individuals (total sample = 191,325) reported having completed 'at least one continuous walk lasting 30 minutes' in the 'last 4 weeks'. The South West reported the highest regional energy expenditure for walking exercise (mean for all body weights = 457 kcal·week<sup>-1</sup>). The lowest level was reported in the West Midlands (mean for all body weights = 442 kcal·week<sup>-1</sup>). The minimum recommended daily physical activity energy expenditure is 150 kcal (American College of Sports Medicine, 2006), this would require a minimum weekly energy expenditure of 750 kcal (5 sessions·week<sup>-1</sup> x 150 kcal). Assuming walking to be the only physical activity undertaken, this minimum level was not achieved through walking exercise for any region (or body weight) (see Figure 3.1).

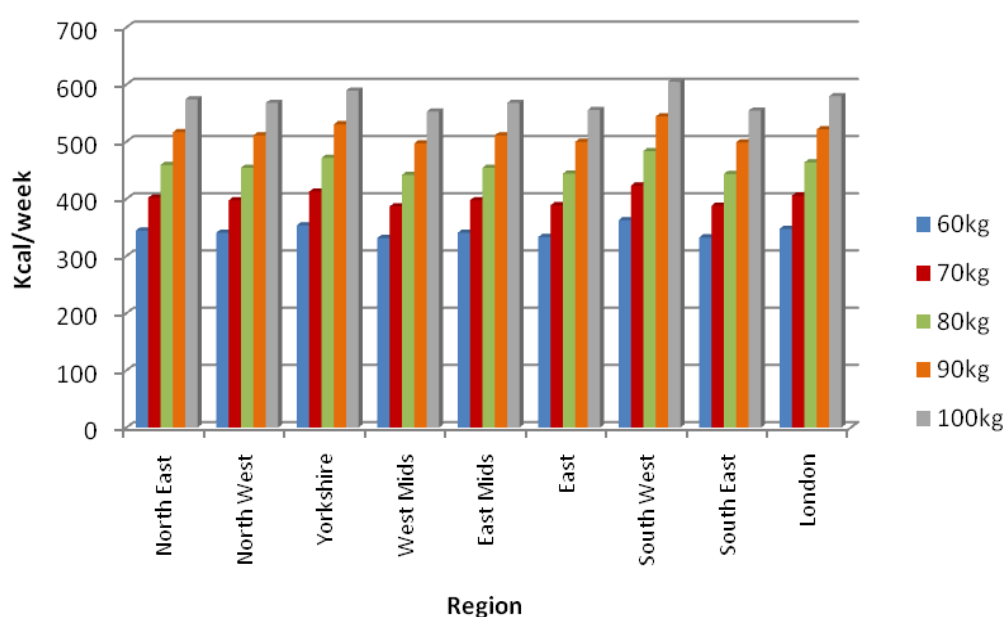


Figure 3.1 Regional calorie map for walking.



Table 3.1 Regional weekly energy expenditure for walking (APS 2 Question 2) (N = 134,920).

Energy expenditure (Kcal.week <sup>-1</sup> )						
Region	60kg	70kg	80kg	90kg	100kg	Population %*
North East	344	402	459	517	574	68.3
North West	341	397	454	511	568	69.6
Yorkshire	354	413	472	530	589	71.1
West Mids	331	387	442	497	552	68.2
East Mids	341	398	454	511	568	70.4
East	333	389	444	500	555	69.7
South West	363	423	484	544	605	74.5
South East	333	388	443	499	554	71.9
London	348	406	464	522	580	69.5
<b>Mean (Kcal)</b>	<b>343</b>	<b>400</b>	<b>457</b>	<b>515</b>	<b>572</b>	<b>70.4</b>

\*Percentage of respondents, per region, undertaking activity in 4 weeks prior to survey.

Table 3.2 Regional weekly energy expenditure for swimming (sport 003) (N = 23,769).

Energy expenditure (Kcal.week <sup>-1</sup> )						
Region	60kg	70kg	80kg	90kg	100kg	Population %*
North East	220	257	293	330	367	11.4
North West	212	247	282	318	353	12.6
Yorkshire	204	238	272	306	340	12.9
West Mids	195	228	260	293	325	11.9
East Mids	192	224	257	289	321	12.3
East	203	237	271	305	339	12.7
South West	198	231	264	297	330	12.6
South East	194	227	259	292	324	12.9
London	194	226	258	290	323	12.0
<b>Mean (Kcal)</b>	<b>201</b>	<b>235</b>	<b>269</b>	<b>302</b>	<b>336</b>	<b>12.4</b>

\*Percentage of respondents, per region, undertaking activity in 4 weeks prior to survey.

Swimming/diving [indoors] (sport 003) was the second most popular physical activity in the Active People Survey 2, with 23,769 individuals (total sample = 191,325) having undertaken this activity in the 4 weeks prior to questioning. Of the 7 sports/physical activities investigated, swimming was ranked lowest for weekly energy expenditure (Table 3.9). These

data suggest that, with the highest energy expenditure for this activity, a 100-kg person from the North East achieved just 49% of the minimum recommended weekly energy expenditure from swimming/diving [indoors] alone (367 kcal·week<sup>-1</sup>).

Cycling was the third most popular physical activity reported in the Active People Survey 2. 20,280 individuals (total sample = 191,325) reported having completed 'at least one continuous cycle ride lasting 30 minutes' in the 'last 4 weeks'. The highest weekly energy expenditure for cycling activity was reported in London (mean for all body weights = 614 kcal·week<sup>-1</sup>). The lowest value was reported in the East region with an energy expenditure of 508 kcal·week<sup>-1</sup> (mean result for all body weights). Only a 100kg person in London achieved the minimum recommended weekly energy expenditure from cycling alone (Table 3.3 and Figure 3.2).

Table 3.3 Regional weekly energy expenditure for cycling (APS 2 Question 6) (N = 20,280).

Region	Energy expenditure (Kcal·week <sup>-1</sup> )					Population %*
	60kg	70kg	80kg	90kg	100kg	
North East	406	473	541	609	676	8.3
North West	446	520	595	669	743	8.7
Yorkshire	416	485	555	624	693	9.6
West Mids	390	455	520	585	650	9.3
East Mids	402	469	537	604	671	10.7
East	381	445	508	572	635	12.4
South West	382	446	510	574	637	11.5
South East	386	451	515	579	644	12.2
London	460	537	614	690	767	10.2
<b>Mean (Kcal)</b>	<b>408</b>	<b>476</b>	<b>544</b>	<b>612</b>	<b>680</b>	<b>10.3</b>

\*Percentage of respondents, per region, undertaking activity in 4 weeks prior to survey.

The fourth most popular activity reported in APS 2 was gym. The mean weekly energy expenditure for all body weights for this activity exceeded 600 kcal in all regions, with a high of 703 kcal·week<sup>-1</sup> in the North East (Table 3.4). However, only individuals in the 90kg and 100kg categories expended sufficient energy through this activity to meet the weekly recommendations for energy expenditure from sport and physical activity. However, given

that many gym activities are weight-supported (e.g. rowing machine, weight bench) and that MET values (used to derive calorie values) may be inaccurate for such activities (see Section 1.4), these results should be treated with caution.

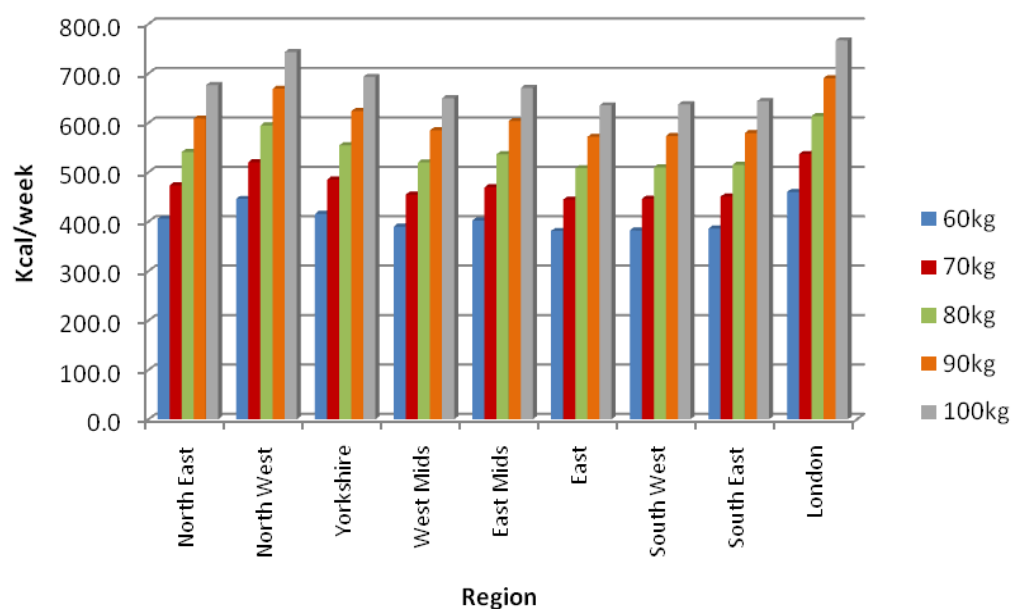


Figure 3.2 Regional calorie 'map' for cycling.

Table 3.4 Regional weekly energy expenditure for gym (sport 014) (N = 18,615).

Energy expenditure (Kcal.week <sup>-1</sup> )						
Region	60kg	70kg	80kg	90kg	100kg	Population %*
North East	528	616	703	791	879	9.0
North West	526	614	701	789	877	9.9
Yorkshire	512	598	683	768	854	9.1
West Mids	516	603	689	775	861	9.5
East Mids	502	586	669	753	837	9.1
East	492	574	656	738	821	9.5
South West	464	542	619	696	774	7.7
South East	479	559	639	719	799	10.2
London	490	572	653	735	817	12.9
<b>Mean (Kcal)</b>	<b>501</b>	<b>585</b>	<b>668</b>	<b>752</b>	<b>835</b>	<b>9.7</b>

\*Percentage of respondents, per region, undertaking activity in 4 weeks prior to survey.

Data presented in Table 3.5 suggests that football provides a valuable means of achieving minimum levels of weekly energy expenditure. Even for a 60kg individual in the East region, which reported the lowest energy expenditure per week, football provided sufficient energy expenditure ( $836 \text{ kcal}\cdot\text{week}^{-1}$ ) to meet the  $750 \text{ kcal}\cdot\text{week}^{-1}$  physical activity energy expenditure target. The highest energy expenditure for football was reported in the South West (mean for all body weights =  $1303 \text{ kcal}\cdot\text{week}^{-1}$ ) and the lowest in the East (mean for all body weights =  $1114 \text{ kcal}\cdot\text{week}^{-1}$ ).

Table 3.5 Regional weekly energy expenditure for football (sport 049) (N = 7,247).

Region	Energy expenditure (Kcal.week <sup>-1</sup> )					Population %*
	60kg	70kg	80kg	90kg	100kg	
North East	893	1042	1191	1340	1489	3.9
North West	878	1025	1171	1317	1464	4.0
Yorkshire	921	1075	1229	1382	1536	3.6
West Mids	925	1079	1234	1388	1542	3.8
East Mids	888	1036	1184	1332	1480	3.7
East	836	975	1114	1253	1393	3.9
South West	977	1140	1303	1466	1628	2.9
South East	838	978	1118	1257	1397	3.7
London	913	1065	1217	1369	1522	4.6
<b>Mean (Kcal)</b>	<b>897</b>	<b>1046</b>	<b>1196</b>	<b>1345</b>	<b>1494</b>	<b>3.8</b>

\*Percentage of respondents, per region, undertaking activity in 4 weeks prior to survey.

Golf/pitch & putt/putting was the sixth most popular sport/physical activity in the Active People Survey 2. Although golf is a low intensity sport, the prolonged duration of this activity resulted in the highest weekly energy expenditures of the 7 sports analysed (mean for all regions and all body weights =  $1502 \text{ kcal}\cdot\text{week}^{-1}$ ). Indeed, the mean energy expenditure (for all body weights) exceeded the minimum recommended levels ( $750 \text{ kcal}\cdot\text{week}^{-1}$ ) by a factor of two in 6 out of the 9 regions (Table 3.6).

A total of 7,098 individuals reported having taken part in road running during the 4 weeks prior to questioning. The North East reported the highest weekly energy expenditure from

this activity (Table 3.7) (mean for all body weights = 934 kcal·week<sup>-1</sup>), with the lowest values being reported in Yorkshire (mean for all body weights = 777 kcal·week<sup>-1</sup>). With the exception of Yorkshire, all individuals over 70kg achieved the minimum recommended weekly energy expenditure from road running.

Table 3.6 Regional weekly energy expenditure for golf (sport 092) (N = 7,098).

Region	Energy expenditure (Kcal·week <sup>-1</sup> )					Population %*
	60kg	70kg	80kg	90kg	100kg	
North East	1229	1434	1639	1844	2049	3.3
North West	1167	1362	1557	1751	1946	3.4
Yorkshire	1242	1449	1656	1862	2069	3.8
West Mids	1129	1317	1505	1693	1881	3.7
East Mids	1169	1364	1559	1754	1949	3.8
East	1091	1273	1455	1637	1819	4.2
South West	1166	1360	1555	1749	1943	3.6
South East	1050	1225	1400	1575	1750	4.5
London	895	1044	1193	1342	1491	2.3
<b>Mean (Kcal)</b>	<b>1127</b>	<b>1314</b>	<b>1502</b>	<b>1690</b>	<b>1878</b>	<b>3.6</b>

\*Percentage of respondents, per region, undertaking activity in 4 weeks prior to survey.

Table 3.7 Regional weekly energy expenditure for road running (sport 075) (N = 5,243).

Region	Energy expenditure (Kcal·week <sup>-1</sup> )					Population %*
	60kg	70kg	80kg	90kg	100kg	
North East	700	817	934	1050	1167	2.3
North West	637	743	849	955	1062	2.7
Yorkshire	583	680	777	874	971	2.5
West Mids	684	798	912	1026	1140	2.2
East Mids	660	770	880	990	1100	2.4
East	669	781	892	1004	1115	2.6
South West	693	808	924	1039	1154	2.9
South East	669	781	892	1004	1115	3.1
London	686	801	915	1029	1144	3.7
<b>Mean (Kcal)</b>	<b>665</b>	<b>775</b>	<b>886</b>	<b>997</b>	<b>1108</b>	<b>2.7</b>

\*Percentage of respondents, per region, undertaking activity in 4 weeks prior to survey.

The final column in Tables 3.1-3.7 provides the percentage of the population from each of the 9 regions who participated in each activity during the 4 weeks prior to survey. A mean 70.4% of respondents across the regions had participated in walking, 12.4% in swimming, 10.3% in cycling, 9.7% in gym-based activities, 3.8% in football, 3.6% in golf and 2.7% in road running. The range of percentages shown in Table 3.8 are relatively narrow for swimming (1.5%), football (1.7%), golf (2.2%) and road running (1.5%), suggesting that there is relatively small variation in regional participation statistics. The difference between the highest and lowest regional respondents was greatest for walking (6.3%), gym activities (5.2%), and cycling (4.1%); suggesting more regional variation for these activities. The distribution of figures across the regions suggests that no individual region skews the figures. London had the highest percentage of respondents for 3 activities: gym, football and road running, but had the lowest percentage of respondents for golf. The South East had the highest percentage of respondents for swimming (with Yorkshire) and golf. The South West had the highest percentage of respondents for walking, but the lowest for gym and football. A full list of the percentage respondents for the 7 selected activities is shown in Table 3.8.

Table 3.8 Regional levels of participation in 7 most popular sports/physical activities.

Activity	Mean % Participating in the Last 4 Weeks	Cross-regional range of % participation	Region with lowest rate of participation	Region with highest rate of participation
Walking	70.4	68.2 - 74.5	West Midlands	South West
Swimming	12.4	11.4 - 12.9	North East	South East/Yorkshire
Cycling	10.3	8.3 - 12.4	North East	East
Gym	9.7	7.7 - 12.9	South West	London
Football	3.8	2.9 - 4.6	South West	London
Golf	3.6	2.3 - 4.5	London	South East
Road Running	2.7	2.2 - 3.7	West Midlands	London

### 3.2 SPORTS/PHYSICAL ACTIVITY ENERGY EXPENDITURE COMPARISONS

A one-way ANOVA identified significant differences between the mean regional values for each sport/physical activity ( $P < 0.001$ ). Post-hoc analysis suggested that walking and cycling energy expenditures were not different ( $P > 0.05$ ) but revealed a significant difference

between cycling and gym ( $P < 0.02$ ) and between all other sports ( $P < 0.0001$ ). Table 3.9 identifies the rank order of weekly energy expenditures per sport for a 70kg individual.

Table 3.9 Weekly calorie expenditure for 7 most popular sports/physical activities.

Energy expenditure (kcal.week <sup>-1</sup> )							
Region	Walking	Cycling	Swimming	Gym	Football	Golf	Road Running
North East	402	473	257	616	1042	1434	817
North West	397	520	247	614	1025	1362	743
Yorkshire	413	485	238	598	1075	1449	680
West Mids	387	455	228	603	1079	1317	798
East Mids	398	469	224	586	1036	1364	770
East	389	445	237	574	975	1273	781
South West	423	446	231	542	1140	1360	808
South East	388	451	227	559	978	1225	781
London	406	537	226	572	1065	1044	801
<b>Mean (kcal)</b>	<b>400</b>	<b>476</b>	<b>235</b>	<b>585</b>	<b>1046</b>	<b>1314</b>	<b>775</b>
<b>Rank order</b>	<b>6th</b>	<b>5th</b>	<b>7th</b>	<b>4th</b>	<b>2nd</b>	<b>1st</b>	<b>3rd</b>

Reference values for a 70kg individual.

### 3.3 PRELIMINARY SOCIAL-DEMOGRAPHIC ANALYSIS

A social-demographic analysis between the sexes identified higher levels of weekly energy expenditure in males in all regions for cycling, gym and football (Table 3.10). Conversely, females expended more energy weekly in all regions for walking activity. Perhaps surprisingly, the weekly energy expenditure for females taking part in golf was higher than males in 4 out of 9 regions. Females in Yorkshire and the East region also expended more weekly energy than males whilst road running. Weekly energy expenditure from swimming was greater in males in all regions except the West Midlands.

Table 3.10 Weekly calorie expenditure for 7 sports/physical activities for males and females.

Energy expenditure (kcal.week <sup>-1</sup> )							
Sex	Walking	Cycling	Swimming	Gym	Football	Golf	Road Running
<b>North East</b>	<b>402</b>	<b>473</b>	<b>257</b>	<b>616</b>	<b>1042</b>	<b>1434</b>	<b>817</b>
Male	399	533	268	721	1082	1458	849
Female	404	374	252	533	593	1280	782
<b>North West</b>	<b>397</b>	<b>520</b>	<b>247</b>	<b>614</b>	<b>1025</b>	<b>1362</b>	<b>743</b>
Male	389	587	263	682	1037	1374	788
Female	404	409	240	562	893	1310	689
<b>Yorkshire</b>	<b>413</b>	<b>485</b>	<b>238</b>	<b>598</b>	<b>1075</b>	<b>1449</b>	<b>680</b>
Male	394	532	272	643	1145	1417	647
Female	424	418	226	564	608	1560	718
<b>West Mids</b>	<b>387</b>	<b>455</b>	<b>228</b>	<b>603</b>	<b>1079</b>	<b>1317</b>	<b>798</b>
Male	378	511	225	670	1108	1339	808
Female	393	365	229	550	890	1222	786
<b>East Mids</b>	<b>398</b>	<b>469</b>	<b>224</b>	<b>586</b>	<b>1036</b>	<b>1364</b>	<b>770</b>
Male	382	550	245	688	1063	1363	786
Female	409	360	216	515	844	1371	754
<b>East</b>	<b>389</b>	<b>445</b>	<b>237</b>	<b>574</b>	<b>975</b>	<b>1273</b>	<b>781</b>
Male	366	498	238	635	1017	1219	775
Female	404	376	237	527	671	1509	787
<b>South West</b>	<b>423</b>	<b>446</b>	<b>231</b>	<b>542</b>	<b>1140</b>	<b>1360</b>	<b>808</b>
Male	396	515	235	603	1141	1387	849
Female	441	364	230	499	1132	1257	766
<b>South East</b>	<b>388</b>	<b>451</b>	<b>227</b>	<b>559</b>	<b>978</b>	<b>1225</b>	<b>781</b>
Male	363	504	235	626	987	1208	823
Female	405	379	224	512	916	1295	733
<b>London</b>	<b>406</b>	<b>537</b>	<b>226</b>	<b>572</b>	<b>1065</b>	<b>1044</b>	<b>801</b>
Male	383	596	247	623	1140	1101	848
Female	421	455	216	532	599	815	749
<b>Mean (kcal)</b>	<b>400</b>	<b>476</b>	<b>235</b>	<b>585</b>	<b>1046</b>	<b>1314</b>	<b>775</b>

Reference values for a 70kg individual.

A feasibility analysis identified a significant difference in energy expenditure between ethnic groups for walking ( $P < 0.001$ ). Post-hoc analysis revealed a significant difference between



ethnic group 1 (“White”) and group 5 (“Other”) ( $P < 0.0001$ ), between group 3 (“Asian”) and group 5 (“Other”) ( $P < 0.026$ ), and between group 5 (“Other”) and group 6 (“Chinese”) ( $P < 0.011$ ).

For reference, calorie expenditure for the top 7 sports/physical activities for each Local Authority is presented in Appendix 1 (Figure A1.1).

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## 4.0 DISCUSSION

### 4.1 THE FEASIBILITY OF CALORIE MAPPING

The results of this investigation build upon the findings of the Health Profile of England 2008 (Department of Health, 2009a). As illustrated in Figure A1.2, the Health Profile of England provided basic descriptive data showing the fraction of the adult population that are physically active in each of the 9 Government regions. By using such data to calculate mean energy expenditure levels for seven sports/physical activities, this investigation illustrates the feasibility of completing a comprehensive 'calorie map' of sport and physical activity in England.

### 4.2 HOW EFFECTIVE ARE THE MOST POPULAR SPORTS/PHYSICAL ACTIVITIES?

The calorie mapping completed in this investigation considered the seven most popular sports reported in the Active People Survey 2. The accessibility of walking made this activity by far the most popular physical activity. Despite this popularity, the results of this investigation suggest that walking, on its own, does not provide sufficient energy expenditure to stimulate any significant health benefit. For a reference 70kg individual, walking only accounted for 56% of the minimum recommended weekly energy expenditure. Clearly, some individuals carry out more than one type of physical activity per week, helping them achieve recommended energy expenditure levels. However, given that just 11.3% of APS 2 respondents reported having undertaken at least 2 sports in the 4 weeks preceding questioning, it is unlikely that a combination of activities contributes to energy expenditure for most people. The prevalence of walking participation (71% APS 2 respondents) compared to the other popular activities (e.g. swimming: 12% APS 2 respondents) suggests that walking is the sole form of physical activity for most people. This analysis shows that the energy expenditure associated with walking is not sufficient to meet even the minimum recommended level of energy expenditure. It is vital, therefore, that individuals who currently rely on walking as their sole form of exercise, supplement this with additional, or more deliberate forms of physical activity. Sport provides an excellent range of such activities.

Few of the sports/physical activities considered provided sufficient energy expenditure to achieve the minimum recommended caloric expenditure. The exceptions were provided by road running, football and golf.

A surprising finding of this investigation was that physical activities commonly associated with significant health and fitness benefits (walking, cycling, swimming, gym activities and road running) provided lower levels of energy expenditure than sports activities (golf and football). This suggests that sports that are often carried out for reasons of enjoyment and social interaction, rather than for specific health reasons, may actually provide a more effective stimulus to health and fitness.

Whilst swimming did not appear to lead to high levels of energy expenditure, it is acknowledged to provide a significant contribution to other aspects of physical health, like muscular strength and flexibility (Lin *et al.*, 2004). These fitness components are particularly important for older adults in order to prevent functional deterioration and to preserve independence and quality of life (Lin *et al.*, 2004).

Energy expenditure through physical activity normally relates to those movements that involve large rhythmical muscle contractions performed in aerobic type exercise (e.g. walking, running, cycling, and swimming). Whilst aerobic activities may potentially provide the greatest health benefit, other aspects of fitness are important for overall health, function and wellbeing. Strength and flexibility contribute to a muscle's ability to produce force and movement around joint complexes. Strength and flexibility development are considered an important part of physical development in children. The Department of Health recommends that children complete two activity sessions per week that specifically target strength and flexibility (Department of Health, 2004a). Older adults lose muscular strength and flexibility with advancing age, so activities that help preserve it should form part of an exercise programme. Improvement in each of these fitness components will: allow comfortable execution of functional tasks of daily living; will contribute to a reduced incidence of falls; and will help to maintain lean body weight and manage healthy levels of body fat. This may require more deliberate forms of strength and flexibility training, e.g. using resistance equipment or performing passive stretching exercises (Nelson *et al.*, 2007).

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Although only seven sports/physical activities were considered in this investigation, these findings may have important implications for strategic decisions on the promotion of key health-promoting physical activities.

### **4.3 REGIONAL VARIATION IN SPORT AND PHYSICAL ACTIVITY ENERGY EXPENDITURE**

This investigation identified some variation in energy expenditure between regions and, indeed, local authorities. Considering a 'regional' calorie map, summing regional weekly energy expenditure values for all 7 sports/physical activities for a reference adult of 70kg, the highest values were reported in the North East (5040 kcal·week<sup>-1</sup>). The lowest levels of energy expenditure were reported in the South East (4608 kcal·week<sup>-1</sup>), whilst London was ranked 8<sup>th</sup> (out of 9) (4650 kcal·week<sup>-1</sup>). Although there were regional differences between sports, the combined results are relatively consistent across sports. The North East was ranked high, and the South East and London were ranked low in most sports/physical activities (see Table 3.9). The reasons for these regional variations in energy expenditure are beyond the scope of this investigation.

Six out of the 7 activities selected had the highest number of participants in southern regions (London, South East or South West). The West Midlands or North East regions had the lowest levels of participation in walking, swimming, cycling, and road running. This evidence suggests that there may be a North-South divide in sport and physical activity participation levels.

### **4.4 SOCIO-DEMOGRAPHIC VARIATIONS**

#### **4.4.1 SEX-RELATED ENERGY EXPENDITURE DIFFERENCES**

The Health Survey for England and the Health Profile of England have reported values for the percentage of male and female populations who are performing the minimum recommended level of physical activity (5 sessions of 30 minutes duration at moderate intensity per week). However, these reports do not provide detailed insight into these observations (e.g. activities undertaken, activity duration, and activity-related energy expenditure). Although the level of physically active adults is important, it is the energy expended from such activity which determines whether or not it is health promoting (American College of Sports Medicine, 2006).

It has been widely reported (Department of Health, 2009a) that males are more physically active than females. Having a larger stature and greater musculature than the average female, the average male also has a significantly greater body weight. Males tend to expend more energy (i.e. burn more calories) during physical activity than females for two reasons: 1) for historical and social reasons (Choi, 2000), a higher percentage of males are physically active than females (Department of Health, 2009a), and 2) for a given bout of physical activity, an individual with a greater body weight will expend more energy than a lighter individual. In line with this rationale, the results of this investigation showed that males generally expended more calories during their activity bouts than females. However, there were some exceptions (see section 3.3). Most notably, females expended more energy per week through walking than males in all regions. Similar weekly caloric expenditure was calculated for males and females for swimming/diving [indoors] in all regions; although, female values exceeded male values in the West Midlands only. Males expended more energy through weekly football activity than females. However, in the South West, female values were just 9 kcal·week<sup>-1</sup> lower than male values. Indeed, the female values were the 4<sup>th</sup> highest of any region and for either sex.

#### **4.4.2 ETHNIC GROUP RELATED ENERGY EXPENDITURE DIFFERENCES**

In previous physical activity surveys, concern has been expressed about the low participation rates amongst certain ethnic groups, particularly those of Asian origin (Department of Health, 2004b). In this investigation, a preliminary investigation of weekly energy expenditure for walking between ethnic groups identified significant differences. White, Asian and Chinese groups were all different to the “Other” group. However, this analysis was affected by an unbalanced design and a large number of blank responses. These data require further analysis to establish whether important energy expenditure differences exist between ethnic groups.

Research has shown that people tend to over-estimate their fitness levels and the amount of physical activity that they perform (Department of Health, 2009b). It is therefore appropriate to assume that the picture of activity levels described by this investigation may represent a ‘best case scenario’.

## 5.0 STUDY LIMITATIONS

### 5.1 SURVEY DATA

In order to provide an accurate calorie map, detailed data are required for activity frequency, duration, and intensity. Survey data are dependent upon participant recall over relatively long time periods and are, therefore, subject to large inaccuracies. As the Active People Survey was not designed specifically to provide data for calorie mapping, it provides only limited data relating to exercise intensity. This restricts the robustness of the calorie mapping results provided.

### 5.2 PHYSICAL ACTIVITY COMPENDIA

In order to calculate caloric expenditure values, MET values for generic physical activities were used. These values do not account for differences in body weight, adiposity, age, sex, efficiency of movement (mechanical or metabolic), or environmental conditions. Whilst these factors mean that error in the calculation of energy expenditure for any given individual may be large, it is probable that such errors are smoothed as a result of the large sample examined.

When establishing the MET level for a given activity the Compendium of Physical Activities (Ainsworth *et al.*, 2000) was used. However, exact matches with the Active People Survey 2 questions/responses were not always available. In such cases, the authors matched to 'similar' activities and, on one occasion, provided a non-coded value half way between values available for high and low intensities. In all cases where exact matches were not available, conservative MET values were utilised, reflecting minimum rather than maximum energy expenditure. For a full discussion of the limitations of this approach see Ainsworth *et al.* (2000).

### 5.3 DATA HANDLING AND PROCESSING

Data handling and processing of the large Active People Survey data sets provided major difficulties during data analysis. The complex calculations required to calculate energy expenditure within Microsoft Excel were severely restricted by a lack of computer processing power and memory. These limitations meant that transfer of data into

appropriate statistical analysis software was not possible. Future calorie mapping exercises should investigate the efficacy of alternative software packages (e.g. Matlab).

## 6.0 RECOMMENDATIONS AND DIRECTIONS FOR FUTURE RESEARCH

### 6.1 RECOMMENDATIONS

#### 6.1.1 LEVELS OF PHYSICAL ACTIVITY

In order to achieve some health benefit from sport and physical activity, adults should perform a minimum of 30 minutes of moderate intensity physical activity on 5 days a week, or 20 minutes of vigorous intensity physical activity on 3 days a week. Individuals might also seek to combine moderate and vigorous intensity activities and should target an intensity in the range 450-900 MET·week<sup>-1</sup> (over and above low intensity activities of daily living). The lower end of this range could be achieved by walking at 2.5 miles·hour<sup>-1</sup> on a firm surface (equivalent to 3.0 METs) for 30 minutes 5 times per week (30 min x 5 = 150 mins·week<sup>-1</sup> x 3.0 METs = 450 MET·week<sup>-1</sup>). This level of energy expenditure might also be achieved by combining different sessions. For example, a 30-minute football session would provide 300 MET·week<sup>-1</sup> (30 mins·week<sup>-1</sup> x 10.0 METs = 300 MET·week<sup>-1</sup>). Adding two 30-minute walk sessions at moderate intensity (60 mins·week<sup>-1</sup> x 3.0 METs = 180 MET·week<sup>-1</sup>) would allow the minimum MET target of 450 MET·week<sup>-1</sup> to be achieved. A combination of one vigorous intensity 30-minute football session and two moderate intensity 30-minute walk sessions accumulates more energy expenditure (300 METs + 180 min = 480 MET·week<sup>-1</sup>) and takes less time than the five moderate intensity walks (90 minutes vs. 150 minutes).

Physical activity beyond the minimum recommendations (450 MET·week<sup>-1</sup>), including that performed at a higher intensity, will likely provide additional health benefits (Haskell *et al.*, 2007). Broadly, sport provides a greater opportunity to engage in vigorous exercise than conditioning activities such as gym and walking. Sports such as football and road running require higher energy expenditure and, therefore, may lead to improved personal fitness and health.

The shape of the dose-response curve, points of maximal benefit and the possible contribution from physical activity bouts shorter than 10 minutes, are as yet unknown (Haskell *et al.*, 2007). The optimal combination of moderate and vigorous intensity physical activity, to produce an achievable programme of effective exercise, also requires further investigation.



### **6.1.2 TYPES OF SPORT/PHYSICAL ACTIVITY**

Exercising at moderate-vigorous intensity has potentially the greatest benefits for health (American College of Sports Medicine, 2006). This is reflected in the total calories expended during activity, which can be a reflection of time spent in the activity and/or the intensity of the activity.

Participation in endurance-type (and muscle-strengthening) physical activities above the minimum recommended amounts provides additional health benefits, reduces the risk for premature chronic health conditions and mortality related to a sedentary lifestyle, and potentially results in higher levels of physical fitness. Of the 7 sports/physical activities selected in this investigation, when carried out as the sole physical activity, only football, road running and golf provided sufficient caloric expenditure to stimulate these positive health benefits. If only carrying out cycling, swimming/diving, walking, and gym activities, individuals should seek to increase the intensity and or duration of activity in order to gain positive health adaptations.

### **6.1.3 THE FEMALE CALORIE MAP**

The number of females achieving sufficient energy expenditure from the activities investigated above may be even less than suggested, as these conclusions are based upon body weights in the range 60kg-100kg. Although most females are accommodated by this range, a significant fraction of the female population may be below this weight. Lower body weights would necessarily reduce the caloric expenditures described in section 3 above. Golf may provide one exception, as relatively high energy expenditures were recorded for both males and females ( $>1000 \text{ kcal}\cdot\text{week}^{-1}$ ). In order to achieve minimum activity levels, golf may therefore offer an effective choice for females. Golf may also provide valuable social interaction, stimulating both physical and mental wellbeing. However, the relatively long duration of golf activity may be impractical for large portions of our time-conscious society.

### **6.1.4 USING CALORIE MAPPING TECHNIQUES TO PLAN PHYSICAL ACTIVITY**

Working backwards from the caloric goals to determine the volume (duration and frequency) of exercise needed to reach the goal is useful in providing key strategic

information to the public about appropriate exercise prescription components (American College of Sports Medicine, 2006).

It should be remembered that 1 MET represents resting metabolic rate and that energy expenditure goals are based on net caloric expenditure from exercise. For a 70kg individual performing a 6 MET activity, the net caloric expenditure from the exercise is actually 5 METs. Therefore, the net caloric expenditure from the exercise is  $6 \text{ kcal}\cdot\text{min}^{-1}$  ( $5 \times 1.2 \text{ kcal}\cdot\text{min}^{-1}$ ). If this individual is attempting to attain the  $1000 \text{ kcal}\cdot\text{week}^{-1}$  target threshold, it is simple to calculate the amount of this 6 MET physical activity that needs to be performed ( $1000 / 6 = 167 \text{ min}\cdot\text{week}^{-1}$  or approximately  $34 \text{ min}\cdot\text{day}^{-1}$  for 5 days or  $24 \text{ min}\cdot\text{day}^{-1}$  for each day of the week).

#### **6.1.5 CALORIE MAPPING AND EDUCATION**

The Change4Life campaign (Department of Health, 2009c) seeks to educate the population to “eat better, move more and live longer”. Although a descriptive tool, calorie mapping methods might also be used to complement such education activities. Understanding the concept of energy balance (calorie intake=calorie expenditure) would stimulate the population to avoid being inactive and overeating. Linking calorie expenditure to different sports and physical activities may help people to recognise the need to accumulate sufficient energy expenditure through a weekly exercise regimen in order to sustain a healthy body and lifestyle.

#### **6.2 DIRECTIONS FOR FUTURE RESEARCH**

In order for there to be confidence in the calorie mapping exercise, the data being used needs to be as accurate as possible. Further work needs to be performed on the collection of data from large population samples, but particularly where it is critical to achieve accurate recall in terms of quantity of activity performed. Of particular relevance to this calorie mapping exercise, the estimation and reporting of the intensity dimension needs to be more detailed. Another aspect of the intensity problem is that in existing data sets, a single intensity value is reported for all physical activity completed in the 4 week sample period. Clearly, the intensity of effort will often vary dramatically within a session and from one bout of physical activity to the next.

Building upon the experiences and successful outcomes of this investigation, a number of questions for future research have been identified.

Methodological Question:

- Can a more accurate and detailed method of data collection be established to enable the collection of exercise mode, frequency, intensity, and duration data?

Analytical Questions:

- How has the calorie map of England changed since suitable data first became available?
- Is there a North/South divide in the amount of energy expended through sport and physical activity?
- What is the impact of education level on weekly levels of energy expenditure?
- Can specific Local Authorities be targeted to have a large impact on national levels of energy expenditure?
- Which non-mainstream sports/physical activities provide the most effective caloric expenditure and, therefore, potentially the greatest health benefit?

## 7.0 CONCLUSIONS

The adult population of England appears to be expending too few calories through sport and/or physical activity. Some sport activities seem to provide a suitable opportunity to expend large amounts of calories, e.g. football and golf. From the activities sampled, football, golf and road running meet the weekly minimum energy expenditure, but not the higher energy expenditure thresholds (2100-2800 kcal·week<sup>-1</sup>) which likely offer greater health benefits.

Thus, even for those individuals engaged in regular physical activity, energy expenditure needs to be increased if the health benefits of exercise are to be realised. Therefore, the key question stemming from this investigation and a key problem to add to the physical activity debate is: How can health promoters get the active population to expend more energy during their exercise bouts?

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## A.1 APPENDIX – Local Authority Energy Expenditure

Table A1.1 Weekly calorie expenditure for top 7 physical activities/sports for all Local Authorities (April 2009 designation).

Local Authority	Walking	Cycling	Swimming	Gym	Football	Golf	Road Running
<b>North East</b>	<b>402</b>	<b>473</b>	<b>257</b>	<b>616</b>	<b>1042</b>	<b>1434</b>	<b>817</b>
<i>Gateshead</i>	377	538	248	628	1017	1105	1728
<i>Newcastle upon Tyne</i>	397	568	252	669	1047	1196	755
<i>North Tyneside</i>	380	396	256	766	811	1517	729
<i>South Tyneside</i>	418	591	324	604	1054	1243	587
<i>Sunderland</i>	383	490	239	609	1729	1337	423
<i>Hartlepool UA</i>	343	328	292	635	818	2069	391
<i>Middlesbrough UA</i>	402	574	286	795	1078	1263	832
<i>Redcar &amp; Cleveland UA</i>	381	519	228	628	807	1184	703
<i>Stockton-on-Tees UA</i>	360	496	350	664	747	1131	853
<i>Darlington UA</i>	379	490	225	622	859	1106	1023
<i>County Durham</i>	407	477	235	596	1189	1333	702
<i>Northumberland</i>	422	437	258	560	922	1603	909
<b>North West</b>	<b>397</b>	<b>520</b>	<b>247</b>	<b>614</b>	<b>1025</b>	<b>1362</b>	<b>743</b>
<i>Allerdale</i>	451	437	263	671	763	1749	1062
<i>Barrow-in-Furness</i>	403	415	196	557	955	1356	977
<i>Carlisle</i>	413	355	269	659	751	1141	889
<i>Copeland</i>	444	584	266	664	1531	1460	1068
<i>Eden</i>	456	496	245	592	829	1002	803
<i>South Lakeland</i>	475	495	185	487	1160	1753	658
<i>Bolton</i>	363	439	255	667	869	1988	548
<i>Bury</i>	379	519	206	737	964	3132	562
<i>Manchester</i>	365	652	245	919	1153	914	518
<i>Oldham</i>	364	589	196	646	719	1506	878
<i>Rochdale</i>	376	617	246	582	1085	1416	783
<i>Salford</i>	403	522	327	565	784	1203	544
<i>Stockport</i>	350	438	379	480	1148	1183	1084
<i>Tameside</i>	389	466	198	563	1016	690	700
<i>Trafford</i>	369	622	249	621	608	1348	742
<i>Wigan</i>	373	604	212	598	596	1593	763
<i>Knowsley</i>	395	565	306	752	1211	1450	1191
<i>Liverpool</i>	399	636	258	659	1141	1128	653
<i>St Helens</i>	384	425	299	654	1478	1495	342
<i>Sefton</i>	387	509	272	683	1172	776	603
<i>Wirral</i>	412	563	308	601	1619	2195	598
<i>Halton UA</i>	441	511	279	606	995	1069	661
<i>Warrington UA</i>	381	473	183	532	672	1125	656
<i>Blackburn with Darwen UA</i>	394	477	248	546	896	1154	525

Table A.1 continued.

Local Authority	Walking	Cycling	Swimming	Gym	Football	Golf	Road Running
<i>Blackpool UA</i>	430	689	249	570	1069	1317	738
<i>Chester and Cheshire West</i>	403	484	232	614	874	1299	802
<i>Cheshire East</i>	385	490	198	551	1278	1556	895
<i>Burnley</i>	415	471	230	611	1226	1461	871
<i>Chorley</i>	374	538	234	657	1068	1235	835
<i>Fylde</i>	409	496	258	514	896	1280	760
<i>Hyndburn</i>	394	404	225	604	1243	1314	807
<i>Lancaster</i>	401	596	238	700	1036	1200	781
<i>Pendle</i>	394	424	244	535	1387	1505	441
<i>Preston</i>	426	473	184	556	852	1583	689
<i>Ribble Valley</i>	392	499	404	588	946	1189	701
<i>Rossendale</i>	359	452	258	630	1019	1414	549
<i>South Ribble</i>	377	504	227	582	605	1361	895
<i>West Lancashire</i>	350	444	252	650	708	1259	487
<i>West Lancashire</i>	439	590	219	470	1032	1274	1045
<b>Yorkshire</b>	<b>413</b>	<b>485</b>	<b>238</b>	<b>598</b>	<b>1075</b>	<b>1449</b>	<b>680</b>
<i>Barnsley</i>	426	430	276	710	1074	1333	584
<i>Doncaster</i>	399	373	252	524	928	1564	1098
<i>Rotherham</i>	340	426	219	715	1159	1323	356
<i>Sheffield</i>	372	558	278	498	1052	1375	667
<i>Bradford</i>	381	576	224	762	1826	1748	438
<i>Calderdale</i>	432	600	219	450	1353	1176	620
<i>Kirklees</i>	376	383	205	639	652	1317	427
<i>Leeds</i>	412	458	353	510	1507	1378	764
<i>Wakefield</i>	410	576	227	734	927	1746	516
<i>Kingston upon Hull, City of</i>	421	553	216	813	2017	1559	1539
<i>East Riding of Yorkshire UA</i>	400	486	238	592	980	1803	548
<i>North East Lincolnshire UA</i>	420	473	264	673	919	1330	747
<i>North Lincolnshire UA</i>	421	516	242	525	1118	1617	1154
<i>York UA</i>	392	528	183	589	628	1176	701
<i>Craven</i>	450	457	216	428	710	1041	532
<i>Hambleton</i>	417	461	223	431	923	1975	529
<i>Harrogate</i>	428	442	225	629	1060	1503	670
<i>Richmondshire</i>	446	443	235	443	731	1034	798
<i>Ryedale</i>	464	466	221	511	473	1109	653
<i>Scarborough</i>	432	468	258	658	625	1321	809
<i>Selby</i>	414	450	222	617	1126	1447	667
<b>West Mids</b>	<b>387</b>	<b>455</b>	<b>228</b>	<b>603</b>	<b>1079</b>	<b>1317</b>	<b>798</b>
<i>Birmingham</i>	391	471	230	622	1127	1317	721
<i>Coventry</i>	348	452	173	683	1581	1429	1142
<i>Dudley</i>	393	424	207	586	793	949	642
<i>Sandwell</i>	375	616	224	622	658	1737	1046



Table A.1 continued.

Local Authority	Walking	Cycling	Swimming	Gym	Football	Golf	Road Running
<i>Solihull</i>	347	422	240	600	634	1053	531
<i>Walsall</i>	345	379	258	584	1167	1677	672
<i>Wolverhampton</i>	419	567	471	652	1313	995	521
<i>Herefordshire UA</i>	396	467	205	612	513	1192	783
<i>Telford &amp; Wrekin UA</i>	388	364	243	686	1133	929	584
<i>Stoke-on-Trent UA</i>	368	509	277	635	989	507	1225
<i>Shropshire</i>	418	443	218	596	804	1243	950
<i>Cannock Chase</i>	375	634	220	679	863	1924	1123
<i>East Staffordshire</i>	385	465	205	568	692	1385	676
<i>Lichfield</i>	372	406	264	512	1123	1474	891
<i>Newcastle-under-Lyme</i>	407	448	252	559	1300	1563	659
<i>South Staffordshire</i>	382	483	219	569	1490	1420	791
<i>Stafford</i>	379	439	281	498	669	1701	828
<i>Staffordshire Moorlands</i>	379	548	230	597	527	1032	602
<i>Tamworth</i>	351	411	228	612	2003	1148	757
<i>North Warwickshire</i>	394	562	214	422	754	1242	922
<i>Nuneaton &amp; Bedworth</i>	349	285	240	644	942	1379	669
<i>Rugby</i>	404	524	203	572	740	1634	692
<i>Stratford-on-Avon</i>	407	316	181	593	1840	1025	531
<i>Warwick</i>	359	544	207	522	957	1029	666
<i>Bromsgrove</i>	387	431	185	765	928	1697	1531
<i>Malvern Hills</i>	389	405	266	640	1659	1409	616
<i>Redditch</i>	371	400	199	547	972	1173	841
<i>Worcester</i>	389	504	225	661	732	1155	1040
<i>Wychavon</i>	387	440	160	546	1588	1568	634
<i>Wyre Forest</i>	384	396	220	602	1863	1094	654
<b>East Mids</b>	<b>398</b>	<b>469</b>	<b>224</b>	<b>586</b>	<b>1036</b>	<b>1364</b>	<b>770</b>
<i>Derby UA</i>	388	449	192	459	1156	1149	679
<i>Leicester UA</i>	411	413	203	679	1268	1084	660
<i>Rutland UA</i>	415	524	211	584	788	1544	847
<i>Nottingham UA</i>	415	578	375	649	1125	1069	896
<i>Amber Valley</i>	395	397	227	509	1096	1496	598
<i>Bolsover</i>	379	529	235	650	891	1207	1097
<i>Chesterfield</i>	379	532	236	614	976	1276	1161
<i>Derbyshire Dales</i>	401	501	204	533	1116	1454	1185
<i>Erewash</i>	371	380	225	548	940	1320	477
<i>High Peak</i>	420	596	180	499	627	1697	554
<i>North East Derbyshire</i>	381	405	260	587	849	1152	831
<i>South Derbyshire</i>	398	383	198	601	864	1183	837
<i>Blaby</i>	372	512	239	668	782	1425	721
<i>Charnwood</i>	355	386	235	632	1377	1380	929
<i>Harborough</i>	386	431	209	560	459	1133	971

Table A.1 continued.

Local Authority	Walking	Cycling	Swimming	Gym	Football	Golf	Road Running
<i>Hinckley &amp; Bosworth</i>	382	497	173	566	906	845	826
<i>Melton</i>	413	448	177	568	813	1385	396
<i>North West Leicestershire</i>	411	478	225	472	1493	1643	829
<i>Oadby &amp; Wigston</i>	384	447	223	620	1107	1987	807
<i>Boston</i>	409	484	239	696	1812	1889	369
<i>East Lindsey</i>	431	658	235	578	656	1582	1184
<i>Lincoln</i>	386	562	223	738	1880	1175	749
<i>North Kesteven</i>	351	535	212	610	559	1702	746
<i>South Holland</i>	421	493	208	609	1065	1072	818
<i>South Kesteven</i>	412	408	245	630	888	1574	717
<i>West Lindsey</i>	454	360	232	563	1511	1155	728
<i>Corby</i>	410	459	239	630	1054	1297	716
<i>Daventry</i>	400	477	231	556	955	1286	928
<i>East Northamptonshire</i>	395	440	176	727	1019	1547	702
<i>Kettering</i>	397	360	193	582	1391	1292	1021
<i>Northampton</i>	372	463	213	651	1080	893	349
<i>South Northamptonshire</i>	404	438	201	431	438	1175	568
<i>Wellingborough</i>	375	420	246	473	1199	1411	819
<i>Ashfield</i>	443	436	239	578	1334	1231	296
<i>Bassetlaw</i>	426	481	211	551	1250	1975	950
<i>Broxtowe</i>	376	425	196	481	758	1160	784
<i>Gedling</i>	382	438	237	565	750	1435	997
<i>Mansfield</i>	399	520	266	635	1077	1188	578
<i>Newark &amp; Sherwood</i>	414	526	209	603	721	1493	699
<i>Rushcliffe</i>	363	425	205	541	730	1580	739
<b>East</b>	<b>389</b>	<b>445</b>	<b>237</b>	<b>574</b>	<b>975</b>	<b>1273</b>	<b>781</b>
<i>Peterborough UA</i>	367	399	300	522	1063	1238	278
<i>Cambridge</i>	354	515	256	610	1136	823	1183
<i>East Cambridgeshire</i>	358	450	245	553	1175	1011	1281
<i>Fenland</i>	387	467	259	724	1151	1177	1363
<i>Huntingdonshire</i>	366	419	203	661	755	1242	735
<i>South Cambridgeshire</i>	364	482	198	509	625	1443	1071
<i>Breckland</i>	400	485	246	539	666	1580	467
<i>Broadland</i>	359	340	179	522	1215	1409	741
<i>Great Yarmouth</i>	420	447	315	608	1243	1574	1103
<i>Kings Lynn &amp; West Norfolk</i>	451	388	239	668	758	1518	776
<i>North Norfolk</i>	429	410	229	581	954	1527	1009
<i>Norwich</i>	383	613	196	554	1132	906	360
<i>South Norfolk</i>	407	493	179	565	747	1713	902
<i>Babergh</i>	435	414	235	597	1164	1622	721
<i>Forest Heath</i>	410	435	202	545	551	1334	538
<i>Ipswich</i>	427	462	229	665	1385	1633	688

Table A.1 continued.

Local Authority	Walking	Cycling	Swimming	Gym	Football	Golf	Road Running
<i>Mid Suffolk</i>	393	447	198	575	1221	1251	646
<i>St Edmundsbury</i>	439	478	199	741	679	994	845
<i>Suffolk Coastal</i>	463	438	386	468	798	1617	1020
<i>Waveney</i>	413	482	193	509	396	1017	888
<i>Luton UA</i>	378	402	191	563	1015	934	1212
<i>Southend UA</i>	399	618	211	803	445	904	824
<i>Thurrock UA</i>	381	484	296	679	1275	1348	944
<i>Central Bedfordshire</i>	391	410	288	681	886	1453	673
<i>Bedford</i>	380	510	242	479	1135	854	772
<i>Basildon</i>	402	485	242	571	1078	846	706
<i>Braintree</i>	404	418	404	617	609	1033	855
<i>Brentwood</i>	346	418	166	508	695	1171	834
<i>Castle Point</i>	362	390	261	483	1265	1564	1330
<i>Chelmsford</i>	359	440	206	568	1058	1502	447
<i>Colchester</i>	382	475	258	456	1103	1596	421
<i>Epping Forest</i>	374	353	214	424	886	2084	948
<i>Harlow</i>	357	506	238	589	1009	903	1152
<i>Maldon</i>	430	500	313	516	2026	1441	510
<i>Rochford</i>	392	339	238	530	528	1190	304
<i>Tendring</i>	409	360	229	712	1046	1353	1039
<i>Uttlesford</i>	425	374	171	567	1541	1364	898
<i>Broxbourne</i>	326	407	222	627	1057	1655	944
<i>Dacorum</i>	381	335	222	540	916	1139	765
<i>East Hertfordshire</i>	342	405	198	459	923	1055	474
<i>Hertsmere</i>	405	437	232	584	687	1168	677
<i>North Hertfordshire</i>	366	382	242	589	981	1066	669
<i>St Albans</i>	376	420	174	535	983	1021	463
<i>Stevenage</i>	371	417	256	677	1113	1137	994
<i>Three Rivers</i>	412	469	249	542	933	1125	652
<i>Watford</i>	368	508	235	543	866	1164	580
<i>Welwyn Hatfield</i>	338	433	308	543	798	1047	742
<b>South West</b>	<b>423</b>	<b>446</b>	<b>231</b>	<b>542</b>	<b>1140</b>	<b>1360</b>	<b>808</b>
<i>Bath &amp; North East Somerset</i>	421	335	213	643	822	1281	592
<i>Bristol, City of UA</i>	386	537	175	564	838	1432	1186
<i>North Somerset UA</i>	415	503	212	599	1136	1167	538
<i>South Gloucestershire UA</i>	378	341	210	487	1037	1175	873
<i>Plymouth UA</i>	426	505	270	584	1047	1104	1169
<i>Torbay UA</i>	446	605	244	702	942	1615	751
<i>Bournemouth UA</i>	387	425	314	750	900	845	672
<i>Poole UA</i>	359	536	196	578	699	1471	894
<i>Swindon UA</i>	368	532	238	547	1085	996	952
<i>Cornwall</i>	433	458	265	483	2053	1631	867

Table A.1 continued.

Local Authority	Walking	Cycling	Swimming	Gym	Football	Golf	Road Running
<i>Isles of Scilly</i>	519	445	164	385	1011	2205	449
<i>East Devon</i>	468	445	227	594	715	1032	614
<i>Exeter</i>	445	458	203	512	1432	1038	527
<i>Mid Devon</i>	409	355	214	477	3939	2487	645
<i>North Devon</i>	457	330	234	407	841	2517	637
<i>South Hams</i>	397	392	238	607	817	1359	499
<i>Teignbridge</i>	448	486	238	477	696	1416	849
<i>Torrige</i>	432	330	251	541	880	1196	972
<i>West Devon</i>	452	384	207	466	698	1189	1056
<i>Christchurch</i>	435	520	213	608	692	1474	931
<i>East Dorset</i>	410	369	214	459	851	1565	803
<i>North Dorset</i>	447	478	236	375	715	1674	1244
<i>Purbeck</i>	449	461	264	538	782	1090	846
<i>West Dorset</i>	440	456	173	449	391	1223	817
<i>Weymouth &amp; Portland</i>	437	501	281	454	1065	1328	678
<i>Cheltenham</i>	396	573	193	485	2927	1693	690
<i>Cotswold</i>	466	475	241	553	604	1185	814
<i>Forest of Dean</i>	405	343	196	568	633	1285	478
<i>Gloucester</i>	392	516	208	559	894	881	844
<i>Stroud</i>	401	459	203	549	1093	1312	575
<i>Tewkesbury</i>	417	414	219	448	484	1152	987
<i>Mendip</i>	410	436	266	1024	1180	1420	724
<i>Sedgemoor</i>	464	355	360	573	1244	1256	957
<i>South Somerset</i>	390	424	193	518	692	1114	590
<i>Taunton Deane</i>	412	418	234	499	719	1348	921
<i>West Somerset</i>	495	506	222	582	1220	1749	961
<i>Wiltshire</i>	406	427	205	513	826	1241	842
<b>South East</b>	<b>388</b>	<b>451</b>	<b>227</b>	<b>559</b>	<b>978</b>	<b>1225</b>	<b>781</b>
<i>Medway UA</i>	359	255	206	533	713	1092	567
<i>Bracknell Forest UA</i>	385	554	197	549	704	1173	796
<i>West Berkshire UA</i>	363	400	239	621	1126	1248	742
<i>Reading UA</i>	374	531	254	560	872	1553	985
<i>Slough UA</i>	408	649	283	579	1144	1363	429
<i>Windsor &amp; Maidenhead UA</i>	419	464	174	532	769	1544	594
<i>Wokingham UA</i>	325	315	189	621	1013	1700	804
<i>Milton Keynes UA</i>	346	493	213	636	649	1511	447
<i>Brighton &amp; Hove UA</i>	410	463	260	588	697	804	927
<i>Portsmouth UA</i>	380	532	258	625	1797	1312	669
<i>Southampton UA</i>	387	356	239	528	1301	2125	783
<i>Isle of Wight UA</i>	408	463	217	400	1510	1065	989
<i>Aylesbury Vale</i>	395	473	188	438	965	925	783
<i>Chiltern</i>	385	375	163	492	1763	1303	758

Table A.1 continued.

Local Authority	Walking	Cycling	Swimming	Gym	Football	Golf	Road Running
<i>South Bucks</i>	350	478	232	604	2470	1260	717
<i>Wycombe</i>	414	549	172	504	965	840	831
<i>Eastbourne</i>	384	498	466	577	958	1309	2343
<i>Hastings</i>	399	488	407	684	726	462	1550
<i>Lewes</i>	452	491	229	690	1089	1525	570
<i>Rother</i>	388	489	207	682	704	1392	918
<i>Wealden</i>	383	336	198	701	618	923	554
<i>Basingstoke &amp; Deane</i>	380	448	233	533	1342	1640	714
<i>East Hampshire</i>	371	536	201	546	619	1185	808
<i>Eastleigh</i>	341	356	199	498	874	1426	836
<i>Fareham</i>	395	412	234	590	1209	1582	778
<i>Gosport</i>	379	563	196	527	937	1198	1195
<i>Hart</i>	367	404	211	596	613	1120	815
<i>Havant</i>	364	518	259	523	847	1368	917
<i>New Forest</i>	381	316	184	567	1410	1296	481
<i>Rushmoor</i>	356	329	249	522	962	1328	793
<i>Test Valley</i>	354	347	217	542	974	1305	489
<i>Winchester</i>	418	379	217	469	746	1117	509
<i>Ashford</i>	425	463	210	620	1688	1375	751
<i>Canterbury</i>	411	437	210	422	839	1042	423
<i>Dartford</i>	409	396	226	715	843	1182	848
<i>Dover</i>	399	471	196	555	729	977	408
<i>Gravesham</i>	403	410	203	660	931	1259	1023
<i>Maidstone</i>	417	450	354	708	946	1107	840
<i>Sevenoaks</i>	390	315	218	414	753	1282	508
<i>Shepway</i>	388	541	253	474	613	1047	804
<i>Swale</i>	430	335	253	673	1406	965	790
<i>Thanet</i>	437	494	273	457	1142	1094	823
<i>Tonbridge &amp; Malling</i>	368	479	224	531	1586	1156	669
<i>Tunbridge Wells</i>	389	457	214	489	909	1184	691
<i>Cherwell</i>	422	442	205	603	590	1596	693
<i>Oxford</i>	392	497	216	553	488	827	617
<i>South Oxfordshire</i>	394	506	208	589	940	1359	940
<i>Vale of White Horse</i>	369	554	197	523	1034	1161	782
<i>West Oxfordshire</i>	399	510	202	543	1245	1022	825
<i>Elmbridge</i>	372	458	181	495	923	1422	637
<i>Epsom &amp; Ewell</i>	386	550	186	538	670	1256	916
<i>Guildford</i>	350	598	173	502	1133	929	921
<i>Mole Valley</i>	395	423	187	515	883	1110	281
<i>Reigate &amp; Banstead</i>	354	498	211	479	1003	1325	846
<i>Runnymede</i>	362	383	197	611	919	1348	707
<i>Spelthorne</i>	363	351	225	556	821	1273	876

Table A.1 continued.

Local Authority	Walking	Cycling	Swimming	Gym	Football	Golf	Road Running
<i>Surrey Heath</i>	371	442	306	531	738	860	691
<i>Tandridge</i>	377	480	217	567	765	996	755
<i>Waverley</i>	408	475	193	530	832	1087	666
<i>Woking</i>	358	456	213	528	852	1281	680
<i>Adur</i>	419	550	197	644	1165	1018	771
<i>Arun</i>	413	363	346	648	796	1420	688
<i>Chichester</i>	504	448	226	501	794	941	898
<i>Crawley</i>	377	348	190	687	829	1097	416
<i>Horsham</i>	384	386	278	521	388	1177	830
<i>Mid Sussex</i>	367	445	264	475	1062	1263	716
<i>Worthing</i>	378	378	199	574	980	1292	1117
<b>London</b>	<b>406</b>	<b>537</b>	<b>226</b>	<b>572</b>	<b>1065</b>	<b>1044</b>	<b>801</b>
<i>City of London</i>	385	525	271	612	2940	643	799
<i>Barking &amp; Dagenham</i>	388	398	218	592	1417	954	694
<i>Barnet</i>	394	608	201	616	963	1127	603
<i>Bexley</i>	368	356	248	545	1580	980	653
<i>Brent</i>	403	490	222	607	1131	894	750
<i>Bromley</i>	364	453	266	548	1008	875	915
<i>Camden</i>	471	580	240	507	993	521	756
<i>Croydon</i>	362	430	229	675	987	1065	563
<i>Ealing</i>	410	532	223	673	1170	796	568
<i>Enfield</i>	360	454	175	618	931	1393	2529
<i>Greenwich</i>	393	439	253	536	985	1338	697
<i>Hackney</i>	466	741	250	615	3212	235	785
<i>Hammersmith &amp; Fulham</i>	441	597	418	597	995	537	932
<i>Haringey</i>	425	463	216	576	865	1350	627
<i>Harrow</i>	373	419	201	591	1023	903	543
<i>Havering</i>	369	436	177	531	961	1854	437
<i>Hillingdon</i>	415	459	173	536	984	1339	633
<i>Hounslow</i>	399	429	194	563	1319	708	646
<i>Islington</i>	435	703	267	472	583	1262	2139
<i>Kensington &amp; Chelsea</i>	461	699	246	579	948	639	810
<i>Kingston upon Thames</i>	380	446	216	516	699	1615	530
<i>Lambeth</i>	379	599	197	586	771	392	793
<i>Lewisham</i>	398	646	235	537	958	861	1009
<i>Merton</i>	392	528	218	532	813	874	502
<i>Newham</i>	495	552	238	519	1021	907	847
<i>Redbridge</i>	370	457	252	616	986	885	578
<i>Richmond upon Thames</i>	370	516	166	550	1201	1382	1028
<i>Southwark</i>	441	654	178	593	1197	694	815
<i>Sutton</i>	348	508	169	492	517	909	681
<i>Tower Hamlets</i>	426	584	192	549	1141	493	462

Table A.1 continued.

<b>Local Authority</b>	<b>Walking</b>	<b>Cycling</b>	<b>Swimming</b>	<b>Gym</b>	<b>Football</b>	<b>Golf</b>	<b>Road Running</b>
<i>Waltham Forest</i>	433	469	247	616	788	1094	650
<i>Wandsworth</i>	364	575	307	569	814	1332	866
<i>Westminster</i>	427	577	193	555	2010	582	1231
<b>Mean (Kcal)</b>	<b>399</b>	<b>470</b>	<b>234</b>	<b>581</b>	<b>1036</b>	<b>1304</b>	<b>780</b>

Reference values for a 70kg individual.

## A.2 APPENDIX – Health Profile of England

HEALTH PROFILE OF ENGLAND													
Summary of Indicators - Regions (using Local Health Profile data)													
INDICATOR	Period	Unit <sup>1</sup>	England	North East	North West	Yorkshire and the Humber	East Midlands	West Midlands	East of England	London	South East	South West	
<b>Our communities</b>													
1	Deprivation	2005	%	19.9	33.6	31.7	27.2	16.6	27.4	6.2	28.5	5.9	9.2
2	Children in poverty	2005	%	22.4	26.0	25.0	23.0	19.5	24.8	16.9	33.9	15.4	16.9
3	Statutory homelessness	2005-06	cr per 1000	4.4	5.2	4.4	4.2	3.7	5.8	3.5	6.8	2.8	3.6
4	GCSE achievement (5 A*-C)	2006-07	%	60.1	60.5	60.3	57.8	57.9	59.3	61.2	60.9	62.0	59.5
5	Violent crime	2006/07	cr per 1000	19.3	18.8	19.7	20.8	18.3	19.7	14.6	24.3	18.6	17.2
6	Carbon emissions	2005	t CO <sub>2</sub> per 3	7.6	9.0	7.6	8.3	8.3	7.4	7.8	6.8	7.3	7.7
<b>Children's and young people's health</b>													
7	Smoking in pregnancy	2006-07	%	16.1	23.6	20.8	19.6	18.3	16.3	14.4	8.9	15.2	16.8
8	Breast feeding initiation	2006-07	%	69.2	49.8	59.8	62.5	70.5	60.3	69.7	81.9	75.6	75.8
9	Physically active children	2006-07	%	85.7	87.0	85.8	84.1	85.9	85.1	86.6	84.9	85.0	88.6
10	Obese children	2006-07	%	9.9	10.9	10.2	9.7	9.7	10.4	9.1	11.3	8.7	9.0
11	Children's tooth decay (at age 5)	2005-06	mean	1.5	2.0	2.0	1.8	1.3	1.0	1.1	1.7	1.1	1.6
12	Teenage pregnancy (under 18)	2004-06	cr per 1000	41.1	49.7	45.4	47.2	40.2	45.7	32.8	46.9	33.4	33.7
<b>Adults health and lifestyle</b>													
13	Adults who smoke	2003-05	%	24.1	29.1	26.0	25.5	24.9	24.0	23.5	23.3	21.8	21.5
14	Binge drinking adults	2003-05	%	18.0	26.5	23.0	22.0	17.7	17.9	15.2	12.7	16.2	15.3
15	Healthy eating adults	2003-05	%	26.3	18.5	23.6	24.7	25.9	25.1	27.0	29.7	30.4	25.9
16	Physically active adults	2005-06	%	11.6	11.4	11.1	11.1	11.6	10.5	11.3	11.6	12.5	12.6
17	Obese adults	2003-05	%	23.6	25.2	24.5	24.1	25.6	26.5	24.8	18.4	22.0	23.2
<b>Disease and poor health</b>													
18	Under-15s not in good health	2001	%	11.6	13.4	12.4	11.8	10.4	12.1	10.4	13.1	10.4	10.7
19	Incapacity benefits for mental illness	2006	cr per 1000	27.5	40.8	40.5	28.3	24.1	28.5	20.0	26.9	19.4	26.3
20	Hospital stays related to alcohol	2006-07	r per 100,000	260.3	422.9	424.2	250.9	238.0	252.5	170.0	239.7	201.9	247.3
21	Drug misuse	2004-05	cr per 1000	9.9	9.5	11.4	11.7	8.2	10.6	6.5	14.4	6.4	9.4
22	People diagnosed with diabetes	2005-06	%	3.7	3.8	3.9	3.7	3.9	4.0	3.4	4.0	3.3	3.5
23	Sexually transmitted infections												
24	New cases of tuberculosis	2004-06	cr per 100,000	15.0	5.0	9.0	11.0	12.0	17.0	7.0	44.0	8.0	5.0
25	Hip fractures in over-65s	2006-07	r per 100,000	479.8	552.3	493.9	484.0	480.1	499.0	467.6	454.4	467.5	462.7
<b>Life expectancy and causes of death</b>													
26	Life expectancy - male <sup>4</sup>	2004-06	years	77.3	75.8	75.8	76.6	77.3	76.6	78.3	77.4	78.5	78.5
27	Life expectancy - female <sup>4</sup>	2004-06	years	81.6	80.1	80.3	81.0	81.3	81.1	82.3	82.0	82.4	82.7
28	Infant deaths	2004-06	cr per 1000	5.0	4.9	5.6	5.8	5.1	6.5	4.1	5.0	4.0	4.4
29	Deaths from smoking <sup>2</sup>	2004-06	r per 100,000	225.4	285.8	270.0	249.2	218.2	228.8	199.3	225.1	197.9	192.3
30	Early deaths: heart disease & stroke	2004-06	r per 100,000	84.2	99.8	102.2	90.5	84.6	90.7	72.9	89.0	70.2	69.5
31	Early deaths: cancer	2004-06	r per 100,000	117.1	136.0	131.0	122.3	115.1	119.2	108.3	114.6	109.8	108.1
32	Road injuries and deaths	2004-06	cr per 100,000	56.3	44.6	57.5	65.1	63.7	50.5	64.4	52.6	55.3	49.8

**Key**

**GREEN** = significantly better than national average  
**AMBER** = not significantly different from national average  
**RED** = significantly worse than national average  
**NO SHADE** = significance not calculated, or data unavailable

Figure A2.1 Excerpt from Health Profile of England 2008.