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Do all activities ‘weigh’ equally?
How different physical activities differ as predictors of weight

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Abstract

In Britain, it is recommended that, to stay healthy, adults should do 150 minutes of moderate-intensity physical activity every week. The recommendations provided by the UK government however remain silent in regards to the type of activity that should be done. Using the annual Health Survey for England (HSE) we compare how different types of physical activities predict a person’s weight. In particular, we consider clinically measured body mass index and waist circumference. We document mean slopes emanating from ordinary least squares regressions with these measures as the dependent variables. We show that individuals who walk at a brisk or fast pace are more likely to have a lower weight when compared to individuals doing other activities. Additionally we highlight that the association between physical activity and weight is stronger for females, and individuals over the age of 50. Our overall conclusions are robust to a number of specifications.

Keywords: physical activities, body mass index, waist circumference.

JEL Classification: I12, I18, J18.

Introduction

The importance of being active is echoed by estimates from the World Health Organization (WHO), which suggest that more than 3 million deaths per year are caused by physical inactivity. [(1)] Given that a person's weight is determined by calorie 'intake' versus calories 'spent', the role 'being active' plays in determining the weight of an individual is direct. However, the literature usually focuses on how only one particular type of physical activity – usually sports or exercise- affects body mass index (BMI). [(2-5)] This paper contributes to the literature by estimating the association between various types of physical activity and a person's weight. Namely we consider housework, manual, brisk or fast walking, sports and total physical activities. This is important given that governments in general recommend a total level of activity that their citizens should achieve to be healthy. They do not however differentiate between activity types.

The type of activity a person chooses may have differing impacts on their ability to maintain a certain level of weight. This arises, for three reasons. Firstly, certain activities may simply be better than others in aiding overall weight loss. That is, they may be less repetitive so a person does not plateau or target areas of the body for fat loss more efficiently. Second, governments generally recommend that a person is active to a level that their heart rate is up and they are sweating. This may be easier to achieve with some activities as opposed to others, however the individuals themselves may not be aware of this and believe that they are meeting the recommended targets. That is, an individual may believe they are active to a moderate level of intensity, but may not be. Finally, upon the completion of certain activities individuals may feel that they can legitimately over-indulge or may over compensate with rest periods. This is in line with studies that highlight that persons who walk or exercise more are also likely to eat more. [(6-7)]

Levels of physical activity vary widely across nations. Recently, Hallal *et al*.,[(8)] estimated global physical activity levels for adults from 122 countries and the results suggest that approximately 30% of adults are physically inactive. Elsewhere, data from the Eurobarometer suggests that 14% of EU citizens are physically inactive.[(9)] In

Britain, it is recommended that to be healthy adults should do 150 minutes of moderate intensity exercise weekly. This equates to five sessions of 30 minutes each where a person is working at an intensity that raises their heart rate and they sweat. Specific to England, data from the Health Survey for England (HSE) in 2008 suggested that almost 70% of adults do not meet these recommendations with this proportion generally decreasing with age.[10] More recently, Farrell *et al*.[11] estimate that almost 80% of the UK population are not meeting the government specified targets.

For Britain, Scarborough *et al*.,[12] estimate that for 2006-2007 physical inactivity cost the health service almost 1 billion pounds, with much of these costs being attributed to being obese. While having a weight in the obese category is known to be bad for your health, the prevalence is still increasing worldwide.[13] Overall policy options around physical activity are more straightforward with respect to tackling increasing obesity rates given that more physical activity is generally seen as a good thing. This is in contrast to the mixed messages people receive regarding food, owing to the government wanting people to minimise consuming foods that are calorie dense, whereas the companies that sell these foods, having deeper pockets, are able to counteract these messages with their own advertising campaigns. Having a straightforward policy message with respect to food intake is also clouded by the fact that nearly all food categories are beneficial as part of a balanced diet [14], but if consumed in excess may adversely affect health.[15]

Many studies have attributed the increase in obesity rates to decreasing levels of physical activity. For example, Fogelholm and Kukkonen-Harjula[16] conducted a systematic review on the association between activity and weight gain among adults and found activity to be negatively associated with long-term weight gain. In another systematic review, Wareham *et al*.[17] report some inconsistent finding between activity and weight gain. However, the authors assert that the most recent empirical evidence reports that an increase in physical activity decreases an individual’s weight. There is however more recent evidence in this regard. For example, it has been found that cycling[18] and physical activity at work[19] reduce body weight along with the probability of being obese. Notably, all of the studies report the association of one type of physical activity to weight (generally measured as BMI).[2-5] Therefore, there is a gap in the literature for a study that considers whether different types of physical activities are equivalent in terms of managing weight.

2. Data

The annual Health Survey for England (HSE) is a household level survey that combines information collected through a face-to-face interview, self-completion questionnaire with a medical examination undertaken by a trained nurse. The prevalence of physical activity among adults is measured by reports of adult participation in various types of physical activity. In particular, of interest to this work are the years 1999, 2002, 2003, 2004, 2006, 2008 and 2012 where consistent questions regarding participation in various physical activities were posed. For the purpose of our analysis we only consider respondents who are aged 16 years and over.

We utilise self-reported responses to the physical activity questions. In particular individuals reported on the number of periods they engaged in 30 minutes or more of:

1) heavy housework (which includes household activities like moving heavy furniture, walking with heavy shopping, scrubbing floors);
2) heavy manual activities (which includes digging, felling trees, chopping wood and moving heavy loads);
3) walking at a fast or brisk pace;
4) moderate intensity sports or exercise (swimming, cycling, working out at a gym, dancing, running/jogging, football/rugby, badminton/tennis, squash and exercises including press-up, sit-ups and back exercises).

Individuals also report on the intensity of these physical activities. We focus on *'heavy'* housework and manual activities, along with *'brisk and fast'* walking so as to capture physical activity of a moderate intensity. That is, the individual's heart rate is up and they are perspiring. Thus, this work can be related to the levels of activity the

UK government would like its' general population to achieve. We sum the responses to get a proxy of the total days of physical activities in the last 4 weeks[1].

2.1 Outcome variables:

The most commonly used measure of obesity is the Body Mass Index (BMI), which provides a proxy measure of total adiposity.[(21)] This work first considers BMI, which is a standardized estimate of an individual's relative body fat. In particular, BMI is calculated by dividing weight in kilograms (kg) by height in meters (m) squared. For this study a nurse has collected both height and weight measurements.

In addition we also consider a measure of 'central obesity' — waist circumference (WC). Although measures of central obesity are closely correlated with BMI, they have been shown to predict future ill health independently of BMI.[(22)] High levels of central adiposity (a high WC) in adults are also known to be associated with increased risk of obesity-related conditions including type II diabetes, hypertension and heart disease.[(23-25)]

Descriptive statistics for our activity and weight measures can be found in Table 1. As a preliminary exploration, Figure 1 illustrates the relationship between BMI, WC and total days of physical activities for more than 30 minutes. The top panel highlights a correlation with BMI, which is clearly negative. That is, the more days of physical activity that an individual undertakes, the lower a person's BMI is. This relationship is stronger for females compared to the males. Similarly, the bottom panel illustrates that those who do more activity have a comparatively smaller WC.

3. Methodology

The goal of this work is to quantify the association between a number of measures of physical activity and a person's weight. In the first instance, this involved running a series of ordinary least squares regressions with BMI, and WC as the dependent variables and the different measures of physical activity included as the explanatory variables of interest. First, we have examined the effect of total physical activities on

[1] We do not include occupation related work in our analysis as detailed question on occupational activities were not consistently asked in the HSE (see Scholes and Mindell).[(20)]

BMI and WC and then we have separated out the effect of different activities by including all four of them separately in the same regression. That is, we estimate:

$$w_{it} = \beta X_{it} + \gamma P_{it} + \theta S_k + \lambda \tau_t + \varepsilon_{it} \quad (1)$$

where, w_{it} is either the WC or BMI of individual i (from household j) at time t and ε_{it} is the individual specific error term, which is non-systematic and vary across individuals. We also include year (τ_t) and seasonal (S_k) fixed effects, which capture the variation of weight across seasons and over years. These effects are picked up by the parameters λ and θ respectively. We are particularly interested in the sign and the value of the parameter γ associated with the variable P_{it} which represents the physical activity level (PAL) for person i at time t. The parameter γ is the mean slope of a particular activity variable emanating from ordinary least squares regressions, after controlling for (or 'netting out') the effect of other individual and household specific characteristics (X_{it}) that may also determine weight. These are: age, age squared, gender, household size, household size squared[2], marital status (married, separated, divorced, widowed, cohabiting and single), ethnicity (white, Asian, mixed, black and the other group), area of residence (Northeast, Northwest, Yorkshire, West-Midlands, East-Midlands, East England, London, Southeast, and Southwest), log household income (in thousand pounds held constant at 2005 prices), level of education (whether the respondent has completed an A level education, which implies that they stayed in secondary level education until approximately 18 years), region of residence (urban, town/fringe or rural region) and employment status (employed, unemployed, retired and 'other economically inactive'). We utilize cluster corrected standard errors across households.

Considering equation 1 allows us to estimate the association between our activity measures and adiposity and central obesity 'netting out' many individual characteristics. However, as individuals, have other characteristics that are difficult to observe we also present a second set of estimates that include household level fixed effects. That is, by adding household fixed effects, we can control for unobservable traits that are common across households. In the absence of panel data we view this as

[2] The results are robust to the inclusion of cubic terms. Results presented in the Appendix.

a second best alternative to individual level fixed effects given that individuals tend to partner with people who are like themselves.[26-27] The fixed effects will also capture eating and drinking habits that are common within the household. Additionally, they capture neighborhood characteristics that make certain neighborhoods more or less compatible to being physically active, for example with respect to walkability[28] or incidence of social disorder[29]. The disadvantage of including household fixed effects is that they also net out physical activity patterns that are common within the household. This may therefore downward bias the association between physical activity and the obesity outcomes, thereby underestimating the true impact of the different physical activities. Thus, we tentatively suggest that the coefficients of the OLS and fixed effects regressions may be thought of as upper and lower bounds respectively. When our control variables vary across the household we retain them in our fixed effects models. That is, we retain age, age squared, gender, marital status, ethnicity, education and employment status. Additionally, we do not estimate these regressions separately by gender owing to there not being enough households who have more than two adults of the same gender.

Including household fixed effects cannot account for selection that varies within households - selection that may vary between a husband or his wife, a bread winner and a home-maker or parents and their children. Moreover, it is feasible that there are heterogeneous gains to physical activity across various socio-economic groups.[11, 30-32] It has been well documented in the literature that physical activity levels vary by gender[33-34], have been found to be strongly associated with low income[32, 35-36] and that people tend to be less active as they age.[11,37] Therefore, in order to inform on the differences in associations across a variety of groups, we re-estimate the baseline model in equation 1 with interaction terms, focusing on the gender (female/male) of the respondent, age (<=50 years and >50 years) and household income quintiles (top two quintiles and bottom two quintiles versus the middle quintile). Additionally, for robustness we also present a falsification test, which relies on randomly assigning individuals to households that are not their own. The idea here is that we are relying on our fixed effects results to do the 'heavy lifting' when it comes to controlling for selection. Thus, by controlling for a fixed effect that does not represent the individual's household the results should be relatively stable to the OLS models described in equation 1, albeit at the loss of some consistency given that we are essentially including a number of nuisance parameters. In this case, we the control variables are the same as equation 1 – that is, those that vary both *within* and *across* households.

4. Results:

The results in Table 2 illustrate the association between our different physical activity and weight measures (see Appendix for the coefficients associated with the full set of controls). The first column in each set of regressions reports the regression results for the association between total physical activity and individual weight, while the next separately includes all the four physical activities in the same regression. First thing to note is that total activity predicts BMI and WC negatively to different degrees for males and females. In particular, total physical activities predicts *more* of the variation in female BMI and WC when compared to males.

Turning to the regressions that disaggregate total activity into activity type, for BMI, males and females who brisk/fast walk have the lowest BMI, *all else equal.* In particular, males and females who do one day of more than 30 minutes activity in the last four weeks have BMIs that are -0.054 and -0.090 units lower respectively. If we think of this in terms of those doing this activity five days a week for more than 30 minutes daily in the last 4 weeks, for men this translates into a BMI that is 1 unit lower. For women, BMIs are about 1.80 units lower. For sports/exercise, the association for men is -0.015, implying that their BMI is 0.3 units lower if they engage in moderate intensity sports/exercise for twenty days over a twenty eight day period. For women who participate to the same degree their BMI is about 1 unit lower. The association between housework and BMI is not significant for males, but significant for females (-0.013). Heavy manual work predicts lower BMIs for both males and females, with an association of -0.018 and -0.030 respectively. To put this in the context of twenty days of participation, this implies BMIs are lower by 0.36 and about 0.6 unit respectively. For total physical activities the associations are -0.042 for males and -0.077 for females. This suggests that those who are active five days a week have BMIs that are on average about 0.84 unit and 1.54 units lower for males and females respectively.

For WC, some similarities to the BMI results emerge. Firstly, the association between WC and our different activities is always significant, with the exception of heavy housework that is not significant for males. This is also the lowest association for females. Secondly for both BMI and WC the association between the individual activities is almost always larger for females. This implies that females may gain more in terms of weight control from being active. Additionally as in the case of BMI, females who take brisk/fast walks experience the biggest gains compared to the other activities considered here. The association of -0.213 implies a WC that is almost 4.3 cms lower if the individual participates for twenty days in a four-week period. Manual work also predicts WC but to a lower degree (coefficient is -0.156). For males, the association is largest for sports/exercise (-0.165), implying that men that partake in sports/exercise for more than 30 minutes five days per week have a WC that is lower by about 3.3 cms. The association for females is somewhat similar in size and magnitude. The coefficients for total physical activities are -0.180 for males and -0.213 for females. Both of these are significant at the 1% level. To put these numbers into context, the results suggest that those who do five days of any of these physical activities every week for a month could decrease their waist circumference on average by 4.3 cms for females and 3.6 cms for males.

The results in Table 3 incorporate household fixed effects into the overall analysis. These can be interpreted as the average correlation for *both* males and females, and therefore if they are robust with respect to the coefficients in Table 2, they should be close to the coefficients from an analysis that would include both males and females. These are also shown in Table 3 for comparison. As expected the OLS results, suggest that we can predict more of the variation in BMI and WC with total physical activity when compared to the fixed effects model (a likely lower bound). For example, in the context of BMI the slope coefficients are -0.061 versus -0.046 respectively.

The results presented in Table 3 highlight that brisk/fast walking is the best predictor of BMI and WC. Moreover, the coefficients for brisk/fast walking are relatively robust to including household fixed effects. Sports/exercise still predicts WC significantly, however the coefficient is more than halved when the fixed effects are added (-0.172 versus -0.070). For heavy manual activities adding the fixed effects follows the same pattern as for sports/exercise. That is, for BMI the coefficient is not significant when the fixed effects are added, while for WC the coefficient shrinks significantly. Heavy housework significantly predicts WC in both the OLS and fixed effects model, but there is a significant association with BMI only in the fixed effects model. Interestingly, the size of the coefficients actually increases when the fixed effects are added. Finally, total physical activities significantly predict both BMI and WC and the coefficients are relatively robust to the addition of the fixed effects.

Table 4 extends the results documented in Table 2 further by considering age differences. The conclusions are in line with Table 2 and shed some light on what is driving the association. Specifically, we consider whether there are differences in the predictive power of physical activity for those who are >50 years versus those who are <=50 years (the omitted category). Once again, in all cases, the association between BMI, WC and activity is larger for females than for males. Interestingly, the associations for those who are over 50 years are almost always larger than the associations for the younger group, particularly for the male sample. This suggests that individuals over the age of 50 who are active have significantly lower BMIs and WCs in comparison to others in the same age group, and those younger to them, all else equal. Additionally, only the associations for brisk walking are consistently significant for both the age groups for both males and females.

The results in Table 4 also suggest that it is the older cohort that was driving the significance of household work for BMI in Table 2. For women doing manual work the association implies a 0.05 decrease in BMI for every day of participation compared to a decline of 0.029 units for men. If an individual is active five days per week this implies a BMI that is about 1 units lower for women and 0.58 units for men. Consistent with Table 2, the results imply that women who brisk walk have a lower BMI and WC. This is also true for males with respect to BMI. For males, the association with sports/exercise is the largest for both age cohorts in terms of WC. While the individual activities have on average different associations with BMI and WC, overall Table 4 suggests that on average, when these activities are summed; those who are active have lower BMIs and WC and the gains are also significantly larger for the older cohort, aged >50 years. This conclusion arises from the total physical activity coefficients.

In a similar manner, we are interested in how our associations differ by income quintiles. Therefore, the results shown in Table 5 relate to the separate association of physical activities among the top two (richest) and bottom two (poorest) income quintiles, in comparison to the middle quintile (the omitted category). Overall, the associations are always significantly highest when we consider brisk/fast walking, particularly among the poorest income quintile. On the other hand, while the association with sports/exercise is statistically significant for WC for both males and females, it is significant only for females when BMI is considered. While brisk walking is significantly associated with lower WC among females from both the top two and bottom two quintiles, the associations with sports/exercise are slightly higher only for females in the top two quintiles[3]. For these groups, the associations for housework and manual are never significant. Again, this suggests that the poor may have the most to gain with respect to being physically active if they engage in brisk/fast walking in comparison to the richest group in the society. However, this becomes less clear-cut when we consider the associations with total activities. That is, while the individual activities have different associations when we compare across the quintile groups considered here, the average association for total physical activities is not significantly different for either males or females with respect to BMI. This implies that gains are equal. Additionally, with respect to WC, while there is no significant difference in the association across income quintile for males, the reverse is true for females. That is, it is those in the bottom two quintiles that have the highest association (-0.218 versus -0.213 for the top two quintiles).

For both males and females, the activities with the highest associations are the same in both quintiles- the highest association is for brisk/fast walking followed by sports/exercise. In particular, females in the bottom two income quintiles who brisk/fast walk for twenty days in a four week period have a BMI that is 2 units lower and a WC that is almost 4.76 cms less. For women in the top two quintiles these

[3] It is possible that the association that sports/exercise is lower because poorer individuals cannot afford the same quality of sports/exercise when compared to the rich (for example, personal trainers, gym memberships etc).

figures are 1.52 units and 4.18 cms respectively. For men in the top two quintiles doing a similar level of sports/exercise reduces their BMI by 0.3 units, while for those in the bottom two quintiles this figure is also 0.3 units lower, though neither is significantly different. For WC the top and the bottom quintile measurements are both 3.64 units lower. Sports/exercise proves to be particularly beneficial in affecting central obesity among men, irrespective of their income. For females who do twenty days sports/exercise for five days in a week at a moderate level, the results imply a BMI that is almost one unit lower if they are in the bottom two quintiles compared to the case of WC, with measurements that are almost 2.0 cms lower. For those in the top two quintiles, for the same example, these figures are 1 unit for BMI and 3.72 cms for WC respectively.

We document the results for the fixed effects models for our age and income sub group analysis in Tables 6A and 6B respectively. These models include both males and females, along with household level fixed effects. We would therefore expect our estimates to lie somewhere between those for males and females documented in Table 4. For different age groups, the results are consistent with Table 4 in the sense that it is the older cohort for which activity level most greatly predicts both BMI and WC. Additionally, manual work is not significant for the <=50 years cohort's BMI and now for their WC, however it remains significant for the >50 years cohort's BMI. Heavy housework is significant for both age cohorts when WC is considered, and if anything the association has gotten larger. For example, -0.185 for WC in the >50 years cohort is significantly larger than the estimates the OLS yielded for either males or females. The coefficients for brisk/fast walking are however more robust to what is documented in Table 4. That is, they lie between the male and female coefficients and are statistically significant at the 1% level. For the >50 years cohort brisk/fast walking is statistically significant but much smaller than for WC. In particular, the coefficient is -0.204, implying that a person who walks brisk/fast for five days a week at a moderate intensity (more than another in the same household given our identification strategy) has a WC that is almost 4 cms smaller. The correlation of sports/exercise with BMI is now not significant, and the correlation with WC is also much smaller than before. That is, the correlation of -0.075 implies that those who engage in sports/exercise to a moderate level five days a week have a WC that is 1.5 cms smaller. Finally, the results for total activities are comparable and robust to those that appear in Table 4 for both BMI and WC and across the two age cohorts, though slightly smaller.

The fixed effects models for our income sub analysis are documented in Table 6B. Comparing these to Table 5 some interesting conclusions emerge. When we consider total physical activities the differences across the two income groups are not significant when it comes to both BMI and WC and total physical activity has a significant and negative correlation with both BMI and WC (the overall effect is -0.043 and -0.134). For the top two quintiles the results for housework are somewhat larger and also significant for WC when compared to those documented in Table 5. For the same income group, heavy manual work is now not significant for both BMI and WC, however they are significant for those in the bottom two quintiles. For brisk/fast walking the results are stable when compared to Table 5. The coefficients lie within the male/female average for BMI (-0.07) but are slightly larger for WC (-0.168). There are however no differences across income groups when walking is considered. Lastly, the sport/exercise coefficients are no longer significant for BMI but have a significant yet smaller association with WC (-0.074).

Robustness Analysis:

Table 7 presents the results from a falsification test, whereby a set of household fixed effects are included in the model, but they do not relate to the individuals own household. That is, we randomly assign individuals to a household. If our results are not spurious we would expect the results from the OLS and fixed effects to be close, albeit we are losing consistency so some differences are to be expected. In particular, from Table 7 we note that all of the coefficients with the exception of housework as being very similar and robust.

There has been emerging evidence that sedentary behaviour is an independent risk factor for obesity and other obesity related health problems[38-39], over and above a lack of physical activity. Thus, we include different measures of sedentary behavior in our analysis to ensure that what we are picking up are effects that are independent of simply being sedentary. In particular, sedentary time was assessed using a set of questions on the usual weekday time spent on i) television (TV including digital video discs) viewing; and ii) any other (non-television-viewing) sitting during leisure time, including reading and computer use (where they responded to "in the last four weeks, how much time did you spend sitting down doing any other activity on an average weekday (that is Monday to Friday)? Please do not include time spent doing these activities while at work."). An equivalent set of questions assessed TV and non-TV sedentary time during the weekend days. Total sedentary time was calculated separately for weekdays and weekends by adding both time spent on TV viewing and other non-TV viewing sitting activities. Both *total* sedentary time as well as time spent watching TV or just sitting on weekdays and on weekend days were introduced separately to the baseline regression in Equation 1.

In addition, the launch of the '5-a-day' fruit and vegetable campaign by the UK in 2003 also lays emphasis on diet as an important determinant of the reduction of the risk of chronic diseases.(40) It recommends a minimum daily intake of 5 portions of fruit and vegetables (excluding potatoes). Again, given that people who exercise are also likely to eat well we wish to comment on whether physical activity has an independent effect. Thus we utilize[4] questions regarding dietary intake[5], where respondents were asked questions about whether their fruit and vegetable consumption were meeting the national dietary recommendations (five portions of fruits and vegetables). Therefore, we add a dummy to determine if the recommendation of '5-a day' of fruits and vegetables were being met and then also included separate dummies for meeting recommendations with only fruits or only vegetables in the baseline specification.

These robustness analysis are documented in Table 8. Brisk/fast walking still independently predicts both lower BMI and WC. Increased time devoted to sedentary behaviour either on weekdays or weekends also has a significant positive association with both BMI and WC. The reported coefficients are also larger and statistically significant for TV viewing than for other non-TV viewing sedentary activities. The

[4] During the periods for which detailed information on physical activity questions was consistently asked in the HSE, the "Food and Vegetable Consumption" (FVC) module was only available for the years 2002, 2003, 2004, 2006 and 2008 and sedentary variables for 2008 and 2012. Therefore these variables are not included in all the regressions.

[5] Respondents have been asked about all vegetables and fresh, canned and frozen fruit, salad, pulses, dried fruit and fruit juice/smoothies during the previous day (during the 24 hour period from midnight to midnight). Participants' responses were then coded into portion sizes following the Department of Health (NHS) guidelines http://www.nhs.uk/5aday.

associations are also significantly larger for sedentary activities undertaken during weekdays compared to those carried out on the weekends. The results presented in Table 8 are somewhat similar to that found in studies focusing on 3 to 6 year old children and on adolescents.[41-42]

6. Conclusion

This work has considered how four independent types of activities predict both BMI and WC. Overall, we find that brisk walking has the highest association with these measures of weight, with sports/exercise being the runner up in this regard. We do not find a consistent narrative with respect to heavy manual or housework. Additionally, we find that physical activity, particularly brisk/fast walking is more highly associated with weight for women in lower income quintiles, females and those aged over 50 years. This implies that these groups may have more to gain by becoming active in terms of weight management. These results are robust to a number of robustness checks. Additionally, a falsification test highlights that our overall conclusion is unlikely to be spurious.

The results thus provide an argument for a campaign to promote walking. Additional evidence needs to be provided to suggest that public health messages about walking are more effective than ones about improving diet. However, we note that focus on physical activity is less controversial as it would not be subject to political lobbying as is the case for ‘fat’ tax and other policies that aim to change consumption of junk foods in a person’s diet[6]. Additionally, while we cannot interpret our findings here as causal, it is likely that the inclusion of household fixed effects biases the results downwards. This arises because within households there are likely to be some common trends in physical activity. Unambiguous evidence on the causal association of physical activity is unlikely to be found with large sample data like we use here. Therefore, we argue, given the obesity epidemic and the fact that a large proportion of

[6] For example a fat tax on soft drinks has been suggested as a policy that may curb the obesity epidemic. In May 2009, the US Senate Finance Committee heard testimony from advocates of public health who argued that the tax could reduce obesity and help finance new health care legislation. The fat tax failed owing to political lobbying. It has since been suggested that a more appropriate policy may be a thin subsidy on diet soft drinks (see Lordan and Quiggin, 2011)[43] as it is both progressive and shouldn’t experience the same lobbying from companies that produce foods that are dense in both sugar and carbohydrates.

people in the UK are inactive [10-11], recommending that people brisk walk more often is an easy policy option. Additionally, there is no monetary cost to walking so it is very likely that the benefits will outweigh the costs. It has also been shown elsewhere that walking is associated with better physical and mental health [37]. So, a simple policy message that 'every step counts' may be a step towards curbing the upward trend in obesity rates and beneficial for other health outcomes.

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Table 1: Summary Statistics for the weight and physical activity variables

Variables of Interest	N	Mean	Std Dev	Min	Max
Panel A: Weight variables					
Body Mass Index (BMI measured as kg/m^2)	59632	26.878	5.106	13.201	62.854
Waist circumference (in cms)	38836	91.433	14.334	34.050	172.850
Panel B: Physical activity variables					
Housework	68012	2.523	4.918	0	28
Manual	68012	0.991	3.261	0	28
Brisk/fast walking	68012	3.910	8.139	0	28
Sports/exercise	68012	3.559	6.709	0	28
Total physical activities	68012	9.670	10.207	0	28

Note: N is the number of observations. Panel B measures the number of days of more than 30 minutes of physical activities performed in the last 4 weeks.

Table 2: OLS Regression Results by Gender

Variables of Interest	Body Mass Index (BMI measured as kg/m^2)				Waist circumference (in cms)			
	Males		Females		Males		Females	
Total Physical Activities	-0.042***		-0.077***		-0.180***		-0.213***	
	(0.003)		(0.003)		(0.010)		(0.010)	
Housework		0.008		-0.013**		0.012		-0.046***
		(0.008)		(0.006)		(0.025)		(0.017)
Manual		-0.018***		-0.030**		-0.116***		-0.156***
		(0.006)		(0.015)		(0.022)		(0.042)
Brisk/fast walking		-0.054***		-0.090***		-0.142***		-0.213***
		(0.003)		(0.004)		(0.011)		(0.010)
Sports/exercise		-0.015***		-0.048***		-0.165***		-0.158***
		(0.004)		(0.005)		(0.014)		(0.016)
Observations	21,721	21,721	26,027	26,027	14,079	14,079	17,108	17,108
R-squared	0.127	0.129	0.094	0.097	0.204	0.204	0.150	0.152
Adj. R-squared	0.125	0.128	0.092	0.096	0.202	0.202	0.148	0.150

Note: OLS is ordinary least squares. The coefficients are the equivalent of conditional slopes and standard errors are in brackets. We report the OLS regression coefficient for the physical activity variables only. *, ** and *** denote significance at .10, .05 and .01 levels. The following controls are included: age, adjusted age squared, gender, household size, household size squared, marital status (single, married, separated, divorced, widowed, and Cohabitees), ethnic group (white, mixed, Asian, black and others), level of education, employment status (employed, unemployed, retired, economically inactive), area of residence, region of residence, log real household income (in thousand pounds in 2005 prices), year and seasonal fixed effects.

Table 3: OLS and FE Regression Results

Variables of Interest	Body Mass Index (BMI measured as kg/m^2)				Waist circumference (in cms)			
	OLS		FE		OLS		FE	
Total Physical Activities	-0.061***		-0.046***		-0.201***		-0.163***	
	(0.002)		(0.004)		(0.007)		(0.011)	
Housework		-0.007		-0.018**		-0.029**		-0.105***
		(0.005)		(0.007)		(0.014)		(0.023)
Manual		-0.014**		-0.007		-0.098***		-0.078**
		(0.006)		(0.010)		(0.019)		(0.031)
Brisk/fast walking		-0.074***		-0.072***		-0.184***		-0.175***
		(0.003)		(0.004)		(0.008)		(0.013)
Sports/exercise		-0.032***		-0.001		-0.172***		-0.070***
		(0.003)		(0.005)		(0.011)		(0.017)
Observations	47,748	47,748	47,748	47,748	31,187	31,187	31,187	31,187
R-squared	0.097	0.100	0.110	0.116	0.282	0.282	0.407	0.409
Adj. R-squared	0.096	0.099	0.109	0.115	0.281	0.281	0.406	0.408

Note: OLS is ordinary least squares and FE is fixed effects. The coefficients are the equivalent of conditional slopes and standard errors are in brackets. We report the OLS and the FE regression coefficient for the physical activity variables only. *, ** and *** denote significance at .10, .05 and .01 levels. The following controls are included in the OLS regressions: age, adjusted age squared, gender, household size, household size squared, marital status (single, married, separated, divorced, widowed, and Cohabitees), ethnic group (white, mixed, Asian, black and others), level of education, employment status (employed, unemployed, retired, economically inactive), area of residence, region of residence, log real household income (in thousand pounds in 2005 prices), year and seasonal fixed effects.

Table 4: OLS Estimates by Age Group and Gender

Variables of Interest	Body Mass Index (BMI measured as kg/m^2) Males		Females		Waist Circumference (in cms) Males		Females	
Aged dummy	0.153	0.157	0.691***	0.639***	0.397	0.593	1.657***	1.500***
	(0.128)	(0.125)	(0.157)	(0.152)	(0.434)	(0.421)	(0.452)	(0.438)
Total Physical activities	-0.031***		-0.062***		-0.154***		-0.185***	
	(0.004)		(0.004)		(0.013)		(0.012)	
Total Physical activities X Aged dummy	-0.029***		-0.041***		-0.063***		-0.074***	
	(0.006)		(0.006)		(0.019)		(0.019)	
Housework		0.021**		-0.004		0.046		-0.046**
		(0.011)		(0.007)		(0.034)		(0.022)
Housework X Aged dummy		-0.027*		-0.022*		-0.077		0.002
		(0.015)		(0.012)		(0.048)		(0.035)
Manual		-0.006		-0.005		-0.089***		-0.118**
		(0.009)		(0.022)		(0.030)		(0.059)
Manual X Aged dummy		-0.023*		-0.045		-0.050		-0.073
		(0.013)		(0.029)		(0.043)		(0.082)
Brisk/fast walking		-0.047***		-0.072***		-0.111***		-0.165***
		(0.004)		(0.005)		(0.015)		(0.013)
Brisk/fast walking X Aged dummy		-0.017**		-0.051***		-0.075***		-0.134***
		(0.007)		(0.007)		(0.022)		(0.021)
Sports/exercise		-0.006		-0.046***		-0.145***		-0.156***
		(0.005)		(0.006)		(0.016)		(0.018)
Sports/exercise X Aged dummy		-0.038***		-0.014		-0.076**		-0.011
		(0.009)		(0.012)		(0.030)		(0.037)
Observations	21,721	21,721	26,027	26,027	14,079	14,079	17,108	17,108
R-squared	0.128	0.131	0.095	0.099	0.205	0.205	0.151	0.153
Adj. R-squared	0.126	0.129	0.094	0.097	0.203	0.203	0.149	0.151

Note: OLS is ordinary least squares. The coefficients are the equivalent of conditional slopes and standard errors are in brackets. We report the OLS regression coefficient for the physical activity variables only. *, ** and *** denote significance at .10, .05 and .01 levels. The Aged dummy takes a value of 1 if age is greater than 50 and 0 otherwise. The following controls are included: age, adjusted age squared, gender, household size, household size squared, marital status (single, married, separated, divorced, widowed, and Cohabitees), ethnic group (white, mixed, Asian, black and others), level of education, employment status (employed, unemployed, retired, economically inactive), area of residence, region of residence, log real household income (in thousand pounds in 2005 prices), year and seasonal fixed effects.

Table 5: OLS Estimates by Income Group and Gender

Variables of Interest	Body Mass Index (BMI measured as kg/m^2)				Waist Circumference (in cms)			
	Males		Females		Males		Females	
Total Physical Activities	-0.034***		-0.066***		-0.193***		-0.159***	
	(0.006)		(0.007)		(0.022)		(0.023)	
Total Physical Activities X Bottom Quintiles	-0.009		-0.012		0.039		-0.059**	
	(0.008)		(0.009)		(0.028)		(0.028)	
Total Physical Activities X Top Quintiles	-0.005		-0.008		0.015		-0.054*	
	(0.008)		(0.009)		(0.026)		(0.028)	
Housework		0.003		-0.023*		0.005		-0.051
		(0.017)		(0.013)		(0.058)		(0.039)
Housework X Bottom Quintiles		-0.012		0.003		0.013		-0.028
		(0.021)		(0.016)		(0.070)		(0.048)
Housework X Top Quintiles		0.029		0.019		0.010		0.037
		(0.022)		(0.016)		(0.073)		(0.048)
Manual		-0.014		0.004		-0.132***		-0.189**
		(0.012)		(0.032)		(0.044)		(0.089)
Manual X Bottom Quintiles		0.005		-0.055		0.028		0.013
		(0.017)		(0.041)		(0.059)		(0.114)
Manual X Top Quintiles		-0.004		-0.020		0.038		0.090
		(0.016)		(0.039)		(0.056)		(0.113)
Brisk/fast walking		-0.041***		-0.076***		-0.125***		-0.153***
		(0.008)		(0.009)		(0.026)		(0.027)
Brisk/fast walking X Bottom Quintiles		-0.019*		-0.025**		-0.026		-0.085**
		(0.010)		(0.011)		(0.034)		(0.033)
Brisk/fast walking X Top Quintiles		-0.012		-0.009		-0.022		-0.056*
		(0.009)		(0.010)		(0.031)		(0.031)
Sports/exercise		-0.010		-0.046***		-0.182***		-0.105***
		(0.008)		(0.011)		(0.030)		(0.040)
Sports/exercise X Bottom Quintiles		-0.005		0.008		0.029		-0.010
		(0.011)		(0.015)		(0.040)		(0.051)
Sports/exercise X Top Quintiles		-0.005		-0.005		0.018		-0.081*
		(0.010)		(0.014)		(0.035)		(0.046)
Observations	19,210	19,210	23,026	23,026	12,171	12,171	14,744	14,744
R-squared	0.127	0.130	0.095	0.099	0.202	0.203	0.150	0.152
Adj. R-squared	0.125	0.128	0.094	0.097	0.199	0.199	0.148	0.149

Note: OLS is ordinary least squares. The coefficients are the equivalent of conditional slopes and standard errors are in brackets. We report the OLS regression coefficient for the physical activity variables only. *, ** and *** denote significance at .10, .05 and .01 levels. The following controls are included: age, adjusted age squared, gender, household size, household size squared, marital status (single, married, separated, divorced, widowed, and Cohabitees), ethnic group (white, mixed, Asian, black and others), level of education, employment status (employed, unemployed, retired, economically inactive), area of residence, region of residence, log real household income (in thousand pounds in 2005 prices), year and seasonal fixed effects.

Table 6A: FE Estimates with Age Group Interactions

Variables of Interest	Body Mass Index (BMI measured as kg/m^2)		Waist Circumference (in cms)	
Aged dummy	0.038	-0.022	0.179	0.140
	(0.183)	(0.179)	(0.555)	(0.544)
Total Physical activities	-0.035***		-0.141***	
	(0.004)		(0.014)	
Total Physical activities X Aged dummy	-0.033***		-0.062***	
	(0.007)		(0.022)	
Housework		-0.007		-0.050*
		(0.009)		(0.029)
Housework X Aged dummy		-0.026*		-0.135***
		(0.014)		(0.046)
Manual		0.014		-0.050
		(0.013)		(0.040)
Manual X Aged dummy		-0.046**		-0.063

		(0.019)		(0.057)
Brisk/fast walking		-0.064***		-0.160***
		(0.005)		(0.016)
Brisk/fast walking X Aged dummy		0.024***		0.044*
		(0.009)		(0.025)
Sports/exercise		0.001		-0.075***
		(0.006)		(0.019)
Sports/exercise X Aged dummy		-0.012		0.019
		(0.013)		(0.040)
Observations	47,748	47,748	31,187	31,187
R-squared	0.111	0.117	0.407	0.409
Adj. R-squared	0.110	0.116	0.407	0.409

Note: FE is fixed effects. The coefficients are the equivalent of conditional slopes and standard errors are in brackets. We report the FE regression coefficient for the physical activity variables only. *, ** and *** denote significance at .10, .05 and .01 levels. The Aged dummy takes a value of 1 if age is greater than 50 and 0 otherwise. The following controls are included: age, adjusted age squared, gender, marital status (single, married, separated, divorced, widowed, and Cohabitees), ethnic group (white, mixed, Asian, black and others), level of education, employment status (employed, unemployed, retired, economically inactive), year and seasonal fixed effects.

Table 6B: FE Estimates with Income Group Interactions

Variables of interest	Body Mass Index (BMI measured as kg/m^2)	Waist Circumference (in cms)
Total Physical activities	-0.043***	-0.134***
	(0.008)	(0.028)
Total Physical activities X Bottom Quintile	-0.012	-0.053
	(0.011)	(0.037)
Total Physical activities X Top Quintile	0.003	-0.014

	(1)	(2)	(3)	(4)
	(0.010)		(0.032)	
Housework		-0.019		-0.049
		(0.015)		(0.051)
Housework X Bottom Quintile		0.009		-0.074
		(0.019)		(0.067)
Housework X Top Quintile		-0.022		-0.110*
		(0.019)		(0.060)
Manual		0.010		-0.075
		(0.019)		(0.066)
Manual X Bottom Quintile		-0.056**		-0.155*
		(0.027)		(0.090)
Manual X Top Quintile		0.005		0.110
		(0.024)		(0.077)
Brisk/fast walking		-0.070***		-0.168***
		(0.010)		(0.031)
Brisk/fast walking X Bottom Quintile		-0.005		-0.019
		(0.014)		(0.043)
Brisk/fast walking X Top Quintile		0.001		0.004
		(0.012)		(0.036)
Sports/exercise		-0.011		-0.074*
		(0.012)		(0.043)
Sports/exercise X Bottom Quintile		-0.005		0.003
		(0.017)		(0.059)
Sports/exercise X Top Quintile		0.025*		0.013
		(0.014)		(0.049)
Observations	42,236	42,236	26,915	26,915
R-squared	0.109	0.116	0.407	0.410
Adj. R-squared	0.109	0.115	0.407	0.409

Note: FE is fixed effects. The coefficients are the equivalent of conditional slopes and standard errors are in brackets. We report the FE regression coefficient for the physical activity variables only. *, ** and *** denote significance at .10, .05 and .01 levels. The following controls are included: age, adjusted age squared, gender, marital status (single, married, separated, divorced, widowed, and Cohabitees), ethnic group (white, mixed, Asian, black and others), level of education, employment status (employed, unemployed, retired, economically inactive), year and seasonal fixed effects.

Table 7: Estimates for falsification tests

Variables of Interest	Body Mass Index (BMI measured as kg/m^2)				Waist Circumference (in cms)			
	OLS		FE		OLS		FE	
Total Physical Activities	-0.061***		-0.060***		-0.201***		-0.196***	
	(0.002)		(0.004)		(0.007)		(0.016)	
Housework		-0.007		-0.006		-0.029**		-0.018
		(0.005)		(0.009)		(0.014)		(0.035)
Manual		-0.014**		-0.004		-0.098***		-0.085*
		(0.006)		(0.013)		(0.019)		(0.047)
Brisk/fast walking		-0.074***		-0.072***		-0.184***		-0.182***
		(0.003)		(0.005)		(0.008)		(0.019)
Sports/exercise		-0.032***		-0.034***		-0.172***		-0.181***
		(0.003)		(0.007)		(0.011)		(0.025)
Observations	47,748	47,748	47,748	47,748	31,187	31,187	31,187	31,187
R-squared	0.097	0.100	0.100	0.103	0.282	0.282	0.296	0.297
Adj. R-squared	0.096	0.099	0.099	0.102	0.281	0.281	0.295	0.296

Note: OLS is ordinary least squares and FE is fixed effects. We report the OLS and FE regression coefficient for the physical activity variables only. *, ** and *** denote significance at .10, .05 and .01 levels. The following controls are included in the OLS regressions: age, adjusted age squared, gender, household size, household size squared, marital status (single, married, separated, divorced, widowed, and Cohabitees), ethnic group (white, mixed, Asian, black and others), level of education, employment status (employed, unemployed, retired, economically inactive), area of residence, region of residence, log real household income (in thousand pounds in 2005 prices), year and seasonal fixed effect.

Table 8: OLS Regression Results with Sedentary Activities and Diet Quality

Variables of Interest	Body Mass Index (BMI measured as kg/m^2)		Waist Circumference (in cms)	
Physical Activities:				
Total Physical Activities	-0.064***		-0.195***	
	(0.005)		(0.014)	
Housework		0.011		0.038
		(0.010)		(0.029)
Manual		-0.019		-0.110**
		(0.014)		(0.045)
Brisk/fast walking		-0.073***		-0.187***
		(0.005)		(0.014)
Sports/exercise		-0.036***		-0.195***
		(0.008)		(0.023)
Diet Quality: **Meeting 5 portions a day recommendation**				
with fruits and vegetables	0.149		-0.082	
	(0.112)		(0.315)	
with vegetables		0.309		1.129
		(0.319)		(0.958)
with fruits		0.186		0.056
		(0.156)		(0.440)
Sedentary Activities:				
Total Sedentary time on weekdays (in hours)	0.104***		0.421***	
	(0.027)		(0.082)	
Total Sedentary time on weekends (in hours)	0.089***		0.135*	
	(0.026)		(0.077)	
Time spent watching TV on weekdays (in hours)		0.158***		0.573***
		(0.039)		(0.120)
Time spent watching TV on weekends (in hours)		0.127***		0.242**
		(0.037)		(0.109)
Time spent sitting on weekdays (in hours)		0.048		0.280**
		(0.040)		(0.115)
Time spent sitting on weekends (in hours)		0.055		0.022
		(0.040)		(0.112)
Observations	10,338	10,338	8,407	8,407
R-squared	0.113	0.119	0.281	0.287
Adj. R-squared	0.110	0.116	0.278	0.283

Note: OLS is ordinary least squares. The coefficients are the equivalent of conditional slopes and standard errors are in brackets. We report the OLS regression coefficient for the physical activity variables only. *, ** and *** denote significance at .10, .05 and .01 levels. The following controls are included: age, adjusted age squared, gender, household size, household size squared, marital status (single, married, separated, divorced, widowed, and Cohabitees), ethnic group (white, mixed, Asian, black and others), level of education, employment status (employed, unemployed, retired, economically inactive), area of residence, region of residence, log real household income (in thousand pounds in 2005 prices), year and seasonal fixed effects.

Appendix Table A: OLS Regression Results with full set of controls

Variables of Interest	Body Mass Index (BMI measured as kg/m^2)		Waist Circumference (in cms)	
Total Physical Activities	-0.061*** (0.002)		-0.201*** (0.007)	
Housework		-0.007 (0.005)		-0.029** (0.014)
Manual		-0.014** (0.006)		-0.098*** (0.019)
Brisk/fast walking		-0.074*** (0.003)		-0.184*** (0.008)
Sports/exercise		-0.032*** (0.003)		-0.172*** (0.011)
Age (in years)	0.298*** (0.009)	0.295*** (0.009)	0.836*** (0.027)	0.814*** (0.027)
Adjusted Age squared	-0.272*** (0.009)	-0.268*** (0.009)	-0.678*** (0.027)	-0.655*** (0.027)
Male dummy	0.380*** (0.043)	0.395*** (0.044)	11.049*** (0.132)	11.187*** (0.137)
Household size	0.006 (0.081)	0.003 (0.082)	0.246 (0.316)	0.197 (0.318)
Household size squared	0.005 (0.011)	0.005 (0.011)	-0.010 (0.046)	-0.005 (0.047)
Married dummy	0.604*** (0.095)	0.550*** (0.095)	1.135*** (0.297)	1.013*** (0.298)
Separated dummy	-0.091 (0.172)	-0.140 (0.172)	-0.699 (0.513)	-0.770 (0.513)
Divorced dummy	0.116 (0.123)	0.079 (0.123)	0.419 (0.372)	0.369 (0.372)
Widowed dummy	0.728*** (0.133)	0.705*** (0.133)	1.506*** (0.407)	1.495*** (0.407)
Cohabitee dummy	0.525*** (0.100)	0.464*** (0.100)	1.093*** (0.317)	0.914*** (0.317)
Black dummy	2.801*** (0.300)	2.795*** (0.300)	5.576*** (0.967)	5.544*** (0.973)
Asian dummy	0.994*** (0.269)	1.010*** (0.270)	3.286*** (0.872)	3.301*** (0.880)
Mixed dummy	1.814*** (0.366)	1.792*** (0.366)	4.875*** (1.094)	4.828*** (1.102)
White dummy	1.680*** (0.242)	1.676*** (0.243)	5.016*** (0.810)	4.966*** (0.818)
North West dummy	-0.015 (0.113)	-0.047 (0.113)	0.227 (0.356)	0.160 (0.355)
Yorks and Humberside dummy	0.115 (0.120)	0.097 (0.120)	1.231*** (0.376)	1.200*** (0.376)
East Midlands dummy	0.180 (0.121)	0.161 (0.121)	0.368 (0.378)	0.317 (0.377)
West Midlands dummy	0.388*** (0.120)	0.366*** (0.120)	1.126*** (0.382)	1.063*** (0.381)
East England dummy	0.064 (0.116)	0.052 (0.116)	1.556*** (0.370)	1.525*** (0.369)
London dummy	-0.302** (0.124)	-0.294** (0.124)	0.859** (0.389)	0.874** (0.388)
South East dummy	-0.180 (0.110)	-0.168 (0.110)	0.830** (0.342)	0.852** (0.342)
South West dummy	0.119 (0.119)	0.118 (0.119)	1.189*** (0.378)	1.193*** (0.377)

Town and Fringe dummy	0.199***	0.205***	0.712***	0.710***
	(0.070)	(0.070)	(0.235)	(0.235)
Urban dummy	0.184**	0.197***	0.725***	0.715***
	(0.076)	(0.076)	(0.230)	(0.231)
A Level dummy	-0.443***	-0.436***	-1.004***	-0.971***
	(0.050)	(0.050)	(0.156)	(0.156)
Log of real household income	-0.213***	-0.208***	-0.623***	-0.572***
	(0.035)	(0.036)	(0.111)	(0.112)
Retired dummy	0.300***	0.272***	-0.061	-0.115
	(0.103)	(0.103)	(0.312)	(0.312)
Unemployed dummy	-0.427***	-0.415***	-2.087***	-2.030***
	(0.121)	(0.121)	(0.388)	(0.388)
Employed dummy	-0.149**	-0.165**	-1.460***	-1.473***
	(0.076)	(0.076)	(0.233)	(0.233)
Constant	18.310***	18.205***	58.732***	58.766***
	(0.368)	(0.370)	(1.290)	(1.299)
Year Fixed Effects	Yes	Yes	Yes	Yes
Season Fixed Effects	Yes	Yes	Yes	Yes
Observations	47,748	47,748	31,187	31,187
R-squared	0.097	0.100	0.282	0.282
Adj. R-squared	0.0963	0.0991	0.281	0.281

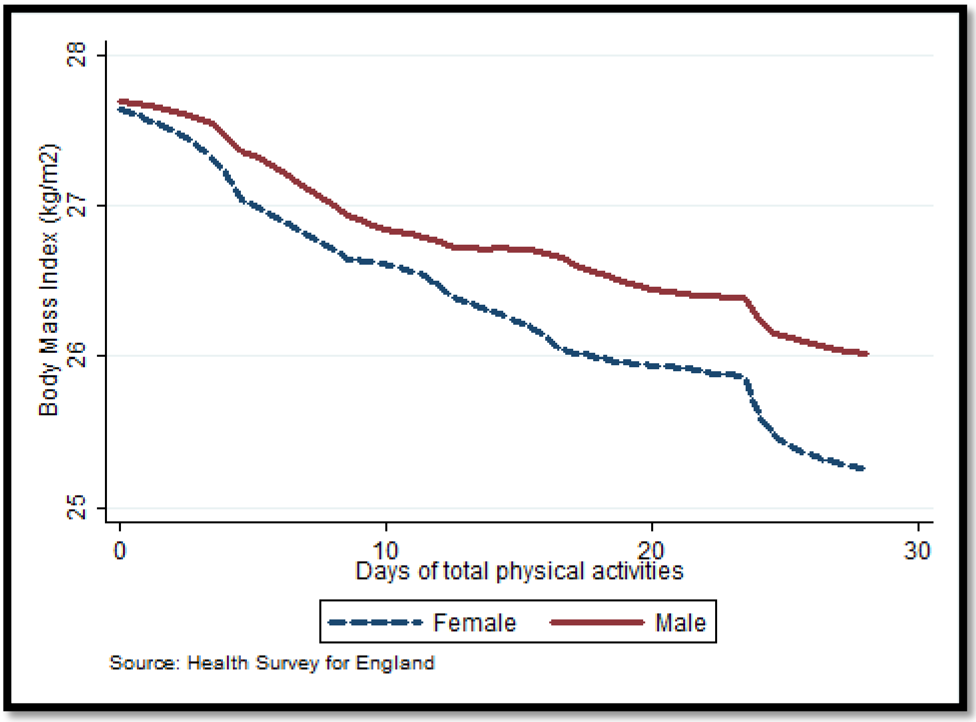
Note: OLS is ordinary least squares. The coefficients are the equivalent of conditional slopes and standard errors are in brackets. *, ** and *** denote significance at .10, .05 and .01 levels.

Appendix Table B: Robustness Check: OLS Regression Results by Gender

Variables of Interest	Body Mass Index (BMI measured as kg/m^2)				Waist circumference (in cms)			
	Males		Females		Males		Females	
Total Physical Activities	-0.042***		-0.077***		-0.179***		-0.213***	
	(0.003)		(0.003)		(0.010)		(0.010)	
Housework		0.008		-0.012**		0.010		-0.045**
		(0.008)		(0.006)		(0.025)		(0.017)
Manual		-0.017***		-0.031**		-0.114***		-0.157***
		(0.006)		(0.015)		(0.022)		(0.042)
Brisk/fast walking		-0.053***		-0.090***		-0.140***		-0.213***
		(0.003)		(0.004)		(0.011)		(0.010)
Sports/exercise		-0.015***		-0.048***		-0.164***		-0.158***
		(0.004)		(0.005)		(0.014)		(0.016)
Observations	21,721	21,721	26,027	26,027	14,079	14,079	17,108	17,108
R-squared	0.128	0.130	0.094	0.097	0.205	0.205	0.150	0.152
Adj. R-squared	0.126	0.128	0.092	0.096	0.203	0.202	0.148	0.150

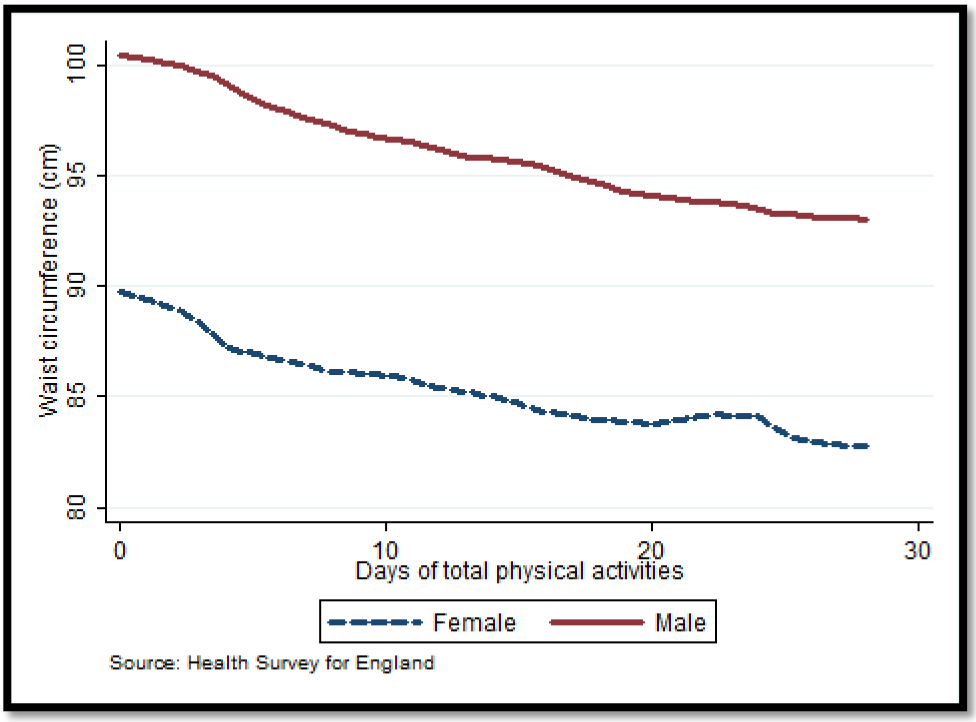
Note: OLS is ordinary least squares. The coefficients are the equivalent of conditional slopes and standard errors are in brackets. We report the OLS regression coefficient for the physical activity variables only. *, ** and *** denote significance at .10, .05 and .01 levels. The following controls are included: age, adjusted age squared, adjusted age cubed, gender, household size, household size squared, household size cubed, marital status (single, married, separated, divorced, widowed, and Cohabitees), ethnic group (white, mixed, Asian, black and others), level of education, employment status (employed, unemployed, retired, economically inactive), area of residence, region of residence, log real household income (in thousand pounds in 2005 prices), year and seasonal fixed effects.

Figure 1: Estimated non-parametric relationship between Mean Body Mass Index and Total Physical Activities



Note: Days of Total physical activities is the total days of more than 30 minutes of physical activities in the last 4 weeks.

Figure 2: Estimated non-parametric relationship between Mean Waist Circumference and Total Physical Activities



Note: Days of Total physical activities is the total days of more than 30 minutes of physical activities in the last 4 weeks.