

**Coastal proximity and physical activity:
Is the coast an under-appreciated public health resource?**

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Abstract**Background**

Recent findings suggest that individuals living near the coast are healthier than those living inland. Here we investigated whether this may be related to higher levels of physical activity among coastal dwellers in England, arising in part as a result of more visits to outdoor coastal settings.

Method

Participants (n = 183,755) were drawn from Natural England's Monitor of Engagement with the Natural Environment Survey (2009-2012). Analyses were based on self-reported physical activity for leisure and transport.

Results

A small, but significant coastal proximity gradient was seen for the likelihood of achieving recommended guidelines of physical activity a week after adjusting for relevant area and individual level controls. This effect was statistically mediated by the likelihood of having visited the coast in the last seven days. Stratification by region, however, suggested that while the main effect was relatively strong for west coast regions, it was not significant for those in the east.

Conclusions

In general, our findings replicate and extend work from Australia and New Zealand. Further work is needed to explain the marked regional differences in the relationship between coastal proximity and physical activity in England to better understand the coast's potential role as a public health resource.

Keywords: Physical activity; Coastal proximity; Monitor of Engagement with the Natural Environment; England

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Introduction

Populations living near the coast in England are healthier than those inland (Wheeler et al., 2012) and longitudinal data suggest that individuals are healthier during periods when they live closer to the coast (White et al., 2013a). One factor may be that living closer to the coast fosters higher levels of physical activity (PA) and consequent health benefits. Regular PA is associated with a reduced risk of obesity, diabetes, heart disease and depression (NICE, 2008, 2012) and can be just as effective as medication in reducing associated mortality (Naci & Ioannidis, 2013). Studies in Australia and New Zealand, mostly using relatively small samples, report a positive association between living near the coast and rates of self-reported PA, (mostly walking; Ball et al., 2007; Bauman et al., 1999; Humpel et al., 2004; Witten et al., 2008). However, as far as we are aware this issue has not previously been investigated outside of Australasia and in countries, such as England, with different cultures and climates.

A further issue is the lack of direct evidence that any coastal proximity effect really is due to greater time spent being active at the coast. Evidence exists that people who live near the sea do spend more leisure time at the coast (White et al., 2013a; Schipperijn et al., 2010) but we know of no research that has explored the relationship between frequency of coastal leisure visits and PA. Establishing this relationship is necessary if visit frequency is to account for any association between coastal proximity and PA, rather than activity being conducted in other locations such as gyms. A similar approach has been taken in studying whether associations between residential neighbourhood green space and PA are mediated by time spent in green space (e.g. Coombes et al., 2010; Lachowycz & Jones, 2014; Ord et al., 2013) but this is yet to be extended to coastal analysis.

Finally, there has been little exploration of potential moderators of any coastal proximity-PA relationship, in part because the relatively small sample sizes of the few studies that have been conducted prevent such an analysis. However, moderators such as socio-economic status (SES, Ord et al., 2013; Jones et al., 2009) and gender (Wheeler et al., 2010) have been identified in studies of the

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relationship between local green space and PA. Whilst findings from these studies are mixed, there is some evidence of effect modification, which may also be important for coastal proximity and PA. In previous research we found a stronger association between residential coastal proximity and population self-reported health in more deprived areas (Wheeler et al., 2012) and this may also be reflected in PA in these areas. Moreover, the Australian studies investigating coastal proximity and PA revealed relatively strong effects for women (Ball et al., 2007; Humpel et al., 2004) but not men (Humpel et al., 2004). Other potential demographic moderators such as age have not been explored previously, nor have issues such as season of data collection or geographical location. Season and location, especially latitude, may play a role due to higher temperatures encouraging more interaction with the coast at some times of the year or in some places.

The current research addressed these underexplored issues using a large nationally representative English survey, the Monitor of Engagement with the Natural Environment (MENE, Natural England, 2011a). Specifically, we asked three key questions: 1) is greater residential coastal proximity associated with increased PA in England?; 2) if there is an association, is it mediated by visits to the coast (i.e. due to time actually spent in this environment)?; and 3) is there any evidence of moderation of the association by age, sex, SES, season or region?

Method

Participants

Participants were 183,755 individuals who took part in the MENE survey during the years 2009-2012 and for whom local area data were available (97.3% of 188,774). The MENE is commissioned by Natural England, a government body promoting public understanding, conservation and enjoyment of the natural environment. It is part of a face-to-face nationally representative omnibus survey conducted across the whole of England and throughout the year to reduce potential geographical and seasonal biases (Natural England, 2011b).

Physical activity

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The primary outcome variable was self-reported physical activity in the last week. Responses were derived from the question: “*In the past week, on how many days have you done a total of 30 minutes or more physical activity which was enough to raise your breathing rate? This may include sport, exercise, and brisk walking or cycling for recreation or to get to and from places, but should not include housework or physical activity that may be part of your job*” (q21, p.39, Natural England, 2011b). Due to the exclusion of work and housework we refer to responses as a measure of self-reported ‘leisure and travel-related physical activity’ (LTPA). As UK guidelines are for a minimum of 150 minutes of moderate PA a week which can be achieved by ≥ 5 days of 30 minutes (Bull et al., 2010), our key outcome variable was whether or not the individual reported engaging in ≥ 5 days of LTPA, thus achieving their recommended PA with leisure and travel alone. Additionally, we explored reports of 1-4 vs. zero days of PA to examine if coastal proximity encourages at least some activity.

Coastal proximity

The approximate distance an individual lived from the coast was derived from the Lower-layer Super Output Area (LSOA) in which they lived. LSOAs are a geographical unit used to report small area statistics and there are 32,482 in England, each containing approximately 1,500 people. As populations within LSOAs may not be uniformly distributed, coastal proximity was defined as the linear distance (in km) to the coast from the population-weighted centroid of the LSOA (Wheeler et al., 2012) and was categorized into four distances: a) <1km; b) 1-5km; c) >5-20km; and d) >20km.

Coastal visits in the last week

At the start of the survey respondents were informed that they were going to be asked about occasions in the last week when they had spent time out of doors. They were instructed, “by out of doors we mean open spaces in and around towns and cities, including parks, canals and nature areas; the coast and beaches; and the countryside including farmland, woodland, hills and rivers. This could be anything

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from a few minutes to all day. It may include time spent close to your home or workplace, further afield or while on holiday in England. However, this does not include routine shopping trips or time spent in your own garden” (Natural England, 2011b, p. 27). For each visit mentioned in the last week they were asked:

, “Which of the following best describes where you spent most of your time?: In a town or city; in a seaside resort or town; other seaside coastline (including beaches & cliffs); in the countryside (including areas around towns and cities)” (q2, p.28, Natural England, 2011b). Of the total sample, 7,511 (4.1%) reported visiting an outdoors destination in a seaside resort, 3,490 (1.9%) reported visiting the open coast, and 824 (0.8%) reported visiting both. Preliminary analysis using these separate groupings suggested that individuals reporting any of these visits all had a significantly greater likelihood of physical activity (than individuals who reported no coastal visit) and that the patterns of visit type were broadly similar across regions (Supplementary Table A). Given also that most seaside resorts are linked directly to open coast and we are not sure which part people visited we collapsed all three categories of coastal visitor into a single group, i.e. coastal visitors, $n = 11,825$ (6.4%). Using a single grouping did not affect the main results (contact the authors for further details).

Area level control variables

Area level controls were also derived from LSOA data. Perhaps the most important, given previous work, was the amount of green space present. This was calculated as the percentage of LSOA land cover (assessed at the resolution of 10m^2) accounted for by ‘green space’ and ‘gardens’ combined (White et al., 2013b) using data from the Generalised Land Use Database (ODPM, 2005). Green space quintiles based on the distribution of green space across all LSOAs in the sample were derived. Mean percentage green space was 89.96% (SD = 5.14) in the highest quintile and 10.50% (SD = 5.61) in the lowest quintile.

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LSOAs were also used to identify local area deprivation (based on factors such as unemployment and crime) with data extracted and imported from the 2004 English Indices of Deprivation (DCLG, 2008). Total Indices of Deprivation (IMD) scores were structured into quintiles (most deprived M = 49.54 (SD = 9.74), least deprived M = 6.22 (SD = 2.10). England is also categorised into nine, Government Office Regions (GORs, Figure 1). It was not possible to control directly for GOR, because two regions (London, West Midlands) had no coastline, and a third (East Midlands) had no participants in the MENE survey who lived within 1km of the coast. Analyses were therefore stratified separately by the six regions with an immediate coastal population in the MENE to examine the effects of North-South, East-West coastal locations.

Individual Level Controls

Individual level controls included: gender, age (categorised as 16-34, 35-64, 65+), occupational social grade (AB, C1, C2, DE) as a proxy for SES, employment status (full-time, part-time, in education, not working, retired), marital status (married vs. single/separated/divorced/widowed), number of children in the household (0 vs. ≥ 1), ethnicity (White British vs. other), work limiting health status, car access and dog ownership. We also controlled for the season and year of data collection.

Analysis strategy

Logistic regressions were conducted in Stata 13 (StataCorp, College Station, TX) to investigate the odds of a) coastal visits, b) ≥ 5 days LTPA and c) 1-4 days LTPA, in the last week, as a function of coastal proximity. Results for unadjusted and adjusted models are reported, with separate models of LTPA also adjusting for coastal visits.

Results

Coastal visits

Table 1 presents descriptives for coastal visits and LTPA as a function of coastal proximity (see Supplementary Table B for details on all variables). As expected, there was a strong coastal proximity gradient for visits (Table 2). In both the unadjusted and adjusted models the odds of visiting the coast within the last week

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were 15 times greater among those living <1km vs. >20km from the coast. In the adjusted model visiting the coast was also significantly more likely if individuals lived in the greenest vs. least green area and in any area other than the most deprived (Supplementary Table C). Coastal visits were also more likely if respondents were <35yrs vs. ≥65yrs old, not in lowest social grades (DE), not in full-time employment, had children in the home, were White British, had no illness or disability, owned a car, owned a dog, and were not interviewed in winter.

Physical activity

A total of 41,856 (22.5%) respondents reported ≥ 5 days of LTPA in the last week (21,159 males (24.8%) and 20,697 females(21%)). Of the remainder, 63,580 (34.6%) respondents reported at least one and up to four days LTPA a week, and 78,319 (42.6%) reported no days.

As hypothesised, there was a coastal proximity gradient for reporting ≥5 days LTPA last week (Tables 1 & 3). In the unadjusted model, the OR comparing residence <1km vs. >20km from the coast was 1.13 (95% CI 1.07, 1.18). Although attenuated in the adjusted model, the associations for both <1km (OR = 1.08, 95% CI 1.03, 1.14) and 1-5kms (OR = 1.04, 95% CI 1.00, 1.08) remained significant.

There was no equivalent green space gradient although the most and third greenest areas were associated with slightly higher odds than the least green area. Reporting ≥5 days LTPA was also significantly more likely if individuals did not live in the most deprived area and were: Male; <35yrs vs. ≥65yrs old; not in the DE social grades; not working (compared to in full-time employment); unmarried; White British, had no illness or disability, owned a dog, did not own a car and were interviewed in any season except winter (Supplementary Table D).

When coast visits were added to the model two findings emerged (Table 3). First, the odds of reporting ≥5 days LTPA were significantly greater for visitors than non-visitors (OR = 1.62, 95% CI 1.55, 1.69). Secondly, the observed coastal gradient disappears.

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No coastal proximity gradient was found for reports of 1-4 vs zero days LTPA (Supplementary Table E); individuals living <1km from the coast were no more likely to report 1-4 days LTPA than those living >20km.

Moderators of the coastal gradient association with ≥ 5 days LTPA

Potential moderating effects of age, gender, SES and season on the association between coastal proximity and ≥ 5 days LTPA were investigated using likelihood ratio tests to compare models with and without interaction terms. In all four cases adding the interaction terms did not significantly improve the models: age, $p = 0.36$; gender, $p = 0.56$; social grade, $p = 0.29$; season, $p = 0.54$. There was therefore no evidence of moderation of the coastal proximity association by these variables.

Stratification by coastal region

Stratification by region, however, revealed very large differences in the relationship between coastal proximity and ≥ 5 days LTPA (Figure 1). Whereas a relatively strong coastal proximity gradient was seen for the North West and South West GORs, there was no such pattern for any east coast region. The significant nature of this regional interaction was confirmed by rerunning the main model excluding the three non-coastal GORs (region x coastal proximity, $p < .001$). Moreover, and also potentially importantly for public health, a coastal gradient for 1-4 days LTPA was also seen in the South West, and to some extent North West, but again not in any eastern region (Figure 2).

Discussion

Taken as a whole, the positive relationship between an increased probability of achieving PA guidelines (through leisure and travel alone), and living near the English coast broadly replicates findings from Australia and New Zealand (Ball et al., 2007; Bauman et al., 1999; Humpel et al., 2004; Witten et al., 2008). That coastal visit frequency mediated the relationship suggests that coastal dwellers are not simply exercising more, for instance in indoor gyms, but are using the coast for

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physical activity. Given the climatic and cultural differences between England and Australasia this finding is encouraging. Further, the findings may help explain evidence suggesting that individuals living near the English coast have better mental and physical health (Wheeler et al., 2012; White et al., 2013a).

The large differences between the west and east coast were unexpected. Several possible explanations exist. For instance, annual temperatures are, on average, higher in the west than east coast regions of England (Cherrie, Wheeler, White, Sarran & Osborne, 2014) and this may encourage more (physically active) visits. Although possible, cloud cover and rain are also higher in the west (Cherrie et al., 2014) which might reduce visit numbers. Moreover, the differences in coastal weather are greater between the south and the north of the country than the east and west, and yet we find no consistent north-south pattern.

Coastal geography might also play a role. To investigate we used GIS analysis of the UK's 2007 Land Cover Map (Morton et al. 2011) to derive estimates of the amounts of 'open shoreline' (including littoral and supra-littoral sediment and rock, i.e. beaches and rocky shores) in each of the six coastal GORs. We found higher levels of open shoreline in the western, than in the eastern regions both in terms of the absolute amount of land cover and land cover per head of the population: North West = 95.8km², 14.2m²per person(pp); South West = 73.1km², 14.8m²pp; North East =23.1 km², 9.2 m²pp; Yorks & Humber =9.1 km², 1.8 m²;pp; East =44.1 km², 8.2 m²pp; South East =58.2 km², 7.3 m²pp. Thus, people in the west appear to have more opportunity for PA on open shorelines. That the South West, with the highest per capita open shoreline, also has the most coastal visits per head and highest level of LTPA appears to support this possibility.

Nevertheless, there are more coastal visits per person in the North East, for instance, than the North West (Supplementary Table A). Further, overall levels of LTPA in the North East and North West are comparable (Supplementary Table B). Together, this suggests that it isn't visit frequency that is key but the activities people engage in when there that might be important. For instance, it may be that western

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visits involve more active pursuits such as jogging or watersports, whereas eastern visits involve more passive activities such as eating out or admiring the view from a car. Further research is needed to explore this, and other, possibilities.

The lack of a clear green space gradient for (leisure and transport related) PA replicates earlier work in the UK (Coombes et al., 2012; Hillsdon et al., 2006; Mytton et al., 2012), New Zealand (Witten et al., 2008) and the Netherlands (Maas et al., 2008). There is increasing awareness that the size, quality or types of activity available at local green space areas may be important for PA rather than the amount of green space *per se* (Cohen et al., 2010; de Jong et al., 2012; Giles-Corti et al., 2005; Paquet et al., 2013). Crucially, issues of quality, access and attractiveness may also be important for coastal locations (Maguire et al., 2011) and may help to explain the regional differences found.

Being cross-sectional, our data are subject to a number of limitations. We also recognize that our measure of PA did not include work or housework and may underestimate total PA. Consistent with this suggestion Health Survey for England data, including these activities, does find higher rates of ≥ 5 days of 30minutes PA a week for both men (43%) and women (32%; Scholes & Mindell, 2013). Whether or not either measure is a valid reflection of actual PA is unclear (NICE, 2008). However, even if people tend to over-report PA levels, there is no obvious reason why such a bias should be affected by how close an individual lives to the coast. Consequently, the relative pattern of PA, if not the actual amount, as a function of coastal proximity is likely to be robust.

Conclusions

Not everyone can live at the coast, but approximately 8 million people in England alone live within 5km and a further 130 million visits are made annually by people living further inland (White et al. 2013a). If coastal locations can encourage more PA among residents and visitors then they could indeed be an as yet under-appreciated public health resource. A remaining challenge is to investigate what are the optimal circumstances to promote PA at the coast and to investigate whether the east-west

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coast differences we found could begin to offer a suggestion. Further work is also needed to increase our broader understanding of why coastal environments are often regarded as relatively appealing places to spend leisure time more generally. Policies improving access or encouraging greater use of coastal environments should also, however, be sensitive to their potential adverse environmental impacts.

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Conflict of Interest Statement

MPW, BWW, IA & MHD declare no conflict of interest. SH is an employee of Natural England, the governmental organization responsible for the collection of the data used in the current study.

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Table 1: Number and percentage of individuals in each coastal proximity category reporting coastal visits and physical activity in the last 7 days in England (2009-2012).

Coastal proximity	Total (valid) sample		Visited the coast ≥ 1 last week		Physical activity			
	(N = 183,755) N	% ^a	(n = 11,825; 6.4%) N	% ^b	≥ 5 per week		1-4 per week	
					(n = 41,856; 22.8%) N	% ^b	(n = 63,580; 34.6%) N	% ^b
<1km	10,451	5.7	3,185	30.5	2,561	24.5	3,519	33.7
1-5 km	19,990	10.9	3,118	15.6	4,794	24.0	6,462	32.3
>5-20km	29,230	15.9	2,059	7.0	6,712	23.0	9,728	33.3
>20km	124,084	67.4	3,463	2.8	27,789	22.4	43,871	35.4

^a Column percentages (i.e. % of people in each coastal proximity category); ^b Row percentages (e.g. % of people living <1km from the coast).

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Table 2. The relationship between coastal proximity and likelihood of reporting visiting the coast at least once in the last 7 days in England (2009-2012).

	Coastal visit last week					
	Unadjusted			Adjusted ^a		
	OR	95% CI		OR	95% CI	
	Lower	Upper	Lower	Upper		
Coastal proximity						
<1km	15.27***	14.47	16.11	15.16***	14.33	16.04
1-5 km	6.44***	6.12	6.77	6.04***	5.73	6.36
>5-20km	2.64***	2.50	2.79	2.37***	2.24	2.51
>20km (ref)	1.00			1.00		
Constant	.03			.01		
N	183,755			183,755		
R2 (Nagelkerke)	.15			.19		

^a: Adjusted for: a) area level data on deprivation (using Indices of Multiple Deprivation) and % green space (using Generalized Land Use Data); b) individual level data on age, gender, socioeconomic status, employment status, marital status, number of children in the home, ethnicity, work limiting illness, car ownership, dog ownership; and c) temporal data on the season and year of data collection. OR = Odds Ratio. CI = Confidence Interval.* p <.05; ** p <.01, ***p < .001.

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Table 3. The relationship between coastal proximity, local green space and likelihood of reporting ≥ 5 days of 30 minutes or more leisure and transport related physical activity in the last 7 days in England (2009-2012).

	Unadjusted			Adjusted ^a			Adjusted ^a + coastal visits		
	OR	95% CIs		OR	95% CIs		OR	95% CIs	
		Lower	Upper		Lower	Upper		Lower	Upper
Coastal proximity									
<1km	1.13***	1.07	1.18	1.08***	1.03	1.14	0.93**	0.89	0.98
1-5 km	1.09***	1.06	1.13	1.04*	1.00	1.08	0.97	0.93	1.01
>5-20km	1.03*	1.00	1.07	0.97	0.94	1.01	0.96**	0.93	0.99
>20km (ref)	1.00			1.00			1.00		
Green space quintile									
1st (M=89.96%)				1.05*	1.01	1.09	1.04*	1.01	1.08
2nd (M=68.95%)				1.00	0.96	1.04	1.00	0.96	1.04
3rd (M=48.67%)				1.05**	1.01	1.09	1.05**	1.01	1.09
4th (M=28.98%)				1.02	0.99	1.05	1.02	0.99	1.05
5th (M=10.50%) (ref)				1.00			1.00		
Coastal visit							1.62***	1.55	1.69
Constant	0.29			0.21			0.22		
N	183,755			183,755			183,755		
R2 (Nagelkerke)	.00			.05			.06		

^a: Adjusted for: a) area level data on deprivation (using Indices of Multiple Deprivation) and % green space (using Generalized Land Use Data); b) individual level data on age, gender, socioeconomic status, employment status, marital status, number of children in

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the home, ethnicity, work limiting illness, car ownership, dog ownership; and c) temporal data on the season and year of data collection. OR = Odds Ratio. CI = Confidence Interval. * $p < .05$; ** $p < .01$, *** $p < .001$.

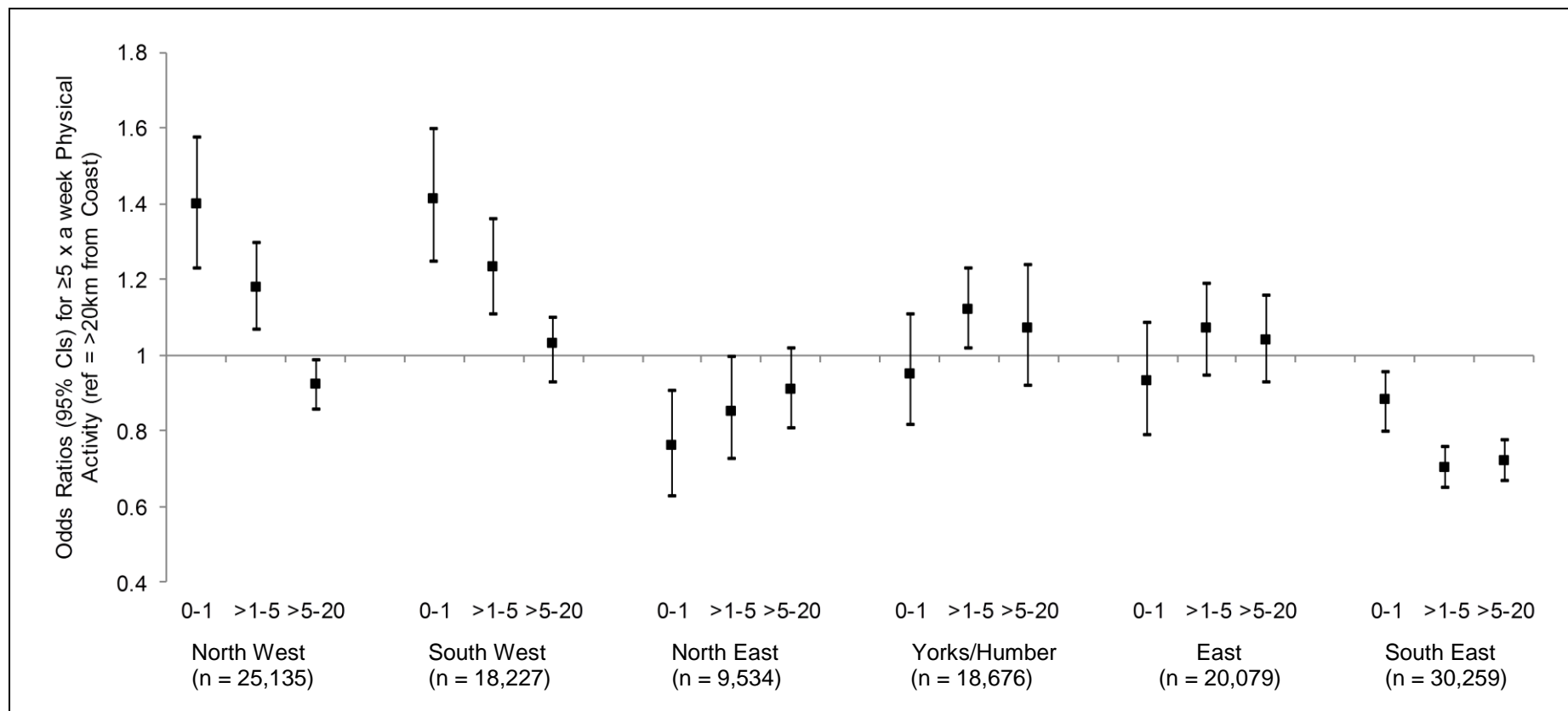
Figure 1: A map of England showing the Government Office Regions (GORs)



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Figure 2: Coastal proximity (in km) and likelihood of reporting ≥ 5 days of 30 minutes or more leisure and transport related physical activity in the last 7 days for the six coastal regions of England (2009-2012).



Adjusted for: a) area level data on deprivation (using Indices of Multiple Deprivation) and % green space (using Generalized Land Use Data); b) individual level data on age, gender, socioeconomic status, employment status, marital status, number of children in

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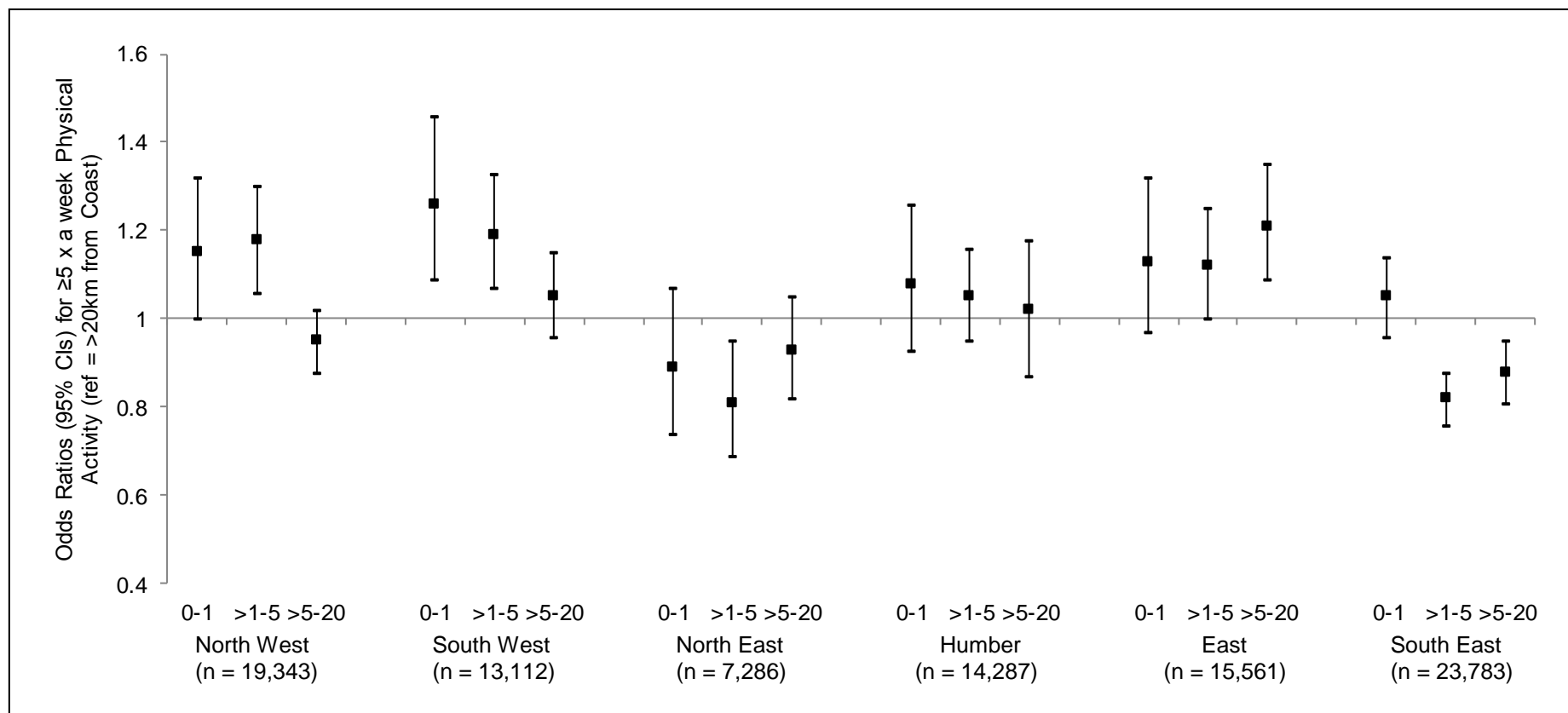
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Figure 3: Coastal proximity (in km) and likelihood of reporting 1-4 (vs. zero) days of 30 minutes or more leisure and transport related physical activity in the last 7 days for the six coastal regions of England (2009-2012).



Adjusted for: a) area level data on deprivation (using Indices of Multiple Deprivation) and % green space (using Generalized Land Use Data); b) individual level data on age, gender, socioeconomic status, employment status, marital status, number of children in

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the home, ethnicity, work limiting illness, car ownership, dog ownership; and c) temporal data on the season and year of data collection. Region Ns are lower than Figure 1 because those who achieved ≥ 5 days are not included in the models.

Supplementary Table A: Individuals who visited the coast in the last week broken down into those who visited a) Any type of coast, b) Only the open coast, c) Only coastal resorts, or d) Both types, across all government office regions in England (2009-2012).

Government Office Region	No coastal visits			Coastal town		Open coast		Town & open coast		Any coastal visit ^b	
	n	n	%	n	%	n	%	n	%	n	%
<i>Coastal GORs</i>											
North West	25135	23529	93.6	956	3.8	553	2.2	97	0.4	1606	6.4
South West	18227	15823	86.8	1361	7.5	840	4.6	203	1.1	2404	13.2
North East	9534	8382	87.9	737	7.7	326	3.4	89	0.9	1152	12.1
Yorks/Humber	18676	17488	93.6	873	4.7	247	1.3	68	0.4	1188	6.4
East England	20079	18916	94.2	753	3.8	345	1.7	65	0.3	1163	5.8
South East	30259	27275	90.1	1950	6.4	824	2.7	210	0.7	2984	9.9
<i>Non-coastal GORs</i>											
West Midlands	19613	19192	97.9	247	1.3	131	0.7	43	0.2	421	2.1
East Midlands ^a	15610	15215	97.5	257	1.6	105	0.7	33	0.2	395	2.4
London	26622	26110	98.1	377	1.4	119	0.4	16	0.1	512	1.9
TOTAL	183755	171930	93.6	7511	4.1	3490	1.9	824	0.4	11825	6.4

^a Although the East Midlands has a coastline, there were no participants in the MENE survey living within 1km. ^b Any coastal visit includes all three of the previous categories and is the variable we use in the main analyses.

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Supplementary Table B: The frequency and percent of respondents in each category who visited the coast or achieved either ≥ 5 or 1-4 days of leisure and travel related physical activity in England (2009-2012).

	Total (valid sample)		Visited the coast		Physical activity			
	(N = 183,755)		(n = 11,825; 6.4%)		(n = 41,856; 22.8%)		(n = 63,580; 34.6%)	
	N	% ^a	N	% ^b	N	% ^b	N	% ^b
Coastal proximity								
<1km	10,451	5.7	3,185	30.5	2,561	24.5	3,519	33.7
1-5 km	19,990	10.9	3,118	15.6	4,794	24.0	6,462	32.3
>5-20km	29,230	15.9	2,059	7.0	6,712	23.0	9,728	33.3
>20km	124,084	67.4	3,463	2.8	27,789	22.4	43,871	35.4
Green space quintile								
1st (M = 89.96%)	29,960	16.3	2,316	7.7	7,467	24.9	10,149	33.9
2nd (M = 68.95%)	22,691	12.3	1,680	7.4	5,236	23.1	7,895	34.8
3rd (M = 48.67%)	29,622	16.1	1,930	6.5	6,932	23.4	10,097	34.1
4th (M = 28.98%)	45,797	24.9	2,523	5.5	10,225	22.3	15,669	34.2
5th (M = 10.50%)	55,685	30.3	3,376	6.1	11,996	21.5	19,770	35.5
Deprivation quintile								
5th (Least deprived)	36,806	20.0	2,262	6.1	8,663	23.5	14,550	39.5
4th	36,744	20.0	2,858	7.8	8,600	23.4	13,252	36.1
3rd	36,721	20.0	2,877	7.8	8,633	23.5	12,563	34.2
2nd	36,738	20.0	2,172	5.9	8,239	22.4	12,076	32.9
1st (Most deprived)	36,746	20.0	1,656	4.5	7,721	21.0	11,139	30.3
Gender								
Female	98,563	53.6	6,488	6.6	20,697	21.0	32,863	33.3
Male	85,192	46.4	5,337	6.3	21,159	24.8	30,717	36.1
Age								

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<i>16-34</i>	54,091	29.4	2,900	5.4	12,998	24.0	22,359	41.3
<i>35-64</i>	84,518	46.0	6,139	7.3	20,549	24.3	29,998	35.5
<i>65+</i>	45,146	24.6	2,786	6.2	8,309	18.4	11,223	24.9
SES								
<i>AB</i>	33,608	18.3	2,930	8.7	8,230	24.5	14,472	43.1
<i>C1</i>	49,286	26.8	3,437	7.0	11,416	23.2	19,766	40.1
<i>C2</i>	37,521	20.4	2,451	6.5	9,109	21.9	12,334	32.9
<i>DE</i>	63,340	34.5	3,007	4.7	13,101	20.7	17,008	26.9
Working status								
<i>Full-time</i>	64,590	35.2	4,330	6.7	16,321	25.3	25,609	39.6
<i>Part-time</i>	21,938	11.9	1,650	7.5	5,150	23.5	8,687	39.6
<i>In education</i>	11,095	6.0	559	5.0	2,591	23.4	5,364	48.3
<i>Not working</i>	33,195	18.1	1,776	5.4	7,620	23.0	10,165	30.6
<i>Retired</i>	52,937	28.8	3,510	6.6	10,175	19.2	13,755	26.0
Work limiting health								
<i>Yes</i>	38,692	21.1	2,046	5.3	6,611	17.1	8,330	21.5
<i>No</i>	145,063	78.9	9,779	6.7	35,245	24.3	55,250	38.1
Marital status								
<i>Married</i>	104,525	56.9	7,564	7.2	24,417	23.4	37,049	35.4
<i>Other</i>	79,230	43.1	4,261	5.4	17,439	22.0	26,531	33.5
Children in household								
<i>Yes</i>	55,590	30.3	3,637	6.5	13,315	24.0	21,009	37.8
<i>No</i>	128,165	69.7	8,188	6.4	28,505	22.2	42,571	33.2
Ethnicity								
<i>White British</i>	147,864	80.5	10,909	7.4	35,189	23.8	50,446	34.1
<i>Other</i>	35,891	19.5	916	2.6	6,667	18.6	13,134	36.6
Car access								
<i>Yes</i>	130,146	70.8	9,908	7.6	30,610	23.5	48,253	37.1
<i>No</i>	53,609	29.2	1,917	3.6	11,246	21.0	15,327	28.6

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Owns dog								
Yes	41,554	22.6	3,707	8.9	14,645	35.2	11,956	28.8
No	142,201	77.4	8,118	5.7	27,211	19.1	51,264	36.3
Season								
Spring	49,062	26.7	3,525	7.2	11,666	23.8	17,182	35.0
Summer	44,357	24.1	3,682	8.3	10,621	23.9	15,691	35.4
Autumn	45,761	24.9	2,742	6.0	10,431	22.8	16,028	35.0
Winter	44,575	24.3	1,876	4.2	9,138	20.5	14,679	32.9
Year								
2009-10	47,797	26.0	3,452	7.2	11,436	23.9	16,208	33.9
2010-11	43,736	23.8	2,636	6.0	9,847	22.5	14,781	33.8
2011-12	46,787	25.5	2,920	6.2	10,679	22.8	16,616	35.5
2012-13	45,435	24.7	2,817	6.2	9,893	21.8	15,975	35.2
Government Office Region								
North West	25,135	13.7	1,606	6.4	5,792	23.0	8,136	32.4
South West	18,227	9.9	2,404	13.2	5,115	28.1	5,345	29.4
North East	9,534	5.2	1,152	12.1	2,248	23.6	2,968	31.1
Yorks & Humber	18,676	10.2	1,188	6.4	4,389	23.5	6,003	32.1
East England	20,079	10.9	1,163	5.8	4,518	22.5	6,970	34.7
South East	30,259	16.5	2,984	9.9	6,476	21.4	11,401	37.7
London	26,622	14.5	512	1.9	5,432	20.4	10,216	38.4
East Midlands	15,610	8.5	395	2.5	3,819	24.5	5,998	38.4
West Midlands	19,613	10.7	421	2.1	4,067	20.7	6,534	33.3
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Supplementary Table C: The relationship between all variables and likelihood of reporting visiting the coast at least once in the last 7 days in England (2009-2012).

	OR	Unadjusted		OR	Adjusted	
		95% CI			95% CI	
		Lower	Upper		Lower	Upper
Coastal proximity						
(ref >20km)						
<1km	15.27***	14.47	16.11	15.16***	14.33	16.03
1-5 km	6.44***	6.12	6.77	6.04***	5.73	6.36
>5-20km	2.64***	2.50	2.79	2.37***	2.24	2.51
Greenspace quintile						
(ref = least green)						
1st (M = 89.96%)				1.09**	1.02	1.16
2nd (M = 68.95%)				1.01	0.95	1.08
3rd (M = 48.67%)				1.01	0.95	1.07
4th (M = 28.98%)				0.92**	0.87	0.98
IMD deprivation						
quintile (ref = most derived)						
5th (Least deprived)				1.14***	1.06	1.23
4th				1.30***	1.21	1.39
3rd				1.28***	1.20	1.37
2nd				1.17***	1.09	1.25
Female (ref = male)				1.03	0.99	1.07
Age (ref = 16-34)						
35-64				1.05	1.00	1.11
65+				0.83***	0.75	0.91

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SES (ref = DE)						
	<i>AB</i>			1.51***	1.42	1.61
	<i>C1</i>			1.29***	1.22	1.37
	<i>C2</i>			1.11**	1.05	1.18
Employment status (ref = Full-time)						
	<i>Part-time</i>			1.17***	1.10	1.25
	<i>Retired</i>			1.23***	1.14	1.33
	<i>In education</i>			1.14*	1.02	1.26
	<i>Not working</i>			1.07*	1.01	1.15
Married/partner (ref = not)						
				1.05	1.00	1.09
Children (ref = none)						
				1.06*	1.01	1.12
White British (Ref = not)						
				1.62***	1.51	1.75
Disability (Ref = none)						
				0.76***	0.72	0.80
Owns car (ref = no)						
				1.70***	1.61	1.81
Owns dog (ref = no)						
				1.39***	1.33	1.45
Season (ref = Winter)						
	<i>Spring</i>			1.81***	1.70	1.92
	<i>Summer</i>			2.17***	2.04	2.30
	<i>Autumn</i>			1.49***	1.40	1.59
Year (ref = 2009-10)						
	<i>2010-11</i>			0.82***	0.78	0.87
	<i>2011-12</i>			0.87***	0.82	0.92
	<i>2012-13</i>			0.87***	0.83	0.92
	Constant	0.03	0.00	0.01		
	N	183,755		183,755		
	Nagelkerke R ²	.15		.19		

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OR = Odds Ratio. CI = Confidence Interval. * $p < .05$; ** $p < .01$, *** $p < .001$.

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Supplementary Table D: The relationship between all variables and likelihood of reporting ≥5 days of 30 minutes or more leisure and transport related physical activity in the last 7 days in England (2009-2012).

	OR	Unadjusted		OR	Adjusted		Adjusted + coastal visits		
		95% CI			95% CI		OR	95% CI	
		Lower	Upper		Lower	Upper		Lower	Upper
Coastal proximity									
(ref >20km)									
<1km	1.12***	1.07	1.18	1.08***	1.03	1.14	0.93**	0.89	0.98
1-5 km	1.09***	1.06	1.13	1.04*	1.00	1.08	0.97	0.93	1.01
>5-20km	1.03*	1.00	1.06	0.97	0.94	1.01	0.95**	0.93	0.99
Greenspace quintile									
(ref = least green)									
1st (M = 89.96%)				1.05*	1.01	1.08	1.04*	1.01	1.08
2nd (M = 68.95%)				1.00	0.96	1.04	1.00	0.96	1.03
3rd (M = 48.67%)				1.05*	1.01	1.09	1.05**	1.01	1.09
4th (M = 28.98%)				1.02	0.99	1.05	1.02	0.99	1.05
IMD deprivation quintile									
(ref = most deprived)									
5th (Least deprived)				1.08***	1.04	1.12	1.08***	1.03	1.12
4th				1.07***	1.03	1.12	1.07**	1.03	1.11
3rd				1.11***	1.07	1.15	1.10***	1.06	1.14
2nd				1.08***	1.04	1.12	1.08***	1.04	1.12
Female (ref = male)				0.77***	0.76	0.79	0.77***	0.76	0.79
Age (ref = 16-34)									
35-64				0.99	0.97	1.02	0.99	0.96	1.02
65+				0.81***	0.76	0.85	0.81***	0.77	0.85
SES (ref = DE)									
AB				1.20***	1.16	1.25	1.19***	1.15	1.23

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C1		1.11***	1.07	1.14	1.10***	1.07	1.14
C2		1.11***	1.08	1.15	1.11***	1.07	1.15
Employment status (ref = Full-time)							
<i>Part-time</i>		1.03	0.99	1.07	1.02	0.98	1.06
<i>Retired</i>		1.05	1.00	1.10	1.04	0.99	1.09
<i>In education</i>		0.97	0.92	1.02	0.97	0.92	1.02
<i>Not working</i>		1.06**	1.03	1.10	1.06**	1.03	1.10
Married/partner (ref = not)		0.96**	0.94	0.99	0.96**	0.94	0.99
Children (ref = none)		0.99	0.96	1.02	0.99	0.96	1.01
White British (Ref = not)		1.22***	1.18	1.26	1.21***	1.17	1.25
Disability (Ref = none)		0.66***	0.64	0.68	0.66***	0.64	0.68
Owens car (ref = no)		0.94***	0.92	0.97	0.93***	0.90	0.96
Owens dog (ref = no)		2.24***	2.19	2.30	2.22***	2.17	2.28
Season (ref = Winter)							
<i>Spring</i>		1.21***	1.18	1.25	1.19***	1.16	1.23
<i>Summer</i>		1.23***	1.19	1.27	1.20***	1.17	1.24
<i>Autumn</i>		1.15***	1.11	1.19	1.14***	1.10	1.18
Year (ref = 2009-10)							
2010-11		0.93***	0.90	0.96	0.93***	0.90	0.96
2011-12		0.95***	0.92	0.98	0.95**	0.92	0.98
2012-13		0.89***	0.86	0.92	0.90***	0.87	0.92
Coastal visit					1.62***	1.55	1.69
Constant	0.29	0.21			0.22		
N	183,755	183,755			183,755		
Nagelkerke R ²	.00	.05			.06		

OR = Odds Ratio. CI = Confidence Interval. * p <.05; ** p <.01, ***p < .001.

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Supplementary Table E: The relationship between all variables and likelihood of reporting 1-4 days of 30 minutes or more leisure and transport related physical activity in the last 7 days in England (2009-2012).

	OR	Unadjusted		OR	Adjusted		Adjusted + coastal visits		
		95% CI			95% CI		OR	95% CI	
		Lower	Upper		Lower	Upper		Lower	Upper
Coastal proximity (ref >20km)									
<1km	0.96	0.92	1.01	1.03	0.98	1.08	0.88***	0.83	0.92
1-5 km	0.88***	0.85	0.92	0.93***	0.89	0.96	0.86***	0.83	0.90
>5-20km	0.91***	0.88	0.94	0.90***	0.87	0.93	0.88***	0.85	0.91
Greenspace quintile (ref = least green)									
1st (M = 89.96%)				0.91***	0.88	0.94	0.91***	0.87	0.94
2nd (M = 68.95%)				0.97	0.93	1.00	0.97	0.93	1.00
3rd (M = 48.67%)				0.98	0.94	1.01	0.98	0.94	1.01
4th (M = 28.98%)				0.98	0.95	1.01	0.98	0.95	1.01
IMD deprivation quintile (ref = most derived)									
5th (Least deprived)				1.35***	1.30	1.40	1.35***	1.30	1.40
4th				1.21***	1.16	1.26	1.20***	1.15	1.25
3rd				1.16***	1.12	1.20	1.15***	1.11	1.20
2nd				1.08***	1.05	1.12	1.08***	1.04	1.12
Female (ref = male)				0.80***	0.78	0.82	0.80***	0.78	0.82
Age (ref = 16-34)									
35-64				0.76***	0.74	0.79	0.76***	0.74	0.78
65+				0.49***	0.46	0.51	0.49***	0.46	0.51
SES (ref = DE)									

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AB		1.99***	1.92	2.06	1.97***	1.90	2.04
C1		1.57***	1.52	1.62	1.56***	1.51	1.61
C2		1.16***	1.13	1.20	1.16***	1.12	1.20
Employment status (ref = Full-time)							
<i>Part-time</i>		1.16***	1.12	1.20	1.15***	1.11	1.20
<i>Retired</i>		0.93**	0.88	0.97	0.92**	0.88	0.97
<i>In education</i>		1.57***	1.49	1.66	1.57***	1.48	1.65
<i>Not working</i>		0.98	0.94	1.01	0.98	0.94	1.01
Married/partner (ref = not)		0.94***	0.92	0.97	0.94***	0.92	0.96
Children (ref = none)		0.98	0.95	1.00	0.97	0.95	1.00
White British (Ref = not)		1.24***	1.21	1.28	1.23***	1.20	1.27
Disability (Ref = none)		0.50***	0.48	0.51	0.50***	0.49	0.52
Owens car (ref = no)		1.32***	1.28	1.36	1.30***	1.27	1.34
Owens dog (ref = no)		0.93***	0.91	0.96	0.92***	0.90	0.95
Season (ref = Winter)							
<i>Spring</i>		1.24***	1.20	1.28	1.22***	1.18	1.25
<i>Summer</i>		1.26***	1.22	1.30	1.23***	1.19	1.27
<i>Autumn</i>		1.19***	1.15	1.23	1.18***	1.14	1.22
Year (ref = 2009-10)							
2010-11		0.95***	0.92	0.98	0.95**	0.92	0.98
2011-12		1.07***	1.04	1.10	1.08***	1.04	1.11
2012-13		1.02	0.99	1.05	1.03	0.99	1.06
Coastal visit					1.92	1.55	1.69
Constant	0.84	0.60			0.61		
N	141,899	141,899			141,899		
Nagelkerke R ²	.00	.13			.13		

OR = Odds Ratio. CI = Confidence Interval. * p <.05; ** p <.01, ***p < .001.

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