# Abstract

Meteorological conditions affect people’s outdoor physical activity. However, we know of no previous research into how these conditions affect physical activity in different types of natural environments – key settings for recreational physical activity, but ones which are particularly impacted by meteorological conditions.

Using responses from four waves (2009-2013) of a survey of leisure visits to natural environments in England (n=47613), visit dates and locations were ascribed estimates of energy expenditure (MET-minutes) and assigned meteorological data. We explored relationships between MET-minutes in natural environments (in particular, parks, woodlands, inland waters, and coasts) and the hourly maxima of air temperature and wind speed, levels of rainfall, and daylight hours using generalised additive models.

Overall, we found a positive linear relationship between MET-minutes and air temperature; a negative linear relationship with wind speed; no relation with categories of rainfall; and an approximately quartic relationship with daylight hours. These same trends were observed for park-based energy expenditure, but differed for visits to other natural environments: only daylight hours were related to energy expenditure at woodlands; wind speed and daylight hours affected energy expenditure at inland waters; and only air temperature was related to energy expenditure at coasts.

Natural environments support recreational physical activity under a range of meteorological conditions. However, distinct conditions do differentially affect the amount of energy expenditure accumulated in a range of natural environments. The findings have implications for reducing commonly-reported meteorological barriers to both recreational physical activity and visiting natural environments for leisure and begin to indicate how recreational energy expenditure in these environments could be affected by future climate change.

# Keywords

Weather; leisure; energy expenditure; green space; spline

**Highlights**

* Meteorological conditions and daylight hours affect recreational physical activity
* Research has not explored how these affect physical activity in different environments
* Park-based physical activity associated with temperature, wind speed, and daylight
* Unique associations for physical activity at woodlands, inland waters, and coasts
* Implications for ‘green prescriptions’ and future climate change are discussed

# 1. Introduction

Many adults worldwide do not achieve recommended levels of physical activity (Hallal et al., 2012), potentially undermining physical and mental health (Nocon et al., 2008; White et al., 2017). However, factors outside of an individual's control, such as meteorological conditions, can affect levels of physical activity (Tucker and Gilliland, 2007). In a US sample, accelerometer-measured physical activity was higher on days with moderate as opposed to cold (<-6°C) or hot (>23°C) temperatures and on dry as opposed to rainy days (Feinglass et al., 2011). Similarly, a Canadian study found clement (vs. inclement) meteorological conditions were associated with an additional 2000 steps per day with mean daily temperatures, total daily rainfall, and maximum wind speeds playing a role (Chan et al., 2006). Seasonal effects such as daylight hours, have also been associated with physical activity. For instance, a study of older English adults found that each quartile of daylight hours was associated with significantly more minutes of daily physical activity than the preceding quartile (Wu et al., 2017b).

Separately, physical environments in which people live and recreate substantially influence physical activity (Bauman et al., 2012; Sallis et al., 2006). In particular, greater availability of natural environments (e.g. parks, woodlands, inland waters, coasts) has been shown to support health-enhancing levels of leisure-time physical activity such as walking and cycling (Elliott et al., 2015; National Institute for Health and Care Excellence, 2008) with considerable implications for health promotion and disease prevention (White et al., 2016). Nevertheless, levels of physical activity in natural environments may be particularly sensitive to meteorological conditions (Wolff and Fitzhugh, 2011). However, we know of no prior research which has disaggregated the relationships between meteorological conditions and different types of natural environment. Parks, woodlands, inland waters, and coasts provide different physical properties and affordances (Ward Thompson, 2013), as well as temperature-regulating properties (Völker et al., 2013), and therefore it cannot be assumed that physical activity in each setting is affected by meteorological conditions in the same way. Knowing this could help address widely-reported meteorological barriers to physical activity amongst the least active (Salmon et al., 2003) and to visiting natural environments more generally (Boyd et al., 2018), and thus support efforts to promote health-enhancing physical activity in these settings (National Institute for Health and Care Excellence, 2008). This study therefore explored whether meteorological conditions (air temperature, wind speed, and rainfall) and daylight hours were associated with physical activity differently in a range of natural environments.

# 2. Method

## 2.1 Sample

Data were taken from the repeat cross-sectional Monitor of Engagement with the Natural Environment (MENE) survey. The survey forms part of the UK Government's National Statistics and is conducted across the whole of England and throughout the year to reduce potential geographical and seasonal biases. A design sampling frame ensures a high degree of representativeness to the adult population with minimal clustering effects (Natural England, 2017). Participants are interviewed about their leisure visits to natural environments in the previous week using in-home face-to-face interviews with responses recorded using Computer Assisted Personal Interviewing (CAPI). For people who reported making ≥1 visit in the previous week (≈42% of the total sample), a visit is randomly selected by the CAPI software for further questions. Pooling data from the first four waves of MENE (February 2009 to March 2013) produced a total of 62238 randomly-selected visits.

## 2.2 Physical activity

Our primary outcome was the estimated energy expended on these visits defined as the metabolic equivalent of task (MET) rate of the primary visit activity, multiplied by visit duration (in minutes), to provide “MET-minutes,” an internationally used measure of physical activity (Ainsworth et al., 2011). MET-minutes were derived from two questions which concerned the participant's randomly-selected visit: (a) "which of these activities did you undertake?" with a possible list of 20 activities that have previously been ascribed MET rates (Elliott et al., 2015); and, (b) "how long did this visit last altogether - from the time you left to when you returned?" Although this question implies two-way travel time, previous research suggests participants respond as though they only reported time spent in the natural environment (Elliott et al., 2015). MET-minutes accumulated on visits were log-normally distributed, although to ease interpretation of results, untransformed coefficients are presented (models with log-transformed MET-minutes are presented in supplementary materials, Tables S5 and S6).

## 2.3 Meteorological conditions and daylight

Our key predictor variables were three meteorological conditions and daylight hours. In line with previous research, maximum air temperature during daylight hours (°C) and maximum wind speed during daylight hours (m/s) were used as continuous variables (Wolff and Fitzhugh, 2011), and maximum rainfall during daylight hours was categorised into "no rain," "light rain" (>0 to 0.5mm/hour), and "moderate/heavy rain" (>0.5mm/hour) (Feinglass et al., 2011; Met Office, 2007). The hourly maxima of air temperature, wind speed, and rainfall are the values for these meteorological conditions on the hour when their maximum occurred on the day of the visit. All three meteorological variables were derived from the Met Office's Numerical Weather Prediction (NWP) model data for the UK (<https://www.metoffice.gov.uk/research/modelling-systems/unified-model/weather-forecasting>), processed into hourly weather "nowcasts" for each postcode district, and applied to the coordinates of each specific visit location in MENE by selecting the postcode district with the closest centroid. These data used observed data from weather stations and other sources and modelled these meteorological conditions in cases where there were no available direct observations, offering the best estimate of the weather at any given location and time (<https://www.metoffice.gov.uk/research/weather/data-assimilation/data-assimilation-methods>). Daylight hours were computed using the ‘suncalc’ R package (Agafonkin and Thieurmel, 2017) by subtracting dawn from dusk (i.e. including civil twilight time).

## 2.4 Type of natural environment

Along with exact coordinates of the visit location, participants self-reported the general type of natural environment they visited. Participants were asked: "Which of the following list of types of place best describe where you spent your time during this visit?" Four (of 16) key settings were selected based on distinct recreational patterns found in earlier work (Elliott et al., 2018): "a park in a town or city" (hereafter 'park'), "a woodland or forest" (hereafter 'woodland'), "a river, lake, or canal" (hereafter 'inland waters'), and "a beach" or "other coastline" collectively (hereafter 'coast'; White et al., 2013).

## 2.5 Covariates

Analyses controlled for sex, age, ethnicity, social grade, disability, marital status, work status, number of children in the household, days of sufficient physical activity in the past week, whether the visit was on a weekday or weekend, and whether the visit was "local" (<1 mile from home). These factors have all been found to influence physical activity in natural environments (Elliott et al., 2015). Details on these variables’ measurement and implementation in analyses are included in supplementary materials (Table S1).

## 2.6 Analyses

The following types of visit were excluded as MET-minutes could not be reliably calculated for them: (a) visits where "any other outdoor activity" or "none of these activities" were reported (n=2689); (b) visits which involved more than one activity (n=11182); (c) visits without complete meteorological data (n=588); and, (d) visits with duration <1 minute (n=14). This left 47613 visits for analysis (Fig. 1).

We planned the following analyses:

1. A generalised additive model (GAM) predicting MET-minutes from meteorological conditions and daylight hours across all environments. This model allowed flexible estimation of the shape of these relationships by introducing smoothed terms. Thin-plate regression splines were chosen for modelling air temperature, wind speed, and daylight hours to avoid arbitrary placement of knots (expected points at which the direction of trend changes), and maximum likelihood parameter estimation was chosen as it has been shown in simulations to avoid occasional under-smoothing (which could affect significance values) (Scheipl et al., 2008).
2. An adjusted GAM which additionally controlled for the covariates known to influence MET-minutes.
3. The adjusted GAM as in (b) but with additional interaction terms between environment type and each meteorological variable. The sample size here was smaller due to the focus on a subset of four (of 16) environments (n=21767).
4. If, as predicted, (c) significantly improved the fit of the model, the above GAM stratified by environment type. Sample sizes for these models would be further reduced (park=11988, woodland=2947, inland waters=2561, coast=4271).

Analyses were performed in R (R Core Team, 2017) using the ‘mgcv’ package (Wood, 2018).

# 3. Results

## 3.1 Descriptive statistics

The percentage of respondents making at least one recreational visit to a natural environment varied seasonally (Fig. 2) with 45% of respondents, on average, reporting at least one visit in August versus 29% in December (Table S2). Towards the end of the sampling period, seasonal variation reduces with decreases in visits in April-August 2012 (vs. 2011) and increases in December 2012-February 2013 (vs. 2011-2012).

The mean maximum air temperature on visits was 14°C (SD=6°C), mean maximum wind speed was 6 m/s (SD=2 m/s), mean maximum rainfall was 0.5 mm/hour (SD=1.1 mm/hour) and mean daylight hours were 14 (SD=3) with seasonal variations accounting for much of this variability (Fig. 3a–d). These averages were largely consistent across all four key environments (Table S3). A median of 300 MET-minutes (SD=528) were expended on visits to natural environments, but these median values varied with environment (park=266; woodland=270; inland waters=360; coast=420).

## 3.2 MET-minutes as a function of meteorological conditions and daylight

In the first minimally-adjusted model, we observed significant associations between MET-minutes and smoothed terms for air temperature, wind speed and daylight hours (Table 1). MET-minutes steadily increased with air temperature until ≈23°C, after which the direction of the relationship was less clear (Fig. 3e). MET-minutes declined linearly with increasing wind speed (Fig. 3f). MET-minutes increased with daylight hours with a plateau around 11–13 hours, followed by an increase and further plateau after 15 hours (Fig. 3h). There were no significant associations between the categories of rainfall and MET-minutes in the untransformed model, but the model in which MET-minutes were log-transformed (Table S5) suggested that visits taken on days of moderate/heavy rain were associated with fewer MET-minutes than days of no rain (*b*=-0.03, 95% CI -0.05, -0.01). Concurvity (similar to multicollinearity but for smoothed terms (Morlini, 2006)) was not excessively high for any variable (air temperature=0.46, wind speed=0.11, rainfall=0.67, daylight hours=0.56).

After adjustment for covariates, categories of rainfall were no longer associated with MET-minutes in the log-transformed model, and our results indicated a positive linear relationship between air temperature and MET-minutes (Fig. 3e). Associations with MET-minutes for wind speed and daylight hours remained similar to the minimally-adjusted model. Significant associations between covariates and MET-minutes included: being male versus female (*b*=92.62, 95% CI 83.01, 102.25); visiting 'further afield' versus 'locally' (*b*=280.64, 95% CI 271.13, 290.15); visiting at a weekend versus on a weekday (*b*=28.16, 95% CI 18.71, 37.61); and being in education versus not working (*b*=31.47, 95% CI 7.60, 55.34). Older age and lower socioeconomic grades were also associated with fewer MET-minutes.

## 3.3 MET-minutes as a function of meteorological conditions, daylight, and environment

Adding interaction terms between the meteorological/daylight variables and the types of natural environment significantly improved the prediction of MET-minutes (*F*(18,21726)=25.31, *p*<.001; Table S5). To better understand these complex interactions, the adjusted GAM was stratified by environment type. However, after stratifying, all relationships between MET-minutes and smoothed terms, in all environments, were penalised to 1 degree of freedom (suggesting entirely linear relationships), so the models were re-run as least-squares linear regressions (Table 2).

For a given park visit, a 1°C increase in air temperature was associated with 3.08 additional MET-minutes (95% CI 1.50, 4.66); a 1 m/s increase in wind speed was associated with 5.14 fewer MET-minutes (95% CI -8.26, -2.02); and a 1 hour increase in daylight was associated with 3.20 additional MET-minutes (95% CI 0.12 6.27). For woodland visits, neither air temperature nor wind speed were related to MET-minutes, but a 1 hour increase in daylight was associated with 12.61 additional MET-minutes (95% CI 4.81, 20.40). For visits to inland waters, air temperature was unrelated to MET-minutes; but a 1 m/s increase in wind speed was associated with 13.43 fewer MET-minutes (95% CI -25.83, -1.04); and a 1 hour increase in daylight was associated with 16.99 additional MET-minutes (95% CI 4.27, 29.72). For coasts, a 1°C increase in air temperature was associated with 12.22 additional MET-minutes (95% CI 6.94, 17.50), but neither wind speed nor daylight hours were associated with MET-minutes. Across all stratified models, no relationships existed between categories of rainfall and MET-minutes.

Meteorological conditions and daylight hours were some of the strongest predictors of MET-minutes across all environments (Fig. 4). While many covariates showed fairly consistent relationships across environments, there were exceptions. For example, White British respondents expended significantly fewer MET-minutes at parks (*b*=-22.95, 95% CI -38.00, -7.90) and coasts (*b*=-89.93, 95% CI -173.65, -6.01) compared to all other ethnicities, but significantly more MET-minutes at inland waters (*b*=122.59, 95% CI 24.14, 221.04). Each extra day of sufficient physical activity in the past week was associated with 3 additional MET-minutes on park visits (*b*=2.92, 95% CI 0.44, 5.41), but 14 fewer MET-minutes on visits to inland waters (*b*=-14.29, 95% CI -24.47, -4.12).

# 4. Discussion

To our knowledge, this is the first study to examine how meteorological conditions and daylight hours affect recreational physical activity in different natural environments. Using a large sample of recreational visits in England, this study found that higher air temperatures, lower wind speeds, and more daylight hours were associated with greater energy expenditure in all types of natural environment. This pattern was also found for park-based energy expenditure. However, only higher air temperatures predicted greater energy expenditure at coastal environments; decreases in wind speed and more daylight hours predicted greater energy expenditure at inland waters; and more daylight hours predicted greater energy expenditure at woodlands. We additionally observed seasonal variations in the proportion of respondents visiting natural environments at least once in the last week (Fig. 2). While these variations appear to be diminishing in latter sampling years, these changes do not correspond with any obvious climatic differences (Met Office, 2018).

## 4.1 Relationship with previous literature

Unlike previous studies in which quadratic relationships between air temperature and physical activity were found (e.g. Feinglass et al., 2011), we found a linear relationship. This linear trend could be due to the larger sample size in the present study, the different range of covariates controlled for, or that respondents chose not to visit natural environments on days that were overly hot. It could also be that in England, air temperatures are often not high enough to provoke the attenuation of physical activity evident in other literature. Other evidence from England has found linear relationships between daily maximum air temperature and accelerometer-measured physical activity (Wu et al., 2017a).

Similarly, the quadratic relationship between physical activity and wind speed found in previous studies (e.g. Chan et al., 2006) was also not evident here. This could be because respondents chose not to visit natural environments on days that were particularly windy. In a previous analysis of six waves of the MENE data (n=16812), such inclement conditions were a key barrier to visiting natural environments for leisure (Boyd et al., 2018).

We categorised rainfall into three categories as over a third of respondents did not visit natural environments on days where it rained, consistent with stated barriers in previous research (Boyd et al., 2018). The lack of association between rainfall and energy expenditure could be explained by people who *are* willing to visit natural environments during inclement meteorological conditions being those who are prepared to endure these conditions for longer (e.g. dog-walkers; Wu et al., 2017a).

We observed a nuanced relationship between MET-minutes and daylight hours that contrasts with previous studies (Feinglass et al., 2011; Klenk et al., 2012; Wu et al., 2017b, 2017a). The change in MET-minutes between 13 and 15 hours of daylight corresponds with: (a) the change to daylight savings time in the UK, and, in the latter half of the year, (b) the end of school summer holidays in the UK. Both could therefore be indicative of a change in how people use their time. It has been demonstrated before that children, at least, tend to conduct more physical activity in the late afternoon and early evening following a change to daylight savings time (Goodman et al., 2014).

After stratifying models by the type of natural environment visited, the lack of significant associations was salient. For example, only one meteorological condition was significantly related to energy expenditure at woodlands (daylight hours) and coasts (temperature). Such results suggest natural environments can promote recreational physical activity under a range of clement and inclement weather conditions. Indeed, woodlands can mitigate extreme temperatures, and provide shelter from wind and rainfall (Tyrväinen et al., 2005), potentially rendering them suitable settings for recreational physical activity promotion (Moseley et al., 2017). Coasts afford a range of recreational activities, both land- and sea-based, and their different relationships with different weather conditions found previously (Patrolia et al., 2017) may explain the null associations found here (e.g. some water sports may be facilitated by windier conditions, but fishing may be impeded).

Such insights may be useful in addressing meteorological barriers to visiting natural environments for physical activity (Boyd et al., 2018), especially tailored to those who are less active (Salmon et al., 2003). For example, at a population level, dog ownership has been shown to mitigate temperature-related barriers to physical activity (Temple et al., 2011; Wu et al., 2017a), and thus could support maintenance of energy expenditure at parks and coasts (where temperature significantly affected MET-minutes in this study). In terms of urban design, strategies could be implemented to shelter from higher wind speeds at parks or inland waters (where higher wind speeds appear to be a barrier to energy expenditure in this study), such as the planting of trees (Tyrväinen et al., 2005). At an individual-level, these results could aid ‘green prescriptions’ (Van den Berg, 2017), where health professionals can recommend patients to spend time in natural environments: the results allow identification of meteorological barriers to physical activity in different natural environments, and thus targeted strategies which could overcome them.

## 4.2 Strengths and limitations

To our knowledge, this is the largest study to date concerning the effects of meteorological conditions on outdoor energy expenditure and the first to do so for a range of natural environments. However, a number of limitations and opportunities for future research exist. Firstly, MET-minutes were ascribed to self-reported activities without regard to factors that affect energy expenditure (e.g. body mass, terrain). Future research could combine geolocation (e.g. GPS on a smartphone) with topography to objectively assess physical activity (Jansen et al., 2017), thereby better accounting for these factors. Secondly, low air temperature and high wind speed likely explain energy expenditure better when interacted with each other (wind chill; Bluestein and Zecher, 1999). However, although we could have calculated wind chill for temperatures below 10°C, the equivalent heat index measure for conditions above 10°C requires humidity to also be accounted for and these data were not available. Thirdly, the models did not explain much variance in MET-minutes. However, models with log-transformed MET-minutes explained up to twice the variance of untransformed models (Tables S5 and S6) and key relationships between meteorological conditions/daylight hours held.

Lastly, the present study could be extended to explore volumes of physical activity that could be supported by a range of natural environments under different climate change scenarios (discussed in a supplementary appendix). Previous research has identified that atmospheric conditions alter preferences for natural environments (Hipp and Ogunseitan, 2011; White et al., 2014) and could prompt increased participation in outdoor recreational physical activity as a result of climate change (Obradovich and Fowler, 2017), but currently neither how much per-person energy is expended, nor how this might be apportioned across different environments under climate change, has been explored. Such research could explore a range of plausible climate scenarios (Obradovich and Fowler, 2017), account for demographic changes (Perch-Nielsen et al., 2008), control for cumulative effects of climate change on meteorological conditions and environment (e.g. sea level rise, droughts), and use international data on leisure visits to natural environments (e.g. Grellier et al., 2017) to gain such an understanding.

## 4.3. Conclusions

Meteorological conditions and daylight can affect physical activity, especially when undertaken in natural environments. The current research suggested that in England, distinct meteorological conditions differentially affect the amount of energy expenditure accumulated in a range of natural environments. Park-based activity was affected by air temperature, wind speed, and daylight hours, whereas coastal activity was only significantly affected by air temperature. Activity at inland waters was sensitive to both wind speed and hours of daylight, while activity at woodlands was only significantly affected by hours of daylight. Knowledge of how different meteorological conditions affect physical activity across a range of natural environments may help address place-specific meteorological barriers to physical activity and begin to indicate how distinct environments may support different levels of energy expenditure under climatic changes. Promisingly though, physical features and affordances mean that natural environments support recreational physical activity in spite of inclement weather conditions for a considerable proportion of the population, which underlines their importance as resilient public health resources.

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# Figure legends

Figure 1: Map of the locations of the 47613 leisure visits to natural environments in England (2009-2013) included in analyses and their environments.

Figure 2: Percentage of respondents reporting at least one recreational visit to a natural environment in the previous week as a function of month of interview.

Figure 3: Monthly averaged (a) daily maximum temperature during daylight hours, (b) wind speed during daylight hours, (c) rainfall during daylight hours, and (d) daylight hours, for the leisure visits to natural environments in England (2009-2013) included in analyses. Minimally (orange) and maximally (blue) adjusted thin plate regression spline smoothed terms with 95% Bayesian credible intervals predicting MET-minutes expended on a visit by (e) temperature, (f) wind speed, and (h) daylight hours, together with parametric terms and 95% confidence intervals for (g) categories of rainfall, for the leisure visits to natural environments in England (2009-2013) included in analyses.

Figure 4: Standardised coefficients and 95% confidence intervals showing the relative strength of all variables in adjusted least-squares linear regression models stratified by type of environment visited for selected leisure visits to natural environments in England (2009-2013).

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| Table 1. MET-minutes on leisure visits to natural environments in England (2009-2013) as a function of meteorological conditions and daylight in minimally and maximally (all covariates) adjusted models. |
|  | Minimally-adjusted modeln=47613R2=.01 | Maximally-adjusted modeln=47613R2=.09(*F*=380.76, *p*<.001) |
|  | edf | res df | *F*-test | edf | res df | *F*-test |
| Max. temperature during daylight | 4.50 | 5.58 | \*\*\*10.06 | 1.02 | 1.03 | \*\*\*46.76 |
| Max. wind speed during daylight | 1.01 | 1.03 | \*4.33 | 1.01 | 1.01 | \*\*\*11.66 |
| Daylight hours | 6.17 | 7.33 | \*\*\*12.41 | 5.63 | 6.78 | \*\*\*12.02 |
|  | *b* | LCI | UCI | *b* | LCI | UCI |
| (Intercept) | 457.14 | 448.90 | 465.38 | 265.60 | 241.10 | 290.09 |
| Rainfall (No rainfall=ref) | / | / | / | / | / | / |
| Light rain (>0mm to 0.5mm) | -5.65 | -16.88 | 5.57 | -0.08 | -10.74 | 10.58 |
| Moderate/heavy rain (>0.5mm) | -12.46 | -26.42 | 1.50 | 5.96 | -19.06 | 7.14 |
| Maximally adjusted model controls for sex, age, ethnicity, disability, marital status, work status, number of children in the household, days of physical activity in the last week, whether the visit was on a weekday or weekend, and whether the visit was "local".N.B Temperature, wind speed, and daylight hours are smooth terms fitted with thin plate regression splines. Estimated degrees of freedom roughly approximate the degree of polynomial in the smooth (see Fig. 3).edf=Estimated degrees of freedom; res df=residual degrees of freedom; LCI=lower bound of 95% confidence interval; UCI=upper bound of 95% confidence interval; \*\*\*=*p*<.001; \*=*p*<.05. |

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| Table 2. MET-minutes on leisure visits to natural environments in England (2009-2013) as a function of meteorological conditions and daylight in maximally adjusted models stratified by environment type. |
|  | Parkn=11988R2=.08 | Woodlandn=2947R2=.08 | Inland watersn=2561R2=.10 | Coastn=4271R2=.06 |
|  | *b* | LCI | UCI | *b* | LCI | UCI | *b* | LCI | UCI | *b* | LCI | UCI |
| (Intercept) | -598.60 | -1024.39 | -172.81 | 86.54 | -42.25 | 215.34 | -135.74 | -346.82 | 75.34 | 117.38 | -51.71 | 286.46 |
| Max. temperature during daylight (°C) | \*\*\*3.08 | 1.50 | 4.66 | -1.16 | -5.18 | 2.85 | 2.73 | -3.96 | 9.42 | \*\*\*12.22 | 6.94 | 17.50 |
| Max. wind speed during daylight (m/s) | \*\*-5.14 | -8.26 | -2.02 | -4.03 | -11.26 | 3.20 | \*-13.43 | -25.83 | -1.04 | -4.26 | -13.52 | 5.00 |
| Hours of daylight | \*3.20 | 0.12 | 6.27 | \*\*12.61 | 4.81 | 20.40 | \*\*16.99 | 4.27 | 29.72 | 4.15 | -5.86 | 14.16 |
| Rainfall (No rainfall=ref) | / | / | / | / | / | / | / | / | / | / | / | / |
| Light rain (>0mm to 0.5mm) | -2.76 | -17.72 | 12.20 | 4.24 | -34.06 | 42.52 | 37.66 | -23.76 | 99.08 | 39.22 | -8.84 | 87.28 |
| Moderate/heavy rain (>0.5mm) | -3.17 | -21.67 | 15.33 | -25.24 | -72.70 | 22.23 | 37.99 | -38.81 | 114.78 | 13.96 | -45.40 | 73.33 |
| N.B Models run as least-squares linear regressions after GAMs penalised smooth terms to approximately 1 degree of freedom for all relevant terms in all environments.Adjusted for sex, age, ethnicity, disability, marital status, work status, number of children in the household, days of physical activity in the last week, whether the visit was on a weekday or weekend, and whether the visit was "local".LCI=lower bound of 95% confidence interval; UCI=upper bound of 95% confidence interval |