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Moderating effect of individual characteristics and neighborhood greenness on the association between ambient temperature and habitual physical activity levels[☆]

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ABSTRACT

Background: Ambient temperature could impact physical activity behavior, as extreme temperatures may be a barrier for physical activity. Adopting a within-subject design, we examined the association between ambient temperature and habitual physical activity levels and explored how individual characteristics and neighborhood greenness influenced this relation.

Methods: Physical activity data was obtained for 8 consecutive days using a thigh-worn triaxial accelerometer during three measurement periods with distinct ambient temperatures: COLD (5.9 ± 0.4 °C), MODERATE (13.9 ± 3.4 °C) and WARM (26.0 ± 0.7 °C). Physical activity parameters were compared between conditions using linear mixed model analysis, with MODERATE as the reference. The moderating effects of age, sex, cardiovascular health status, baseline physical activity levels, and neighborhood greenness on the association between ambient temperature and physical activity was subsequently explored.

Results: Participants (n = 151, 62 ± 11 years) had lower daily step counts in WARM (10,576 ± 3395 steps/day, p = 0.003) and COLD (10,641 ± 3483 steps/day, $p < 0.001$) compared to MODERATE (11,602 ± 3636 steps/day). LIPA and MVPA were lower in COLD (244 ± 62 min/day, p = 0.004, and 91 ± 30 min/day, $p < 0.001$, respectively) compared to MODERATE (255 ± 66 min/day and 104 ± 36 min/day, respectively). Sitting time (545 ± 89 min/day) did not differ across conditions (p = 0.68). Baseline physical activity was an effect modifier for step count, sitting time, and MVPA, whereas neighborhood greenness was an effect modifier for sitting time.

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Conclusion: Colder ambient temperatures were associated with reduced physical activity levels (*i.e.*, lower step count, LIPA, and MVPA), while warmer ambient conditions were only associated with reduced step count. Effects were more prominent in the most active *versus* least active individuals, with little impact of neighborhood greenness.

1. Introduction

Regular physical activity is associated with reduced risk of chronic diseases and all-cause mortality, enhanced mental well-being and improved quality of life (Bull et al., 2020; Eckstrom et al., 2020). However, the prevalence of people that are physically inactive is high, with an estimated 31.3% of the global adult population not meeting the WHO physical activity guidelines in 2022 (Strain et al., 2024). Climate change-induced extreme temperatures may negatively impact physical activity behaviors (Wald and Demorest, 2022), thereby raising potential health concerns (Franco Silva et al., 2024).

An inverted U-shaped relation between ambient temperature and physical activity has previously been reported (Turrisi et al., 2021; Ho et al., 2022), indicating that adults are less active during more extreme temperatures. However, findings are inconsistent across studies, which may partially relate to differences in climates and regional contexts (Ho et al., 2022; Ferguson et al., 2023; Giannouli et al., 2019; Crosby et al., 2024; Witham et al., 2014). Moreover, previous studies largely relied on *i)* cross-sectional designs, *ii)* subjectively measured physical activity characteristics, and/or *iii)* devices such as smartphones that are not validated to capture the 24-h activity spectrum. Besides, the impact of individual factors or neighborhood characteristics on the association between physical activity and ambient temperature remains unclear, whereas this may explain some of the variation that was observed in previous work. For example, age, sex, and health status influence the perception of ambient temperatures and may accordingly lead to different adjustments of physical activity behavior (von Mackensen et al., 2005). Similarly, green spaces can locally reduce ambient temperatures and improve thermal comfort, which could stimulate maintenance of physical activity despite warm outdoor temperatures (Knight et al., 2021; Ho et al., 2021; Lee et al., 2024). More insights in potential moderators of physical activity behavior under certain weather conditions are essential for designing targeted recommendations to optimize public health.

Therefore, we examined the association between ambient temperature and habitual physical activity levels and explored how individual characteristics and neighborhood greenness influenced this relation. Our primary outcomes were step count, light-intensity physical activity (LIPA), and moderate-to-vigorous physical activity (MVPA), whereas sitting time and sleeping time were evaluated as secondary outcomes to capture the full 24-h activity cycle. Based on previously reported inverted U-shape associations between ambient temperature and physical activity, we hypothesized that physical activity would decrease with both high and low ambient temperatures, when compared to moderate conditions.

2. Methods

2.1. Participants

Recruitment took place among participants of the Nijmegen Exercise Study (NES) who visited the research center in April and May 2024. The NES is a prospective cohort study of Dutch individuals designed to explore the impact of lifestyle characteristics on disease development (van der Sluijs et al., 2025). Inclusion criteria were Dutch residency and an age of 18 years or older. All participants provided written informed consent. The study protocol was approved by the local medical ethics committee of the Radboud university medical center (#2024–17233) and the study was conducted in accordance with the Declaration of Helsinki.

2.2. Study design

This observational study consisted of three measurement periods with distinct ambient conditions. Physical activity characteristics were assessed at moderate environmental conditions (MODERATE, April 17 to June 19, 2024), warm environmental conditions (WARM, August 27 to September 5, 2024), and cold environmental conditions (COLD, January 31 to February 11, 2025). The physical activity assessment of MODERATE was part of the NES study visit, where participants received the physical activity monitor during or after their visit to the research center. Physical activity monitors and attachment instructions were sent via mail at the start of WARM and COLD, as participants were already familiar with the accelerometry measurements.

2.3. Measurements

2.3.1. Physical activity

Physical activity was measured using activPAL3 and activPAL4 micro triaxial accelerometers (PAL Technologies, Glasgow, UK). The activPAL device (25 × 45 × 5 mm) was sealed for waterproof protection and attached to the participant's thigh using hypoallergenic tape. During each study period, participants were instructed to wear the activPAL on the right thigh for 8 consecutive days for 24 h/day. After 8 days of wearing the monitor, participants removed the monitor from their thigh and sent it back to the research center via mail. Participants were asked to fill in a sleep diary in which they reported the date and time the activPAL was attached and removed, as well as the time they went to bed and the time of waking up each day. ActivPAL data were extracted via PALconnect software and the raw data was analyzed using the ActiPASS (version 2025.04) software, which is an open-source software package implementing the validated Acti4 algorithms that has been widely adopted for processing thigh-worn accelerometry data (Hettiarachchi, 2025). Further details on the processing procedures can be found elsewhere (The National Research Centre for the Working Environment NFA, 2020). Outcome variables included step count (steps/day), time spent in light physical activity (LIPA; min/day) and moderate-to-vigorous physical activity (MVPA; min/day), sitting time (min/day), and sleeping time (min/day). Each variable was averaged across the number of valid days to calculate the daily average. Days were considered invalid in case of <20 h of wear time, and participants with <4 valid days were excluded. In addition, participants who went on holiday during the measurement period were excluded, as their physical activity during this time could not be considered habitual. Finally, participants with valid data for only 1 out of 3 measurement periods were excluded from the analyses.

2.3.2. Individual characteristics

Height and weight were measured during the initial study visit (Seca GmbH & Co.KG, Hamburg, Germany). Participants' age, sex, and cardiovascular health status were obtained from an online questionnaire at the start of the study. Participants were classified into three groups based on medical history and medication use: control, cardiovascular risk factors (CVRF) or cardiovascular disease (CVD). The CVRF group included participants who reported having hypercholesterolemia, hypertension, or diabetes mellitus and used cholesterol-lowering, antihypertensive, or diabetic medication (van der Sluijs et al., 2024). The CVD group included participants with a history of myocardial infarction, heart failure, thrombosis, or stroke and who used cardiovascular medication. Participants without CVRF or CVD were assigned to the control group (van der Sluijs et al., 2024).

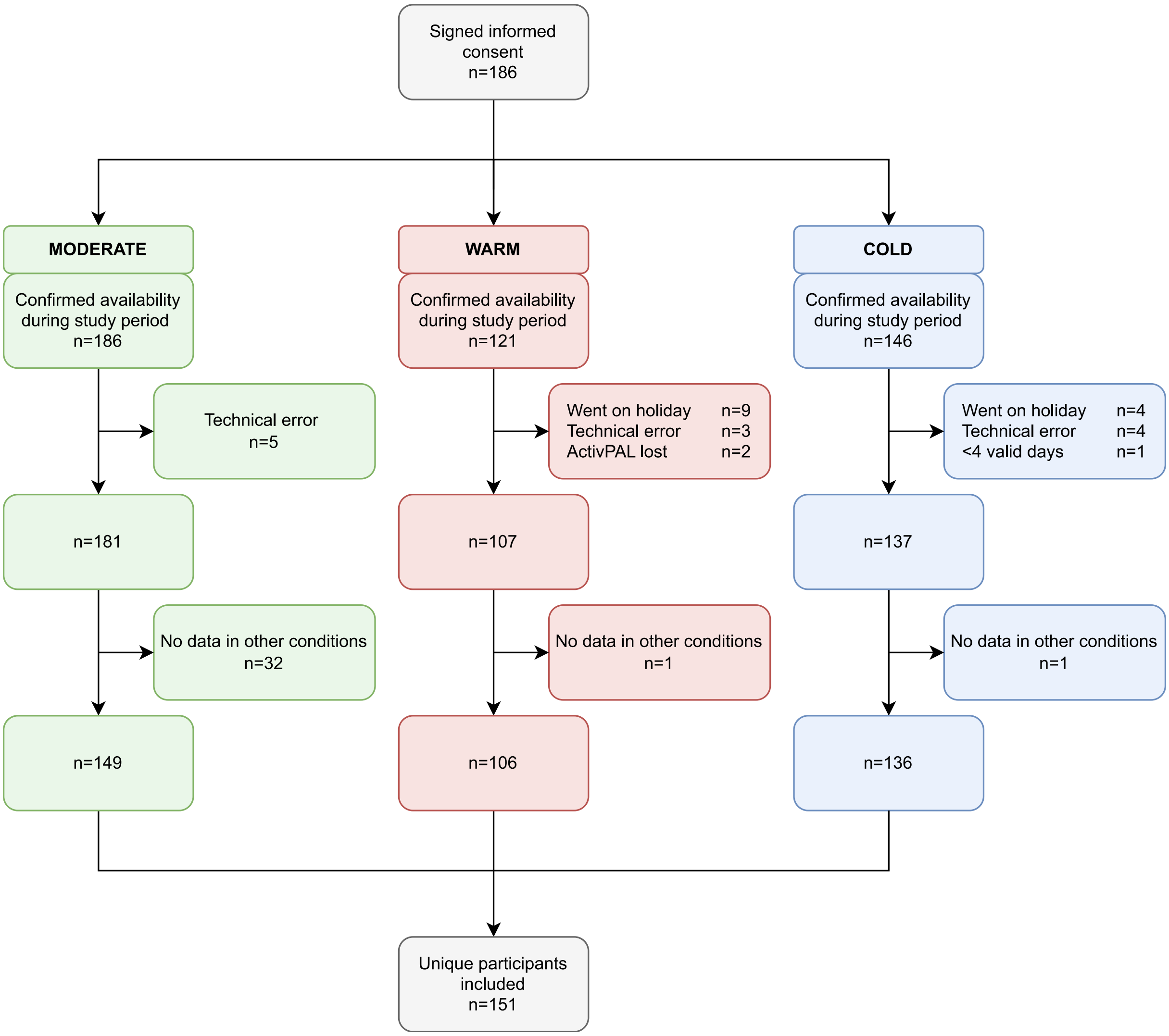

Fig. 1. Flowchart of participants' inclusion and exclusion.

2.3.3. Neighborhood greenness

Greenness was defined as the percentage of tree canopy cover within a 300 m buffer of each respondent's 6-character postal code. Tree canopy cover is one of the main spatial features related to urban microclimates in public space (Klemm et al., 2015; Konijnendijk, 2023), and covers the two main mechanisms through which green infrastructure decreases urban heat exposure (*i.e.*, shading and evapotranspiration) (Knight et al., 2021). The tree canopy cover data are based on high-resolution aerial photography in combination with digital surface model data, quantifying the percentage of each 10 m pixel covered by trees above 2.5 m in height (Rijksinstituut voor Volksgezondheid en Milieu, 2026). Since the presence of canopy cover may be related to urban density, which may confound its effect on both microclimates and on physical activity, urban density was corrected for in the model when assessing greenness as effect modifier. Urban density is defined as the number of addresses per square kilometer within each respondents' administrative neighborhood (CBS, 2025).

2.4. Statistical analysis

Statistical analyses were performed using R (RStudio, version 2023.02.2). Level of significance was set at $p < 0.05$. Continuous variables were visually inspected for normality and tested using Shapiro-Wilk test. Data were presented as mean ± standard deviation (SD) in case of normal distribution or median [first quartile – third quartile] in case of non-normal distribution. Categorical data were presented as count (percentage). Differences between males and females were assessed using an independent samples *t*-test for normally distributed variables and Mann-Whitney *U* test for non-normally distributed variables, while a Chi-square test was used for categorical variables. Physical activity parameters were compared between conditions using linear mixed model analysis with random intercept, with MODERATE as the reference. Assumptions of normality of residuals and homoscedasticity were checked for all models. Next, effect modification across subgroups was examined by adding each potential effect modifier as an interaction term to the separate models. Potential effect modifiers were selected *a priori* and included age, sex, cardiovascular health status, baseline physical activity levels (defined as MVPA in MODERATE), and greenness. In case of significant effect modification, additional exploratory analyses were performed to calculate the unstandardized regression coefficient (beta) and 95% confidence interval in subgroups based on a tertile split of the continuous variable.

3. Results

3.1. Participants

Of the 357 NES participants approached for this add-on study, 186 participants provided informed consent and were enrolled. These participants were contacted at the start of the WARM and COLD measurement periods. Due to missing data because of technical problems with the accelerometer, having less than four valid days of physical activity data, or leaving for holiday during the measurement period, we had to exclude $n = 5$ participants for MODERATE, $n = 14$ for WARM and $n = 9$ for COLD (Fig. 1). Finally, 34 participants with valid data for just one measurement period were excluded, resulting in an analytical cohort of 151 participants (Table 1). Average weekly maximum ambient temperatures during the study periods were 5.9 ± 0.4 °C (range: 5.1–7.0 °C), 13.9 ± 3.4 °C (range: 10.1–19.4 °C), 26.0 ± 0.7 °C (range: 23.8–27.3 °C) for COLD, MODERATE, and WARM, respectively.

3.2. Physical activity parameters

Step count was lower in COLD (−1055 steps/day, 95% CI -1570 to −540, $p < 0.001$) and WARM (−856 steps/day, 95% CI -1421 to −292, $p = 0.003$; Fig. 2) compared to MODERATE. Both LIPA and MVPA were significantly lower in COLD compared to MODERATE (−12 min/day LIPA (95% CI -20 to −4, $p = 0.004$) and − 13 min/day MVPA (95% CI -18 to −8, $p < 0.001$)), while no differences were observed between WARM and MODERATE (Table 2). No differences between conditions were found for sitting time ($p = 0.80$), whereas sleeping time was significantly higher in COLD (8 min/day, 95% CI 2 to 15, $p = 0.02$) and lower in WARM compared to MODERATE (−20 min/day, 95% CI -27 to −12, $p < 0.001$; **Supplementary Table 1**). A sensitivity analysis including only participants with data in all three conditions ($n = 89$) confirmed these findings (**Supplementary Table 2**).

Table 1
Baseline characteristics of participants.

	All participants ($n = 151$)	Male ($n = 81$)	Female ($n = 70$)
Age (years)	62 ± 11	65 ± 11	58 ± 10
Height (cm)	175 ± 9	181 ± 7	168 ± 6
Weight (kg)	72.5 [64.5–80.9]	77.4 [73.2–85.0]	64.5 [59.6–70.8]
Body mass index (kg/m^2)	23.4 [21.6–25.6]	23.6 [22.4–25.6]	23.3 [21.1–25.5]
Cardiovascular health status			
Cardiovascular disease	11 (7%)	9 (11%)	2 (3%)
Cardiovascular risk factors	29 (19%)	14 (17%)	15 (21%)
Control	111 (74%)	58 (72%)	53 (76%)

Data are presented as mean ± SD, median [first quartile – third quartile] or count (percentage).

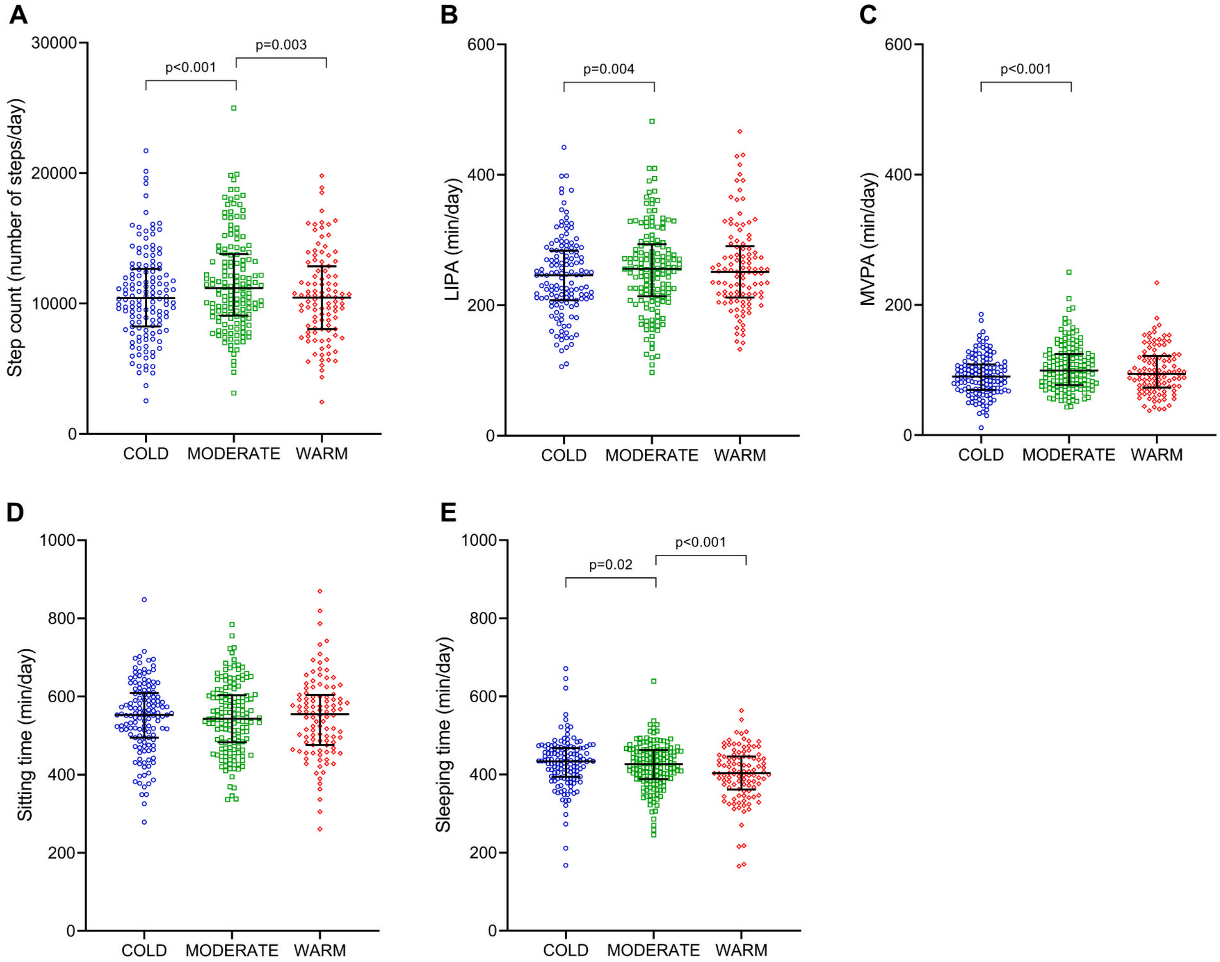

Fig. 2. Differences in physical activity patterns between COLD (blue circles), MODERATE (green squares), and WARM (red diamonds) expressed as step count (A), light-intensity physical activity (LIPA; B), moderate-to-vigorous physical activity (MVPA; C), sitting time (D), and sleeping time (E). Every dot represents an individual data point, whereas lines represent median and interquartile range. *P*-values are based on mixed model analyses. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Table 2
Average daily physical activity outcomes per condition.

	COLD ($n = 136$)	MODERATE ($n = 149$)	WARM ($n = 106$)	*p*-value
Step count (steps/day)	10,641 ± 3483[a]	11,602 ± 3636	10,576 ± 3395[a]	<0.001
LIPA (min/day)	244 ± 62[a]	255 ± 66	258 ± 67	0.002
MVPA (min/day)	91 ± 30[a]	104 ± 36	99 ± 36	<0.001
Sitting time (min/day)	547 ± 92	545 ± 89	547 ± 103	0.68
Sleeping time (min/day)	430 ± 66[a]	422 ± 58	400 ± 70[a]	<0.001

Data are presented as mean ± SD. LIPA, light-intensity physical activity; MVPA, moderate-to-vigorous physical activity. [a] Significantly different from MODERATE.

3.3. Individual characteristics

No evidence was found supporting effect modification across subgroups based on age, sex or cardiovascular health status for any of the physical activity metrics (all $p > 0.05$; **Supplementary Table 3**). In contrast, baseline physical activity level (defined as MVPA in MODERATE) was an effect modifier for step count ($p_{interaction} < 0.001$), MVPA ($p_{interaction} < 0.001$), and sitting time ($p_{interaction} < 0.001$). Additional explorative mixed model analysis in tertile-based subgroups of baseline physical activity level found that participants in the high baseline physical activity group (>115 min/day MVPA) had lower step count in COLD and WARM *versus* MODERATE, lower MVPA in both COLD and WARM *versus* MODERATE, and higher sitting time in COLD *versus* MODERATE (Fig. 3). The middle baseline physical activity group (84–115 min/day MVPA) had lower step count and lower MVPA in COLD *versus* MODERATE, with no differences between conditions for sitting time. Moreover, the lowest baseline physical activity group (<84 min/day MVPA) showed no differences in step count and sitting time between conditions, while MVPA was higher in WARM *versus* MODERATE.

3.4. Neighborhood greenness

Median tree canopy cover was 10.0% [IQR: 6.5–13.8%]. No evidence was found supporting effect modification of greenness for step count, LIPA, MVPA, and sleeping time (all $p > 0.05$). However, greenness significantly modified the association between ambient temperature condition and sitting time ($p = 0.03$). In subgroups based on tertiles of tree canopy cover (<7%, 7–12%, >12%), there was a trend towards a decreased sitting time in WARM *versus* MODERATE in the middle tree canopy cover group ($p = 0.07$; Fig. 3), whereas the same group showed a significant decrease in sitting time in WARM *versus* COLD (p = 0.03).

4. Discussion

This longitudinal repeated-measures study examined the association between ambient temperature and objectively measured habitual physical activity levels and explored how individual characteristics and neighborhood greenness influence this relation. We found that colder ambient temperatures were negatively associated with physical activity characteristics as reflected in lower step count, LIPA, and MVPA, while warmer ambient conditions were only associated with reduced step count. Sitting time did not differ between conditions, but sleeping time was lower with higher temperatures. In addition, age, sex, and cardiovascular health status were no effect modifiers for any of the physical activity outcomes. Baseline physical activity level was found to affect the association between ambient temperature and step count, MVPA, and sitting time, with the effects being more prominent in the most active *versus* least active individuals. Moreover, neighborhood greenness had no impact on our primary outcomes, whereas it appeared to be an effect modifier for sitting time, with a trend for lower sitting times in WARM *versus* MODERATE in participants in the middle tree canopy coverage group (*i.e.*, 7–12%). These results suggest that ambient temperature influences physical activity behavior, whereas the magnitude of the effect depends on individual characteristics.

We found that daily step count was ~1000 steps lower in both COLD and WARM compared to MODERATE. These findings align with previous observations (Turrisi et al., 2021; Ho et al., 2022) and indicate an inverted U-shaped relationship between ambient temperature and physical activity levels. Although our study did not capture extremely high temperatures in WARM or extremely low temperatures in COLD, we observed the highest daily step counts in the moderate condition during spring, with average temperatures of ~14 °C. This temperature is slightly lower compared to previous studies reporting optimal temperatures for step count in Japan (~17 °C, (Togo et al., 2005)) and China (16 °C to 24 °C, (Ho et al., 2022)). However, since our study does not allow for precise determination of the optimal temperature, it is possible that daily step count peaks at temperatures between our distinct conditions. The clinical relevance of the reduction of 1000 steps/day at lower and higher ambient temperatures may be limited. Participants in our study reported on average > 10,000 steps/day in all three conditions, while previous research has shown that no additional risk

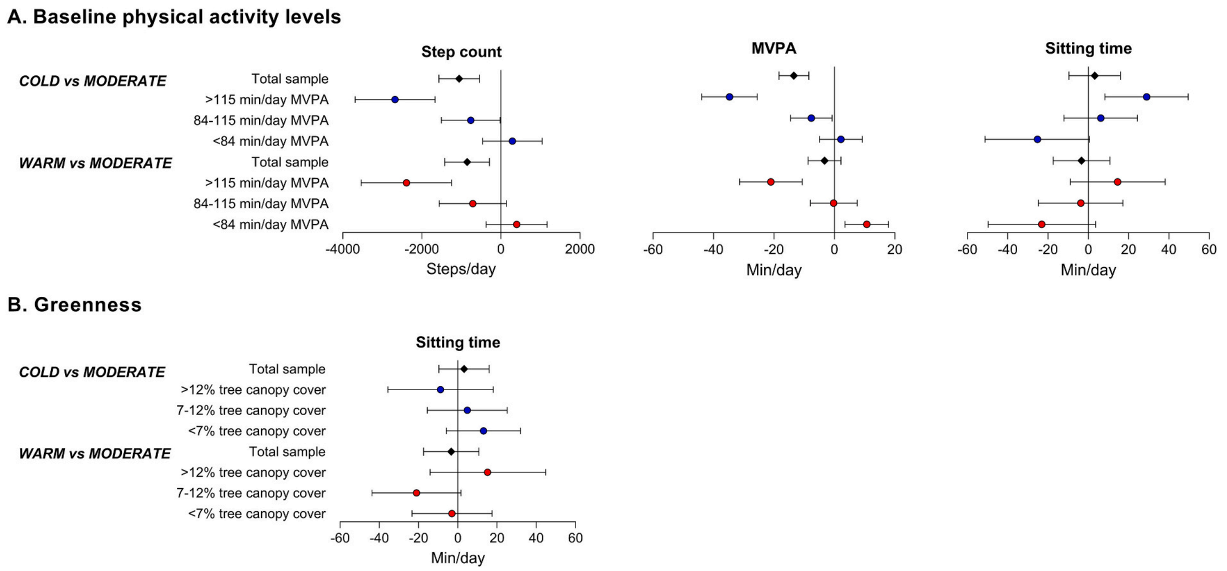

Fig. 3. Regression coefficients with 95% confidence intervals describing the association between COLD, MODERATE, and WARM with step count, sitting time, and moderate-to-vigorous physical activity (MVPA). Results are presented for the total sample (black squares) and for subgroups (blue circles for COLD *versus* MODERATE, red circles for WARM *versus* MODERATE) based on a tertile split of baseline physical activity levels (*i.e.*, MVPA in MODERATE; A) and subgroups based on a tertile split of greenness (*i.e.*, tree canopy cover; B). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

reductions for all-cause mortality and incident CVD were obtained beyond 8800 and 7200 steps/day, respectively (Stens et al., 2023). Thus, although high and low ambient temperature were negatively associated with daily step count, these variations are unlikely to induce health implications for our physically active population.

We found that time spent in both LIPA and MVPA was lower in COLD compared to MODERATE. Indeed, a recent scoping review reported greater MVPA in spring compared to winter (Turrisi et al., 2021). Temperature increases from MODERATE to WARM did, however, not result in different levels of LIPA and MVPA in our study. This may be attributed to the relatively high baseline physical activity levels of our participants, as all of them are meeting the WHO physical activity guidelines (Bull et al., 2020), suggesting they might be intrinsic motivated to remain active despite warmer outdoor temperatures. In addition, participants may have adapted their behavior by shifting physical activities to cooler moments of the day, thereby reducing heat exposure during physical activities while maintaining overall activity levels (Lanza et al., 2022; Fan et al., 2023). While average maximum ambient temperatures in our study were $\sim 26\ ^{\circ}$C, more extreme temperatures may in fact decrease physical activity levels due to higher thermoregulatory strain during exercise in hot circumstances.

Sitting time did not differ between ambient conditions, whereas sleeping time was higher in COLD and lower in WARM compared to MODERATE. This is in line with previous studies who reported an inverse association between ambient temperature and sleep duration (Ferguson et al., 2023; Minor et al., 2022). The differences in sleeping time may be partially explained by shorter daylight exposure in the colder conditions, which causes longer durations of melatonin secretion and thereby increases sleep duration (Blume et al., 2019). Nonetheless, Cepeda et al. (Cepeda et al., 2018) showed that the seasonal variation in sleep duration was mostly attributable to ambient temperature rather than sunlight hours, suggesting that ambient temperature importantly influences sleep duration. However, in relation to physical activity, previous studies suggested that daylight duration may affect physical activity behavior, with shorter daylight hours being associated with reduced activity levels (Turrisi et al., 2021). Accordingly, our observed differences in physical activity may not only reflect ambient temperature differences, but also concurrent variation in other seasonal factors. Therefore, future research should further explore the independent effects of ambient temperature and daylight duration on physical activity behavior.

Some studies suggest that a higher age, being female, and having worse health status are negatively associated with physical activity levels in general (Choi et al., 2017), but our study found no evidence that these factors also moderated the associations between ambient temperature and any of the physical activity outcomes. Instead, we found that baseline physical activity level was an effect modifier for step count, MVPA, and sitting time. Interestingly, exploratory subgroup analyses indicated that participants who had higher baseline physical activity levels decreased their number of steps and time spent in MVPA in both COLD and WARM compared to MODERATE. Importantly, participants in our highest baseline physical activity group substantially exceed the recommended levels of physical activity, so although they decreased their activity levels in both COLD and WARM, they still remained sufficiently active, meeting the physical activity guidelines.

Finally, we found that greenness moderated the association between ambient temperature and sitting time, but not step count, LIPA, MVPA, and sleeping time. Previous literature has shown that higher levels of tree canopy cover have been associated with reductions in ambient temperature (Sanusi et al., 2016), creating cooler environments which might stimulate adults to remain active, particularly during warmer conditions. A study among four European cities confirmed that surrounding greenness can moderate the relation between ambient temperature and physical activity, but the direction and strength of these effects varied across cities (Ho et al., 2021). In some cities, physical activity peaked at moderate temperatures in greener areas, while in other cities physical activity did not differ or further increased with rising temperatures when greenness was higher. Future work should, therefore, further investigate the role of greenness on the 24-h activity spectrum, and how this can be used to mitigate the impact of extreme ambient temperatures on lifestyle characteristics. Moreover, it could be interesting to further explore the role of different greenness metrics and additional area-level contextual factors, such as neighborhood characteristics and urban design, to better capture residents' environmental exposures.

A strength of this study is the longitudinal repeated-measures study design in which we followed the same participants during three measurement periods with different environmental conditions, which controls for between-subject variability. Moreover, this study objectively assessed physical activity using an accelerometer which allows to capture different physical activity metrics across the 24-h lifestyle cycle. However, some limitations should be considered. First, despite the repeated-measures design, the observational nature of the study limits causal inference. Second, our study population was relatively active, considering the high baseline physical activity levels and the fact that all participants adhered to the physical activity guidelines, which might underestimate the impact of ambient temperature on physical activity in a less active population. Next, ambient temperatures in our study periods were different but not extremely hot (*i.e.* heat wave) or cold. Nevertheless, these temperatures correspond to the typical seasonal variation within the Netherlands, increasing its ecological validity, whereas the magnitude of the effects may be further amplified under more extreme conditions. For instance, warmer temperatures may increase physiological heat strain and thermal discomfort, potentially resulting in stronger behavioral adaptations and therefore larger effects on physical activity levels (Périard et al., 2021; Niu et al., 2022; Vargas et al., 2018). Future studies should explore these effects in the context of climate change, as the frequency and intensity of extreme weather events are expected to increase (Romanello et al., 2023). In addition, future studies could investigate potential temperature thresholds beyond which physical activity becomes substantially constrained. Finally, greenness was based on participants' residential postal codes, without accounting for time spent in other environments such as work, where greenness may differ. Future studies could improve this by considering the specific environments in which participants spend time.

In conclusion, we found that people are less physically active with colder ambient temperatures as reflected in lower step count, LIPA, and MVPA, while warmer ambient conditions were associated with reduced step count. Moreover, baseline physical activity levels, but no other individual characteristics (*i.e.*, age, sex, cardiovascular health status), modified the association between ambient temperature and step count, MVPA, and sitting time, while the modifying effect of neighborhood greenness was limited.

CRediT authorship contribution statement

Mandy A.G. Peggen: Writing – original draft, Visualization, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Janneke I.A. Vloet:** Writing – review & editing, Investigation, Data curation. **Koen M. van der Sluijs:** Writing – review & editing, Investigation, Data curation. **Milou Netten:** Writing – review & editing, Formal analysis, Data curation. **Maarten Hogeweij:** Writing – review & editing, Data curation. **Dick H.J. Thijssen:** Writing – review & editing, Data curation. **Esmée A. Bakker:** Writing – review & editing, Data curation. **Maria T.E. Hopman:** Writing – review & editing, Supervision, Methodology, Conceptualization. **Thijs M.H. Eijsvogels:** Writing – review & editing, Supervision, Methodology, Conceptualization. **Coen C.W.G. Bongers:** Writing – review & editing, Supervision, Methodology, Conceptualization.

Ethics approval

All participants provided written informed consent. The study protocol was approved by the local medical ethics committee of the Radboud university medical center (#2024-17233) and the study was conducted in accordance with the Declaration of Helsinki.

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Declaration of competing interest

The authors declare that they have no competing interests.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.uclim.2026.103056.

Data availability

Data are internationally available to scientific researchers upon request. Researchers can submit a research proposal to the corresponding author by e-mail, detailing which data are requested and for which purpose. Upon approval, data and linked data will be made accessible via a secure, virtual workspace that includes standard analysis software. Contact the corresponding author (Thijs.Eijsvogels@radboudumc.nl) for data availability inquiries and visit our website for more information (www.radboudumc.nl/nes).

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