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Testing the stress-buffering claims of nature-based biopsychosocial resilience theory: A cross-sectional pathway analysis

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ABSTRACT

Background: The aim of this study was to test the hypothesis that greater nature contact is associated with higher resilience to daily stressors, which in turn is associated with lower psychological distress.
Methods: In this cross-sectional study, home interviews were conducted in 2024 with a representative sample of 1506 adults (53.32% female; age 18–94 years) residing in Plovdiv, Bulgaria. Nature contact included the availability of urban green/blue spaces within 300-meter and 300–2000-meter residential buffers and self-reported weekly time spent in neighbourhood and distal natural areas. Frequency of experiencing daily stressors was measured by questionnaire, alongside walking-related physical activity, social contacts and social cohesion, perceived restoration in nature, trait psychological resilience, and psychological distress. Path models were utilized to test the study hypotheses.
Results: Partially supporting predictions, results indicated that more time in nature was associated with lower psychological distress and that this was partly explained by the association between perceived restoration and psychological resilience acting as serial mediators. Another mediation pathway to lower psychological distress included walking-related physical activity. While higher levels of the putative moderators appeared to mitigate the relationship between daily stressors and psychological distress, those buffering effects were explained only in part by the duration of nature contact.
Conclusion: These findings suggest that nature may promote mental health through multiple parallel pathways, with resilience-based buffering potentially shaped more by cumulative, long-term nature experiences or other life factors. Data from subsequent waves of the study will explore these processes longitudinally.

1. Introduction

Globally, rapid urbanization entails significant social challenges and environmental degradation (Kuddus et al., 2020). These share blame for increasing rates of common mental disorders such as anxiety and depression, which place a substantial burden on societies and economies (WHO, 2025a, 2025b). Anxiety and depression reduce people's capacity to function effectively in their daily lives, to engage in positive relationships with others, and to contribute to their communities (Hirschfeld et al., 2000; Saris et al., 2017). Managing their symptoms poses several challenges, not least that effective intervention requires explicit recognition of the complex pathways between a range of causal factors and mental ill health. Environmental, genetic, and social factors all have a role to play in determining mental health (van den Bosch and Meyer-Lindenberg, 2019; Núñez-González et al., 2020). Formal acknowledgement of this complexity demands the use of comprehensive modelling frameworks to tease out and understand the interplay of these determinants. This new understanding can then be exploited in formulating effective strategies that can disrupt the pathways to psychological distress and enhance mental well-being.

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Outdoor environments that prominently feature vegetation, water elements, and other representations of "nature" have garnered significant attention as potentially beneficial contexts for mental well-being (Hartig et al., 2014; Jimenez et al., 2021). Mental health benefits have been observed across various geographic contexts and definitions of "nature" (Li et al., 2023; Guo et al., 2026), and from various types of "exposure" or "contact", from brief incidental views of residential green and blue spaces from home windows (Soga et al., 2025; Xie et al., 2026) to commuting and purposeful urban park visits (McDougall et al., 2024), to excursions to more distal natural areas (Guardini et al., 2023). Such benefits have accrued to both those experiencing psychological distress and those in good health (Bratman et al., 2019), and by multiple pathways. Natural environments can mitigate exposure to environmental stressors, such as air pollution and noise, support the acquisition and development of adaptive resources and response patterns that help soften the impact of potentially stressful demands, and help people to recover from psychophysiological stress and otherwise replenish adaptive resources depleted in efforts to meet the ordinary and extraordinary demands of life (e.g., Dzhambov et al., 2019; White et al., 2020; Bratman et al., 2024; for reviews, see e.g., Hartig et al. (2014)). Research has organized this diverse array of beneficial processes into interrelated domains defined in terms of their adaptive relevance – in reducing harm, building capacities, and restoring capacities (e.g., Markevych et al., 2017; Astell-Burt et al., 2022). The behaviors involved, and the short- and long-term benefits they generate commonly have highly valued phenomenological aspects. In natural settings, people commonly enjoy psychological and cognitive forms of restoration, higher engagement in physical activity and social interactions, and stronger feelings of community cohesion, in comparison with experiences in common urban outdoor settings with few natural features (e.g., Knopf, 1987). A study of almost 16 000 people from 18 countries found support for many of these processes (Elliott et al., 2023) though the literature is inconsistent and some of them, such as perceived restoration, have received less attention from public health researchers (Dzhambov et al., 2020).

Recent theorizing has used an elaborated concept of resilience to integrate processes looking across the domains of adaptive pathways. Nature-based biopsychosocial resilience theory (NBRT; White et al., 2023) posits that nature contact supports the building and maintenance of biological, psychological and social resources that people can draw upon when meeting the demands of life. According to NBRT, as individuals respond to and recover from stressors, biopsychosocial resilience built through contact with nature comes into play in different phases of this stress-response-recovery cycle. By supporting people in building stocks of resilience resources, nature contact has the potential to prevent the accumulation of stress or its escalation to a significant level (preventive resilience), to mitigate the impact of adversities by promoting adaptive responses (response resilience), and/or to contribute to a faster and more complete recovery (recovery resilience) (White et al., 2023).

Diverse empirical studies informed the articulation of these different resource and resilience concepts and with them NBRT (for reviews, see e.g., Hartig, 2021; Wells, 2021). For instance, Wells and Evans (2003) found that children with more nature in and around a rural home experienced less psychological distress from stressful life events than those living with less nearby nature. A meta-analysis revealed that childhood resilience is enhanced by recreational activities in green and bluespace (Fan et al., 2025). Korpela et al. (2001) found that young adults had developed particularly strong preferences for places they had learned would support ongoing emotional- and self-regulation needs, and that natural places were disproportionately well-represented among those favored places (see also Korpela et al., 2018). Despite many such affirmative findings interpretable with regard to resilience, research on beneficial effects of exposure to and more intentional engagement with nature has not shown complete consistency. Reviewers have attributed mixed findings to heterogeneity of, inter alia, study designs, samples, representations of "nature" and modes of encounter with nature, and intermediate and distal outcome measures (e.g., Ohly et al., 2016; Dzhambov et al., 2020; Shrestha et al., 2025). Of greater significance here, however, we see a lack of empirical research that attends to the kind of integrated view of the resilience-mediated relationship between health and nature offered by NBRT.

NBRT posits that exposure to and engagement with nature influences the stocks and flows of multiple biological, psychological, and social resilience resources concurrently, and that these processes are intertwined (White et al., 2023; cf. Hartig et al., 2014). Interdependencies between various pathways from nature to health through building psychological resilience have been explored (Dzhambov et al., 2019), but not specifically in terms of resilience buffering (i.e., moderating) the impacts of stressors. Since resilience also develops and gets deployed through processes in addition to any that may get activated by nature contact (Southwick et al., 2014; Schäfer et al., 2024), it is unclear how much of the potential of resilience to buffer stressors can be attributed to nature. Such a mediated moderation effect, where nature is associated with higher resilience, which in turn buffers the effect of stress, remains under-appreciated and under-explored (Wells, 2021).

Toward addressing this significant research gap, the current study aimed to examine the association between nature contact and aspects of biopsychosocial resilience. Although temporal constraints in the available data precluded examination of the respective phases, the study tested the overarching hypothesis that greater resilience resources, conceptually situated within the preventive and response resilience domains, would be associated with lower levels of psychological distress. Furthermore, it investigated the pathways underlying these associations and the potential of nature contact to buffer the impact of stressful everyday events on mental health through higher levels of resilience.

Specifically, the current study aimed to operationalize and test several claims, which may have implications for aspects of NBRT (Fig. 1). We hypothesized, for instance, that the availability of natural spaces would be positively associated with their habitual use, and that such direct contact would in turn be positively associated with greater biological, psychological, and social resilience resources that could help mitigate stress. For example, living near and spending time in nature is positively associated with walking behaviour, neighbourhood social cohesion and social contacts, and psychological restoration (Markevych et al., 2017; White et al., 2020). In turn, these factors can contribute to enhanced mental well-being, both directly and through higher biopsychosocial resilience (White et al., 2023). The conceptual model shown in Fig. 1 reflects the potential interplay between these constructs, where biological and social factors may serve as both resilience resources and as predictors of psychological resilience, and are also interrelated. Trait resilience is not static and can be shaped in response to personal experience and environmental influences (Blanke et al., 2023). Accordingly, repeated instances of individual restorative experiences in nature can, over time, contribute to trait resilience (White et al., 2023). Psychological restoration, on the other hand, as a process integral to resilience, works toward maintaining stocks of resilience resources for later deployment. Psychological restoration commonly co-occurs with physical activity, which cumulatively has been shown to enhance physical fitness, boost self-esteem and body image satisfaction, and reduce systemic inflammation (White et al., 2024), thus contributing to physiological resilience (Silverman and Deuster, 2014). While physical activity is not itself a direct representation of biological resilience in the framework of NBRT, it is a behavioural pathway that activates physiological responses (e.g., neuroendocrine, anti-inflammatory, autonomic regulation), that exert stress-buffering effects (Silverman and Deuster, 2014). Social interaction and perceived social cohesion can fortify social support systems and cultivate a sense of belonging (Jennings et al., 2019). These pathways may also reinforce each other in the context of contact with nature, with physical activity and social engagement contributing to restorative experiences resulting from nature contact (Dzhambov et al., 2018a). Natural settings are commonly

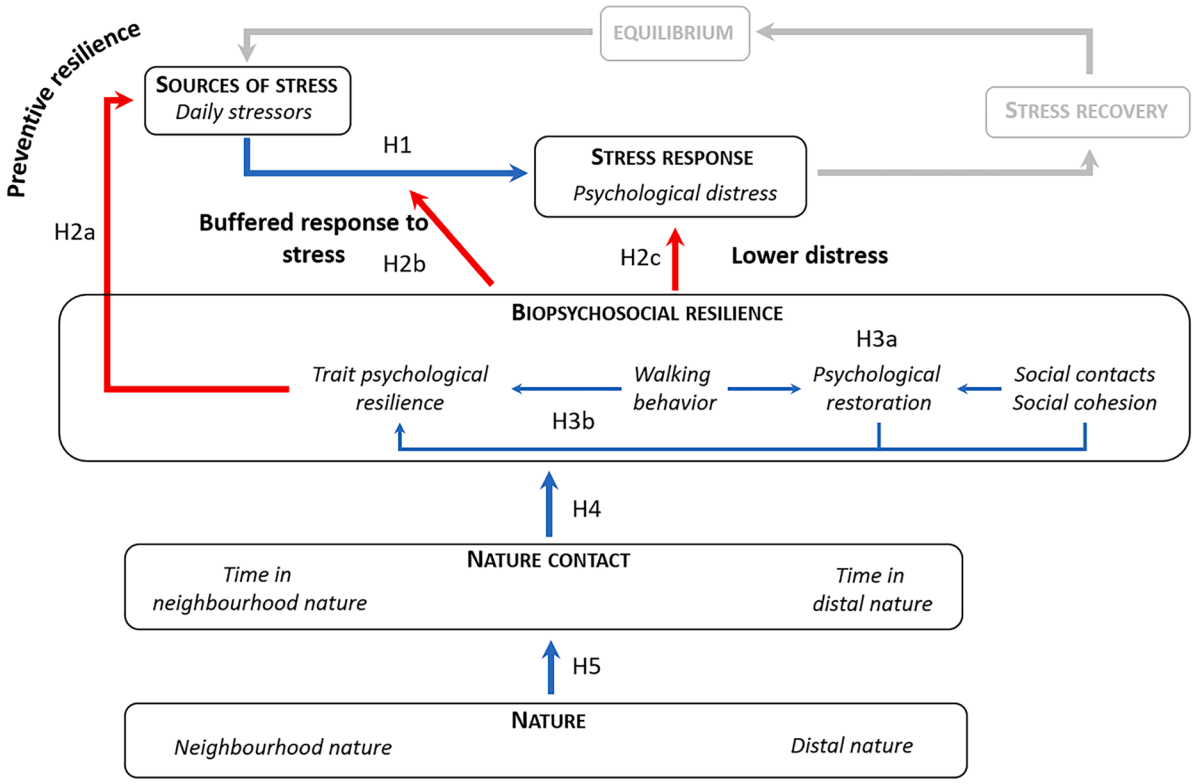


Fig. 1. Operationalization of claims for nature-based biopsychosocial resilience as a buffer against daily stressors, adapted from NBRT (White et al., 2023). The blue arrows represent hypothesized associations with a positive sign, and red arrows represent inverse associations, where positive/negative does not necessarily reflect health benefit/harm. Please refer to the text for definition of the study hypotheses H1-H5.

preferred for walking when people experience a need for restoration (e.g., Knopf, 1987; Hartig and Staats, 2006), and walking in natural settings can confer greater short-term and cumulative psychological benefits over and above those of physical activity in other contexts (Hartig et al., 2003; see also Mitchell (2013)). Walking with others in an urban park or along a riverfront may work synergistically over time to enhance all three forms of resilience resources by reducing stress levels (Marselle et al., 2014), strengthening emotional bonds and affection (Hartig, 2021; Pasanen et al., 2023).

In addition to the three types of resilience resources, the model used here attends to some of the phases in which they might get deployed in the stress-response-recovery cycle. It operationalises preventive resilience in terms of the deployment of resources associated with trait resilience to mitigate the number or frequency of daily stressors, before a stress response has occurred (Hu et al., 2015), while buffered response to stress can be inferred if biopsychosocial resources, which are likely to change as a result of frequent nature contact, weaken the association between daily stressors and psychological distress. The stress recovery phase in NBRT could not be directly operationalized in the study. Hence, the following hypotheses were formulated and tested (Fig. 1):

- More daily stressors are associated with more psychological distress (H1);
- Trait resilience is inversely associated with daily stressors (H2a);
- Biopsychosocial resilience resources buffer the association between daily stressors and psychological distress with a weaker association expected with higher resilience (H2b);
- Biopsychosocial resilience resources are associated with lower psychological distress (H2c);
- Higher walking and social cohesion/contacts are associated with higher perceived restoration (H3a);
- Higher walking, perceived restoration, and social cohesion/contacts are associated with higher trait resilience (H3b);
- More time in nature is associated with higher biopsychosocial resilience (H4)
- Greater availability of nature is associated with more time spent in nature (H5).

2. Methods

2.1. Participant sampling

For the present cross-sectional study, we employed data collected in the baseline wave of a longitudinal panel survey administered to residents of Plovdiv, Bulgaria for the RESONATE (Building individual and community resilience through nature-based therapies) project, which more broadly investigates how nature-based interventions might be able to build and maintain various aspects of biopsychosocial resilience at different levels (White et al., 2026). The initial sample was designed to be representative of the demographic composition of the study area in terms of age, sex, ethnicity, and education. Participants were interviewed at their homes (Fig. 2). See Supplementary File 1, Section 1 for a description of the study area. The study was approved by the Scientific Ethics Committee of the Medical University of Plovdiv with Protocol No 2/07.02.2024 and Opinion No P-442/15.02.2024. The study protocol was registered at the Open Science Framework platform on 09.06.24 (Dzhambov et al., 2024).

Adult residents of Plovdiv who were literate, non-institutionalized and had lived at their current address for at least one year were invited to participate. The recruitment was conducted from May to July of 2024 by a subcontracted professional survey company. To ensure population representativeness of the baseline sample, a one-stage stratified per quota sampling method was employed (Fig. 2).

Computer-assisted personal interviews were conducted face-to-face

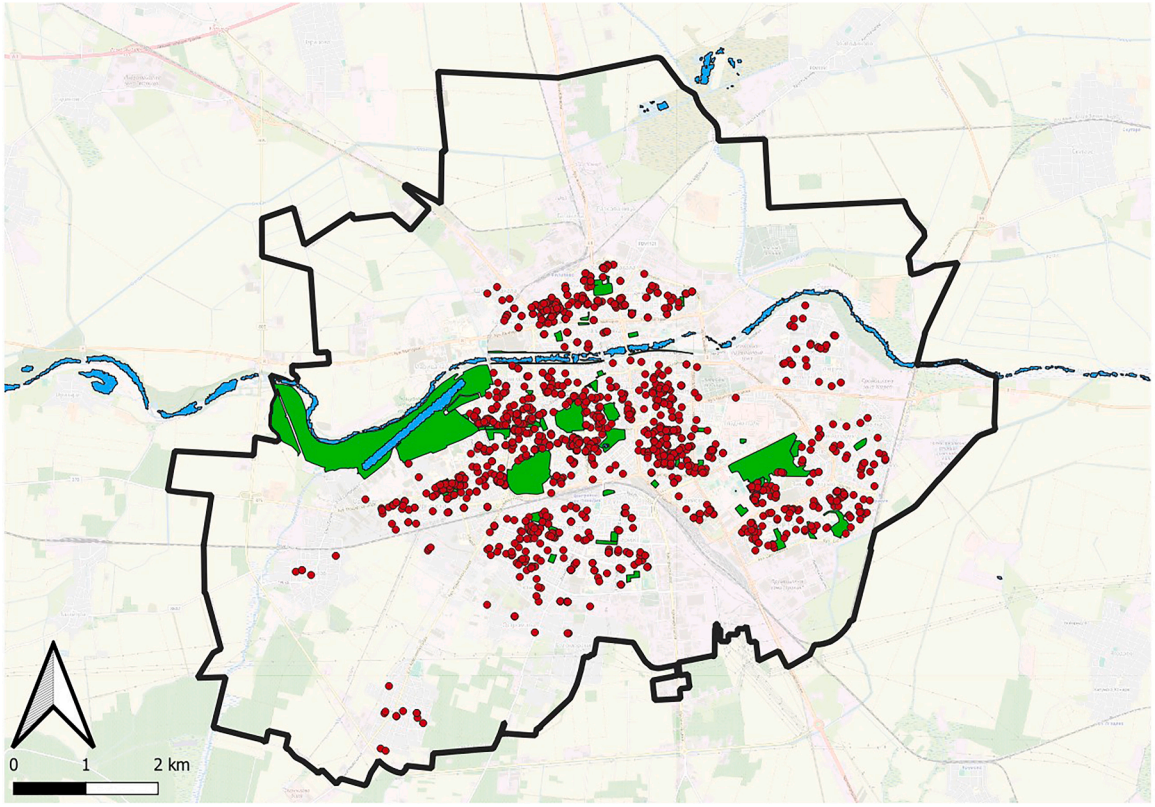


Fig. 2. Map of the city of Plovdiv showing the municipal boundaries. Red dots represent the approximate locations of the participants' homes. Green and blue polygons represent urban greenspace and permanent water bodies, respectively.

in the participants' homes or in the immediate vicinity. Of the 3 351 potential respondents who were approached by interviewers and met the inclusion criteria, 1 506 agreed to participate and completed the interview (a response rate of 45%). The mean duration of the interview was 23.93 ± 9.02 min. Further details on the participant sampling are available in Supplementary File 1, Section S2.

2.2. Psychological distress

Symptoms of anxiety and depression over the last two weeks were measured using the Bulgarian version (Georgieva, 2010; Dzhambov et al., 2018b) of the 12-item General Health Questionnaire (GHQ-12) (Goldberg et al., 1997; Goldberg and Williams, 1988). GHQ-12 was used as a continuous score in the analyses considering statistical power. Further details on the psychometric instruments used are available in Supplementary File 1, Section S3.

2.3. Daily stressors

The Brief Daily Stressors Screening Tool (BDSST) (Scholten et al., 2020) assessed daily stressors experienced by participants over the past 12 months. Consisting of ten items, this measure asks about inconveniences and challenges in daily life related to social obligations, people, health, housing, finances, and employment.

2.4. Psychological resilience

Psychological resilience to stressors was operationalized as trait resilience, which was likely to precede in conceptual time the occurrence of daily stressors in the last year and recently experienced psychological distress (cf. Tate, 2015). This construct was measured using the State-Trait Assessment of Resilience Scale (STARS) (Lock et al., 2020), chosen in part to be consistent with other studies in the RESONATE project that would be measuring trait and state resilience at specific moments in different natural settings (White et al., 2026). The **trait resilience** scale consisted of seven items probing how participants generally felt.

2.5. Resilience resources

Walking behaviour was collected using the International Physical Activity Questionnaire - Short Form (IPAQ-SF; Craig et al., 2003; Lee et al., 2011). Participants were specifically instructed to think of a typical week in the previous month, excluding any periods of illness or travel. This included all instances of walking related to work, home, commuting, and leisure activities.

To assess experiences of restoration that participants had during their visits to green and natural spaces in the last month, we employed the Restoration Outcome Scale (ROS) (cf. Hartig et al., 1998; Korpela et al., 2009, 2014). For the present study, however, we adjusted the wording in the instructions so that the items reflected more frequent contact with nature and how one usually feels during nature visits. All items were rated on a 7-point Likert-style scale ranging from 0 = "Completely disagree" to 6 = "Completely agree". The ratings were then aggregated to generate a **perceived restoration** score ($\omega = 0.94$; 95% CI: 0.93, 0.94)

Additionally, we inquired about the frequency of **social contacts** with friends, relatives, or colleagues (European Social Survey, 2022). Perceived **neighbourhood social cohesion** was measured in terms of agreement with three items about the people living in the participant's neighbourhood (Dzhambov et al., 2018b).

2.6. Nature availability and nature contact

Interviewers used global positioning system (GPS) devices to geocode residential addresses of interviewees. The spatial accuracy of the

address coordinates was evaluated based on auxiliary data, such as from a cadaster, and, if needed, manually corrected on a case-by-case basis using QGIS 3.28.2 (QGIS Development Team, 2024). Participants' geocoded addresses were linked to objective indicators of nature.

Participants' contact with nature was measured by the number of days they spent in local green or natural spaces during a typical week in the last month, and how long they spent there on an average visit. They also reported frequency and duration of visits to green or natural spaces outside of their everyday environment, like a park far from their neighbourhood or out of town. From these, we constructed measures of contact with nature: **time in neighbourhood nature** and **time in distal nature** in hours per week.

Since we were interested in participants' actual use of and contact with nature rather than the overall greenspace and bluespace of their neighbourhood (European Union, Copernicus Land Monitoring Service, 2020a; European Union, Copernicus Land Monitoring Service, 2020b), we took only as antecedent factors urban green areas and surface water bodies likely to serve social functions and afford outdoor activities such as social interaction, relaxation, and walking (rather than metrics such as remotely-sensed vegetation/water indices). The percentage of natural areas was derived within a 300-m Euclidean buffer distance from the home in line with the conventional assumption on living within a ~ 5 min walking distance to a greenspace (WHO, 2016; Konijnendijk, 2023) (representing **neighbourhood nature**). This buffer size is expected to capture meaningful nature exposure around homes in dense urban areas where social and behavioural mechanisms working in mental health are investigated in a general population sample (Zare Sakhvidi et al., 2025). To calculate the percentage of **distal nature** within a 300- to 2 000-m buffer distance from the home, a nested ("donut") buffer was constructed to exclude the smaller 300-meter buffer. While a distance of up to 2 000 m can be considered to still represent the neighbourhood scale and approximately mark a maximum typical walking distance (Zare Sakhvidi et al., 2025), given the compact dimensions of Plovdiv and the spatial distribution of residential addresses, the upper limit of these buffers was set at 2 000 m to avoid considerable overlap between buffers constructed around residential locations. In addition, we calculated the average normalized difference vegetation index (NDVI) in the same circular buffers as a proxy for **neighbourhood** and **distal greenness** (Supplementary File 1, Section S3).

2.7. Covariates

Several individual-level covariates were considered in the analyses because they have the potential to strongly influence multiple variables in the conceptual model, including nature availability, interaction with nature, biopsychosocial resilience resources, and psychological distress. Participants were asked to report their **age** in completed years, their **gender** (male, female, or other), and their self-identified **ethnicity**. The **marital status** categories included single, married or living with a partner, divorced/separated, and widowed. The highest level of **educational attainment** was grouped into three categories: primary education or none, secondary education (high school or vocational), and higher education (bachelor's, master's, or PhD degree). **Perceived income** adequacy was assessed by asking about the ease of making ends meet financially considering the total monthly income of the household that participants relied on (Eurofound, 2017). Participants replied on a scale from 0 to 5, where 0 stood for "Very difficult" and 5 stood for "Very easy".

2.8. Statistical analysis

After examining the descriptive statistics, the presence of outliers and sparse data categories were investigated through cross-tabulation and histograms. To statistically test the conceptual model shown in Fig. 1, we employed a path analysis using the "*lavaan*" v. 0.6–19 package for R (Rosseel, 2012). The model specified multi-item scales serving as observed summary scores, as the factor structure of the scales had been previously assessed. This approach was adopted to focus on the structural model and mitigate the risk of misspecification of inter-item covariances in the measurement model (Anderson and Gerbing, 1988).

First, we estimated the path model solution without any interaction terms to establish the basic mediation pathways from nature contact to psychological distress via trait resilience and other putative mediators. We then examined whether perceived restoration, walking, social cohesion, social contacts, and trait resilience moderated the effect of daily stressors on psychological distress by introducing an interaction term between the putative moderator and daily stressors. Each of the putative moderators was tested one-at-a-time to facilitate interpretability and model estimability. For this **mediated moderation** analysis, the putative moderator variable and daily stressors scores were mean centred prior to creating the interaction variable (moderator × daily stressors), and the path between them was removed. We estimated the conditional relationship between daily stressors and psychological distress at the 10th, 50th, and 90th percentiles of the moderator, representing low, moderate, and high levels of the moderator. Although somewhat arbitrary, these percentile values for probing conditional effects were assumed to represented typical as well as sufficiently contrasting levels of the moderator similarly to other commonly used arbitrary thresholds (Hayes, 2022). We also calculated an index of mediated moderation similar to the more widely used index of moderated mediation (Hayes, 2015). In order to include participant data with missing information, we used multiple imputation. The model fit of all models was evaluated using conventional cut-off criteria for the indices proposed by Hu and Bentler (1999). Supplementary File 1, Section S4 reports extended methodological analytical details.

As a sensitivity analysis, the path models were also fitted to complete-case data. Bias-corrected and accelerated bootstrapping with 500 draws was employed to compute 95% CI for all path coefficients and defined, and indirect effects (Hayes and Scharkow, 2013). The modelling approach was as with the multiply imputed data.

As another sensitivity analysis, we used the normalized difference vegetation index instead of LU/LC-based to fit the main model, assuming that overall vegetation level may be differentially related to time spent in nature.

Statistical significance was indicated when the 95% confidence interval (CI) for a parameter estimate excluded zero. However, we also inferred the presence of a potentially meaningful association based on the precision of its point estimate, the consistency of its direction across sensitivity analyses, and its magnitude (Wasserstein et al., 2016; Wasserstein et al., 2019). Analyses were conducted using the statistical software Stata MP v. 19 (StataCorp, 2025), JASP version 0.95.0.0 (JASP Team, 2025), and R v. 4.5.1 (R Core Team, 2024).

3. Results

3.1. Sample characteristics and bivariate associations

The sample included a total of 1 506 participants, of whom 956 participants (63%) had complete data. The percentage of missing values for specific variables reached 13% for the ROS score and 16% for trait resilience. For other variables the percentage of missing values was negligible. Table 1 shows participants' characteristics. (See Supplementary File 1, Figure S1 for variable distribution plots.)

The sample was representative of the population of Plovdiv in terms of basic sociodemographics (see Supplementary File 1, Table S1). The majority of the participants were middle-aged, with the youngest being 18 years old and the oldest 94 years old. Participants had lived in their homes for a median of 21 years, with only 10.43% having a residence duration of <5 years. A little over half of the sample were female, and the overwhelming majority self-identified as ethnic Bulgarians. Two-thirds were married or were living with a partner. Half of the sample

Table 1
Characteristics of the study participants.

Characteristics	N (%) / Median (P25 – P75)
Sociodemographics	
Age [years]	48.00 (36.00 - 64.00)
Female gender	803 (53.32%)
Bulgarian ethnicity	1388 (92.16%)
Education	
Primary or none	137 (9.11%)
Secondary	768 (51.06%)
Higher	599 (39.83%)
Marital status	
Single	269 (18.08%)
Married or living with a partner	996 (66.94%)
Divorced/separated	83 (5.58%)
Widowed	140 (9.41%)
Perceived income [0–5 scale]	2.00 (2.00 - 3.00)
Psychological factors	
Psychological distress [GHQ-12, 0–36 scale]	6.00 (6.00 - 8.00)
Daily stressors [BDSST, 0–40 scale]	3.00 (1.00 - 7.00)
Trait resilience [STARS, 7–28 scale]	24.00 (21.00 - 25.00)
Other resilience resources	
Walking [hrs/week]	3.50 (1.75 - 7.00)
Neighbourhood social cohesion [0–18 scale]	12.00 (10.00 - 14.00)
Social contacts [days/month]	12.00 (4.00 - 30.00)
Perceived restoration [ROS, 0–54 scale]	41.00 (36.00 - 45.00)
Nature availability and contact	
Neighbourhood nature [%]	3.18 (0.00 - 10.54)
Distal nature [%]	7.85 (6.11 - 13.36)
Neighbourhood greenness [NDVI, 0–1 scale]	0.37 (0.33 - 0.42)
Distal greenness [NDVI, 0–1 scale]	0.39 (0.37 - 0.43)
Time in neighbourhood nature [hrs/week]	3.00 (1.00 - 7.00)
Time in distal nature [hrs/week]	0.92 (0.00 - 4.00)

Note. Abbreviations: P25-P75 – 25th and 75th percentiles; BDSST – Brief Daily Stressors Screening Tool; GHQ-12 – 12-item General Health Questionnaire; NDVI – normalized difference vegetation index; ROS – Restoration Outcome Scale; STARS – State-Trait Assessment of Resilience Scale. The measurement scale or units are given in "[]" next to each variable. Descriptive statistics are shown prior to imputation of missing values.

had completed secondary education. Most participants reported some difficulty making ends meet considering their disposable income.

Regarding their psychological profile, the participants reported relatively low levels of distress and perceived daily stressors, and relatively high levels of resilience. About 91% had GHQ-12 scores below a cut-off of 12 points, sometimes regarded as psychometrically relevant for clinical screening of mental health problems (Anjara et al., 2020) (Supplementary File 1, Table S2). Participants generally perceived their neighbourhood as socially cohesive and were regularly engaging in social interactions. Spending time in nature was associated with relatively high levels of perceived restoration. Average walking-related physical activity amounted to several hours a week, similar to the time they spent in neighbourhood nature. On the other hand, participants spent less time in distal nature and lived in areas with a relatively low percentage of neighbourhood and distal nature, and moderate amount of overall greenness.

The correlation patterns shown in Fig. 3 were mostly aligned with theoretical expectations. Most importantly, psychological distress was positively correlated with daily stressors and negatively correlated with trait resilience. Psychological distress was also positively correlated with age, being female, being divorced or widowed, and, perhaps more surprisingly, distal nature. Conversely, psychological distress was negatively associated with income, education, social contacts, walking, restoration, and more time spent in distal nature. There was a positive correlation between trait resilience and factors such as restoration, walking, younger age, being married, more social contacts, higher education, income, time spent in nature, and lower daily stressors. Perceived restoration correlated positively with walking and social cohesion and contacts, while walking and social contacts were negatively correlated. Neighbourhood and distal urban nature were not associated with time spent in nature; associations between greenness and time spent in nature were somewhat stronger.

3.2. Multiple mediation model

The fit of the model that explored the basic pathways from nature contact to psychological distress was evaluated using multiple indices. CFI (0.92) and SRMR (0.04) indicated acceptable fit, and RMSEA (0.07; 90% CI: 0.06, 0.08) was within the commonly accepted range. Although TLI (0.70) and PNFI (0.25) were below conventional thresholds, both are sensitive to model complexity and are less informative for absolute

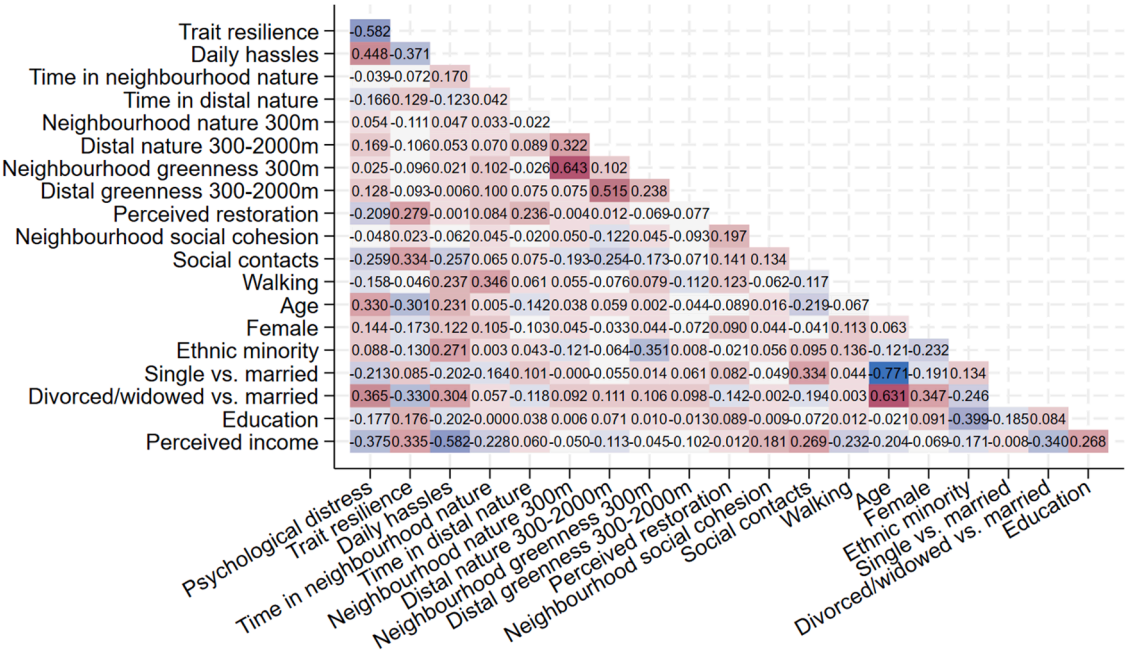


Fig. 3. Polychoric correlations between the main variables in the study. Note. Correlations are shown prior to imputation of missing values. The intensity of the colour scale corresponds to the strength of the correlation, with the red spectrum representing positive, and the blue spectrum negative correlations.

fit. A significant χ^2 (df = 41, 357.80, $p < 0.001$) is expected with a relatively large sample size. Given the acceptable fit on key indices and strong theoretical justification, we retained the current model. A path diagram illustrating the estimated main pathways of interest is shown in Fig. 4. For a complete list of the model parameters see Supplementary File 2. The model explained fairly large percentages of the variation in psychological distress, daily stressors, and resilience, while perceived restoration, social contacts, and walking were explained to a moderate degree. The model confirmed many of the hypothesized pathways, such as inverse associations between trait resilience and daily stressors (H2a) and different biopsychosocial resilience resources and psychological distress (H2c), and a positive association between daily stressors and psychological distress (H1). Time spent in nature was not predicted by neighbourhood and distal nature (H5). There was partial support for H4 as times in neighbourhood and distal nature were differentially associated with the resilience resources. The negative association of time in neighbourhood nature with psychological distress was mediated by more walking and higher perceived restoration. It was also mediated by higher restoration and more frequent social contacts, which in turn led to higher trait resilience (H3b). Walking, social cohesion and contacts were also mediating the association between time in nature and perceived restoration, and through it related to resilience indirectly. We also noted a weak positive association of social contacts with psychological distress. The negative effect of time in distal nature was mediated by higher perceived restoration and walking, and by a serial path involving higher perceived restoration and trait resilience (H3b), which in turn led to lower psychological distress. Table 2 shows the estimated total and decomposed effects of time in nature.

3.3. Mediated moderation model

The introduction into the model of interaction terms, one-at-at-time, for daily stressors and trait resilience (−0.45; 95% CI: −0.54, −0.36), walking (−0.14; 95% CI: −0.23, −0.06), neighbourhood social cohesion (−0.16; 95% CI: −0.30, −0.02), social contacts (−0.21; 95% CI: −0.30, −0.11), and perceived restoration (−0.22; 95% CI: −0.40, −0.05) showed that the effect of daily stressors on psychological distress was moderated by different biopsychosocial resilience resources (H2b) (Fig. 5).

As illustrated in Fig. 5, the relationship between daily stressors and psychological distress varied across levels of each moderator. When moderator levels were high, daily stressors were no longer associated with psychological distress, except for neighbourhood social cohesion, where the moderation effect was less evident (Supplementary File 1, Figure S2). The moderation was most clear for trait resilience, walking, social contacts, and perceived restoration. The index of mediated moderation, shown in Table 3, was small and varied depending on the moderator. For neighbourhood social cohesion, it indicated no evidence of mediated moderation.

3.4. Sensitivity analyses

The general patterns observed in the path models based on imputed data were preserved in the sensitivity analyses that used bootstrapping and the complete case data (Supplementary File 1, Figure S3). Nevertheless, the 95% confidence intervals of some paths (time in distal nature, social contacts, and perceived restoration → psychological distress; time in distal nature → walking) included zero, while others paths emerged (time in neighbourhood nature → psychological distress) (Supplementary File 3). A total effect on psychological distress was only supported for neighbourhood nature. With regard to the interaction terms, they were significant for trait resilience, perceived restoration, and social contacts (Supplementary File 1, Figure S4). The index of mediated moderation was significant only for perceived restoration and both types of nature contact (Supplementary File 1, Table S3).

Using the NDVI instead of LU/LC nature in the main model revealed a path from neighbourhood greenness to time in neighbourhood nature (0.14; 95% CI: 0.08, 0.21). The other paths remained mostly materially unchanged (Supplementary File 4).

4. Discussion

4.1. General findings

The present study sought to test mechanisms through which contact with nature might foster biopsychosocial to the effects of stress, thereby contributing to a reduction in psychological distress. While an association was observed between daily stressors and higher psychological distress, higher levels of biopsychosocial resilience-related constructs appeared to attenuate the association of daily stressors with psychological distress. Time spent in nature was associated with higher levels of resilience and lower psychological distress, but explained only a part of the buffering capacity of perceived restoration, walking, social cohesion and contacts, and psychological resilience. The protective associations

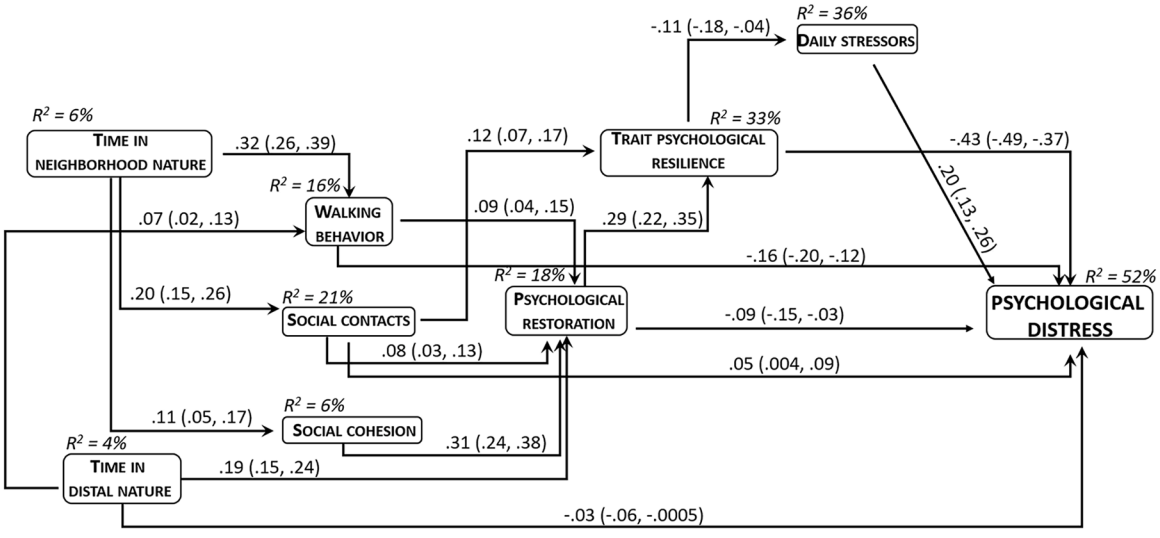


Fig. 4. Pathways from nature contact, biopsychosocial resilience, and daily stressors to psychological distress (N = 1 506). Note. Path coefficients shown are statistically significant at $p < 0.05$; Percentage values indicate the variance explained in the respective variable. Control variables, pathways from control variables, and those associated with non-significant coefficients are not shown to enhance clarity. The full model output is reported in Supplementary File 2.

Table 2
Estimated total, direct and indirect effects of time in neighbourhood and distal nature on psychological distress (N = 1 506).

Decomposed pathways	Estimate	95% CI bounds	
Time in neighbourhood nature → Psychological distress			
Total effect	**−0.101**	**−0.150**	**−0.051**
Direct effect	−0.040	−0.084	0.004
Indirect effects	**−0.060**	**−0.097**	**−0.024**
→ Trait resilience →	0.022	−0.003	0.047
→ Walking →	**−0.053**	**−0.070**	**−0.035**
→ Neighbourhood social cohesion →	−0.004	−0.009	0.002
→ Social contacts →	**0.009**	**0.00004**	**0.018**
→ Restoration →	−0.001	−0.006	0.003
→ Walking → Trait resilience →	−0.006	−0.014	0.002
→ Social contacts → Trait resilience →	**−0.010**	**−0.016**	**−0.004**
→ Restoration → Trait resilience →	−0.002	−0.009	0.006
→ Walking → Restoration →	**−0.003**	**−0.005**	**−0.001**
→ Neighbourhood social cohesion → Restoration →	**−0.003**	**−0.005**	**−0.001**
→ Social contacts → Restoration →	−0.001	−0.003	0.00003
→ Walking → Restoration → Trait resilience →	**−0.004**	**−0.006**	**−0.001**
→ Neighbourhood social cohesion → Restoration → Trait resilience →	**−0.004**	**−0.007**	**−0.001**
→ Social contacts → Restoration → Trait resilience →	**−0.002**	**−0.004**	**−0.0003**
Time in distal nature → Psychological distress			
Total effect	**−0.092**	**−0.130**	**−0.054**
Direct effect	**−0.031**	**−0.062**	**−0.0005**
Indirect effects	**−0.061**	**−0.088**	**−0.033**
→ Trait resilience →	−0.006	−0.024	0.012
→ Walking →	**−0.012**	**−0.022**	**−0.002**
→ Neighbourhood social cohesion →	0.00001	−0.001	0.001
→ Social contacts →	−0.00008	−0.003	0.003
→ Restoration →	**−0.017**	**−0.029**	**−0.005**
→ Walking → Trait resilience →	−0.001	−0.003	0.0004
→ Neighbourhood social cohesion → Trait resilience →	−0.00001	−0.001	0.0005
→ Social contacts → Trait resilience →	0.0001	−0.003	0.003
→ Restoration → Trait resilience →	**−0.024**	**−0.033**	**−0.015**
→ Walking → Restoration →	**−0.001**	**−0.001**	**−0.0001**
→ Neighbourhood social cohesion → Restoration →	0.00003	−0.001	0.001
→ Social contacts → Restoration →	0.00001	−0.0003	0.0003
→ Walking → Restoration → Trait resilience →	**−0.001**	**−0.002**	**−0.0001**
→ Neighbourhood social cohesion → Restoration → Trait resilience →	0.00003	−0.002	0.002
→ Social contacts → Restoration → Trait resilience →	0.00002	−0.001	0.001

Note. Effect estimates shown are standardized path coefficients and their 95% confidence intervals (CI), obtained from a model estimated using diagonally weighted least squares across five multiply imputed datasets. The full model output is reported in Supplementary File 2.

in question were primarily mediated by perceived restoration in nature and elevated levels of walking-related physical activity, with higher perceived restoration and more frequent social contacts in turn being associated with higher resilience and then lower psychological distress. Foundational evidence of pathways previously found to link nature contact to psychological distress informed our conceptual model (Dzhambov et al., 2020; Hartig, 2021), which builds on previous tests of mediation pathways by including mediated moderation components, thereby acknowledging that processes from nature to psychological wellbeing not only flow in one direction, but also intertwine in complex ways, creating contingencies that depend on each other. Another nuance is that the walking and social contacts pathways were more related to time spent in neighbourhood nature, while restoration, to time in distal nature. Local green and blue spaces may more readily facilitate habitual walking, including walking with family members or pets, as well as interactions with neighbours and engagement in community activities. Through those activities, neighbourhood nature indirectly relates to perceived restoration (Dzhambov et al., 2018a). In contrast, visits to more distant natural environments, such as larger greenspaces elsewhere in the city, the rowing canal park (cf. van den Berg et al., 2010), or natural areas outside the city (cf. Qiu et al., 2021), may involve more intense, stimulating, and enjoyable encounters with nature allowing deeper reflection and restoration. Such experiences may provide greater physical, and consequently psychological, distance from everyday environments and routines, thereby creating greater opportunities for more immediate restoration (van den Berg et al., 2010).

These findings align with a substantial body of evidence indicating that regular exposure to natural environments contributes to mental well-being. Such benefits have been observed in systematic reviews of intervention studies (Britton et al., 2020; Coventry et al., 2021) and in the epidemiological literature (Smith et al., 2021). For example, a large survey in 18 countries found that while the frequency of recreational visits was associated with better psychological well-being, the mere presence of nature in the neighbourhood had a much smaller effect (White et al., 2021). Studies conducted in Plovdiv have also demonstrated support for our findings, although they were based on smaller convenience samples of youth (Dzhambov et al., 2018a, 2018b). In the present study, we investigated several well-studied pathways to health, including physical activity and social cohesion/contacts. We also expanded the literature on the restoration pathway, which has been directly tested in a limited number of population studies. Most prior studies that specifically engaged with the restoration pathway used measures of perceived restorative quality rather than of restoration outcomes (Dzhambov et al., 2020). And yet, we found their findings to be consistent with our own, which suggest that restoration plays a central role in a network of pathways linking nature to mental health. Contrary to expectations (Toth et al., 2023), walking did not contribute to psychological resilience in our model. It was associated with lower psychological distress though. Even lower-intensity physical activity confers multiple health benefits that can reduce psychological distress through neurocognitive changes, such as improved self-esteem and mood, better sleep quality, and better neuroplasticity (Arida et al., 2021). Pathways through perceived social cohesion and social contacts as single mediators were not robust in the sensitivity analyses. The statistical characteristics of the data and patterns of missingness could also potentially explain changes in the precision of the path coefficients. However, social contacts consistently linked resilience to time in neighbourhood nature.

The findings of the present study indicated that, while nature contact contributed to trait resilience, physical activity, social cohesion and contacts, and perceived restoration, it accounted for a small portion of the observed stress buffering capacity. This suggests that contact with nature, as operationalized in this study, worked primarily by building resilience resources that reduced stressors intensity and psychological distress levels. Concerning trait resilience, its stress-buffering function may be a relatively stable characteristic of already resilient individuals, less sensitive to recent variations in nature contact, as suggested by evidence that resilience moderates the effect of daily stressors and stressful life events in different population groups and circumstances (Sheerin et al., 2018; Zhang et al., 2023; Wang et al., 2024). In the present study, resilience was defined as a collection of adaptive resources that can be deployed to mitigate stress, adapt to change, and resist disturbance (White et al., 2023). We also recognise that not all walking takes place in nature, therefore any resilience benefits of walking are only partially attributable to the nature setting. That also applies to the neighbourhood social cohesion and social contacts pathways. Greater levels of neighbourhood social cohesion and social contacts are powerful resources in themselves, which may offer protection in different stressful situations (Klijs et al., 2017; Kingsbury et al., 2020; Zeng et al., 2022) by helping individuals to respond to the needs elicited by stressful events (Cohen and Wills, 1985). The mental well-being of

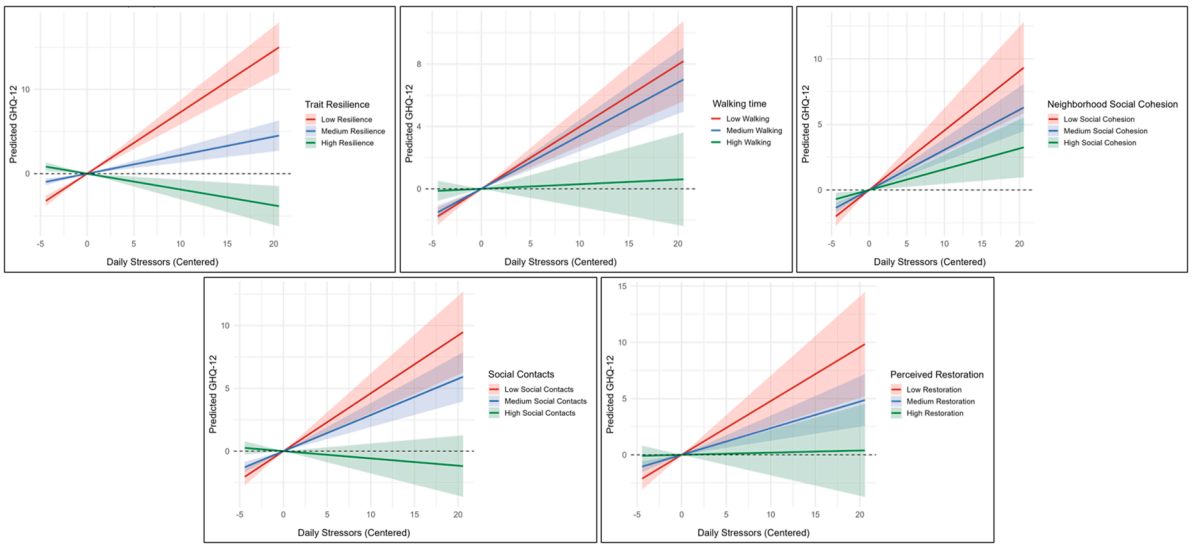


Fig. 5. Conditional relationship between daily stressors and psychological distress across different levels of trait resilience, walking, neighbourhood social cohesion, social contacts, and perceived restoration. Note. The lines represent the effect of daily stressors on the predicted psychological distress score (12-item General Health Questionnaire; GHQ-12), with each line corresponding to the estimated slope at different levels of the moderator (Low: 10th percentile, Medium: 50th percentile, and High: 90th percentile). Simple slopes are displayed without including the intercept of GHQ-12 and thus represent patterns in the effect of daily stressors, not absolute predicted values of GHQ-12. The model is estimated using diagonally weighted least squares across ten multiply imputed datasets.

Table 3
Estimated index of mediated moderation of time in neighbourhood and distal nature on the association between daily stressors and physiological distress across different biopsychosocial resilience resources.

Biopsychosocial resilience resource	Time in neighbourhood nature	Time in distal nature
Trait resilience	−0.004 (0.04, 0.03)	**−0.10 (−0.19, −0.02)**
Walking	**−0.05 (−0.08, −0.05)**	−0.01 (−0.02, 0.001)
Neighbourhood social cohesion	−0.02 (−0.04, 0.003)	−0.001 (−0.02, 0.02)
Social contacts	**−0.04 (−0.06, −0.02)**	−0.004 (−0.02, 0.01)
Perceived restoration	−0.02 (−0.05, 0.01)	**−0.05 (−0.09, −0.004)**

others who spend time in nature may also constitute a resource or absence of additional demands that can be drawn upon to support one's own mental well-being (Hartig, 2021; Huang et al., 2025).

While acknowledging that resilience is a dynamic and transactional process, likely to be shaped by the environment, we focused on trait resilience for better conceptual timing with daily stressors (Kuldas and Foody, 2021). Previously, resilience has been investigated in the context of nature and health literature mostly implicitly, with select studies exploring the potential of nature exposure or contact to modify the association between stressors and health through the conceptual framework of resilience. For instance, in an online survey of UK adults, nature availability and visit frequency were associated with higher psychological well-being, and even individuals with poor social connectedness exhibited high levels of well-being if they reported high levels of visible nature from their residence and their neighbourhood (Cartwright et al., 2018). Wells and Evans (2003) found that rural children interacting with greenery exhibited a mitigated negative impact of life stress on psychological well-being. A study of Dutch adults indicated suggestive evidence of a weaker effect of stressful life events on mental health in participants exposed to more greenspace within a 3-km radius of their residence (van den Berg et al., 2010). This buffer area was similar to how distal greenspace was defined in our study. However, another study did not demonstrate a moderating effect of group walks in nature on the effect of stressful life events on mental health in adults, despite a main effect of nature walks that was opposite to that of stressful life events, with the potential to offset it (Marselle et al., 2019).

The weak statistical evidence supporting the hypothesis of mediated moderation may be attributed to data distribution and insufficient power or could reflect a conceptual timing issue of the study's framework operationalisation. It is conceivable that resilience had been built over time, and carried into the present, rather than a result of recent nature contact. Even during very early life stages, such as childhood, nature experiences have been found to predict adulthood nature connectedness and well-being (Preuß et al., 2019; Li et al., 2022; Vitale et al., 2022), which by extension may also apply to resilience. An alternative explanation may be found in the characteristics of the sample, which exhibited relatively high levels of mental well-being and resilience. That may have constrained the study's capacity to discern substantial effect sizes across gradients of nature contact. It is also plausible that a psychometric scale specifically based on the NBRT was necessary to measure the aspects of resilience most relevant to the study. It is reasonable to hypothesize that, depending on the context, individual differences, the temporality and form of nature contact, and other pertinent factors, different types of resilience can be supported by nature. Alternatively, nature-based resilience could work in concert with pre-existing resilience or resilience made available through other means.

Resilience, defined as a stable trait that predates exposure to stressors and also concurrently conceptualized as a psychological process, was associated with less daily stressors, lower psychological distress, and a weaker association between the two. This suggests that individuals who are already high on trait resilience possess a certain stock of adaptive resources that help them avoid stressors or face stressors of smaller magnitude or intensity. At the same time, adaptive resources available for deployment at the time of facing the stressors mitigate the response and support a quicker recovery. Drawing on NBRT, our original conception of "everyday stressors" included mundane hassles that regularly happen to people. Evidence of resilience would be found if the relationship between the frequency of these stressors and psychological distress was mitigated, with for example presence of many stressors but low distress would be indicative of resilience (i.e., a moderation hypotheses). This interpretation depends

on the reported stressors being external or exogenous to the individual. However, because participants self-reported these daily stressors, their individual levels of resilience may have influenced both their exposure to stressors and their perceptions of what constituted or was worth reporting as a stressor, potentially introducing common method bias. For example, a resilient person may be both better equipped to avoid some stressful situations (e.g., through adaptive situation selection; Troy et al., 2023) and/or view an equivalent external event as not worthy of reporting as a "daily stressor" because they have sufficient resources to cope with it (e.g., Kalisch et al., 2017). This likely made the self-assessment of the frequency of "daily stressors" endogenous to the individual, resulting in self-reported daily stressors as a stronger mediator between resilience and distress, rather than resilience being solely an external moderator of the relationship between daily stressors and distress. Future research could benefit from incorporating more objective measures of stress exposure, such as traffic noise or stressful life events arising from societal perturbations, which would provide an assessment of stress that is less influenced by individual perceptions.

4.2. Future research

This study encourages future empirical tests of NBRT for gaining insights into the building of nature-based resilience resources to support better mental well-being. Few prior studies have statistically tested the hypothesis that nature buffers stressors through nature-based resilience (White et al., 2023). It was interesting observation worth further study that the walking and social contacts pathways were more related to time spent in neighbourhood nature, while restoration, to time in distal nature.

Even though we found small effect sizes suggesting the presence of mediated moderation, this line of research could hold particular significance for effective prevention of psychological distress through nature-based interventions. Recommendations regarding the forms and frequency of contact with nature require mechanistic understanding, but as it stands, there is surprisingly little literature explicitly on the effects of habitual nature contact on resilience (White et al., 2023), and this of itself encourages the further testing of the NBRT. We recognize that limitations of the present study could partially explain the absence of stronger associations, and knowledge of the limitations as well as the strengths of the present study should help to guide further research.

Overall happiness levels of the Bulgarian population are comparatively low (Helliwell et al., 2025) and Bulgarians are experiencing significant economic challenges (OECD, 2023). Concurrently, the country's psychiatric healthcare system is confronted with the imperative for both structural and conceptual reforms (Stoyanov and Nakov, 2023). Future studies on nature contact and mental health could have implications for the advocacy of nature-based solutions and therapies as a complementary strategy for enhancing public mental health. The majority of resilience training programs do not incorporate nature-based activities (Hollaar et al., 2025) and nature-based interventions in the community do not tend to explore resilience processes (Fry et al., 2025). On a local scale, scientific arguments are needed to support efforts to transform the urban landscape of Bulgarian cities such as Plovdiv. Plovdiv, a medium-sized city with compact mid-rise development, scores higher on urban design in comparison to other Bulgarian cities, as indicated by the recently proposed Healthy Urban Design Index (Montana et al., 2025). Recent meta-analytic evidence suggests that varying levels of greenspace provision across urban forms modifies the greenspace – mental health relationship. European cities typically offer a more balanced relationship between greenspace supply and demand, while observed benefits of greenspace access may be weaker in sprawling US cities with high baseline greenspace due to potential saturation, and stronger in densely built Asian megacities where greenspace is more limited (Guo et al., 2026). However, residents of Plovdiv have unequal access to greenspace. The available public greenspace varies considerably between city districts, ranging from approximately 55.5 m^2 per resident in the Western district to approximately 3.9 m^2 per resident in the Southern district (Fig. 2). The dramatically lower amount of greenspace per person in the latter is a product of a compact urban design with high population density and the small area of available land for greenspace. Approximately half of the city's territory is devoid of public greenspace within a 15-minute walking radius, and half of the streets exhibit suboptimal levels of greening. The city of Plovdiv has several noteworthy urban parks and smaller gardens, in addition to six distinctive natural hill formations and greenspaces along the riverfront. However, the greenspace is predominantly fragmented and disconnected (Gyulemetova and Stanev, 2022; Plovdiv Municipality, n.d.b). In a similar vein, the Maritza River, which bisects the city, and the regatta course lake (rowing canal) located in the Western district, exhibit poor connectivity with the green hills (Dzhambov et al., 2025). In addition to these areas, access from the city to the nearby Rhodope Mountains should be facilitated, as it would offer recreational opportunities for health promotion. Vacationing (de Bloom et al., 2009) and spending time in non-urban nature (Mygind et al., 2019) have been shown to have a beneficial effect on well-being, with tourism in forest environments positively impacting hedonic and eudaimonic well-being (Guardini et al., 2023).

4.3. Strengths and limitations

The present study tested the contribution of nature contact to the buffering of stressors mediated by various resilience resources relevant for the representation of biopsychosocial resilience in NBRT (White et al., 2023). It also incorporated an examination of multiple serial and parallel mediation components, a complexity that is still uncommon in the extant literature. Furthermore, the study operationalized objectively measured nature exposure and actual contact separately at different home proximity scales. The majority of prior research measured greenspace at the neighbourhood scale and rarely accounted for the role of engagement with distal natural areas (Zare Sakhvidi et al., 2025). As indicated by our findings, neighbourhood nature seems conducive to multiple health-supportive pathways, while distal nature contact appeared to activate only the restoration pathway.

It is also important to acknowledge the limitations of this study. To begin with, we exclusively utilized data from the initial wave of the longitudinal survey. Another limitation is that with a 45% response rate, non-response bias and potential over-representation of nature-engaged, resilient individuals cannot be ruled out, and we had no direct estimate of those biases. The observed trends suggest that closer examination is warranted.

Further, we lacked full information on the integrated NBRT stress-response-recovery cycle. We did not have direct measures of biological resilience and dynamic stress recovery. To test the phase-specific processes of NBRT, an intervention design is necessary (Lymeus et al., 2018). It is also possible that some associations were underestimated due to the underrepresentation of people in poor psychological states.

The spatial scale alignment between self-reported time in nature (neighbourhood/distal) and objective nature (300m/300–2000 m) may have been suboptimal as we had no information on the location of the natural places that participants frequented. We also relied on circular buffers rather than street-network buffers to derive these nature variables, which may have provided a less accurate representation of actual walking accessibility (Zare Sakhvidi et al., 2025). It is possible that some of participants' engagement with nature occurred during commuting or in unstructured or undesignated green spaces. This might explain the weak associations between them. For that reason, we focused on time in nature as the starting variable in the path models. Another potential explanation for the weaker-than-anticipated associations observed in this study is inaccurate recall, given that nature contact and mediator constructs, including perceived restoration, physical activity and social interaction, were assessed using self-reports.

From a statistical perspective, the sample size was deemed adequate

for the main analysis. However, we did not find it sufficiently large to support dichotomization of the GHQ-12, which would provide more a clinically-interpretable measure. In a similar vein, the study was underpowered to test stratified analyses or a multi-group path model to address issues of environmental justice or gender inequalities. Furthermore, given our utilization of the DWLS estimator, it is possible that most fit indices may have overestimated model fit according to the Hu and Bentler (1999) criteria we applied (Groskurth et al., 2024). The SRMR is an exception as it is robust to the method used to estimate the model parameters (Shi and Maydeu-Olivares, 2020). Extended discussion of the study's limitations is given in Supplementary File 1, Section S5.

5. Conclusion

This study tested stress-buffering claims derived from nature-based biopsychosocial resilience theory. The findings indicated that nature contact was associated with lower psychological distress. Evidence supports several underlying pathways including psychological resilience, walking-related physical activity, social contact, and restorative experiences in nature. While higher levels of the proposed and tested moderators appeared to mitigate the relationship between daily stressors and psychological distress, those buffering effects were explained only in part by the duration of nature contact. These findings affirm that nature may promote mental health simultaneously through multiple and intertwined pathways that work in given encounters with nature, with resilience-based buffering, potentially shaped more by cumulative, long-term nature experiences or other life factors.

Declaration of generative AI in scientific writing

During the preparation of this work, the authors used DeepL to improve the readability and language of the manuscript. OpenAI's ChatGPT was used to assist in optimizing and debugging the R scripts employed in this study. All content generated with these tools was subsequently reviewed and edited by the authors, who take full responsibility for the final version of the published article.

Availability of data and materials

The anonymized survey and land use data is part of an on-going longitudinal study. These data, except for geographic microdata that can be used to triangulate residential locations, will be made publicly available after the planned results are published or two years after the project has ended, whichever comes earlier.

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Ethics statement

The study was approved by the Scientific Ethics Committee of the Medical University of Plovdiv with Protocol No 2/07.02.2024 and Opinion No P-442/15.02.2024. The study protocol was registered at the Open Science Framework platform on 09.06.24 (Dzhambov et al., 2024).

Human studies statement

The study was approved by the Scientific Ethics Committee of the Medical University of Plovdiv with Protocol No 2/07.02.2024 and Opinion No P-442/15.02.2024. The study protocol was registered at the Open Science Framework platform on 09.06.24 (Dzhambov et al., 2024).

The respondents were invited to participate in the survey on a voluntary basis. Prior to their participation, they were provided with information regarding the project, and they were asked to consent to their involvement in the study and to the use of their personal data for scientific research. Following the interviews, debriefing forms were provided, containing information regarding the project, as well as the schedule for subsequent interviews and the contact information of the research team. In addition, the participants were provided with a gift card amounting to 10 Bulgarian lev (~ 5 euro), which they acknowledged with their signatures on receipt forms.

Ethics declaration

Written informed consent to take part in the study and to publish the article has been obtained from all participants or their legal representatives. The privacy rights of participants have been observed.

This study was performed in compliance with relevant laws, regulatory frameworks and guidelines where the research took place. This study was approved by the Scientific Ethics Committee of the Medical University of Plovdiv. (Approval No Protocol No 2/07.02.2024 and Opinion No P-442/15.02.2024)

CRediT authorship contribution statement

Angel M. Dzhambov: Writing – original draft, Visualization, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Angel Burov:** Writing – review & editing, Methodology, Investigation, Data curation. **Donka Dimitrova:** Writing – review & editing, Methodology, Investigation, Conceptualization. **Leanne Martin:** Writing – review & editing. **James Grellier:** Writing – review & editing. **Benedict W. Wheeler:** Writing – review & editing. **Terry Hartig:** Writing – review & editing, Methodology, Conceptualization. **Mathew P. White:** Writing – review & editing, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.wss.2026.100492.

References

Anderson, J.C, Gerbing, D.W., 1988. Structural equation modeling in practice: a review and recommended two-step approach. Psychol. Bull. 103 (3), 411–423. https://doi.org/10.1037/0033-2909.103.3.411.

Anjara, S.G, Bonetto, C., Van Bortel, T., Brayne, C., 2020. Using the GHQ-12 to screen for mental health problems among primary care patients: psychometrics and practical considerations. Int. J. Ment. Health Syst. 14, 62. https://doi.org/10.1186/s13033-020-00397-0.

Arida, R.M, Teixeira-Machado, L., 2021. The contribution of physical exercise to brain resilience. Front. Behav. Neurosci. 14, 626769. https://doi.org/10.3389/fnbeh.2020.626769.

Astell-Burt, Thomas, Hartig, Terry, Putra, I Gusti Ngurah Edi, Walsan, Ramya, Dendup, Tashi, Feng, Xiaoqi, 2022. Green space and loneliness: A systematic review with theoretical and methodological guidance for future research. Sci. Total Environm. 847, 157521. https://doi.org/10.1016/j.scitotenv.2022.157521. https://linkinghub.elsevier.com/retrieve/pii/S0048969722046198.

Blanke, E.S, Schmiedek, F., Siebert, S., Richter, D., Brose, A., 2023. Perspectives on resilience: trait resilience, correlates of resilience in daily life, and longer-term

change in affective distress. Stress. Health 39 (1), 59–73. https://doi.org/10.1002/smi.3164.
Bratman, G.N, Anderson, C.B, Berman, M.G, Cochran, B., de Vries, S., Flanders, J., Folke, C., Frumkin, H., Gross, J.J, Hartig, T., Jr, K.PH., Kuo, M., Lawler, J.J, Levin, P. S, Lindahl, T., Meyer-Lindenberg, A., Mitchell, R., Ouyang, Z., Roe, J., Scarlett, L., Smith, J.R, van den Bosch, M., Wheeler, B.W, White, M.P, Zheng, H., Daily, G.C, 2019. Nature and mental health: an ecosystem service perspective. Sci. Adv. 5 (7), eaax0903. https://doi.org/10.1126/sciadv.aax0903.
Bratman, G.N, Mehta, A., Olvera-Alvarez, H., Spink, K.M, Levy, C., White, M.P, Kubzansky, L.D, Gross, J.J., 2024. Associations of nature contact with emotional ill-being and well-being: the role of emotion regulation. Cogn. Emot. 38 (5), 748–767. https://doi.org/10.1080/02699931.2024.2316199.
Britton, E., Kindermann, G., Domegan, C., Carlin, C., 2020. Blue care: a systematic review of blue space interventions for health and wellbeing. Health Promot. Int. 35 (1), 50–69. https://doi.org/10.1093/heapro/day103.
Cartwright, B.DS., White, M.P, Clitherow, T.J., 2018. Nearby nature 'Buffers' the effect of low social connectedness on adult subjective wellbeing over the last 7 days. Int. J. Environ. Res. Public Health 15 (6), 1238. https://doi.org/10.3390/ijerph15061238.
Cohen, S., Wills, T.A., 1985. Stress, social support, and the buffering hypothesis. Psychol. Bull. 98 (2), 310–357.
Coventry, P.A, Brown, J.E, Pervin, J., Brabyn, S., Pateman, R., Breedvelt, J., Gilbody, S., Stancliffe, R., McEachan, R., White, P.L., 2021. Nature-based outdoor activities for mental and physical health: systematic review and meta-analysis. SSM. Popul. Health 16, 100934. https://doi.org/10.1016/j.ssmph.2021.100934.
Craig, C.L, Marshall, A.L, Sjostrom, M., Bauman, A., Booth, M.L, Ainsworth, B.E, Pratt, M., Ekelund, U., Yngve, A., Sallis, J.F, Oja, P., 2003. International physical activity questionnaire: 12-country reliability and validity. Med. Sci. Sports Exerc. 35, 1381–1395. https://doi.org/10.1249/01.MSS.0000078924.61453.FB.
de Bloom, J., Kompier, M., Geurts, S., de Weerth, C., Taris, T., Sonnentag, S., 2009. Do we recover from vacation? Meta-analysis of vacation effects on health and well-being. J. Occup. Health 51 (1), 13–25. https://doi.org/10.1539/joh.k8004.
Dzhambov, A., Hartig, T., Markevych, I., Tilov, B., Dimitrova, D., 2018a. Urban residential greenspace and mental health in youth: different approaches to testing multiple pathways yield different conclusions. Environ. Res. 160, 47–59. https://doi.org/10.1016/j.envres.2017.09.015.
Dzhambov, A.M, Markevych, I., Hartig, T., Tilov, B., Arabadzhiev, Z., Stoyanov, D., Gatseva, P., Dimitrova, D.D., 2018b. Multiple pathways link urban green- and bluespace to mental health in young adults. Environ. Res. 166, 223–233. https://doi.org/10.1016/j.envres.2018.06.004.
Dzhambov, A.M, Hartig, T., Tilov, B., Atanasova, V., Makakova, D.R, Dimitrova, D.D., 2019. Residential greenspace is associated with mental health via intertwined capacity-building and capacity-restoring pathways. Environ. Res. 178, 108708. https://doi.org/10.1016/j.envres.2019.108708.
Dzhambov, A.M, Browning, M., Markevych, I., Hartig, T., Lercher, P., 2020. Analytical approaches to testing pathways linking greenspace to health: a scoping review of the empirical literature. Environ. Res. 186, 109613. https://doi.org/10.1016/j.envres.2020.109613.
Dzhambov A., Egger J.AM., White M.P. RESONATE Case Study 3: quantitative follow-up social survey in three waves of nature contact and well-being of the residents of Plovdiv [Internet]. 2024. Available from: https://doi.org/10.17605/OSF.IO/9GF3J.
Dzhambov, Angel M., Dimitrova, Donka, Burov, Angel, Helbich, Marco, Markevych, Iana, Nieuwenhuijsen, Mark J., 2025. Physical urban environment and cardiometabolic diseases in the five largest Bulgarian cities. Internat. J. Hygiene Environm. Health 264, 114512. https://doi.org/10.1016/j.ijheh.2024.114512. https://linkinghub.elsevier.com/retrieve/pii/S1438463924001937.
Elliott, L.R, Pasanen, T., White, M.P, Wheeler, B.W, Grellier, J., Cirach, M., Bratman, G. N, van den Bosch, M., Roiko, A., Ojala, A., Nieuwenhuijsen, M., Fleming, L.E., 2023. Nature contact and general health: testing multiple serial mediation pathways with data from adults in 18 countries. Environ. Int. 178, 108077. https://doi.org/10.1016/j.envint.2023.108077.
Eurofound, 2017a. European Quality of Life Survey 2016: Quality of life, Quality of Public services, and Quality of Society. Publications Office of the European Union, Luxembourg.
European Social Survey, 2022. ESS Round 11 Source Questionnaire. ESS ERIC Headquarters c/o City, University of London, London.
European Union, Copernicus Land Monitoring Service, 2020a. High resolution layer – water & wetness status 2018, version 2.0 [Internet] [cited 2025 Sep 13]. Available from: https://land.copernicus.eu/pan-european/high-resolution-layers/water-wetness.
European Union, Copernicus Land Monitoring Service, 2020b. Urban atlas land cover/land use 2018 (vector), Europe, 6-yearly, version 1 [Internet] [cited 2025 Sep 13]. Available from: https://land.copernicus.eu/en/products/urban-atlas/urban-atlas-2018.
Fan, M.SN., Li, W.HC., Ho, L.LK., Choi, K.C, Phiri, L., Pacchiani, S., Antal, B., Cheung, C. SK., Khaleel, D.KA., 2025. Nature-based interventions for enhancing resilience in children: a systematic review and meta-analysis. Discov. Ment. Health 5 (1), 109. https://doi.org/10.1007/s44192-025-00258-7.
Fry, D., Antoine, J., Simpson, K., Steed, A.C, Branas, C.C, Nieuwenhuijsen, M., Mmari, K., Kondo, M.C., 2026. The effect of place-based nature interventions on Human health: a systematic review. Environ. Res. 288, 123157. https://doi.org/10.1016/j.envres.2025.123157.
Georgieva, E.K., 2010. Izsledvane Na Elementi Ot Kachestvoto Na Zhivot Na Patsienti Sas Sardechnosasudovi Zabolyavaniya [A Study of Quality of Life Elements in Patients With Cardiovascular diseases] [dissertation]. Medical University – Sofia, Sofia. Bulgarian.
Goldberg, D., Williams, P., 1988. A User's Guide to the General Health Questionnaire. NFER-Nelson, Windsor, UK.
Goldberg, D.P, Gater, R., Sartorius, N., Ustun, T.B, Piccinelli, M., Gureje, O., Rutter, C., 1997. The validity of two versions of the GHQ in the WHO study of mental illness in general health care. Psychol. Med. 27 (1), 191–197. https://doi.org/10.1017/s0033291796004242.
Groskurth, K., Bluemke, M., Lechner, C.M., 2024. Why we need to abandon fixed cutoffs for goodness-of-fit indices: an extensive simulation and possible solutions. Behav. Res. 56, 3891–3914. https://doi.org/10.3758/s13428-023-02193-3.
Guardini, B., Secco, L., Moè, A., Pazzaglia, F., De Mas, G., Vegetti, M., Perrone, R., Tilman, A., Renzi, M., Rapisarda, S., 2023. A three-day forest-bathing retreat enhances positive affect, vitality, optimism, and gratitude: an option for green-care tourism in Italy? Forests 14, 1423. https://doi.org/10.3390/f14071423.
Guo, M., Liu, G., Huo, Z., Chang, W., Zhang, D., Li, J., et al., 2026. Unpacking the heterogeneity: a global meta-analysis and multidimensional framework for urban green space and mental health. J. Environ. Psychol. 112, 103087. https://doi.org/10.1016/j.jenvp.2026.103087.
Gyulemetova, E., Stanev, P., 2022. Ekologichna Otsenka Na Izmenenie Na Obsht Uredstven Plan Na Obshtina Plovdiv [Environmental assessment of Changes to the General Development Plan of Plovdiv Municipality] [Internet]. Obshtina Plovdiv, Plovdiv [cited 2026 Feb 21]. Available from: http://isut.plovdiv.bg:998/_docs/EO/EO-OUP-Plovdiv.pdf. Bulgarian.
Hartig, T., Staats, H., 2006. The need for psychological restoration as a determinant of environmental preferences. J. Environ. Psychol. 26, 215–226.
Hartig, T., Lindblom, K., Ovefelt, K., 1998. The home and near-home area offer restoration opportunities differentiated by gender. Scand. Hous. Plan. Res. 15, 283–296.
Hartig, T., Evans, G.W, Jamner, L.D, Davis, D.S, Gärling, T., 2003. Tracking restoration in natural and urban field settings. J. Environ. Psychol. 23, 109–123.
Hartig, T., Mitchell, R., de Vries, S., Frumkin, H., 2014. Nature and health. Annu. Rev. Public Health 35, 207–228. https://doi.org/10.1146/annurev-publhealth-032013-182443.
Hartig, Terry, 2021. Restoration in Nature: Beyond the Conventional Narrative. Nebraska Symposium on Motivation. Springer International Publishing, Cham, ISBN 9783030690199, pp. 89–151. https://doi.org/10.1007/978-3-030-69020-5_5. https://link.springer.com/10.1007/978-3-030-69020-5_5. (Accessed 24 August 2021).
Hayes, A.F, Scharkow, M., 2013. The relative trustworthiness of inferential tests of the indirect effect in statistical mediation analysis: does method really matter? Psychol. Sci. 24 (10), 1918–1927. https://doi.org/10.1177/0956797613480187.
Hayes, A.F., 2015. An index and test of linear moderated mediation. Multivariate Behav. Res. 50 (1), 1–22. https://doi.org/10.1080/00273171.2014.962683.
Hayes, A.F., 2022. Introduction to mediation, moderation, and Conditional Process analysis: a Regression-Based Approach, 3rd ed. The Guilford Press, New York.
Helliwell, J.F, Layard, R., Sachs, J.D, De Neve, J.-E., Aknin, L.B, Wang, S., 2025. World Happiness Report 2025. University of Oxford, Wellbeing Research Centre, Oxford. ISBN 978-1-7348080-8-7.
Hirschfeld, R.M, Montgomery, S.A, Keller, M.B, Kasper, S., Schatzberg, A.F, Möller, H.J, Healy, D., Baldwin, D., Humble, M., Versiani, M., Montenegro, R., Bourgeois, M., 2000. Social functioning in depression: a review. J. Clin. Psychiatry 61 (4), 268–275. https://doi.org/10.4088/jcp.v61n0405.
Hollaar, M.HL., Kemmere, B., Kocken, P.L, et al., 2025. Resilience-based interventions in the public sector workplace: a systematic review. BMC. Public Health 25, 350. https://doi.org/10.1186/s12889-024-21177-2.
Hu, L.T, Bentler, P.M., 1999. Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. Struct. Equ Model. 6 (1), 1–55. https://doi.org/10.1080/10705519909540118.
Hu, T., Zhang, D., Wang, J., 2015. A meta-analysis of the trait resilience and mental health. Pers. Individ. Dif. 76, 18–27. https://doi.org/10.1016/j.paid.2014.11.039.
Huang, D., Li, J., He, F., Song, Z., Jiao, C., 2025. Greenspace exposure and parental mental well-being: environmental-behavioral mechanisms stratified by gender and health status. Habitat. Int. 166, 103624. https://doi.org/10.1016/j.habitatint.2025.103624.
JASP Team. JASP (Version 0.95.1) [Computer software]. 2025.
Jennings, V., Bamkole, O., 2019. The relationship between social cohesion and urban green space: an avenue for health promotion. Int. J. Environ. Res. Public Health 16 (3), 452. https://doi.org/10.3390/ijerph16030452.
Jimenez, M.P, DeVille, N.V, Elliott, E.G, Schiff, J.E, Wilt, G.E, Hart, J.E, James, P., 2021. Associations between nature exposure and health: a review of the evidence. Int. J. Environ. Res. Public Health 18 (9), 4790. https://doi.org/10.3390/ijerph18094790.
Kalisch, R., Baker, D.G, Basten, U., Boks, M.P, Bonanno, G.A, Brummelman, E., Chmitorz, A., Fernàndez, G., Fiebach, C.J, Galatzer-Levy, I., Geuze, E., Groppa, S., Helmreich, I., Hendler, T., Hermans, E.J, Jovanovic, T., Kubiak, T., Lieb, K., Lutz, B., Müller, M.B, Murray, R.J, Nievergelt, C.M, Reif, A., Roelofs, K., Rutten, B.PF., Sander, D., Schick, A., Tüscher, O., Diest, I.V, Harmelen, A.V, Veer, I.M, Vermetten, E., Vinkers, C.H, Wager, T.D, Walter, H., Wessa, M., Wibral, M., Kleim, B., 2017. The resilience framework as a strategy to combat stress-related disorders. Nat. Hum. Behav. 1 (11), 784–790. https://doi.org/10.1038/s41562-017-0200-8.
Kingsbury, M., Clayborne, Z., Colman, I., Kirkbride, J.B, 2020. The protective effect of neighbourhood social cohesion on adolescent mental health following stressful life events. Psychol. Med. 50 (8), 1292–1299. https://doi.org/10.1017/S0033291719001235.
Klijs, B., Mendes de Leon, C.F, Kibele, E.UB., Smidt, N., 2017. Do social relations buffer the effect of neighborhood deprivation on health-related quality of life? Results from the LifeLines Cohort Study. Health Place 44, 43–51. https://doi.org/10.1016/j.healthplace.2017.01.001.

Knopf, R.C., 1987. Human behavior, cognition, and affect in the natural environment. In: Stokols, D., Altman, I. (Eds.), Handbook of Environmental Psychology. Wiley, New York, pp. 783–825.
Konijnendijk, C.C., 2023. Evidence-based guidelines for greener, healthier, more resilient neighbourhoods: introducing the 3–30–300 rule. J. For. Res. 34, 821–830. https://doi.org/10.1007/s11676-022-01523-z.
Korpela, K.M, Ylén, M.P., 2009. Effectiveness of favorite-place prescriptions: a field experiment. Am. J. Prev. Med. 36 (5), 435–438. https://doi.org/10.1016/j.amepre.2009.01.022.
Korpela, K.M, Hartig, T., Kaiser, F.G, Fuhrer, U., 2001. Restorative experience and self-regulation in favorite places. Environ. Behav. 33, 572–589.
Korpela, K., Borodulin, K., Neuvonen, M., Paronen, O., Tyrväinen, L., 2014. Analyzing the mediators between nature-based outdoor recreation and emotional well-being. J. Environ. Psychol. 37, 1–7. https://doi.org/10.1016/j.jenvp.2013.11.003.
Korpela, K.M, Pasanen, T.P, Repo, V., Hartig, T., Staats, H., Mason, M., Alves, S., Fornara, F., Marks, T., Saini, S., Scopelliti, M., Soares, A.L, Stigsdotter, U.K, Thompson, C.W., 2018. Environmental strategies of affect regulation and their associations with subjective well-being. Front. Psychol. 9, 562. https://doi.org/10.3389/fpsyg.2018.00562.
Kuddus, M.A, Tynan, E., McBryde, E., 2020. Urbanization: a problem for the rich and the poor? Public Health Rev. 41, 1. https://doi.org/10.1186/s40985-019-0116-0.
Kuldas, S., Foody, M., 2022. Neither resiliency-trait nor resilience-state: transactional resiliency/e. Youth. Soc. 54 (8), 1352–1376. https://doi.org/10.1177/0044118X211029309.
Lee, P.H, Macfarlane, D.J, Lam, T.H, Stewart, S.M., 2011. Validity of the International Physical Activity Questionnaire Short Form (IPAQ-SF): a systematic review. Int. J. Behav. Nutr. Phys. Act. 8, 115. https://doi.org/10.1186/1479-5868-8-115.
Li, H., Browning, M., Cao, Y., Zhang, G., 2022. From childhood residential green space to adult mental wellbeing: a pathway analysis among Chinese adults. Behav. Sci. (Basel) 12 (3), 84. https://doi.org/10.3390/bs12030084.
Li, H., Browning, M., Rigolon, A., Larson, L.R, Taff, D., Labib, S.M, Benfield, J., Yuan, S., McAnirlin, O., Hatami, N., Kahn Jr, P.H, 2023. Beyond "bluespace" and "greenspace": a narrative review of possible health benefits from exposure to other natural landscapes. Sci. Total. Environ. 856 (Pt 2), 159292. https://doi.org/10.1016/j.scitotenv.2022.159292.
Lock, S., Rees, C.S, Heritage, B., 2020. Development and validation of a brief measure of psychological resilience: the state–trait assessment of resilience scale. Aust. Psychol. 55 (1), 10–25. https://doi.org/10.1111/ap.12434.
Lymeus, F., Lindberg, P., Hartig, T., 2018. Building mindfulness bottom-up: meditation in natural settings supports open monitoring and attention restoration. Conscious. Cogn. 59, 40–56. https://doi.org/10.1016/j.concog.2018.01.008.
Markevych, I., Schoierer, J., Hartig, T., Chudnovsky, A., Hystad, P., Dzhambov, A.M, de Vries, S., Triguero-Mas, M., Brauer, M., Nieuwenhuijsen, M.J, Lupp, G., Richardson, E.A, Astell-Burt, T., Dimitrova, D., Feng, X., Sadeh, M., Standl, M., Heinrich, J., Fuertes, E., 2017. Exploring pathways linking greenspace to health: theoretical and methodological guidance. Environ. Res. 158, 301–317. https://doi.org/10.1016/j.envres.2017.06.028.
Marselle, M.R, Irvine, K.N, Warber, S.L., 2014. Examining group walks in nature and multiple aspects of well-being: a large-scale study. Ecopsychology 6 (3), 134–147. https://doi.org/10.1089/eco.2014.0027.
Marselle, M.R, Warber, S.L, Irvine, K.N., 2019. Growing resilience through interaction with nature: can group walks in nature buffer the effects of stressful life events on mental health? Int. J. Environ. Res. Public Health 16 (6), 986. https://doi.org/10.3390/ijerph16060986.
McDougall, C.W, Elliott, L.R, White, M.P, Grellier, J., Bell, S., Bratman, G.N, Nieuwenhuijsen, M., Lima, M.L, Ojala, A., Cirach, M., Roiko, A., van den Bosch, M., Fleming, L.E., 2024. What types of nature exposure are associated with hedonic, eudaimonic and evaluative wellbeing? an 18-country study. J. Environ. Psychol. 100, 102479. https://doi.org/10.1016/j.jenvp.2024.102479.
Mitchell, Richard, 2013. Is physical activity in natural environments better for mental health than physical activity in other environments? Soc. Sci. Med. 91, 130–134. https://doi.org/10.1016/j.socscimed.2012.04.012. https://linkinghub.elsevier.com/retrieve/pii/S0277953612003565.
Montana, F., Mueller, N., Barboza, E.P, Khomenko, S., Iungman, T., Cirach, M., Daher, C., Chakraborty, T.C, de Hoogh, K., Battiston, A., Schifanella, R., Nieuwenhuijsen, M., 2025. Building a healthy urban design index (HUDI): how to promote health and sustainability in European cities. Lancet Planet. Health 9 (6), e511–e526. https://doi.org/10.1016/S2542-5196(25)00109-3.
Mygind, L., Kjeldsted, E., Hartmeyer, R.D, Mygind, E., Bølling, M., Bentsen, P., 2019. Immersive nature-experiences as health promotion interventions for healthy, vulnerable, and sick populations? A systematic review and appraisal of controlled studies. Front. Psychol. 10, 943. https://doi.org/10.3389/fpsyg.2019.00943.
Núñez-González, S., Delgado-Ron, J.A, Gault, C., Lara-Vinueza, A., Calle-Celi, D., Porreca, R., Simancas-Racines, D., 2020. Overview of "systematic reviews" of the built environment's effects on mental health. J. Environ. Public Health 2020, 1–10. https://doi.org/10.1155/2020/9523127, 9523127.
OECD, 2023. OECD Economic surveys: Bulgaria 2023. OECD Publishing, Paris. https://doi.org/10.1787/5ca812a4-en.
Ohly, H., White, M.P, Wheeler, B.W, Bethel, A., Ukoumunne, O.C, Nikolaou, V., Garside, R., 2016. Attention Restoration Theory: a systematic review of the attention restoration potential of exposure to natural environments. J. Toxicol. Environ. Health. B 19 (7), 305–343. https://doi.org/10.1080/10937404.2016.1196155.
Pasanen, T.P, White, M.P, Elliott, L.R, van den Bosch, M., Bratman, G.N, Ojala, A., Korpela, K., Fleming, L.E., 2023. Urban green space and mental health among people living alone: the mediating roles of relational and collective restoration in an 18-country sample. Environ. Res. 232, 116324. https://doi.org/10.1016/j.envres.2023.116324.
Plovdiv Municipality. Green system [Internet]. n.d.b Available from: https://www.plovdiv.bg/item/ecology/green_system/.
Preuß, M., Nieuwenhuijsen, M., Marquez, S., Cirach, M., Dadvand, P., Triguero-Mas, M., Gidlow, C., Grazuleviciene, R., Kruize, H., Zijlema, W., 2019. Low childhood nature exposure is associated with worse mental health in adulthood. Int. J. Environ. Res. Public Health 16 (10), 1809. https://doi.org/10.3390/ijerph16101809.
QGIS Development Team. QGIS Geographic Information System, version 3.28.2 Firenze. Open Source Geospatial Foundation Project; 2024. Available from: https://qgis.org.
Qiu, M., Sha, J., Scott, N., 2021. Restoration of visitors through nature-based tourism: a systematic review, conceptual framework, and future research directions. Int. J. Environ. Res. Public Health 18 (5), 2299. https://doi.org/10.3390/ijerph18052299.
R Core Team, 2024. R: a Language and Environment For Statistical Computing. R Foundation for Statistical Computing, Vienna. Available from: https://www.R-project.org/.
Rosseel, Y., 2012. Lavaan: an R package for structural equation modeling. J. Stat. Softw. 48 (2), 1–36. https://doi.org/10.18637/jss.v048.i02.
Saris, I.MJ., Aghajani, M., van der Werff, S.JA., van der Wee, N.JA., Penninx, B., 2017. Social functioning in patients with depressive and anxiety disorders. Acta Psychiatr. Scand. 136 (4), 352–361. https://doi.org/10.1111/acps.12774.
Schäfer, S.K, Supke, M., Kausmann, C., et al., 2024. A systematic review of individual, social, and societal resilience factors in response to societal challenges and crises. Commun. Psychol. 2, 92. https://doi.org/10.1038/s44271-024-00138-w.
Scholten, S., Lavallee, K., Velten, J., Zhang, X.C, Margraf, J., 2020. The brief daily stressors screening tool: an introduction and evaluation. Stress. Health 36 (5), 686–692. https://doi.org/10.1002/smi.2965.
Sheerin, C.M, Lind, M.J, Brown, E.A, CO, G., Kendler, K.S, Amstadter, A.B., 2018. The impact of resilience and subsequent stressful life events on MDD and GAD. Depress. Anxiety. 35 (2), 140–147. https://doi.org/10.1002/da.22700.
Shi, D., Maydeu-Olivares, A., 2020. The effect of estimation methods on SEM fit indices. Educ. Psychol. Meas. 80 (3), 421–445. https://doi.org/10.1177/0013164419885164.
Shrestha, T., Voon Yi Chi, C., Cassarino, M., Foley, S., Di Blasi, Z., 2025. Factors influencing the effectiveness of nature-based interventions (NBIs) aimed at improving mental health and wellbeing: an umbrella review. Environ. Int. 196, 109217. https://doi.org/10.1016/j.envint.2024.109217.
Silverman, M.N, Deuster, P.A., 2014. Biological mechanisms underlying the role of physical fitness in health and resilience. Interface Focus. 4 (5), 20140040. https://doi.org/10.1098/rsfs.2014.0040.
Smith, N., Georgiou, M., King, A.C, Tieges, Z., Webb, S., Chastin, S., 2021. Urban blue spaces and human health: a systematic review and meta-analysis of quantitative studies. Cities 119, 103413. https://doi.org/10.1016/j.cities.2021.103413.
Soga, M., Gaston, K.J., 2025. Health benefits of viewing nature through windows: a meta-analysis. Bioscience 75 (8), 628–636. https://doi.org/10.1093/biosci/biaf089.
Southwick, S.M, Bonanno, G.A, Masten, A.S, Panter-Brick, C., Yehuda, R., 2014. Resilience definitions, theory, and challenges: interdisciplinary perspectives. Eur. J. Psychotraumatol. 5. https://doi.org/10.3402/ejpt.v5.25338.
StataCorp, 2025. Stata Statistical Software: Release 19. StataCorp LLC, College Station, TX.
Stoyanov, D., Nakov, V., 2023. The mental health system in Bulgaria: socialist heritage and prospects. Consort. Psychiatr. 4 (2), 115–124. https://doi.org/10.17816/CP8631.
Tate, C.U., 2015. On the overuse and misuse of mediation analysis: it may be a matter of timing. Basic. Appl. Soc. Psychol. 37, 235–246. https://doi.org/10.1080/01973533.2015.1062380.
Toth, E.E, Ihász, F., Ruíz-Barquín, R., Szabo, A., 2023. Physical activity and psychological resilience in older adults: a systematic review of the literature. J. Aging Phys. Act. 32 (2), 276–286. https://doi.org/10.1123/japa.2022-0427.
Troy, A.S, Willroth, E.C, Shallcross, A.J, Giuliani, N.R, Gross, J.J, Mauss, I.B., 2023. Psychological resilience: an affect-regulation framework. Annu. Rev. Psychol. 74, 547–576. https://doi.org/10.1146/annurev-psych-020122-041854.
van den Berg, A.E, Maas, J., Verheij, R.A, Groenewegen, P.P., 2010. Green space as a buffer between stressful life events and health. Soc. Sci. Med. 70 (8), 1203–1210. https://doi.org/10.1016/j.socscimed.2010.01.002.
van den Bosch, M., Meyer-Lindenberg, A., 2019. Environmental exposures and depression: biological mechanisms and epidemiological evidence. Annu. Rev. Public Health 40, 239–259. https://doi.org/10.1146/annurev-publhealth-040218-044106.
Vitale, V., Martin, L., White, M.P, Elliott, L.R, Wyles, K.J, Browning, M., Pahl, S., Stehl, P., Bell, S., Bratman, G.N, Gascon, M., Grellier, J., Lima, M.L, Lõhmus, M., Nieuwenhuijsen, M., Ojala, A., Taylor, J., van den Bosch, M., Weinstein, N., Fleming, L.E., 2022. Mechanisms underlying childhood exposure to blue spaces and adult subjective well-being: an 18-country analysis. J. Environ. Psychol. 84, 101876. https://doi.org/10.1016/j.jenvp.2022.101876.
Wang, J., Wang, T., Cheng, Y., 2024. Resilience as a moderator of the relationship between stress and different symptom dimensions of depression in adolescents with a history of childhood maltreatment: a multi-wave longitudinal study. Child. Abuse. Negl. 154, 106888. https://doi.org/10.1016/j.chiabu.2024.106888.
Wasserstein, R.L, Lazar, N.A., 2016. The ASA's statement on p-values: context, process, and purpose. Am. Stat. 70 (2), 129–133. https://doi.org/10.1080/00031305.2016.1154108.
Wasserstein, R.L, Schirm, A.L, Lazar, N.A., 2019. Moving to a world beyond "$p < 0.05$". Am. Stat. 73 (sup1), 1–19. https://doi.org/10.1080/00031305.2019.1583913.
Wells, N.M, Evans, G.W., 2003. Nearby nature: a buffer of life stress among rural children. Environ. Behav. 35 (3), 311–330. https://doi.org/10.1177/0013916503035003001.

Wells, N.M., 2021. The natural environment as a resilience factor: nature's role as a buffer of the effects of risk and adversity. In: Schutte, A.R., Torquati, J.C., Stevens, J. R. (Eds.), Nature and psychology. Nebraska Symposium On Motivation, Nature and psychology. Nebraska Symposium On Motivation, 67. Springer, Cham, pp. 195–233. https://doi.org/10.1007/978-3-030-69020-5_7.

White, M.P, Elliott, L.R, Gascon, M., Roberts, B., Fleming, L.E., 2020. Blue space, health and well-being: a narrative overview and synthesis of potential benefits. Environ. Res. 191, 110169. https://doi.org/10.1016/j.envres.2020.110169.

White, M.P, Elliott, L.R, Grellier, J., Economou, T., Bell, S., Bratman, G.N, Cirach, M., Gascon, M., Lima, M.L, Lõhmus, M., Nieuwenhuijsen, M., Ojala, A., Roiko, A., Schultz, P.W, van den Bosch, M., Fleming, L.E., 2021. Associations between green/blue spaces and mental health across 18 countries. Sci. Rep. 11 (1), 8903. https://doi.org/10.1038/s41598-021-87675-0.

White, M.P, Hartig, T., Martin, L., Pahl, S., van den Berg, A.E, Wells, N.M, Costongs, C., Dzhambov, A.M, Elliott, L.R, Godfrey, A., Hartl, A., Konijnendijk, C., Litt, J.S, Lovell, R., Lymeus, F., O'Driscoll, C., Pichler, C., Pouso, S., Razani, N., Secco, L., Steininger, M.O, Stigsdotter, U.K, Uyarra, M., van den Bosch, M., 2023. Nature-based biopsychosocial resilience: an integrative theoretical framework for research on nature and health. Environ. Int. 181, 108234. https://doi.org/10.1016/j.envint.2023.108234.

White, R.L, Vella, S., Biddle, S., Sutcliffe, J., Guagliano, J.M, Uddin, R., Burgin, A., Apostolopoulos, M., Nguyen, T., Young, C., Taylor, N., Lilley, S., Teychenne, M., 2024. Physical activity and mental health: a systematic review and best-evidence synthesis of mediation and moderation studies. Int. J. Behav. Nutr. Phys. Act. 21 (1), 134. https://doi.org/10.1186/s12966-024-01676-6.

White, M.P, Egger, J.AM., Amato, G., Astell-Burt, T., Bekke-Hansen, S., Borja, A., et al., 2026. Testing nature-based biopsychosocial resilience theory: a research programme protocol. Arch. Pub. Health 84 (1), 90. https://doi.org/10.1186/s13690-026-01903-5.

WHO, 2016. Urban Green Spaces and Health. WHO Regional Office for Europe, Copenhagen.

WHO, 2025a. Mental Health Atlas 2024. World Health Organization, Geneva. ISBN 978-92-4-011448-7 Licence: CC BY-NC-SA 3.0 IGO.

WHO, 2025b. World Mental Health today: Latest Data. World Health Organization, Geneva. ISBN 978-92-4-011381-7 . Licence: CC BY-NC-SA 3.0 IGO.

Xie, X., Yang, S., Liu, X., Yang, Y., Jiang, Q., Huang, D., 2026. Can your window view outsmart urban stress? Decoding the indoor-outdoor green exposure duel in office workers' anxiety battle. J. Environ. Psychol. 110, 102955. https://doi.org/10.1016/j.jenvp.2026.102955.

Zare Sakhvidi, M.J, Browning, M., Samuelsson, K., Labib, S.M, Psyllidis, A., Amegah, A. K, Astell-Burt, T., Bach, A., Jerrett, M., Bratman, G.N, van den Bosch, M., de Hoogh, K., de Vries, S., Dzhambov, A.M, Fallah Madvari, R., Feng, X., Fernandes, A., Fuertes, E., Giannico, V., Gouveia, N., Hartig, T., Heinrich, J., Hystad, P., Ibarluzea, J., Jacquemin, B., James, P., Jashni, M., Knibbs, L.D, Knobel, P., Kogevinas, M., Lertxundi, A., Markevych, I., Mehrparvar, A., Miri, M., Mitchell, R., Nawrot, T.S, Nieuwenhuijsen, M.J, O'Callaghan-Gordo, C., Pearce, J., Plusquin, M., Sanesi, G., Su, J.G, Triguero-Mas, M., Ubalde-Lopez, M., Valentin, A., White, M.P, Yang, B.Y, Yang, J., Zhang, J., Zhao, T., Helbich, M., Dadvand, P., 2025. Methodological guidance for selecting buffers in greenspace-health studies. Lancet Planet. Health 9, 101370. https://doi.org/10.1016/j.lanplh.2025.101370.

Zeng, D., Wu, X., 2022. Neighborhood collective efficacy in stressful events: the stress-buffering effect. Soc. Sci. Med. 306, 115154. https://doi.org/10.1016/j.socscimed.2022.115154.

Zhang, X., Brown, A.M, Rhubart, D.C., 2023. Can resilience buffer the effects of loneliness on mental distress among working-age adults in the United States during the COVID-19 Pandemic? A latent moderated structural modeling analysis. Int. J. Behav. Med. 30 (6), 790–800. https://doi.org/10.1007/s12529-022-10151-0.