

Can Nature Make Us Feel Younger? Evidence from Daily Diary and Experience Sampling Studies

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Abstract

Numerous studies have shown that nature exposure enhances vitality and well-being. The present paper examines whether nature can make us feel younger. To answer this question a daily diary study (Study 1) and an experience sampling study (Study 2) have been conducted. The results of Study 1 ($N = 117$; $M = 62.97$, $SD = 9.16$ years; age-range = 50–85; 55% female) showed that participants reported a younger subjective age on days when they spent more time in nature compared with their own average over two weeks, even after controlling for subjective health and education. Study 2 ($N = 103$; $M = 47.51$, $SD = 17.78$ years; age-range = 19–79; 56% female) replicated this finding when controlling for covariates and showed that the association between momentary nature exposure and subjective age was stronger among middle-aged and older adults. The results indicate that the advantages of nature exposure are not limited to individuals who habitually spend more time in nature but arise when people encounter more nature than is typical for them. These findings underscore the potential of everyday interventions that increase contact with natural environments – especially among middle-aged and older adults – to promote a younger subjective age.

Introduction

As we grow older, age becomes an increasingly salient aspect of our self-concept and identity. However, one's subjective perception of their age along the young-old continuum may differ from their actual chronological age. This subjective interpretation of one's age has been found to predict numerous health and well-being indicators related to successful development and aging (for a review, see Alonso Debreczeni & Bailey, 2021; Diehl et al., 2021). Despite their relevance, environmental factors that may contribute to a younger subjective age have rarely been examined in previous research (Schmidt et al., 2024). One particularly valuable factor is nature exposure, with proven biological, psychological, and social benefits across the lifespan (Grave et al., 2023; White et al., 2023). As nature exposure has been shown to enhance overall vitality and well-being (Grave et al., 2023; White et al., 2023), an important question is can nature also make us feel younger. The current paper addresses this question by investigating the relationship between nature exposure and subjective age in two studies: a daily diary and an experience sampling study.

Subjective Age

Subjective age refers to how old a person feels, perceives, or considers themselves, regardless of their actual chronological age (Rubin & Berntsen, 2006). This psychological construct reflects personal and social influences on aging perceptions (Diehl et al., 2021). Extensive research has demonstrated that subjective age is reliably linked to a wide range of significant outcomes (Diehl et al., 2021). For example, studies have confirmed the benefits of a younger subjective age for functional and psychological outcomes, such as well-being (Hajek & Konig, 2020), life satisfaction, optimism, meaning in life (Ambrosi-Randic et al., 2018), and longevity (Westerhof et al., 2023).

Subjective age has been consistently found to be associated with physical and cognitive health (Alonso Debreczeni & Bailey, 2021; Tovel et al., 2019), particularly among older adults (Wettstein et al., 2021). Although research consistently found that younger subjective age is associated with better physical health and mental well-being (Aftab et al., 2022; Stephan et al., 2014), health indicators have been reported as antecedents of subjective age as well (Schonstein et al., 2021). For instance, in a five-year follow-up study, good self-rated physical and mental health were significant predictors of a younger subjective age, especially among older adults (Bergland et al., 2014). Given this robust empirical evidence on association between an older age identity and negative health outcomes, encouraging a youthful self-perception has been noted as a crucial objective for public health efforts (see meta-analysis Westerhof et al., 2014). Therefore, identifying factors that contribute to a more positive subjective age is of high relevance.

The Effect of Nature on Functioning and Vitality

A large body of research demonstrated benefits of nature on human health and functioning. For example, studies have shown that spending time in nature alleviates subjective and physiological stress (Shuda et al., 2020), reduces anxiety and depression symptoms (Grassini, 2022) and improves cognitive function (Gamble et al., 2014). Nature exposure is also positively associated with better social and psychological health (Finlay et al., 2015). Similarly, a higher level of nature in the surrounding residential area is associated with a slower decline in physical performance (de Keijzer et al., 2019), a lower mortality rate (Barboza et al., 2021; Rojas-Rueda et al., 2019), and longevity (Connolly et al., 2023). Even simply looking at images of nature has a positive effect on social and psychological well-being (Elsadek et al., 2021).

The beneficial effects of nature are attributable to biological, psychological and social factors. First, vegetation in natural environment suppresses airborne pollutants, improves air quality (Janhäll, 2015) and decreases overheating (Gill et al., 2007). As such, it benefits cardiovascular and immunological health parameters (Andersen et al., 2021; Bind et al., 2012; Dahlkvist et al., 2016; Yuan et al., 2021). Second, natural environments restore cognitive and affective capacities resulting in overall higher well-being and vitality (Grave et al., 2023). Finally, exposure to green and blue spaces in nature enhances social cohesion and sense of connectedness (Finlay et al., 2015). Two major frameworks account for the positive influence of nature on health and functioning: *Attention Restoration Theory* (Kaplan, 1995) and *Stress Reduction Theory* (Ulrich et al., 1991). The theories highlight nature's capacity to restore cognitive resources and reduce negative affect, which in turn promotes greater well-being as well as improved cognitive, social, and psychological functioning (for a review, see Grave et al., 2023). Given its beneficial effects on overall well-being and vitality, the question arises whether nature exposure can make us feel younger?

The Relationship Between Nature and Subjective Age

Two theoretical perspectives – sociopsychological and biological – explain the mechanism of the predictors of subjective age. It has been proposed that the felt age is influenced by age-related social, as well as other environmental cues, but that is also sensitive to status of one's physical health and functioning (Stephan et al., 2015). For example, research has shown that the induction of sad mood via cues such as music and text causes an older subjective age (Dutt & Wahl, 2017). Other studies showed broader environmental cues, such as stressors (Kornadt et al., 2022) or situational demands at work (Goecke & Kunze, 2020) to shape momentary perceptions of one's age. On the other hand, empirical evidence confirmed biomedical factors – perceptible indices of fitness and biological age (e.g., higher peak expiratory flow, higher grip strength, and lower waist circumference) – as positive predictors of a younger subjective age (Stephan et al., 2015). Nature exposure may affect subjective age through both mechanisms: As an overall restorative environment, natural environments provide cues that enhance both objective and perceived physical health and functioning (Twohig-Bennett & Jones, 2018). As a result, one could feel younger in natural environments.

The contextual model of subjective age (Hughes & Touron, 2021) emphasizes the role of one's immediate and proximal situational context for subjective age. According to this model, different situations could trigger reflection processes that lead to the changes in subjective age (Hughes & Touron, 2021). Thus, the perception of how old or young people feel is significantly influenced by the context in which they evaluate and interpret their age (for a detailed discussion, see Kornadt et al., 2021). Following that reasoning – if a context accentuates youthfulness, one could deem oneself younger in that context. Given the contextual characteristics of nature that enhance vitality and overall mental and physical fitness, one could assume that nature could provide a framework to facilitate a younger age identity.

Correlational studies showed a link between nature exposure and positive views of aging (Nikitin et al., 2024). A recent daily diary study found no notable day-to-day association between sunshine duration and subjective

age; however, participants assessed during sunnier periods felt younger on average than those assessed during cloudier periods (Schmidt et al., 2024). Another study examining the relationship between neighborhood greenspace and health in Toronto's urban environment found that an increase of 10 trees per city block was, on average, associated with improved health perceptions, comparable to feeling seven years younger (Kardan et al., 2015). However, to our knowledge, no research has specifically explored how nature exposure is related to an individual's subjective perception of their own age.

The Present Study

The first objective of this paper addresses the question of whether nature is linked to feeling younger. Prior research reported considerable variation in subjective age from day to day, with worse subjective health (Kotter-Gruhn et al., 2015), stressors, negative affect, fewer positive events (Klaiber & Pauly, 2025), and cloudy days (Schmidt et al., 2024) being related to older subjective age. Moreover, recent empirical studies have established significant fluctuations in age identity even from moment to moment, showing that how old people feel can vary on a momentary basis (Kornadt et al., 2021; Schmidt et al., 2024). To this end, we first conducted a daily diary study to capture day-to-day fluctuations, followed by an experience sampling study to examine momentary dynamics. Together, these approaches provide a more nuanced and robust test of the link between nature exposure and subjective age. We expect that greater daily (Study 1) and momentary (Study 2) nature exposure will be associated with a younger daily and momentary subjective age, at both the within- and between-person levels. However, as evidence shows that the positive effects of a younger subjective age on health—by counteracting the detrimental effects of stress—are particularly pronounced among older adults (e.g., Wettstein et al., 2021), we hypothesize that the increased sense of biological, psychological, and social well-being that results from nature exposure may serve as a particularly salient cue for older adults. Thus, experiences of vitality from nature should be more noticeable and impactful in later life, leading to a stronger shift in how older adults feel compared to younger adults. Therefore, we expect age to moderate the relationship between nature exposure and subjective age.

Study 1: Daily Diary Study

Method

Participants and Procedure

Participants were part of the “The Daily Experience of Aging – A Cross-National Study” daily diary study. The convenience sample was recruited from Austria, Germany and Switzerland. Ethical approval was obtained from the ethics commission of the Faculty of Educational and Developmental Psychology at University of Vienna. Participants were recruited by students in a research seminar between April 9 and June 10, 2025, during the summer semester. Participants received monetary compensation: €35 for completing all questionnaires, €25 for participating on at least 10 days, and €15 for completing at least 7 days. A total of 117 adults aged 50–85 years ($M = 62.97$, $SD = 9.16$ years; 55% female) participated in the study. Among the participants, 68.4% were married or in a relationship, 52.2% reported having a higher education degree, an additional 26.4% reported having completed vocational training or a high school diploma, and 59% were employed. The study was conducted in accordance with the Declaration of Helsinki, and informed consent was obtained from all participants.

Daily measures

Subjective Age. Subjective age was assessed by asking participants: “Many people feel older or younger than they actually are. How old did you feel during the past 24 hours? Please answer in years.” To adjust for

differences in chronological age, we calculated a proportional subjective age score by subtracting participants' chronological age from their felt age and dividing the result by chronological age. Negative values reflect feeling younger, positive values reflect feeling older, and a value of zero indicates feeling exactly one's chronological age (Stephan et al., 2015).

Daily Nature Exposure. Daily nature exposure was assessed with two items. First, participants indicated whether they had spent any time in nature that day ("No time in nature today"). If they had, they were asked to estimate the total duration of their nature exposure: "How much time did you spend in nature today in total?" with response options ranging from 1 = less than 15 minutes, 2 = 15-30 minutes, 3 = 31-60 minutes, 4 = 1-2 hours, to 5 = more than 2 hours. For analysis, these two items were combined such that reporting no time in nature was coded as 0 in the duration variable, resulting in a single measure of daily nature exposure ranging from 0 = no nature exposure to 5 = more than 2 hours of nature exposure.

Covariates. Education level, assessed at baseline, was included as a covariate in the analyses. It was coded on a 7-point scale ranging from 1 = no formal education to 7 = doctoral degree. Subjective health was measured at the baseline using one item: "How would you describe your health?" with response options ranging from 1 = not good at all to 5 = excellent.

Exploratory analysis items. As part of the exploratory analyses, participants indicated how old they felt in different domains using four single items assessing mental/emotional health, physical health, physical appearance, and behavior. The items read, "With regard to my mental or emotional health/physical health/physical appearance/behavior, today I felt...". All items were answered on a 5-point Likert-type scale ranging from 1 = felt much younger than my age to 5 = felt much older than my age.

Analyses

As single measurement points (days) are nested within individual participants, we used linear multilevel modeling to appropriately address the hierarchical structure of the data including within-person variability (daily fluctuations over time), and between-person variability (individual difference in levels of subjective age and nature exposure over a week). First, a null model (Model 0) was estimated, including only a random intercept for participants. The intraclass correlation coefficient (ICC) was calculated to assess the extent to which subjective age fluctuates within individuals over time versus remains stable between individuals. Next, a random slope model (Model 1) was estimated to assess the within-person association between daily nature exposure and subjective age. In this model, daily nature exposure predicted subjective age at the between-person and within-person levels, and the within-person effect was allowed to vary across individuals (i.e., the random slope). The intercept variance accounted for individual differences in subjective age. In Model 1, daily nature exposure was grand-mean centered. At level 1 (daily level), the model was based on the equation:

$$SA_{ti} = \beta_{0i} + \beta_{1i} \text{daily NE}_{ti} + e_{ti}, (1)$$

where SA_{ti} represents the subjective age for individual i at time t , β_{0i} denotes an individual-specific intercept parameter, β_{1i} represents the person-specific slope for the within-person effect of daily nature exposure, and e_{ti} represents residual error.

At level 2 (person level), the model was set up as:

$$\beta_{0i} = \gamma_{00} + \gamma_{01}(\text{Average NE}_i) + u_{0i} (2)$$

$$\beta_{1i} = \gamma_{10} + u_{1i} (3)$$

where γ_{00} represents the sample-average intercept for subjective age, γ_{01} captures the between-person effect of nature exposure, reflecting whether individuals who, on average, experience more nature exposure tend to report higher subjective age compared to those with lower average exposure, u_{0i} represents individual specific deviations from the sample average subjective age, γ_{10} represents the sample-average within-person effect of daily nature exposure on subjective age, and u_{1i} represents individual-specific deviations from this sample-average within-person slope.

In Model 2, age was added as a level-2 and modeled to predict between-person differences in average subjective age and to moderate the within-person effect of daily nature exposure (cross-level interaction). Finally, covariates were added to Model 2 to create Model 3. Specifically, education and subjective health, measured at baseline, were included as level-2 predictors of between-person differences in average subjective age. All multilevel models were estimated in Mplus 8.3 using Bayesian estimation with Markov chain Monte Carlo (MCMC) methods (2 chains, 50,000 iterations, median point estimates). In Bayesian estimation, Mplus reports a one-tailed posterior p-value, which represents the probability that the parameter has the opposite sign than estimated (e.g., that a positive coefficient is actually negative). In addition to these one-tailed probabilities, we report 95% credible intervals (CIs), which indicate the range of parameter values that contain 95% of the posterior probability mass. A parameter is considered statistically credible (analogous to “significant”) if its 95% credible interval does not include zero.

Results

Descriptives

Table 1 presents means, standard deviations, and intra- and interindividual correlations, as well as intraclass correlations (ICCs) for the main variables in Study 1. The average level of nature exposure across all participants was $M = 2.57$ ($SD_{inter} = 1.16$), with considerable within-person variability ($SD_{intra} = 1.65$), suggesting that individuals’ exposure to nature fluctuated substantially from day to day. The interclass correlation shows that 66.5% of variance reflects within-person fluctuations across days. For subjective age, about half of the total variance in subjective age is attributable to between-person differences, while the other half reflects within-person fluctuations across days. On average, participants felt about 11 years younger than their chronological age. Among all variables, only the within-person correlation between nature exposure and subjective age was statistically significant: although small in effect size, higher daily nature exposure was associated with feeling subjectively younger.

Table 1
Descriptives and Bivariate Intercorrelations of the Variables in Daily Diary Study.

Variable	Mean	<i>SD_{inter}</i>	<i>SD_{intra}</i>	ICC	1	2	3	4	5
1. Nature Exposure	2.61	1.17	1.65	0.335		-0.02	0.17	0.08	-0.07
2. Subjective Age	-11.35	9.47	8.81	0.536	-0.10***		-0.12	-0.01	-0.12
3. Subjective Health	3.64	0.85	-	1				-0.11	0.12
4. Age	62.97	9.16	-	1					-0.05
5. Education	4.71	1.48	-	1					
<i>Note.</i> ICC = intraclass correlation; <i>SD</i> = standard deviation. Means, interindividual and intraindividual standard deviations, as well as ICCs are reported on the left side of the table. Bivariate intraindividual correlations (Level 1) are reported below the diagonal, interindividual correlations (Level 2) are reported above the diagonal. Significant parameters are printed bold. *** $p < .001$.									

Main Effect of Nature Exposure on Subjective Age

As shown in Table 2, at the within-person level, greater momentary nature exposure was significantly associated with feeling younger relative to chronological age. The average within-person slope was negative indicating that on days when participants reported more nature exposure than usual, they tended to feel younger. At the between-person level, participants' average nature exposure across the study period was not significantly associated with their overall subjective age. The variance of the random slope was significant, indicating that the strength of the within-person association between nature exposure and subjective age varied across participants.

Table 2
Results for Models predicting Subjective Age in Daily Diary Study.

	Model 1			Model 2			Model 3		
	γ (SE)	p	95% CI	γ (SE)	p	95% CI	γ (SE)	p	95% CI
Intercept	-11.06 (2.43)	< .001	[-15.52, 5.74]	-10.84 (2.30)	< .001	[-15.65, 6.42]	-10.41 (2.68)	< .001	[-15.90, -5.09]
Nature exposure Average (between-person)	-0.12 (0.88)	.435	[-1.78, 1.45]	-0.18 (0.84)	.422	[-1.81, 1.41]	-0.26 (0.97)	.415	[-2.30, 1.41]
Nature exposure Daily (within-person)	-0.54 (0.15)	< .001	[-0.87, -0.27]	-0.55 (0.14)	< .001	[-0.81, -0.27]	-0.51 (0.17)	< .001	[-0.86, -0.19]
Age				-0.01 (0.10)	.445	[-0.21, 0.19]	-0.02 (0.12)	.460	[-0.24, 0.22]
Age moderation				0.01 (0.02)	.233	[-0.02, 0.05]	0.01 (0.02)	.285	[-0.03, 0.04]
Subjective health							-1.00 (1.16)	.195	[-3.67, 0.97]
Education							-0.89 (0.71)	.130	[-2.39, 0.41]
Random slope	0.35 (0.28)	< .001	[0.01, 1.06]	0.29 (0.33)	< .001	[0.01, 1.08]	0.55 (0.39)	< .001	[0.18, 1.62]
R^2_{between} (% explained)	0.02 (0.01)	< .001	[0.01, 0.04]	0.01 (0.02)	< .001	[0.00, 0.07]	0.03 (0.03)	< .001	[0.01, 0.10]
R^2_{within} (% explained)	0.02 (0.01)	< .001	[0.01, 0.04]	0.02 (0.01)	< .001	[0.01, 0.04]	0.03 (0.01)	< .001	[0.01, 0.05]
R^2 (% explained)									
<i>Note.</i> Subjective age is predicted by multilevel models. Unstandardized coefficients are reported together with standard errors in parentheses (γ_{10} for within-person effects and γ_{01} for between-person effects). Significant parameters are printed bold.									

Age Moderation

The results of Model 2 showed that daily nature exposure was significantly associated with subjective age at the within-person level. The between-person effect was not significant. Chronological age was not significantly linked to between-person differences in subjective age. The random slope variance was significant, indicating that there were individual differences in the association of nature exposure and subjective age. However, chronological age was not significantly related to these individual differences.

When covariates – education level and subjective health – were added to the model, the within-person effect of daily nature exposure on subjective age remained significant. At the between-person level, average nature exposure was not associated with average subjective age. Chronological age was not significantly associated with subjective age. The random slope variance for the effect of nature exposure on subjective age was significant, indicating individual differences in the within-person effect. However, chronological age did not moderate this slope.

Exploratory Analyses

The significant within-person association with daily nature exposure was also observed for subjective age related to mental/emotional and physical health when controlling for covariates, but not for subjective age

related to appearance or behavior. The results are presented in Table S1 in the supplementary material.

Discussion

In this study, we examined the association of nature exposure and subjective age through daily diary assessments. The results showed that individuals reported a younger subjective age on days when they spent more time in nature compared to their own average. This association remained robust even after controlling for subjective health and education level, and observed for general subjective age, as well as for subjective age related to mental/emotional and physical health. People who generally spend more time in nature on average over the study days do not report feeling consistently younger (or older) compared to those who spend less time in nature. The interaction with chronological age was not significant, contrary to our expectations, which may be attributable to the relatively narrow age-range of participants in this sample. To address this limitation, the second study was conducted with a broader age range. Building on prior evidence that subjective age can fluctuate even over shorter time intervals than a day (Kornadt et al., 2021), the second study employed an experience sampling design to capture a more nuanced examination of the relationship between nature exposure and subjective age.

Study 2: Experience Sampling Study

Method

Participants and Procedure

Participants were part of the "Quality of Daily Life 2" experience sampling study. The convenience sample was recruited from German-speaking countries. Ethical approval was obtained from the ethics commission of the Faculty of Educational and Developmental Psychology at University of Vienna. Participants were recruited by students in a research seminar during the winter semester 2024, between November 12, 2024, and December 26, 2024. Participants received a one-time monetary compensation of 10 EUR at baseline. A total of 103 adults aged 19–79 years ($M = 47.51$, $SD = 17.78$ years; 56% female) participated in 2,800 situations ($M = 27$, $SD = 11.90$, range 1–76 situations) over a one-week period. Among the participants, 73.8% were married or unmarried in a relationship, 36.9% reported having a university degree, an additional 50.4% reported having completed vocational training or a high school diploma, and 66% were employed. The study was conducted in accordance with the Declaration of Helsinki, and informed consent was obtained from all participants.

Procedure

After completing a baseline questionnaire, daily assessments were conducted with the open-source experience sampling app ESM-Quest (Goetz et al., 2023). Across seven consecutive days, the experience sampling protocol included six scheduled prompts per day in which participants were instructed to describe their current situation in terms of activity and surroundings. The momentary assessment contained questions on the type of current activity (social, physical, mental, etc.), surrounding (place, nature intensity), persons present, nature-related variables (eco and social generativity, nature connectedness, perceived environmental benefit of an action), valence and emotional experience of activity, subjective health, subjective age and age salience.

Measures

Momentary Measures

Subjective Age. To ensure comparability across momentary assessments and to reduce cognitive load during repeated measurements in the experience sampling design, momentary subjective age was measured with the

item: "How old did you feel in the situation?" with Likert scale ranging from 1 = "Much younger" to 7 = "Much older" ($M = 3.92$, $SD = 0.49$).

Momentary Nature Exposure. Subjectively perceived closeness to nature in everyday situations was measured with the item: "How close to nature was the environment?" wherein participants had to indicate whether during the momentary assessment they were 1 = "not at all close to nature", 2 = "somewhat close to nature", 3 = "quite close to nature", 4 = "in pure nature" ($M = 1.82$, $SD = 0.80$).

Covariates. Education level from baseline was used as a covariate in the momentary analyses. It was coded on a 5-point scale ranging from 1 = no formal education to 5 = university degree. Subjective health was assessed at baseline with one item: "How would you describe your general health status over the past three months? My health status was ..." Responses were given on a 6-point Likert scale ranging from 1 = "excellent" to 6 = "very poor."

Analyses

Study 2 adopted the same analytical approach as Study 1, with the difference that the hierarchical structure of the data was defined at the situational (Level 1: situations, Level 2: participants) rather than the daily level.

Results

Descriptive Results

Means, inter- and intraindividual SD s, intraclass correlations (ICCs), and inter- and intraindividual correlations are presented in Table 3. The results indicate relatively low average nature exposure and substantial within-person fluctuation – about 78% of the variance occurred within individuals across situations. Approximately 76% of the total variance occurred within individuals' subjective age across measurement occasions, confirming that subjective age is highly momentary and dynamic in daily life (Schmidt et al., 2024). The correlation analysis results showed again that higher nature exposure was associated with feeling subjectively younger. Younger subjective age was also significantly associated with higher subjective health.

Table 3
Descriptives and Bivariate Inter correlations of the Variables in Experience Sampling Study.

Variable	Mean	SD_{inter}	SD_{intra}	ICC	1	2	3	4	5
1. Nature Exposure	1.82	0.38	0.70	0.227		-0.19	-.01	0.25	-0.11
2. Subjective Age	3.92	0.24	0.43	0.245	-0.06**		0.31*	-0.24	-0.07
3. Subjective Health	2.66	1.02		1				-0.20	-0.30*
4. Age	47.51	17.78		1					-0.10
5. Education	4.11	0.88		1					
<i>Note.</i> ICC = intraclass correlation; SD = standard deviation. Means, interindividual and intraindividual standard deviations, as well as ICCs are reported on the left side of the table. Bivariate intraindividual correlations (Level 1) are reported below the diagonal, interindividual correlations (Level 2) are reported above the diagonal. Subjective health reversed coded (lower values - higher subjective health). Significant parameters are printed bold.									
** $p < .01$, * $p < .05$.									

Main Effect of Nature Exposure on Subjective Age

As shown in Table 4, greater momentary nature exposure was not significantly associated with lower subjective age at the within-person level in Model 1. However, the posterior probability of a negative association was 96% ($p = .040$), indicating that higher momentary nature exposure was very likely associated with feeling younger. The random slope variance was significant, indicating that the association between nature exposure and subjective age varied significantly across individuals. At the between-person level, the association between average nature exposure and average subjective age was not significant, with posterior probability of 97% indicating a tendency for higher average nature exposure to be associated with feeling younger.

Table 4
Results for Models predicting Subjective Age in Experience Sampling Study.

	Model 1			Model 2			Model 3		
	γ (SE)	p	95% CI	γ (SE)	p	95% CI	γ (SE)	p	95% CI
Intercept	3.91 (0.03)	< .001	[3.85, 3.96]	3.92 (0.03)	< .001	[3.87, 3.96]	3.92 (0.03)	< .001	[3.87, 3.96]
Nature exposure Average (between-person)	-0.14 (0.08)	.030	[-0.32, 0.00]	-0.07 (0.08)	.160	[-0.24, 0.07]	-0.10 (0.07)	.100	[-0.21, 0.06]
Nature exposure Daily (within-person)	-0.04 (0.02)	.040	[-0.08, 0.01]	-0.03 (0.02)	.070	[-0.06, 0.01]	-0.03 (0.02)	.015	[-0.08, -0.01]
Age				-0.003 (0.00)	< .001	[-0.01, -0.001]	-0.003 (0.00)	.010	[-0.01, -0.001]
Age moderation				-0.002 (0.00)	.030	[-0.007, -0.001]	-0.003 (0.00)	< .001	[-0.01, -0.001]
Covariate Subjective health							0.09 (0.03)	< .001	[0.03, 0.15]
Covariate Education							-0.02 (0.03)	.335	[-0.07, 0.05]
Random slope	0.02 (0.00)	< .001	[0.01, 0.03]	0.01 (0.01)	< .001	[0.01, 0.02]	0.01 (0.01)	< .001	[0.00, 0.02]
R^2_{between} (%) explained)	0.05 (0.05)	< .001	[0.00, 0.19]	0.05 (0.03)	< .001	[0.01, 0.14]	0.16 (0.06)	< .001	[0.05, 0.26]
R^2_{within} (%) explained)	0.04 (0.02)	< .001	[0.02, 0.09]	0.04 (0.02)	< .001	[0.02, 0.10]	0.04 (0.02)	< .001	[0.02, 0.07]
R^2 (%) explained)									
<i>Note.</i> Subjective age is predicted by multilevel models. Unstandardized coefficients are reported together with standard errors in parentheses (γ_{10} for within-person effects and γ_{01} for between-person effects). Significant parameters are printed bold.									

Age Moderation

In Model 2, the average within-person slope of nature exposure predicting subjective age was not statistically significant. The random slope variance was significant, indicating heterogeneity in the within-person effect. At the between-person level, average nature exposure was not associated with average subjective age. Chronological age was significantly associated with subjective age, with older participants reporting feeling younger relative to their chronological age. Moreover, age moderated the within-person nature-subjective age relationship, suggesting the association between nature exposure and feeling younger was more pronounced in older individuals.

After controlling for covariates, the average within-person association of nature exposure and subjective age was significant, indicating that on occasions with more nature exposure, people felt younger relative to their chronological age. At the between-person level, average nature exposure was not significantly related to average subjective age. Chronological age was again negatively associated with subjective age. The random slope variance was significant, evidencing heterogeneity in the within-person nature effect. Importantly, age significantly moderated the within-person association between nature exposure and subjective age. As illustrated in Fig. 1, the within-person association between nature exposure and younger subjective age was weak or absent at younger ages but became increasingly negative from midlife onward, indicating a stronger rejuvenating effect of nature exposure with increasing age.

Discussion

Study 2 built on Study 1 by examining the association between momentary nature exposure and momentary subjective age across a broader age range. After controlling for covariates, the results showed younger subjective age in persons when exposed to nature more than usually. The results also showed, as expected, that nature exposure was more strongly associated with a younger subjective age among participants approximately from age 47 onward, suggesting that the benefits of nature exposure for feeling younger are particularly pronounced in mid-life and older age.

General Discussion

The aim of the current paper was to investigate the association between nature exposure and subjective age on a daily and momentary level, and to test whether these beneficial effects of nature exposure on subjective age are particularly pronounced in later life. Overall, the pattern in our findings suggests that day-to-day and moment-to-moment increases in nature exposure above one's personal baseline were associated with younger subjective age when controlling for education and subjective health, while individuals who generally spent more time in nature did not report feeling younger on average compared to those with less exposure. This suggests that the benefits of nature may lie less in stable differences between individuals and more in the dynamic, situational gains derived from daily and momentary fluctuations in exposure.

Although Schmidt et al. (2024) reported negligible intraindividual but consistent interindividual associations between sunshine and subjective age, it seems that nature restorative capacity beyond sunlight (stress reduction, mood improvement, cognitive recovery) via biopsychosocial pathways are inherently situational and immediate. This is in line with Attention Restoration Theory (Kaplan, 1995) and Stress Recovery Theory (Ulrich et al., 1991), as well as a large body of experimental and meta-analytic research that confirms that short-term and momentary exposure to nature—ranging from a few minutes to an hour—can produce immediate improvements in mood, reductions in stress (as measured by both self-report and physiological markers), and enhanced cognitive performance (Bettmann et al., 2024; Jimenez et al., 2021; Mason et al., 2021; Mygind et al., 2019; Shuda et al., 2020; Zhang et al., 2023). Evidence for long-term or sustained restorative effects are limited and less conclusive (de Keijzer et al., 2019; Jimenez et al., 2021; Moll et al., 2022). Although studies focusing specifically on the dosage of nature required to achieve restorative or salutogenic effects often suggest promoting longer green space visits, they nevertheless identify short thresholds—as low as 30 minutes—as sufficient to produce such effects (e.g., Shanahan et al., 2016). Our results thus align with both theories and majority of empirical work and emphasize immediate and short-term effects of nature exposure.

The consistent non-significant between-person association between nature exposure and subjective age may suggest that restoration does not accumulate in a simple additive way. Alternatively, cumulative effects of nature exposure on age identity may emerge over longer durations of exposure rather than over the few days or weeks as examined in this study. Moreover, subjective age may be shaped more by stable self-views and life course factors. Thus, our findings show that nature exposure may help people “reset” their felt age in everyday

life, but it does not redefine their long-term age identity. Interventions should aim to create opportunities for individuals to engage with nature more frequently than is typical for them, rather than focusing solely on promoting high overall levels of nature exposure.

Interestingly, the significant within-person association with nature exposure is also observed for subjective age related to physical and mental health, and it does not extend to subjective age for appearance and behavior. This suggests the effect generalizes more to internal than outward perceptions of age. This is in line with empirical evidence showing the salutogenic effects of nature in terms of biological and psychological pathways (White et al., 2023), but not with the research on effect of nature on maintaining a positive self-image (e.g., Stieger et al., 2022). For instance, exposure to natural environments – such as urban parks, beaches, and botanic gardens – has been found to improve self-image in terms of body and physical appearance (e.g., Swami et al., 2020). However, feeling younger in terms of appearance may be shaped by age-related characteristics that are not directly influenced by nature exposure (e.g., wrinkles, hair color). Similarly, although nature exposure may encourage behaviors typically associated with younger age (e.g., greater physical activity), behavioral self-perceptions are embedded in broader social and cultural frameworks and may therefore be less amenable to daily or momentary change through nature exposure.

Importantly, the results of the experience sampling study showed that the effect of nature exposure on younger subjective age is particularly pronounced in mid-life and old age. This aligns with the finding on positive effects of a younger subjective age on health—by counteracting the detrimental effects of stress—being pronounced with increased age (Wettstein et al., 2021). Our results show that nature exposure may allow middle-aged and older individuals to maintain a younger subjective age. As such, our findings point to promising avenues for public health interventions in later life. Incorporating nature visits that go slightly beyond an individual’s usual level of exposure—for example, organizing outings within community-based programs or in care homes for institutionalized people—may help persons feel younger and consequently support their overall health and functioning.

However, it is important to note that while much research emphasizes the benefits of feeling younger, this framing implicitly reinforces the view that “feeling old” is undesirable. A recent study showed that aging individuals try to maintain the self-concept of a *young* person, either by feeling younger than they are or by distancing themselves from their age or older people of their age because they are associated with negative stereotypes (Rupprecht et al., 2025). A broader societal and scientific goal should also be to make people feel good with their old age. Nature may provide a particularly fertile context for this process. As it inherently represents the cycles of life and death, nature reflects the continuous processes of birth, growth, and decay (Koole & Van den Berg, 2004). It also evokes existential, meaning-making and spiritual reflection in later life (Korlat et al., 2026; Orr et al., 2016), all of which could help older individuals to come to terms with their aging and mortality. With increasing age, natural places may take on even greater significance, offering comfort, belonging, and a sense of being part of something larger than oneself (Korlat et al., 2026). In this way, nature could not only help older adults feel energized, vitalized and well, but also help them dissociate from negative age stereotypes and enable them to embrace old age as a meaningful and positive life phase.

Future research should therefore examine the underlying psychological mechanisms linking nature exposure to subjective age and broader views of aging in later life. The observed individual variability in the within-person association between daily nature exposure and subjective age in our model indicates that not all older adults respond to nature in the same way. Understanding for whom, how and under which conditions nature contributes most to feeling younger could provide valuable insights for promoting positive aging experiences.

Several limitations of the present study should be acknowledged. First, the number of nature exposure moments captured in our data was relatively limited, with the majority of situations in Study 2 occurring in environments with little or no nature. While this constrains the variability in nature exposure, it can also be viewed as a strength: even under these conservative conditions, significant associations emerged, suggesting

that stronger or more consistent contact with nature could yield even more pronounced effects. Future studies should apply a more fine-grained scale (e.g., 0-100 sliding scale), to allow for more variance. Second, the operationalization of nature exposure differed between the two studies: in the daily diary study, it reflected the intensity of daily nature exposure (i.e., how much time participants spent in natural environments throughout the day), whereas in the ESM study, it captured the situational presence of nature (i.e., how much nature was perceived in the momentary environment). Although this difference was required by the respective methodologies, it may have introduced some conceptual variability. Third, the two studies were conducted in different seasons (spring vs. winter), which introduces variability in weather and daylight conditions and could reinforce the significance of the results in Study 1. At the same time, this may also enhance the robustness of the findings from Study 2, indicating that the beneficial effects of nature exposure can be observed even during winter and are potentially not limited to specific seasonal contexts. Fourth, we did not account for any situational characteristics (e.g., social context, activity type, or environmental quality) that could explain the observed heterogeneity in individual slopes. Nevertheless, the fact that a general positive effect of nature exposure emerged despite this variability strengthens the reliability of the overall finding. Future studies should aim to identify contextual and individual factors that explain when and for whom nature most strongly influences subjective age.

Overall, the results revealed a prevailing pattern of significant within-person associations between nature exposure and subjective age, indicating that individuals felt younger on days or in situations when they were more exposed to nature. These effects remained significant even after accounting for education as a proxy for socioeconomic status and for subjective health. Moreover, the experience sampling study demonstrated that this association was more pronounced among older adults. The finding that nature exposure was associated with subjective age at the within-person but not the between-person level suggests that the benefits of nature are not limited to those who generally spend more time in nature but rather occur when individuals experience more nature than they typically do. This finding highlights the potential of everyday interventions that increase momentary contact with nature—particularly for older adults—as a means of fostering a younger subjective age and potentially supporting other positive developmental and health outcomes related to subjective age.

Declarations

Author contributions:

SK: Conceptualization, Methodology, Writing - Original Draft, Visualization; **GH:** Software, Formal analysis, Writing - Review & Editing; **CR:** Data Curation, Writing - Review & Editing; **IW:** Data Curation, Writing - Review & Editing; **JN:** Investigation, Writing - Review & Editing, Supervision.

Data availability statement:

The data that support the findings of this study are available from the corresponding author upon request.

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We have no conflicts of interest to disclose.

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During the preparation of this manuscript, ChatGPT-5.2) was used for language editing. Consensus and Elicit were used to assist with AI-powered literature searches. The authors take full responsibility for the selection,

interpretation, and synthesis of the literature, as well as for all analyses, conclusions, and final wording of the manuscript.

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Figures

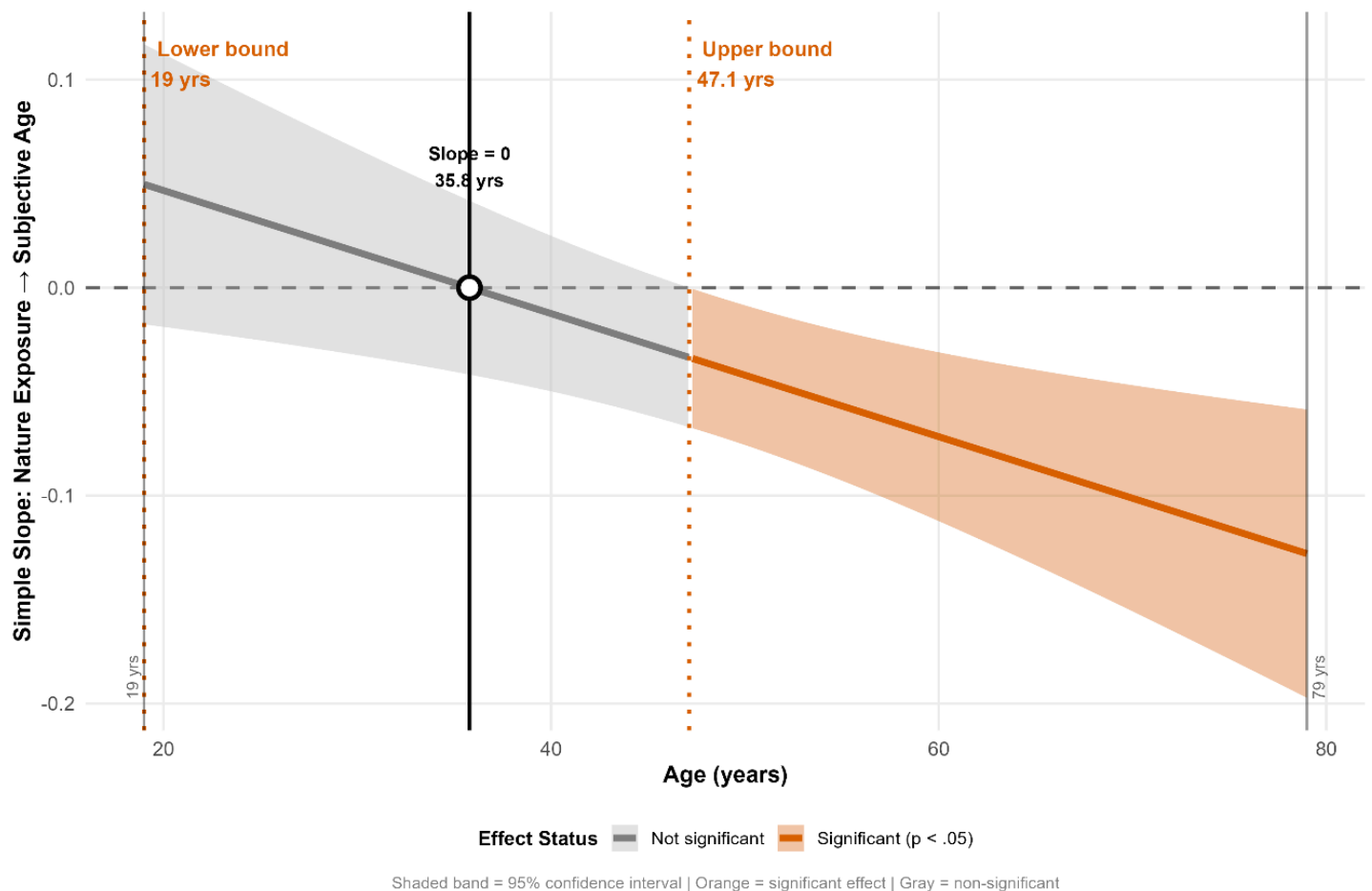


Figure 1

Johnson-Neyman plot depicting the conditional within-person effect of daily nature exposure on subjective age across chronological age

Note. Solid line depicts estimated simple slope and shaded bands represent 95% confidence intervals. Orange regions indicate age ranges with statistically significant effects ($p < .05$), whereas gray regions indicate non-significant effects. The dotted vertical line marks the Johnson-Neyman threshold, and the solid vertical line denotes the crossover point where the slope equals zero.

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