Frequent-Individual Walking in Nature Decreases Stress Cortisol and Promotes a Better Quality of Life in Older Adults

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Abstract

There was no significant difference between subject factors either in SCC or SAA. Within-subject factors showed an inverse result where SCC significantly declined from baseline to endline (p<0.001), while SAA increased (p<0-001). The quality of life, mainly in mental health components, rose considerably after the a-month of intervention.

Keywords: Natural environment; salivary cortisol; salivary alpha amylase; quality of life

Introduction

By 2050, older adults will account for 2.1 billion, which is double what we have today [1]. Age-associated psychological changes are marked remarkably by a decline in cognitive performance and mental health. Anxiety disorders, stress, depression, and dementia are seniors' most prevalent psychological illnesses that lead to lower quality of life [2]. Empirically, studies have profoundly proved the benefits of the natural environment's restorative effects on mental health-related outcomes, and well-being. People who live in higher greenspaces have a steeper cortisol slope profile compared with people in lower greenspaces [3]. A large amount of greenery is associated with less mental stress, and greater happiness [4]. However, the dosage (frequency and duration) and way to access the nature (individual or group visit) still remain unclear and need to be well-documented and translated into public health policy. Therefore, the present study seeks to investigate experimentally the effects of individual but frequent exposure to the natural environment on stress and quality of life in Slovak seniors.

Methodology

- A randomized-parallel intervention study
- Natural environment indicators (objectively): NDVI (Landsat surface reflectance-derived NDVI-USGS), tree cover (European Environment Agency), Distance to park and forest (Geofabric.de) – ArcGIS 10.1
- Participants: 54 Slovak seniors
- Inclusion criteria: (1) age of 60+, (2) vaccinated from COVID-19, (3) being able to walk independently (walking aid was possible), (4) not living in the institutional care, (5) not under the prescribed anti-depressant (6) willing to participate.
- Main intervention: forest exposure vs urban environment as active control
- Outcomes:
  1. Salivary cortisol–alpha amylase concentration: Collected with salivary tubes (Salivette® device; Sarstedt). Salivary cortisol concentration was determined using enzyme-linked immunosorbent assay (IBL International, Germany). Intra and inter assay CV were 2.9% and 5.0% respectively. For SAA, the Salimetrics, Suffolk, UK was occupied. The coefficient of intra- and inter-assay variation was 6.7% and 3.6%.
  2. Quality of life - Standardized Slovak version of the 36-item Sort-Form Health Survey (SF-36). Components: physical functioning (PF), role physical (RP), bodily pain (BP), general health (GH), social functioning (SF), role emotional (RE), and mental health (MH).
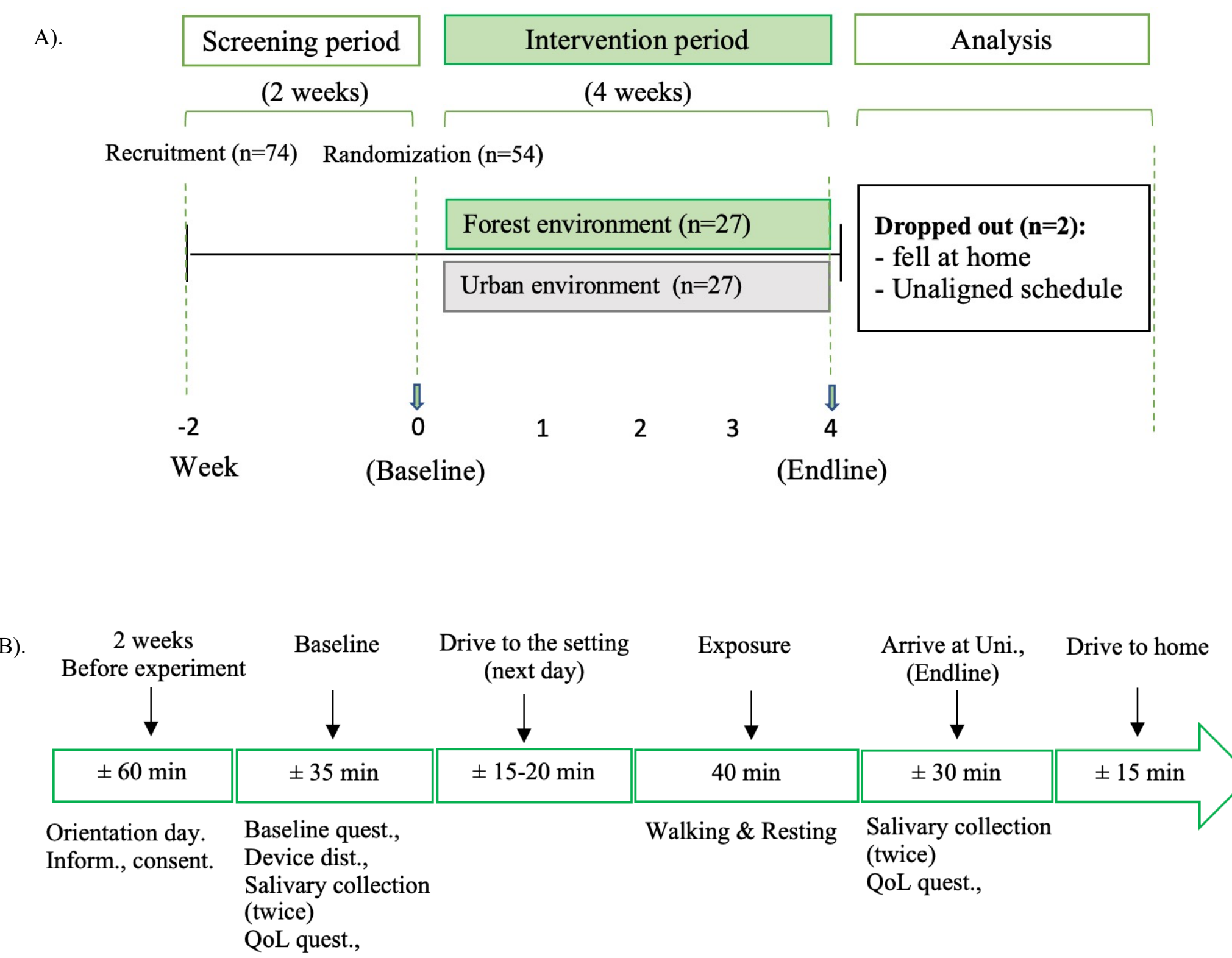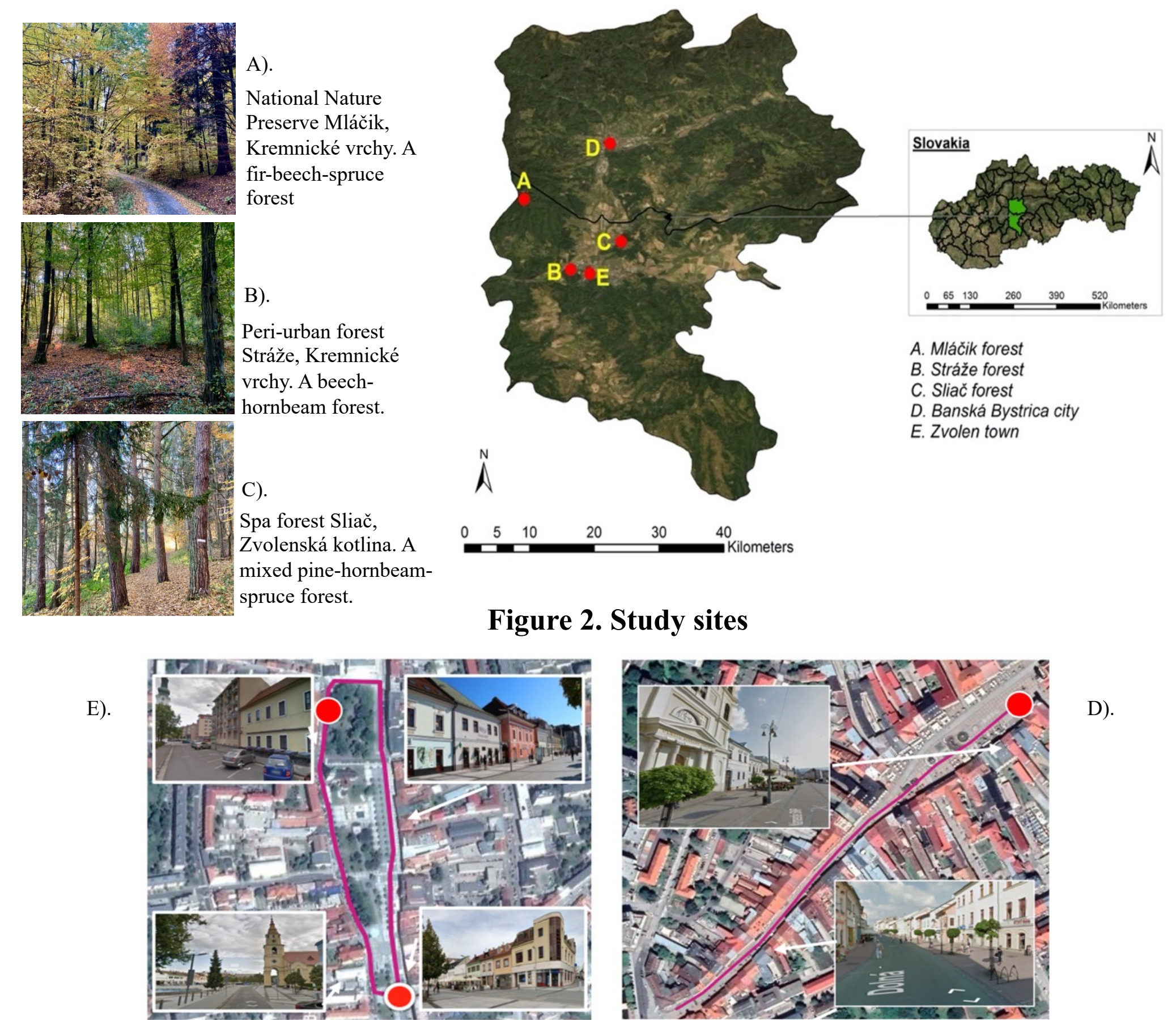

Figure 1. (A) Experimental design (Randomized Parallel intervention). The study was performed for 4 consecutive weeks. Each day, three to four people were allocated individually to six different research sites. (B) Research timeline: the primary measurement was conducted twice (baseline and endline) with total 8 walks with 40 minutes per visit.

Results

Figure 2. Study sites

Table 1. Baseline characteristics of study participants by environment

Characteristics	Forest (n=27)	Urban (n=27)	Comparison Significant Level (p)
Sex, male (n (%))	10 (37)	10 (37)	1
Age in years (Mean (SD))	72.3 (5.2)	69.7 (4.5)	0.055
BMI (mean (SD))	27.94 (4.5)	27.87 (4.4)	0.95
BMI Underweight (n (%))	4 (14)	4 (14)	0.17
BMI Overweight (n (%))	10 (37)	8 (29)	0.27
Marital status			
Married/partnership	15	18	0.57
Unmarried	1	0	1
Divorced	3	3	1
Widowed	8	6	0.75
Education			
Basic	0	3	0.23
Medium	17	11	0.17
High School	10	13	0.58
Tobacco/Smoking status			
Non-smoker	20	25	0.14
Ex-smoker	2	2	1
Current smoker	5	0	0.06
No. of chronic illness			
Has 1	11	13	0.78
Has >1	10	10	1
None	6	4	0.72
SES			
Employed	0	1	1
Entrepreneur	0	0	-
Retired	27	26	1
Disabled retired	0	0	-
Unemployed	0	0	-
Others	0	0	-
Household Income (€)			
≤ 500	3	7	0.29
501-800	11	10	1
801-1500	13	8	0.26
>1500	0	2	0.47
COVID-19 History			
No	23	25	0.66
Yes	4	2	0.66
Garmin Device**			
Steps	7267.14 (3695.41)	7054.33 (2596.46)	0.80
HR	69.42 (7.91)	71.01 (4.94)	0.38
HRV (Δ)	2.70 (5.05)	2.17 (6.41)	0.74
Stress level	31.98 (5.67)	30.88 (4.80)	0.44
Sleep Quality**			
Light sleep	4.56 (0.56)	4.61 (0.60)	0.77
Deep sleep	1.48 (0.75)	1.24 (0.69)	0.22
REM	1.55 (0.49)	1.61 (0.45)	0.64
Sleep duration	7.33 (0.93)	7.32 (0.68)	0.95
Natural Environment**			
NDVI	0.23 (0.07)	0.27 (0.08)	< 0.01
Tree canopy	5.07 (12.85)	7.02 (16.34)	0.13
Distance to park	726.91	1288.4	0.08
Distance to Forest	644.2	515.1	0.20

Figure 3. Natural environment indicators (objectively)
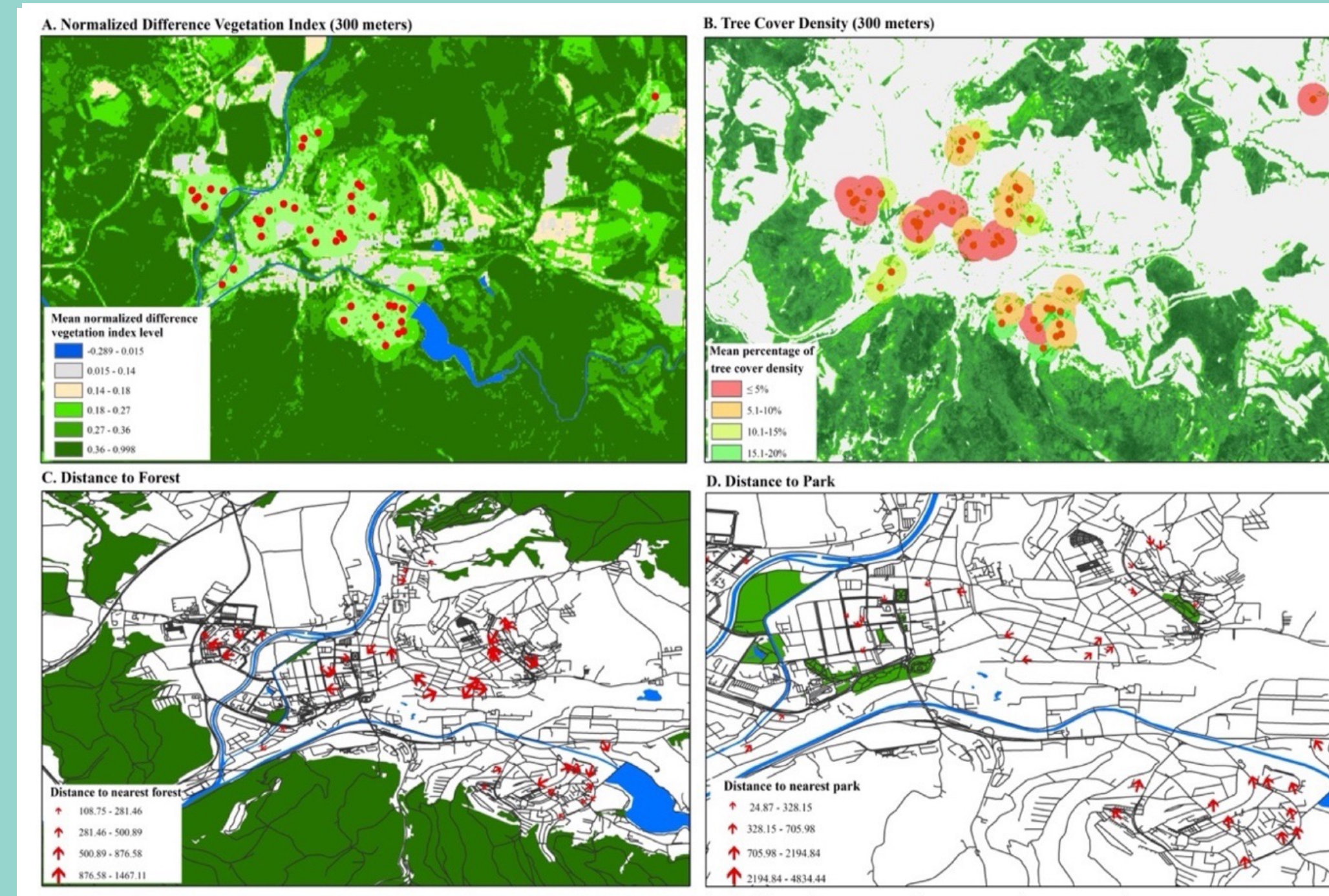
Table 2. Repeated Measures ANOVA of Salivary Cortisol and Alpha Amylase Concentration

		SCC (ng/mL)	SAA (U/ml)
		Baseline	
Forest	Morning	4.68 (2.03)	80.27 (81.59)
	After walking	1.04 (0.54)	122.12 (93.61)
		Endline	
	Morning	3.37 (1.73)	84.74 (108.37)
	After walking	1.05 (0.79)	132.68 (114.43)
		Baseline	
Urban	Morning	4.5 (2.1)	64.05 (45.51)
	After walking	0.89 (0.33)	140.99 (115.42)
		Endline	
	Morning	4.89 (2.6)	66.08 (53.49)
	After walking	0.96 (0.42)	101.77 (66.24)
p-value	Condition[a]	0.37 vs 0.19	0.91 vs 0.61
	Time[b]	<0.001 vs <0.001	<0.001 vs <0.001
	Interaction[c]	0.43 vs 0.05	0.33 vs 0.46
	η2ρ[d]	0.012 vs 0.074	0.019 vs 0.011

a. between subject factor . b. within subject factor c. CxT . d. Partial eta squared interaction
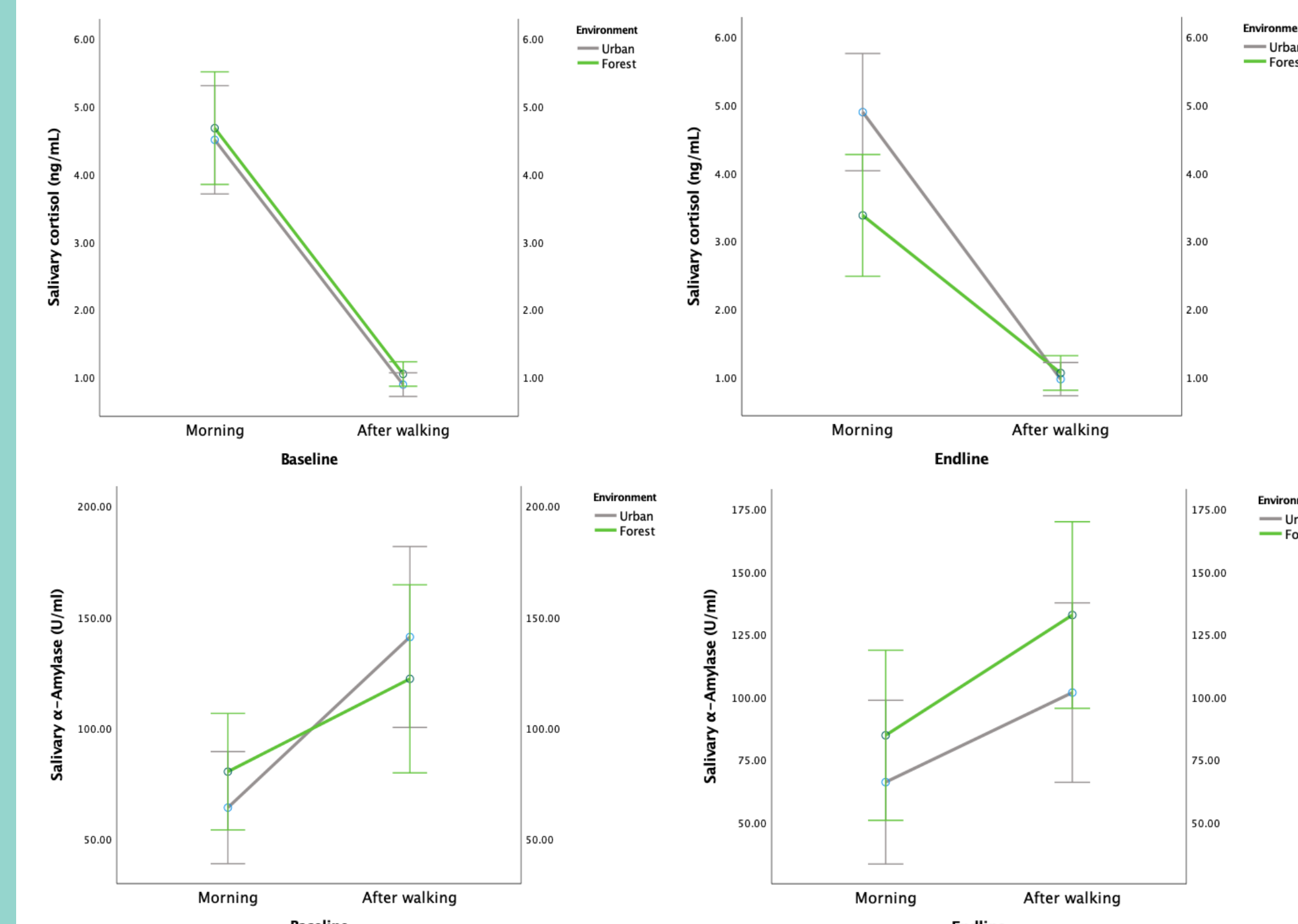

Figure 4. Baseline and endline means of environments on SCC and SAA

Table 3. Friedman test and post-hoc analysis on the quality of life

Quality of life	Median Baseline	Median Endline	χ2	p-value	Z*	p-value**
Physical health						
Physical functioning	85	85	1.195	0.274	*Do not significant*	
Role limitation physical	62.5	68.75	4.667	0.031	−1.615	0.106
Bodily pain	67.5	77.5	3.103	0.078	−1594	0.111
General health	68.75	75	0.857	0.355	*Do not significant*	
Mental health						
Emotional well-being	75	82.5	12.755	<0.001	−3.533	<0.001
Role limitation emotional	75	75	0.024	0.876	*Do not significant*	
Social functioning	75	87.5	4.235	0.040	−1.473	0.141
Energy/vitality	68.75	75	15.244	<0.001	−3.487	<0.001

* Z-score of Wilcoxon Sign Rank test. ** p-value of Wilcoxon test adjusted with Bonferroni correction

Figure 5. Walking and resting activities

Table 4. Numbers of participants who manifested improved/deteriorated QoL

Quality of life	Urban Improved	Urban Constant	Urban Deteriorate	Forest Improved	Forest Constant	Forest Deteriorate	Pearson χ2*	p-value
Physical health:								
Physical functioning	8 (47.1%)	9 (69.2%)	10 (41.7%)	9 (52.9%)	4 (30.8%)	14 (58.3%)	2.649	0.266
Role limitation physical	14 (50%)	7 (58.3%)	6 (42.9%)	14 (50%)	5 (41.7%)	8 (57.1%)	0.619	0.734
Bodily pain	12 (48.0%)	8 (53.3%)	7 (50%)	13 (52.0%)	7 (46.7%)	7 (50%)	0.107	0.948
General health	10 (55.6%)	9 (75.0%)	8 (33.3%)	8 (44.4%)	3 (25.0%)	16 (66.7%)	5.889	0.053
Mental health:								
Emotional well-being	16 (43.2%)	4 (80.0%)	7 (58.3%)	21 (56.8%)	1 (20.0%)	5 (41.7%)	2.809	0.245
Role limitation emotional	11 (55.0%)	9 (69.2%)	7 (33.3%)	9 (45.0%)	4 (30.8%)	14 (66.7%)	4.456	0.108
Social functioning	10 (43.5%)	12 (60.0%)	5 (45.5%)	13 (56.5%)	8 (40.0%)	6 (54.5%)	1.282	0.527
Energy/Vitality	17 (51.5%)	7 (53.8%)	3 (37.5%)	16 (48.5%)	6 (46.2%)	5 (62.5%)	0.607	0.738

*Pearson chi-square of environment on QoL status

Discussion and conclusion

- Most baseline characteristics in Table 1 were not significantly different between urban and forest environments. Only NDVI differed profoundly (0.23 and 0.27, respectively).
- Figure 3 portrays the overall mean of NDVI of residential greenness within 300m is 0.26, tree cover density ranges from 0 to 19.91%, with a mean of 3.48%. Participants' residentials are closer to the forest (576.68 meters) than park (1025.65 meters).
- There is no significant difference between–subject factors (Condition) either in SCC or SAA (Table 2).
- The main effects of Time (within-subject factors) significantly declined from baseline to endline in SCC, while the trend is vice versa in SAA (both p<0.001). The condition by time effect shows a medium but profound effect (η2p=0.074, p=0.05), particularly for SCC endline.
- Almost all aspects of the QoL are increased after the intervention. Only physical functioning and role limitation emotional are unchanged. Mental health components majority rose considerably.
- Post hoc analysis was carried out to compare whether QoL is improved, constant, or deteriorated. Wilcoxon test result with Bonferroni adjustment (0.05/3) attained a new p-value (0.017) showing that only emotional well-being and energy (vitality) were significantly different in positive, negative, and unchanged responses before and after intervention (Z= −3.533, p<0.001, and Z= −3.487, p<0.001, respectively).
- To summarize, there was a significant difference after one-month intervention with individuals walking on the SCC, SAA, and QoL. However, after adjusting the environment, the significance disappeared. Our further direction is to perform a big-scale analysis to establish the multiple pathways of nature and mental health by utilizing the available data source. Thus, the magnitude of the result can be generalized to broader settings, especially in older adults' context.

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Acknowledgement

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