International Journal of Geo-Information

MDPI

*Article*

# The Moderating Role of Street-View Greenery in the Relationship Between Mental Health and Life Satisfaction: An Exploratory Case Study Across Contrasting Community Contexts in Korea

**Yoohyung Joo [1], Jaeyoung Jung [1], Jiwan Hong [1], Sangyoon Park [2], Jaelim Cho [3], Juyeon Ko [3], Changsoo Kim [3] and Joon Heo [1,*]**

[1] Department of Civil and Environmental Engineering, Yonsei University, Seoul 03722, Republic of Korea; yooju01@yonsei.ac.kr (Y.J.); ind02222@naver.com (J.J.); hjw24865@yonsei.ac.kr (J.H.)
[2] Lyles School of Civil and Construction Engineering, Purdue University, West Lafayette, IN 47907, USA; parksangyoon@yonsei.ac.kr or park1858@perdue.edu
[3] Department of Preventive Medicine, Yonsei University College Medicine, Seoul 03722, Republic of Korea; chojael@yuhs.ac (J.C.); kojuyuan92@yuhs.ac (J.K.); preman@yuhs.ac (C.K.)
* Correspondence: jheo@yonsei.ac.kr

**Abstract**

Growing evidence suggests that urban greenery is associated with improved mental health, yet how eye-level exposure functions within specific socio-environmental contexts remains underexplored. This study presents an exploratory case study utilizing semantic segmentation of street-view imagery to quantify eye-level greenery ("open greenery") across two contrasting community contexts: a densely developed area (Region 1) and a less developed area (Region 2) in Korea. Using interaction models reinforced by 5000-iteration bootstrap analyses, we identified the moderating role of greenery in the relationship between mental health (depression and cognitive function) and life satisfaction. Our findings indicate that the psychological benefits of greenery are highly contingent upon the interplay between individual vulnerability and regional context. Specifically, in Region 1, greenery moderated well-being for the low-cognitive function subgroup, while in Region 2, the moderating effect was most pronounced among individuals with depressive symptoms. Despite the inherent limitations of small subgroup samples, the stability of these patterns across repeated bootstrap iterations highlights meaningful "spatial intersections" where greenery plays a role in shaping psychological well-being. By adopting a case-centric approach, this study highlights that the benefits of street-view greenery are not uniform but context-dependent. These results underscore the necessity of context-aware green infrastructure strategies tailored to the specific environmental needs of vulnerable populations in diverse community settings.

**Keywords:** street-view imagery; eye-level greenery; mental health; life satisfaction; spatial contexts

Check for updates

Academic Editor: Wolfgang Kainz

Received: 7 May 2026
Revised: 10 July 2026
Accepted: 14 July 2026
Published: 22 July 2026

**Copyright:** © 2026 by the authors. Published by MDPI on behalf of the International Society for Photogrammetry and Remote Sensing. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license.

## 1. Introduction

Subjective well-being is closely linked to the surrounding environment, and numerous studies show that neighborhood greenery positively affects residents' mental health and subjective well-being [1–3]. Green spaces promote physical activity [1,4], help prevent diseases [5], and offer calming environments that reduce psychological distress [6,7]. Stress

Reduction Theory [8] posits that viewing nature elicits restorative emotional responses, while Attention Restoration Theory [9] highlights nature's ability to restore cognitive resources. Experimental evidence supports these theories, demonstrating that exposure to natural settings lowers stress and improves attentional functioning [10,11].

Recent advances in deep learning and semantic segmentation have enabled the extraction of greenery from street-view images, providing a perspective that reflects what residents actually see [12–14]. Street-view imagery offers fine-grained, ground-level views of trees and sky, capturing greenery that may be obscured in aerial imagery [15]. This approach complements traditional greenery measures—such as spatial proximity and satellite-based indices (e.g., NDVI)—which may not fully capture how greenery is perceived at eye level [16,17].

Notably, street-view greenery has been associated with improved mental health outcomes, including reductions in depression among older adults [18]. While traditional satellite-based indices primarily capture the presence of vegetation from an aerial perspective, street-view imagery reflects the visual environment as perceived at eye level. This approach captures the sensory and experiential qualities of greenery that are often overlooked in top-down measures [2,19]. By representing the environment as individuals navigate and interact with it in daily life, street-view greenery provides a more nuanced measure of environmental exposure.

Existing research has consistently identified positive links between greenery, mental health, and life satisfaction. Previous studies have also suggested a reciprocal relationship between mental health and life satisfaction [20–22]. Nevertheless, most studies examining greenery have focused on direct or mediated pathways, where greenery improves psychological states which, in turn, enhance life satisfaction [1,2]. Far less understood is whether greenery moderates the relationship between mental health and life satisfaction.

Mental health indicators, such as depression and cognitive function, are strongly associated with life satisfaction [23,24]. Specifically, depression has been shown to reduce life satisfaction by fostering persistent negative evaluations of one's life circumstances, whereas better cognitive function supports adaptive appraisal and coping processes that contribute to higher subjective well-being [25–27]. Although previous studies suggest that mental health and life satisfaction may reinforce one another over time, it remains unclear whether greenery modifies this relationship. Understanding whether greenery buffers the negative effects of poor mental health or amplifies positive psychological states in shaping life satisfaction is therefore an important research question.

Another gap in the literature concerns spatial context. Evidence suggests that the mental health benefits of greenery may vary across community settings [28,29]. However, empirical comparisons of street-view greenery across such contexts remain limited. Environmental and social conditions differ substantially between densely developed and less developed areas, potentially shaping how individuals experience restorative benefits. Examining how the moderating role of greenery varies across local contexts is therefore essential for informing place-specific planning and public health strategies. Given its rapid urbanization and diverse urban forms, Korea provides a valuable context for examining how variations in development density influence the psychological benefits of greenery.

This study addresses these gaps by investigating whether street-view greenery moderates the relationship between mental health and life satisfaction across two distinct community settings. We examine depression and cognitive function—two key indicators of mental health among middle-aged and older adults—and assess whether their associations with life satisfaction vary with levels of greenery exposure. Focusing on middle-aged and older adults is particularly important, as this population is more vulnerable to age-related mental health challenges, including depression and cognitive decline [30]. Given that

older adults spend more time in their immediate residential environments, street-level greenery may serve as a more salient determinant of life satisfaction in this group than in younger populations [31]. To better reflect how individuals visually perceive their residential environments from a pedestrian's eye-level perspective, this study combines visible green (tree canopy) and blue (sky) elements into a measure of "open greenery." Rather than quantifying vegetation density alone, this measure was designed to capture the visual openness of the surrounding natural environment as experienced in everyday life. Additionally, individual-level covariates were included to isolate the associations between open greenery, mental health, and life satisfaction.

Two hypotheses guide this study. First, street-view greenery moderates the relationship between mental health and life satisfaction, such that the magnitude or direction of this association varies across levels of greenery exposure. Second, this moderating effect differs across spatial contexts, reflecting the influence of local environmental and social conditions. By exploring these relationships in geographically distinct community settings, this study contributes to a deeper understanding of how eye-level environmental features shape life satisfaction. (Figure 1). Given the focus on two contrasting community settings, this study adopts a case-based analytical approach to explore context-specific patterns rather than to establish universal relationships.

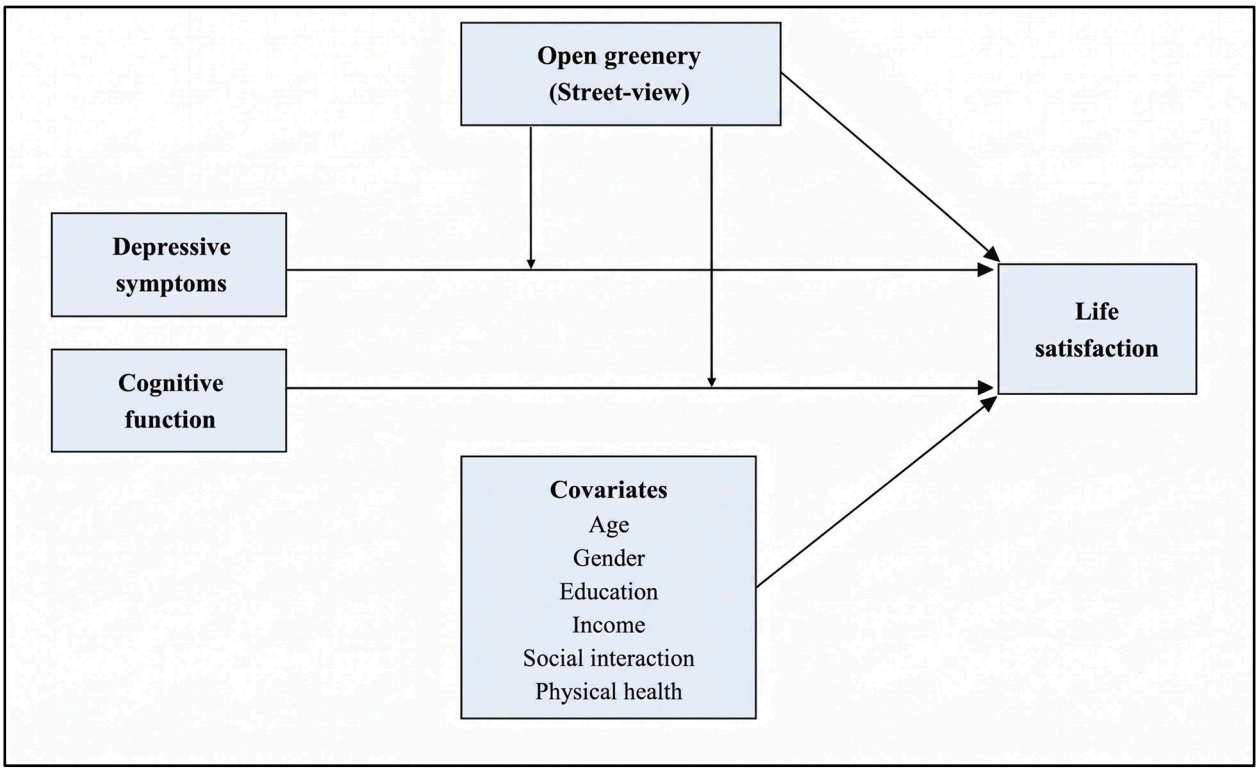



**Figure 1.** Research frame.

## 2. Materials and Methods

### *2.1. Study Area and Population*

The study was conducted in two contrasting regions in Korea: the more densely developed Namdong-gu in Incheon (Region 1) and the less developed Pyeongchang-gun in Gangwon-do (Region 2) (Figure 2). While 93% of the land in Region 2 is agricultural or forested, Region 1 contains less than 30% green space.

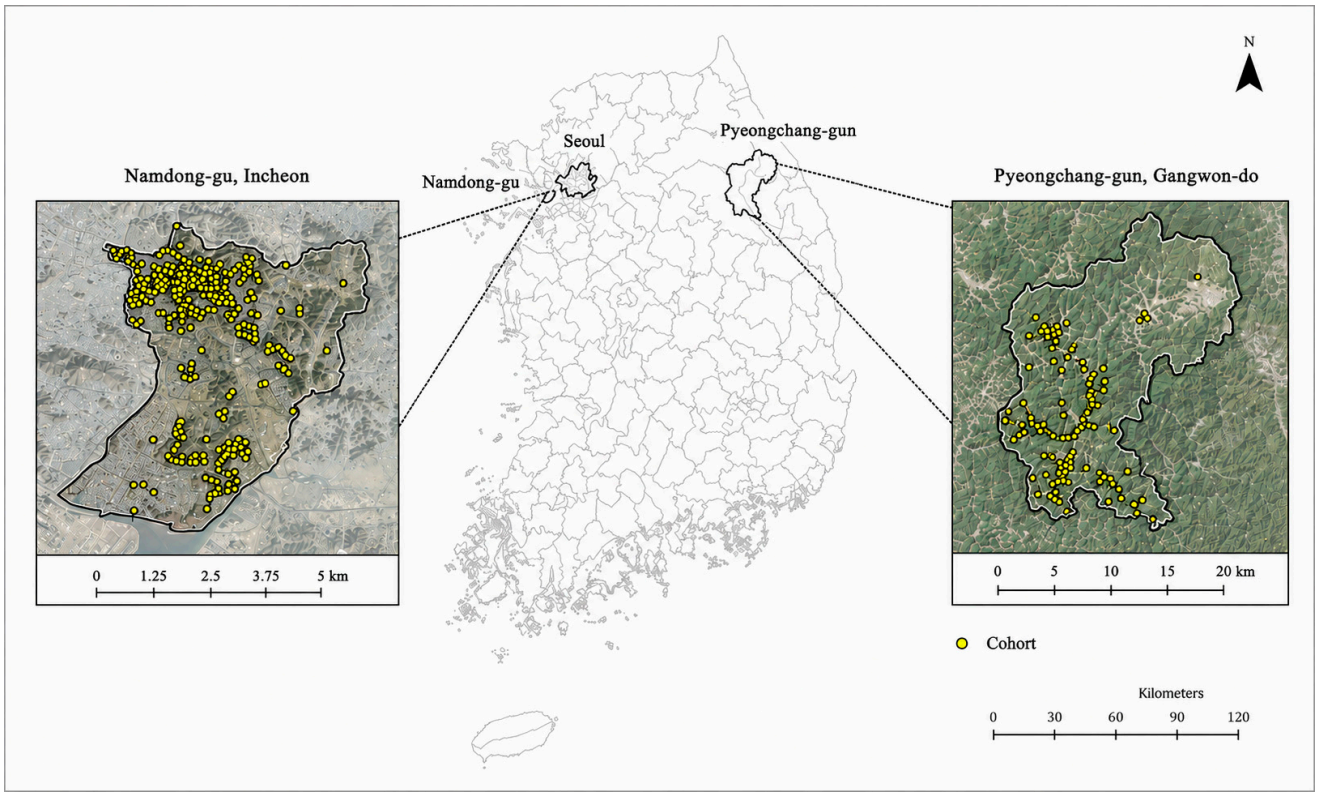



**Figure 2.** Geographical locations of the two contrasting study areas in South Korea: Namdong-gu (Region 1) and Pyeongchang-gun (Region 2). Yellow dots indicate the spatial distribution of the cohort participants.

A total of 901 participants from the Environmental Pollution-Induced Neurological Effects (EPINEF) cohort were analyzed [32]. Eligible participants were aged 50 or older with no prior neurological disorders. Baseline data (2014–2017) encompassed demographics, socioeconomic status, health behaviors, and clinical measures including cognitive ability and functional status (Table 1). Detailed information regarding participant recruitment and ethical approval of the EPINEF cohort has been described previously [32]. The sample included 718 individuals from Region 1 (distributed across 21 communities) and 183 from Region 2 (7 communities). The study adopted a case-based analytical approach to explore context-specific relationships rather than to make population-level inferences.

**Table 1.** Study areas: Namdong-gu & Pyeongchang-gun.

| Area | Province | Area Contexts | Pop. | Area ($km^2$) | Pop. Density | Agri. & Forest | Agri. & Forest (%) | Number of Cohort |
|---|---|---|---|---|---|---|---|---|
| Region 1: Namdong -gu | Incheon-si | Densely developed | 3,010,476 | 57.45 | 2826.1 | 17 | 29.7 | 718 |
| Region 2: Pyeongchang -gun | Ganwon-do | Less developed | 42,051 | 1463.96 | 28.7 | 1373 | 93.8 | 183 |

### *2.2. Street-View Images: Semantic Segmentation and Open Greenery Index*

To quantify the residential environment, 360° street-view panoramas were collected at 10 m intervals within a 1 km buffer around each participant's residence, resulting in a total of 211,880 images (approximately 233 images per participant). To minimize seasonal variation in vegetation and capture peak foliage conditions, the majority of the street-view images were acquired in May 2021.

Semantic segmentation was performed using the pretrained DeepLab v3 architecture implemented in MATLAB (MathWorks, Natick, MA, USA) to extract visually salient environmental components from each panorama [33]. The network utilized was pretrained on the CamVid dataset (University of Cambridge, Cambridge, UK). DeepLab v3 was selected because it provided high segmentation accuracy for the target classes (vegetation and sky). The model was used to identify tree (vegetation) and sky pixels, with classification accuracies of 0.93 for vegetation and 0.94 for sky (Table A1 in Appendix A) [34].

Based on the segmented outputs, an *Open greenery* index was calculated as the proportion of *Green pixels* (representing vegetation) and *Blue pixels* (representing sky) relative to the *Total pixels* in each image (Figure 3). This index captures the visual openness of the environment at eye level, reflecting the direct exposure to natural elements in the immediate surroundings of each residence:

$$Open\ greenery = \frac{\sum Green\ pixels + \sum Blue\ pixels}{\sum Total\ pixels} \quad (1)$$

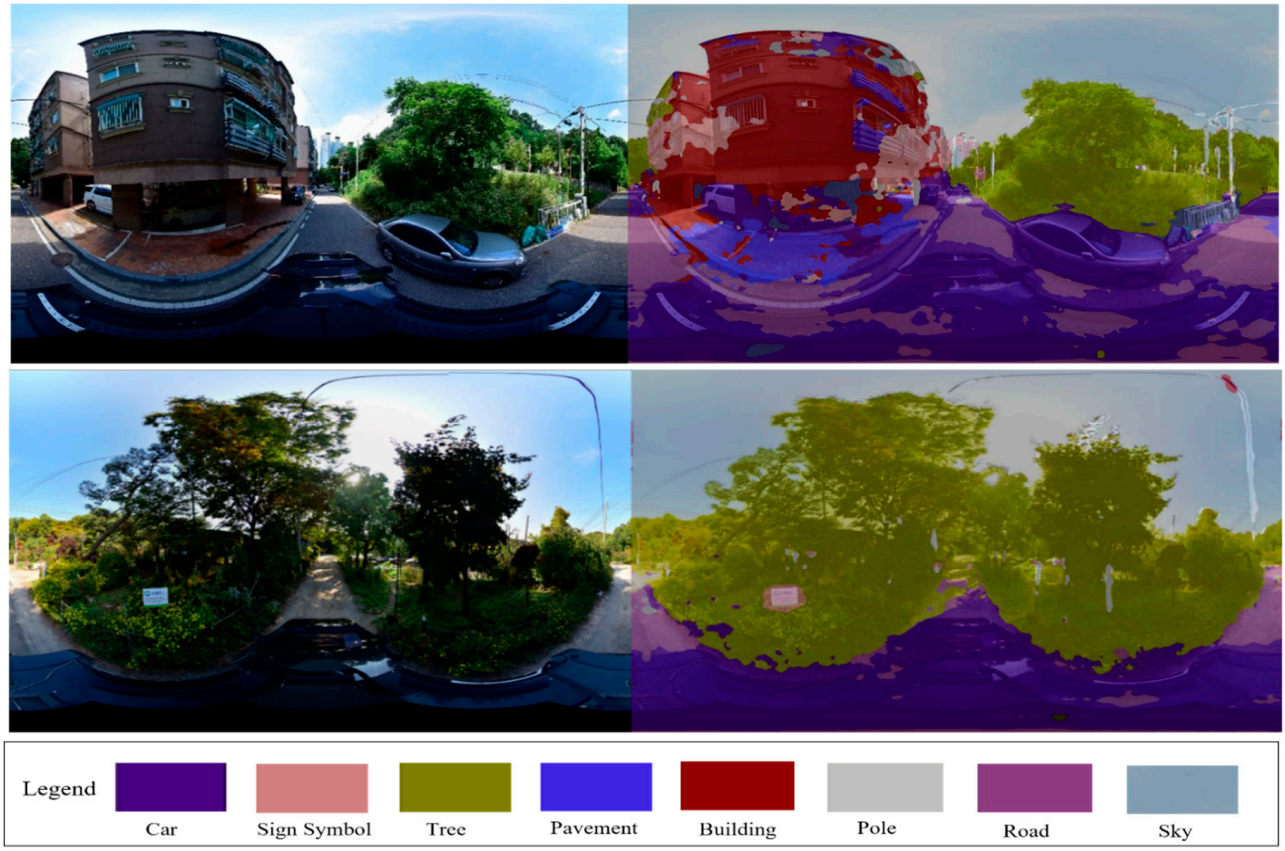



**Figure 3.** Before and after semantic segmentation and Open Greenery Index (top: Incheon/0.45; bottom: Pyeongchang/0.81).

This approach complements conventional top-down measures such as satellite-based vegetation indices by capturing the visual dimensions of greenery experienced by individuals at eye level.

### 2.3. Life Satisfaction

Life satisfaction was measured with a single validated question: "On a scale of 1 to 10, how satisfied are you with your life?" This served as the dependent variable.

### 2.4. Mental Health Variables: Depression and Cognitive Function

Depression was measured using the Korean SGDS-K (0–15; ≥8 = depressive symptoms). Cognitive function was assessed using the MMSE and categorized as low (≤17), mid (18–23), and high (≥24).

### 2.5. Covariates

Covariates included age, gender, marital status, education, income, smoking, drinking, physical activity, social interaction, and functional ability.

### 2.6. Statistical Analysis

Descriptive statistics summarized area and participant characteristics. Regression models with interaction terms were used to assess whether open greenery moderates the relationships between mental health and life satisfaction. The open-greenery index was normalized to reduce multicollinearity [35].

Because life satisfaction is censored between 1 and 10, Tobit regression was applied [36]. A Breusch–Pagan test indicated clustered and heteroskedastic errors (BP = 42.73, $p < 0.01$). Although between-community variation was minimal (ICC = 0.039), clustered standard errors were used to avoid underestimated variance, rather than applying multilevel modelling [37]. In order to confirm statistical robustness, robust clustered errors were employed. Separate models were estimated for each region, and Variance Inflation Factors (VIF < 3) confirmed that multicollinearity was not a concern.

To address potential estimation uncertainty arising from differences in sample sizes between the two regions and the limited number of observations in key subgroups, we employed bootstrap resampling with 5000 iterations. This non-parametric approach was used to assess the robustness of the interaction effects and to derive percentile-based 95% confidence intervals. This approach allows for a more robust evaluation of parameter stability in the presence of unbalanced group sizes and small subgroup samples, focusing on the consistency of the observed patterns across disparate contexts.

Two sets of models were estimated:

1. Unadjusted models examining depression only, cognitive function only, and both (Model 1).
2. Fully adjusted models including all covariates for robustness (Model 2).

Models were estimated separately for Region 1 (Models a, b, c) and Region 2 (Models d, e, f) (Table 2).

**Table 2.** Model description.

| Region | Depression | Cognitive Function | Depression + Cognitive Function |
|---|---|---|---|
| Region 1 (Namdong-gu) | Model 1a/2a | Model 1b/2b | Model 1c/2c |
| Region 2 (Pyeongchang-gun) | Model 1d/2d | Model 1e/2e | Model 1f/2f |

Model 1 = covariates not included; Model 2 = covariates included.

## 3. Results

### 3.1. Summary Statistics

Participants in Region 1 (Namdong-gu; more developed) reported slightly lower life satisfaction (M = 6.65) than those in Region 2 (Pyeongchang-gun; less developed) (M = 6.79). Region 1 was characterized by lower open greenery (M = 0.389 vs. 0.528) and a higher prevalence of depressive symptoms (15% vs. 9%), although high cognitive function was more prevalent in Region 1 (95% vs. 89%). Regarding demographics, participants in Region 1 were generally older, more likely to be female, and less likely to be married. While

education and income levels were higher in Region 1, participants in Region 2 reported more frequent social interactions (Table 3).

**Table 3.** Descriptive statistics.

| Area | Region 1 (Namdong-gu) | | | Region 2 (Pyeongchang-gun) | | |
|---|---|---|---|---|---|---|
| Statistics | Mean | SD | Proportion (*n*) | Mean | SD | Proportion (*n*) |
| Satisfaction | 6.653 | 1.851 | | 6.787 | 1.698 | |
| Open-green index | 0.389 | 0.046 | | 0.528 | 0.066 | |
| Depression | | | | | | |
| Depressed | | | 14.9 (107) | | | 9.3 (17) |
| Non-depressed | | | 85.1 (611) | | | 90.7 (166) |
| Cognitive function | | | | | | |
| Low | | | 1.5 (11) | | | 1.6 (3) |
| Mid | | | 3.6 (26) | | | 9.3 (17) |
| High | | | 94.8 (680) | | | 89.1(163) |
| Age | 68.494 | 5.586 | | 64.06 | 8.115 | |
| Gender: Female | | | 72.7 (522) | | | 63.4 (116) |
| Marital status: Married or have a partner | | | 74.9 (538) | | | 88.5 (162) |
| Education level | | | | | | |
| Primary school or lower | | | 28.7 (206) | | | 60.7 (111) |
| High school | | | 47.2 (339) | | | 34.4 (63) |
| College or higher | | | 24.1 (173) | | | 4.9 (9) |
| Income | | | | | | |
| Not reported | | | 8.9 (64) | | | 5.5(10) |
| Low (<2,000,000 KRW) | | | 49.4 (355) | | | 69.4 (127) |
| Middle (2,000,000–<4,000,000 KRW) | | | 29.2 (210) | | | 17.5 (32) |
| High (≥4,000,000 KRW) | | | 12.5 (90) | | | 7.7 (14) |
| Ever Smoking: Yes | | | 22.7 (163) | | | 24.6 (45) |
| Ever Drinking: Yes | | | 46.5 (334) | | | 44.3 (81) |
| Functional ability | | | | | | |
| Not restricted | | | 98.1 (704) | | | 96.2 (176) |
| Moderately restricted | | | 1.7 (12) | | | 3.3 (6) |
| Highly restricted | | | 0.3 (2) | | | 0.5 (1) |
| Physical activity | 4.61 | 2.35 | | 4.22 | 2.63 | |
| Social interaction | | | 539 (0.75) | | | 158 (0.86) |

### *3.2. Association Between Open Greenery, Mental Health, and Life Satisfaction*

In unadjusted models, open greenery was not directly related to life satisfaction. Depression significantly reduced life satisfaction in both regions, with a stronger effect in Region 2, where greenery partially buffered its impact (β = 0.862, $p < 0.1$) (Models 1a and 1d; Tables 4 and 5).

**Table 4.** Association between open greenery, mental health, and life satisfaction in Region 1.

| Region 1 | Model 1a | Model 1b | Model 1c |
|---|---|---|---|
| | Coef. (SE) | Coefficient | Coefficient |
| Open greenery | 0.129 (0.17) | 0.195 (0.14) | 0.137 (0.17) |
| Depression | −2.276 *** (0.34) | | −2.264 *** (0.35) |
| Cognitive function (Low) | | 1.181 ** (0.59) | 1.374 ** (0.67) |
| Cognitive function (Mid) | | −1.087 ** (0.55) | −0.836 * (0.47) |
| Open greenery * Depression | −0.453 (0.49) | | −0.444 (0.50) |
| Open greenery * Cognitive function (Low) | | 2.266 (1.57) | 1.988 (1.38) |
| Open greenery * Cognitive function (Mid) | | −1.717 * (0.89) | −1.562 ** (0.79) |
| Log likelihood | −1412 | −1458 | −1405 |
| AIC | 2834 | 2930 | 2878 |

Significance levels: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$ SE = standard errors.

In Region 1, low cognitive function was linked to higher life satisfaction (β = 1.181, $p < 0.05$), while mid-level cognitive function was associated with lower satisfaction (β = −1.087, $p < 0.05$) (Model 1b). Greenery amplified the negative effect of mid-level function (β = −1.717, $p < 0.1$). However, no significant cognitive moderation was found in Region 2 (Model 1e).

When depression and cognitive function were modeled together (Models 1c and 1f; Tables 4 and 5), Region 1 showed similar patterns: depression (β = −2.264, $p < 0.01$) and mid-level cognitive function (β = −0.836, $p < 0.05$) reduced satisfaction, while low cognitive function increased it (β = 1.374, $p < 0.05$). Greenery continued to intensify the negative effect of mid-level function (β = −1.562, $p < 0.05$) (Table 4). In Region 2, depression remained strongly negative (β = −3.492, $p < 0.01$), and greenery again buffered this effect (β = 0.879, $p < 0.1$) (Table 5).

**Table 5.** Association between open greenery, mental health, and life satisfaction in Region 2.

| Region 2 | Model 1d | Model 1e | Model 1f |
|---|---|---|---|
| | Coef. (SE) | Coef. (SE) | Coef. (SE) |
| Open greenery | −0.072 (0.12) | −0.035 (0.16) | −0.102 (0.13) |
| Depression | −3.452 *** (0.87) | | −3.492 *** (0.85) |
| Cognitive function (Low) | | 2.434 (2.64) | 0.245 (1.92) |
| Cognitive function (Mid) | | −0.541 (0.74) | −0.855 (0.58) |
| Open greenery * Depression | 0.862 * (0.48) | | 0.879 * (0.46) |
| Open greenery * Cognitive function (Low) | | −1.130 (1.52) | −0.049 (1.07) |
| Open greenery * Cognitive function (Mid) | | 0.337 (0.45) | 0.404 (0.36) |
| Log likelihood | −343.6 | −357.6 | −343.3 |
| AIC | 697.2 | 729.2 | 704.6 |

Significance levels: * $p < 0.1$; *** $p < 0.01$ SE = standard errors.

### *3.3. Fully Adjusted Model with Covariates*

With covariates included, open greenery remained nonsignificant. Depression continued to reduce life satisfaction, with a stronger effect in Region 2 (β = −3.302, $p < 0.01$) than Region 1 (β = −2.081, $p < 0.01$) (Tables 6 and 7, Models 2a and 2d). Greenery buffered the depressive effect in Region 2 (β = 0.919, $p < 0.01$) (Table 7, Model 2d). Income increased life satisfaction, while physical restrictions lowered it.

**Table 6.** Fully adjusted model with covariates in Region 1.

| Region 1 | Model 2a | Model 2b | Model 2c |
|---|---|---|---|
| | Coef. (SE) | Coef. (SE) | Coef. (SE) |
| Open greenery | 0.021 (0.13) | 0.112 (0.12) | 0.073 (0.15) |
| Depression | −2.081 *** (0.26) | | −2.077 *** (0.36) |
| Cognitive function (low, ref.: high) | | 1.260 * (0.70) | 1.453 * (0.80) |
| Cognitive function (mid, ref.: high) | | −0.565 (0.54) | −0.450 (0.51) |
| Age | −0.030 (0.09) | −0.020 (0.09) | −0.027 (0.08) |
| Gender | −0.204 (0.19) | −0.289 (0.21) | −0.204 (0.18) |
| Marital status | 0.148 (0.20) | 0.247 (0.21) | 0.131 (0.20) |
| Income (Ref.:<2,000,000 KRW) | | | |
| Income (Not answered) | 0.363 (0.28) | 0.429 (0.27) | 0.343 (0.24) |
| Income (Mid, 2,000,000–<4,000,000 KRW) | 0.185 (0.14) | 0.248 * (0.13) | 0.188 (0.13) |
| Income (High, ≥4,000,000 KRW) | 0.442 ** (0.22) | 0.532 ** (0.26) | 0.453 ** (0.22) |
| Education (Ref.: Primary school or below) | | | |
| Education (High school) | 0.041 (0.20) | 0.073 (0.20) | 0.205 (0.20) |
| Education (College or higher) | 0.197 (0.19) | 0.310 (0.20) | 0.013 (0.20) |
| Functional ability (Ref.: Not restricted) | | | |
| Restricted (moderate) | −1.315 ** (0.54) | −1.749 *** (0.59) | −1.609 *** (0.49) |
| Restricted (high) | 2.035 (1.70) | 4.324 *** (0.91) | 3.438 *** (1.02) |
| Smoke (ref.: No Smoke) | −0.144 (0.22) | −0.142 (0.21) | −0.150 (0.22) |
| Drink (ref.: No drink) | −0.244 (0.16) | −0.327 * (0.17) | −0.209 (0.15) |
| Physical activity | 0.020 (0.03) | 0.032 (0.03) | 0.013 (0.03) |
| Social interaction | 0.059 (0.15) | 0.187 (0.16) | 0.018 (0.16) |
| Open greenery * Depression | −0.408 (0.51) | | −0.434 (0.50) |
| Open greenery * Cognitive function (low, ref.: high) | | 4.876 *** (0.83) | 4.356 *** (0.90) |
| Open greenery * Cognitive function (mid, ref.: high) | | −1.441 *** (0.86) | −1.429 * (0.80) |
| Log likelihood | −1373 | −1408 | −1364 |
| AIC | 2854 | 2858 | 2774 |

Significance levels: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$ SE = standard errors.

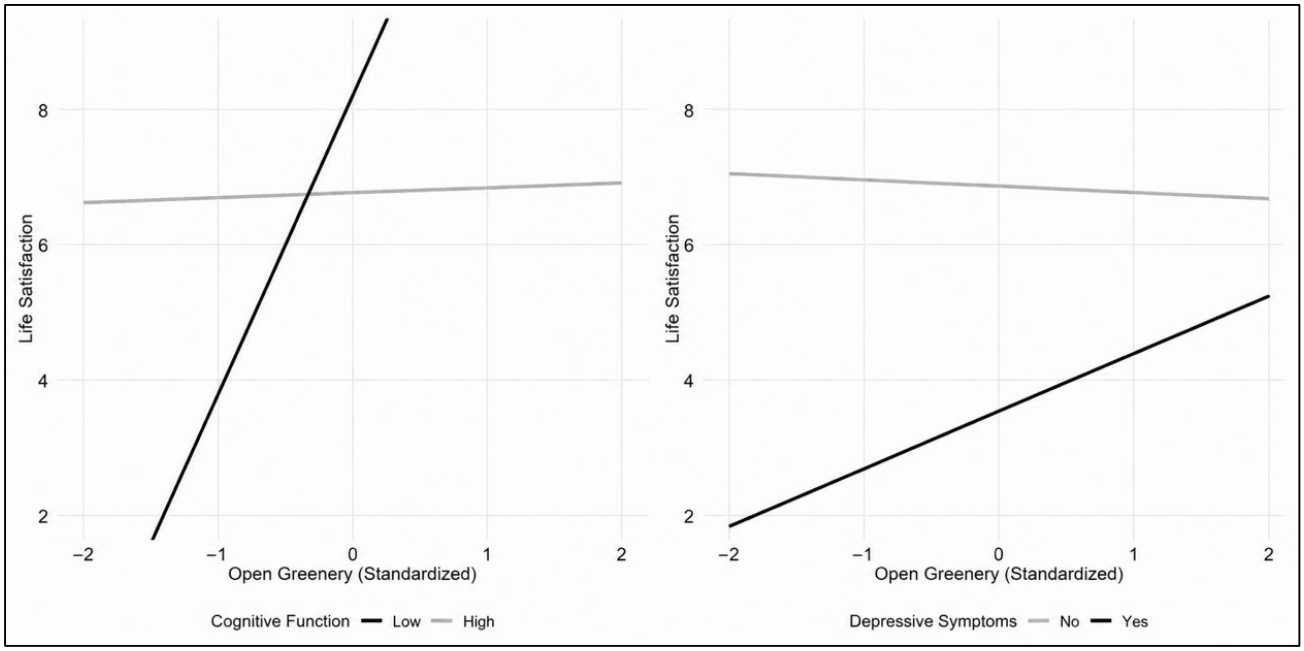
For cognitive models (Tables 6 and 7, Models 2b and 2e), low cognitive function in Region 1 was positively associated with life satisfaction (β = 1.260, $p < 0.1$), and greenery strengthened this association (β = 4.876, $p < 0.01$). Greenery also worsened the effect of mid-level function (β = −1.441, $p < 0.01$). In Region 2, neither cognition nor greenery showed direct effects, although income and education were positive predictors, and restrictions remained negative.

**Table 7.** Fully adjusted model with covariates in Region 2.

| Region 2 | Model 2d | Model 2e | Model 2f |
|---|---|---|---|
| | Coef. (SE) | Coef. (SE) | Coef. (SE) |
| Open greenery | −0.059 (0.10) | 0.003 (0.16) | −0.094 (0.11) |
| Depression | −3.302 *** (0.52) | | −3.326 *** (0.46) |
| Cognitive function (low, ref.: high) | | 0.029 (3.57) | −0.438 (2.79) |
| Cognitive function (mid, ref.: high) | | 0.194 (0.36) | −0.381 (0.25) |
| Age | 0.046 (0.10) | 0.031 (0.07) | 0.040 (0.09) |
| Gender | −0.165 (0.25) | −0.152 (0.25) | −0.203 (0.22) |
| Marital status | 0.562 (0.53) | 0.447 (0.56) | 0.529 (0.52) |
| Income (Ref.:<2,000,000 KRW) | | | |
| Income (Not answered) | 0.393 (0.59) | 0.493 (0.78) | 0.446 (0.64) |
| Income (Mid, 2,000,000–<4,000,000 KRW) | 0.541 *** (0.18) | 0.506 * (0.26) | 0.571 *** (0.18) |
| Income (High, ≥4,000,000 KRW) | 0.449 (0.32) | 0.679 (0.56) | 0.468 (0.37) |
| Education (Ref.: Primary school or below) | | | |
| Education (High school) | 0.096 (0.25) | 0.083 (0.28) | 0.105 (0.26) |
| Education (College or higher) | 0.625 (0.48) | 0.902 * (0.47) | 0.602 (0.49) |
| Functional ability (Ref.: Not restricted) | | | |
| Restricted (moderate) | −1.704 *** (0.59) | −2.449 ** (0.98) | −1.727 *** (0.58) |
| Restricted (high) | −1.324 *** (0.22) | −0.795 ** (0.34) | −1.339 *** (0.23) |
| Smoke (ref.: No Smoke) | −0.079 (0.09) | 0.062 (0.10) | −0.081 (0.07) |
| Drink (ref.: No drink) | 0.046 (0.16) | −0.229 (0.15) | 0.042 (0.17) |
| Physical activity | 0.028 (0.09) | 0.054 (0.08) | 0.023 (0.09) |
| Social interaction | −0.206 (0.26) | −0.187(0.35) | −0.197 (0.25) |
| Open greenery * Depression | 0.919 *** (0.35) | | 0.944 *** (0.31) |
| Open greenery * Cognitive function (low, ref.: high) | | −0.158 (1.78) | 0.210 (1.39) |
| Open greenery * Cognitive function (mid, ref.: high) | | 0.142 (0.09) | 0.325 *** (0.10) |
| Log likelihood | −333.8 | −345.2 | −333.5 |
| AIC | 705.6 | 732.4 | 713 |

Significance levels: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$ SE = standard errors.

In the combined models (Tables 6 and 7, Models 2c and 2f), depression (β = −2.077, $p < 0.01$) emerged as a significant predictor in Region 1. Furthermore, the relationship between low cognitive function and life satisfaction showed a significant positive interaction with greenery (β = 4.356, $p < 0.01$) (Figure 4). While the main effect of low cognitive function was less stable in bootstrap analyses, its interaction with greenery remained significant in bootstrap analyses based on 5000 resamples. In Region 2, greenery consistently buffered the negative impact of depression (β = 0.944, $p < 0.01$) (Figure 4), a pattern supported by bootstrap analyses. Although the initial models indicated significant moderation effects for mid-level cognitive function in both regions (β = −1.429, $p < 0.1$ in Region 1; β = 0.325, $p < 0.01$ in Region 2), bootstrap analyses revealed these effects to be less stable. This suggests that the benefits of eye-level greenery are most robust among individuals with low cognitive function in Region 1 and those experiencing depression in Region 2 (See Tables A2 and A3 in Appendix B).




(**a**) (**b**)

**Figure 4.** Interaction effects of open greenery on life satisfaction across regions. (**a**) Region 1 (**left**): The positive association between open greenery and life satisfaction is more pronounced among individuals with low cognitive function. (**b**) Region 2 (**right**): Open greenery buffers the negative impact of depressive symptoms on life satisfaction. For clarity, the mid-level cognitive function group in Region 1 is excluded due to instability observed in bootstrap analyses.

## 4. Discussion

This study examined how eye-level open greenery influences the relationship between mental health—specifically depression and cognitive function—and life satisfaction across two distinct community settings. By using street-view images to capture participants' visual exposure to trees and sky, this study provides a perceptual measure of open greenery that reflects everyday environmental experience. Although prior research has linked street-level greenery to subjective well-being [13,18,38], this study is among the first to examine whether greenery moderates the association between mental health and life satisfaction across different spatial contexts among middle-aged and older adults. Given that life satisfaction predicts later cognitive decline and dementia [39], understanding these moderating processes is essential for supporting mental health in this population.

### *4.1. Major Finding*

While unadjusted models provided baseline associations, the fully adjusted models offered a more reliable assessment by accounting for potential confounding factors. The results from the full models indicate that the relationship between mental health and life satisfaction varies by region. Although eye-level greenery alone was not directly associated with life satisfaction—contrary to some previous studies [40,41]—our results align with research showing no direct relationship between residential greenery and mental health [38,42]. This highlights the importance of considering contextual and individual factors when evaluating greenery's effects.

In Region 1, open greenery was associated with a stronger positive relationship between low cognitive function and life satisfaction. Although this finding should be interpreted with caution given the small subgroup size, it remained consistent in bootstrap analyses. One possible explanation is that individuals with more severe cognitive impairment may experience lower levels of self-awareness, thereby reducing the subjective

distress associated with cognitive decline [43]. In addition, greenery may provide a psychologically restorative environment by reducing environmental stress, promoting emotional comfort, and enhancing psychological comfort, even among individuals with impaired cognitive function [44,45]. While previous studies have primarily emphasized the preventative role of greenery in slowing cognitive decline [46,47], our findings suggest that greenery may also contribute to maintaining life satisfaction among individuals who already exhibit lower cognitive function. Nevertheless, this interpretation remains exploratory and should be confirmed in future studies with larger samples and longitudinal designs.

In Region 2, the negative effect of depression on life satisfaction was pronounced, reflecting limited healthcare access and financial stress in less developed areas [48]. Open greenery buffered this effect, supporting evidence that exposure to natural elements improves mood and reduces depressive symptoms [13,18].

These findings indicate that the impact of open greenery on mental health and life satisfaction is context-dependent. Specifically, greenery appears more protective for individuals with low cognitive function in the densely developed Region 1, whereas its benefits are more pronounced for those experiencing depression in the less developed Region 2. This suggests that eye-level greenery does not uniformly enhance life satisfaction; instead, its beneficial impact is contingent upon the dynamic interplay between individual mental health conditions and the surrounding built environment.

Covariate effects were broadly consistent across regions. Income was positively associated with life satisfaction, although different income levels showed stronger effects by region, possibly reflecting varying satisfaction thresholds [49,50]. Functional limitations were consistently linked to lower life satisfaction, with slight variations in magnitude. In Region 1, greater functional limitations were associated with somewhat higher life satisfaction, potentially reflecting better access to services or adaptive coping [51,52]. Overall, while contextual differences influenced the moderating effects of greenery, covariate patterns demonstrated stability.

### *4.2. Strengths and Limitations*

This study suggests that street-view open greenery moderates the relationship between mental health and life satisfaction in ways that differ across regional contexts. These findings underscore that the mental health benefits of greenery are shaped by both the surrounding community context and the specific psychological status of the resident.

This study has several limitations. First, ambient air pollution was not controlled for, which may influence both depressive symptoms and the visible sky component of the open-greenery measure [53,54]. Second, social interaction was captured using a relatively broad metric (attendance at gatherings once per month or more), which may not fully capture the nuanced quality or frequency of social support [55]. Third, this study only accounted for individual-level covariates and did not consider broader environmental contexts that may have influenced the observed associations. Distance-decay effects were also not considered when measuring open greenery. In addition, the street-view imagery was acquired in 2021, whereas the baseline health data were collected between 2014 and 2017. Although street-level greenery is generally a relatively stable environmental characteristic, changes in the built environment or vegetation may have occurred during this period. Future studies should consider distance-decay weighting, temporally aligned environmental data, and broader community contexts (e.g., neighborhood built environments and residents' preferences for natural environments) to better capture actual residential exposure to greenery.

Finally, we acknowledge the unbalanced sample sizes between Region 1 and Region 2. This disparity may reflect real-world population distributions and densities rather than

solely sampling bias. Because all models were estimated separately for each region, the larger sample size in Region 1 does not statistically compromise or bias the parameter estimates for Region 2. Rather than directly comparing regression coefficients between the two regions, this study adopted a case-based analytical approach to explore how eye-level greenery moderates the relationship between mental health factors and life satisfaction under distinctly different community conditions. Given that this study aims to examine context-specific relationships within real-world residential environments, preserving these contextual differences allows for a more realistic representation of the study settings. However, some subgroup analyses were based on small sample sizes, which may introduce statistical uncertainty. To address this issue, bootstrap resampling (5000 iterations) was conducted as a robustness check for all subgroup analyses. Only findings that remained statistically supported after the bootstrap analysis were interpreted in this study. Consequently, the interpretation focused only on statistically robust findings. Therefore, while these findings should be interpreted with appropriate caution, this exploratory case-based study provides meaningful insights into the context-specific relationships between the built environment and mental health.

## 5. Conclusions

By utilizing street-view imagery to capture eye-level greenery, this study suggests that the moderating effect of the visual environment on life satisfaction varies across regional contexts. In the densely developed Region 1, greenery was associated with higher well-being among individuals with low cognitive function, whereas in the less developed Region 2, it was associated with greater life satisfaction among those experiencing depressive symptoms.

Although the specific focus groups were limited in sample size, the consistency of these patterns—supported by bootstrap analyses based on 5000 resamples—indicates that the psychological benefits of greenery depend on both individual mental health status and environmental context. Despite these sampling constraints, this study provides a preliminary foundation for future research. By identifying these context-specific moderation patterns, our findings offer initial theoretical and empirical grounding for subsequent large-scale longitudinal studies to further examine these relationships in more extensive cohorts.

These findings provide critical implications for planning and public health policy. By showing that the psychological benefits of greenery are contingent upon local environmental contexts and individual mental health status, this study underscores the necessity of place-sensitive, targeted urban greening strategies. Enhancing street-level greenery—particularly in areas where it can effectively buffer mental health challenges—offers a strategic pathway toward fostering healthier and more resilient communities.

**Author Contributions:** Conceptualization, Yoohyung Joo and Joon Heo; methodology, Yoohyung Joo; software, Jaeyoung Jung, Jiwan Hong and Sangyoon Park; validation, Yoohyung Joo, Jaeyoung Jung, Jiwan Hong and Sangyoon Park; formal analysis, Yoohyung Joo; investigation, Yoohyung Joo, Jaelim Cho, Juyeon Ko and Changsoo Kim; resources, Joon Heo; data curation, Yoohyung Joo; writing—original draft preparation, Yoohyung Joo; writing—review and editing, Yoohyung Joo, Jaelim Cho, Juyeon Ko, Changsoo Kim and Joon Heo; visualization, Yoohyung Joo; supervision, Joon Heo; project administration, Joon Heo; funding acquisition, Joon Heo. All authors have read and agreed to the published version of the manuscript.

**Funding:** This work is supported by the Korea Agency for Infrastructure Technology Advancement (KAIA) grant funded by the Ministry of Land, Infrastructure and Transport (Grant RS-2022-00143336).

**Data Availability Statement:** The datasets presented in this study are not available due to privacy and ethical restrictions.

**Conflicts of Interest:** The authors declare no conflicts of interest.

## Appendix A

The pretrained DeepLabV3 segmentation model demonstrated high validation accuracy for key environmental classes, including sky and vegetation (Table A1) [28,48].

**Table A1.** Segmentation accuracy by object class using DeepLabV3.

| Classes | Accuracy Rate |
|---|---|
| Sky | 0.94 |
| Building | 0.88 |
| Pole | 0.40 |
| Road | 0.95 |
| Pavement | 0.86 |
| Tree | 0.93 |
| Sign Symbol | 0.63 |
| Fence | 0.82 |
| Car | 0.75 |
| Pedestrian | 0.27 |
| Bicyclist | 0.71 |

Note: Accuracy values were obtained from MathWorks, "Semantic Segmentation Using Deep Learning." Available online: https://www.mathworks.com/help/vision/ug/semantic-segmentation-using-deep-learning.html (accessed on 3 May 2026).

## Appendix B

*Appendix B.1*

To ensure statistical stability despite small subgroups in Region 1, a 5000-resample bootstrap analysis was performed (Table A2). Effects are considered robust if the 95% confidence intervals (CIs) exclude zero, confirming they are not due to random sampling variability.

**Table A2.** Robustness check: bootstrapped estimates and confidence intervals for Region 1.

| Variable | Original Coef. | 95% Bootstrap CI |
|---|---|---|
| (Intercept) | 6.822 | [6.284, 7.350] *** |
| Open greenery | 0.068 | [−0.193, 0.347] |
| Depression | −2.025 | [−2.634, −1.383] *** |
| Cognitive function (low, ref.: high) | 1.235 | [−0.075, 3.730] |
| Cognitive function (mid, ref.: high) | −0.441 | [−1.421, 0.559] |
| Age | −0.03 | [−0.159, 0.132] |
| Gender | −0.181 | [−0.571, 0.140] |
| Marital status | 0.121 | [−0.257, 0.440] |
| Income (Ref.: <2,000,000 KRW) | | |
| Income (Not answered) | 0.344 | [−0.062, 0.737] |
| Income (High, ≥4,000,000 KRW) | 0.456 | [0.033, 0.851] ** |
| Income (Mid, 2,000,000–<4,000,000 KRW) | 0.188 | [−0.077, 0.415] |
| Education (Ref.: Primary school or below) | | |
| Education (High school) | 0.242 | [−0.100, 0.621] |
| Education (College or higher) | 0.038 | [−0.324, 0.403] |
| Functional ability (Ref.: Not restricted) | | |
| Restricted (moderate) | −1.511 | [−2.371, −0.452] ** |
| Restricted (high) | 2.483 | [0.957, 4.237] *** |
| Smoke (ref.: No Smoke) | −0.123 | [−0.536, 0.287] |
| Drink (ref.: No drink) | −0.209 | [−0.489, 0.076] |
| Physical activity | 0.017 | [−0.034, 0.073] |
| Social interaction | 0.014 | [−0.285, 0.299] |
| Open greenery * Depression | −0.434 | [−1.341, 0.465] |
| Open greenery * Cognitive function (low, ref.: high) | 3.573 | [1.488, 9.571] *** |
| Open greenery * Cognitive function (mid, ref.: high) | −1.285 | [−2.657, 0.498] |

Significance levels: ** $p < 0.05$; *** $p < 0.01$. Results are based on 5000 bootstrap samples. CI = Confidence Interval.

*Appendix B.2*

To ensure statistical stability despite small subgroups in Region 2, a 5000-resample bootstrap analysis was performed (Table A3). Effects are considered robust if the 95% confidence intervals (CIs) exclude zero, confirming they are not due to random sampling variability.

**Table A3.** Robustness check: bootstrapped estimates and confidence intervals for Region 2.

| Variable | Original Coeff. | 95% Bootstrap CI |
|---|---|---|
| (Intercept) | 6.685 | [5.973, 7.821] *** |
| Open greenery | −0.093 | [−0.400, 0.282] |
| Depression | −3.292 | [−6.058, −2.134] ** |
| Cognitive function (low, ref.: high) | −0.323 | [−5.158, 65.465] |
| Cognitive function (mid, ref.: high) | −0.364 | [−1.946, 0.969] |
| Age | 0.042 | [−0.150, 0.181] |
| Gender | −0.216 | [−0.671, 0.318] |
| Marital status | 0.497 | [−1.009, 1.215] |
| Income (Ref.: <2,000,000 KRW) | | |
| Income (Not answered) | 0.399 | [−0.268, 3.147] |
| Income (High, ≥4,000,000 KRW) | 0.434 | [−0.439, 1.086] |
| Income (Mid, 2,000,000–<4,000,000 KRW) | 0.569 | [0.143, 1.295] ** |
| Education (Ref.: Primary school or below) | | |
| Education (High school) | 0.636 | [−0.487, 3.772] |
| Education (College or higher) | 0.105 | [−0.368, 1.121] |
| Functional ability (Ref.: Not restricted) | | |
| Restricted (moderate) | −1.71 | [−3.105, 0.785] * |
| Restricted (high) | −1.312 | [−1.706, −0.759] *** |
| Smoke (ref.: No Smoke) | −0.112 | [−0.845, 0.084] |
| Drink (ref.: No drink) | 0.039 | [−0.334, 0.835] |
| Physical activity | 0.024 | [−0.111, 0.256] |
| Social interaction | −0.16 | [−1.308, 0.228] |
| Open greenery * Depression | 0.942 | [0.485, 2.753] ** |
| Open greenery * Cognitive function (low, ref.: high) | 0.173 | [−27.964, 2.749] |
| Open greenery * Cognitive function (mid, ref.: high) | 0.327 | [−0.184, 1.136] |

Significance levels: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. Results are based on 5000 bootstrap samples. CI = Confidence Interval.

## References


1. Liu, Y.; Wang, R.; Grekousis, G.; Liu, Y.; Yuan, Y.; Li, Z. Neighbourhood greenness and mental wellbeing in Guangzhou, China: What are the pathways? *Landsc. Urban Plan.* **2019**, *190*, 103602. [CrossRef]
2. Wang, R.; Helbich, M.; Yao, Y.; Zhang, J.; Liu, P.; Yuan, Y.; Liu, Y. Urban greenery and mental wellbeing in adults: Cross-sectional mediation analyses on multiple pathways across different greenery measures. *Environ. Res.* **2019**, *176*, 108535. [CrossRef] [PubMed]
3. Yang, W.; Yang, R.; Li, X. A canonical correlation analysis study on the association between neighborhood green space and residents' mental health. *J. Urban Health* **2023**, *100*, 696–710. [CrossRef] [PubMed]
4. Qin, B.; Zhu, W.; Wang, J.; Peng, Y. Understanding the relationship between neighbourhood green space and mental wellbeing: A case study of Beijing, China. *Cities* **2021**, *109*, 103039. [CrossRef]
5. Newton, J. *Wellbeing and the Natural Environment: A Brief Overview of the Evidence*; University of Bath: Bath, UK, 2007.
6. James, P.; Hart, J.E.; Banay, R.F.; Laden, F. Exposure to greenness and mortality in a nationwide prospective cohort study of women. *Environ. Health Perspect.* **2016**, *124*, 1344–1352. [CrossRef] [PubMed]
7. Marselle, M.R.; Bowler, D.E.; Watzema, J.; Eichenberg, D.; Kirsten, T.; Bonn, A. Urban street tree biodiversity and antidepressant prescriptions. *Sci. Rep.* **2020**, *10*, 22445. [CrossRef] [PubMed]
8. Ulrich, R.S. Aesthetic and affective response to natural environment. In *Behavior and the Natural Environment*; Altman, I., Wohlwill, J.F., Eds.; Springer: New York, NY, USA, 1983; pp. 85–125.
9. Kaplan, R.; Kaplan, S. *The Experience of Nature: A Psychological Perspective*; Cambridge University Press: Cambridge, UK, 1989.
10. Jiang, X.; Hu, Y.; Larsen, L.; Chang, C.-Y.; Sullivan, W.C. Impacts of urban green infrastructure on attentional functioning: Insights from an fMRI study. *Front. Psychol.* **2023**, *14*, 1047993. [CrossRef] [PubMed]
11. Liu, Y.; Zhang, J.; Liu, C.; Yang, Y. A review of attention restoration theory: Implications for designing restorative environments. *Sustainability* **2024**, *16*, 3639. [CrossRef]
12. Biljecki, F.; Ito, K. Street view imagery in urban analytics and GIS: A review. *Landsc. Urban Plan.* **2021**, *215*, 104217. [CrossRef]

13. Wu, W.; Yao, Y.; Song, Y.; He, D.; Wang, R. Perceived influence of street-level visible greenness exposure in the work and residential environment on life satisfaction: Evidence from Beijing, China. *Urban For. Urban Green.* **2021**, *62*, 127161. [CrossRef]
14. Cheng, L.; Chu, S.; Zong, W.; Li, S.; Wu, J.; Li, M. Use of Tencent street view imagery for visual perception of streets. *Int. J. Geo-Inf.* **2017**, *6*, 265. [CrossRef]
15. Gaw, L.Y.; Chen, S.; Chow, Y.S.; Lee, K.; Biljecki, F. Comparing street view imagery and aerial perspectives in the built environment. *ISPRS Ann. Photogramm. Remote Sens. Spat. Inf. Sci.* **2022**, *10*, 49–56. [CrossRef]
16. Min, K.D.; Kim, J.S.; Park, Y.H.; Shin, H.Y.; Kim, C.; Seo, S.W.; Kim, S.Y. New assessment for residential greenness and the association with cortical thickness in cognitively healthy adults. *Sci. Total Environ.* **2021**, *778*, 146129. [CrossRef] [PubMed]
17. Cinnamon, J.; Jahiu, L. Panoramic street-level imagery in data-driven urban research: A comprehensive global review of applications, techniques, and practical considerations. *ISPRS Int. J. Geo-Inf.* **2021**, *10*, 471. [CrossRef]
18. Helbich, M.; Yao, Y.; Liu, Y.; Zhang, J.; Liu, P.; Wang, R. Using deep learning to examine street view green and blue spaces and their associations with geriatric depression in Beijing, China. *Environ. Int.* **2019**, *126*, 107–117. [CrossRef] [PubMed]
19. Larkin, A.; Hystad, P. Evaluating street view exposure measures of visible green space for health research. *J. Expo. Sci. Environ. Epidemiol.* **2019**, *29*, 447–456. [PubMed]
20. Hill, K.C.; Pfund, G.N.; Rule, P.D.; Hill, P.L.; James, B.D.; Hassenstab, J.J.; Willroth, E.C. A coordinated analysis of bidirectional associations between life satisfaction and cognitive function. *J. Pers. Soc. Psychol.* **2026**, *130*, 357–374. [CrossRef] [PubMed]
21. Joshanloo, M. Longitudinal relations between depressive symptoms and life satisfaction over 15 years. *Appl. Res. Qual. Life* **2022**, *17*, 3115–3130. [CrossRef]
22. Joshanloo, M.; Blasco-Belled, A. Reciprocal associations between depressive symptoms, life satisfaction, and eudaimonic well-being in older adults over a 16-year period. *Int. J. Environ. Res. Public Health* **2023**, *20*, 2374. [CrossRef] [PubMed]
23. Gigantesco, A.; Fagnani, C.; Toccaceli, V.; Stazi, M.A.; Lucidi, F.; Violani, C.; Picardi, A. The relationship between satisfaction with life and depression symptoms by gender. *Front. Psychiatry* **2019**, *10*, 419. [CrossRef] [PubMed]
24. Li, A.; Wang, D.; Lin, S.; Chu, M.; Huang, S.; Lee, C.Y.; Chiang, Y.C. Depression and life satisfaction among middle-aged and older adults: Mediation effect of functional disability. *Front. Psychol.* **2021**, *12*, 755220. [CrossRef] [PubMed]
25. Beck, A.T. *Depression: Clinical, Experimental, and Theoretical Aspects*; University of Pennsylvania Press: Philadelphia, PA, USA, 1967.
26. Mehlsen, M.; Kirkegaard Thomsen, D.; Viidik, A.; Olesen, F.; Zachariae, R. Cognitive processes involved in the evaluation of life satisfaction: Implications for well-being. *Aging Ment. Health* **2005**, *9*, 281–290. [CrossRef] [PubMed]
27. Enkvist, Å.; Ekström, H.; Elmståhl, S. Associations between cognitive abilities and life satisfaction in the oldest-old: Results from the longitudinal population study Good Aging in Skåne. *Clin. Interv. Aging* **2013**, *8*, 845–853. [CrossRef] [PubMed]
28. Pretty, J.; Peacock, J.; Sellens, M.; Griffin, M. The mental and physical health outcomes of green exercise. *Int. J. Environ. Health Res.* **2005**, *15*, 319–337. [CrossRef] [PubMed]
29. Yoo, E.H.; Roberts, J.E.; Eum, Y.; Li, X.; Konty, K. Exposure to urban green space may both promote and harm mental health in socially vulnerable neighborhoods: A neighborhood-scale analysis in New York City. *Environ. Res.* **2022**, *204*, 112292. [CrossRef] [PubMed]
30. Szymkowicz, S.M.; Gerlach, A.R.; Homiack, D.; Taylor, W.D. Biological factors influencing depression in later life: Role of aging processes and treatment implications. *Transl. Psychiatry* **2023**, *13*, 160. [CrossRef] [PubMed]
31. Webber, S.C.; Porter, M.M.; Menec, V.H. Mobility in older adults: A comprehensive framework. *Gerontologist* **2010**, *50*, 443–450. [CrossRef] [PubMed]
32. Jang, H.; Kim, W.; Cho, J.; Sohn, J.; Noh, J.; Seo, G.; Lee, Y.; Hong, C.; Kim, C. Cohort profile: The Environmental-Pollution-Induced Neurological EFfects (EPINEF) study: A multicenter cohort study of Korean adults. *Epidemiol. Health* **2021**, *43*, e2021067. [CrossRef] [PubMed]
33. Chen, L.-C.; Papandreou, G.; Kokkinos, I.; Murphy, K.; Yuille, A.L. DeepLab: Semantic image segmentation with deep convolutional nets, atrous convolution, and fully connected CRFs. *IEEE Trans. Pattern Anal. Mach. Intell.* **2018**, *40*, 834–848. [CrossRef] [PubMed]
34. MathWorks. Semantic Segmentation Using Deep Learning. Available online: https://www.mathworks.com/help/vision/ug/semantic-segmentation-using-deep-learning.html (accessed on 3 May 2026).
35. Marquardt, D. You should standardize the predictor variables in your regression models. *J. Am. Stat. Assoc.* **1980**, *75*, 87–91. [CrossRef]
36. Austin, P.C.; Escobar, M.; Kopec, J.A. The use of the Tobit model for analyzing measures of health status. *Qual. Life Res.* **2000**, *9*, 901–910. [CrossRef] [PubMed]
37. Peugh, J.L. A practical guide to multilevel modeling. *J. Sch. Psychol.* **2010**, *48*, 85–112. [CrossRef] [PubMed]
38. Helbich, M.; Poppe, R.; Oberski, D.; van Emmichoven, M.Z.; Schram, R. Can't see the wood for the trees? An assessment of street view- and satellite-derived greenness measures in relation to mental health. *Landsc. Urban Plan.* **2021**, *214*, 104181. [CrossRef]
39. Peitsch, L.; Tyas, S.L.; Menec, V.H.; John, P.D.S. General life satisfaction predicts dementia in community-living older adults: A prospective cohort study. *Int. Psychogeriatr.* **2016**, *28*, 1101–1109. [CrossRef] [PubMed]

40. Alcock, I.; White, M.P.; Wheeler, B.W.; Fleming, L.E.; Depledge, M.H. Longitudinal effects on mental health of moving to greener and less green urban areas. *Environ. Sci. Technol.* **2014**, *48*, 1247–1255. [CrossRef] [PubMed]
41. Douglas, O.; Lennon, M.; Scott, M. Green space benefits for health and well-being: A life-course approach for urban planning, design and management. *Cities* **2017**, *66*, 53–62. [CrossRef]
42. Feng, X.; Astell-Burt, T. Residential green space quantity and quality and symptoms of psychological distress: A 15-year longitudinal study of 3897 women in postpartum. *BMC Psychiatry* **2018**, *18*, 348. [CrossRef] [PubMed]
43. Azocar, I.; Livingston, G.; Huntley, J. The association between impaired awareness and depression, anxiety, and apathy in mild to moderate Alzheimer's disease: A systematic review. *Front. Psychiatry* **2021**, *12*, 633081. [CrossRef] [PubMed]
44. Rappe, E.; Topo, P. Contact with outdoor greenery can support competence among people with dementia. *J. Hous. Elder.* **2007**, *21*, 229–248. [CrossRef]
45. Zhang, Y.; Wu, L.; Zhao, W.; Zheng, L.; Zuo, L. Nature's shield-harnessing green spaces to combat dementia: A global meta-analysis. *Neurosci. Biobehav. Rev.* **2025**, *178*, 106360. [CrossRef] [PubMed]
46. Jimenez, M.P.; Elliott, E.G.; DeVille, N.V.; Laden, F.; Hart, J.E.; Weuve, J.; James, P. Residential green space and cognitive function in a large cohort of middle-aged women. *JAMA Netw. Open* **2022**, *5*, e229306. [CrossRef] [PubMed]
47. Slawsky, E.D.; Hajat, A.; Rhew, I.C.; Russette, H.; Semmens, E.O.; Kaufman, J.D.; Leary, C.S.; Fitzpatrick, A.L. Neighborhood greenspace exposure as a protective factor in dementia risk among U.S. adults aged 75 years or older: A cohort study. *Environ. Health* **2022**, *21*, 14. [CrossRef] [PubMed]
48. Probst, J.C.; Laditka, S.B.; Moore, C.G.; Harun, N.; Powell, M.P.; Baxley, E.G. Rural–urban differences in depression prevalence: Implications for family medicine. *Fam. Med.* **2006**, *38*, 653–660. [PubMed]
49. John, P.D.S.; Menec, V.; Tate, R.; Newall, N.; Cloutier, D.; O'Connell, M.E. Life satisfaction in adults in rural and urban regions of Canada: The Canadian Longitudinal Study on Aging. *Rural Remote Health* **2021**, *21*, 6631. [CrossRef]
50. Sørensen, J.F. Rural–urban differences in life satisfaction: Evidence from the European Union. *Reg. Stud.* **2014**, *48*, 1451–1466.
51. Steels, S. Key characteristics of age-friendly cities and communities: A review. *Cities* **2015**, *47*, 45–52. [CrossRef]
52. van Hoof, J.; Marston, H.R. Age-friendly cities and communities: State of the art and future perspectives. *Int. J. Environ. Res. Public Health* **2021**, *18*, 1644. [CrossRef] [PubMed]
53. Yang, T.; Wang, J.; Huang, J.; Kelly, F.J.; Li, G. Long-term exposure to multiple ambient air pollutants and association with incident depression and anxiety. *JAMA Psychiatry* **2023**, *80*, 305–313. [CrossRef] [PubMed]
54. Zhao, X.; Cao, Y.; Cheng, Z. Perception matters: How air pollution influences life satisfaction in China. *Heliyon* **2024**, *10*, e31448. [CrossRef]
55. Khodabakhsh, S. Factors affecting life satisfaction of older adults in Asia: A systematic review. *J. Happiness Stud.* **2022**, *23*, 1289–1304.


**Disclaimer/Publisher's Note:** The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.