Impacts of urban green landscapes on citizens’ mental health & well-being

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Share of population with mental health and substance use disorders, 2017

Share of population with any mental health or substance use disorder; this includes depression, anxiety, bipolar, eating disorders, alcohol or drug use disorders, and schizophrenia. Due to the widespread under-diagnosis, these estimates use a combination of sources, including medical and national records, epidemiological data, survey data, and meta-regression models.

Source: IHME, Global Burden of Disease

Source: https://ourworldindata.org/mental-health
Share of population with mental health and substance use disorders, 1990 to 2017

Share of population with any mental health or substance use disorder; this includes depression, anxiety, bipolar, eating disorders, alcohol or drug use disorders, and schizophrenia. Due to the widespread under-diagnosis, these estimates use a combination of sources, including medical and national records, epidemiological data, survey data, and meta-regression models.
Urban Green & Mental Health

Three mechanisms (3 studies)

Ten actions
Three Mechanisms

Exposure to Nature

- Stress Reduction
- Brings People Together
- Attention Restoration
Mechanism 1. Social Justice

Exposure to Nature

- Stress Reduction
- Brings People Together
- Attention Restoration
Green spaces make people have more trust and love.
Study A

Provision of green landscapes significantly mitigates racial disparity in COVID-19 infection rate:
A nationwide study
Research Team

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Wenyan Xu                Chris Webster  
William C. Sullivan     Bin Jiang *

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Healthy Urban and Building Lab, City University of Hong Kong
A higher ratio of green spaces means a lower racial disparity in severe acute respiratory syndrome coronavirus 2 infection rates: A nationwide study of the United States

Yi Lu, Long Chen, Xueming Liu, Yuwen Yang, Wenyan Xu, Chris Webster, William C. Sullivan, Bin Jiang

doi: https://doi.org/10.1101/2020.11.11.20228130

Highlights

• The first study to identify significant relationships between green spaces and the racial disparity of SARS-CoV-2 infection rates.

• A nationwide study of the 135 most urbanized counties of the United States.

• A within-subject study: The black-white racial disparity of SARS-CoV-2 infection rates was measured within each county.

• A higher ratio of green spaces in a county is associated with a lower racial disparity of SARS-CoV-2 infection rates after controlling for socio-economic, demographic, pre-existing chronic disease, and built-up area factors.

• Four green space factors are significantly associated with a lower racial disparity of SARS-CoV-2 infection rates.
Racial disparity
Racial disparity

Socioeconomic Disparity

Health Disparity
Racial disparity

Socioeconomic Disparity

Environmental Disparity

Health Disparity
Racial disparity in COVID-19 infection rate

Race or ethnicity with the highest coronavirus rate in each county

**Procedure**

137 most urbanized counties in USA

COVID-19 data collection (by July 10th, 2020)

Environment factor data collection

Socioeconomic & demographic data collection

Comparison: Black vs White infection rate

Multi-layer regression analysis

**Within-County Comparison Study**
The paired t-test was conducted to examine the difference between Black infection rate and White infection rate.

There is a significant difference of infection rate (per 100k individuals) between Black and White (t=13.241, p<0.001). The error bar: 1 Standard Deviation.
The distribution of **Black and white** infection rate per 100k
The distribution of **Black minus White infection rate** per 100k
The distribution of four significant green landscape factors in the Model 3

Urban Open Space %

Grasslands and Herbaceous %

Forest %

Shrub and Scrub %
The distribution of urban green open space percentage
The distribution of forest percentage
The distribution of **shrub and scrub percentage**
The distribution of grasslands and herbaceous percentage
Three-layer Linear Regression Results

Model 1
Adjusted $R^2$
0.119
Socioeconomic and demographic factors

Model 2
Adjusted $R^2$
0.113
Pre-existing chronic disease factors

Model 3
Adjusted $R^2$
0.288
Green space factors
Three-layer Linear Regression Results

Model 3

Socioeconomic and demographic factors
Household size  $\beta = -0.42$  $p < 0.001^{***}$

+ 

Pre-existing chronic disease factors
Heart failure death rate  $\beta = 0.26$  $p = 0.020^*$

+ 

Green space factors
Developed open space  $\beta = -0.31$  $p = 0.011^*$
Forest  $\beta = -0.31$  $p = 0.006^{**}$
Shrub and scrub  $\beta = -0.32$  $p = 0.012^*$
Grassland and herbaceous  $\beta = -0.42$  $p < 0.001^{***}$

Racial disparity in SARS-CoV-2 infection rates
Racial Disparity of Infection Rate & Significant Green Space Factors

- Urban Green Open Space Percentage
- Grasslands and Herbaceous Percentage
- Forest Percentage
- Shrub and Scrub Percentage
Urban Green Open Space Percentage
Grasslands and Herbaceous Percentage
Interpretation 1

Larger portions of green space provided greater access to residents of all racial groups and promoted physical activity before and during the pandemic.

Interpretation 2

Proportionately more green spaces in a county may result in enhanced mental and social health regardless of race before and during the pandemic.

Interpretation 3

Having access to green spaces that pull people outdoors. Being outdoors makes it easier than indoors to maintain safe social distance.

More green spaces may decrease the SARS-CoV-2 infection risk by improving air quality and decreasing exposure to air pollutants.

Mechanism 2. Stress Reduction

Exposure to Nature

- Stress Reduction
- Brings People Together
- Attention Restoration
Why stress is harmful?

- Perceived stress
- Individual differences
- Physiological responses
- Behavioral responses
- Chronic stress
- Diseases/Death

Why stress is harmful?

- Perceived stress
- Individual differences
- Physiological responses
- Behavioral responses
- Chronic stress
- Diseases/Death
Chronic stress

Nervous system
Respiratory
Cardiovascular
Endocrine
Gastrointestinal
Reproductive
Immune
Musculoskeletal
Stress & Leading cause of death, U.S. 2010

Source: Centers for Disease Control and Prevention.
Opportunity for environmental interventions

Perceived stress → Physiological responses → Chronic stress → Severe Diseases/Death

- Individual differences
- Behavioral responses

Perceived stress

Physiological responses

Chronic stress

Severe Diseases/Death
Study B

Dose of nature and stress recovery

Jiang, Chang, & Sullivan, 2013-2018
A Dose-Response Curve Describing the Relationship Between Urban Tree Cover Density and Self-Reported Stress Recovery

Bin Jiang1, Dongying Li2, Linda Larsen1, and William C. Sullivan1

Abstract

Although it is well established that viewing nature can help individuals recover from a stressful experience, the dose-response curve describing the relationship between tree cover density and stress recovery is totally unclear. A total of 160 participants engaged in a standard Trier Social Stress Test to induce stress. Participants were then randomly assigned to watch one of 10 three-dimensional videos of street scenes that varied in the density of tree cover (from 2% to 62%). Participants completed a Visual Analog Scale questionnaire at three points in the experiment. Analysis revealed a positive, linear association between the density of street trees and self-reported stress recovery, adjusted R² = .05, F(1, 149) = 8.53, p < .01. This relationship holds after controlling for gender, age, and baseline stress levels. A content analysis of participants’ written narratives revealed a similar but even stronger association. These findings suggest that viewing

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Shape of dose-response curve

Low Density of Greenness

High Recovery from Stress

Unhealthy

Healthy

Density of Greenness

Recovery from Stress

?
3D Video of Community Streets

Four mid-west urban areas
Medium annual income $50,000-75,000
255 sites, selected 50
Ordinary street scenes
3D video camera
Tree cover density (%)
10 videos with 10 levels of tree cover density (6’/video)
Multiple measures

Objective

- Continuously measured
  - skin conductance
  - finger temperature
  - blood volume pulse
  - heart responses

Subjective

- 1st Visual Analog Scale
- 2nd VAS
- 3rd VAS
- Narratives

1st salivary cortisol sample

1st visual
2nd sample
3rd sample

3’rest & 7’ introduction
3’ rest
13’ stressor
6’ nature treatment
3’ rest
30’ rest/Survey

49
Narratives of recovery experience

Percentage of reporting stress recovery increases 2.50 times
Dose-response curve

Summary Stress Reduction ($d$)

$$Y = 0.006X + 0.724$$

$$F(1, 146) = 7.56, \beta = 0.22, p < 0.01$$
The effect size increases 1.51 times.

Effect Size

Eye Level Tree Cover Density

- 2%: 0.73
- 62%: 1.10
Mechanism 3. Attention Restoration

Exposure to Nature

- Stress Reduction
- Brings People Together
- Attention Restoration
Symptoms of Mental Fatigue

Inattentiveness
Symptoms of Mental Fatigue

Irritability

https://www.researchgate.net/publication/258859204_Still_a_long_way_to_go_on_the_road_for_parallel_mechanisms/figures?lo=1

https://www.merkur.de/leben/karriere/chefs-beleidigt-muss-fristloser-kuendigung-rechnen-zr-8272935.html
Symptoms of Mental Fatigue

Impulsivity

Attention Restoration Theory

By Rachel Kaplan & Stephen Kaplan

Involuntary attention  Directed attention

https://www.airport-data.com/aircraft/photo/001063458.html
Nature uses involuntary attention but restores directed attention.
Are green landscapes still restorative in spite of technological engagement?

Jiang, Schmillen, & Sullivan (2018)

How to Waste a Break: Using Portable Electronic Devices Substantially Counteracts Attention Enhancement Effects of Green Spaces

Bin Jiang\textsuperscript{1}, Rose Schmillen\textsuperscript{2}, and William C. Sullivan\textsuperscript{3}

Abstract
Overuse of portable electronic devices depletes one's attention capacity, a critical cognitive resource. Although contact with nature promotes attentional functioning, we do not know the extent to which exposure to nature and the use of electronic devices interact to promote or inhibit attentional functioning. In this study, 81 participants performed cognitive tasks and then were randomly assigned to one of four rest treatments: green settings with or without a laptop computer and barren settings with or without a laptop computer. Attention was measured three times. Analysis showed a significant effect for both setting and use of a laptop as well as a significant interaction between setting and laptop use. A further analysis controlling for time spent focused on the laptop screen produced similar results. The findings show that using an electronic device in green settings substantially counteracts the attention enhancement benefits of green spaces.

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When people are busy using technical devices, is the green landscape still effective for mental health recovery?
<table>
<thead>
<tr>
<th></th>
<th>Laptop</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barren Spaces</td>
<td>20 subjects</td>
<td>19 subjects</td>
</tr>
<tr>
<td>Green Spaces</td>
<td>18 subjects</td>
<td>19 subjects</td>
</tr>
</tbody>
</table>
Figure 1. The four barren settings to which participants were randomly assigned during the rest portion of the experiment.
Figure 2. The four green settings to which participants were randomly assigned during the rest portion of the experiment.
Figure 3. The procedure used in this experiment included five main activities.
Figure 4. Changes in attentional functioning after the rest treatment for four conditions.
Figure 4. Changes in attentional functioning after the rest treatment for four conditions.
Figure 5. Changes in attentional functioning after the rest treatment for six conditions.
Figure 5. Changes in attentional functioning after the rest treatment for six conditions.
Healthy City & Healthy Landscape

Ten Actions
Pull people’s attention away from screens

Infrastructure to “Green+ Infrastructure”

https://friendsoftheearth.uk/climate/roads-ruin-uks-most-controversial-road-plans
Find the optimal density of built environments

https://hkpsychogeography.wordpress.com/page/3/
Green view for each family

https://www.cabinlife.com/articles/6-easy-ways-to-create-shade
Green view for each working place
Invite people to create green communities
Find every opportunity to promote urban nature

http://www.ecodesenvolvimento.org/noticias/designer-cria-telhado-verde-para-onibus
Equal access to nature
Let children play in the green & nature
Think out of the box: Preserve nature context of cities

https://saportareport.com/ormewood-forest-opportunity-preserve-key-piece-atlantas-tree-canopy/