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From Urban Development to Cognitive Outcomes: Implications for Brain Health

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ABSTRACT

Background: Urban living has been extensively linked to schizophrenia, but it remains uncertain which specific environmental factors are accounted for in this epidemiological finding, as well as how they influence how the brain develops.

Purpose: To see the effect of urban settings on cognitive function and brain health.

Methodology: We examined a potential correlation of urban upbringing in the human brain, utilizing preclinical data for permanent neurological consequences associated with initial social anxiety.

Results: The level of population density, accessibility, road connectivity, the quantity of transit stops near the residence, land use mix, green space, neighbourhood resources, and the general quality of architecture in the surrounding area all showed a generally positive association with adults' cognitive abilities.

Conclusion: The level of population density, accessibility, road connectivity, the quantity of transit stops near the residence, land use mix, green space, neighbourhood resources, and the general quality of architecture in the surrounding area all showed a generally positive association with adults' cognitive abilities.

1. Introduction

Numerous environmental variables that many individuals who reside in cities are exposed to can mix and overlap, negatively impacting mental health (Haddad *et al.*, 2015). Even though every aspect of the urban atmosphere has been thoroughly assessed independently, very little attempt has been undertaken to emulate the complex connection involving actual existence, exposure to urban life, and brain and mental health, as well as how genetic factors influence this relationship. By 2050, two-thirds of the global population will be living in urban places, with more than fifty percent currently residing there. As a result, environments are experiencing significant modifications. The urban environment is designated by higher densities of both residential and business structures, which additionally implies that there are fewer availabilities of green spaces and greater exposure to both legal and illegal substance use, as well as more stressful social situations.

For centuries, substantial practices in the fields of science, philosophy, poetry, and religion have drawn attention to the essential role of environmental factors in promoting sensations of psychological well-being in different cultures around the globe (Crous-Bou *et al.*, 2020). A significant amount of investigation in the present-day context of scientific practice has highlighted the crucial role of nature in humanity's physical wellness, conveying all the different ways in which humanity may depend on the natural world for safety in their needs of food, water, electricity, environmental stability, and various other apparent elements that constitute well-being (Kasap *et al.*, 2021). Investigators have recently begun focusing on the important role of the natural world for mental health as well, particularly the increasing impact that humans have on our natural surroundings, which is most probably evident in the form of agricultural conversion, urbanization, and pollution of the air and water.

For example, recent studies have demonstrated, though they have not yet established an evolutionary explanation, the disadvantage that people living in cities have in managing stress in comparison with their rural counterparts (Xu *et al.*, 2023). For many years, views surrounding the benefits of spending time in nature for mental wellness have been influential in political and civic debates regarding conservation. In particular, authors including John Muir and the initiators of the wilderness law in the United States concisely and systematically emphasized the beneficial effects of the natural world for mental health. There is certainly a lot more regarding this dialogue than "the wilderness." With reference to St. Bernard's writings, which stretch back nearly a millennium, Marcus and Barnes' investigation into the development of therapeutic gardens within healthcare settings explores the utilization of therapeutic gardens, as well as natural areas within infirmaries, back to the Middle Ages (Trott *et al.*, 2025). The authors utilize English, German, and French hospital designs that date from the 1600s to 1800s to demonstrate these "courtyard traditions."

Nevertheless, individuals who reside in urban areas may have possession of greater employment opportunities and improved facilities compared to those who reside in remote regions (Neale *et al.*, 2020). It is still questionable how residing in an urban setting influences psychological wellness. It is believed that urban regions have more effective physical health compared to rural ones. Nonetheless, in spite of the contradictions, there is evidence that adults who reside within urban areas are more likely to struggle with mental health problems. Despite the association between urbanization and schizophrenia drawing focus, among the most prevalent psychological disorders linked to urbanization are depression and anxiety symptoms. Conversely, previous studies examined distinct environmental variables that have become essential to urban living (Bratman *et al.*, 2012). One study conducted in China concluded that subjective well-being (SWB) parameters such as "happy" and "very happy" were 60.59% and 18.46%, respectively, in urban residents, which is more than rural residents, while 1.66% and 6.85% were "very unhappy" and "unhappy," respectively, as shown in Figure 1 (Li *et al.*, 2021).

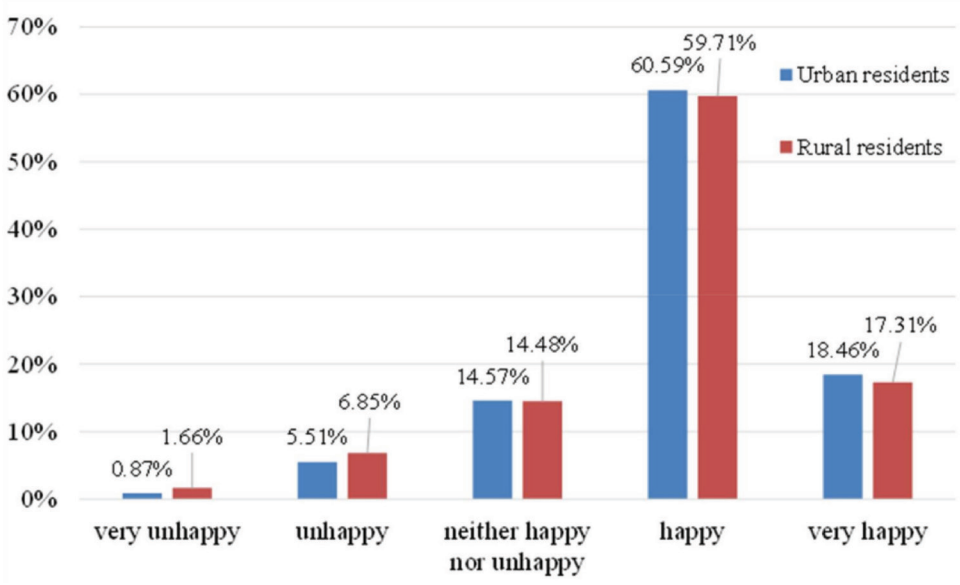

Figure 1: SWB between Urban Residents and Rural Residents

2. Methodology

A literature assessment was successfully carried out from a period of year 1997 to 2025, utilizing Google Scholar, PubMed, Scopus search engine, Cochrane Digital Library, and other databases with the goal of finding potentially significant research publications examining the impacts of urban settings on cognitive function and brain health. In both PubMed and Google Scholar search engines, the following set of keywords, search phrases, and subject headers were employed: brain health, cognitive function, and urban areas. The compiled list of references was thoroughly reviewed for necessary papers to find additional references that could be considered unnoticed, in an attempt to minimize findings bias.

3. Ecology and Psychological Health

Roszak was the first person to describe ecopsychology, which investigates the relationship between psychological wellness

and attachment to the environment. Ecology is the study of the interactions among many different kinds of organisms and the environment as a whole. It links psychology and ecosystems together (Xiang *et al.*, 2018). Even though ecological psychology has a close relationship to the field of psychology, it may additionally have an important relationship with different spiritualities, concepts, and lifestyles. Subsequently, it is essential to investigate ecological science and psychology collaboratively because several methods of therapy concur that experiencing nature connectivity and thinking linked to the natural world advantageously enhance psychological wellness.

Individuals can be considered mentally well whenever they experience an overwhelming feeling of being connected to a larger system, as suggested by eco-psychological theory (Song *et al.*, 2024). Ecological psychology and psychological well-being are closely interconnected. Yet, individuals' psychological well-being will likely be increased by introducing them to a handful of pleasant nature-related encounters throughout the span of several days within urban environments, which might include witnessing an animal in a playground, a beautiful flower on a building, or a view of a blue sky. Furthermore, one month following the investigation, some people stated that they felt healthier.

Participants in the therapeutic nature-based horticultural program were comprised of elderly individuals. Pea sprout cultivation, planter setup, and growing vegetables in many different ways, along with additional nature-themed art projects, including snatchers and leaf attraction, were a part of the program. Each activity was developed to stimulate the participants' sense of touch, sight, smell, etc. (He *et al.*, 2022). The people's psychological health, levels of anxiety, and sleeping patterns all increased as a result.

By enhancing individual concentration, levels of stress, discipline, curiosity, and satisfaction in acquiring knowledge, physical activity, and physical fitness, the environment could encourage learning. Furthermore, the environment could provide an increasingly quiet, peaceful, comfortable, cooperative, and trustworthy atmosphere for learning. On the contrary, fascination with the outside natural environment and internal mental wandering could come about effortlessly throughout an environmental experience (Roe *et al.*, 2020). There are numerous techniques that can enhance control over attention amid this shift. Being surrounded by nature promotes adaptability, cognitive wandering, as well as the development of interconnections between concepts, all of the qualities essential to creativity. In accordance with the Attention Restoration Theory, the executive attention system is rejuvenated by interaction with landscapes. For example, a group of hikers' innovative thinking and problem-solving abilities are greatly strengthened by four consecutive days of outdoor engagement and the corresponding disconnection from multimedia and technology (Liu *et al.*, 2021).

4. Evaluation of Urban Setting Impact on Living Conditions

Respondents in the present research were questioned regarding their daily living circumstances with the goal of assessing their living atmosphere. The people taking part answered questions concerning their exposure to external noise, which includes house dust and noise from vehicles, which may make them uncomfortable and interrupt their everyday lives. Additionally, those who responded were also asked whether or not they resided within one kilometre of an entertainment venue (i.e., senior exercise and recreation facilities) (Freund & Szinovacz, 2002).

The constructed surroundings in the present investigation were determined by measuring the driving distances between the residences of the subjects and the nearest restaurant, playground, healthcare facility, and supermarket. Each participant's full street address was initially entered into an internet mapping tool, which subsequently converted it into longitude and latitude coordinates. Furthermore, Baidu Search or its companion app was utilized to discover centres of interest and acquire knowledge regarding green spaces, eateries, healthcare facilities, or stores (Dalgard & Tambs, 1997).

Regarding the setting of China, each of the four facilities—parks, eateries, medical centres, and stores—was designated as a key construct to explore, since they may facilitate interpersonal relationships, athletic endeavours, medication access, or everyday activities for residents, respectively (Liu *et al.*, 2021). Thirdly, utilizing the geographical coordinates from both locations, the journeys between the dwellings and the nearest amenities mentioned previously were estimated.

The OpenStreetMap land-use surface information was analysed in the present research to pinpoint greenery (such as parkland and natural woodlands) and blue spaces (such as lakes and rivers) (Crous-Bou *et al.*, 2020). Histograms were built with the objective of independently confirming the information's statistical distribution. Quartile-split characteristics were implemented, spanning the first quarter (which symbolizes the shortest distance) to the fourth quarter (reflecting the greatest distance), given the exponential statistical distributions of the examinations of travel distance to the closest facilities (Chen *et al.*, 2021). The two mentioned environmental characteristics were categorized as "any" and "none," given that the distribution patterns of the percentages of blue and green spaces were extremely skewed.

5. Relationship Between Cognitive Function and Residential/Population Density

Based on previous studies, elderly individuals' cognitive function could benefit from population density, but dwelling

density is not believed to have a positive effect on their cognitive abilities (Shen *et al.*, 2021). Several investigations focused on how older people's mental performance was influenced by residential and population density factors. Particularly, an association between increased urban population density and enhanced mental functioning in older persons has been identified (Wight *et al.*, 2006). Elderly individuals' cognitive health advantages originate from greater population density.

Additionally, a Japanese study observed that deterioration in cognitive function in older individuals who reside in rural areas could be predicted by increased residential density and steep terrain. Nonetheless, there may be an important influence of the percentage of domestic land utilization on older individuals' overall cognitive function as well as processing speed. Dwelling density did not significantly influence older individuals' language, visuospatial/construction abilities, immediate and delayed memory recall, or global cognition, based on either objective or subjective measurements (Trott *et al.*, 2025).

6. Relationship Between Cognitive Function and the Diversity of Architectural Features in Urban Areas

Indicators that could demonstrate the range of characteristics of a community's urban environment include land use mix and neighbourhood assets. The majority of research has reached the understanding that residential neighbourhoods with a broader local resource base and a more diverse ecological mix could improve elderly persons' mental functioning (Galea & Ahern, 2006). A cross-sectional investigation demonstrated that subjective evaluations of different types of land use mix were significantly and positively correlated with spoken language, visuospatial/constructive competence, immediate and delayed memory recall, and global cognition.

Furthermore, a cross-sectional investigation conducted in Hong Kong, China, discovered that improved cognitive performance was demonstrated by older individuals residing within neighbourhoods with a greater land use mix. Additionally, research has shown that dwelling in locations with diverse land use was associated with a nearly thirty percent decreased risk of cognitive impairment (Armfield *et al.*, 2025). Community centres, supermarkets, healthcare facilities, recreation centres, libraries, grocery shops, and fast-food restaurants are examples of fundamental facilities and amenities regarded as neighbourhood resources.

A greater degree of cognitive function in elderly people was associated with dwelling in urban areas with greater accessibility to recreational facilities and higher business density, according to findings from an ongoing investigation conducted in the United States of America. The kernel density of senior centres, civic and social organizations, and cognitive ability also showed a substantial positive correlation. However, some studies additionally discovered no significant correlation between elderly individuals' cognitive functioning and the availability of local resources (Chen *et al.*, 2021).

7. Relationship Between Cognitive Function and the Standard of the Urban Setting

Although there continues to be a dearth of investigation on the subject at hand, the vast majority of research investigations that have been performed indicate that enhanced local environmental conditions could improve cognitive health in older people (Dickerson *et al.*, 2007). The study of aesthetics, neighbourhood physical disorder index, road degradation index, neighbourhood landscape, traffic safety, unlawful safety, and sanitation are just a few of the variables that constitute the standard of the neighbourhood's urban setting that have been addressed in this study.

Where evidence was found, less wealthy neighbourhood characteristics have been linked to decreased cognitive abilities in older White people; poor neighbourhood quality was associated with decreased psychological function in Black people of all ages, and the perception of neighbourhood unhygienic practices had been linked to greater cognitive function in more educated Mexicans yet decreased cognitive function in less educated Mexicans (Bratman *et al.*, 2012).

With regard to neighbourhood physical disorder, poorer baseline episodic memory as well as verbal proficiency were linked to higher neighbourhood physical disorder. Similarly, many researchers confirmed that worse overall intellectual and cognitive abilities in female participants were associated with their perceived neighbourhood physical disorder (Crous-Bou *et al.*, 2020). A cross-sectional investigation demonstrated a significant association between worse episodic memory and older people's perceptions of increased neighbourhood physical disorder.

Community problems and cognitive function, however, have not been demonstrated to be linked in several investigations. A research investigation carried out in both Taiwan and China indicated an advantageous relationship between elderly people's perceptions of security and neighbourhood safety. Better memory performance was associated with a decreased number of vehicle crashes. In addition, there was also an associated relationship between decreased cognitive vulnerability and elevated self-reported neighbourhood pleasantness. Another study revealed a significant and unfavourable relationship between mental health and the road deterioration index (Kasap *et al.*, 2021).

8. Relationship Between Urban Transportation Systems and Cognitive Function

In line with the vast majority of previous studies, aged individuals' cognitive function has a negative relationship with their home's distance from a main road, yet it has a beneficial relationship with the quantity of public transportation stops nearby. More specifically, four investigations evaluated the influence of distance from an important road on individuals' cognitive function; three of these investigations revealed an adverse relationship with distance from a main road, whereas one reported no effect (Bratman *et al.*, 2012).

A Canadian study revealed that an increased risk of dementia was associated with a home's proximity to a road. Nevertheless, it was also demonstrated that Chinese people's mental functioning is not impacted by the distance between their home and a bus stop. Furthermore, two investigations evaluated how the quantity of public transportation stations near a senior adult's residence impacted their cognitive efficiency, and both discovered that increasing the quantity of public transit stops enhanced mental function (Speldewinde *et al.*, 2009).

For instance, it has been found that elderly people who lived in neighbourhoods containing gathering places and mass transit stops exhibited a slower rate of cognitive decline over time. Researchers demonstrated that individuals who are 80 years of age or younger can function more effectively cognitively in communities that have many public transit stations (Evans & McCoy, 1998).

9. Correlation Between Cognitive Function and Green/Blue Regions

The presence of greenery usually enhances individuals' mental functioning, but fewer investigations have examined the association between blue space and mental processes, and the results have been contradictory (Brunner, 2005). Increased investigation is therefore needed. Only three of the included studies addressed the impact of blue space on mental processes, whereas more than fifty percent addressed the connection between blue and green space and memory in older persons.

Neighbourhoods with the greatest number of green spaces had twenty percent lower odds of Alzheimer's disease compared to neighbourhoods with a smaller amount of green space (Aneshensel & Sucoff, 1996). Increased park accessibility has been scientifically shown to boost cognitive performance. Compared with households with a low percentage of greenery, those with an increased amount of green space have a reduced likelihood of dementia. Nevertheless, no significant association was detected between the overall percentage of green space and the likelihood of dementia or mild cognitive impairment (MCI) (Aneshensel *et al.*, 2011).

Densely forested green space was associated with a decreased likelihood of MCI, whereas green space diversity was linked to a reduced likelihood of dementia events. According to a long-term investigation, people who resided in more environmentally conscious communities were less likely to experience cognitive impairment compared to those with a low likelihood of hereditary transmission (Speldewinde *et al.*, 2011). Nevertheless, among individuals at elevated risk of hereditary Alzheimer's disease, no apparent association was found between greenery and cognitive impairment.

According to a cross-sectional investigation carried out in Australia, people's cognitive performance is positively impacted by residing in an environment that has blue spaces. A United Kingdom investigation, however, found no link between dementia and the abundance of blue space (Aneshensel *et al.*, 2011). A number of academic investigations have suggested that local blue space is associated with mental performance but not with MCI. These studies also discovered that participants who had any blue space within an 800-meter buffer surrounding their residence performed more effectively cognitively compared to those who did not; however, this association was observed only in female participants (Freund & Szinovacz, 2002).

10. Conclusion

A comprehensive review of how urban settings influence adults' cognitive performance has been provided. The level of population density, accessibility, road connectivity, the quantity of transit stops near residences, land use mix, green space, neighbourhood resources, and the general quality of architecture in surrounding areas all showed a generally positive association with adults' cognitive abilities. Nevertheless, there was an adverse association between individuals' cognitive function and road congestion, as well as the distance between their residence and major roads.

To enhance cognitive functioning and reduce the likelihood of neurological disorders in adults, public health initiatives could consider community-built environment characteristics based on the findings of this review. These results may serve as a scientific reference for policymakers and support the development of intervention strategies aimed at improving cognitive function.

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Authorship Contribution

Nuwo David, Inderpreet Kaur, Purnima Jindal: Wrote the manuscript; **Elijah Dennis, Sapna**: Curated the data; **Vivek Kumar Garg**: Conceived the idea, proofread and edited the manuscript.

Ethical Approval

Authors declare that the ethical approval was not required for this study.

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Conflict of Interest

The authors declare no conflict of interest, financial or otherwise, related to this work.

Data Availability Statement

Authors declare that the data sharing is not applicable as no new data were generated or analyzed.

Declarations

The authors declare that this manuscript is original, has not been published previously, and is not under consideration for publication elsewhere. All authors have contributed significantly and consent to publication in the present journal.

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