Proceedings of the 4th International Conference on Modern Medicine and Global Health
DOI: 10.54254/2753-8818/2026.31385

The Mediating Mechanism of Health Awareness: Linking Urban Built Environment to Residents' Depression

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Abstract. As times now go on, health awareness has raised, however mental health problems in crowded city environments have grown more. Depression is a severe disorder and important indicator of mental health, now it's a public health concern related to urbanization. This paper looks at how various kinds of residential built environment factors affect people's health awareness and depression levels and also looks at how health awareness can be a reason for something. According to 775 questionnaires collected in the main urban area of Zhengzhou, multiple linear regression and mediation effect analysis were conducted. Depression was judged with the HADS questionnaire and health awareness through a survey questionnaire, Results show that: (1) Green view ratio raises depression but NDVI and average building height lessen it. (2) Green view ratio, green space quantity, and road network density bring about higher health awareness, concurrently fewer people, sky openness, transit stations, and walkability also improve health awareness. (3) Health awareness acts as a mediator linking improved environmental elements like greenness, streets, and vegetation, to lower depressive illnesses. On contrast, it also explained how certain specific urban arrangement like abundant foliage, a lot of open sky, concentrated residential pattern, pedestrian-friendly infrastructure, a lot of public transport hubs etc. associated itself with higher level of depressive symptoms This study proves that improving the residential built environment can lead to better mental health both directly and indirectly as a result of health awareness.

Keywords: Residential built environment, Depression levels, Health awareness, Multiple linear regression model, Mediation effect

1. Introduction

Mental health is a big deal everywhere. In China, it shows in the form of the "Healthy China" national strategy, which has officially integrated mental health into the public health system. Like this policy change aligning with more public awareness making us have a better understanding of how important mental health is. Depression is a prevalent health issue, a typical example of current problems. Globally, it affects about 280 million people [1]. In China, the lifetime and annual prevalence is about 3.4% and 2.1%. Women, unemployed and post separationorlost individuals tend to have a higher risk. Depression is an urgent matter concerning public health across the globe; for China, given its extensive populace and considerable number of individuals in need of care, it

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naturally requires special attention [2]. A large population in China leads to a large number of people suffering from depression and is an urgent public health issue that requires intervention.

China’s fast-paced urbanization has created living spaces that are full of people, and this has a big effect on how people’s thoughts and feelings are. There are four major domains that study housing environment and mental well-being: land use, environmental quality, transit infrastructure, and urban design patterns. As for land use patterns, it is found from research that the increased local amenities together with easy access to neighborhood resources like medical centers and recreational complexes contribute to a better feeling and joy [3]. Mixed land use and many differentconvenient facilitiescanalsoaid yourstate of mind [4]. Ecological quality is a big part, green places and water make folks feel better, but empty places can have an opposite effect [5]. Transportation infrastructure is an infrastructure of an infrastructure; although the increase in road density and connection makes transport and travel more convenient, it can also increase people's exposure to harmful pollutants such as PM2.5, and may result in an increased risk of suffering from depression [6]. From space, it’s high density environments cause anxiety and stress. Low depression in the middle density suburban and open spaces [7].

“Healthy China” has slipped off the poster in the clinic waiting room and into the daily calculus of ordinary lives: stay ahead of decay rather than queue for repair. The proof is not the annual blood draw but the quieter discipline of learning why sleep frays and then guarding the hour before midnight like a promise you make to yourself [8]. City people who manage this usually carry diplomas and subway cards, yet the trick travels: take the stairs, rinse the salt off the plate, greet the neighbour you only know by sight. Each act feels weightless, but together they file down the mornings when getting out of bed seems pointless and keep the calendar of faces and names from smudging too soon [9].

The current research is aware of two main gaps in academic knowledge, which shows that there is a little amount of research on how the living spaces, health awareness, depressive symptoms connect when we do multidimensional built environment assessments, and also the link where health awareness plays as the main bridge hasn’t been explored yet. Study currently looks at the symbols in neighborhoods near the outside ring city road in Zhengzhou, and tries to find out more about elements in urban design that can effect mental health consequence and opinion of public health by using field probes, tons of data, and techniques from mathematics. With awarenesson how to turn health awareness as mediator, I’m going to give some useful clues on how city planning cancurb depression.

2. Research methodology

2.1. Study area

Zhengzhou's demographic trends reveal notable patterns in urban development. The city has seen consistent growth in population numbers, with official statistics recording 13.086 million inhabitants by late 2024, marking a rise of 78,000 residents from the previous year. Within the Fourth Ring Road's urban zone, varied residential communities coexist, while the densely populated urban core serves as a microcosm of the city's broader population distribution.

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2.2. Data sources and processing

2.2.1. Built environment data

(1) 2D Built Environment: The study is combined with many spatial datasheet, 1m-resolutio impervious surface mapping (2023) and 1km population density distribution (2023). Building metrics (density, height, volume) were generated via AI-based analysis of landsat 8 and nighttime lights imagery. Vegetation patterns are assessed via 30m resolution NDVI data from landsat 8 OLI. Rd networks were digitizd from OSM repositories, POI diversity & public transit info from Gaode Map (accessed May 2024). Blue-green infrastructure features were identified & mapped with BIGMAP platform integration with ArcGIS workflow. (2) 3D Built Environment: We used Baidu street view images to analyse green view index, sky openness walkability and street convenience. The study collected 70,077 sampling points at intervals of 50m and obtained images from four directions. Then analyzed the obtained image samples using PSPNet's semantic segmentation. While a certain amount of time inaccuracy occurs for the collected data, the temporary environment of the residential area will not cause any impact to the findings due to the residence, so the robustness of the result is still strong.

2.2.2. Social survey data

Researchers did a residential health survey in Zhengzhou's main urban places from Nov 2024 to Jan 2025. After running quality checks to remove incomplete answers, the research got 775 valid responses, making up for 95.33% of total answers.

2.3. Variable selection and measurement

2.3.1. Dependent variable

This study takes the residents' depression level as the most important element, using Hospital Anxiety and Depression Scale (HAD) as screening tool, which is mostly used to examine the residents' psychological health in the research [10]. The depression subscale is composed of 7 statements: I still participate in activities I used to enjoy, but I still find things to laugh at and appreciate the good around me, I stay in good spirits all day, I stopped paying attention to how I look, I am positive about everything and look forward to the future, I feel my mood is dropping, I like reading a good book or watching some TV Score ranging 0-21 is a high score. This means having a serious case of being depressed. A score ≥8 is considered a positive score for being depressed and a negative score <8.

2.3.2. Independent variables

The independent variables include residents' demographic attributes (age, gender, education, family structure, income, household registration, and property ownership) and four aspects of the residential built environment: land use and facilities, ecological quality, transportation and streets, and spatial form. The residential area is defined as a 1000-meter street network buffer zone, in line with the 15-minute residential life circle planning guideline.

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2.3.3. Mediator variable

This study employs residents' health awareness as a mediating variable. The questionnaire items were adapted from the Health Awareness Survey Database (CSPH series) of Renmin University of China. The health awareness scale consists of six items covering psychological support, health knowledge learning, first-aid skills, balanced diet, daily exercise, and timely medical care. Scores range from 0 to 30, with higher scores indicating stronger awareness. The scale demonstrates good reliability and validity (Cronbach's α = 0.857, KMO = 0.863).

2.4. Analytical methods

2.4.1. Descriptive statistics

Descriptive statistics summarize the sample characteristics using the median, interquartile range, and percentages to show central tendency and dispersion, providing a basis for further analysis.

2.4.2. Multiple linear regression model

This study includes two levels of variables: individual control variables and residential area independent variables. Since the variables do not exhibit nested characteristics, and the focus is on the fixed effects of the residential built environment rather than heterogeneity between areas, a multiple linear regression model is used to assess the effect of independent variables on depression levels. The analysis is conducted using RStudio 4.3 with a random intercept model. The specific model formula is as follows:

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_k X_K + \epsilon \tag{1}$$

2.4.3. Mediation effect analysis

This study investigates the mediating effect of health awareness using the causal steps method by Baron & Kenny and the Bootstrap method for significance testing. The model formula is as follows:

(1) Mediating Variable Model

$$M = \alpha_1 + \beta_1 X + \gamma_1 C + \epsilon m \tag{2}$$

(2) Dependent Variable Model

$$Y = \alpha_2 + \beta_2 X + \gamma_2 C + \varphi M + \epsilon y \tag{3}$$

3. Results and analysis

3.1. Descriptive statistics

3.1.1. Resident basic information

The statistical summary shows that respondents' ages are balanced across groups, with a nearly even gender ratio. Most respondents have a college degree or higher (40.15%), are married or cohabiting

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(69.2%), and have lived in their current residence for over 10 years (31.43%). Income levels are mostly below 5000 (57.2%), and the majority are workers, service personnel, or self-employed (58.12%). Over half of the respondents (51.01%) hold urban household registrations in Zhengzhou city, and most own their homes (59.39%). Health awareness is generally high, with a median score of 24 and moderate variability (IQR = 7). Depression levels are relatively low, with a median score of 6 and moderate variability (IQR = 6).

3.2. Multiple linear regression analysis results

3.2.1. Multicollinearity detection of built environment factors

The Variance Inflation Factor (VIF) was used to assess multicollinearity. Floor area ratio and building density were excluded (VIF > 7.5). The final regression model included POI density, POI functional diversity, impervious land area ratio, population density, green view ratio, sky openness, NDVI, number of blue spaces, number of green spaces, road network density, public transport stations density, walkability, street facility convenience, average building volume, and height.

3.2.2. The impact of built environment on depression levels

Model 1 results show that higher education is linked to lower depression levels. Specifically, residents with a college education or higher ($\beta = -1.92$, $p < 0.01$) and those with a graduate degree or higher ($\beta = -2.93$, $p < 0.01$) have significantly lower depression scores compared to those with primary school education or below. Widowed residents ($\beta = 1.75$, $p = 0.02$) have higher depression scores than married/cohabiting residents. Rural residents in the city ($\beta = 1.29$, $p < 0.01$) also have higher depression scores than urban residents. In terms of the built environment, as shown in Figure1, the green view ratio ($\beta = 0.40$, $p = 0.03$) is positively correlated with depression levels, while NDVI ($\beta = -0.47$, $p < 0.01$) and average building height ($\beta = -0.60$, $p < 0.01$) are negatively correlated with depression levels.

3.2.3. The impact of built environment on health awareness

Model 2 results indicate that higher educational attainment is associated with greater health awareness. Specifically, residents with a high school education ($\beta = 1.80$, $p < 0.01$) and those with a college degree or higher ($\beta = 1.51$, $p = 0.015$) report significantly higher health awareness scores compared to those with only primary school education or below. In contrast, widowed residents show lower scores than married/cohabiting individuals ($\beta = -2.12$, $p = 0.018$). Additionally, residents from other cities ($\beta = -1.73$, $p < 0.01$) and rural areas ($\beta = -0.80$, $p = 0.042$) have lower health awareness than locally registered urban residents. Regarding the built environment, the green view ratio ($\beta = 0.95$, $p < 0.01$), number of green spaces ($\beta = 0.61$, $p < 0.01$), and road network density ($\beta = 0.68$, $p < 0.01$) are positively correlated with health awareness. On the contrary, sky openness ($\beta = -0.81$, $p = 0.02$), population density ($\beta = -0.65$, $p = 0.02$), public transportation stations density ($\beta = -0.62$, $p = 0.013$) and walkability ($\beta = -0.78$, $p < 0.01$) are negatively correlated with health awareness levels, as shown in Figure1.

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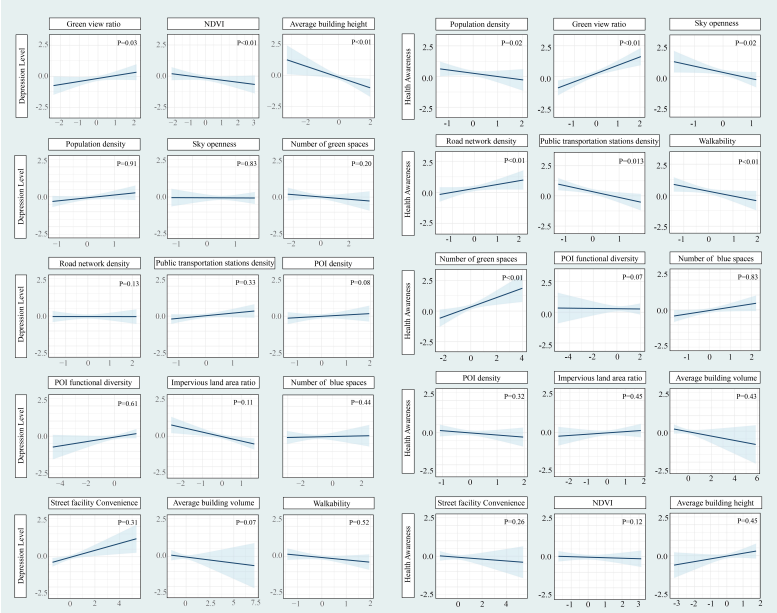

Figure 1. Partial regression plot of the built environment's effect on depression and health awareness levels

3.2.4. Mediation effect analysis results

To explore the role of health awareness on the relationship between built environments and depression severity, we conducted Baron and Kenney's causal steps method with bootstrap analysis to verify the statistical analysis as shown in table 1. Analysis reveals: Greenvisibility has an indirect impact of–0.19 (p< 0.01), the overall effect coefficient is 0.50 (p < 0.01): The -26. 30% mediated proportion (p < 0. 01), which displays the amount of counteract happening via this route. An indirect effect of the NDVI of 0.08 (p = 0.03) occurs through health awareness, which partially offsets the direct negative effect of -0.54 (p < 0.01). This interaction produces an overall effect coefficient of -0.46 (p < 0.01), with mediation accounting for -18.41% (p = 0.03) of the total effect. This is to say that health awareness bears an impact in between the environmental factors holding an influence on people. And depression is increased. A few environmental factors displayed strong mediations through health awareness. Sky openness, population density, walkability, and access to public transit exerted their positive indirect effects on depressive symptoms with respective coefficients of 0.19, 0.15, 0.15, and 0.13 (all p ≤ 0.016). Conversely, green space availability showed a negative indirect association (-0.12, p < 0.01) with depression levels when mediated through health awareness mechanisms.

Table 1. Mediation effect test results based on health awareness (using the Bootstrap method)

Independent variables	ACME (95%CI)	ADE (95% CI)	Total effect (95% CI)	Mediation proportion (%)	Mediation type
Population density	0.149* (0.034,0.28)	-0.320 (-0.717,0.10)	-0.171 (-0.593,0.25)	-42.00%	/
NDVI	0.083* (0.015,0.16)	-0.541*** (-0.795,-0.29)	-0.457*** (-0.716,-0.20)	-18.41%*	Partial Mediation
Number of green spaces	-0.116** (-0.204,0.04)	-0.068 (-0.339,0.22)	-0.184 (-0.470,0.11)	49.45%	/

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Table 1. (continued)

Green view ratio	-0.191*** (-0.296,0.10)	0.579*** (0.266,0.92)	0.389* (0.055,0.73)	-48.86%*	Partial Mediation
Sky openness	0.192** (0.057,0.35)	-0.136 (-0.629,0.35)	0.056 (-0.445,0.55)	42.83%	/
Road network density	-0.135** (-0.235,-0.05)	0.638*** (0.326,0.94)	0.503** (0.178,0.82)	-26.30%**	Partial Mediation
Public transportation stations density	0.127* (0.026,0.24)	-0.276 (-0.633,0.10)	-0.150 (-0.521,0.22)	-40.24%	/
Walkability	0.155* (0.038,0.28)	-0.271 (-0.691,0.14)	-0.117 (-0.529,0.31)	-41.01%	/

4. Discussion

4.1. Results on the impact of depression levels

People who are better educated experience less depression. And this association is mainly due to improved health literacy, better lifestyle choice, and better work condition. Those going through widowhood always have higher marks of sad feelings than married people, and this is caused by feeling not okay, being alone, not having help around them, and having lots of problems that cost money. Rural people also have higher depression levels because of having more life stressors, lower incomes, worse healthcare, less social support, and fewer mental health resources. Residential areas with a lot more visible green space, there were more depressed people. This sort of unintentional pattern could be due to greater health awareness in those places, maybe even pushing people's personal wellness standards and causing mental strain. But if the actual benefits from greener places don't line up with how people think they should feel, that might make folks have jumbled thoughts about their homes, which could make them think any health stuff isn't as good. And places that had more plant growth, which was measured by NDVI, had fewer depressed people. These results support the conventional viewpoint that there is more green space that is better for the environment in general. This provides a neighborhood with cleaner air as well as a place to go for recreation and talk with others. And it works to ease and promote. Like previous studies have also concluded there is a negative relationship between average building height and depression. Taller buildings usually suggest better living conditions, having more natural light, amounting feeling safer and more comfy, which can help lessen depressive feeling.

4.2. Results on the impact of health awareness

Demographic aspects have a great effect on health awareness. Education does play a huge part in all of this when it comes to improving health literacy. On the contrary, being married to a spouse or to be a migrant would be associated with less of an awareness regarding health. For widows, it is usually because there is less social support and less desire to pay attention to problems that have to do with health and so on. In migrant population, these groups struggle with coping with socioeconomic hardships and has difficulty in integrating with the local community and also unfamiliar with the local healthcare system. These all add up to slower adoption of health awareness. The results are in line with the results in academic studies. The constructed world has various aspects that shape healthy thoughts in different ways. Boosted the visibility of greenery as well as better accessibility to parks would raise this awareness through great spaces that appeal for doing outdoor activities and physical workout. Also well connectedroad density boost public health

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awareness because they give people a better way to uses medical things and help. But Some conditions are bad for health-conscious behavior: Month of winter open areas discourage all sorts of outside activity without weather protection. A high population count usually causes health priorities to drop in light of resource shortages and environmental stress. Proximity to transit hubs usually has urban stressors such as noise and crowding, which is bad for health awareness. Cold winter months when we increase pedestrian accessibility unknowingly lower health watchfulness by spending too long exposed to freezing temperatures and air pollution making us think we are not feeling so well.

4.3. Mediation effect results

The study points out the complicated ways that the various qualities of the built environment affect depression through different routes, and that the indirect effects go through health consciousness. NDVI shows positive overall impact: Even indirectly by increasing worry about health issues it could be dangerous but it has also an effect on improving environmental quality which reduces stress level more than it. Not like green spacesand road density is negative: Green spaces have a direct negative impact, and the indirect benefits due to a lowered sense of safety are less. As for the latter, it is the direct harm done by traffic pollution and noise that outweighs the indirect benefits of more convenient access to health care services. On the other hand, like open sky visibility, the walkable neighborhoods, population density and those near transit stations mainly with regard to health awareness. It links to environmental exposures, competition over resources, and psychosocial stressors. While the green areas making us happy through this channel is understandable, the complete effect is still unknown as there are many factors. And therefore we need urban planning to actually take those into account and balance them all together to have an overall benefit for our mental health.

5. Conclusion

In this research, we combine multi source urban data from Zhengzhou with deep learning and regression to analyze how 2d and 3d built environment affects depression to people living there. Our analysis shows the effect of our environment on how we feel but also shows that being health conscious is in between. In the study they admit that it has some biases because they use a survey cross-sectional data collection. Future work could use street view imagery plus wearable sensing and machine learning together, making it better to see what the city is like and how people’s bodies feel, using all these things together.

Funding

This work was supported by the National Natural Science Foundation of China [grant number 52308084], the China Postdoctoral Science Foundation [grant number 2022M712877], and the Key R&D and Promotion Projects of Henan Province [grant number 222102110125; 232102321078].

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