新冠肺炎（COVID-19）疫情下
居住区绿地对居民心理健康影响
的实证研究
AN EMPIRICAL STUDY ON THE IMPACT OF GREEN SPACES IN RESIDENTIAL AREAS ON THE MENTAL HEALTH OF RESIDENTS UNDER COVID-19

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Abstract
As one of the frequently used green spaces of urban residents, residential green spaces have a positive effect on people’s mental health status. In order to understand the impact of residential green spaces on citizens’ mental health during the COVID-19 epidemic, this study collected the sociodemographic data of 556 residents from 15 residential communities in Hefei New Municipal and Culture District, Anhui Province, China in March, 2020 through online questionnaires, then adopted the Kessler Psychological Distress Scale (K10 Scale) to evaluate the residents’ mental health status, and used GIMP Grid to quantify the green view index of residential green spaces outside the windows. Besides, a multiple linear regression model was used to explore the correlations between residential green spaces and residents’ mental health status. The findings show that green coverage ratio, satisfaction of the landscapes of green space, green view index outside the window, and green viewing duration of the residential green spaces have positive effects on residents’ mental health status. The study verifies the benefits of residential green spaces to promoting resident’s mental health status under COVID-19, providing a scientific guidance for the future practice of urban construction.

KEYWORDS
COVID-19; Residential Green Spaces; Green Spaces Welfare; Mental Health; Green View Index; Green Coverage Ratio; Green Space Satisfaction; Green Viewing Duration; K10 Scale

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1 Introduction

China was hit by the COVID-19 epidemic at the beginning of 2020, and Chinese people immediately started a two-month home quarantine, making the outbreak effectively controlled finally. Nonetheless, the long-term home quarantine disrupted people’s normal life and might have caused psychological problems such as depression and anxiety[1]. According to a survey conducted by Song Feifei et al., during the COVID-19 epidemic, some of respondents reported the symptoms of obsessive-compulsive disorder, interpersonal relationship sensitivity, depression, anxiety, hostility, fear, paranoia, and psychotic disorder, among which anxiety, fear, and depression ranked top three[2]. In the survey by Wang Cuiyan et al., 53.8% of 1,210 respondents reported that the epidemic has a medium or severe impact on their mental health condition, 16.5% reported medium or severe depression, and 28.8% reported medium or severe anxiety[3].

Since the advent of modern city, urban green spaces as natural spaces in the constructed environment play a key role in improving the public health level. Restorative Environment Theory validates the effect of the natural green environment to relieve people’s mental pressure[4]. The theory mainly includes the Attention Restoration Theory and the Stress Recovery Theory[5]. The former theory claims that when in nature, people only use the involuntary attention while recovering the voluntary attention[6]. The latter theory proposed by Roger S. Ulrich holds that mental pressure is a stress response at both physical and psychological levels when dealing with problems, which would arouse negative emotions and generate bad impact on physical and mental health condition. Pleasant green spaces can help relieve tensions, decrease the stress level, and recover people’s health status[7].

In this background, this paper focuses on answering the following questions: Whether the long-distance watching of green spaces, the only available way for the residents to connect with nature during the home quarantine, could help improve people’s mental health level? As the major green landscape available to the residents, did the green spaces in residential areas provide different health benefits due to the differences of landscape composition and characteristics? If yes, to what extent did the functions vary? By evaluating the residents’ health status during the quarantine, this research discusses the impact of the green spaces in residential areas on people’s mental health level, aiming to enrich the research on the health benefits of green spaces in residential areas and provide guidance on the construction of residential landscapes.
2 Literature Review

2.1 The Promoting Effects of Urban Green Spaces on Mental Health

WHO defines mental health as “a state of well-being in which the individual realizes his or her own abilities, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to his or her community.”[8] Therefore, a healthy mental status not only refers to that one does not have mental disease but also feels happy or satisfied in their daily life. Existing studies suggest that urban green spaces help promote mental health, such as improving the overall mental health condition[9][10], and life satisfaction[11], increasing the sense of happiness[12], promoting healthy lifestyles[13], improving sleep quality[14], reducing pressure[15][16], and alleviating anxiety[17], attention deficit, hyperactivity[13][18], and depression[19][20].

2.2 The Promotion Mechanism of Urban Green Spaces on Mental Health

According to the Stress Recovery Theory and Attention Restoration Theory, urban green spaces are key places for urban residents to relieve pressure and recover attention[21]-[23]. Relevant studies prove that different types of green spaces can all help improve people’s mental health level. For example, parks have remarkable effects on relieving mental pressure and allaying tiredness: the longer one stays in the park, the better one’s mental health status will be[24][25]. In residential green spaces, the higher frequency one visits the green spaces, the better one’s mental health status will be[26]-[28]. In campus green spaces, playgrounds with natural landscapes help enhance students’ attention and raise their learning efficiency[29]. In workplace green spaces, better sight access to the outdoor green spaces makes employees happier and more satisfied while lowering their work pressure[30].

Studies on the characteristics of green spaces and people’s mental health status focus on spatial attributes and compositions of green spaces. Studies on spatial attributes show that a high accessibility of green spaces helps recover residents’ mental health[31][32]. Studies on green space compositions reveal that diverse planting design and plant species spectrum, and the use of native tree species would encourage residents to visit the green spaces and promote the recovery of mental health[33]. Varied landforms and attractive landscapes and facilities would enhance users’ visiting experience, which also helps mitigate psychological distress[34]. Well-developed service facilities can ease residents’ psychological pressure: the better the quality of service facilities is, the less stressful the residents feel[35].
此外，有关绿地接触形式与人群心理健康的研究表明，各种形式的绿地体验对人群心理健康均具有改善作用\cite{35}。在户外实验研究中，通过对比人们在自然绿色环境和城市建成环境中的行走体验，包括情感、认知能力和生理维度的变化，揭示了绿色环境体验对人群心理健康的促进作用\cite{36,37}；而利用虚拟实验室进行的控制性研究表明，观看风景图像同样有利于缓解人群的心理压力\cite{38}。

3 研究方法

3.1 研究地点

本研究以安徽省合肥市政务文化新区为研究范围。新区自2002年3月正式启动建设，规划面积为12.67 km\textsuperscript{2}，是一座集行政办公、文教体育和居住休闲等多种功能于一体的城市新区。目前，新区内居住区入住率高，但依建成时序，居住区绿地品质存在差异性。研究于2020年3月采用网络问卷调查的方式对新区内居住区进行调研，共收到来自37个居住区的1547份问卷。根据问卷反馈量，剔除反馈量少于10户的居住区，确定了30个初选研究地点。

在此基础上，从绿地品质和人口特征两个层面对初选地点进行精选。通过已有的绿地健康功效研究发现，植物景观是绿地环境影响居民心理健康的重要因素\cite{34}，而植物景观品质主要体现在绿地面积和植物配置两个方面\cite{39}。基于此，研究以绿化覆盖率和可指示植物多样性的香农-威纳多样性指数作为居住区绿地质量分析指标，其中绿化覆盖率指标反映居住区绿地的相对面积，植物多样性指标则反映绿地的植物配置情况。基于笔者于2019年9月对新区范围内的73个居住区进行的绿地调研结果，居住区园林植物以常绿树种为主，植物季相对绿化覆盖率和植物多样性数据的影响较小。据此，本研究的绿化覆盖率数据利用CITYgreen模型分析经过几何坐标校正和投影转换处理的百度地图获取，香农-威纳多样性指数则根据笔者获得的绿地调查数据进行计算。

分析结果显示，在30个初选研究居住区内，绿化覆盖率达到50%及以上的共5个，45% – 50%的为5个，40% – 45%的为9个，35% – 40%的为6个，低于35%的为5个；香农-威纳多样性指数大于3.0的居住区为3个，2.5 – 3.0的为6个，2.0 – 2.4的为8个，1.5 – 1.9的为9个，小于1.5的为4个。对绿化覆盖率和香农-威纳多样性指数进行相关性分析，发现

3 Study Methodology

3.1 Study Site

This study focuses on Hefei New Municipal and Culture District (New District hereafter) in Anhui Province which started its construction in March 2002, cover a planning area of 12.67 km\textsuperscript{2}, and accommodate administration, office, cultural, sports, recreational, and residential land uses. The residential communities within the New District have a high occupancy rate, and the quality of green spaces vary due to different completion phases. Based on the online questionnaire results collected from 1,547 respondents living in 37 residential areas in March 2020, 30 candidate study sites were chosen first after excluding the ones with less than 10 respondents.

Then, the candidate study sites were further screened given the consideration of green space quality and demographics. Studies on the health functions of green spaces reveal that, greenery is an important factor to mental health status\cite{34}, and the landscape quality is mostly defined by the area and planting design of the green space\cite{39}. This study takes green coverage ratio as an indicator for the green space ratio to the size of residential communities, and Shannon–Weiner Diversity Index as the indicator for the plant species diversity and combination. Based on the green spaces survey in 73 residential areas in New District carried out in September 2019, most of the landscape plants are evergreen species, meaning that seasonal change has little impact on the green coverage ratio and plant species diversity. Therefore, the green coverage ratio in this study was obtained with the CITYgreen model, which is processed with the geometric correction and projection transformation of Baidu Maps, and the Shannon–Weiner Diversity Index was calculated with the collected data of green spaces.

According to the analysis results, 5 of 30 candidate residential communities have relatively high green coverage ratio (higher than 50%), 5 ranging from 45% to 50%, 9 ranging from 40% to 45%, 6 ranging from 35% to 40%, and 5 less than 35%. The Shannon-Weiner Diversity Index of 3
指标，从上述绿化覆盖率等级不同的居住区内进行分层随机抽样，共筛选出20个居住区。为进一步减少人口抽样偏差，从人口年龄结构和人口数量层面对20个居住区进行再次筛选。通过居住区物业获取居住人口信息，最终选取了15个入住率高于70%的居住区作为本次研究的具体地点（图1）。

3.2 研究对象

按照伦理学要求，进行网络问卷的研究对象为上述15个居住区内未感染新冠肺炎的常住居民，所有参与者均在知情情况下自愿填写问卷。因疫情期间的管控措施，最终共收回来自15个居住区的问卷1273份，其中有效问卷762份，问卷有效回复率为59.86%，排除患有慢性病的居民，以及没有上传窗外居住区绿地照片或上传的窗外绿地照片为其他城市公共绿地的问卷，最终获得有效样本556份。

3.3 研究内容与方法

研究内容包括居民的社会人口特征信息及心理健康状况、居民居住区绿地满意度（以下简称“绿地满意度”）、居民窗外居住区绿地绿视率（以下简称“窗外绿视率”）和居民每日观看窗外居住区绿地时长（以下简称“绿视时长”）。社会人口特征信息通过问卷调查采集，包括性别、年龄、身高、体重、婚姻状况、教育程度、职业和经济收入水平等；居民心理健康状况采用凯斯勒心理困扰量表（以下简称K10）进行评价；绿地满意度和绿视时长采用问卷调查的方式获取；窗外绿视率采用GIMP网格法计算。

residential areas are higher than 3.0, 6 ranging from 2.5 to 3.0, 8 ranging from 2.0 to 2.4, 9 ranging from 1.5 to 1.9, and 4 lower than 1.5. The green coverage ratio of the study areas is positively correlated with the Shannon–Weiner Diversity Index. With the green coverage ratio as the screening indicator, a total of 20 residential communities were further chosen through stratified random sampling. To reduce the sampling deviation, another screening was conducted by the population size and age structure. Finally, by acquiring the demographic data from the property management offices of the residential areas, 15 residential communities with the occupancy rate higher than 70% were selected as the study sites (Fig. 1).

3.2 Study Object

In line with associated ethical requirements, the online questionnaire respondents were permanent residents in the study sites and not infected with COVID-19. All respondents filled in the questionnaire on an acknowledged and voluntary basis. Subject to the epidemic prevention and control measures, a total of 1,273 responses were collected, 762 (59.86%) of which were valid. By further excluding the respondents with chronic diseases, and the questionnaires without any uploaded photo of residential green spaces outside the window or with any photo of other urban public green spaces, 556 valid samples were finally obtained.

3.3 Study Objectives and Methods

The study examined the sociodemographics and mental health conditions of the residents; the residents’ satisfaction of the residential green spaces (green space satisfaction hereafter), the green view index of the residential green spaces outside the window (green view index outside the window hereafter), and the daily green viewing duration on the residential green spaces outside the window (green viewing duration hereafter). The sociodemographic data covering gender, age, height, weight, marital status, educational background, occupation, and income were collected by questionnaire. The mental health conditions were evaluated with the Kessler Psychological Distress Scale (K10). The green space satisfaction and green viewing duration were self-reported by the residents. The green view index outside the window was calculated with the GIMP grid.

3.3.1 The Survey on Residents’ Mental Health Status

The residents’ mental health conditions were evaluated with K10 developed by Ronald C. Kessler et al. in 1992. In 2005, Xu Lingzhong et al. translated it into Chinese. Zhou Chengchao et al. verified the high reliability of the Chinese K10,
3.3.1 居民心理健康状况调查

居民心理健康状况采用K10进行调查。K10由罗纳德·C·凯斯勒等于1992年编制而成[40]，徐凌忠等于2005年将其翻译为中文版K10量表[41]。周成超等验证了K10量表中文版具有高信度，可广泛用于中国城市人群心理健康状况的评价[42]。

K10是用于评估人群在过去4周内经历焦虑和压力等心理状况的频率的一种简短自测量表，共包含10项心理状况，分别是“无原因疲劳” “感到紧张” “通过任何事情都无法平息紧张情绪” “无助感” “不安或烦躁” “坐立不安” “感到沮丧” “感到做任何事情都很困难” “对待事物没有兴趣”，以及“感觉自己无用”。其评分标准依据症状出现的频率共分为5个等级: 1表示“没有”、2表示“偶尔”、3表示“部分时间”、4表示“大部分时间”、5表示“所有时间”。量表总分为50分，10 ~ 15分表明受调者心理健康状况良好，16 ~ 21分表明心理健康状况一般，22 ~ 29分表明心理健康状况较差，30 ~ 50分表明心理健康状况差。

3.3.2 绿地满意度调查

绿地满意度采用自行设计的满意度问卷进行调研。问卷包括三个问题: “您对居住区绿地面积是否满意?” “您对居住区绿地设施是否满意?” “您对居住区绿地景色是否满意?” 调研采用李克特量表法，分值范围为1~5分，1分表示“非常不满意”，5分表示“非常满意”。

3.3.3 绿视率调查

绿视率由日本学者青木阳二提出[45]，是用于反映城市空间绿化水平的物理指标。其定义是当人在一个环境中处于静止或行走状态时，眼睛看到的绿化面积占整个视觉面积的百分比，可用来衡量和评价人们对于绿地的感知程度。研究表明，当绿视率高于25%时，人的视觉感知和精神状态较为舒适，这种舒适感对人群的身心健康具有积极作用[46]。

因居家隔离期间居民只能通过窗户观看居住区绿地或周边绿地景观，因此本研究在进行网络问卷调查时，要求被调查者以疫情期间观看窗外居住区绿地时常用的角度拍摄一张绿地照片（分辨率为2 000×1 500 ——不符合要求的照片会通过Photoshop进行调整），研究团队通过分析这些照片获得被调查者的窗外绿视率。绿视率采用GIMP suggesting that it can be widely used to evaluate the mental health status of urban residents in China[42]。K10 is a brief self-evaluation scale that measures the frequency of anxiety and pressure, etc. experienced over the past 4 weeks. It includes 10 items, namely feeling tired out with no good reason, feeling nervous, feeling so nervous that nothing could calm you down, feeling hopeless, feeling restless or fidgety, feeling so restless and could not sit still, feeling depressed, feeling that everything was an effort, feeling so sad that nothing could cheer you up, and feeling worthless. Each item is scored at 5 frequency-levels: 1 means none of the time, 2 means a little of time, 3 means some of the time, 4 means most of the time, and 5 means all of the time. The total score ranges from 10 to 50: 10 ~ 15 means the respondent is in good mental health status, 16 ~ 21 for a mediocre mental health status, 22 ~ 29 for a dismal mental health status, and 30 ~ 50 for a poor one. [40][43][44]
| 变量 | 赋值说明 | 数据类型 |
|------|----------|----------|
| 性别 | 0 = 男, 1 = 女 | 定类数据 |
| 年龄 (岁) | 1 = 14 ~ 18, 2 = 19 ~ 23, 3 = 24 ~ 30, 4 = 31 ~ 50, 5 > 50 | 定序数据 |
| 身高 (cm) | 1 < 150, 2 = [150, 160), 3 = [160, 170), 4 = [170, 180], 5 > 180 | 定序数据 |
| 体重 (kg) | 1 < 45, 2 = [45, 55), 3 = [55, 65), 4 = [65, 75], 5 > 75 | 定序数据 |
| 婚姻状况 | 1 = 单身, 2 = 已婚, 3 = 离异, 4 = 其他 | 定类数据 |
| 教育背景 | 1 = 小学, 2 = 初中, 3 = 高中, 4 = 大专, 5 = 本科及以上 | 定类数据 |
| 职业类型 | 1 = 学生, 2 = 脑力工作者, 3 = 体力工作者, 4 = 退休 | 定类数据 |
| 收入水平 (元 / 月) | 1 <= 1,550, 2 = (1,550, 3,500], 3 = (3,500, 5,000], 4 = (5,000, 8,000], 5 > 8,000 | 定距数据 |
| 绿视时长 (分钟) | 1 <= 15, 2 = (15, 30], 3 = (30, 45], 4 = (45, 60], 5 >= 61 | 定序数据 |
| 绿地面积满意度 | 1 = 非常不满意, 2 = 不满意, 3 = 一般, 4 = 满意, 5 = 非常满意 | 定类数据 |
| 绿地设施满意度 | 1 = 非常不满意, 2 = 不满意, 3 = 一般, 4 = 满意, 5 = 非常满意 | 定类数据 |
| 绿地景色满意度 | 1 = 非常不满意, 2 = 不满意, 3 = 一般, 4 = 满意, 5 = 非常满意 | 定类数据 |
| 绿视覆盖率 | 乔木、灌木和草本植物垂直投影面积与用地面积之比 | 定类数据 |
| 窗外绿视率 | GIMP网格法计算获得 | 定距数据 |
| 心理健康状况得分 | K10量表评估计算获得 | 定距数据 |
was counted with the rounding method, the result of which would be green view index of the observation point. (Fig. 2).

3.4 Analysis Methods and Variable Assignment

To minimize the sampling bias and the limitation of small sample size, this study adopted Bootstrap to increase the number of samples. As a statistical method, Bootstrap takes the samples observed as the “whole” and conducts random re-sampling. In this research, STATA 15.0 was used for data processing and statistical analysis: Shapiro–Wilk Test (SW Test hereafter) was employed for the normality test of variables; the demographic features and residents’ mental health conditions, green view index outside the window and green space satisfaction in different residential communities, and residents’ mental health status in different residential communities with varied green view indexes were compared with ANOVA; the Pearson correlation test was used to analyze the correlations between the residents’ mental health status and the green space satisfaction, green coverage ratio, green view index outside the window, and green viewing duration; and an integrated regression analysis was made with the multiple linear regression model.

The score of residents’ mental health status, green space satisfaction, and green view index outside the window are indicated by Mean ± SD. In the multiple linear regression analysis, the residents’ mental health status was taken as a dependent variable, and green space satisfaction, green coverage ratio, green view index outside the window, and green viewing duration were independent variables. The residents’ social demographic data were taken as moderating variables (Table 1).

4 Research Findings

4.1 Residents’ Sociodemographics

The collected sociodemographic data of 556 residents from 15 residential areas are listed in Table 2.

4.2 Scores of Residents’ Mental Disorders

The average score of mental disorders of 556 respondents is 22.49 ± 6.94, indicating an unsatisfactory mental health condition by K10. The SW Test results show that gender, age, height, weight, marital status, educational background, occupation, and income conform to normal distribution (P < 0.05). The ANOVA results suggest that the score disparities of residents in gender (P < 0.05), age (P < 0.001), height (P < 0.05), weight (P < 0.05), marital status (P < 0.01), education background (P < 0.001), occupation (P < 0.01), and income (P < 0.001) are significant.
As shown in Table 3, the score disparity of the mental disorder of residents from different residential communities is significant ($P < 0.001$). The mental disorder scores of 6 residential communities range from 16 to 21, suggesting an overall mediocre mental health status; and those of the rest 9

| Demographic characteristics | Number of people | Proportion (%) | Scores of mental disorders |
|-----------------------------|------------------|----------------|-----------------------------|
| Overall                     | 556              | 100            | 22.49 ± 6.94                |
| Gender                      |                  |                | F = 2.74, P < 0.05          |
| Male                        | 257              | 46.22          | 22.87 ± 6.83                |
| Female                      | 299              | 53.78          | 21.86 ± 7.08                |
| Age (years old)             |                  |                | F = 4.59, P < 0.001         |
| 14 - 18                     | 46               | 8.23           | 21.29 ± 6.65                |
| 19 - 23                     | 157              | 28.24          | 22.09 ± 7.14                |
| 24 - 30                     | 178              | 32.02          | 24.17 ± 7.15                |
| 31 - 50                     | 105              | 18.88          | 24.60 ± 5.99                |
| > 50                        | 70               | 12.59          | 22.07 ± 6.08                |
| Height (cm)                 |                  |                | F = 3.71, P < 0.05          |
| <= 150                      | 30               | 5.40           | 24.60 ± 9.53                |
| (150, 160)                  | 104              | 19.06          | 23.77 ± 6.22                |
| (160, 170)                  | 240              | 43.14          | 22.75 ± 7.04                |
| (170, 180)                  | 156              | 28.06          | 22.38 ± 6.99                |
| > 180                       | 24               | 4.32           | 18.76 ± 4.52                |
| Weight (kg)                 |                  |                | F = 2.66, P < 0.05          |
| <= 45                       | 61               | 10.97          | 21.33 ± 6.94                |
| (45, 55)                    | 150              | 26.98          | 21.83 ± 6.72                |
| (55, 65)                    | 143              | 26.08          | 22.67 ± 6.19                |
| (65, 75)                    | 122              | 21.94          | 23.35 ± 6.91                |
| > 75                        | 78               | 14.03          | 24.23 ± 7.93                |
| Marital status              |                  |                | F = 4.65, P < 0.01          |
| Single                      | 178              | 32.02          | 20.25 ± 5.19                |
| Married                     | 245              | 44.06          | 21.54 ± 6.78                |
| Divorced                    | 105              | 18.88          | 24.23 ± 7.46                |
| Others                      | 28               | 5.04           | 23.53 ± 6.89                |
| Educational background      |                  |                | F = 6.05, P < 0.001         |
| Primary school              | 50               | 8.99           | 23.00 ± 6.81                |
| Middle school               | 104              | 19.06          | 23.29 ± 6.71                |
| High school                 | 156              | 28.06          | 23.79 ± 6.39                |
| Junior college              | 172              | 30.94          | 23.76 ± 6.77                |
| Bachelor or above           | 72               | 12.95          | 20.71 ± 7.01                |
| Occupation                  |                  |                | F = 5.93, P < 0.01          |
| Student                     | 117              | 21.04          | 22.13 ± 6.49                |
| Intellectual labor          | 217              | 39.03          | 24.60 ± 6.57                |
| Manual labor                | 128              | 23.02          | 23.41 ± 5.61                |
| Retired                     | 94               | 16.91          | 21.82 ± 7.34                |
| Income (yuan/month)         |                  |                | F = 18.58, P < 0.001        |
| <= 1,550                    | 72               | 12.95          | 22.76 ± 6.44                |
| (1,550, 3,500)              | 234              | 42.09          | 24.73 ± 6.26                |
| (3,500, 5,000)              | 145              | 26.08          | 23.51 ± 7.19                |
| (5,000, 8,000)              | 61               | 10.97          | 23.36 ± 7.20                |
| > 8,000                     | 44               | 7.91           | 17.93 ± 5.62                |
表3: 15个居住区内居民心理健康状况、窗外绿视率得分和绿地满意度评价得分描述性统计分析

Table 3: Descriptive statistics of residents' mental health status, green looking ratio, and green space satisfaction in the studied residential communities

| 居住区名称 | Name of residential area | 心理困扰得分 | Score of mental disorder | 窗外绿视率 | Green view index outside the window | 绿地面积满意度 | Satisfaction of the area of green spaces | 绿地设施满意度 | Satisfaction of the facilities of green spaces | 绿地景色满意度 | Satisfaction of the landscapes of green spaces |
|-----------|--------------------------|-------------|--------------------------|----------|------------------------------------|----------------|----------------------------------------|----------------|----------------------------------------|----------------|----------------------------------------|
| 天鹅湖壹号 | Tian'ehuyihao            | 16.22 ± 3.92 | 0.679 ± 0.014            | 4.45 ± 0.56 | 4.03 ± 0.80                       | 4.27 ± 0.65     |
| 蓝蝶苑     | Landieyuan               | 17.84 ± 5.60 | 0.578 ± 0.016            | 3.97 ± 0.72 | 4.00 ± 0.52                       | 4.05 ± 0.66     |
| 浅水湾     | Qianshuiwan              | 19.59 ± 5.99 | 0.535 ± 0.018            | 4.05 ± 0.71 | 3.79 ± 0.72                       | 4.05 ± 0.72     |
| 森林海     | Sanlinhai                | 21.03 ± 7.41 | 0.510 ± 0.007            | 3.86 ± 0.72 | 3.61 ± 0.84                       | 3.84 ± 0.72     |
| 玫瑰苑     | Meiguixuan               | 21.67 ± 6.47 | 0.477 ± 0.009            | 4.08 ± 0.77 | 3.72 ± 0.92                       | 4.07 ± 0.68     |
| 水岸茗都    | Shui'anmingdu            | 21.87 ± 6.35 | 0.475 ± 0.003            | 4.05 ± 0.76 | 3.67 ± 0.66                       | 4.08 ± 0.77     |
| 西霞花苑    | Xihuahuayuan             | 22.00 ± 6.01 | 0.450 ± 0.004            | 3.79 ± 0.58 | 3.50 ± 0.60                       | 3.79 ± 0.58     |
| 湖东景园    | Hudongjingyuan           | 22.63 ± 6.71 | 0.439 ± 0.006            | 3.79 ± 0.58 | 3.74 ± 0.55                       | 3.76 ± 0.59     |
| 翠庭园     | Cuitingyuan              | 23.73 ± 6.56 | 0.413 ± 0.016            | 3.77 ± 1.06 | 3.35 ± 0.82                       | 3.81 ± 1.10     |
| 丹青苑     | Danqinghuayuan           | 23.87 ± 5.63 | 0.388 ± 0.011            | 3.76 ± 0.59 | 3.66 ± 0.63                       | 3.79 ± 0.58     |
| 岸上玫瑰    | Anshangmeigui            | 24.03 ± 6.30 | 0.351 ± 0.005            | 3.74 ± 0.64 | 3.18 ± 0.61                       | 3.74 ± 0.64     |
| 书香苑     | Shuxiangyuan             | 24.87 ± 6.79 | 0.361 ± 0.012            | 3.58 ± 0.70 | 3.77 ± 0.43                       | 3.54 ± 0.76     |
| 汇林阁     | Hulinge                  | 25.61 ± 6.57 | 0.329 ± 0.013            | 3.44 ± 0.61 | 3.19 ± 0.70                       | 3.38 ± 0.76     |
| 嘉和苑     | Jiahaysuan               | 25.82 ± 7.92 | 0.325 ± 0.011            | 3.32 ± 0.84 | 3.23 ± 0.75                       | 3.03 ± 1.03     |
| 绿怡居     | Lyuyiju                  | 26.72 ± 6.44 | 0.267 ± 0.017            | 3.02 ± 0.81 | 3.31 ± 0.62                       | 3.01 ± 0.67     |
| 均分       | Average score            | 22.49 ± 6.94 | 0.429 ± 0.107            | 3.78 ± 0.79 | 3.58 ± 0.73                       | 3.75 ± 0.81     |

| F          | F = 18.58                | F = 21.23                | F = 8.64                | F = 6.01                | F = 9.72                |
| P          | P < 0.001               | P < 0.001               | P < 0.001               | P < 0.001               | P < 0.001               |

其他9个居住区的居民心理困扰得分介于22~29分之间，表明居民心理健康状况总体较差。
示，15个居住区的窗外绿视率得分差异具有统计学意义（P<0.001）。

根据绿量感知程度，窗外绿视率可分为5个组别：绿视率低
于0.15的绿量感知差；0.15~0.25（不含0.25）的绿量感知一般；
0.25~0.35（不含0.35）的绿量感知较好；0.35~0.45（不含0.45）
的绿量感知很好；0.45及以上的绿量感知非常好

SW检验显示，心
理健康状况变量数据满足正态分布（P<0.05）。对不同绿视率组别进行
单因素方差分析，结果显示，各组别之间心理困扰得分差异具有统计
学意义（P<0.001）（表4）。

4.4 绿地满意度情况

15个居住区居民绿地面积满意度评价均分为3.78±0.79，绿
地设施满意度评价均分为3.58±0.73，绿地景色满意度评价均分为
3.75±0.81。SW检验显示，居民绿地各满意度变量数据符合正态分
布（P<0.05）。单因素方差分析结果显示，不同居住区的绿地面积
满意度（P<0.001）、绿地设施满意度（P<0.001）和绿地景色满意度
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4.5 相关性分析

SW检验显示，绿化覆盖率和绿视时长变量数据满足正态分
布（均P<0.05），皮尔森相关性分析（表5）显示绿地面积满意度
（P<0.01）、绿地设施满意度（P<0.01）、绿化覆盖率（P<0.001）、
窗外绿视率（P<0.001）和绿视时长（P<0.001）与居民心理健康困扰得
分呈显著负相关性，其中绿视时长（r=-0.839）与心理健康状况得分相
关性较强。

4.6 居住区绿地与居民心理健康状况关系的回归分析

既有的城市绿地与人群心理健康实证研究多采用线性回归模来

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（P<0.001）得分差异具有统计学意义（表3）。
4.4 Green Space Satisfaction

The average scores of the satisfaction of green spaces in the studied residential areas are 3.78 ± 0.79, 3.58 ± 0.73, and 3.75 ± 0.81 in area, facilities, and landscapes respectively. The SW Test results verify that the variables of green space satisfaction conform to normal distribution (P < 0.05). The ANOVA analyses further show that the score disparities of residents’ satisfaction with the area (P < 0.001), facilities (P < 0.001), and landscapes (P < 0.001) across 15 residential communities are of statistical significance (Table 3).

4.5 Correlation Analyses

The SW Test results show that the variables of green coverage ratio and green viewing duration conform to normal distribution (P < 0.05). According to the Pearson correlation analyses (Table 5), residents’ satisfaction of green spaces in the area (P < 0.01), landscapes (P < 0.001), green coverage ratio (P < 0.001), green view index outside the window (P < 0.001) and green viewing duration (P < 0.001) are significantly negatively correlated with the residents’ mental health conditions. Particularly, the green viewing duration (r = -0.839) is of strong correlation with the mental health status.

4.6 Regression Analysis of the Correlations between the Residential Green Spaces and Residents’ Mental Health Status

Existing empirical studies on urban green spaces and mental health often adopt linear regression model to test the correlation between green spaces and people’s mental health status[27][35]. Accordingly, this paper comes up with a linear regression model between the residential green spaces and residents’ mental health conditions. Table 6 lists the regression coefficients. The analyses verify that the satisfaction of the landscapes of green spaces, green coverage ratio, green view index, and green viewing duration are of positive correlations with the residents’ mental health conditions.

5 Discussions and Suggestions

By studying residents’ mental health conditions in 15 residential communities of New District under COVID-19, this paper reveals the impacts of green spaces in residential areas on residents’ mental health status. Existing studies on the health benefits of green spaces proved green spaces have positive effects on people’s mental health[28], while this paper further verifies that the long-distance observation to residential green spaces also helps improve residents’ mental health level. The research findings show that a higher green space satisfaction,

| Coef. | t-value | 95% CI | VIF |
|-------|---------|-------|-----|
| Height | -0.489* | -2.35 | -0.895 ~ -0.082 | 1.05 |
| Weight | 0.568** | 3.13 | 0.212 ~ 0.925 | 1.52 |
| Occupation: retired | -1.644** | -2.99 | -2.724 ~ -0.565 | 1.47 |
| Income: ≥ 8,000 | -2.529* | -1.24 | -6.517 ~ -1.459 | 2.55 |
| Green viewing duration | -4.019*** | -5.01 | -4.175 ~ -3.862 | 1.39 |
| Satisfaction of the landscapes of green spaces | -0.162* | -0.59 | -0.704 ~ -0.380 | 2.13 |
| Green coverage ratio | -0.101* | -0.01 | -3.986 ~ -4.785 | 3.74 |
| Green visible index outside the window | -15.012*** | -2.95 | -24.983 ~ -5.042 | 2.74 |
| Constant | 40.648*** | 11.46 | 33.697 ~ 47.599 | 1.05 |

** Chi-square = 8,305.785, P < 0.000

NOTE

* means p < 0.05, ** means p < 0.01, *** means p < 0.001;  △ means taking student and income ≤ 1,550 as comparisons.
的满意度和绿视率以及增加观赏绿地时长，对改善人群心理健康的促进作用，这对研究居住区绿地质量与人群心理健康的关系具有借鉴意义。

本研究的不足之处在于，疫情期间严格的防控措施导致研究样本量偏少，使得结论的可推广性不强；其次，研究采用横断面数据，缺乏前后对照检验，研究结论在因果关系论证上存在局限性；最后，居民心理健康状况评价采用主观性自评式量表，数据缺乏客观性，在未来的研究中可采用实验测量数据（如脑电波、血压、皮肤导电性等可以反映心理健康状况的人体生理数据）来进一步提高结论的可靠性。

在中国城镇化发展的上半场，高速的城市发展模式使城市建设量激增，与之伴生的是城市人工环境中绿色景观的缺失。这一问题近年来已逐渐暴露，特别是在疫情期间，长期的居家隔离使居民对能够舒缓焦虑的绿色景观的需求愈显迫切。而在城市土地供应紧张和高密度发展策略的背景下，发挥居住区绿地的健康功效无疑是低成本缓解这一问题的有效途径。基于本研究结果可知，在绿地面积难以增加的前提下，提高绿化覆盖率（即居住区的乔灌木比例）和绿地景色满意度（如增加观赏性彩叶树种的数量）对于发挥居住区绿地健康功效具有很强的实操性。因此，在中国步入城镇化进程下半场的背景下，科学高效地利用城市居住区绿地，发挥居住区绿地的健康功效既是本次疫情带给景观设计专业的挑战，也是本专业未来发展的重要方向之一。

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green coverage ratio, and green view index, and a longer green viewing duration would benefit residents’ mental health, which are valuable to further discuss the relationship between the quality of residential green spaces and residents’ mental health conditions.

The limitations of this study can be summarized in three folds. To begin with, the sample size is small because during the survey most residential communities in Chinese cities adopted epidemic prevention and control measures, leaving the conclusions with limited applicability. Also, without control tests, the conclusions drawn based on cross-section data are less convincing in terms of causality verification. Lastly, residents’ mental health conditions were measured with self-evaluation scale. Therefore, future studies are expected to source data from physiological experiments, such as electroencephalogram, blood pressure, and Galvanic Skin Reaction, which could indicate people’s mental health status, to improve the reliability of the research findings.

During China’s rapid urbanization, urban construction has increased sharply throughout the country, while causing the decrease of green spaces in the built environment in cities. This issue becomes even more prominent in recent years, particularly during the COVID-19 epidemic when the residents under quarantine are more desperate for green spaces to relieve anxiety. With the acute shortage of land use and high-density urban development, a low-cost solution that makes full use of green spaces in residential areas is required. As shown in this study, when no new green spaces can be built, it is suggested to increase green coverage ratio, i.e. improving the tree–shrub ratio in residential areas, and residents’ satisfaction of the landscapes of residential green spaces, such as increasing the number of color-leaved tree species, to improve people’s mental health status. In the current stage of urbanization, urban planners and designers should leverage residential green spaces to improve residents’ health benefits. This is not only a challenge for landscape design posed by the epidemic, but also one of the future interests of the discipline.

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