

## 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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### 摘要

居住区绿地作为城市居民接触频率较高的城市绿地类型之一，对居民的心理健康具有积极作用。为了解居住区绿地在2020年新冠肺炎疫情（COVID-19）疫情期间对居民心理健康的影响，本研究于2020年3月以中国安徽省合肥市政务文化新区内15个居住区的556名住户为样本，通过网络问卷调查获取住户社会人口特征信息，采用凯斯勒心理困扰量表（K10量表）评估居民心理健康状况，使用GIMP网格法量化并计算住户窗外的居住区绿地绿视率，并运用多元线性回归模型分析居住区绿地与居民心理健康的关系。研究结果显示，居住区的绿化覆盖率、绿地景色满意度、窗外居住区绿地绿视率，以及每日观看绿地时长对居民心理健康状况具有正向影响效应。研究揭示了疫情背景下居住区绿地促进人群心理健康的效益，可为未来景观设计行业的城市绿地建设提供理论依据。

### 关键词

新冠肺炎；居住区绿地；绿地福祉；心理健康；绿视率；绿化覆盖率；绿地满意度；绿视时长；K10量表

### 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 引言

2020年伊始，新冠肺炎（COVID-19）疫情爆发。在国家的号召下，中国人民积极响应配合，居家隔离长达两个月，使疫情得到了有效控制。然而，长期居家的限制性措施打乱了人们的正常生活节奏，可能会产生抑郁、焦虑等症状<sup>[1]</sup>。宋斐翡等人发现，在新冠肺炎疫情期间，部分调查人群呈现出强迫症状、人际关系敏感、抑郁、焦虑、敌对、恐惧、偏执及精神病性等方面的病状，其中焦虑、恐惧和抑郁三种情绪占比最高<sup>[2]</sup>。王翠艳等人对1 210名受访者进行了调研，其中53.8%的受访者认为疫情对自身心理健康情况的影响为中度或重度，16.5%的受访者表示存在中度至重度的抑郁症状，28.8%的受访者表示存在中度至重度的焦虑症状<sup>[3]</sup>。

自现代城市产生以来，城市绿地作为城市人工环境中的自然空间，一直在改善公共健康水平中扮演着重要角色。恢复性环境理论证实了自然绿色环境在缓解人群精神压力方面的积极作用<sup>[4]</sup>。该理论主要包括注意力恢复理论和压力缓解理论<sup>[5]</sup>。其中，注意力恢复理论由卡普兰夫妇提出，该理论认为人群在接触自然时仅消耗人的无意注意力，使其有意注意力得以休息和恢复<sup>[6]</sup>。压力缓解理论由罗杰·S·乌尔里希提出，该理论认为精神压力是人们在处理各类问题时，从生理和心理层面上做出的一种应激反应，这种反应会产生消极情绪，给人的身心健康状况带来负面影响。而令人愉悦的绿地环境能够缓解体验者的紧张情绪，降低其压力应激水平，进而恢复其身心健康<sup>[7]</sup>。

在此背景下，本文尝试探索的主要问题有：在居家隔离期间，作为居民体验绿地的唯一途径，远距离观看绿地是否对其心理健康具有改善作用？居住区绿地作为居民可观看的主要绿色景观，其内部特征的差异性是否影响绿地的健康功效？如是，其影响程度如何？为此，本研究通过对隔离期间居民心理健康状况的评估，探讨居住区绿地在疫情背景下对人群心理健康的影响，以期丰富居住区绿地健康功效方面的研究，并为城市居住区绿地建设提供理论依据。

## 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<sup>[1]</sup>. 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<sup>[2]</sup>. 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<sup>[3]</sup>.

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<sup>[4]</sup>. The theory mainly derives the Attention Restoration Theory and the Stress Recovery Theory<sup>[5]</sup>. Proposed by Rachel and Steven Kaplan, the former theory claims that when in nature, people only use the involuntary attention while recovering the voluntary attention<sup>[6]</sup>. 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<sup>[7]</sup>.

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 文献综述

### 2.1 城市绿地对人群心理健康的促进功效

世界卫生组织（WHO）将心理健康定义为一种幸福状态，在这种状态下，一个人能够实现自我潜力，能够应对正常的生活压力，能够富有成效地工作，能够为自己或其社区作出贡献<sup>[8]</sup>。因此，健康的心理状态不应仅限于没有精神疾病，还应具有幸福感。已有文献研究成果显示，城市绿地对人群心理健康的功效既包括心理健康状况的提升，如提高总体心理健康水平<sup>[9][10]</sup>和生活满意度<sup>[11]</sup>、增加快乐感和主观幸福感<sup>[12]</sup>、改善生活规律<sup>[13]</sup>和睡眠质量<sup>[14]</sup>、减轻压力<sup>[15][16]</sup>等，也包括心理疾病状况的改善，如改善焦虑症<sup>[17]</sup>、注意力缺陷和多动症<sup>[13][18]</sup>，以及抑郁症<sup>[19][20]</sup>等。

### 2.2 城市绿地对人群心理健康的影响途径

在压力缓解理论和注意力恢复理论的支持下，城市绿地被认为是城市居民缓解精神压力和恢复注意力的重要场所<sup>[21]-[23]</sup>。相关研究表明，不同类型的绿地在改善人群心理健康方面均有积极作用。例如，公园绿地对缓解人群精神压力、消除疲劳具有明显效果，且使用公园时间越长，心理健康状况越好<sup>[24][25]</sup>；在居住区绿地中，居民访问居住区绿地频率越高，心理健康状况越好<sup>[26]-[28]</sup>；在校园绿地中，拥有自然景观的操场能够增强学生注意力，从而提高其学习效率<sup>[29]</sup>；在办公绿地中，增强窗外绿地的视线可达性有助于提高员工的幸福感和满意度，并降低工作压力水平<sup>[30]</sup>。

在绿地特征与人群心理健康水平的研究中，研究成果主要从绿地空间属性和绿地内部特征两方面展开论证。涉及绿地空间属性的研究结果表明，提高绿地可达性有利于人群心理健康的恢复<sup>[31][32]</sup>。涉及绿地内部特征的研究结果表明，丰富植物品种和植物配置、采用乡土树种均有助于提高居民访问绿地的频率，进而有益于人群心理健康的恢复<sup>[33]</sup>；多变的地形和美观的景观设施可提高居民的审美体验，有助于改善其心理健康状况<sup>[34]</sup>；完善的绿地服务设施可缓解居民的心理压力，且服务设施品质越高，缓解程度越高<sup>[26]</sup>。

## 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.”<sup>[8]</sup> 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<sup>[9][10]</sup> and life satisfaction<sup>[11]</sup>, increasing the sense of happiness<sup>[12]</sup>, promoting healthy lifestyles<sup>[13]</sup>, improving sleep quality<sup>[14]</sup>, reducing pressure<sup>[15][16]</sup>, and alleviating anxiety<sup>[17]</sup>, attention deficit, hyperactivity<sup>[13][18]</sup>, and depression<sup>[19][20]</sup>.

### 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<sup>[21]-[23]</sup>. 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<sup>[24][25]</sup>. In residential green spaces, the higher frequency one visits the green spaces, the better one's mental health status will be<sup>[26]-[28]</sup>. In campus green spaces, playgrounds with natural landscapes help enhance students' attention and raise their learning efficiency<sup>[29]</sup>. In workplace green spaces, better sight access to the outdoor green spaces makes employees happier and more satisfied while lowering their work pressure<sup>[30]</sup>.

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<sup>[31][32]</sup>. 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<sup>[33]</sup>. Varied landforms and attractive landscapes and facilities would enhance users' visiting experience, which also helps mitigate psychological distress<sup>[34]</sup>. Well-developed service facilities can ease residents' psychological pressure: the better the quality of service facilities is, the less stressful the residents feel<sup>[26]</sup>.

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<sup>[35]</sup>。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发生的变化,揭示了绿色环境体验对人群心理健康的促进作用<sup>[36][37]</sup>;而利用虚拟实验室进行的控制性研究表明,观看自然风景图像同样有利于缓解人群的心理压力<sup>[38]</sup>。

### 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12.67km<sup>2</sup>,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筛选。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<sup>[34]</sup>,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<sup>[39]</sup>。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,发现在本次调研的居住区内两者呈正相关性。因此,以绿化覆盖率为筛选

Related studies suggest that diversified experiences of green spaces all can help improve people's mental health<sup>[35]</sup>. Comparative studies on the changes of individuals' emotional, cognitive, and physiological status when they walk in natural green spaces and urban built environments reveal the promoting role of natural experience on mental health<sup>[36][37]</sup>. The control study at the virtual lab shows that watching images of natural landscapes (indirect nature experience) helps relieve mental pressure as well<sup>[38]</sup>.

### 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<sup>2</sup>, 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<sup>[34]</sup>, and the landscape quality is mostly defined by the area and planting design of the green space<sup>[39]</sup>. 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

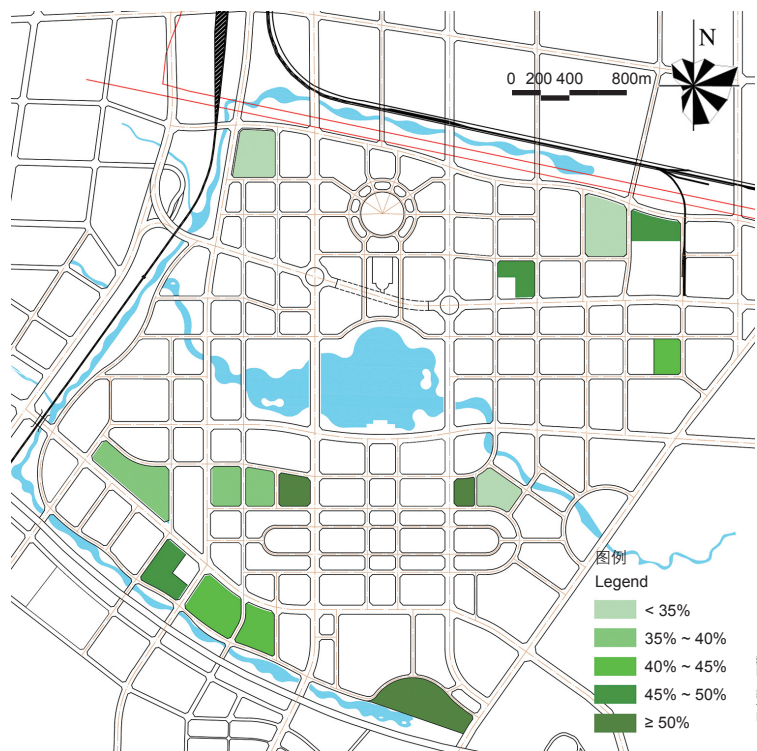
指标, 从上述绿化覆盖率等级不同的居住区内进行分层随机抽样, 共筛选出20个居住区。为进一步减少人口抽样偏差, 从人口年龄结构和人口数量层面对20个居住区进行再次筛选。通过居住区物业获取居住人口信息, 最终选取了15个入住率高于70%的居住区作为本次研究的具体地点(图1)。

### 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1 273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<sup>[40]</sup>. In 2005, Xu Lingzhong et al. translated it into Chinese<sup>[41]</sup>. Zhou Chengchao et al. verified the high reliability of the Chinese K10,

1. 研究最终选取的15个居住区及其绿化覆盖率
1. The selected 15 residential communities in this study and their green coverage ratios

### 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<sup>[40]</sup>，徐凌忠等于2005年将其翻译为中文版K10量表<sup>[41]</sup>。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<sup>[42]</sup>。

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。<sup>[40][43][44]</sup>

### 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，是用于反映城市空间绿化水平的物理指标<sup>[45]</sup>。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<sup>[45]</sup>，可用来衡量和评价人对绿地的感知程度。研究认为，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<sup>[46]</sup>。

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<sup>[42]</sup>.

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.<sup>[40][43][44]</sup>

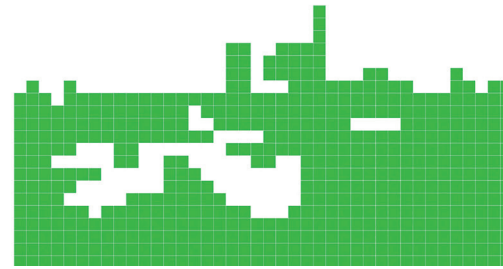
### 3.3.2 The Survey on Green Space Satisfaction

The green space satisfaction was evaluated by a questionnaire designed by the authors that includes three questions: Are you satisfied with the area of the existing green spaces in your residential community? Are you satisfied with the existing green space facilities in your residential community? Are you satisfied with the existing green space landscape in your residential community? Each question was measured by Likert Scale scoring from 1 to 5: 1 for very unsatisfied and 5 for very satisfied.

### 3.3.3 The Survey on Green View Index

The green view index, proposed by the Japanese scholar Yoji Aoki, is an indicator of the greening rate of urban spaces<sup>[45]</sup>. It measures the percentage of the green area to the whole visual area when one is in a stationary or walking state<sup>[45]</sup>, to evaluate one's perception of the green space. Studies suggest that when the green view index is greater than 25%, people will have a pleasant visual perception and mental status, which is beneficial to their mental health<sup>[46]</sup>.

During the quarantine, the residents could only look at residential green spaces through windows. Therefore, the questionnaire required the respondents to take a picture of the green spaces from a frequent viewpoint to look at the residential green spaces outside the window, and the resolution of the picture should be 2,000 × 1,500—pictures that did not meet the requirement were adjusted through Photoshop. The green view index was calculated with GIMP grid of the uploaded pictures of residential green spaces. The pictures were divided by a 10 mm × 10 mm grid, and the proportion of green squares



2. 窗外绿视率测量方法
2. The measurement method of green view index outside the window

表1: 变量赋值表  
Table 1: Variable assignments table

变量 Variable	赋值说明 Assignment description	数据类型 Data type
性别 Gender	0=男, 1=女 0 = male, 1 = female	定类数据 Nominal
年龄 (岁) Age (years old)	1 = 14 ~ 18, 2 = 19 ~ 23, 3 = 24 ~ 30, 4 = 31 ~ 50, 5 > 50	定序数据 Ordinal
身高 (cm) Height (cm)	1 ≤ 150, 2 = [150, 160], 3 = [160, 170], 4 = [170, 180], 5 > 180	定序数据 Ordinal
体重 (kg) Weight (kg)	1 ≤ 45, 2 = [45, 55], 3 = [55, 65], 4 = [65, 75], 5 > 75	定序数据 Ordinal
婚姻状况 Marital status	1=单身, 2=已婚, 3=离异, 4=其他 1 = single, 2 = married, 3 = divorced, 4 = others	定类数据 Nominal
教育背景 Educational background	1=小学, 2=初中, 3=高中, 4=大专, 5=本科及以上 1 = primary school, 2 = middle school, 3 = high school, 4 = junior college, 5 = bachelor or above	定序数据 Ordinal
职业类型 Occupation	1=学生, 2=脑力工作者, 3=体力工作者, 4=退休 1 = student, 2 = intellectual labor, 3 = manual labor, 4 = retired	定类数据 Nominal
收入水平 (元/月) Income (yuan / month)	1 ≤ 1,550, 2 = [1,550, 3,500], 3 = [3,500, 5,000], 4 = [5,000, 8,000], 5 > 8,000	定序数据 Ordinal
绿视时长 (分钟) Green viewing duration (minute)	1 ≤ 15, 2 = 16 ~ 30, 3 = 31 ~ 45, 4 = 46 ~ 60, 5 ≥ 61	定序数据 Ordinal
绿地面积满意度 Satisfaction of the area of green spaces	1=非常不满意, 2=不满意, 3=一般, 4=满意, 5=非常满意 1 = very unsatisfied, 2 = unsatisfied, 3 = moderately satisfied, 4 = satisfied, 5 = very satisfied	定类数据 Nominal
绿地设施满意度 Satisfaction of the facilities of green spaces	1=非常不满意, 2=不满意, 3=一般, 4=满意, 5=非常满意 1 = very unsatisfied, 2 = unsatisfied, 3 = moderately satisfied, 4 = satisfied, 5 = very satisfied	定类数据 Nominal
绿地景色满意度 Satisfaction of the landscapes of green spaces	1=非常不满意, 2=不满意, 3=一般, 4=满意, 5=非常满意 1 = very unsatisfied, 2 = unsatisfied, 3 = moderately satisfied, 4 = satisfied, 5 = very satisfied	定类数据 Nominal
绿化覆盖率 Green coverage ratio	乔木、灌木和草本植物垂直投影面积与用地面积之比 The ratio of the vertical projection area of trees, shrubs and herbs to the total land area	定距数据 Interval
窗外绿视率 Green view index outside the window	GIMP网格法计算获得 Calculated with GIMP grid	定距数据 Interval
心理健康状况得分 Score of mental health condition	K10量表评价计算获得 Evaluated with K10	定距数据 Interval

网格法计算, 将所拍摄照片按照10mm×10mm的网格进行划分, 采用四舍五入法统计绿色方块所占比例, 将其作为拍摄观测点的绿视率<sup>[46]</sup> (图2)。

### 3.4 分析方法与变量赋值

为解决抽样偏差和小样本量的问题, 本研究采用自展法扩增样本。自展法是一种统计方法, 其基本思想是将观测到的样本变为“总体”, 进行随机再抽样来组成研究样本。研究通过STATA 15.0软件进行数据处理和统计分析, 包括运用Shapiro-Wilk检验(以下简称“SW检验”)进行变量数据正态性检验, 运用单因素方差分析(ANOVA)比较不同人口学特征和居住区居民的心理健康状况、不同居住区的窗外绿视率和绿地满意度评价、不同绿视率组之间居民的心理健康状况, 运用皮尔森相关性检验分析绿地满意度、绿化覆盖率、窗外绿视率、绿视时长与居民心理健康的相关性程度, 以及运用多元线性回归模型进行综合回归分析。

居民心理健康状况、绿地满意度和窗外绿视率得分以均值±标准差的形式表示。多元线性回归分析以居民心理健康状况得分为因变量, 以绿地满意度评价得分、居住区绿化覆盖率、窗外绿视率和绿视时长为自变量, 同时纳入居民社会人口特征信息作为调节变量(表1)。

## 4 研究结果

### 4.1 居民社会人口特征情况

15个居住区内556名居民的社会人口特征情况详见表2。

### 4.2 居民心理困扰得分情况

556名调查对象心理困扰平均得分为 $22.49 \pm 6.94$ , 按照K10量表评分分级标准, 居民心理健康状态总体较差。SW检验显示性别、年龄、身高、体重、婚姻状况、教育背景、职业类型和收入水平变量数据均符合正态分布( $P < 0.05$ )。单因素方差分析结果显示, 具有不同性别( $P < 0.05$ )、年龄( $P < 0.001$ )、身高( $P < 0.05$ )、体重( $P < 0.05$ )、婚姻状况( $P < 0.01$ )、教育背景( $P < 0.001$ )、职业类型( $P < 0.01$ )和收入

was counted with the rounding method, the result of which would be green view index of the observation point<sup>[46]</sup> (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  $22.49 \pm 6.94$ , 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.

表2: 居民社会人口特征及心理健康状况得分描述性统计分析  
 Table 2: Descriptive statistics of residents' sociodemographic characteristics and mental health scores

人口特征 Demographic characteristics		人数 Number of people	构成比 (%) Proportion (%)	心理困扰得分 Scores of mental disorders	F / P
总体情况 Overall	—	556	100	22.49 ± 6.94	—
性别 Gender	男 Male	257	46.22	22.87 ± 6.83	F = 2.74 P < 0.05
	女 Female	299	53.78	21.86 ± 7.08	
年龄 (岁) Age (years old)	≤ 14 ~ 18	46	8.27	21.29 ± 6.65	F = 4.59 P < 0.001
	19 ~ 23	157	28.24	22.09 ± 7.16	
	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	
身高 (cm) Height (cm)	≤ 150	30	5.40	24.60 ± 9.53	F = 3.71 P < 0.05
	[150, 160]	106	19.06	23.77 ± 6.82	
	[160, 170]	240	43.16	22.75 ± 7.04	
	[170, 180]	156	28.06	22.38 ± 6.99	
	> 180	24	4.32	18.76 ± 4.52	
体重 (kg) Weight (kg)	≤ 45	61	10.97	21.33 ± 6.94	F = 2.66 P < 0.05
	[45, 55]	150	26.98	21.83 ± 6.72	
	[55, 65]	145	26.08	22.67 ± 6.19	
	[65, 75]	122	21.94	23.35 ± 6.91	
	> 75	78	14.03	24.23 ± 7.93	
婚姻状况 Marital status	单身 Single	178	32.02	20.25 ± 5.19	F = 4.65 P < 0.01
	已婚 Married	245	44.06	21.54 ± 6.78	
	离异 Divorced	105	18.88	24.23 ± 7.46	
	其他 Others	28	5.04	23.53 ± 6.89	
教育背景 Educational background	小学 Primary school	50	8.99	23.00 ± 6.81	F = 6.05 P < 0.001
	初中 Middle school	106	19.06	23.29 ± 6.71	
	高中 High school	156	28.06	23.75 ± 6.39	
	大专 Junior college	172	30.94	23.76 ± 6.77	
	本科及以上 Bachelor or above	72	12.95	20.71 ± 7.01	
职业类型 Occupation	学生 Student	117	21.04	22.13 ± 6.69	F = 3.93 P < 0.01
	脑力工作者 Intellectual labor	217	39.03	24.60 ± 6.57	
	体力工作者 Manual labor	128	23.02	23.41 ± 5.61	
	退休 Retired	94	16.91	21.82 ± 7.34	
收入水平 (元/月) Income (yuan / month)	≤ 1,550	72	12.95	22.76 ± 6.44	F = 18.58 P < 0.001
	[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 ± 5.42	

水平 ( $P < 0.001$ ) 的居民, 其心理健康状况得分差异具有统计学意义。

表3显示, 不同居住区之间的人群心理困扰得分差异具有统计学意义 ( $P < 0.001$ )。其中, 共有6个居住区的居民心理困扰得分介于16 ~ 21

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

分之间,表明这6个居住区的居民心理健康状况总体一般;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。

#### 4.3 窗外绿视率情况

15个居住区的窗外绿视率平均得分为 $0.439 \pm 0.107$ 。SW检验显示窗外绿视率变量数据满足正态分布( $P < 0.05$ )。单因素方差分析进一步显

residential communities range from 22 to 29, indicating a dismal mental health status in general.

#### 4.3 Green View Index outside the Window

The average score of green view index outside the window in 15 studied residential areas is  $0.439 \pm 0.107$ . The SW Test results conform to normal distribution ( $P < 0.05$ ). The ANOVA analyses further show that the differences of the green view

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 ± 0.45
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 Senlinhai	21.03 ± 7.41	0.510 ± 0.007	3.84 ± 0.72	3.61 ± 0.84	3.84 ± 0.72
玫瑰苑 Meiguiyuan	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
西湖花苑 Xihuayuan	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
丹青花园 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	0.341 ± 0.012	3.58 ± 0.70	3.77 ± 0.43	3.54 ± 0.76
汇林阁 Huilinge	25.61 ± 6.57	0.329 ± 0.013	3.46 ± 0.61	3.19 ± 0.70	3.38 ± 0.76
嘉和苑 Jiaheyuan	25.82 ± 7.92	0.325 ± 0.011	3.32 ± 0.84	3.23 ± 0.75	3.03 ± 1.03
绿怡居 Lyujiyu	26.72 ± 6.64	0.267 ± 0.017	3.02 ± 0.81	3.31 ± 0.62	3.01 ± 0.67
均分 Average score	22.49 ± 6.94	0.439 ± 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				

表4: 不同窗外绿视率组别的心理健康状况比较

Table 4: The mental health status in different residential communities with varied green view index outside the window

窗外绿视率组别 5 levels of green view index outside the window	居民心理困扰得分 Score of residents' mental disorder	F / P
差 Poor	30.17 ± 7.41	F = 17.75 P < 0.001
一般 Mediocre	24.11 ± 6.25	
较好 Slightly satisfied	23.19 ± 6.83	
很好 Satisfied	22.56 ± 7.13	
非常好 Very satisfied	17.04 ± 4.88	

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<sup>[46]</sup>。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 $3.78 \pm 0.79$ , 绿地设施满意度评价均分为 $3.58 \pm 0.73$ , 绿地景色满意度评价均分为 $3.75 \pm 0.81$ 。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 ( $P < 0.001$ ) 得分差异具有统计学意义 (表3)。

#### 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 ( $P < 0.01$ )、绿地景色满意度 ( $P < 0.001$ )、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型来

index outside the window across 15 residential areas are of statistical significance ( $P < 0.001$ ).

The green view index outside the window can be divided into 5 levels based on the residents' perception of greenery: poor when the green view index is less than 0.15, mediocre when the ratio is between 0.15 and 0.25 (excluding), slightly satisfied when the ratio is between 0.25 and 0.35 (excluding), satisfied when the ratio is between 0.35 and 0.45 (excluding), and highly satisfied when the ratio is 0.45 and above<sup>[46]</sup>. The SW Test results suggest a normal distribution of variables of mental health conditions ( $P < 0.05$ ). The ANOVA analyses on green view index in varied residential areas further show that the score disparity of mental disorder is of statistical significance ( $P < 0.001$ ) (Table 4).

表5: 皮尔森相关性分析  
Table 5: Pearson correlation analysis

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	绿化覆盖率 Green coverage ratio	窗外绿视率 Green view index outside the window	绿视时长 Green viewing duration
-0.142**	-0.040	-0.127***	-0.283***	-0.328***	-0.839***

注

\*代表 $p < 0.05$ , \*\*代表 $p < 0.01$ , \*\*\*代表 $p < 0.001$ 。

NOTE

\* means  $p < 0.05$ , \*\* means  $p < 0.01$ , and \*\*\* means  $p < 0.001$ .

表6: 居住区绿地与居民心理健康状况回归模型系数表  
Table 6: Regression model coefficients between the residential green spaces and resident's mental health status

	Coef.	t-value	95% CI	VIF
身高 Height	-0.489*	-2.35	-0.895 ~ -0.082	1.05
体重 Weight	0.568**	3.13	0.212 ~ 0.925	1.52
职业: 退休△ Occupation: retired△	-1.644**	-2.99	-2.724 ~ -0.565	1.67
收入水平: ≥8 000△ Income: ≥ 8,000△	-2.529*	-1.24	-6.517 ~ -1.459	2.55
绿视时长 Green viewing duration	-4.019***	-50.41	-4.175 ~ -3.862	1.39
绿地景色满意度 Satisfaction of the landscapes of green spaces	-0.162*	-0.59	-0.704 ~ -0.380	2.13
绿化覆盖率 Green coverage ratio	-0.101*	-0.01	-3.986 ~ -4.785	3.74
窗外绿视率 Green visible index outside the window	-15.012***	-2.95	-24.983 ~ -5.042	2.76
常数 Constant	40.648***	11.46	33.697 ~ 47.599	
<b>Chi-square</b>	8,305.785	<b>P</b>	< 0.000	

注

\*代表 $p < 0.05$ , \*\*代表 $p < 0.01$ , \*\*\*代表 $p < 0.001$ ; △表示以学生、收入水平≤1 550作为对照。

NOTE

\* means  $p < 0.05$ , \*\* means  $p < 0.01$ , and \*\*\* means  $p < 0.001$ ; △ means taking student and income ≤1,550 as comparisons.

检验绿地与人群心理健康之间的关系<sup>[27][35]</sup>。据此,本文构建了居住区绿地与居民心理健康状况的线性回归模型,回归系数见表6。回归分析结果表明,绿地景色满意度、绿化覆盖率、窗外绿视率和绿视时间与居民心理健康状况呈正相关。

## 5 讨论及启示

本研究通过调查新冠肺炎疫情期间合肥市政务文化新区15个居住区的居民心理健康状况,揭示了疫情背景下居住区绿地对居民心理健康状况的影响。既有的绿地健康功效研究证实了绿地对人群心理健康的改善作用<sup>[28]</sup>,本研究则进一步验证了远距离观看居住区绿地对人群心理健康的改善作用,并揭示了提高绿地绿化覆盖率、居民对绿地景观

## 4.4 Green Space Satisfaction

The average scores of the satisfaction of green spaces in the studied residential areas are  $3.78 \pm 0.79$ ,  $3.58 \pm 0.73$ , and  $3.75 \pm 0.81$  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<sup>[27][35]</sup>. 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<sup>[28]</sup>, 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,

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（即脑电波、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，与之伴生的则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。**LAF**

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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. **LAF**

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