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Linking University Campus Green Space and Students' Mental Health and Well-Being: A Systematic Literature Review

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Abstract

The positive impact of urban green space on human mental health and well-being has become a consensus in the fields of environment and health research. Due to the increasing pressure faced by contemporary university students and the worsening mental crises, university campus green space, as a particular type of urban green space, have received increasing attention. This study reviews the evidence on the effects of university campus green space on students' mental health and well-being. A systematic search of WOS databases yielded 715 articles, of which 25 articles were included in the review. We extracted useful information from 25 studies. By summarizing and analysing the information, three main questions involving each step of an ecosystem services framework on nature and mental health were addressed. In terms of natural and environmental features, there was adequate evidence for association between landscape types and subjective landscape quality and mental health and well-being, while evidence for association between objective landscape quality and mental health and well-being was inadequate. In terms of exposure, there was adequate evidence for association between visit frequency and mental health and well-being. In terms of experience, evidence for association between types of activity and mental health and well-being was limited. University campus green space has positive associations with students' mental health and wellbeing (perceived restoration, increased positive emotion and lower negative emotion). Future research needs to develop more effective and robust landscape quality assessment instruments and use stronger research designs to improve the strength of evidence.

Keywords: University Campus Green Space, Mental Health and Well-Being, Natural and Environmental Features, Exposure, Experience

Introduction

The mental health of university students has been a public health issue of increasing concern in recent years with a growing body of empirical research showing that university students are a 'very high risk population' for psychological distress and mental disorders (Baik et al.,

2019). The COVID-19 epidemic which broke out in the early 2020 especially intensified the mental health problem of university students and a high proportion of this group suffered from depression, anxiety and/or suicidal thoughts (Chen & Lucock, 2022; Chirikov et al., 2020; Wang et al., 2020). How to provide the mental support for university student and to improve their mental health level become a problem that needs to be solved urgently. From the ancient time, human beings recognized the positive effect of the natural environment on their psychology in many different cultures and societies. The belief that viewing vegetation, water and other natural elements can ameliorate stress and is beneficial for patients in healthcare environments had formed in the earliest large cities of ancient civilization such as Persia, China and Greece (Velarde et al., 2007). Until 1980s, the issue about the relationship between natural environment and human mental health and well-being developed from subject cognition which was formed based on the life experience and personal intuition to scientific empirical study. A series of evolutionary theories of landscape preference such as Biophilia, Prospect-refuge Theory and the Savanna Theory elucidated human being's preference towards natural environment or natural environment with some kind of landscape characteristic. Human beings reap benefits because of specific landscape qualities that satisfy human biological needs (Velarde et al., 2007). Later, two fundamental theories attempted to explain the mechanisms behind the mental benefits people derive from exposure to natural environment and they argue that the positive effects of contact with nature on human mental health and well-being are 'restorative' (Yakınlar & Akpinar, 2022): Attention Restoration Theory (ART) (Kaplan, Rachel & Kaplan, 1989) and Stress Reduction Theory (SRT) (Ulrich et al., 1991). These two theories have supported much of the recent research on restorative effects of nature experience (Zhu et al., 2022; Fleming et al., 2022; Akpinar, 2021). In addition, some concepts relating to salutary effects of landscape are known as 'Healing Gardens' Marcus (2007),'Therapeutic Landscapes' Gesler (1992) or 'positive landscape' (Yan et al., 2023). "The terms 'healing' or 'therapeutic' generally refer to a beneficial process that promotes overall well-being" (Velarde et al., 2007). there is already a wealth of literature to explain the ways in which natural environments positively affect human's mental health and well-being. So far, numerous studies have linked viewing or spending time in natural environment and mental benefits such as stress reduction Wang et al (2019); Payne et al (2020), increased positive affect Duan & Li (2022); Hung & Chang (2022), recovery from concentration fatigue Hartig et al (2003); Kaplan et al (1989), avoidance of negative moods (Ibes & Forestell, 2022; Pratiwi et al., 2022b, 2022a), higher life satisfaction (Honold et al., 2016; Payne et al., 2020), quality of life (Holt et al., 2019; Stepansky et al., 2022) , happiness Houlden et al (2017); Marselle et al (2016) and subjective well-being Chen & Ye (2023); Liu et al (2022); positive social interactions, cohesion, and engagement Jennings & Bamkole (2019); Sugiyama et al (2008); a sense of meaning and purpose in life (O'Brien et al., 2011).

A conceptual model integrating mental health with ecosystem services which initially proposed by Bratman and his colleagues traces a pathway from natural environment to mental health and subjective well-being. This conceptual model has been proven to be applicable to studies on the relationship between recreational blue space visit and subjective mental well-being (Garrett et al., 2023). Therefore, it may also explain how campus green space contribute to students' mental health and well-being. There are four steps in this conceptual model namely natural features, exposure, experience and effects which is shown in Figure 1.1. The step 1 'natural features' stand for the characteristic of natural environment which potentially influence human mental health. Natural features can range from size,

composition (proportions of different types of natural elements) and spatial configuration of natural landscapes to other relevant natural attributes, such as tree canopy density, vegetation structure, species composition, or biodiversity (Bratman et al., 2019). The next step 'exposure' refers to the quantity of getting in touch with nature. The actual nature exposure is usually difficult to quantify, so we can only use some indicators (such as cumulative opportunity and proximity measures Ekkel & de Vries (2017) to estimate. In addition, the frequency to visit nature and duration in nature may also predict nature exposure. "Measurement approaches based on location alone can fail to account for differences in exposure that are due to factors such as access to transportation corridors, time demands, income disparities, and perceived safety" (Bratman et al., 2019). therefore, the experiential characteristics of nature exposure which is called nature experience is introduced. Experience is the third step of conceptual model which can be classified into interaction and dose (Bratman et al., 2019). There are numerous interaction patterns between human beings and nature and different interaction patterns have different effects on human mental health and well-being. The concept of dose comes from toxicology, which refers to 'the amount or intensity of a physical, chemical, or other environmental agent that reaches the target population or organism' (Sandifer et al., 2015). The last step of conceptual model is "effects". According to Bratman et al (2019), Effects on mental health and well-being which is the consensus of academic circles contain increased psychological well-being (e.g., improved mood) and a reduction of risk factors and burden of some types of mental illness (e.g., stress reduction). Notably, the effects also depend on individual factors such as age, gender, current affective state, and other personal characteristics.

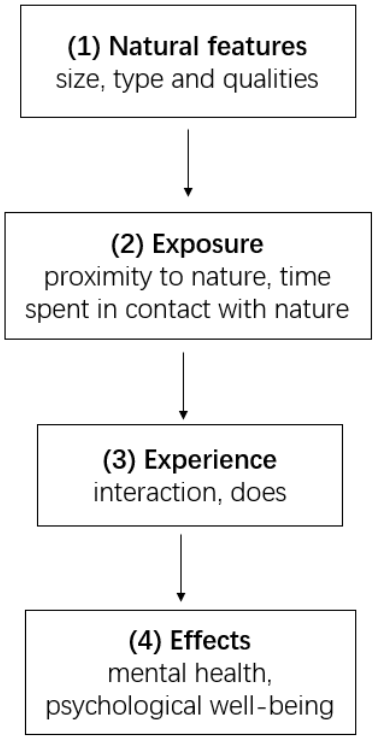

Figure 1: *A conceptual model for mental health as an ecosystem service (Bratman et al., 2019)*

Campus green space which includes grassy lawns, tree-lined walkways, courtyards, and views intermingled within campus buildings is regarded as an essential component of the campus

environment (Liu et al., 2022). At the same time, campus green space as an important medium to get in touch with nature is an important place for university students to relax in their spare time (Liu et al., 2018). Although more and more researchers have already found that university campus green space have effects on students' mental health and well-being, on earth what kind of university campus green space are more conducive to exposure to nature, improving the experience quality, so as to improve the mental health status of university students? In order to answer these questions, we try to use Bratman et al (2019)'s concept model and systematically gather the evidences on the effects of campus green space on university students' mental health and well-being. These knowledges can guide the design and planning of campus green space for policy maker to use nature-based solution to solve less and less optimistic mental health status of university students. In a systematic literature review in this respect, van den Bogerd et al (2020) conclude that research on the effects of nature in the study environment on students' well-being is still in its infancy and that there is still much to be learned in this regard. Meanwhile, to the best of our knowledge, no previous study has systematically gathered the evidence on the effects of natural features, nature exposure and nature experience of university campus green space on students' mental health and well-being. Furthermore, more researchers who are skilled in landscape architecture's accession make the research achievements of health-promoting university campus green space more abundant in recent years. Therefore, the summary and review of these research findings will contribute to the planning, design and management of health-promoting university campus green space. Moreover, campus green space as an important health resource is still widely overlooked Foellmer et al (2021), this systematic literature review may cause university administrators to pay more attention to protecting the natural elements and natural spaces in the university campus.

For this, we addressed three main questions involving each step of this ecosystem service conceptual model (Fig. 2).

RQ1: what is the effect of natural and environmental features of university campus green space on university students' mental health and well-being?

RQ2: What is the effect of the exposure to university campus green space on university students' mental health and well-being?

RQ3: What is the influence of the exposure to university campus green space on university students' mental health and well-being?

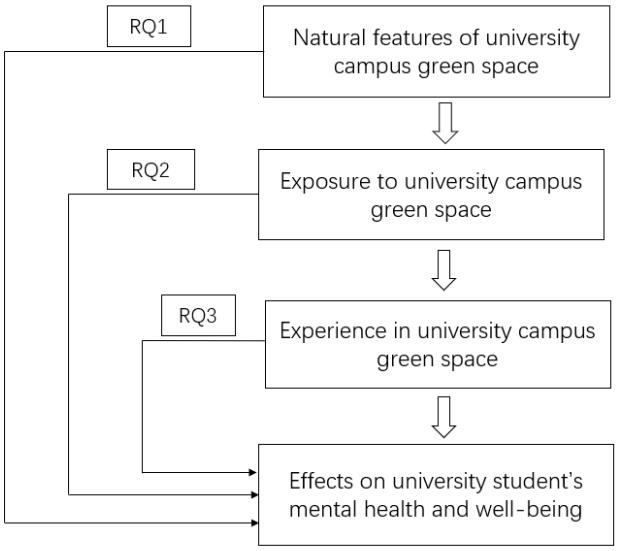

Figure 2: *Graphical display of research questions*

Methodology

Search Strategy

We performed the review between 19 and 22 August 2023, using Web of Science database. We further completed this search using the most common synonyms founded in the research area. The final search syntax was: TITLE-ABS-KEY= (university campus green space* OR university campus greenspace* OR university campus green environment* OR university campus green area*OR university campus outdoor environment* OR university green space* OR university greenspace* OR university campus space* OR university campus environment*) AND TITLE-ABS-KEY= (mental health OR psychological health OR mental well-being OR psychological well-being OR mental wellbeing OR psychological wellbeing OR mental benefit* OR psychological benefit* OR mental restoration* OR psychological restoration* OR attention restoration* OR restoration*)

Selection of Studies

We focused exclusively on empirical scientific articles published at scientific journals, relating university campus green space to students' mental health and well-being and published in recent ten years from 2014 to 2023, because 80% of the articles were published in these years in the Web of Science database. Dissertation thesis, Meeting, news and other literature types were excluded. Additionally, review articles were eliminated as well. The languages of select articles were English. Next, we choose the core collection from web of science database.

After the screening of the studies according to the above procedure, 374 articles are identified at last. We read the abstracts of the selected 374 articles and the whole text when the abstract was not enough to determine whether they met the inclusion criteria. In the end, 342 articles were excluded. The main reasons for exclusion were that:

1. The studies were about green space but not university campus green space (e.g. other urban green space).
2. The studies were about university students' health and well-being but not mental health and well-being (e.g. thermal comfort).

3. The studies were about university students' mental health and well-being, but the invention did not include campus green space exposure or nature experiences (e.g. campus sport experience)
4. The object of study is not university student (e.g. university staff).
5. Not campus outdoor green space (e.g. campus indoor green wall).
Consequently, a total of 25 individual studies were included in this systematic literature review (Fig.3)

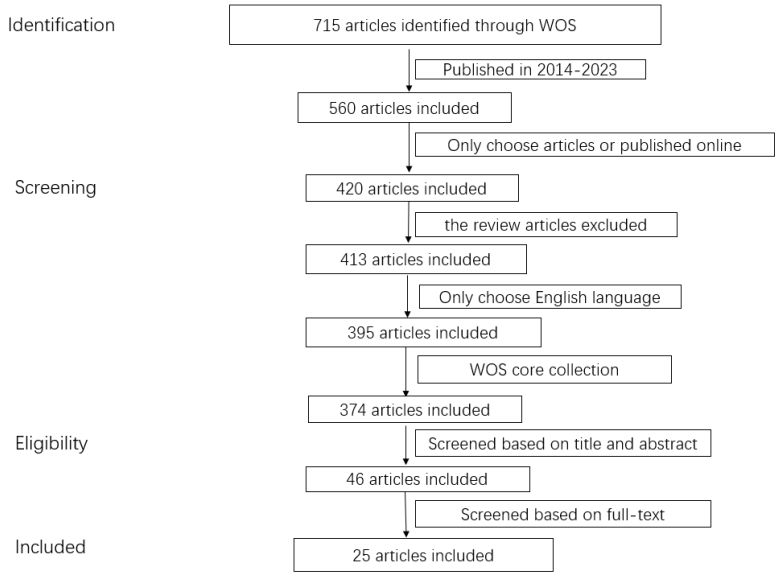

Figure 3: *Flow chat of the literature search*

The operationalization of four steps in ecosystem conceptual model

For step1, refer to Garrett et al (2023), we operationalise 'natural features' in terms of campus green space types, e.g. waterfront spaces or courtyard spaces, subjective quality, e.g. perceived greenness or perceived naturalness and objective quality of campus green space, e.g. the objective greenness or objective diversity, which we call here 'Natural and Environmental features', to incorporate both natural and artificial elements of campus outdoor space. For step 2 exposure, the studies screened for this systematic literature review did not use two principal approaches (cumulative opportunity and proximity measures) to estimate the exposure to university campus green space. But a considerable studies measured campus green space visit frequency and duration to estimate the exposure to campus green space, which is in line with the original authors' call to integrate other metrics (Garrett et al., 2023). For step 3, most researches used university students' activity types in campus green space to characterize nature experience, which are the specific ways in which people interact with nature. Notably, only one study used presence of companions to enrich the interaction between university students and nature. For step 4, just as the two consensus statements (increased psychological well-being and a reduction of risk factors and burden of some types of mental illness) which were summarized by the original authors state, the mental health and well-being effect includes increase in positive mood or emotion and psychological restoration and decrease in negative mood or emotion (such as depression, perceived stress, anxiety).

Data Extraction

Data elements extracted included author, study country, research design and findings. Meanwhile, natural and environmental features of campus green space, visit frequency, duration, activity in campus green space and mental benefit were extracted.

Results

Description of included studies

The systematic review included 9 experimental and intervention studies (Table 1). These 9 studies included 7 experimental and intervention studies executed in a real-life setting Kim et al (2021); Ning et al (2023); Pratiwi et al (2022a); Zhang et al (2023); Bang et al (2017); Ibes & Forestell (2022); Stepansky et al (2022) and 2 experimental studies using virtual reality (Ha & Kim, 2021)(Guo et al., 2020). This systematic review further included 16 cross-sectional studies Baur (2022); Gulwadi et al (2019); Hipp et al (2016); Holt et al (2019); Lee et al (2022); Liu et al (2022, 2018); Liu et al (2022); Liu et al (2022); Loder et al., 2020; Lu & Fu, 2019; Malekinezhad et al (2020); Sun et al (2023); Sun et al (2021); Van Den Bogerd et al (2018), of which 1 study used a cross-sectional sample to examine the differences between photograph stimuli (Van Den Bogerd et al., 2018).

Natural and environmental features and mental health and well-being

Out of the 25 studies included in this systematic review, 18 studies regarded natural and environmental feature as a variable and it can be classified into landscape type and landscape quality. 7 studied involved in landscape type and 12 studies involved in landscape quality. Meanwhile, 1 study involved in landscape type and landscape quality simultaneously.

Landscape types of university campus green space and university students' mental health and well-being

In terms of landscape types which was involved in 7 studies, the standard of classification was diverse. For example, it can depend on the landscape element that occupy the main body of campus green space (waterfront space, vegetation space, dense or sparse forest space), or the extent to which it is enclosed by buildings (courtyard space, square space), or the function of the space (sports ground, exercise area space), or the eight perceived sensory dimensions proposed by Grahn & Stigsdotter (2010) (*ginkgo* garden, *Jiuqu* bridge), or the species of campus street tree (*Ginkgo biloba* landscape*, Sophora japonica* landscape). As a contrast, Space dominated by hard landscape include grey space and the district road.

Overall, the results indicated that all types of campus green space were beneficial for university students' mental health and well-being compared with hard landscape. The benefits included more psychological restoration Sun et al (2021); Ning et al (2023); Lu & Fu (2019); Guo et al (2020) and positive emotion Chen & Ye (2023), less negative moods (Pratiwi et al., 2022a; Pratiwi et al., 2022a; Guo et al., 2020). In addition, blue space and waterfront space which is dominated by the water landscape element had better restorative effects than other landscape types such as vegetation space, courtyard space and forest space Ning et al., 2023; Sun et al., 2021; Lu & Fu, 2019). In terms of viewing different species of campus street tree landscape, *Ginkgo biloba* showed more potentially restorativeness than *Sophora japonica, Platanus acerifolia and Koelreuteria paniculata* (Guo et al., 2020). Meanwhile, the *ginkgo* garden which was defined as a prospect and social space was more helpful to reduce negative emotion，*Jiuqu* bridge which was defined as a cultural and sheltered space was

more beneficial for increasing positive emotion and *Laoban* hill space with natural and tranquil characteristics had the most effective restorative potential (Zhang et al., 2023). Therefore, evidence for association between landscape types of campus green space and mental health and well-being is adequate.

Landscape quality of campus green space and university student' mental health and well-being

Out of 12 studies which involved in landscape quality, most of them used subjective measurement to assess landscape quality (Hipp et al., 2016; Q. Liu et al., 2018, 2022; S. Liu et al., 2022; W. Liu et al., 2022; Loder et al., 2020; Malekinezhad et al., 2020; N. Sun et al., 2023) except that 2 studies used objective indicator (Ha & Kim, 2021; Van Den Bogerd et al., 2018). In addition, 1 study used subjective and objective methods at the same time (Gulwadi et al., 2019). Objective landscape quality include objective greenness Gulwadi et al (2019), plant diversity Ha & Kim (2021) and the number of greenery (Van Den Bogerd et al., 2018). Notably, Ha & Kim (2021) considered the presence of natural sound (e.g. bird, insect song) in university campus green space except simple visual features. The results showed more objective greenness, high plant diversity with the presence of natural sound and more greenery in university campus space are significantly related to students' increasing psychological restoration. Therefore, evidence for association between objective quality of campus green space and mental health and well-being is inadequate.

In terms of subjective landscape quality, which is also called perceived quality include perceived greenness (Gulwadi et al., 2019)(Hipp et al., 2016)(Loder et al., 2020), perceived naturalness Liu et al (2022); Liu et al (2022); Liu et al (2018), perceived sensory dimensions (Malekinezhad et al., 2020), perceived aesthetics, perceived plants diversity, perceived reasonable degree of layout and perceived comfort (Liu et al., 2022). The results showed that perceived sensory dimensions Malekinezhad et al (2020) was significantly positively related to university students' psychological restoration, while perceived aesthetics, perceived plants diversity, perceived reasonable degree of layout, perceived comfort (Liu et al., 2022; Sun et al (2023) were significantly positively related to positive emotion. Perceived naturalness and perceived greenness were significantly positively related to both psychological restoration and positive emotion. (Gulwadi et al., 2019; Hipp et al., 2016; Q. Liu et al., 2018, 2022; S. Liu et al., 2022; Loder et al., 2020). Therefore, evidence for association between perceived quality of campus green space and mental health and well-being (perceived restoration and positive emotion) is adequate.

Exposure to university campus green space and students' mental health and well-being

In the present systematic literature review, 7 articles involved in visit frequency of campus green space or the duration of campus green space use (Holt et al., 2019; Liu et al., 2022; Stepansky et al., 2022; Lee et al., 2022; Ning et al., 2023; Pratiwi et al., 2022a; Zhang et al., 2023). However, 3 experimental design studies failed to regard the duration of campus green space use as a variable (Ning et al., 2023; Pratiwi et al., 2022a; Zhang et al., 2023). 3 studies involved in visit frequency Holt et al., 2019; Liu et al., 2022; Lee et al (2022) and 1 studies simultaneously involved in visit frequency and duration (Liu et al., 2022). In terms of visit frequency, 3 studies indicated the significant positive association with mental benefits (Holt et al., 2019; Liu et al., 2022; Lee et al., 2022). With respect to duration, 1 study found a positive association between time spent in a campus green space and student's positive emotion

Stepansky et al (2022) while 1 study showed no effect of the duration of campus green space use on mental restoration and self-rated mental health (Liu et al., 2022). Therefore, evidence for association between visit frequency and mental health and well-being (perceived restoration, increased positive emotion and low negative emotion) is adequate.

Experience in university campus green space and mental health and well-being

Experience in university campus green space emphasizes the interaction between university students and campus natural environment. 2 studies tried to classify the interaction by students' activity types in campus green space, for example, physical activity or non-physical activity Holt et al (2019) or mental and social activity (Chen & Ye, 2023). 1 study used the presence of companion to describe the social environment when visiting campus green space (Liu et al., 2022). At first, in terms of the effect of experience in campus green space on the mental health and well-being of students, 3 experimental research design studies showed students who interact with green space reported more mental benefits including positive increases in their mood and stress response and decrease in total mood disturbance and depression than those do not (Kim et al., 2021; Ibes & Forestell, 2022; Bang et al., 2017). Next, mixed results on the influence of activity types on students' mental health and well-being. Just as mentioned above, 1 study indicated that students who frequently did physical activities in campus green space report more positive mood and less perceived stress than those did non-physical activities (Holt et al., 2019). In contrast, another 2 studies failed to find the association between activity types and mental benefits (Lee et al., 2022; Chen & Ye, 2023). Therefore, evidence for association between types of activity in campus green space and mental health and well-being is limited.

Discussion

In this systematic review, we synthesized the evidence on the effects of university campus green space on students' mental health and well-being and try using Bratman et al. (2019)'s conceptual model which include natural features, exposure, experience and effects four steps to explain this process. By summarizing the results of 25 articles, we explore the effect of natural and environmental features, exposure to campus green space and experience in campus green space on the mental health and well-being of university students. The classification standards for landscape types of university campus green spaces are diverse, ranging from broad (e.g. blue space and green space Sun et al (2021), waterfront space and vegetation space Lu & Fu (2019) to specific (e.g. campus street trees of different species Guo et al (2020), landscape space of different perceived sensory dimensions (Zhang et al., 2023). So no consensus was observed regarding campus green space typology, which is consistent with another systematic literature review about the relationship between greenspace and the mental wellbeing of adults (Houlden et al., 2018). Blue space of campus green space may has more restorative values for mental health and well-being than other spaces such as forest space Ning et al (2023), square space Sun et al (2021) and courtyard space (Lu & Fu, 2019). This finding was consistent with another study conducted in an indoor campus setting which found that students rated settings with views of dramatic nature murals, especially those with water, more restorative (Felsten, 2009). However, since the three pieces of evidence supporting this finding were all obtained from Chinese university campus green space, more research on university campus green space from other countries is needed to demonstrate its generalization.

Additionally, most studies use subjective (perceived) landscape quality which covers many aspects such as naturalness, aesthetics, diversity, layout, accessibility, and so on. Perceived greenness and naturalness were found to be positively related with human's mental health in other settings such as community-dwelling Pun et al (2018), neighbourhood Sugiyama et al (2008) and urban green space (Fisher et al., 2021; Hoyle et al., 2019). In addition, there are few studies that utilize objective landscape quality, which leads to insufficient evidence on the impact of objective landscape quality on mental health and well-being.

Strength and limitations of this review

At first, the present systematic review precisely summarized the studies about the mental benefits brought by the university campus outdoor nature. To our best knowledge, it is the first time. Next, the conceptual model used in this study is proposed by numerous researchers in the field and has been validated through empirical research to be effective. Finally, this research focuses on the landscape design of university campus and students' mental health that may that may guide the health-promoting campus space design.

Inevitably, it has limitations. First of all, it only used Web of Science database due to the limited number of researchers. Though the core collection of Web of Science is valuable, we may omit other important articles in this topic. Secondly, by restricting the language of the included studies to English, we may have missed other studies. For example, some articles in this area used Chinese or Korean. Finally, we only included peer-reviewed, quantitative studies and 1 method study, which may hinder a full insight into the impact of campus green space on the students' mental health and well-being.

Future Research

Future research could adopt more detailed methods for evaluating the landscape quality of university campus green space and explore their impact on the mental health and well-being of university students. This could provide more specific and feasible design guidelines for creating mental health-promoting campus green spaces. For example, Olszewska-Guizzo et al (2023) developed an effective and robust instrument (Contemplative Landscape Model) for assessing the visual quality of urban green space, which can inform landscape design with regard to the mental health and well-being of urban residents. Additionally, in the present systematic review, just as Ha & Kim (2021) utilized both visual and audio approaches of landscape perception, the impact of university campus soundscapes on the mental health and well-being of college students remains to be investigated. Just like the proposal of Health Restoration Soundscapes Criteria in urban green space Kogan et al (2021), the development of a tool for the recognition of potential health-restoring soundscapes in campus green space is essential for strengthening evidence. At last, most studies used cross-sectional design, which means causal relationships cannot be drawn. Therefore, we call for more longitudinal or intervention studies in this area.

Conclusion

The present systematic review includes experimental, cross-sectional and simulation studies. Because we focused on the university campus green space setting and university students' mental health and well-being, consequently, a limited number of studies were identified (n=25). University campus green space has positive associations with students' mental health and wellbeing (perceived restoration, increased positive emotion and lower negative

emotion). Future research needs to develop more effective and robust landscape quality assessment instruments and use stronger research designs to improve the strength of evidence.

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