Determining Correlation between Experiences of a Sensory Courtyard and DAS (Depression, Anxiety and Stress)

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ABSTRACT

Background and objective: There is growing concern about the effects of modern society on mental health, coming with Covid-19-related caveats on depression, anxiety, and stress (DAS). This can be a subject to provide alternative methods which alleviate DAS. In line with this context, sensory gardens are widely acknowledged to stimulate the five major senses (sight, sound, taste, touch, and smell) and can have a significant (positive) impact on mental health. However, there is limited empirical evidence on the effect of these gardens with regard to alleviating DAS – particularly with respect to urban society. This is a gap in knowledge how such limits can be addressed. Accordingly, this present study is clearly needed in order to verify if there are any correlations between sensory gardens and (positive) effects on DAS. The aim of this study was therefore to understand current levels of DAS in a high density building with a sensory garden in a courtyard and determine correlations between experiences in the sensory courtyard and levels of DAS.

Methods: The Depression Anxiety and Stress Scale (DASS-21) was employed to test the level of DAS.

Results: Additionally, 13 different factors associated with experiences in the building, including the stimulation of the five major senses in the sensory courtyard, were measured to reveal their contribution to mitigating depression, anxiety, and stress. It is noted that the average levels of DAS were 7.91, 7.77 and 9.01 respectively indicating that the mental health of participants requires mental health management. However, results show that factors associated with the sensory courtyard could improve mental health. For example, new social relationships, walking with colleagues, and the stimulation of each of the five major senses in the sensory garden could improve DAS.

Conclusion: This illustrates that external experiences are more effective at mitigating depression, anxiety, and stress than internal ones. Factor analysis revealed four components: stimulating the five senses; internal and external facilities; internet-based device use; and new social relationships. There was a strong positive correlation between new social relationships and walking with colleagues. There were also strong positive correlations among the stimulation of each of the five senses. In conclusion, there are strong indications that sensory courtyards can help alleviate DAS and should therefore be promoted, particularly in the current Covid-19 situation wherein the physical and mental health of the public at large are threatened. Accordingly, courtyard design should be rethought in light of the relationship between the positive impact of sensory gardens and mental health.

Keywords: Sensory Garden, Five Senses, DASS, Covid-19

Introduction

Rapid urbanization-not only in Korea but worldwide-has brought increasing amounts of gray space. Such rapid urbanization is widely known to negatively affect human

mental health. Specifically, mental health problems such as depression, anxiety, and stress have increased the death rate by suicide and the onset of chronic diseases, which have become universal social issues. The recent Covid-19 pandemic has exacerbated mental health problems, and as

Received: May 12, 2021, **Revised:** June 9, 2021, **Accepted:** August 2, 2021

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the gravity of this issue becomes more apparent measures need to be put in place urgently to address this matter (Xiong et al., 2020).

Significant health issues related to depression, anxiety, and stress, which are listed among the top five most serious mental disorders according to the DSM-5 (Diagnostic and Statistical Manual of Mental Disorders, 5th edition) - the most commonly used mental disorder classification system (Yoon et al., 2020)- should be prioritised.

In order to address this matter, in Korea, there has been an increasing tendency to manage one's mental health through visits to outdoor facilities such as parks and it has been reported that there has been a sharp increase (of 51%) in such visits since the Covid-19 pandemic began (Google Community Mobility Reports, 2020). This can be viewed as a positive use of the benefits provided by green spaces in parks and gardens (Nam and Kim, 2019). However, due to the high density of buildings caused by urbanization and accessibility issues related to parks, there are limits regarding the use of parks as facilities for routine mental health management. In particular, Korea has a large number of skyscrapers on account of its rapid urbanization. This makes it even harder to experience the natural attributes of parks. This has led to a higher interest in landscaped spaces inside buildings, such as courtyards, as aids to manage mental health. In addition, several studies on healing gardens in Korea have shown that courtyards and internal gardens provide mental health benefits: in some instances, there have been correlations between landscape factors-such as plant type (Jung and Park, 2017), improvements in air quality (Jang et al., 2017), and interactions between nature and humans (Ahn and Park, 2018)-and mental health. However, Cheon and Lee (2016) asserted the need to quantitatively determine correlations between mental health and various landscape factors in healing gardens. Interestingly, such studies in other countries have focused on the correlations between specific aspects of gardens and mental health, especially depression, anxiety, and stress. In addition, a historical review of the origin of public parks in 19th-century United Kingdom has been of particular interest, as they were created to enhance the mental health of the citizens in response to the spread of cholera - which bears a striking resemblance to the current situation

(Nam, 2020). Of particular interest in these studies is the correlation between the stimulation of the five major senses and mental health. Sensory gardens contribute to the recovery of mental health through stimulating the five major senses (sight, sound, smell, taste, and touch). More positively, increasing the beauty of Korean gardens through stimulating the five senses has been emphasized since the 1990s (Min, 1992), which has promoted the need for discussion regarding sensory gardens in Korea. Furthermore, the recent worsening of mental health as a result of the Covid-19 pandemic requires the prompt verification of such beneficial effects.

Thus, this study aims to examine the effects of stimulating the five major senses in a Korean sensory courtyard with regard to alleviating depression, anxiety, and stress. The goals of this study are as follows: (1) examine the levels of depression, anxiety, and stress that people experience in a high-density building structure; and (2) verify the correlation between mental health and the stimulation of the five senses in a sensory courtyard.

Literature Review

Effects of Natural Environment on Depression, Anxiety, and Stress

The theories on the positive effects of natural environments on mental health very often refer to the Attention Restoration Theory (ART) (Kaplan, 1995) and the Stress Reduction Theory (SRT) (Ulrich et al., 1991). Both theories discuss psychological recovery based on people's experience from their activities in the natural environment. However, the two theories differ in that, while ART emphasizes recovery from fatigue through utilizing cognitive abilities such as powers of concentration, SRT focuses more on alleviating physical and psychological stress. According to Kaplan (1995), who advocated ART, experiencing 'Being Away,' 'Extent,' 'Fascination,' and 'Compatibility' in certain environments helps users of the natural environment recover from fatigue that arises from a decline in cognitive ability. Conversely, Ulrich's SRT demonstrated a correlation between the natural environment and the induction of positive emotions in humans. It claims that this suppresses tension and negative emotions (Ulrich et al., 1991). Humans

tend to respond mainly to visual stimulation, but SRT claims that factors of natural environments other than visual stimulation make people feel relaxed, thus reducing stress. These important theories are supported by multiple studies. Berman et al. (2012) and Aspinall et al. (2015) showed that activities in natural environments increase positive emotions such as stability and happiness while reducing depression and anxiety in humans. Thus, they conclude that natural environments contribute to improving human mental health, with positive effects on depression, anxiety, and stress. However, the classification and definitions of the factors associated with natural environments mentioned in these studies are not clear. Several research initiatives have also been conducted in Korea on physical and mental recovery (Shim et al., 2019) and healing environments (Kim, 2017), based on the Attention Restoration Theory. However, these studies do not clearly demonstrate direct correlations with depression, anxiety, and stress, as they are emerging major problems, particularly since the Covid-19 pandemic. Furthermore, there is currently a lack of research on the effects of accessible places where people living in cosmopolitan cities can experience natural environments, such as courtyards inside buildings, on the reduction of depression, anxiety, and stress.

Sensory Gardens

The five major senses in humans are generally considered to be sight, sound, smell, taste, and touch. The importance of these five senses to health has recently been significantly emphasized. The five major senses contribute to a reduction in physical and mental symptoms and the enhancement of other senses, thus improving the ability for health recovery (Lee, 2012; Cheon and Lee, 2016). Research on the enhancement of physical and mental health

through healing gardens is being actively conducted in Korea. For example, there have been studies on recovering human physical and mental health through constructing healing gardens in various spaces, such as roof gardens in universities (Shim et al., 2020), elderly care facilities (Kwon and Lee, 2019), psychiatric hospitals (Ahn, 2015), an decrepit campuses (An, 2017), and apartment complexes (Chun and Lee, 2017). Studies in Korea have comprehensively discussed the contribution of healing gardens to physical and mental health.

In a wider context, studies conducted overseas show that sensory gardens contribute to mental health by stimulating the five major senses. According to the Sensory Trust (2009), a sensory garden is defined as a “self-contained space” that contains a wide range of sensory experiences. Sensory gardens are different from ordinary or healing gardens because each factor in a sensory garden must be carefully selected and designed to maximize the stimulation of the five major senses (Lambe, 1995:114; Shoemaker, 2002) (Table 1).

The big difference between the design principles of healing gardens and sensory gardens is elucidated in Mahmoud and Mohamed’s research in 2020. According to their findings, healing gardens focus on physical actions, such as motion, movement, exercise, and activities, whereas sensory gardens focus on mental responses through experiences perceived through the five major senses. According to a more detailed theoretical background, sensory gardens have their origins in horticultural therapy and were developed in the United Kingdom in the 1970s (Hussein, 2012). The first sensory garden was constructed in a public park for the visually impaired. Sensory gardens contribute to the development of the five major senses through the experiences gained in the gardens and make spaces for nature and landscapes more accessible (Ellis, 2011). Therefore, they are thought to maximize positive effects on mental

Table 1. Principles of healing gardens and sensory gardens

Healing Garden	Sensory Garden
Feeling of security (body, employment, resources, the family, health, property)	Access and usability
Movement, rhythm, and exercise	Comfort, mood, and ambiance
Activities	Sensory experiences (touch, sound, sight, smell, and taste)
Social support (among patients, visitors, and staff)	Sight (color, pattern, and shape; movement and visual contrast)

Source : Mahmoud and Mohamed (2020)

health. Sensory gardens have been recently constructed in a diverse array of spaces, such as children's hospitals, schools, retirement communities, and apartment complexes (Souter-Brown et al., 2021). In particular, sensory gardens play a positive role in recovery from unstable and uncomfortable psychological states such as depression, anxiety, and stress (Friedrich, 2017).

Sensory gardens are designed to stimulate the five major senses. It is widely known that sight is highly important, to the extent that it generally dominates the other senses. Sensory gardens also stimulate sight through the presence of plants of various types and various colors, sizes, and shapes (Wagenfeld, 2019). Additionally, according to Mahmoud and Mohamed (2020), sounds coming from fountains, waterfalls, and the shaking of trees or branches positively stimulate the sense of sound. Smells, such as scents of plants, flowers, or grasses, convey positive experiences, and edible vegetables and herbs that stimulate the sense of taste are included in sensory gardens as well (Harris, 2019). Contact with plants and other materials in the garden, and various types of contact that occur while cultivating and managing the garden, stimulate the sense of touch (Hussein, 2009). As such, research on the effects of sensory gardens on the five major senses has been conducted, such as in the Lerner Garden in Maine, USA (Fig. 1).

The layout of the Lerner Garden follows the principles

Source: Reformed figure derived from Mahmoud and Mohamed (2020)

Fig. 1. Layout of the Lerner Garden, Maine, USA.

of sensory gardens. It contains separate zones for each of the five major senses, creating purpose. Also, the construction of paths allows users to gain a full experience in each zone, rather than overlapping multiple senses. However, correlations between stimulating the five major senses and depression, anxiety, and stress have not been clearly discussed.

Research Methods

Depression Anxiety and Stress Scale (DASS-21)

The Depression Anxiety and Stress Scale (DASS) is a scale devised by Antony et al. (1998), commonly used to measure depression, anxiety, and stress (Psychology Foundation of Australia, 2018). DASS originally consisted of 42 items, but Henry and Crawford (2005) studied the relationships between items and proved the validity of only using 21 items (DASS-21), which have been widely employed since. DASS includes three subscales and is widely used to measure mental health states arising from psychological depression, anxiety and stress. The depression scale measures low self-esteem and motivation (seven items), the anxiety scale measures fear of uncertainty (seven items), and the stress scale measures hypersensitivity and difficulties (seven items). All items are reported on a four-point scale from "Did not apply to me at all" (0 points) to "Applied to me very much or most of the time" (3 points), and a higher score indicates a higher degree of depression, anxiety, and stress. The items are ordered irregularly; depression items are 3, 5, 10, 13, 16, 17, and 21, anxiety items are 2, 4, 7, 9, 15, 19, and 20, and stress items are 1, 6, 8, 11, 12, 14, and 18. DASS-21 is considered to be a highly reliable scale, used by the National Health Service of the United Kingdom as the official index for measuring major aspects of mental health, and also used by other areas, including Europe and the United States of America. Moreover, in relation to the recent Covid-19 pandemic, countries worldwide, including Italy (Mazza et al., 2020), Iran (Moghanibashi-Mansourieh, 2020), Spain (Ozamiz-Etxebarria et al., 2020), and China (Wang et al., 2020), frequently use DASS-21 to measure depression, anxiety, and stress. It has also been used in Korea for measuring depression, anxiety, and stress for re-

search purposes in fields like medicine, psychology, and nursing, but there are few cases where DASS-21 has been employed in relation to gardens.

Research Area and Data Collection

The research area was a courtyard inside a building located in Gyeonggi-do Province. The building has about 400 employees working inside and contains internal and external resting areas, an internal multipurpose space, an internal landscaped area, and a courtyard. There is a sensory garden that stimulates sight, sound, smell, taste, and touch inside the courtyard. The courtyard contains various visual landscaped factors, and it also allows for sound experiences from water and wind. Users can also smell natural scents coming from grasses, flowers, and soil, and can also experience taste from growing fruit and vegetables. Meanwhile, the users can also experience touch from plants that they grow themselves and from other plants that they naturally come into contact with inside the space.

Data were collected in September 2020, through a survey directly handed out to participants in the research area. For data collection, the researchers explained the purpose of this study to the participants and stated clearly beforehand that the data collected from the survey would not be used outside of the purpose of the study. The survey was filled out only by participants that agreed to participate. The researchers approached 140 people and collected 77 of the surveys, resulting in a return rate of 55%.

Survey Composition and Analysis

The survey consisted of three parts. The first part collected brief demographic information from the survey participants. Due to the sensitivity of mental health information, the amount of personal information collected was minimized. The second part consisted of the DASS-21 scale. While DASS-21 is a scale originally written in English, we used the Korean interpretation of DASS-21. The Korean interpretation is a translation into Korean of DASS-21 that references the version of DASS-21 employed by the Psychology Foundation of Australia. In the third part, information was collected on the participants' experiences with regard to

the stimulations of the five major senses in the sensory garden, as well as with other experiences in the building that may be related to the alleviation of depression, anxiety, and stress.

All data analyses were conducted using the statistics software SPSS 26.0. Descriptive statistical analyses were conducted to gather basic data regarding factors of the courtyards that may relate to the participants' depression, anxiety, and stress. T-tests were also carried out to derive differences in depression, anxiety, and stress levels by gender and to determine the effect of the courtyard. A one-way ANOVA was employed to analyze differences among age groups. Correlation analyses were used to determine the correlations between depression, anxiety, and stress and the experiences of participants, including stimulation of each of the five major senses. A factor analysis was conducted to describe variability among correlated variables which contribute to reducing depression, anxiety, and stress in the courtyard.

Results and Discussion

Descriptive Statistical Analysis

The results of the descriptive statistical analysis showed that 77.9% of respondents were male and 22.1% were female among the 77 total respondents. Most respondents were in their twenties (37.7%), forties (26%), and fifties (26%). Based on DASS-21, the average levels of depression, anxiety, and stress were 7.91, 7.77, and 9.01, respectively (Table 2).

The values are in the ranges requiring management for depression and anxiety, and close to the range requiring management for stress. This signifies that the level of depression, anxiety, and stress in the respondents of the survey poses a threat to mental health. There were no statistical differences in depression, anxiety, and stress by gender or age. This indicates that depression, anxiety, and stress affected all genders and age groups alike.

The average regarding the level of depression, anxiety, and stress since the Covid-19 pandemic was 3.17 (where significant exacerbation is 1 and a significant improvement

Table 2. Results of DASS test

Level/Disorder	Depression	Anxiety	Stress
Normal	0-4	0-3	0-7
Mild	5-6	4-5	8-9 (9.01)*
Moderate	7-10 (7.91)*	6-7 (7.77)*	10-12
Severe	11-13	8-9	13-16
Extremely Severe	≥ 14	≥ 10	≥ 17

Source: Scoring standard derived from Lovibond, S.H. and P.E. Lovibond (1995)

* Average values for depression, anxiety, or stress across respondents and their corresponding ranges

is 5), which shows that there was little change. This can be interpreted that while the preexisting depression, anxiety, and stress levels were not exacerbated, they were consistently at a level of concern.

The stimulation of each of the five major senses in the sensory garden, as well as experiencing the external resting areas and courtyard landscaped areas had positive effects on alleviating depression, anxiety, and stress since the Covid-19 pandemic. Additionally, new social relationships and walking with colleagues were shown to help alleviate depression, anxiety, and stress (Fig. 2). This can be considered as indicating that there has been increasing positive significance placed on social intimacy under long-lasting social distancing circumstances.

It is interesting that external experiences contributed more to alleviating depression, anxiety, and stress than internal experiences. This is in line with the promotion of outdoor activities since the start of the Covid-19 pandemic to overcome social distancing practices. This also reflects an increase in experiences in green spaces since the Covid-19 pandemic, as reported in the Google Community Mobility Reports (2020). Furthermore, this study also shows that the positive effects of sensory gardens on stress in patients, as shown in Souter-Brown et al. (2021), can also be applied to the general public.

Socio-Demographic Characteristics in Depression, Anxiety, and Stress

Alleviation of depression, anxiety, and stress differed by gender. This coincides with Lee (1998)'s research that there are psychological differences between females and males under similar conditions (e.g., population density, social

Fig. 2. Effects of a sensory courtyard on mitigating DASS. (No effect at all, 0 ; very large effect, 5)

relationships, and architectural space). The results showed that, for alleviating depression, new social relationships ($t = 2.671$, $df = 74$, $p = .01$) and the stimulation of taste ($t = 3.549$, $df = 74$, $p = .001$) had greater positive effects on females than males. For anxiety, landscaped facilities ($t = 2.749$, $df = 74$, $p = .008$), the stimulation of sound ($t = 2.919$, $df = 74$, $p = .005$), and the stimulation of taste ($t = 3.202$, $df = 74$, $p = .002$) had greater positive effects on females than males. For reducing stress, new social relationships ($t = 2.668$, $df = 73$, $p = .009$), the stimulation of sight ($t = 2.680$, $df = 74$, $sig = .009$), and the stimulation of taste ($t = 3.202$, $df = 74$, $p = .002$) had greater positive effects on females than males. These differences are con-

Table 3. Results of factor analysis

Factor	Component			
	1	2	3	4
Stimulation of Smell	0.895	0.217	0.082	0.044
Stimulation of Touch	0.880	0.047	-0.009	0.051
Stimulation of Taste	0.863	0.239	-0.020	0.183
Stimulation of Sound	0.860	0.217	0.081	0.146
Stimulation of Sight	0.796	0.299	0.185	0.057
External Resting Facility	0.259	0.816	0.096	0.211
Internal Resting Facility	0.080	0.766	-0.088	0.102
Internal Multipurpose Space	0.158	0.678	0.214	-0.262
Courtyard Landscaped Facility	0.323	0.676	0.013	0.265
Cellphone Use	0.111	0.068	0.953	-0.045
Internet Use	0.093	0.104	0.947	-0.097
Walking with Colleagues	0.111	-0.068	-0.102	0.865
New Social Relationships	0.215	0.264	-0.056	0.781

Scoring standard derived from Lovibond, S.H. and P.H. Lovibond (1995)

Extraction Method : Principal Component Analysis.

Rotation Method : Varimax with Kaiser Normalization. Rotation converged in six iterations.

sistent with Recovery Across Mental Health (2021) that indicated that females are twice as likely to experience depression, anxiety, and stress compared to males. This study shows that stimulating the five senses in sensory gardens can alleviate such depression, anxiety, and stress in females. However, there were no statistically significant differences in factors for alleviating depression, anxiety, and stress across age groups.

Correlations Among Factors Alleviating Depression, Anxiety, and Stress

A factor analysis to illustrate variability of the 13 factors alleviating depression, anxiety, and stress reveals that there were four principal components with eigenvalues greater than 1. These four components summarized the observed data well. Component 1 included the stimulation of the five senses, component 2 included internal and external facilities, component 3 included the use of internet-based devices, and component 4 included new social relationships (Table 3).

Significant correlations between factors alleviating depression, anxiety, and stress were commonly observed. New social relationships showed a strong positive correla-

tion with walking with colleagues. This suggests that walking with colleagues contributes to new social relationships, alleviating depression, anxiety, and stress. There was also a strong positive correlation between external landscaped facilities and external resting facilities. It was interesting that courtyard landscaped facilities and external resting facilities also showed strong positive correlations with the stimulation of all five senses, except for touch. This shows that when constructing courtyard landscaped facilities and resting facilities, how they stimulate the five major senses must be considered.

It should be noted that there were strong positive correlations among stimulations of the five senses. This indicates that, while humans tend to psychologically respond to visual stimulations, they strongly respond to sound, smell, taste, and touch as well. However, relationships between the five senses need to be studied in greater depth. The results show that stimulation of the five senses in the sensory garden plays a positive role in reducing depression, anxiety, and stress.

Stimulation of Sight in Sensory Gardens

Human senses are important factors in designing garden

spaces. The strong impact of sight on the human senses is generally well-known. Sight in healing gardens is especially underlined, as it incorporates colors, forms, patterns, and movements. Sight is also highly valued in sensory gardens; especially so if the origins of sensory gardens is considered. The fact that the sensory garden was first constructed for the visually impaired (Stonham, 2006) also emphasizes the importance of sight. However, based on the results of this study, an excessive domination of and concentration on visual factors may lead us to overlook the importance of other senses. The remaining senses also play important roles alongside sight in alleviating depression, anxiety, and stress (refer to Fig. 2). The five senses were grouped into one component (Table 3), suggesting that they

are connected to each other. Moreover, there were strong positive correlations between stimulation of the five senses (Table 4). Therefore, the relationships between the senses need to be considered further. Stimulation of the five major senses should be actively used as alternatives for alleviating depression, anxiety, and stress arising from the Covid-19 pandemic. New social relationships and walking with colleagues also played significant positive roles in reducing depression, anxiety, and stress. However, prolonged social distancing can limit these interactions. However, unquestionably, experiences in sensory gardens can be sufficient substitutes for external experiences.

Construction of sensory gardens that stimulate the five major senses requires establishing design principles. The

Table 4. Results of correlation analysis

Factors		Walking with Colleagues	Courtyard Landscaped Facility	External Resting Facility	Stimulation of Sight	Stimulation of Sound	Stimulation of Smell	Stimulation of Taste	Stimulation of Touch
New Social Relationships	D	0.625**	0.285*	0.273*	0.244*	0.330**	0.199	0.323**	0.249*
	A	0.579**	0.296*	0.245*	0.234*	0.293*	0.144	0.268*	0.175
	S	0.515**	0.326**	0.394**	0.237*	0.381**	0.231*	0.414**	0.203
Walking with Colleagues	D		0.192	0.173	0.208	0.218	0.213	0.300**	0.238*
	A		0.196	0.150	0.193	0.228*	0.201	0.256*	0.229*
	S		0.190	0.138	0.158	0.182	0.143	0.215	0.167
Courtyard Landscaped Facility	D			0.680**	0.239*	0.267*	0.363**	0.322**	0.255*
	A			0.683**	0.408**	0.389**	0.438**	0.446**	0.285*
	S			0.635**	0.497**	0.380**	0.489**	0.485**	0.393**
External Resting Facility	D				0.447**	0.520**	0.488**	0.433**	0.383**
	A				0.470**	0.489**	0.395**	0.399**	0.282*
	S				0.516**	0.519**	0.435**	0.470**	0.318**
Stimulation of Sight	D					0.740**	0.671**	0.697**	0.642**
	A					0.736**	0.627**	0.616**	0.633**
	S					0.789**	0.754**	0.731**	0.646**
Stimulation of Sound	D						0.820**	0.837**	0.747**
	A						0.824**	0.858**	0.788**
	S						0.782**	0.823**	0.723**
Stimulation of Smell	D							0.839**	0.828**
	A							0.877**	0.843**
	S							0.844**	0.807**
Stimulation of Taste	D								0.747**
	A								0.791**
	S								0.757**

* $p < .05$, ** $p < .01$

fundamental principles (Table 1) and the layout of the Lerner Garden (Fig. 1) do not provide sufficient data. Other design principles have been suggested, such as the use of diverse plants and materials (Ellis, 2011) or the placement and use of abundant materials that can stimulate each of the five senses (Souter-Brown et al., 2021). However, more research needs to be conducted to gain sufficient data that can be applied to establishing design principles. Considering that the first sensory garden was constructed in a public park (Hussein, 2012), we should anticipate their expansion from the physical environments of courtyards and gardens to public parks.

Conclusion

This study investigated current mental health issues, especially the rise in depression, anxiety, and stress triggered by the recent Covid-19 pandemic. In particular this study aimed to determine the positive role that courtyards in buildings can play in contributing to mental health in many countries with a high building density, like Korea. Thus, the study examined the correlations between levels of depression, anxiety, and stress and experiences in a sensory garden in the courtyard of a building.

The results showed that, since the beginning of the Covid-19 pandemic, the mental health of individuals reached levels that required, or almost required, mental health management. However, various factors associated with courtyards were found to be able to alleviate depression, anxiety, and stress. In particular new social relationships, walking with colleagues, and the stimulation of the five senses in the sensory garden contributed to alleviating depression, anxiety, and stress. The factors were classified into four components. Component 1 included the stimulation of the five senses, component 2 included the internal and external facilities, component 3 included the use of internet-based devices, and component 4 included new social interactions. Strong positive correlations were observed between the factors that alleviated depression, anxiety, and stress. Specifically, there was a significant positive correlation between new social interactions and walking with colleagues, and courtyard landscaped facilities and external resting facilities

were significantly positively correlated with the stimulation of the five senses. Moreover, very strong correlations were observed among the stimulation of the five senses. These results carry the following implications. First, there is a need for the management of depression, anxiety, and stress arising from Covid-19. Second, courtyards can provide alternatives to green spaces in parks, which may be less accessible in highly dense areas. Third, in terms of designing courtyards, thinking about the five senses, relevant aspects must be considered, along with their correlations with social interactions, to maximize their overriding positive effects on alleviating depression, anxiety, and stress. However, this study did not consider the variability in recent individual experiences and could not suggest guidelines for designing systematic sensory gardens. This calls for future research on the specific factors comprising sensory gardens and the construction of gardens based on individual and psychological effects.

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