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Women's Preferences of Urban Green Space Landscape Elements and Relationship Between Sensory Dimensions, Perceived Restoration, and Stress Restoration

Abstract: - The stress index of Asian women is rising. In Taiwan, 93% of Taiwanese women feel stressed, which is much higher than the global average of 83%. Women are more susceptible to psychological vulnerabilities than men, with factors such as increased stress, insomnia, anxiety, perceived stress, adjustment disorders and depression having a greater psychological impact on women. Urban green space is more accessible to urban residents than the natural environment, and is known as a natural pill, and providing a variety of physical and mental health benefits such as increased physical activity, reduced urban noise, and reduced psychological stress. This study included "female", "landscape elements", and "perceived sensory dimension", and explore the relationship and program evaluation between "perceived restoration " and "stress restoration ". The research results found that most women visit parks more than seven times a year. They mostly go for walks and relieve stress in urban green space, and stay for about 1 to 2 hours. Appropriate flowers, plants and water elements can be used to create spatial quality, which can help create a compatible landscape for women. In addition, partial least squares method structural equation (Partial Least Squares SEM, PLS-SEM) The research results show that the landscape elements of women in urban green spaces have a significant impact on their perceived sensory dimension and perceived restoration, but they have no significant impact on stress restoration. The research results show that the landscape elements of women in urban parks and green spaces have a significant impact on their perceived sensory dimension. The perceived sensory dimension has a significant impact on perceived restoration, but have no significant impact on stress restoration. Stress restoration must be carried out through environmental awareness. Therefore, it is suggested that relevant units should not only focus on perceived sensory dimension projects in the design of urban park green spaces, but also focus on functional design of perceived restoration, in order to further alleviate women's pressure. The results of the research can be used as an important reference for relevant units and follow-up research in the urban green space planning and design of SDGs: gender equality and gender mainstreaming, social justice and environmental sustainability.

Keywords: Women, Urban Green Space, Landscape elements, Perceived Sensory Dimensions (PSDs), Perceived Restoration, Stress Restoration, Partial Least Squares SEM (PLS-SEM), SDGs: Gender Equality, Gender Mainstreaming.

I. INTRODUCTION

In recent years, Taiwan has experienced a major decline in its family index, and Taiwan currently ranks bottom among countries in the Asia-Pacific region in this regard. This reality suggests the need for a means to ameliorate some of the pressure and challenges that Taiwanese people face in their lives. A survey found that 93% of Taiwanese women reported feeling stressed; notably, this figure was considerably higher than the global average of 83% (Health Life, 2021). According to the 1111 Job Bank (2021), in a survey of female office workers, 36.1% of the respondents rated themselves as being very stressed or on the verge of a mental health crisis; their symptoms included insomnia (43.5%), irritability (34.3%), depression or bipolar disorder (25.6%), deterioration in skin quality (22.1%), and obesity or weight loss (22.1%). Mintz et al. (2021) indicated that exposure to outdoor environments improves physical and mental well-being to a greater extent among women than among men (Buckley & Westaway, 2020). O'Callaghan-Gordo et al. (2020) indicated that urban green spaces can provide residents living in urban areas with opportunities for physical activity. In addition, such spaces can eliminate urban noise, reduce psychological stress, and provide other benefits to help people maintain their physical and mental health. Therefore, urban green spaces can be viewed as an indispensable element of modern urban life. Specifically, such spaces provide a restorative environment (Ha et al., 2022; Meyer-Grandbastien et al., 2020) through elements such as urban forests and vegetation (Tomao et al., 2018) and can thus play a key role in reducing stress and enhancing quality of life (Olszewska-Guizzo et al., 2020).

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Moreover, Stigsdotter et al. (2017) have classified sensory experiences in natural environments and have accordingly identified eight perceived sensory dimensions (PSDs), namely nature, serenity, space, species abundance, society, prospect, culture, and refuge. These dimensions can be used to assess all types of urban green spaces and their landscape elements and landscape patterns. Accordingly, these dimensions can be employed to analyze the relationship between urban green spaces and stress restoration in humans. In summary, related studies have confirmed that the landscape elements and sensory dimensions of urban green spaces can have an impact on perceived restoration and stress restoration in humans. However, a gap in the literature remains regarding the corresponding needs of women, which have yet to be comprehensively explored. Nevertheless, studies have found that women's preferences related to environmental perceptions and landscape elements differ from men's and that such perceptions and elements exert different effects on well-being among men versus women (Tarashkar et al., 2020). For example, among the indicators of women's preferences related to landscape elements and environmental perceptions in urban parks, the mysterious nature of shrubs and trees, the coherence of tree figures, and the complexity of flowers yielded the strongest preferences (Tarashkar et al., 2020). Accordingly, this study explored the relationships of urban green space landscape elements with PSDs, environmental perceptions, and stress restoration in women, employing anxiety as its mediating variable. First, preliminary measurement factors were established on the basis of related studies conducted in Taiwan and overseas. Next, we administered a questionnaire among a sample of women with the aim of understanding the influences of urban green space landscape elements on PSDs, environmental perceptions, and stress restoration in these women, who encompassed a range of ages and occupations.

II. Literature Review

2.1 Stress of Women

Across all life stages and in many countries and societies worldwide, the incidence of depression is higher among women than men (Halliday et al., 2019; Hodes & Epperson, 2019). Women play a key role in any society, and efforts to improve the mental health of women will have benefits for society as a whole (Kar & Somani, 2015). Many studies have observed gender differences in preferences related to landscape perceptions and the influence of landscape elements on health. Stafford et al. (2005) found that the residential environment has a greater effect on women's health than on men's health; possibly because women generally spend more time in contact with this environment (Kavanagh et al., 2006). Richardson and Mitchell (2010) found that gender differences affect people's perceptions of urban green spaces, with men and women holding different views and attitudes toward such spaces. Furthermore, O'Brien (2005) revealed that women tend to worry about their personal safety when visiting urban green spaces alone and have a significantly lower preference for visiting remote natural environments compared with men. Foster et al. (2004) found that in a sample of men and women, women were considerably less likely to walk alone in their local environment when they perceived their personal safety to be more compromised, whereas men's choices to walk alone in this environment were not affected by such concerns. Notably, whereas the health benefits of time spent in urban green spaces for men can be clearly demonstrated using objective measures of green space quantity, women's use of urban green spaces is more affected by subjective measures of green space quality and perceived personal safety. Women's feelings regarding the social quality of their local environment are closely related to their health (Molinari et al., 1998); therefore, understanding the relationship between the characteristics of green spaces and women's health is crucial for both promoting women's health and well-being and ensuring the appropriate distribution, planning, and design of urban green spaces (Richardson & Mitchell, 2010).

Regarding landscape elements, among the indicators of women's perceived preferences for green spaces such as parks, three elements gained the strongest preferences; these elements were "the mysterious nature of shrubs and trees," "the coherence of tree figures," and "the complexity of flowers." Specifically, these elements created spatial quality and helped cultivate attractive landscapes for women living in urban areas, assisting them in their stress restoration (Tarashkar et al., 2020). Kellert and Wilson (1993) asserted that women perceive escapism and a sense of security in green spaces and that the spatial quality of the green space is a key factor affecting women's preferences. In addition, complexity and coherence also have positive impacts on women's preferences. In summary, exposure to restorative environments, such as urban green spaces, through outdoor activities can reduce stress and promote physical and mental well-being in women. Nevertheless, further analysis of women's preferences with regard to such environments is warranted.

2.2 Landscape elements

Local landscape elements can be designed into the urban park of an urban area and to enhance residents' sense of cultural identity and local connections, thereby improving the potential for stress restoration among urban residents (Liu et al., 2022). In other words, urban residents can cultivate a strong sense of local identity and can achieve stress restoration through the incorporation of local landscape elements (Liu et al., 2020). Although urban parkland is not technically natural, such parkland contains elements from nature, including trees, shrubs, lawns, and flowers. Studies have indicated that increasing the quantity or proportion of natural elements in an urban area leads to enhanced stress restoration potential and promotes psychological well-being in humans (Norh et al., 2011) Tarashkar et al. (2020) indicated that research regarding landscape elements and related perceptual preferences has focused on (1) spatial configurations or (2) landscape elements (Kaplan & Kaplan, 1989). Studies on landscape elements have investigated the following features. (1) Plants: This feature encompasses forest phases; seasonal phases; and colorful plant scenery composed of trees, shrubs, grass, and flowers, be they naturally or artificially grown. (2) Water features: Water features include (a) rivers, dams, and embankments (large water bodies); (b) ponds, ditches, and streams (small water bodies); (c) water banks (including shore walls and shore facilities); and (d) ancillary and waterscape facilities (including fountains and running water). (3) Topography: Landscape refers to the arrangement of all visible features, both natural and artificial, on an area of Earth's surface. Landscapes produced by natural processes can be referred to as "natural landscapes," whereas those produced by the human use of resources are part of the "topography." Understanding the concept of a natural landscape involves understanding natural materials and the functions that they serve; by contrast, a cultural landscape encompasses the social, cultural, economic, and political driving forces that shape the landscape. (4) Landscape constructions: Landscape constructions, also known as architectural landscapes, include historical monuments and buildings. Buildings can be divided into sports facilities and leisure facilities. (5) Roads & pavements: Pavements (pedestrian lanes) are roads paved specifically for pedestrians to walk on. (6) Garden facilities: A garden is a place where flowers, trees, fruits, and vegetables are planted. That is, a garden features natural scenery. The outdoor space attached to an individual's place of residence can be referred to as a garden. Gardens, and also parks, provide people with opportunities to relax and feel refreshed (Kimbell et al., 2009); water features, diverse vegetation, open lawns, and flowers have been identified as key restorative attributes of gardens, whereas roads and other paved spaces have been identified as negative attributes in gardens that do not contribute to well-being (Wang et al., 2019).

2.3 Perceived Sensory Dimensions, PSDs

In PSDs, the cultural attributes of nature serve as one dimension (simply termed "culture"); the other seven dimensions are termed nature, prospect, society, space, species abundance, refuge, and serenity; these dimensions are designed to characterize restorative environments. To classify the characteristics of an environment. Stigsdotter et al. (2017) created these dimensions to classify sensory experiences in the environment, from pocket urban parks to larger regional green spaces, and to analyze the relationship between urban green spaces and stress restoration. Peschardt and Stigsdotter (2013) further tested the associations of these dimensions with perceived restoration by exploring people's perceptions of nine small public urban green spaces in Copenhagen. Regarding the correlation between the sensory dimension and perceived restorative ability, that study found that the culture dimension had a positive impact on the ratings of four measures, namely "degree," "distance," "fascination," and "preference." In other words, the PSDs of urban green spaces appear to have a positive relationship with perceived restorative ability; however, further in-depth analysis of this relationship specifically in women is warranted. Grahn and Stigsdotter (2010) proposed measurement indicators for sensory dimensions in their study of urban green spaces and stress relief; again, these indicators were nature, serenity, space, species abundance, society, prospect, culture, and refuge. Subsequently, Stoltz and Grahn (2021) noted that since 2010, more than 60 studies regarding PSDs have been conducted worldwide, and they found that regardless of cultural background, experiences of PSDs have been generally similar in such studies, suggesting that PSDs can be universally used to measure human needs. The measurement indicators of the eight PSDs are described as follows: (1) PSD 1: Nature—Nature is defined as a green environment with high-quality natural space, containing a low proportion of human-made structures, and where grass grows spontaneously. Such a green environment should enable people to feel safe and at peace with nature to cultivate inner strength and power. (2) PSD 2: Culture—Culture refers to characteristics of an environment that are imbued with the unique history and practices of the locale. Such

environment promotes fascination among visitors (Grahn & Stigsdotter, 2010). (3) PSD 3: Space—An environment characterized by space is primarily composed of landscape elements such as freely growing shrubs and trees (Grahn & Stigsdotter, 2010), which give the environment an expansive and cohesive quality. A space where one can explore and linger for a long period is associated with the experience of space and spatial extension (Stoltz & Grahn, 2021). (4) PSD 4: Rich in species—A Diverse quality is key elements contributing to the restorative ability of green spaces. For example, diversity in vegetation is considered a vital restorative attribute. The presence of natural elements such as shrubs and grass, together with biodiversity, is conducive to the restorative experience of spending time in green spaces given that such elements provide an attractive visual landscape (Deng et al., 2020). Van den Berg et al. (2014) found that because the composition of urban green spaces is heterogeneous, a space's restorative ability depends on individual perceptions and environmental characteristics. Carrus et al. (2015) found that biodiversity in the environment has a positive impact on mental well-being and also contributes to sustainable development. (5) PSD 5: Refuge—Refuge refers to the need for an environment to provide a sense of shelter and protection so that it may serve as a safe haven where a person can relax either alone or with others (Stoltz & Grahn, 2021). (6) PSD 6: Prospect—Prospect refers to a green space having an open quality (i.e., being exposed and unobstructed). In other words, the prospect dimension relates to the need for a barrier-free environment that provides opportunities for both activities and also vista and panoramic views. Such views enable people to see far into the distance and gain an overview of their surroundings. An example of such an environment is a flat and manicured lawn with scattered trees. Foreground openness carries two distinct qualities, offering (a) a vantage point overlooking the surrounding environment and (b) an area with access to open space to roam freely or engage in leisure activities (Stoltz & Grahn, 2021). In summary, the prospect dimension relates to a multifunctional and relatively flat green space that offers an unobstructed view and has no physical barriers (Grahn & Stigsdotter, 2010). This sense of openness contrasts with the sense of a bounded safe space represented by the refuge dimension (Stoltz & Grahn, 2021). (7) PSD 7: Serene—Serene quality refers to the need for a calm and safe place that is quiet but not absolutely silent (the reassuringly peaceful sounds of nature are welcome) and that features well-maintained spatial qualities (e.g., cleanliness, no traffic noise, a sense of security) (Grahn & Stigsdotter, 2010). Serenity is often associated with recovery from stress, which is closely related to physical fatigue (Stoltz & Grahn, 2021). (8) PSD 8: Society—A social environment is one that involves other people and serves as a place to meet and interact with others. In a social environment, whether hidden in a crowd or interacting with others, a person is not alone. Such environments can also involve active participation in social activities (Stoltz & Grahn, 2021).

2.4 Perceived restoration and stress restoration

Environmental awareness recovery is commonly understood in relation to two major theories.

(1) Restoration of environmental perception and attention restoration theory

Attention restoration theory primarily focuses on the bottom-up perceptual properties of restorative environments. Excessive mental fatigue can cause many negative health outcomes, and perceived restoration is an environmental condition that helps people improve their mental well-being through the experience of psychological recovery (Malekinezhad et al., 2020). Environments with four specific psychological components are the most conducive for attracting people's attention in a manner that reduces stress and restores their mental abilities. These four components are described as follows: (a) Being away: escape from daily stress and fatigue; (b) Extent or Coherence: time and space made for exploration and understanding; (c) Fascination: events, objects, or processes that easily attract one's attention and interest; (d) Compatibility: an environment that helps individuals maintain consistent personal intentions and goals. Attention restoration theory recognizes that high degrees of coherence and compatibility between humans and the natural environment help to reduce stress and mental fatigue (Kaplan & Kaplan, 1989). Attention restoration theory also states that recovery is most likely to occur in environments and situations that involve all four of the aforementioned components (Kaplan, 1995). Recovery requires psychological and geographical distance from the source of the stress. An environment featuring all four of these components can promote involuntary attentional patterns related to information processing and thus can lead to restorative experiences that enable the individual in question to develop a clear cognitive, pleasant, and contemplative cognitive state (Korpela et al., 2001).

(2) Stress reduction theory

Urban green spaces promote physical and psychological well-being in humans (Deng et al., 2020), and the active use of green infrastructure in the urban planning process helps reduce stress among urban residents (Navarrete-Hernandez & Laffan, 2019). Meyer-Grandbastien et al. (2020) demonstrated a positive relationship between the diversity of plant species in urban green spaces and psychological recovery among tourists. Even small urban green spaces can have substantial restorative value. In recent years, many studies have focused on urban green spaces and public health, including neighborhood green spaces (Deng et al., 2020), which can serve as therapeutic landscapes (Labib et al., 2020; Shuvo et al., 2020). In addition, studies have investigated the positive effects of green spaces on reducing stress and improving quality of life (Ward Thompson et al., 2012). Urban green spaces offer restorative environments (Ha et al., 2022), and exposure to such spaces through various activities plays a key role in providing psychophysiological benefits to urban populations (Olszewska-Guizzo et al., 2020). One study found that mental health is positively correlated with the amount of green space in a given urban area (Liu et al., 2019). Furthermore, urban parks can not only relieve stress (Ulrich et al., 1991) but also serve as a location for social contact, thereby promoting a sense of security and belonging among urban residents (Wolch et al., 2014).

The SRRS (Han, 2003) adopts a relatively broad concept of recovery and incorporates stress by integrating the theories proposed by Kaplan and Kaplan (1989) and Ulrich (1983). The four dimensions of stress responses (i.e., emotional, cognitive, physiological, and behavioral responses; Eloïse Sok-Paupardin, 2019; Memari et al., 2017) are described in greater detail as follows: (1) Emotion: At the emotional level, an individual's mood is affected by stress, and cognitive states and events such as irritability, mood swings, unpredictable bouts of anger, and sadness are all exacerbated by increased stress. (2) Cognition: The cognitive manifestations of stress are related to an individual's thought processes. If an individual's stress level increases and does not come down again, their ability to concentrate, organize, and think clearly is hindered; in other words, when a person becomes stressed, not only their memory and active listening ability but also their time management and organizational skills are affected. (3) Physiology: At the physiological level, high stress affects a person's appetite and sleep quality and can lead to weight gain or loss or other health problems. (4) Behavior: Increased stress leads to changes in behavior and can damage an individual's relationships with others. As stress increases, the individual's ability to interact with others in a positive manner decreases.

2.5 Anxiety

Anxiety is a temporary emotional state that can also refer to a more permanent and stable personality trait. Anxiety refers to an individual's timely response when faced with a threat, and term encompasses a range of cognitive and psychological reactions caused by certain types of pressure or stimuli; these reactions can include complex emotional states such as worry, fear, annoyance, tension, or uneasiness (Zhang Chunxing, 2000). Spielberger (1972) proposed the State–Trait Anxiety Inventory, which posits that anxious emotions can be divided into so-called state anxiety and trait anxiety on the basis of the stability of the anxiety in question. In addition, these two types of anxiety differ in their causes and expressions. State anxiety refers to the tension and worry that individuals experience in certain situations and in response to certain stimuli. In other words, state anxiety is a temporary emotional state caused by external factors in one's environment; accordingly, once the situation that triggered the anxiety disappears, so does the anxiety itself. The intensity of state anxiety can be measured using self-rating scales or on the basis of physiological changes caused by the autonomic nervous system (e.g., temporary changes in heart rate or blood pressure). By contrast, trait anxiety refers to an individual having an anxious personality; in other words, it is a persistent, long-term, stable personality trait. Trait anxiety can manifest during childhood, constituting a unique emotional tendency that develops gradually in response to factors in one's living environment (Cross & Huberty, 1993; He Dongxing, 2006).

The State–Trait Anxiety Inventory was developed by Spielberger (1989) as a tool to enable clinicians and researchers to assess people's levels of state and trait anxiety. This scale is divided into two parts, each containing 20 questions. The first part, called State¬–Trait Anxiety Inventory—State Anxiety, measures situational anxiety, a temporary emotional state that changes over time and involves emotions such as tension and depression experienced by an individual. The second part, called State–Trait Anxiety Inventory—Trait Anxiety, measures an individual's anxiety symptoms under typical circumstances, including the individual's frequency of experiences of anxiety and related feelings and symptoms. Overall, the State–Trait Anxiety Inventory measures an individual's personal anxiety level by considering both intrinsic and extrinsic factors.

III. Research Analysis and Results

As mentioned, this study explored the relationship between landscape elements of urban green spaces and PSDs, environmental perceptions, and stress restoration among women. For this purpose, this study employed partial least squares (PLS) structural equation modeling (SEM) (PLS-SEM) to understand landscape elements in urban green spaces, the aforementioned PSDs, and the relationship between environmental perceptions and stress restoration indicators. Greater understanding of the landscape elements of urban green spaces in Taiwan could yield benefits for women related to environmental perception and stress restoration. The results of the study could serve as a reference for the planning and design of urban green spaces. This study employed the Taipei Botanical Garden as its research setting. The Taipei Botanical Garden is a key center for recreation in Taipei City and served as an important station for plant study during the Japanese occupation. The garden covers an area of approximately 8 hectares and retains many of the experimental research plant species introduced from Japan, mainland China, and Southeast Asia during the Japanese occupation. Today, the garden and its buildings contain approximately 2,000 plants. In addition, it features water bodies and other landscape elements.

In this study, we conducted a questionnaire regarding landscape elements, environmental preferences, stress restoration, and personality traits in the Taipei Botanical Garden, as well as on-site visits to the garden to understand the relationships among these measurement items. In addition, a survey conducted by the Taipei City Government Bureau of Tourism and Communications (2024) regarding the number of visitors to major tourist and recreational areas revealed that the number of visitors to the Taipei Botanical Garden was 1,463,634. The formula for calculating the sample size in this study was $n=Z^2 \cdot p(1-p)/e^2$, where n represents the sample size, Z represents the trust level, p represents the true proportion of the population, and e represents the tolerable error. Because the size of the p value could not be determined, p = 0.5 was set to maximize the value of n. Accordingly, this study adopted a reliability level of 95% (Z = 1.96), an allowable estimation error of 5% (e = 0.05), and a random sample proportion of 1/2 (p = 0.5); consequently, the ideal sample size was calculated to be approximately 385. However, considering the possibility of invalid questionnaire responses or refusals to complete the questionnaire, random sampling was adopted. By September 2023, 400 questionnaires had been distributed; from these, 385 valid responses were returned, yielding a valid questionnaire rate of 97%. The items on the questionnaire concerned, in order, basic demographic information, landscape elements of urban green spaces, PSDs, environmental perceptions, stress restoration, and anxiety. The questionnaire surveyor focused on the plant characteristics in the urban park landscape elements. The explanations were based on proper nouns such as the "sensory dimension of natural perception" in relation to urban parks and "remoteness" in environmental perceptions. The level of agreement for each explanation was measured on a 5-point Likert scale; each potential variable was given a score from 1 to 5, with examples including 1 = "very unimportant" to 5 = "very important" and 1 = "very dissatisfied" to 5 = "very satisfied."

3.1 Narrative statistics results

Most participants were aged 26–35 years (28.8%), were in the workforce, visited the park was more than seven times per year (37.3%), were college educated (59.9%), visited parks and other urban green spaces for walking (22.9%) or stress relief (18.8%), were single (54%), had children (53.7%). preferred park and green space Urban park green space (39.3%), and stayed in urban green spaces for 1 to 2 hours each time (42.9%). As for the urban park landscape elements, garden landscape had the highest score, namely 2.95, with plant landscape ranking second with 2.62, water landscape ranking third with 2.45, and architectural landscape ranking fourth with 2.18. As for PSDs, refuge had the highest score, namely 2.52, with species abundance ranking second with 2.27 and space ranking third with 2.08. As for the four psychological environmental components, compatibility had the highest score, namely 2.50, with distance ranking second with 2.42 and extent or coherence ranking third with 2.41. As for stress responses, the emotional dimension had the highest score, namely 3.78, with the behavioral dimension ranking second with 2.51 and the cognitive dimension ranking third with 2.32. Finally, state anxiety had the highest score for anxiety, namely 2.85.

Table 1: Descriptive statistics

Age	Samples	Percentage	Marriage	Samples	Percentage
Under 18 years' old	23	3.7%	Married	164	36.0%
19-25 years' old	59	13.8%	Unmarried	231	54.0%
26-35 years' old	112	28.8%			
36-45 years' old	94	23.7%			
46-55 years' old	59	13.8%			
56-65 years' old	26	4.5%			
Over 66 years old	12	.6%			
Occupation	**Samples**	**Percentage**	**Number of children**	**Samples**	**Percentage**
Student	38	9.5%	None	190	53.7%
Service industry	52	14.0%	One	53	15.0%
Industry	30	7.0%	Two	66	18.6%
Business	56	15.2%	Others	6	1.7%
Freelancing	36	8.9%			
Military, police, public, education	24	5.4%			
financial industry	15	2.5%			
None (household management, unemployed, retired)	68	19.0%			
others	66	18.4%			
Frequency of visits to the park	**Samples**	**Percentage**	**Favorite type of park**	**Samples**	**Percentage**
1~3 times a year	39	6.2%	National Park	39	7.9%
4~6 times a year	129	31.4%	Nature reserve	35	6.8%
More than 7 times a year	67	14.1%	Urban park	151	39.3%
	150	37.3%	Square, children's playground	43	11.6%
				60	13.6%
			Riverside Park	47	9.9%
			Scenic Area		
Education level	**Samples**	**Percentage**	**Duration of stay in park**	**Samples**	**Percentage**
Junior high school or below	24	2.0%	Within 1 hour	122	30.5%
High school vocational	81	18.1%	1~2 hours	166	42.9%
University/College	230	59.9%	2~3 hours	52	10.7%
Graduate school or above	50	9.0%	3~4 hours	26	3.4%
			More than 4 hours	19	1.4%
Activities mostly used in park	**Samples**	**Percentage**			
Jogging	58	6.1%			
Play ball	20	2.1%			
walk	218	22.9%			
Riding a bicycle	51	5.3%			
Relieve stress	179	18.8%			
change mood	162	17.0%			
Away from the hustle and bustle	99	10.4%			
Friends gathering	42	4.4%			
Family gathering	56	5.9%			
Go alone	69	7.2%			

Table 2: Descriptive statistics (continued)

	research aspects	average		research aspects	average
landscape elements	plant landscape	2.62	**perceived restoration**	being away	2.42
	water landscape	2.45		fascination	2.18
	terrain landscape	2.06		extension	2.41
	architectural landscape	2.18		compatibility	2.50
	Road and walkway landscaping	1.96	**stress restoration**	**research aspects**	**average**
	garden view	2.95		physiological dimension	2.23
sensory dimension of perception	**research aspects**	**average**		behavioral dimension	2.51
	nature	1.93		cognitive dimension	2.32
	culture	2.10		emotional dimension	3.78
	space	2.08	**anxiety condition**	**research aspects**	**average**
	species richness	2.27		situational anxiety	2.86
	refuge	2.52		trait anxiety	2.7
	prospect	1.99			
	peaceful	1.78			
	society	2.08			

3.2 Relationships of the characteristics of urban green spaces with PSDs, environmental perceptions, stress restoration, and anxiety

The relationships of the landscape elements of urban green spaces with PSDs, environmental perceptions, and stress restoration were investigated using PLS-SEM.

(1) PLS-SEM

This study used PLS-SEM and the SmartPLS statistical software package, version 3 (Ringle; Wende & Becker, 2015), to estimate the model and to conduct the analysis. PLS-SEM differs from covariance-based SEM. Specifically, PLS-SEM is a multivariate analysis method used to estimate path models with latent variables. This method is useful if normally distributed data from a large sample are not available (Hair et al., 2017; Henseler et

al., 2016). It thus has an advantage over covariance-based SEM and is being increasingly used in market research and the social sciences (Hair et al., 2012). The measurement model in the PLS-SEM model was evaluated in terms of indicator reliability, construct reliability, convergent validity, and discriminant validity (Hulland, 1999; Hair et al., 2014).

First, indicator reliability is indicated by a standardized factor loading for each observed variable that is >0.7 in theory (Hair et al., 2014) or >0.5 in practice (Hulland, 1999; Chen Kuanyu, 2018). Second, a construct reliability value of >0.7 (ranging from 0 to 1) indicates internal consistency (Fornell & Larcker, 1981; Hair et al., 2014). Third, an average variance extracted (AVE)—which indicates how much the latent variable is explained by variation in the measured variables—that is >0.5 indicates convergent validity. However, an AVE higher than 0.5 also means that the factor loadings needs to be higher than 0.7. Given the characteristics of the data used in this study, an AVE higher than 0.36 was also considered acceptable (Fornell & Larcker, 1981). Compared with traditional assessment methods (e.g., cross-loadings and Fornell and Larcker's criteria), the heterotrait–monotrait ratio (HTMT) has become a superior option in recent years (Henseler et al., 2015; Voorhees et al., 2016). Henseler et al. (2015) asserted that discriminant validity is indicated only if the HTMT confidence interval between all aspects does not include 1. HTMT < 0.9 indicates discriminant validity between the two respective facets (Chen Kuanyu, 2018). In addition, structural fit relates to the size of the explanatory power. The R^2 and adjusted R^2 can explain variation in potential variables. The R^2 value is always between 0 and 1; however, there is no standard threshold value. Generally, low, moderate, and high explanatory power are indicated by R^2 values less than 0.25, between 0.25 and 0.5, and above 0.75, respectively (Hair et al., 2014). In addition, according to the evaluation principle of Cohen (1998), regarding the f2 value (index for the influence of exogenous variables on endogenous variables), when $0.02 < f^2 \leq 0.15$, the influence is low; when $0.15 < f^2 \leq 0.35$, the influence is moderate; and when $f^2 > 0.35$, the influence is high (Chen Kuanyu, 2018).

(2) Analysis of research results

The AVE values were all higher than the threshold of 0.5, indicating that the average explanatory power of each aspect of the indicators exceeded 50% and that each aspect exhibited convergence (Table 6). Furthermore, the combined reliability values were all higher than the threshold of 0.7, also indicating that each aspect exhibited convergence. The facet measurement indicators all demonstrated internal consistency reliability, with Cronbach's α values higher than 0.7. The loadings between the observed variables and latent variables were all higher than 0.5, indicating that each indicator had at least moderate reliability. In addition, as shown in Table 3, the HTMT values of all facets were lower than 0.9, indicating discriminant validity. In summary, the analysis results revealed that all the measurement models met the thresholds and requirements for reliability and validity. Subsequently, the structural model was divided to test the causal path relationship of each facet.

Table 3: Measurement model parameter estimation

Aspects	Index	Factor loadings	Cronbach's α	CR	AVE	R^2
Landscape elements	Plant	0.65	0.712	0.807	0.512	
	Water feature	0.58				
	Topography	0.59				
	Landscape constructions	0.58				
	Roads & pavements	0.57				
	Garden facilities	0.54				
Perceived Sensory Dimensions	Nature	0.54	0.758	0.826	0.574	0.559 (0.557)
	Culture	0.56				
	Space	0.75				
	Rich in species	0.64				
	Refuge	0.54				
	Prospect	0.72				
	Serene	0.53				
	Social	0.65				
Perceived Restoration	Being Away	0.56	0.840	0.893	0.675	0.729 (0.727)
	Extent or Coherence	0.62				
	Fascination	0.57				
	Compatibility	0.65				
Stress Reduction	Physiology	0.58	0.751	0.808	0.555	0.702 (0.700)
	Behavior	0.56				
	Cognition	0.74				
	Emotion	0.63				
Anxiety	State anxiety	0.79	0.654	0.880	0.787	0.195 (0.192)
	Trait anxiety	0.63				

Table 4: Discriminant validity meter (HTMT)

	Stress Reduction	Perceived Sensory Dimensions	Landscape elements	Anxiety	Perceived Restoration
Stress Reduction					
Perceived Sensory Dimensions	**0.804**				
Landscape elements	**0.556**	**0.751**			
Anxiety	**0.824**	**0.459**	**0.307**		
Perceived Restoration	**0.886**	**0.818**	**0.622**	**0.581**	

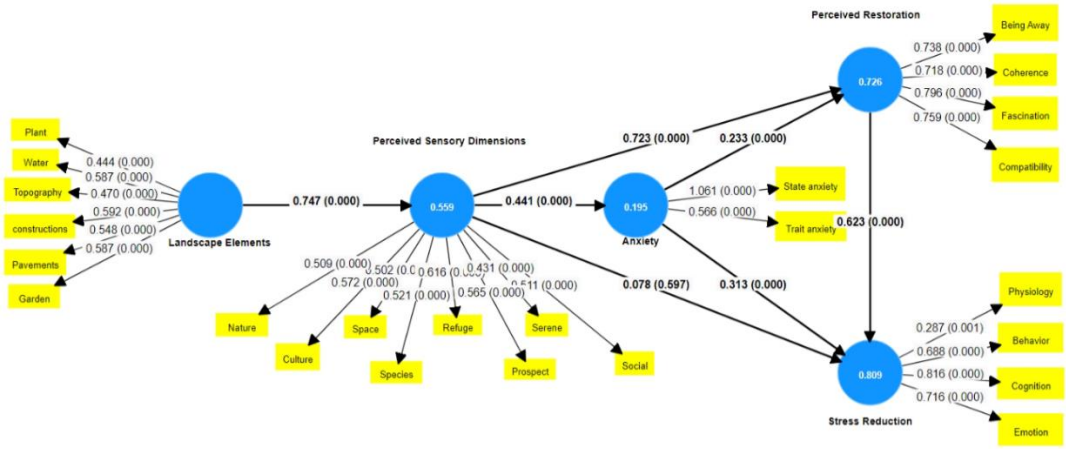
The R2 values indicating structural fit are shown in Table 3. Environmental perceptions had the highest explanatory power, followed by stress restoration, PSDs, and finally anxiety, which represents the environmental perception and stress level of landscape elements. The model has the highest degree of configuration, followed by the sensory perception dimension, and the lowest degree of anxiety. In addition, regarding discriminant validity (Table 4), the HTMT values for each variable were all lower than 0.9, indicating that discriminant validity was present between the reactive facets of landscape elements, PSDs, stress restoration, and anxiety. Finally, according to the f^2 values (Table 5), the following influences were observed: PSDs → environmental perceptions; landscape elements → PSDs (largest influence); PSDs → stress restoration; PSDs → anxiety; anxiety → environmental perceptions; anxiety → stress restoration; environmental perceptions → stress restoration. These outcomes indicate that the exogenous variables had at least a moderate influence on the endogenous variables.

Table 5: Effect size (f2)

	Stress Reduction	Perceived Sensory Dimensions	Landscape elements	Anxiety	Perceived Restoration
Stress Reduction					
Perceived Sensory Dimensions	**0.033**			**0.167**	**0.530**
Landscape elements		**0.439**			
Anxiety	**0.198**				**0.146**
Perceived Restoration	**0.229**				

This study conducted 5000 iterations of bootstrapping on the statistical results of the path analysis to evaluate model fit and the PLS-SEM model's path coefficient (Dijkstra & Henseler, 2015). The path analysis results of the PLS structural model are shown in Figure 14; the landscape elements had a significant effect on the PSDs, and the PSDs had a significant effect on environmental perceptions and stress restoration; in addition, anxiety had mediating effects on PSDs, environmental perceptions, stress restoration, and the degree of model adaptation. The part is relatively low, and it could thus be understood that landscape elements in urban green spaces had a significant influence on PSDs, environmental perceptions, and stress restoration among women. Landscape elements also had a mediating effect on anxiety among women, although the explanatory power was not high.

As for the subindicators of landscape elements, PSDs, anxiety, environmental perceptions, and stress restoration, each of these indicators exerted significant effects, meaning that each subindicator had high explanatory power and thus heavily influenced the corresponding indicator; this outcome could be used as the basis for future research. Furthermore, the path coefficient indicated that among the subindicators of landscape elements, the participating women had the highest preferences for water bodies, buildings, and garden landscapes. Among the subindicators of PSDs, they had the highest preferences for refuge, culture, and prospect. Among the environmental perception subindicators, they had the highest preferences for fascination and compatibility. Finally, among the stress restoration subindicators, the greatest benefits were noted in the emotional and cognitive dimensions. In summary, water bodies, buildings, flowers, and cultural elements can be incorporated into urban green spaces to create spatial quality and to help cultivate a sheltered, attractive, and compatible landscape that enables women to relieve their emotional and cognitive pressure.



	Path coefficient (β value)	T value	P value
PSD→SR	0.723	7.313	0.000***
PSD→A	0.441	7.160	0.000***
PSD→PS	0.078	13.801	0.000***
LE→PSD	0.747	13.173	0.000***
A→SR	0.313	5.664	0.000***
A→PS	0.233	3.670	0.000***
PS→SR	0.623	4.141	0.000***

Figure 14. PLS structural model path analysis

IV. Conclusions and Suggestions

This study first provides planners with indicators to fully consider urban green space landscape elements from women's perspectives when planning urban green spaces, and also incorporates the sensory dimension, and uses anxiety factors as mediating variables to comprehensively explore the impact on stress restoration and environmental perception. , in order to achieve the development goals of social justice and environmental sustainability of gender mainstreaming and equality, in addition to being able to plan more realistically, it is also something that has not been discussed in past planning and research.

The present findings indicated that most of the participating women visited urban green spaces more than seven times per year. In addition, they used these spaces to go for walks and to relieve stress, and they would stay in these spaces for 1 to 2 hours per visit. Among landscape elements, the participating women's primary preference was for garden elements, and among the analyzed PSDs, they favored refuge. The environmental perception of compatibility and the emotional dimension of stress restoration were the main areas of benefit that the women believed that urban green spaces provided. Furthermore, urban green space landscape elements had a significant impact on women's PSDs, environmental perceptions, and stress restoration and a moderate impact on anxiety reduction. In summary, plans and designs for urban green spaces and their landscape elements with consideration of potential psychological benefits for women could enhance women's sensory perceptions, environmental perceptions, and stress restoration; for example, flowers, water bodies, architecture, and cultural elements could be incorporated into such plans and designs to create spatial quality and to help cultivate a sense of refuge and compatibility for women, enabling them to experience relief from emotional and cognitive pressure; these findings are consistent with those of Tarashkar et al. (2020). Among the indicators of women's perceived preferences for urban green spaces, the complexity of flowers had the strongest preference; this finding is consistent with that of Kirillova and Lehto (2016), namely that shelter had the strongest correlation with stress restoration among elderly people.

Regarding suggestions for future research, because various sub indicators of landscape elements, PSDs, environmental perceptions, and stress restoration may be correlated, this paper recommends that future studies employ the Analytic Network Process (ANP) to calculate the weight of factor indicators and to formulate an index priority order and program selection; we expect that this methodology would provide relevant units with further key data for reference for the planning and design of urban green spaces for women. Moreover, This study conducted in-depth interviews with women and then employed an established planning model to conduct case analysis and sensitivity analysis in order to confirm the feasibility of the construction model in practice. The present analysis results could serve as a key reference for planning units for the construction of urban green spaces for women.

REFERENCES

[1] Buckley, R. & Westaway, D. (2020). Mental health rescue effects of women's outdoor tourism: A role in COVID-19 recovery. Annals of Tourism Research 85 (2020) 103041.

[2] Carrus, G., Scopelliti, M., Lafortezza, R., Colangelo, G., Ferrini, F., Salbitano, F., Agrimi, M., Portoghesi, L., Semenzato, P., Sanesi, G. (2015). Go greener, feel better? The positive effects of biodiversity on the well-being of individuals visiting urban and peri-urban green areas. Landscape and Urban Planning, 134, 221–228.

[3] Cross, R. W., & Huberty, J. J. (1993). Factor analysis of the state – trait anxiety inventory for children with a sample of seventh and eighth grade students. Journal of Psycho educational assessment, 11, 232-241.

[4] Deng, L., Li, X., Luo, H., Fu, E.K., Ma, J., Sun, L.X., Huang, Z., Cai, S.Z., Jia, Y. (2020). Empirical study of landscape types, landscape elements and landscape components of the urban park promoting physiological and psychological restoration. Urban Forestry & Urban Greening, 48: 126488.

[5] Fornell, C. and Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. Journal of Marketing Research, 18(1): 39-50.

[6] Grahn, P. & Stigsdotter, U.K. (2010). The relation between perceived sensory dimensions of urban green space and stress restoration. Landscape and Urban Planning, 94: 264-275.

[7] Ha J., Kim, H. J., With, K. A. (2022). Urban green space alone is not enough: A landscape analysis linking the spatial distribution of urban green space to mental health in the city of Chicago. Landscape and Urban Planning, 218: 104309.

[8] Hair, J. F., Hult, G. T. M., Ringle, C. M., and Sarstedt, M. (2017). A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM). 2nd Ed. Thousand Oaks, CA: Sage.

[9] Hair, J. F., Sarstedt, M., Hopkins, L. and Kuppelwieser, V. G. (2014). Partial least squares structural equation modeling (PLS-SEM): an emerging tool in business research, European Business Review, 26 (2): 106- 121.

[10] Hair, J. F., Sarstedt, M., Ringle, C. M. and Mena, J. A. (2012). An assessment of the use of partial least squares structural equation modeling in marketing research, Journal of the Academy of Marketing Science, 40: 414- 433.

[11] Halliday, A. J., Kern, M. L., & Turnbull, D. A. (2019). Can physical activity help explain the gender gap in adolescent mental health? A cross-sectional exploration. Mental Health and Physical Activity, 16, 8–18.

[12] Han, K.T. (2003). A reliable and valid self-rating measure of the restorative quality of natural environments. Landscape and Urban Planning, 64: 209–232.

[13] Henseler J., Ringle C. M. and Sarstedt M. (2016). Testing measurement invariance of composites using partial least squares, International Marketing Review, 33 (3): 405-431.

[14] Hodes, G. E., & Epperson, C. N. (2019). Sex differences in vulnerability and resilience to stress across the lifespan. Biological Psychiatry, 86, 421–432.

[15] Hulland, J. S. (1999). Use of partial least squares (PLS) in strategic management research: A review of four recent studies. Strategic Management Journal, 20(4), 195–204.

[16] Kaplan, R., & Kaplan, S. (1989). The experience of nature: A psychological perspective. New York: Cambridge University Press.

[17] Kaplan, S. (1995). The restorative benefits of nature: Toward an integrative framework. Journal of Environmental Psychology, 15(3), 169–182.

[18] Kar, S.K. & Somani, A. (2015). Impact of rapid urbanization on women's mental health: a review of literature. Delhi Psychiatry Journal, 18 (1), 171–176.

[19] Kavanagh, A.M., Bentley, R., Turrell, G., Broom, D.H., Subramanian, S.V. (2006). Does gender modify associations between self-rated health and the social and economic characteristics of local environments? Journal of Epidemiology and Community Health, 60: 490-495.

[20] Kellert, S.R., Wilson, E.O. (Eds.) (1993). The Biophilia Hypothesis. Island Press, Washington, DC.

[21] Kimbell, A.R., Schuhmann, A., Brown, H. (2009). More kids in the woods: reconnecting americans with nature. Journal of Forestry, 107: 373–377.

[22] Korpela, K. M., Hartig, T., Kaiser, F. G., & Fuhrer, U. (2001). Restorative experience and self-regulation in favorite places. Environment and Behavior, 33(4), 572–589.

[23] Labib, S.M., Lindley, S., Huck, J.J. (2020). Spatial dimensions of the influence of urban green-blue spaces on human health: a systematic review. Environmental Research, 180: 108869.
[24] Liu, L., Qu, H., Ma Y., Wang, K., Qu H. (2022). Restorative benefits of urban green space: Physiological, psychological restoration and eye movement analysis. Journal of Environmental Management, 301: 113930.
[25] Malekinezhad, F., Courtney, P. R., Lamit, BinH., & Vigani, M. (2020). Investigating the Mental Health Impacts of University Campus Green Space Through Perceived Sensory Dimensions and the Mediation Effects of Perceived Restorativeness on Restoration Experience. Frontiers in Public Health, 8, 874.
[26] Memari S., Pazhouhanfar M., Nourtaghani A. (2017). Relationship between perceived sensory dimensions and stress restoration in care settings. Urban Forestry & Urban Greening, 26: 104–113.
[27] Meyer-Grandbastien, A., Burel, F., Hellier, E., Bergerot B. (2020). A step towards understanding the relationship between species diversity and psychological restoration of visitors in urban green spaces using landscape heterogeneity. Landscape & Urban Plannning, 195: 103728.
[28] Mintz, K. K., Ayalon, O., Nathan, O., Eshet, T. (2021). See or Be? Contact with nature and well-being during COVID-19 lockdown. Journal of Environmental Psychology, 78: 101714.
[29] Molinari, C., Ahern, M., Hendryx, M. (1998). The relationship of community quality to the health of women and men. Social Science & Medicine, 47 (8): 1113-1120.
[30] Navarrete-Hernandez, P. & Laffan, K. (2019). A greener urban environment: Designing green infrastructure interventions to promote citizens' subjective wellbeing. Landscape and Urban Planning, 191: 103618.
[31] Nordh, H., Alalouch, C., Hartig, T. (2011). Assessing restorative components of small urban parks using conjoint methodology. Urban Forestry & Urban Greening, 10: 95–103.
[32] O'Brien, E.A. (2005). Publics and woodlands in England: well-being, local identity, social learning, conflict and management. Forestry, 78 (4): 321-336.
[33] O'Callaghan-Gordo, C., Espinosa, A., Valentin A., Tonne, C., Pérez-Gómez B., Castaño-Vinyals, G., Dierssen-Sotos, T., Moreno-Iribas, C., Sanjose, S., Fernandez-Tardón, G., Vanaclocha-Espi,M., Chirlaque, M. D., Cirach, M., Aragoné, N., Gómez-Acebo, I., Ardanaz, E., Moreno, V., Pollan, M., Bustamante, M., Nieuwenhuijsen, M. J., Kogevinas, M. (2020). Green spaces, excess weight and obesity in Spain, International Journal of Hygiene and Environmental Health, 223(1): 45-55.
[34] Olszewska-Guizzo, A., Escoffier, N., Chan, J. & Yok, T. P. (2018). Window view and the brain: Effects of floor level and green cover on the alpha and beta rhythms in a passive exposure eeg experiment [Article]. International Journal of Environmental Research and Public Health, 15(11), Article 2358.
[35] Olszewska-Guizzo, A., Sia, A., Fogel, A. & Ho, R. (2020). Can exposure to certain urban green spaces trigger frontal alpha asymmetry in the brain?—Preliminary findings from a passive task EEG study. International Journal of Environmental Research and Public Health, 17(2), 394.
[36] Peschardt, K.K., Stigsdotter, U.K. (2013). Associations between park characteristics and perceived restorativeness of small public urban green spaces. Landscape and Urban Planning, 112: 26–39.
[37] Richardson, E.A., Mitchell, R. (2010). Gender differences in relationships between urban green space and health in the United Kingdom. Social Science & Medicine, 71 (3): 568–575.
[38] Ringle, C. M., Wende, S. and Becker, J. M. (2015). SmartPLS 3, Bönningstedt: SmartPLS, http://www.smartpls.com.
[39] Shuvo, F.K., Feng, X., Akaraci, S., Astell-Burt, T. (2020). Urban green space and health in low and middle-income countries: a critical review. Urban Forestry & Urban Greening, 52, 126662.
[40] Spielberger, C. D. (1989). State-Trait Anxiety Inventory: Bibliography (2nd ed.). Palo Alto, CA: Consulting Psychologists Press.
[41] Spielberger, C. D.(1972). Anxiety: Current trends in theory and research. New York: Academic Press. 24-54.
[42] Stigsdotter, U.K., Corazon, S.S., Sidenius, U., Refshauge, A.D., Grahn, P. (2017). Forest design for mental health promotion—Using perceived sensory dimensions to elicit restorative responses. Landscape and Urban Planning, 160: 1–15.
[43] Stoltz J. & Grahn P. (2021). Perceived sensory dimensions: An evidence-based approach to greenspace aesthetics. Urban Forestry & Urban Greening, 59: 126989.
[44] Tarashkar, M., Hami, A., Namin, F.E. (2020). The Effects of Parks' Landscape elements on Women's Perceptual Preferences in Semi-arid environments. Journal of Arid Environments 174: 104080.
[45] Tomao, A., Secondi, L., Carrus, G., Corona, P., Portoghesi, L., Agrimi, M., 2018. Restorative urban forests: exploring the relationships between forest stand structure, perceived restorativeness and benefits gained by visitors to coastal Pinus pinea forests. Ecological Indicators, 90, 594–605.
[46] Ulrich R.S. (1991). Effects of interior design on wellness: theory and recent scientific research. Journal of Health Care Interior Design, 3:97–109.
[47] Ulrich, R. S. (1983). Aesthetic and affective response to natural environment. In I. Altman, & J. F. Wohlwill (Eds.), Behavior and the natural environment: Vol. 6. Human behavior and environment (pp. 85-125). New York: Plenum Press.

[48] Van den Berg, A.E., Jorgensen, A., Wilson, E.R. (2014). Evaluating restoration in urban green spaces: Does setting type make a difference? Landscape and Urban Planning, 127: 173–181.
[49] Wang, X., Rodiek, S., Wu, C., Chen, Y., Li, Y. (2016). Stress restoration and restorative effects of viewing different urban park scenes in Shanghai, China. Urban For Urban Green, 15: 112.
[50] Ward Thompson, C., Roe, J., Aspinall, P., Mitchell, R., Clow, A., Miller, D. (2012). More green space is linked to less stress in deprived communities: evidence from salivary cortisol patterns. Landscape & Urban Planning, 105, 221–229.
[51] Wolch, J. R., Byrne, J., & Newell, J. P. (2014). Urban green space, public health, and environmental justice: The challenge of making cities 'just green enough'. Landscape and urban planning, 125, 234-244.