Flowers or Leaves? Assessing the Impact of Crape Myrtle Observation on the Physical and Mental Well-being of Senior Citizens

Siwen Hao[1], Donglin Zhang[2], Yafeng Wen[1], Yiqun Yang[3], Hengwei Zhang[4], and Lu Hou[5]

Keywords. elderly, health, *Lagerstroemia*, positive and negative affect schedule

Abstract. **Previous studies have demonstrated the beneficial impact of plants on the overall well-being of elderly individuals. However, there remains a gap in our understanding which specific plant species have a notable influence on the physical and mental health of the elderly population. Among the various woody ornamental plants used worldwide, crape myrtle (*Lagerstroemia indica*) holds a growing significance in the natural environment. This study aimed to investigate the physiological parameters (such as blood pressure, heart rate, blood oxygen saturation, and fingertip pulse) as well as psychological aspects (measured using positive and negative affect schedule scores and smile face scale) associated with crape myrtle observation activities. The finding revealed the following key points: 1) engaging in crape myrtle observation activities significantly enhanced the physical and mental well-being of elderly participants; 2) the impact of observing crape myrtle flowers differed notably from that of observing its leaves, with flower observation having a more positive effect on the physical and mental health of elderly individuals; and 3) the natural environment was found to exert an influence on the physical and mental health of elderly individuals through visual stimulation. Following the observation of crape myrtle, there was a significant decrease in the physiological indices of elderly individuals. Our findings offer valuable insights into the therapeutic benefits of crape myrtle observation activities and contributing evidence-based recommendations for future landscape design aimed at enhancing well-being.**

Aging poses a substantial global challenge (Detweiler et al. 2012), and the available medical resources fall short of adequately addressing the physical and mental health requirements of elderly individuals (Goodwin 1999). Urban green spaces, being an indispensable resource for senior citizens, have consistently demonstrated their positive impact on human physical health, mental well-being, and overall quality of life (Mansor and Harun 2014; Nejatian et al. 2022). Consequently, recent research has focused on creating healthy living environments for elderly individuals, with healing landscapes emerging as a pivotal strategy in this endeavor (Beard and Bloom 2015). Previous studies have concluded the manifold benefits of green spaces in enhancing the physical and mental well-being of elderly individuals. Within healing landscapes, plants assume an important role, capable of eliciting positive emotions, triggering memories, preserving social roles, and nurturing interpersonal relationships (Asano et al. 2008), which have been demonstrated to alleviate physical and mental stress, enhance emotional states, boost cognitive performance, and foster satisfaction and happiness (Soga et al. 2017).

There are a growing number of publications focusing on plants and their positive impact on health. Existing research has delved into the effects of plants on human physical and mental well-being, exploring different aspects such as color, fragrance, and other plant features (Igarashi et al. 2014). In addition, numerous scholars have conducted in-depth studies on the same plant species. Lyu et al. (2018) found that bamboo groves (*Neosinocalamus affinis*) can effectively alleviate tension in young individuals. Zhao et al. (2019) discovered that observing peonies (*Paeonia* sp.) not only significantly affected systolic blood pressure, diastolic blood pressure, heart rate, and fingertip pulse levels of middle-aged and elderly participants but also reduced their anxiety levels. Kim and Mattson (1999) suggested that the benefits of viewing red-flowered cranesbill (*Pelargonium* sp.) were improving positive attention and enhancing stress recovery for both nonstress and high-stress female college students. However, there remains a scarcity of studies investigating the effects of plant-viewing activities on the physical and mental well-being of elderly individuals.

Crape myrtle (*L. indica*) is a popular ornamental plant worldwide for its diverse varieties, extended flowering season, and wide adaptability (Wang et al. 2021). The practice of observing crape myrtle has enjoyed popularity since the 1700s (Wang 1981), even used by the ancient Chinese poet and gardener, Juyi Bai, to alleviate loneliness. Introduced to Royal Botanic Gardens, Kew (London, UK) in the 16th century and subsequently to the United States in the 17th century, it has garnered recognition for its exceptional ornamental attributes (Egolf 1967). Beyond its aesthetic allure, crape myrtle holds significance as an important medicinal plant known for its hypoglycemic and antioxidant properties (Kolakul and Sripanidkulchai 2017). Although numerous studies have focused on its medicinal applications, scant attention has been paid to exploring the positive effects of its aesthetic value.

This study used randomized controlled experiments to investigate the physiology and psychology impact of crape myrtle observation on elderly individuals. Specifically, it aimed to address the following research questions: 1) whether crape myrtle observation activities have a significant impact on the physical and mental well-being of older adults, and 2) if such an influence exists, whether there are distinguishable effects associated with ornamental activities during the flowering and leafing periods.

Received for publication 20 Nov 2023. Accepted for publication 1 Apr 2024.

Published online 23 May 2024.

[1]College of Landscape Architecture, Central South University of Forestry and Technology, Changsha, Hunan 410004, China

[2]Department of Horticulture, University of Georgia, Athens, GA 30602, USA

[3]Skidmore, Owings & Merrill LLP, Shanghai, 200000, China

[4]China Architecture Design & Research Group, Beijing, 100000, China

[5]The Affiliated Hospital of Inner Mongolia Medical University, Hohhot, Inner Mongolia 010110, China

D.Z. is the corresponding author. E-mail: donglin@uga.edu.

https://doi.org/10.21273/HORTTECH05364-23

Methods and data sources

Experimental site and material

Due to limitations imposed by the plant's growth cycle, it was not feasible to simultaneously present participants with live crape myrtle in different stages of growth (flowering and leafing). Therefore, the experiment used indoor video viewing to overcome this constraint. This method effectively eliminated potential outdoor interference factors and allowed for better control of variables. Furthermore, given that virtual reality glasses may induce discomfort or require some time for adaptation (Kawano et al. 2013), particularly among elderly individuals, potentially influencing experimental outcomes, it was decided to present the videos on a 55-inch television (EA55, Xiaomi, Beijing, China). The duration of the video material was set at 15 min (Zhao et al. 2019). The videos were shot using a Sony camera (Alpha 7, Sony, Tokyo, Japan) and a smartphone (P50 Pocket, Huawei, Shenzhen, China), edited using Final Cut Pro (Final Cut Pro 10.6.5, Apple Inc., Cupertino, CA, USA), and maintained a resolution of Full HD (1920 × 1080 pixels).

The experimental material for the videos was crape myrtle, specifically focusing on the three most popular flower colors: violet, red, and multicolored. Given that crape myrtle with a height of 1.5–2 m is the most widely used variety globally, this experiment exclusively featured crape myrtle plants within this height range. The flowering stage videos were captured between July and September and the leaf stage videos between April and May. To control for sound interference, the background audio for both flowering and leaf stage videos consisted of the same ambient sounds recorded by the authors in a crape myrtle nursery in a remote rural area in Jun 2021.

This study used a randomized controlled trial to investigate potential variations in the physical and mental health of elderly participants during different durations of crape myrtle observation, employing a green-free viewing condition as a control group. In line with prior research, physiological parameters, including blood pressure, heart rate, blood oxygen saturation, and fingertip pulse (Park et al. 2010; Taelman et al. 2009; Zhao et al. 2019), alongside psychological metrics such as the positive and negative affect schedule (PANAS) scores and smile face scale, were used to measure the impact on overall well-being (Antunes et al. 2020; Dos-Santos et al. 2018). This selection aimed to facilitate the expression of genuine emotions and enhance comprehension among older individuals. To mitigate the influence of seasonal fluctuations and other confounding variables, indoor video viewing was preferred over outdoor observations.

The study was conducted in two quiet, unoccupied rooms located on the second floor of Ordos Square in Dalate District, Ordos, China in May 2022. These rooms had windows offering views only of roads and buildings, devoid of any green vegetation. One room served as the preparation area, and the other functioned as the experimental laboratory. Participants were randomly assigned to watch videos depicting crape myrtle during its flowering phase, crape myrtle in the leaf state, or no video exposure.

Participants

A total of 90 participants from the local community, aged between 60 and 99 years, with an average age of 75 years, were recruited for this study. All participants were nonprofessionals in the field of horticulture and were not familiar with crape myrtle. All participants had no history of mental illness, were devoid of significant mental illness, and demonstrated cooperation with researchers in performing physiological measurements and emotional self-assessments. Before the commencement of the experiment, informed consent was obtained from all participants, and their fundamental health status was evaluated using a health information form. Only those meeting the inclusion criteria were randomly assigned to either the flowering or leaf stage viewing group, or the control group with no video exposure. Furthermore, to ensure the sample's representativeness, we collected basic information including gender, ethnicity, and detailed registration information.

Variables

Physiological indicators were obtained using the biofeedback measurement method (Chang and Chen 2005), and psychological indicators were gathered through a psychological test (Morfeld et al. 2007). These methods have been extensively used in horticultural therapy, particularly in the investigation of plant-human relationships. For physiological measurements, we selected blood pressure, fingertip pulse, heart rate, and blood oxygen saturation because of their responsiveness, enabling a more precise reflection of short-term changes. In terms of psychological indicators, we opted for the smile face scale and PANAS scores, as they are readily comprehensible for elderly participants and more effective in capturing psychological shifts. Blood pressure and heart rate were monitored using an Omron blood pressure machine (HEM8713, Omron, Kyoto, Japan), and fingertip pulse and blood oxygen saturation were measured using a Fingertip Pulse Oximeter (XY306, Yuwell, Shanghai, China). For psychological indicators, we collected data using questionnaires. The smile face scale comprises five expressions ranging from extremely happy to extremely sad. The PANAS questionnaire includes 20 positive and negative emotions, with each emotion categorized into five levels: almost none, comparatively few, moderate, comparatively many, and extremely many. The completion of the questionnaire typically requires ~10 min.

Procedure

The experimental procedure consisted of three distinct phases, with each participant progressing through the experiment individually.

Step 1: Preparation. Before the experiment, participants received a detailed explanation of the process and provided their consent. Initial physiological measurements were taken and participants completed the first positive and negative mood measurements, as well as smile face scales.

Step 2: Observational stage. Participants were individually ushered into the laboratory and randomly assigned to watch either crape myrtle in the flowering stage, crape myrtle in the leaf state, or no video at all. Building on prior research, we have set the duration of the observational activity to 15 min (Zhao et al. 2019), during which participants were allowed to stand, walk, and take photographs but were not permitted to leave prematurely. The control group did not watch any videos during this period. Similarly, they were allowed to stand,

Table 1. Physiological and psychological differences among pre- and post-viewing of crape myrtle videos within three groups distinguished by watching flowering video, foliage video, and no video viewed (control group), comprising 90 senior citizens (aged 60–99 years) without professional horticultural backgrounds. The observations were conducted in three tranquil, unoccupied rooms situated on the second floor of Ordos Square in Dalate District, Ordos, China, during May 2022.

Attributes			Flowering view group	Foliage view group	Control group
Physiological and biochemical indices	Blood pressure (mm Hg)	Systolic blood pressure	4.63*	2.43***	−0.57 (ns)
		Diastolic blood pressure	0.93 (ns)	0.47**	0.37 (ns)
	Heart rate (bpm)		2.63**	2.10***	−0.40 (ns)
	Fingertip pulse (bpm)		2.53**	1.33***	−0.30 (ns)
	Blood oxygen saturation (%)		−0.97***	−0.57***	−0.27 (ns)
Psychological index	Positive emotion scale (score 1–50)		−6.40***	−5.27***	−4.6***
	Negative emotion scale (score 1–50)		4.17***	1.43**	−0.60 (ns)
	Smile face scale (score 1–5)		1.33***	0.93***	0.23**

***, **, * Significant differences at $P \leq 0.01$, 0.05, and 0.1; ns, not significant.

walk, and take photographs but were not permitted to leave prematurely.

Step 3: Posttest phase. After completing the aforementioned steps, the research team proceeded to conduct the second round of physiological measurements. This involved assessing parameters such as blood pressure, heart rate, fingertip pulse, and oxygen saturation. Participants, with the assistance of the staff, completed the positive and negative mood scale and smile face scale for the second time.

In addition, given the advanced age of the participants and to mitigate the impact of comprehension bias on the experiment, we assigned staff to assist elderly individuals facing difficulties in better understanding the questionnaire during the pre- and posttest phases. This assistance included explanations of various emotions in the PANAS questionnaire and the meanings of different expressions in the smile face scale.

Data analysis

To compare the psychological and physiological indices of the three groups before and after the viewing activity, Mauchly's test of sphericity was used. Analysis of variance was used to evaluate differences in the changes observed in physiological and psychological index values across various viewing periods and among different genders. All data were analyzed using statistical software (IBM SPSS Statistics version 26.0; IBM Corp., Armonk, NY, USA).

Results

The *t* test results of the three groups before and after the crape myrtle viewing activities are presented in Tables 1−3. With exception of the diastolic pressure of the flower-watching group, all indices of the subjects exhibited significant changes before and after observing crape myrtle. The differences between the control group before and after the test were not significant, except for the PANAS scores and the smile face scale. These results indicated a degree of reliability for the experiment. Detailed analysis results for each index are presented in the following.

Sample profile

In the survey sample of 90 participants, 43 were male, constituting 47.8%, and 47 were female, making up 52.2%. Among the respondents, 66 were of Han Chinese ethnicity, representing 73.7%, and 24 belonged to other ethnicities, accounting for 26.7%. Notably, 35 participants held rural household registration, comprising 38.9%, whereas 55 had urban household registration, comprising 61.1%. These statistics suggested a certain degree of representativeness in the questionnaire.

Physiological and biochemical indices

Blood pressure. Mauchly's test of sphericity revealed a significant decrease in both systolic and diastolic blood pressure after observing crape myrtle. Specifically, the systolic blood pressure decreased by an average of 4.6 mm Hg (millimeters of mercury) during the flowering period and 2.4 mm Hg during foliage period, whereas it increased by an average of 0.57 mm Hg without any viewing activity. The diastolic blood pressure decreased by an average of 0.93 mm Hg during the flowering period and 0.47 mm Hg during the foliage period, compared with a 0.37-mm Hg increase without any viewing activity. The results indicated that observing crape myrtle significantly affected the participants' blood pressure, with a notable difference between the flower-viewing and the leaf-viewing groups (Fig. 1).

Heart rate. The heart rate (beats per minute) of the subjects exhibited a declining trend after engaging in crape myrtle viewing activities. On average, the heart rate of the participants who viewed the flowering period decreased by 2.63 beats per minute, and those who watched the foliage period saw a decrease of 2.1 beats per minute. Conversely, the average heart rate of those who did not engage in any viewing activity increased by 0.4 beats per minute, which was not statistically significant. These findings concluded that crape myrtle viewing activities, particularly during the flowering phase, had a positive impact on stabilizing the heart rate of elderly individuals (Fig. 2).

Fingertip pulse. Fingertip pulse (beats per minute) measurements of subjects before and after viewing crape myrtle also demonstrated a downward trend. On average, the fingertip pulse of participants who watched the flowering period decreased by 2.53 beats per minute, and those who observed the foliage period experienced a decrease of 1.33 beats per minute. In contrast, the average fingertip pulse of the subjects who did not engage in any viewing activity increased by 0.30 beats per minute. These results demonstrated that crape myrtle viewing activities, especially the observation of flowering crape myrtle, played a more active role in stabilizing the fingertip pulse of elderly individuals (Fig. 3).

Blood oxygen saturation. Blood oxygen saturation levels (%) of

Table 2. The independent sample *t* test results on effects of systolic blood pressure (mm Hg), diastolic blood pressure (mm Hg), heart rate (beats per minute), fingertip pulse (beats per minute), and blood pressure saturation (%) among pre- and post-viewing of crape myrtle videos within three groups distinguished by viewing flowering video, viewing foliage video, and no video viewed (control group), comprising 90 senior citizens (aged 60–99 years) without professional horticultural backgrounds. The observations were conducted in three tranquil, unoccupied rooms situated on the second floor of Ordos Square in Dalate District, Ordos, China, during May 2022.

Categories	Mean	*SD*	*t*	*P*	*df*
Systolic blood pressure previewing flowering video	135.533	17.886	41.504	0.001*	29
Diastolic blood pressure previewing flowering video	84.333	11.096	41.628	0.001*	29
Heart rate previewing flowering video	79.867	8.262	52.948	0.001*	29
Fingertip pulse previewing flowering video	80.667	9.98	44.27	0.001*	29
Blood oxygen saturation previewing flowering video	94.733	2.677	193.807	0.001*	29
Systolic blood pressure post-viewing flowering video	130.9	19.725	36.349	0.001*	29
Diastolic blood pressure post-viewing flowering video	83.233	12.461	36.584	0.001*	29
Heart rate post-viewing flowering video	77.233	7.886	53.644	0.001*	29
Fingertip pulse post-viewing flower video	78.133	7.7	55.578	0.001*	29
Blood oxygen saturation post-viewing flowering video	95.7	2.693	194.649	0.001*	29
Systolic blood pressure previewing foliage video	130.133	13.584	52.47	0.001*	29
Diastolic blood pressure previewing foliage video	81.933	5.669	79.167	0.001*	29
Heart rate previewing foliage video	79.367	7.568	57.44	0.001*	29
Fingertip pulse previewing foliage video	78.733	5.717	75.43	0.001*	29
Blood oxygen saturation previewing foliage video	94.733	1.413	367.323	0.001*	29
Systolic blood pressure post-viewing foliage video	127.7	11.241	62.224	0.001*	29
Diastolic blood pressure post-viewing foliage video	81.467	5.513	80.935	0.001*	29
Heart rate post-viewing foliage video	77.267	5.225	80.989	0.001*	29
Fingertip pulse post-viewing foliage video	77.4	5.021	84.427	0.001*	29
Blood oxygen saturation post-viewing foliage video	95.3	1.368	381.463	0.001*	29
Systolic blood pressure pre-entering nonvideo room	75.367	6.682	61.775	0.001*	29
Diastolic blood pressure pre-entering nonvideo room	132.067	6.883	105.095	0.001*	29
Heart rate pre-entering nonvideo room	85.4	5.531	84.568	0.001*	29
Fingertip pulse pre-entering nonvideo room	79.967	7.318	59.853	0.001*	29
Blood oxygen saturation pre-entering nonvideo room	80.033	7	62.624	0.001*	29
Systolic blood pressure post-staying nonvideo room	94.433	1.194	433.072	0.001*	29
Diastolic blood pressure post-staying nonvideo room	132.633	6.105	118.989	0.001*	29
Heart rate post-staying nonvideo room	85.033	5.53	84.216	0.001*	29
Fingertip pulse post-staying nonvideo room	80.567	7.171	61.535	0.001*	29
Blood oxygen saturation post-staying nonvideo room	80.2	7.131	61.598	0.001*	29

* Significant differences at $P \leq 0.01$.

the subjects increased significantly after observing crape myrtle. After viewing flowers, oxygen saturation levels rose by an average of 0.97%, and for those who observed foliage, it increased by an average of 0.57%. The control group, on the other hand, showed a decrease of 0.27%, which was not statistically significant. These findings revealed that viewing crape myrtle greatly improved the blood oxygen saturation of elderly individuals to a certain extent, with a more pronounced effect during the flowering viewing compared with the foliage viewing (Fig. 4).

Psychological index

Before and after the crape myrtle viewing activities, all participants underwent assessments of their PANAS scores and the smile face scale. Mauchly's test of sphericity for positive emotion, negative emotion, and smile face scale before and after the experiment found that the crape myrtle viewing activities had a significant impact on improving the emotions of the elderly individuals.

Positive emotion (between 1 and 50). Mauchly's test of sphericity revealed that the positive emotion of the subjects who watched flowering crape myrtle increased by 6.40 points after the viewing activity, and the positive mood of those who observed the foliage crape myrtle increased by 5.27 points. The control group showed an increase of 4.60 points. These results provided evidence that engaging crape myrtle viewing activities significantly enhanced the positive mood of elderly individuals.

Negative emotion (between 1 and 50). The subjects' negative emotion decreased by 4.17 points after observing flowering crape myrtle and decreased by 1.43 points after viewing the foliage crape myrtle. In contrast, the control group showed an increase of 0.60 points, which was not statistically significant. These results suggested that crape myrtle viewing activities alleviated tension and anxiety of elderly individuals (Fig. 5).

Smile face scale (between 1 and 5). The scores of the smile face scale, representing overall mood, were converted to a scale from 1 to 5 for statistical analysis, with lower scores indicating a more positive overall mood. The results showed that the crape myrtle viewing activities had a significant impact on the score of the smile face scale. The average score of the smile face scale decreased by 1.33 after viewing flowers, decreased by 0.93 after viewing leaves, and dropped by 0.23 in the control group. These findings indicated that the crape myrtle viewing activities positively influenced mood, with a greater impact

Table 3. The independent sample *t* test results on effects of positive emotion (score 1–50), negative emotion (score 1–50), and smile face scale (score 1–5) among pre- and post-viewing of crape myrtle videos within three groups distinguished by viewing flowering video, viewing foliage video, and no video viewed (control group), comprising 90 senior citizens (aged 60–99 years) without professional horticultural backgrounds. The observations were conducted in three tranquil, unoccupied rooms situated on the second floor of Ordos Square in Dalate District, Ordos, China, during May 2022.

Categories	Mean	*SD*	*t*	*P*	*df*
Positive emotion previewing flowering video	29.367	4.803	33.49	0.001*	29
Positive emotion previewing foliage video	28.067	4.242	36.239	0.001*	29
Positive emotion pre-entering nonvideo room	27.2	3.925	37.955	0.001*	29
Positive emotion post-viewing flowering video	35.733	6.459	30.302	0.001*	29
Positive emotion post-viewing foliage video	33.333	3.698	49.366	0.001*	29
Positive emotion post-staying nonvideo room	31.8	3.357	51.885	0.001*	29
Negative emotion previewing flowering video	18.7	4.879	20.993	0.001*	29
Negative emotion previewing foliage video	28.067	4.242	36.239	0.001*	29
Negative emotion pre-entering nonvideo room	17.833	4.086	23.905	0.001*	29
Negative emotion post-viewing flowering video	14.533	4.761	16.718	0.001*	29
Negative emotion post-viewing foliage video	16.433	3.213	28.015	0.001*	29
Negative emotion post-staying nonvideo room	18.5	1.943	52.146	0.001*	29
Smile face scale previewing flowering video	2.467	0.776	17.409	0.001*	29
Smile face scale previewing foliage video	2.967	0.183	89	0.001*	29
Smile face scale pre-entering nonvideo room	2.667	0.479	30.463	0.001*	29
Smile face scale post-viewing flowering video	1.133	0.571	10.865	0.001*	29
Smile face scale post-viewing foliage video	1.5	0.572	14.355	0.001*	29
Smile face scale post-staying nonvideo room	2.433	0.504	26.444	0.001*	29

* Significant differences at $P \leq 0.01$.

observed during flower observation compared with leaf viewing (Fig. 6).

Discussion

As demonstrated previously, the act of viewing crape myrtle yielded significant change in both physiological and psychological indicators of the participants, with the exception of diastolic blood pressure during the flowering period. Blood pressure, heart rate, and fingertip pulse all exhibited significant decreases, while blood oxygen levels showed significant increase. In addition, positive emotion and the smile face scale significantly improved, and negative emotion significantly decreased. This phenomenon was more pronounced among those who watched crape myrtle during the flowering period. These findings aligned with previous studies highlighting the capacity of viewing activities to enhance positive emotions (Hong et al. 2019; Zhu et al. 2021), alleviate negative emotions (Lim et al. 2018), increase happiness (Lai et al. 2018), and improve physiological

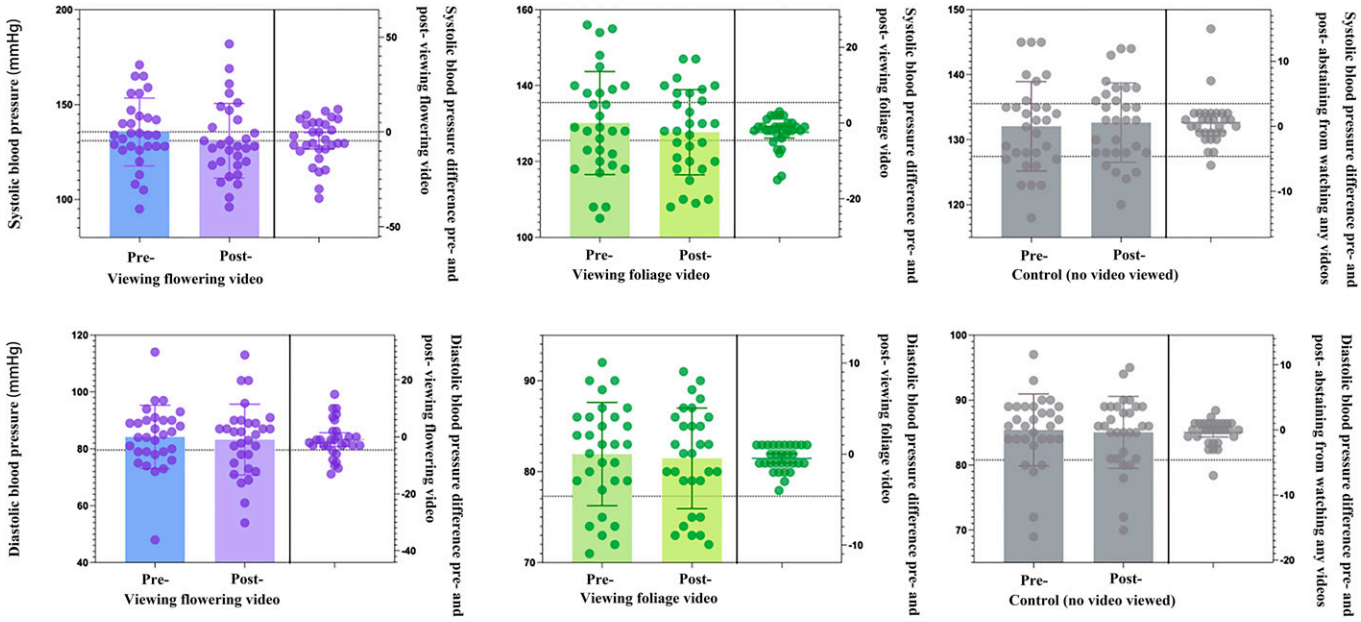

Fig. 1. Blood pressure measurements and variations before and after viewing crape myrtle videos were assessed across three distinct groups categorized by the type of video watched: flowering, foliage, and no video. The study involved 90 senior citizens aged 60 to 99 years, all lacking professional horticultural backgrounds. Data collection took place in three serene, unoccupied rooms located on the second floor of Ordos Square in Dalate District, Ordos, China, in May 2022.

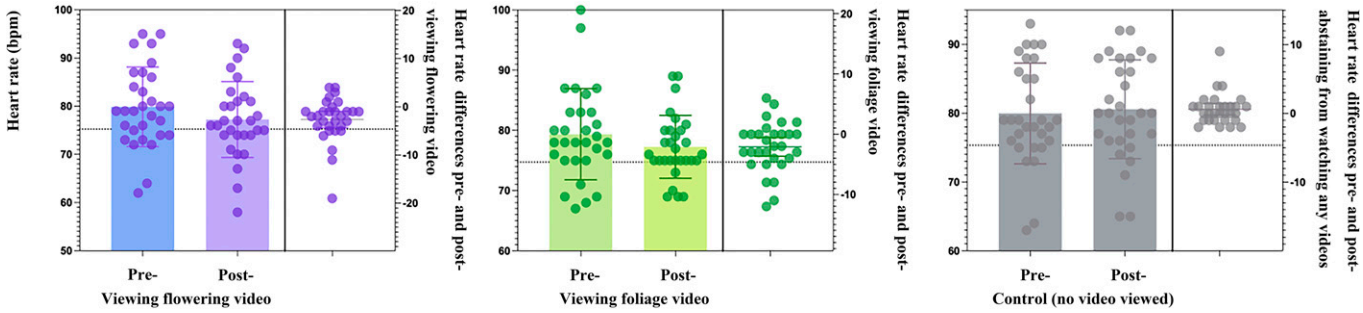

Fig. 2. Heart rate and variations before and after viewing crape myrtle videos were assessed across three distinct groups categorized by the type of video watched: flowering, foliage, and no video. The study involved 90 senior citizens aged 60 to 99 years, all lacking professional horticultural backgrounds. Data collection took place in three serene, unoccupied rooms located on the second floor of Ordos Square in Dalate District, Ordos, China, in May 2022.

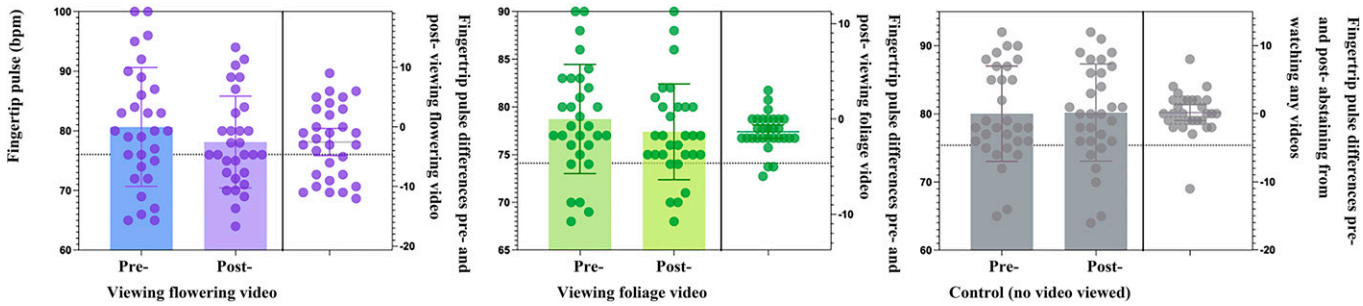

Fig. 3. Fingertip pulse and variations before and after viewing crape myrtle videos were assessed across three distinct groups categorized by the type of video watched: flowering, foliage, and no video. The study involved 90 senior citizens aged 60 to 99 years, all lacking professional horticultural backgrounds. Data collection took place in three serene, unoccupied rooms located on the second floor of Ordos Square in Dalate District, Ordos, China, in May 2022.

parameters in elderly individuals (Han et al. 2018), reinforcing the reliability of our experiments.

The biophilia hypothesis posits that individuals harbor an intrinsic longing for nature, a concept substantiated by prior research using eye movement data (Chen et al. 2022). The attention restoration theory further suggested that natural elements could effectively rejuvenate and restore emotions, whether through subconscious or conscious processes (Treisman and Gelade 1980). The natural environment primarily stimulated the senses, offering relief to both body and mind, subsequently influencing physiological and psychological indicators. These theories and our experimental findings collectively explain why crape myrtle viewing activities exert a positive influence on the physical and mental health of elderly individuals. It has been proven that visual stimuli play a role in recovery among elderly individuals, with superior recovery effects observed when the stimulus intensity is increased (Cronin-Golomb et al. 2007). Flowering crape myrtle provided a rich and more colorful stimulus, elucidating the superior impact on physical and mental indicators following the observation of flowering crape myrtle compared with foliage viewing.

Enhancements in blood oxygen levels bolstered resistance to infections (Jönsson et al. 1988), improved blood circulation (Krogh 1919), and altered tissue perfusion of elderly individuals (He et al. 2015). The stability of

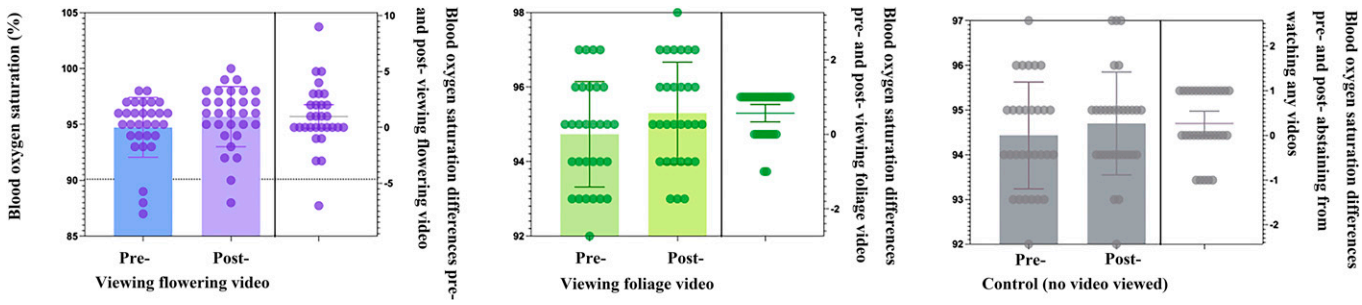

Fig. 4. Blood oxygen saturation and variations before and after viewing crape myrtle videos were assessed across three distinct groups categorized by the type of video watched: flowering, foliage, and no video. The study involved 90 senior citizens aged 60 to 99 years, all lacking professional horticultural backgrounds. Data collection took place in three serene, unoccupied rooms located on the second floor of Ordos Square in Dalate District, Ordos, China, in May 2022.

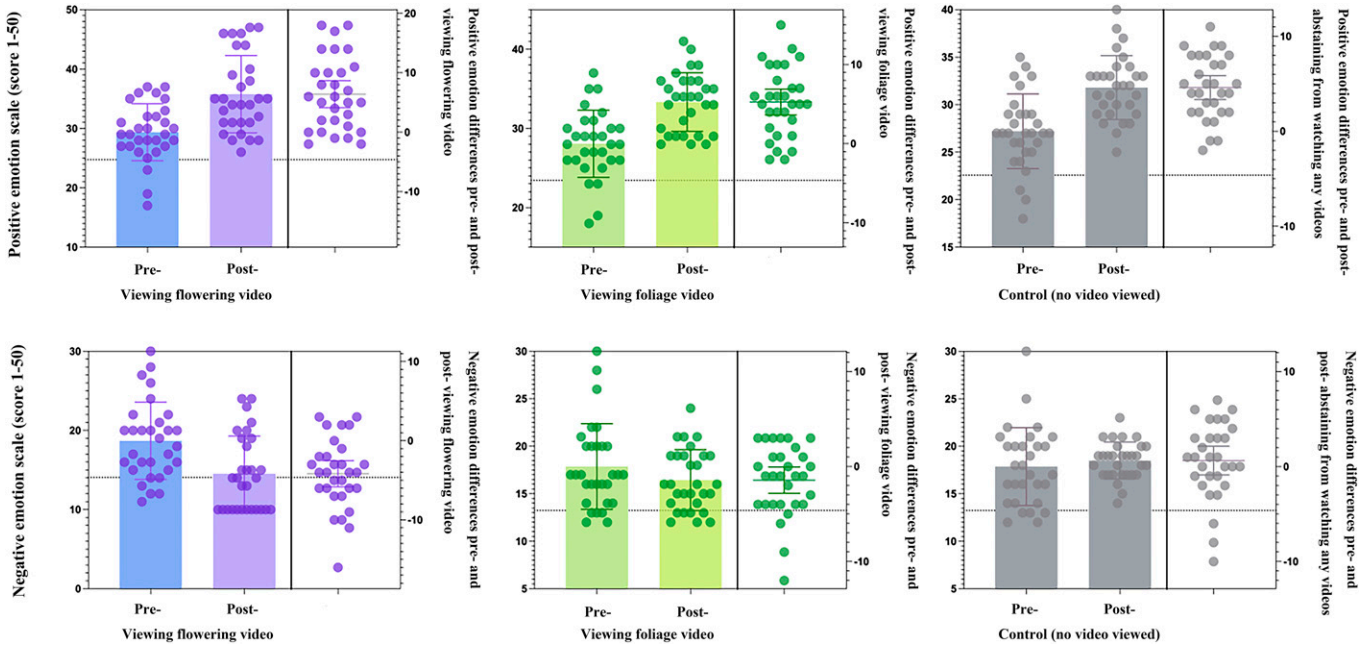

Fig. 5. Positive and negative emotion and variations before and after viewing crape myrtle videos were assessed across three distinct groups categorized by the type of video watched: flowering, foliage, and no video. The study involved 90 senior citizens aged 60 to 99 years, all lacking professional horticultural backgrounds. Data collection took place in three serene, unoccupied rooms located on the second floor of Ordos Square in Dalate District, Ordos, China, in May 2022.

blood pressure, heart rate, and fingertip pulse reduced the strain on the heart, safeguarded the cardiovascular system, aided in blood pressure control, mitigated damage to target organs, and subsequently reduced the morbidity and mortality associated with cardiovascular diseases.

Fluctuations in positive and negative emotions wielded a substantial impact not only on mental well-being but also on physical health. In light of this study, it is plausible to infer that crape myrtle viewing activities positively impact the physical and mental health of elderly individuals, with flowering crape myrtle observation yielding a more pronounced effect. This study not only affirmed natural environmental factors on the well-being of elderly individuals but also quantitatively assessed the effects of viewing crape myrtle during distinct stages of its life cycle. It substantiated that even short-term viewing activities exerted a significant influence on the physical and mental health of elderly individuals. The findings demonstrated that a brief crape myrtle viewing program held significant potential in the horticultural therapy market, offering notable health benefits. Therefore, for future senior-friendly health gardens in the adapted regions, the consideration of crape myrtle or similar ornamental plants as priority plants should be beneficial.

The interplay between natural landscapes on the physical and mental health of elderly individuals is a multifaceted process entailing various mechanisms. Although crape myrtle viewing activities exhibited a substantial impact on the physical and psychological dimensions of the study group, it is essential to acknowledge that crape myrtle observation remains a highly intricate and comprehensive activity. Different species and varieties of crape myrtle present varying flower shapes, colors, plant heights, fragrances, and flowering periods. Hence, future research should delve deeper into these aspects to optimize the utilization of crape myrtle, particularly in the context of healing gardens. Our experiment was conducted in a controlled indoor environment and the positive results should lead to implementation of more gardens

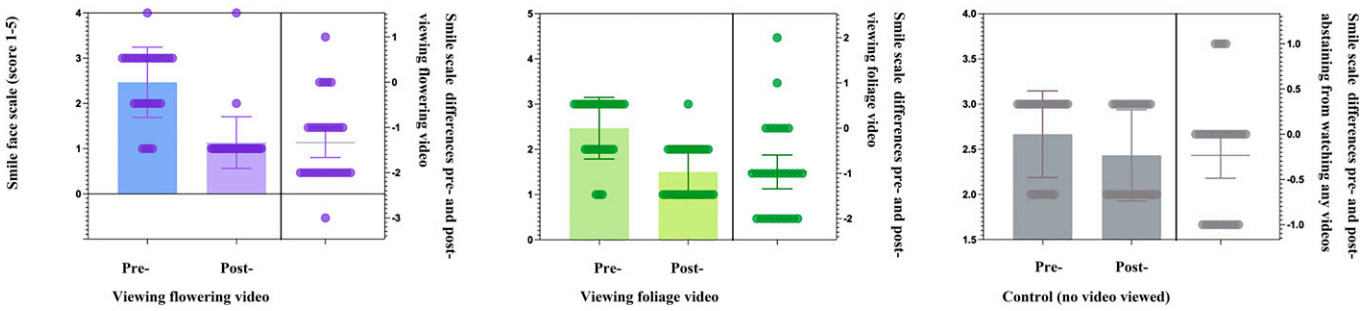

Fig. 6. Smile face scale and variations before and after viewing crape myrtle videos were assessed across three distinct groups categorized by the type of video watched: flowering, foliage, and no video. The study involved 90 senior citizens aged 60 to 99 years, all lacking professional horticultural backgrounds. Data collection took place in three serene, unoccupied rooms located on the second floor of Ordos Square in Dalate District, Ordos, China, in May 2022.

in controlled medical environments, such as windowless or very urban areas. In terms of outdoor settings with fluctuating temperatures, humidity, light, and other factors, comprehensive consideration is required to refine crape myrtle viewing activities for the intricate outdoor environment.

Conclusion

This study sought to substantiate the positive effects of observing crape myrtle on the physical and mental well-being of elderly individuals, emphasizing the superior therapeutic benefits during the flowering stage compared with the leaf stage. It not only validated previous research but also quantitatively analyzed the impact of observing different crape myrtle stages on the overall health of older adults. The study yielded the following conclusions: 1) the observation of crape myrtle significantly enhances the physical and mental health of older adults, 2) flower viewing has a more favorable impact on the physical and mental health of elderly individuals compared with leaf viewing, with statistically significant distinctions observed between the two, and 3) the natural environment can exert influence on the physical and mental well-being of older adults through visual stimulation.

The integration of crape myrtle observation as a valuable therapeutic intervention enhanced the health and overall well-being of elderly individuals. Future research should focus on optimizing the use of different crape myrtle species and varieties, as well as investigating the potential impact of outdoor settings on the effectiveness of these observation activities. In some regions, crape myrtle is terribly overplanted. In other regions, crape myrtle will not grow well because of environmental conditions. We highly recommend planting some native or well-adapted flowering plants for a region with crape myrtle as specimens or companion plants. Further research on garden scenes that include winter vs. spring and summer seasons with a variety of ornamental plants is encouraged to see if our findings would be replicated.

References cited

Antunes R, Couto N, Vitorino A, Monteiro D, Marinho DA, Cid L. 2020. Physical activity an effect of the elderly: Contribution to the validation of the Positive and Negative Affect Schedule (PANAS) in the Portuguese population. J Hum Sport Exerc. 15(2): 330–343. https://doi.org/10.14198/JHSE.2020.152.08.

Asano F, Takaesu Y, Matsuo E. 2008. Surveillance study on healing landscape: Meaning of existence of plant specially in landscape. Acta Hortic. 790:193–198. https://doi.org/10.17660/ActaHortic.2008.790.27.

Beard JR, Bloom DE. 2015. Towards a comprehensive public health response to population ageing. Lancet. 385(9968): 658–661. https://doi.org/10.1016/S0140-6736(14)61461-6.

Chang CY, Chen PK. 2005. Human response to window views and indoor plants in the workplace. HortScience. 40:1354–1359. https://doi.org/10.21273/HORTSCI.40.5.1354.

Chen BJ, Chen G, Li SH. 2022. Looking at buildings or trees? Association of human nature relatedness with eye movements in outdoor space. J Environ Psychol. 2022(Apr): 80. https://doi.org/10.1016/j.jenvp.2022.101756.

Cronin-Golomb A, Gilmore GC, Neargarder S, Morrison SR, Laudate TM. 2007. Enhanced stimulus strength improves visual cognition in aging and Alzheimer's disease. Cortex. 43(7):952–966. https://doi.org/10.1016/S0010-9452(08)70693-2.

Detweiler MB, Sharma T, Detweiler JG, Murphy PF, Lane S, Carman J, Chudhary AS, Halling MH, Kim KY. 2012. What is the evidence to support the use of therapeutic gardens for the elderly? Psychiatry Investig. 9(2):100–110. https://doi.org/10.4306/pi.2012.9.2.100.

Dos-Santos SB, Rocha GP, Fernandez LL, De-Padua AC, Reppold CT. 2018. Association of lower spiritual well-being, social support, self-esteem, subjective well-being, optimism and hope scores with mild cognitive impairment and mild dementia. Front Psychol. 9:371. https://doi.org/10.3389/fpsyg.2018.00371.

Egolf DR. 1967. Four new *Lagerstroemia indica* L. cultivars, 'Catawba', 'Conestoga', 'Potomac' and 'Powhatan'. Baileya. 15:7–13.

Goodwin JS. 1999. Geriatrics and the limits of modern medicine. N Engl J Med. 340(16):1283–1285. https://doi.org/10.1056/NEJM199904223401612.

Han AR, Park SA, Ahn BE. 2018. Reduced stress and improved physical functional ability in elderly with mental health problems following a horticultural therapy program. Complement Ther Med. 38:19–23. https://doi.org/10.1016/j.ctim.2018.03.011.

He H, Long Y, Liu D, Zhou X. 2015. Clinical classification of tissue perfusion based on the central venous oxygen saturation and the peripheral perfusion index. Crit Care. 19:330. https://doi.org/10.1186/s13054-015-1057-8.

Hong SK, Lee SW, Jo HK, Yoo M. 2019. Impact of frequency of visits and time spent in urban green space on subjective well-being. Sustainability. 11(15): 1–25. https://doi.org/10.3390/su11154189.

Igarashi M, Song C, Ikei H, Ohira T, Miyazaki Y. 2014. Effect of olfactory stimulation by fresh rose flowers on autonomic nervous activity. J Altern Complement Med. 20:727–731. https://doi.org/10.1089/acm.2014.0029.

Jönsson K, Hunt TK, Mathes SJ. 1988. Oxygen as an isolated variable influences resistance to infection. Ann Surg. 208(6): 783. https://doi.org/10.1097/00000658-198812000-00018.

Kawano N, Iwamoto K, Ebe K, Aleksic B, Ozaki N. 2013. Slower adaptation to driving simulator and simulator sickness in older adults aging clinical and experimental research. Aging Clin Exp Res. 24(3): 285–289. https://doi.org/10.1007/BF03325260.

Kim E, Mattson RH. 1999. Viewing red-flowering geraniums altered fast-beta brain wave activity and improved positive attention of low- attentive female college students. HortScience. 34(3):531. https://doi.org/10.21273/HORTSCI.34.3.531E.

Kolakul P, Sripanidkulchai B. 2017. Phytochemicals and anti-aging potentials of the extracts from *Lagerstroemia speciosa* and *Lagerstroemia floribunda*. Ind Crops Prod. 109:707–716. https://doi.org/10.1016/j.indcrop.2017.09.026.

Krogh A. 1919. The supply of oxygen to the tissues and the regulation of the capillary circulation. J Physiol. 52(6):457. https://doi.org/10.1113/jphysiol.1919.sp001844.

Lai CKY, Kwan RYC, Lo SKL, Fung CYY, Tse MMY. 2018. Effects of horticulture on frail and prefrail nursing home residents: A randomized controlled trial. J Am Med Dir Assoc. 19(8):696–702. https://doi.org/10.1016/j.jamda.2018.04.002.

Lim KH, Lee KE, Kendal D, Rashidi L, Vasardani M. 2018. The grass is greener on the other side: Understanding the effects of green spaces on twitter user sentiments, p 275–282. In: WWW '18 Companion: The 2018 Web Conference Companion, April 23–27, 2018, Lyon, France. ACM, New York, NY, USA. https://doi.org/10.1145/3184558.3186337.

Lyu B, Zeng C, Deng S, Liu S, Chen Q. 2018. Bamboo forest therapy contributes to the regulation of psychological responses.

J For Res. 24(1):1–10. https://doi.org/10.1080/13416979.2018.1538492.

Mansor M, Harun NZ. 2014. Health issues and awareness, and the significance of green space for health promotion in Malaysia. Procedia Soc Behav Sci. 153:209–220. https://doi.org/10.1016/j.sbspro.2014.10.055.

Morfeld M, Petersen C, Krügerbödeker A, Von Mackensen S, Bullinger M. 2007. The assessment of mood at workplace – psychometric analyses of the revised profile of mood states (POMS) questionnaire. Psychosoc Med. 4:Doc06. https://api.semanticscholar.org/CorpusID:17994109.

Nejatian A, Makian M, Gheibi M, Fathollahi-Fard AM. 2022. A novel viewpoint to the green city concept based on vegetation area changes and contributions to healthy days: A case study of Mashhad, Iran. Environ Sci Pollut Res Int. 29(1):702–710. https://doi.org/10.1007/s11356-021-15552-4.

Park BJ, Tsunetsugu Y, Kasetani T, Kagawa T, Miyazaki Y. 2010. The physiological effects of shinrin-yoku (taking in the forest atmosphere or forest bathing): Evidence from field experiments in 24 forests across Japan. Environ Health Prev Med. 15(1):18. https://doi.org/10.1007/s12199-009-0086-9.

Soga M, Gaston KJ, Yamaura Y. 2017. Gardening is beneficial for health: A meta-analysis. Prev Med Rep. 5:92–95. https://doi.org/10.1016/j.pmedr.2016.11.007.

Taelman J, Vandeput S, Spaepen A, Huffel SV. 2009. Influence of mental stress on heart rate and heart rate variability. Springer Berlin Heidelberg. 22:1366–1369. https://doi.org/10.1007/978-3-540-89208-3_324.

Treisman AM, Gelade G. 1980. A feature-integration theory of attention. Cognit Psychol. 12(1):97–136. https://doi.org/10.1016/0010-0285(80)90005-5.

Wang J. 1981. Shi Yi Ji (Forgotten Tales). Zhonghua Publishing House, Beijing, China.

Wang Y, Ni F, Yin D, Chen L, Zhang Y. 2021. Physiological response of *Lagerstroemia indica* (L.) Pers. seedlings to drought and rewatering. Trop Plant Biol. 14:360–370. https://doi.org/10.1007/s12042-021-09294-3.

Zhao RL, Zhang G, Wang X, Zhang BT, Guo LN, Niu LX, Zhang YL. 2019. Psycho-physiological effects of a peony-viewing program on middle-aged and elderly individuals at different phenological stages. Int J Environ Res Public Health. 16(3):439. https://doi.org/10.3390/ijerph16030439.

Zhu X, Gao M, Zhang R, Zhang B. 2021. Quantifying emotional differences in urban green spaces extracted from photos on social networking sites: A study of 34 parks in three cities in northern China. Urban For Urban Green. 62(127133):1–11. https://doi.org/10.1016/j.ufug.2021.127133.