Construction of Residential Landscape Environment Evaluation System for Elderly with Mild Cognitive Impairment

Lifang Qiao*, Ke Ma, Jian Zhou, Chaoping Chen

ABSTRACT
In the face of aging population, the residential landscape environment must meet the needs of the senior citizen. Mild cognitive impairment (MCI) is one of the common diseases for the elderly population. The landscape environment, as a natural resource for medical assistance and rehabilitation, needs the adaption in favor of the elderly with MCI. In this paper, the indicator is selected from the three aspects of rehabilitation, safety and ecological environment, and Analytic Hierarchy Process (AHP) is used to establish an evaluation system composed of the target, the criterion and the indicator. With the application of Yaahp software, the weights of indicators are ranked based on the evaluation of 10 evaluators from different fields. The results show that the indicators such as dynamic space, vegetation coverage, landscape naturalness, landscape aesthetics, static space, identifiability, rehabilitation facilities and accessibility have relatively higher weights and should be prioritized in the construction of residential landscape environment. Meanwhile, other indicators should also be taken into consideration so as to make the residential landscape more perfect.

Key Words: Mild Cognitive Impairment, The Elderly, Landscape Environment, Residential Community, Evaluation

Introduction
The aging population is a widespread problem across the world. China, facing a severe problem of aging population, is no exception. Statistical Communiqué on Social Service Development in 2016 released by Chinese Ministry of Civil Affairs shows that as of the end of 2016, there were 230 million elderly people aged 60 and above in China, accounting for 16.7% of the total population, of which 150 million were aged 65 and above, accounting for 10.8% of the total population. The aging population will result in a series of social problems such as a decrease in the workforce of the right age and an increase in the medical burden.

The elderly group is prone to fall ill, mainly due to the descending physiological function with age. At present, in China, the incidence of MCI happening in people over the age of 65 is about 40% (Wang et al., 2015). Cognitive disorder mainly refers to the abnormalities occurring in the intelligent processing of brain pertaining to learning, memorizing and logical thinking which will cause serious learning and memory impairment accompanied by pathological processes such as aphasia, apraxia, agnosia or disturbance in executive functioning. MCI, a state between normal aging and dementia, is a cognitive disorder syndrome. Compared with the normal elderly who have similar age and educational background, patients have mild cognitive downgrade, but their basic activities of daily living are not significantly impaired. MCI occurs for many reasons, and is currently diagnosed mainly by

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medical scale, biomarker inspection and neuroimaging (Liang, 2014).

Emotion has obvious effects on human cerebral nervous system and endocrine system, while the landscape environment possesses the function of regulating emotion. The holistic concept of convalescence environment medicine and the non-pharmacological treatment are in line with the philosophy of green, environment-friendly development (Zhang et al., 2009). The rehabilitation landscape that integrates environment, behavior and neuroscience has enjoyed a rapid development in recent years. Using neuroscience knowledge to guide the design of rehabilitation environment has been widely applied in the design of residential landscape environment (Liu and Li, 2012; Zeisel et al., 1994; Tyson, 1991). Cognitive disorder is irreversible, but its progression can be retarded by intervention. For example, horticultural facilities, evocative stuffs and the sense of security, are included in the design of rehabilitation landscape of the living environment of patients with Alzheimer's disease (Hoover, 1995), while in Sedgewood Commons Garden designed for people with dementia, safety, enjoyment, mobility and memory recovery are important criteria (Liu et al., 2015). Susan's psychological assessment of 17 elderly people at a mean age of 84.7 after treated with the rehabilitation garden found that the cortisol content in the elderly people of experimental group treated with garden was significantly lower than that of the control group living indoor, which means that using a garden environment can greatly relieve stress (Rodiek, 2002).

The supporting models for the aged in developed countries are that the community or institution provides service to the aged (Jia et al., 2017). In China, influenced by traditional culture, there are three mainstream modes in China, i.e. home-based, community-based, and institution-based care for the senior citizen (Wang et al., 2016). Home-based mode holds the highest proportion, which still put the family at the core. Under this model, children and their elderly parents live together. The landscape environment has the function of rehabilitation. However, currently, most of the residential communities in China have no difference in landscape construction without suitable design for aging population. The needs of an aging society are not met. The residential landscape environment must respond to MCI, a disease of high incidence in the elderly population, and take into account the needs of the elderly in the design. The objective of this study is to establish a residential landscape environment evaluation system for the elderly with MCI which also concerns the needs of the general elderly, and to provide the reference for landscape construction of residential environment.

Research Methods

According to the construction requirements of the residential landscape environment evaluation system for the elderly with MCI, the indicators are selected first based on the evaluation scale, literature search, investigation and interview results, and then the evaluation system is established by means of the Group Analytic Hierarchy Process (GAHP). Yaahp software is also used to build the structure of evaluation system. The software can automatically complete the complicated calculation process of AHP. It is easy to use and enables the evaluators to finish the evaluation quickly and accurately.

The Source and Selection of Indicators of Evaluation System

The source of evaluation indicators

Evaluation scale

Currently, there is no uniform assessment standard for MCI. The Montreal Cognitive Assessment (MoCA) is one of the commonly used standards (Nasreddine et al., 2005). This scale assesses the degree of cognitive impairment by considering such indicators as Visuoexecutive, Naming, Digit span, Attention, Calculation, Repetition, Verbal fluency, Abstraction, Recall, Orientation. The residential landscape environment, as a natural resource that can assist medical treatment and rehabilitation, has great significance (Wu, 2016), and can enhance most of the indicators. Research suggests that sensory stimulation, multi-sensory training, reminiscence therapy, kinesitherapy, cognitive training, etc. are important ways to treat and prevent MCI (Wei, 2015). Tai Chi, a traditional Chinese sport, can significantly improve memory and executive function of elderly with MCI (Wang and Sheng, 2016), while garden activities can positively adjust one’s blood pressure, heart rate and focus. Garden and garden activities both contribute to the emotional, physical and spiritual renewal of the aged (Milligan et al., 2004). Spatial
characteristics of landscape affect the specific outcome of rehabilitation and conditions of use (Liu et al., 2015).

*Literature search*
According to the results of literature search, the incidences of cardiovascular and cerebrovascular diseases and diabetes are also high in the elderly with MCI (Tuo, 2014). The design of residential landscape environment should be targeted for the treatment of these common diseases in order to promote physical and psychological recovery of the elderly. Physical exercise has an important role in the health of the elderly (Yoo and Kim). Outdoor fitness facilities have a significant effect on reducing fitness, insulin resistance, and chemerin (Kim et al., 2018). Aerobic exercise can promote the physical and mental health of the elderly (Zhao, 2001). Factors of landscape environment can promote and regulate immune function, improve nervous system function, lower blood pressure and mitigate the antibody (Zhao, 2009). Medicinal plants release antimicrobial and antiviral volatiles, and diffuse aromatic gases into the air. These substances enter the human body through the human respiratory system or skin pores, thereby preventing diseases and strengthening the human body (Qiao and Zhang, 2012). Therefore, dense vegetation constitutes an important factor in rehabilitation (Kang et al., 2008) and plays an important role in the design of rehabilitation landscape. In addition, waterscape and wetlands have significant benefit to the rehabilitation of the elderly (Ulrich, 1981; Barton and Pretty, 2010).

Communication with the outside world, a safe environment, a place for fitness activities and easy identification are the needs of the elderly (Zhang and Qi, 2014), while static and dynamic spaces can meet the needs of different senior citizens (Liu, 2016). The outdoor environment of residential areas should pay attention to enhancing the identifiability so as to make up for the deteriorating and lost body functions of the elderly and create a living environment suitable for the elderly (Zhang, 1998).

*Selection of Evaluation Indicators*
The construction of residential landscape environment evaluation system for the elderly with MCI needs to consider many factors. In this paper, 12 indicators are selected from the three aspects of rehabilitation, safety and ecological environment. According to the requirements of AHP, the evaluation system is composed of the target, the criterion and the indicator (Table 1).

### Table 1. Residential Landscape Environmental Evaluation System for the Elderly with MCI

<table>
<thead>
<tr>
<th>No.</th>
<th>Target</th>
<th>Criterion</th>
<th>No.</th>
<th>Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Landscape Environmental Evaluation</td>
<td>B1 Rehabilitation</td>
<td>C11</td>
<td>Static Space</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>C12</td>
<td>Visual Rehabilitation</td>
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<td></td>
<td></td>
<td>C13</td>
<td>Identifiability</td>
</tr>
<tr>
<td>A</td>
<td></td>
<td>B2 Safety</td>
<td>C14</td>
<td>Rehabilitation Facilities</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>C15</td>
<td>Dynamic Space</td>
</tr>
<tr>
<td>A</td>
<td></td>
<td>B3 Ecological Environment</td>
<td>C16</td>
<td>Intelligent Monitoring</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>C17</td>
<td>Facility Safety</td>
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<td></td>
<td>C18</td>
<td>Accessibility</td>
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<td>C19</td>
<td>Vegetation Coverage</td>
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<td>C20</td>
<td>Salutary Vegetation</td>
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<td></td>
<td>C21</td>
<td>Landscape Aesthetics</td>
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<td></td>
<td></td>
<td></td>
<td>C22</td>
<td>Landscape Naturalness</td>
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</tbody>
</table>

*Investigation and interview*
According to the investigation and interviews with relatives of the elderly, there are also many problems concerning the care given to the elderly. Since many old people in China live with their offspring, most of children have to work, which reduces the time spent with parents and adds many risks. First, old people are more likely to feel lonely and aggravate the cognitive disorder due to lack of companionship. Second, the safety of outdoor activities for the elderly is also a matter of concern to their children. According to the research, falling down easily leads to disability, serious injury, or even accidental death of the elderly. Third, it is rather easy for the elderly to wander away, which is also concerned by their children.

*Results and Discussion*
**Structural System and Expert Evaluation**
AHP is an evaluation method that combines qualitative and quantitative evaluation. It is widely used in planning and evaluation of architectural design (Mosadeghi et al., 2015; Jin et al., 2013). In general, the method of group decision is often adopted in order to increase the
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Figure 1. AHP structure established by Yaahp software

Figure 2. The weight of the indicator

accuracy of evaluation results (Rico and González, 2015). After the AHP structure is established by Yaahp software (Figure 1), ten evaluators, including landscape architects, doctors, the elderly and their relatives, are selected to compare the relative importance of the indicators in 1-9 scales so that the weight of each indicator can be obtained.

The Weight of the Indicator
As can be seen from Figure 2, in the evaluation system of residential landscape environment for the elderly with MCI, the indicators including dynamic space, vegetation coverage, landscape naturalness, landscape aesthetics, static space, identifiability, rehabilitation facilities and accessibility possess higher weights, which indicates that these indicators should be prioritized in the construction of environmental landscape. Dynamic space is primarily a place for fitness activities for the elderly with MCI. In China, many social problems have been triggered by the lack of dynamic space for the elderly (Zhao and Tang, 2015), which highlights the importance of the dynamic space for the elderly. The static space is mainly for providing social interaction such as conversation to improve the neighborhood relation, increase the satisfaction of life and enhance the sense of happiness (Zhang et al., 2004). Vegetation coverage is mainly to provide a good ecological environment and serve as a shade in summer. With the forest landscape, the surveyed people’s brain waves appear smooth and calm (Li and Zhang, 2009), so that viewers can
adjust the mood, relief the anxiety and reduce the blood pressure (Hartig et al., 2003). Identifiability helps old people to establish a clear, identifiable scenario and provides a basis for them to identify places and locations. Adding rehabilitation facilities in landscape settings is an urgent need for the elderly and has an important role in physical and psychological recovery (Cui, 2016). At present, China has formulated a national standard for accessibility design of buildings, but the accessibility design standard for the landscape environment is still not in place. Accessibility design in residential landscape for the elderly with MCI is especially important. Although other indicators have lower weights, they should also be improved in the construction of environmental landscape.

Discussion
To guarantee the accuracy of evaluation data, increasing the number of evaluation experts is undoubtedly the best way. Certainly, the evaluator’s career, knowledge, experience, etc. will also affect the accuracy of the evaluation results. As far as AHP method is concerned, the scientifi city of indicator system and the accuracy of the evaluation criteria impose an impact on the evaluation results. Ignoring some of the key factors that have a significant impact on the evaluation also can affect the entire system. Therefore, the above problems and deficiencies should be further studied. It should be noted that the weight of indicators only represents the relative importance of the indicators, which does not mean that indicator of low weight is not important. Residential landscape environment for the elderly with MCI should focus on the overall development while highlight key points. It is the only way to meet the needs of the elderly.

Conclusions
In the face of aging population, the increase of the elderly population with MCI poses a challenge to the construction of residential landscape environment. However, at present, the construction of residential landscape environment in China rarely considers the needs of this group. China’s home-based model requires that the residential landscape environment should make adaptive improvements in favor of the elderly with MCI and take into consideration the general old population. Without doubt, given the large number of influencing factors, it is of great importance to choose the key influencing indicators based on scientific methods. AHP is a method based on mathematical theory, which solves the sorting problem in light of the idea of comparison between two. It is suitable for the systematic and hierarchical evaluation that combines qualitative and quantitative methods. In the evaluation of residential landscape environment for the elderly with MCI, 12 influencing indicators are selected from three aspects, and the GAHP method is employed to establish the structure and the system, and rank the influencing factors according to their weights with a purpose that the construction of residential landscape environment for the elderly with MCI can realize all-round development while highlight the key points and provide a wholesome and comfortable residential environment for the elderly with MCI.

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