Research on the Role of Natural Landscapes in Tropical Coastal Cities in Residents' Physical Activities

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Abstract. This study focuses on the impact mechanism of the natural landscape of parks in tropical coastal areas on residents' physical activities. Taking Haikou Baishamen Park and its adjacent beach as a case study, it integrates methods such as on-site observation, in-depth interviews, and online text investigation to study the characteristics of residents' physical activities in typical natural landscape areas (beach, lake, lawn, grove, and stream). Based on the coding and analysis of textual data, this study reveals significant differences in the activity patterns of residents within different landscape types, and explores the promoting and restricting effects of various landscapes on physical activities and their internal mechanisms. The results clarify the site effect of different natural landscapes, and then put forward targeted suggestions for optimizing the landscape design of tropical coastal parks to improve the residents' physical activity levels.

1 Introduction

Globally, insufficient physical activity (PA) has been widely recognized as one of the core risk factors affecting public health, significantly associated with the incidence of chronic non-communicable diseases such as cardiovascular diseases, type 2 diabetes, obesity, and certain cancers[1]. However, factors including accelerated urbanization and the prevalence of sedentary lifestyles have led to a widespread problem of insufficient PA worldwide, which is particularly prominent among residents in large and medium-sized cities of developing countries[2]. Therefore, how to effectively promote residents' daily PA has become a key entry point to improve public health levels and reduce medical burdens, as well as a research hotspot in the interdisciplinary fields of urban planning, public health, and environmental behavioral science.

The natural environments, especially urban parks and green spaces, have been proven to be important venues for promoting residents' leisure-time PA. Compared with indoor or artificial hardscapes, natural landscapes possess unique "health promotion" potential. A large body of research evidence indicates that exposure to natural environments can effectively relieve psychological stress [3], improve emotional states[4], and enhance attention restoration capacity[5]. Meanwhile, natural elements such as vegetation, water landscapes, and topographical changes not only improve the microclimate and enhance the comfort of outdoor activities, but their rich sensory stimuli also greatly increase the pleasure and attractiveness of activities, thereby encouraging longer-duration and higher-frequency participation[6]. Therefore, optimizing the natural landscape design of parks is regarded as an low-cost and high-benefit strategy to promote national fitness.

However, existing studies on PA promotion by natural environments have insufficient attention to parks in tropical areas with unique climatic, geographical, and ecological characteristics. Tropical coastal areas exhibit significant particularities in the "human-environment" relationship affecting residents' PA:

First, the core restrictive and shaping power of climatic conditions: prominent high temperature, high humidity, strong sunlight, frequent rainfall, and potential typhoon impacts pose direct and intense challenges to the thermal comfort and safety of outdoor activities. This affects residents' activity willingness, duration, and intensity, and reshape their activity time selection rules.

Second, the physical and perceptual characteristics of core natural landscape elements: tropical coastal parks possess iconic landscapes and ecosystems. These landscapes not only have distinct visual features and varying attractiveness, but their specific physical attributes and the resulting environmental perceptions directly and differentially affect activity participants' physical experiences, comfort levels, and behavioral preferences, thereby shaping unique activity patterns.

Third, the potential regionality of residents' activity patterns: residents living in tropical coastal areas for a long time may develop specific heat resistance, preferences for certain landscapes, and leisure habits adapted to the local climate, and these potential regional behavioral patterns need to be specifically investigated.

This study aims to address this crucial gap and focuses on the core issue of the role of the natural landscape of parks in tropical coastal areas in residents' PA. Aiming to go beyond the general consensus that green spaces are

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beneficial to health, it conducts in-depth exploration in the unique tropical coastal environmental context: How do specific natural landscape types shape the PA patterns of residents? What are the differential trends of the effects of these landscapes? How to optimize the design of the natural landscape in response to the particularities of tropical coastal areas to more effectively motivate and sustain residents' participation in PA? By answering these questions, this study will enrich the theoretical understanding of PA promotion in specific regional contexts, and provide empirical evidence and operable design guidelines for tropical coastal cities to improve the health promotion effectiveness of urban parks and green spaces.

2 Research Area and Methods

2.1 Research area introduction

This study focuses on Haikou's Baishamen Park and its adjacent beach area, Hainan Province, China. As a tropical island city, Haikou features a typical tropical marine monsoon climate, with year-round warmth and humidity, abundant sunshine, and a distinct rainy season.

Baishamen Park is located in the northeast of the main urban area of Haikou City, bordering the Qiongzhou Strait to the north. As a comprehensive urban coastal park integrating ecological leisure, cultural entertainment and tourism sightseeing, it has high usage intensity and a large resident base. The internal and surrounding environments of the park encompass the core natural landscape types focused on in this study (see Fig.1): 1) Beach: a wide natural sandy beach. 2) Lawn: an open and flat lawn. 3) Grove: planted with tropical arbor trees such as coconut trees, palm trees, and banyan trees. 4) Lake: a large irregularly shaped artificial lake. 5) Stream: a small-scale strip-shaped water system connected to the lake scenery.

Fig. 1. Baishamen park and the natural landscape area

The landscape types in this area are typical, with clear boundary definitions and relatively high utilization intensity, providing an ideal research site for exploring the differential impacts of different types of natural landscapes in tropical coastal parks on residents' PA.

2.2 Research methods

This study adopts three complementary data collection methods: on-site observation, in-depth interviews, and online text investigation. Among them, On-site observation is used to record the actual types of residents' PA in various natural landscapes and the characteristics of the corresponding landscapes; in-depth interviews focus on exploring residents' subjective experiences of the landscape environment and how these environments affect their activity behaviors; online text data is used to extract and identify the general opinions and attitudes towards landscapes and activities reflected in public discussions on social media. These three methods complement each other, and their specific implementation is as follows:

On-site observation: This study adopted the on-site observation to systematically record the PA characteristics of residents in five typical natural landscape areas of Baishamen Park in Haikou City. The observations were conducted on typical weekdays, weekends, and at different time periods (early morning, morning, afternoon). Information recorded included the types of activities, the number of participants, demographic characteristics, the spatio-temporal distribution of activities, and details of environmental interactions.

In-depth interview: To deeply explore the internal mechanisms of residents' experience perception, motivation, and restrictive factors during their activities in specific landscapes, this study conducted semi-structured in-depth interviews. 15 respondents were recruited, covering different age groups, activity types, and landscape user groups. The interview duration was 20-30 minutes. The interview outline focused on: the logic of activity selection (reasons for landscape preferences), multi-dimensional experience evaluation (physical comfort, psychological pleasure, social interaction), landscape perception dimensions (safety, aesthetics, microclimate comfort, interestingness), and restrictive/promoting factors. The entire interview process was recorded and transcribed verbatim. The grounded theory was used for coding to explore and the landscape's role influencing PA.

Online text investigation: The online text data collection focused on local mainstream platforms (Xiaohongshu and Douyin). Landscape and activity keyword combinations (such as "Baishamen Park, lawn", "Baishamen Park, beach") were used to search for relevant posts. After cleaning and denoising, 619 valid texts were retained. These texts were used to supplement the interview data texts, aiming to capture the public's spontaneous evaluations about the landscape and PA in Baishamen Park.

The specific research framework is as follows (see Fig. 2.): Integrate on-site observation records, interview transcripts, and online text data. Through systematic coding analysis, two categories of core information were identified: the types of PA performed by residents and their characteristics; the basic components of natural landscapes and their spatial characteristics. Meanwhile, from the analysis of interview and online text data, residents' elaboration on landscapes and PAs was explored. Subsequently, comprehensive analysis of the above information was performed to identify the characteristics of PAs in different landscape types and the influencing mechanisms of natural landscapes, as well as to construct the correlation between specific landscape elements and the influencing mechanisms.

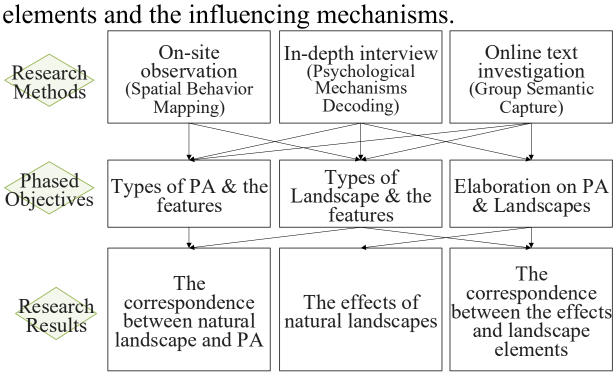

Fig. 2. The research process

3 Results

3.1 The correspondence between natural landscape and PA

The findings show that in tropical coastal parks, the five landscape areas form activity clusters due to their unique landscape element compositions (see Table 1 for details). In general, the activity types dominated in natural landscape areas are mainly low-to-moderate intensity leisure activities and daily exercises. The activity intensity characteristics listed in the table represent the intensity of the dominant activity types of the main user groups within each landscape area. For example, although beach activities show a diverse range of intensities, according to the data from observations and interviews, the statistically dominant activities (such as leisurely strolls and sand games) are of low intensity. Therefore, it is marked as "low intensity" in the table. It should be noted that this marking does not exclude the presence of high-intensity activities (such as beach football) within the area.

In addition, the temporal distribution of activities in different landscape types shows significant differences. In some landscape areas, there are single-peak or double-peak characteristics of peak activities within a daily cycle, while in some other landscape areas, there are characteristics of being significantly more active during holidays.

3.2 The effects of natural landscapes on PA: promotion and restriction

The analysis of this study shows that different types of landscape in the park have differential driving effects on residents' PA. Through coding and thematic analysis of the textual data, two core categories of effects were identified: promotion effects and restriction effects. During the decision-making process of engaging in PA, residents dynamically assess the comprehensive impact of these positive and negative effects, and ultimately form their choices of PA (see Fig. 3).

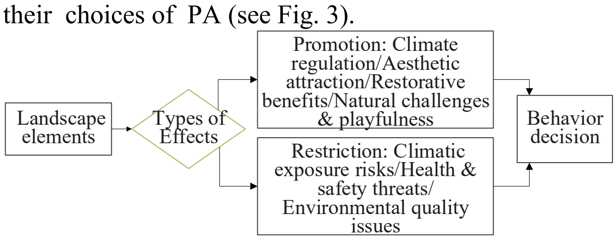

Fig. 3. The relationship between the forces of natural landscapes and PA

Table 1. The corresponding characteristics of natural landscapes and PA

Landscape types	Core landscape elements	Main types of PA	Activity features	Temporal distribution
Beach	·sand ·wave soundscapes ·wide-open views ·sea breeze	·leisure strolls ·sand games ·ball games ·kayaking ·water play & swimming	·low-intensity ·hydrophilic ·dynamic and free	Bimodal type: concentrated in early morning and evening
Lawn	·flat terrain ·high openness · no obstructions	·party games ·frisbee ·ball games ·kite flying ·yoga/aerobics	·moderate intensity ·high social interactivity ·group collaboration	Unimodal type: concentrated in the afternoon, with a sharp increase on weekends.
Grove	·dense tree canopies ·shady micro-environment ·low noise level	·leisure strolls ·TaiChi/Qigong ·meditation	·low-intensity ·static and healing	Diurnal type: relatively stable during all daytime hours, but drops after sunset.
Lake	·static water bodies ·lakeside walkways ·lake views	·leisure strolls ·Tai Chi/Yoga ·boating	·medium and low intensity ·static and healing ·individual activity preference	Unimodal type: concentrated in early morning, with sporadic activities in the afternoon.
Stream	·accessible shallow water ·flowing soundscape ·small-scale ecology	·parent-child exploration ·leisure strolls	·low intensity ·fun & interactive	Holiday type: active on weekends and holidays, occasional on weekdays.

Table 2. Descriptive keywords for promotion effects

Promotion Effects	Landscape Type	Descriptive Keywords
Climate regulation	Beach	Pleasant cool sea breeze; Never too hot or stuffy; Comfortable on the skin; Moist but not dry
	Lawn	Open and breezy; Never stuffy; Cooler than the pavement; Refreshing feel
	Grove	All shaded; Never sun-baked; Extra cool; Comfy forest breeze; Fresh air
Aesthetic attraction	Beach	Endless views; Blue seas and skies; Amazing sunset; Clean beach
	Lawn	Vibrant green; Open and comfy; Neatly trimmed; Full of life; Springy grass fragrance
	Grove	Stunning shady trees; Woods full of life; Nature's silence
	Lake	Mirror-flat lake; Sparkling shimmer; Blended blue horizon
	Stream	Twisting streams; Splendid lotuses
Restorative benefits	Beach	Relaxing waves; Stress-free strolls; Worry-blowing breeze; Mind-clear calm; Mood-lifting peace
	Lawn	Lawn lounging; Mood-lifting sunshine; Fatigue-fading rest; Carefree calm; Blissful ease
	Grove	grove serenity; Fatigue-fading calm; Mind-soothing stillness; Pressure-break breaths; Thought-free zen; Grounded peace
	Lake	Peaceful lake views; Mind-expanding vistas; Stress-melting moments
Natural challenges & playfulness	Beach	Sandy footprints; Wave-chasing fun; Sandcastle building; Surf wading; Tide pool finds
	Grove	grove exploring; Bug watching; Leaf collecting; Hide-and-seek; Tree trunk climbing
	Lake	Fish feeding thrills; Waterbird spotting
	Stream	Splashing in shallows; Stone hunting; Tadpole catching

Table 3. Descriptive keywords for restriction effects

Restriction Effects	Landscape Type	Descriptive Keywords
Climatic exposure risks	Beach	Blinding sun glare; Sunburn-level UV; Face-stinging sea winds; Rain-soaked muddy beaches; Heatstroke risk in open areas; Typhoon dangers
	Lawn	Scorching summer sun ; Rain-flooded muddy zones
	Grove	Slippery rain-soaked trails; Steam-room summer humidity; Bone-chilling winter winds; Fog-induced low visibility; Damp leaf-pile slipping hazards
Health & safety threats	Beach	Stepping on sharp rocks; Cuts from shells; Drowning risks
	Lawn	Bug bites; Scratchy weeds on legs
	Grove	Scratches from branches; Bug bites; Tripping over roots; Wildlife encounters; Dense branches blocking views
	Stream	Poor water quality; Bug bites; Steep creek-bank slides
Environmental quality issues	Beach	Plastic trash on sand; Strong fishy smells
	Grove	Rotting leaf stink; Branch piles blocking paths; Pitch-dark woods at night

3.2.1 Promotion effects

The promotional nature of the landscape stems from four core mechanisms:(1) Climate regulation: Vegetation or water bodies optimize micro-environment via shading or evaporation, reducing extreme climate inhibition on activities.(2) Aesthetic attraction: Psychological pleasure from multi-sensory beauty enhances activity willingness and immersion through emotional arousal.(3) Restorative benefits: Natural environments regenerate attention and relieve stress by reducing sensory overload and providing soft stimuli, enhancing activity tolerance.(4) Natural challenges & playfulness: Playful challenges brought by unique landscape terrains or materials convert physical exertion into voluntary and enjoyable activities. Inductive thematic words from respondents' descriptions of restriction effects across different landscape types are presented in Table 2.

3.2.2 Restriction effects

The restrictiveness is manifested as the mismatch between environmental attributes and activity requirements: (1) Climatic exposure risks: The lack of buffered spaces or presence of reflective surfaces intensifies radiant heat or glare, exceeding the human thermal comfort threshold and thus disrupting PA. (2)Health & safety threats: Deficiencies in landscape attributes or management increase the risk of physical injury, while biological hazards raise safety concerns, reducing residents' willingness to engage in PA. (3) Environmental quality issues: Pollution or environmental disorder triggers sensory or psychological aversion, undermining the cleanliness and sense of place essential for PA. Inductive thematic words from respondents' descriptions of restriction effects across different landscape types are presented in Table 3.

3.3 The correspondence between the effects and landscape elements

The study found that descriptions of environmental effects across different landscape areas, derived from interview and online text data, mostly focus on specific landscape elements. Based on this, the study systematically classifies the elements in different landscape environments and explains the specific mechanism through which each element operates. Landscape elements can be divided into two categories: tangible landscape elements and ambient environmental elements. Figure 3 presents the cross-coupling relationship between landscape elements and their environmental influences within the study area and sample.

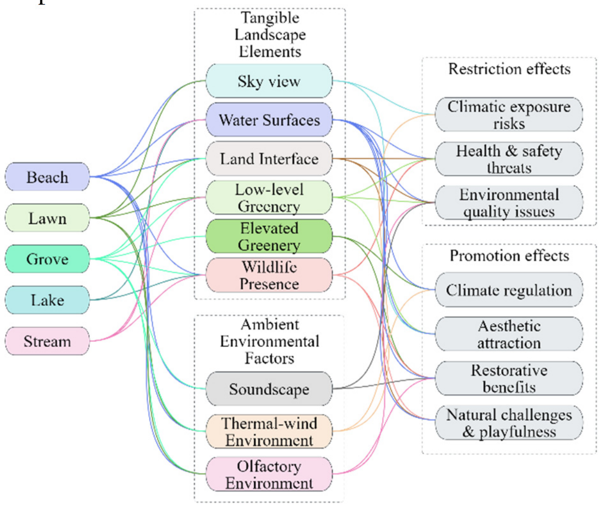

Fig. 3. The corresponding relationship between natural landscape elements and the effects

In the landscape environments examined in this study, users' perceptions of the grove and the beach demonstrate a high degree of element complexity. In contrast, the perceived elements of lake landscapes are significantly simplified, focusing on core components such as the water body itself and associated wildlife (e.g., fish, waterbirds). This characteristic may be restricted by the landscape construction pattern around the lake within the study. Furthermore, the study reveals that all landscape elements exhibit a dual mechanism of promotion and restriction, with no single element found to exert only positive effects. Among these elements, water surface elements display the most notable diversity in the dimensions of their effects. At the level of perceived environmental influences, the public shows the highest attention to the climate regulation function and environmental exposure risks of natural landscape elements; meanwhile, they generally focus on three core issues: the healing power of landscapes, health and safety benefits, and the optimization of environmental quality.

4 Discussion

4.1 Strategies for utilizing natural landscapes to promote PA

Construct a full-time dynamic landscape system: The research results show that there are significant differences in the PA behaviors supported by distinct landscape types and their spatio-temporal distribution characteristics (such as single or double peak patterns within a daily cycle and periodic peaks on holidays). Based on this, the core strategy is to construct a highly dynamic landscape system that covers the full day including nighttime and the complete cycle including holidays. This system will be established through the systematic integration and optimization of diverse natural landscape resources within the park, ensuring residents can conveniently and safely access a variety of activity and healing spaces at any time.

Strengthen artificial intervention and maintenance support: To overcome the inherent environmental constraints of specific natural landscapes, it is necessary to implement refined artificial intervention and continuous maintenance measures. These measures include: improving the night lighting system for day-dominated spaces such as groves to eliminate safety hazards and expand the effective use period; in open areas vulnerable to extreme weather (such as intense sunlight exposure), strategically configure tall tree canopies or construct sun-shading and wind-sheltering facilities to effectively improve the comfort of the local microclimate. These basic support measures aim to enhance environmental friendliness and ensure the sustainability and attractiveness of activities.

Transforming environmental risks into experiential value: Potential environmental risks or disadvantages should be converted into unique activity experiences and drivers for health promotion. For example, introducing aromatic insect-repellent plant communities at the edges of groves to create integrated recreational corridors that combine mosquito-repellent functionality with sensory healing effects; repurposing exposed tree roots into balance beams or stepped stone matrices of varying heights, transforming safety hazards into engaging physical training facilities. The strategies lead to conduct transformative design based on the characteristics of the restrictive effects of specific landscape elements to eliminate risks and create positive experiences that deepen natural interaction and stimulate PA.

4.2 Limitations

The main limitation of this study lies in its regional specificity. The research location is confined on Hainan Province, China. Given the unique sociocultural background, the daily activity patterns of local residents, and the typical climate environment in this area, the main conclusions of this study may not be directly applicable to other cities and regions with significantly different natural and humanistic backgrounds. This limitation stems from the inherent characteristics of case studies themselves. In addition, the current sample size is limited; future studies will expand the sample size and focus on exploring the perceived differences in the influence mechanism of natural environments on PA among different populations.

5 Conclusion

Different landscape types have different PA-carrying capacities. Among them, the lawn landscape support the most diverse range of PA types, ,while the coastal beach stands out in terms of residents' perceived environmental experiences. Water surface elements display the most notable diversity in the dimensions of their effects.The core mechanism by which natural landscapes enhance the willingness for PA lies in their climate regulation function, aesthetic appeal, restorative benefits, as well as the challenges & playfulness they embody. In tropical environments, climate regulation is identified as the primary influencing factor of the landscape. Correspondingly, the risk of climate exposure also constitutes the main restrictive effect, resulting in significant climate sensitivity and time limitations for landscapes such as open lawns and beaches. In contrast, the grove landscape with stronger shelter shows a higher all-weather utilization rate. Meanwhile, the effectiveness of groves and streams depends more on the supplementation of artificial intervention measures (such as forest trails and hydrophilic boardwalks). From the perspective of different landscape elements, water surface elements exhibit the most notable diversity in the dimensions of their effects. Therefore, constructing composite landscape sites that integrate diverse micro-environments and facility support, while enhancing the usability of water-friendly environments and facilities, is a key strategy to effectively expand the time window and and improve experiences for PA.

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