22nd International Conference on Sustainable Energy Technologies
Kuala Lumpur, Malaysia, 13 to 15 August 2026 · ISBN 978-1-995850-00-9 · ISSN 2978-4387

CONFERENCE PAPER · URBAN & ENVIRONMENT

Validation of an Adaptive Outdoor Thermal Comfort Questionnaire for Therapeutic Park in Hospital Environments: Evidence from Content Validity

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RECEIVED 16 May 2026 · REVISED 11 June 2026 · ACCEPTED 20 June 2026
PRESENTED 13 to 15 August 2026 · PUBLISHED 23 November 2026

ABSTRACT

Hospital therapeutic parks are increasingly recognised as supportive healthcare landscapes that aid psychological restoration, gentle physical activity, and social interaction. Yet in tropical climates, the practical value of these spaces hinges on whether patients, visitors, and staff can comfortably tolerate and manage outdoor thermal conditions. The aim of this study is to develop and evaluate the adaptive outdoor thermal comfort for therapeutic park in hospital environments instrument through expert panel review. The questionnaire was developed in two phases. First phase, an 11-item questionnaire was constructed. Second phase, a panel of six subject matter experts evaluated each item for relevance, simplicity, and clarity using a four-point ordinal scale. Both qualitative feedback and quantitative ratings were analysed to assess content validity. The results show that the Scale-level Content Validity Index based on the average method (S-CVI/Ave) reached 0.94 for both relevance and simplicity, and 0.83 for clarity. Item-level content validity (I-CVI) ranged from 0.67 to 1.00, while kappa statistic ranged from 0.565 to 1.00, indicating moderate to excellent agreement among experts. The validated instrument offers researchers, healthcare administrators, and landscape designers a context-sensitive tool to evaluate whether therapeutic parks are not only present but also usable, safe, and thermally supportive for diverse hospital users.

KEYWORDS Thermal comfort, Therapeutic park, Validation, Hospital landscape, Tropical climate

1. Introduction

Hospitals were once understood primarily as buildings designed around medical efficiency. In recent decades, however, a growing body of evidence in evidence-based healthcare design has repositioned the outdoor landscape as an active contributor to patient outcomes, staff wellbeing, and visitor experience (Ulrich *et al.* 2008). Therapeutic parks, healing gardens, and hospital green spaces have therefore been integrated into masterplans of contemporary medical centres, particularly in tropical and subtropical regions where year-round outdoor access is climatically possible. Their reported benefits include psychological restoration, reduction in perceived stress, opportunities for low-intensity movement, and informal social contact between caregivers and patients.

Beneath these aspirations sits a more pragmatic question: are these landscapes actually usable? In hot–humid environments such as Malaysia, the success of an outdoor therapeutic space depends not only on its planting palette or seating arrangement but crucially on its thermal performance.

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Published by Caravel Press.

doi.org/10.65582/set.2026.039

Excessive solar radiation, low air movement, and heat radiated from paved surfaces can convert an inviting park into an unused one within minutes. Hospital users, moreover, are not a homogenous group. Elderly patients, post-operative individuals, paediatric visitors, and shift-working clinical staff differ markedly in their thermal sensitivity, hydration status, clothing, and capacity to relocate when discomfort sets in.

Adaptive thermal comfort theory offers a useful conceptual anchor here. Unlike steady-state heat-balance models, the adaptive approach acknowledges that people interact with their environment by changing clothing, reducing activity, seeking shade, drinking water, or moving indoors (de Dear and Brager 1998; Nikolopoulou and Steemers 2003). Within hospital landscapes, this behavioural dimension becomes particularly meaningful: a well-designed park is one that not only minimises thermal stress but also supports users in exercising their adaptive options.

Despite the conceptual maturity of adaptive comfort research, the instruments commonly used in field surveys tend to fall into two camps. The first relies on technically dense parameters such as clothing insulation (Clo) and metabolic rate (Met), which, while scientifically precise, often exceed the everyday vocabulary of lay respondents. The second adopts simplified comfort scales that capture sensation but neglect the behavioural and contextual layers central to adaptive theory. Neither, in isolation, is well-suited to the heterogeneous user base of a hospital therapeutic park.

The therapeutic landscape concept established by Gesler (1992) has progressively informed the design of hospital healing gardens and therapeutic parks, with empirical evidence linking green space exposure to reduced stress, improved patient mood, and greater care satisfaction (Marcus and Sachs 2014). However, a persistent weakness in the literature is that post-occupancy evaluations tend to prioritise aesthetic quality over actual usage patterns: a park may appear restorative yet remain underutilised if its microclimate is thermally uncomfortable for the populations it serves.

Outdoor thermal comfort in tropical climates is governed by the interplay of air temperature, relative humidity, wind speed, mean radiant temperature, and solar exposure (Lin 2009). Critically, Nikolopoulou and Steemers (2003) demonstrated that psychological adaptation encompassing expectation, thermal history, perceived control, and duration of exposure significantly shapes whether a given microclimate is judged tolerable. Hospital users transitioning from air-conditioned interiors to outdoor spaces may therefore perceive identical conditions very differently from those who have acclimatised through prolonged outdoor exposure, underscoring the need for instruments that capture both physical and perceptual dimensions of comfort.

Addressing this requires psychometrically sound measurement tools. For newly developed questionnaires, content validity is the foundational form of evidence, evaluating whether items adequately represent the construct domain in terms of relevance, clarity, and simplicity (Polit and Beck 2006; Yusoff 2019). The Content Validity Index (CVI) operationalises this at both the item level (I-CVI) and scale level (S-CVI), while the Kappa statistic provides a complementary measure of inter-rater agreement beyond chance, offering a more nuanced indicator of consistency (Polit *et al.* 2007; Md Nasir *et al.* 2022). Despite these established frameworks, few published instruments integrate thermal comfort measurement within a hospital therapeutic-park context using transparent psychometric validation.

This study addresses that gap by developing and validating an eleven-item questionnaire designed specifically for use in tropical hospital therapeutic parks. The instrument was built to capture clothing, activity, perceived comfort, current satisfaction, sources of discomfort, adaptive responses, environmental facilities, and user-generated recommendations. The present study aimed to develop the instrument and evaluate its content validity through expert panel review. In addition, the study sought to examine how qualitative feedback provided by the experts informed and guided substantive revisions at the item level, thereby refining the instrument to enhance its clarity, relevance, and overall content validity. Together, these contributions are intended to make the questionnaire transparent, reproducible, and usable for both research and practice.

2. Methodology

2.1. Research design

The study adopted a mixed-methods validation design consistent with established guidance on questionnaire development for survey research (Yusoff *et al.* 2021). This study was conducted in two phases, as presented in Figure 1. In the first phase, quantitative expert ratings were combined with qualitative expert commentary, while in the second phase, internal consistency and stability were analyzed. This sequencing was chosen so that item-level refinements driven by expert insight could be embedded into the instrument before it was administered to a larger sample.

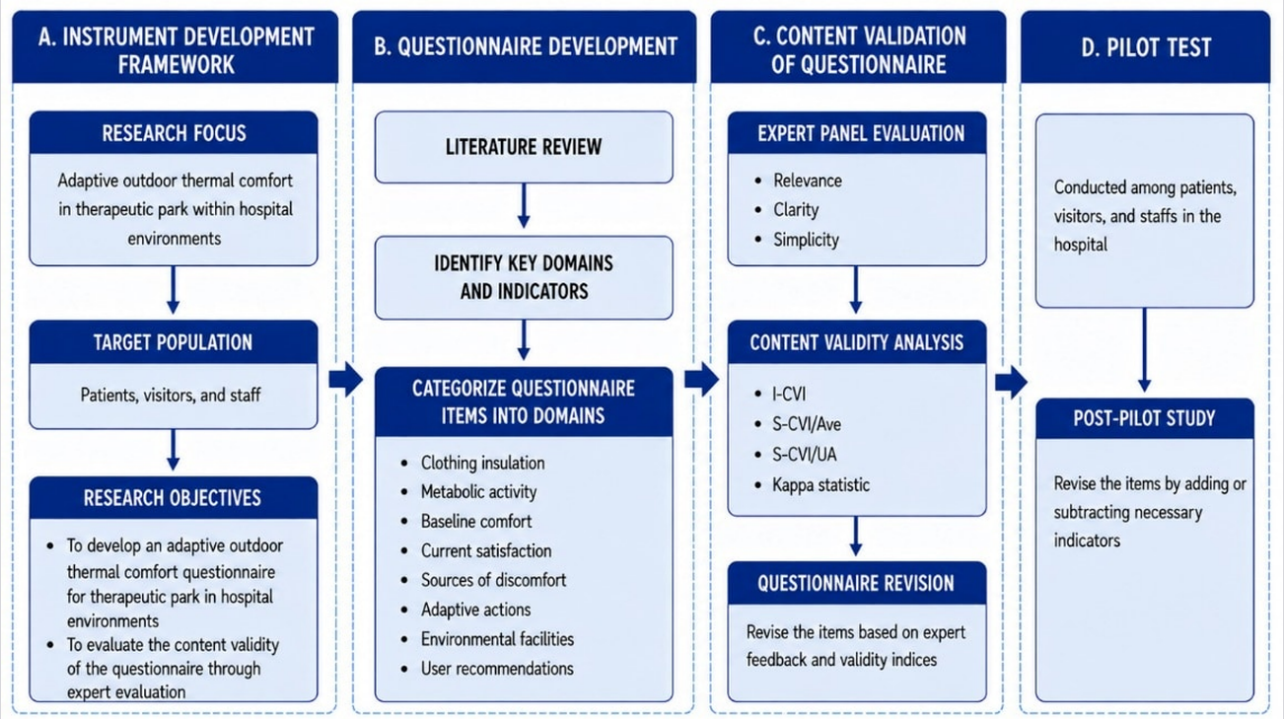

Figure 1. Development process of adaptive outdoor thermal comfort in therapeutic park in hospital environments.

2.2. Instrument development

Item generation drew on three sources. First, established adaptive thermal comfort survey templates used in field studies. Second, climatic and behavioural variables relevant to tropical outdoor settings. Third, the practical realities of hospital therapeutic-park usage observed through informal site visits. The resulting instrument comprised 11 items organised around eight conceptual domains in Table 1: clothing insulation, recent metabolic activity, baseline thermal comfort, current satisfaction, sources of discomfort (four sub-items), adaptive actions, environmental facilities present in the area, and open-ended user recommendations. Each item was prepared bilingually in English and Malay to suit the linguistic profile of the intended respondents.

Table 1. Construct mapping of the adaptive outdoor thermal comfort questionnaire.

Item	Construct domain	Purpose of item
Q1	Clothing insulation	Captures current clothing as a proxy for personal heat adaptation.
Q2	Metabolic activity	Records activity performed within the previous 30 minutes.
Q3	Baseline comfort	Measures the respondent's typical level of thermal comfort.
Q4	Current satisfaction	Measures momentary satisfaction with the prevailing temperature.
Q5–Q8	Sources of discomfort	Assesses discomfort attributable to air movement (high/low), incoming solar radiation, and surrounding hot or cold surfaces.

Table 1. (continued)

Item	Construct domain	Purpose of item
Q9	Adaptive actions	Identifies behavioural responses respondents would take to adjust their environment.
Q10	Environmental facilities	Captures the presence and operation of shading, fans, or misting equipment.
Q11	User recommendations	Open-ended item inviting suggestions to improve thermal comfort on site.

2.3. Content validity assessment

Six subject matter experts with backgrounds in landscape architecture, environmental design, and outdoor microclimate research were invited to review the instrument. The panel size aligns with the lower bound recommended by Polit *et al.* (2007) for content validity index (CVI) analysis. Each expert independently rated every item on a four-point ordinal scale for relevance, simplicity, and clarity, where 1 = not relevant, simple, or clear; 2 = needs some revision; 3 = relevant, simple or clear; and 4 = very relevant, simple or clear. For the purpose of analysis, ratings of 3 or 4 collapsed to indicate agreement that the item was acceptable for each criterion and were recoded as 1, whereas ratings 1 and 2 were recorded as 0. Open-ended comments were also collected and analysed thematically to identify issues related to wording problems, ambiguous terms, structural concerns, and missing response options.

There are two forms of CVI: the item-level CVI (I-CVI) and the scale-level CVI (S-CVI). The Item-level Content Validity Index (I-CVI) was calculated as the proportion of experts rating an item as relevant, simple, or clear. The Scale-level Content Validity Index based on the average method (S-CVI/Ave) was computed as the mean I-CVI across all 11 items, while the universal agreement variant (S-CVI/UA) was computed as the proportion of items achieving complete (6/6) expert agreement. The formulas for I-CVI, S-CVI/Ave and S-CVI/UA are presented in Equations 1, 2 and 3, respectively (Polit and Beck 2006).

$$\text{I-CVI} = \frac{\text{Agreed item}}{\text{Number of experts}} \tag{1}$$

$$\text{S-CVI/Ave} = \frac{\text{Sum of I-CVI scores}}{\text{Number of items}} \tag{2}$$

$$\text{S-CVI/UA} = \frac{\text{Sum of UA scores}}{\text{Number of items}} \tag{3}$$

The selection of experts for questionnaire review and critique was typically guided by their demonstrated expertise in the subject area. Accordingly, Table 2 summarises the criteria used to determine acceptable cut-off values for the CVI (Davis 1992; Polit *et al.* 2007).

Table 2. Comparison between total experts and the cutoff value.

Number of experts	Acceptable CVI
2 experts	At least 0.80
3 to 5 experts	Should be 1
At least 6 experts	A minimum of 0.83

Moreover, the CVI remains widely used in research because it is straightforward to compute, easy to interpret and provides item-level evidence that supports decisions on revising or removing instrument items (Polit and Beck 2006; Polit *et al.* 2007).

2.4. Kappa statistic

The computation of the Kappa statistic provides a more complete understanding of content validity by accounting for agreement that may occur by chance. The Kappa statistic is a widely used index of inter-rater agreement that adjusts for chance agreement and is therefore an important complement to the CVI (Shrotryia and Dhanda 2019). It provides additional information on the extent of expert agreement beyond what is captured by the CVI alone (Wynd *et al.* 2003). The probability of chance agreement was computed in Equation 4.

$$P_c = \left[\frac{N!}{Y!\,(N-Y)!} \right] \times 0.5^N \tag{4}$$

Where:

- N = the number of experts
- Y = the number of experts who rated the item as relevant, simple or clear that depending on the evaluated dimension.

The Kappa statistic was then calculated using Equation 5.

$$K = \frac{\text{I-CVI} - P_c}{1 - P_c} \tag{5}$$

Where:

- *I-CVI* = the item-level CVI
- P_c = probability of chance agreement

The interpretation of Kappa values follows established guidelines, where values above 0.74 indicate excellent agreement, values between 0.6 and 0.74 indicate good agreement, and between 0.4 and 0.59 indicate fair agreement (Polit and Beck 2006).

2.5. Pilot test

A pilot study was conducted to evaluate the feasibility of the survey instrument and data collection procedures for assessing thermal perception and comfort within hospital park environments. The study was carried out across three designated hospital park locations, with an equal number of respondents recruited from each site. A total of 30 participants comprising hospital staff, patients, and visitors were included in the pilot survey to ensure representation of the primary user groups of the hospital park. Participants were selected through convenience sampling based on their presence within the study areas during the data collection period and their willingness to participate.

The pilot study was primarily intended to assess the clarity of the questionnaire items, the suitability of the thermal perception scales, and the practicality of conducting thermal comfort surveys within a hospital park setting. Feedback obtained during the pilot phase was used to identify any ambiguities in the survey instrument and to refine the wording, structure, and administration procedures prior to the implementation of the main study. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarize respondent characteristics and thermal perception responses.

Simultaneously, on-site microclimatic measurements were collected at each hospital park location to characterize the thermal environment experienced by respondents. Subjective thermal responses were subsequently analysed alongside the environmental measurements to evaluate the applicability of thermal comfort assessment methods within the hospital park setting and to inform the design of the full-scale study.

3. Results

3.1. Content validity

This study explored the validity of three dimensions: Relevance, simplicity and clarity. As presented in Table 3 and Table 4, the expert ratings demonstrated consistently strong levels of relevance and simplicity, with both dimensions achieving an S-CVI/Ave of 0.94. Seven of the eleven items achieved unanimous expert agreement (I-CVI = 1.00) for both dimensions, whereas the four sub-items (Q5–Q8), which assessed sources of discomfort, each obtained an I-CVI of 0.83. These values met the recommended retention threshold of 0.83, indicating acceptable content validity. Nevertheless, the lower agreement observed for these items suggests concerns regarding coverage or wording.

Table 3. The relevance and simplicity rating on the scale of the items.

Item	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	I-CVI	UA	P_c	Kappa
Q1	1	1	1	1	1	1	1.00	1	0.015625	1
Q2	1	1	1	1	1	1	1.00	1	0.015625	1
Q3	1	1	1	1	1	1	1.00	1	0.015625	1
Q4	1	1	1	1	1	1	1.00	1	0.015625	1
Q5	1	1	0	1	1	1	0.83	0	0.09375	0.816
Q6	1	1	0	1	1	1	0.83	0	0.09375	0.816
Q7	1	1	0	1	1	1	0.83	0	0.09375	0.816
Q8	1	1	0	1	1	1	0.83	0	0.09375	0.816
Q9	1	1	1	1	1	1	1.00	1	0.015625	1
Q10	1	1	1	1	1	1	1.00	1	0.015625	1
Q11	1	1	1	1	1	1	1.00	1	0.015625	1
					S-CVI/Ave =		0.94			
					S-CVI/UA =			0.64		

Table 4. The clarity rating on the scale of the items.

Item	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	I-CVI	UA	P_c	Kappa
Q1	1	1	1	1	0	1	0.83	0	0.09375	0.816
Q2	1	1	1	1	1	0	0.83	0	0.09375	0.816
Q3	1	1	1	1	1	0	0.83	0	0.09375	0.816
Q4	1	1	1	1	1	1	1.00	1	0.015625	1
Q5	0	1	0	1	1	1	0.67	0	0.2344	0.565
Q6	0	1	0	1	1	1	0.67	0	0.2344	0.565
Q7	0	1	0	1	1	1	0.67	0	0.2344	0.565
Q8	0	1	0	1	1	1	0.67	0	0.2344	0.565
Q9	1	1	1	1	1	1	1.00	1	0.015625	1
Q10	1	1	1	1	1	1	1.00	1	0.015625	1
Q11	1	1	1	1	1	1	1.00	1	0.015625	1
					S-CVI/Ave =		0.83			
					S-CVI/UA =			0.36		

The clarity dimension produced comparatively lower agreement, as shown in Table 4. The S-CVI/Ave for clarity was 0.83, indicating acceptable for content validity but lower than the values obtained for relevance and simplicity. Within this dimension, items Q5 to Q8 demonstrated lower agreement, with each obtaining an I-CVI of 0.67. These values fell below the recommended retention threshold, suggesting that revisions to improve the clarity of these items were necessary rather than changes to the content.

Furthermore, Kappa statistic for the relevance, simplicity and clarity dimensions ranged from 0.565 to 1, as presented in Table 3, and 4. For the relevance and simplicity dimensions, Kappa values ranged from 0.816 to 1, indicating excellent agreement among the experts. Similarly, most items in the clarity dimension demonstrated excellent agreement. However, four items (Q5–Q8) obtained a Kappa value of 0.565, representing fair agreement. These findings suggest that although the content of these items was considered relevant and simple, their wording should be revised to improve clarity.

3.2. Instrument refinement

The qualitative feedback provided by the expert reviewers complemented the quantitative content validity findings and informed several revisions to improve the instrument. Four major themes emerged consistently from the reviewers' comments. The first theme concerned the use of technical terminology. One expert reviewer questioned whether respondents would be able to interpret technical concepts such as Clo and Met. The reviewer recommended replacing these technical terms with more descriptive questions, such as about the clothing the respondents were currently wearing and the activities they had performed within the previous half hour. This revision preserved the intended construct while reducing the cognitive burden on respondents.

The second theme related to linguistic precision in the Malay-language version of the questionnaire. One expert reviewer noted that the standard Malay reference dictionary (Kamus Dewan) recommends the term keselesaan terma rather than keselesaan haba when referring to thermal comfort in a technical context. Accordingly, the terminology was revised to align with standard academic Malay usage and to minimise potential ambiguity.

The third theme involved temporal anchoring of the questionnaire items. Several expert reviewers indicated that questions referring to general terms (e.g. your typical level of thermal comfort) could encourage responses based on general perceptions rather than their immediate experience. Consequently, the wording was revised to include expressions such as "at the moment" particularly for items assessing current thermal comfort, satisfaction and adaptive intentions. This modification is consistent with adaptive thermal comfort theory, which emphasises the assessment of real-time behavioural and perceptual responses within the existing environment.

The fourth theme concerned the structure and response format of items Q5 to Q8. Two expert reviewers observed that respondents who did not experience a particular source of discomfort had no appropriate response option, potentially resulting in forced responses. To address this issue, the experts recommended introducing a "not applicable" response option, and restructuring the four discomfort items into a single matrix question in which respondents rate the contribution of each potential source of discomfort using a five-point scale. In addition, another expert suggested relocating these items to a later section of the questionnaire, as they were conceptually more consistent with subsequent questions. Collectively, these revisions transformed items Q5 to Q8 from four separate single-choice items into a structured multi-factor assessment of thermal comfort.

Finally, two additional refinements were incorporated. Item Q9 was reworded to adopt a prospective perspective by asking respondents which actions they would take to adjust their environment rather than which they were currently performing. This revision was intended to better capture respondents' adaptive intentions. Item Q10 was also revised to clarify the spatial reference of the term "area" by explicitly distinguishing between the respondent's immediate seating zone and the broader surroundings.

3.3. Pilot study

Table 5 shows the findings of pilot respondents which involved 30 respondents recruited equally from the three hospital park sites, with 10 participants (33.3%) representing each location. The respondents comprised hospital staff (n = 14, 46.7%), visitors (n = 11, 36.7%), and patients (n = 5, 16.7%), providing perspectives from the main user groups of the hospital parks. Regarding hospital visitation patterns, more than half of the visitors reported visiting the hospital two times or less per week (54.5%), while the remaining 45.5% visited the hospital between three and fewer than five times per week. No respondents reported visiting the hospital more than five times per week.

Table 5. The demographic statistics of pilot study respondents.

Characteristics	N (%)
Location	
Site 1	10 (33.3)
Site 2	10 (33.3)
Site 3	10 (33.3)
Category	
Staff	14 (46.7)
Patient	5 (16.7)
Visitor	11 (36.7)
Frequency of visits (visitors, n = 11)	
≤ 2 times/week	6 (54.5)
3 to < 5 times/week	5 (45.5)
5 to < 7 times/week	- (0)
≥ 7 times/week	- (0)
Comorbidity	
Yes	10 (33.3)
No	20 (66.7)
Gender	
Male	16 (53.3)
Female	14 (46.7)
Ethnic	
Malay	22 (73.3)
Chinese	7 (23.4)
Indian	- (0)
Others	1 (3.3)
Age	
(mean ± SD)	44 ± 4.6

The demographic profile of the respondents showed a relatively balanced gender distribution, with males accounting for 53.3% (n = 16) and females 46.7% (n = 14). The majority of participants were Malay (73.3%, n = 22), followed by Chinese respondents (23.4%, n = 7), while one respondent (3.3%) belonged to Borneo ethnic group. One third of the respondents reported having at least one comorbidity (n = 10, 33.3%), while the remaining two thirds reported no comorbid conditions (n = 20, 66.7%). The mean age of the respondents was 44 ± 4.6 years, indicating that the study population was predominantly composed of middle-aged adults. Overall, the sample captured a diverse range of hospital park users with varying demographic characteristics, health conditions, and patterns of park use, providing a suitable basis for assessing perceptions and experiences of the outdoor therapeutic environment.

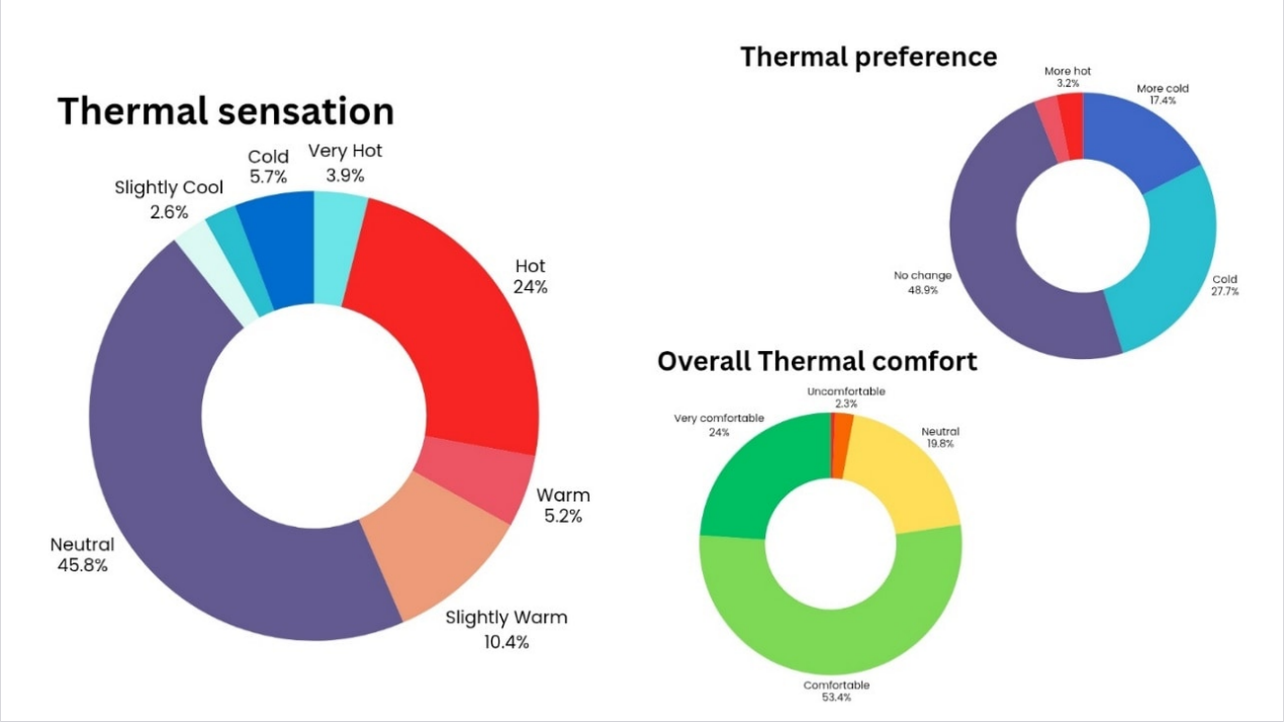

Figure 2. Distribution of respondents' thermal sensation, thermal preference, and overall thermal comfort in the hospital parks.

The subjective thermal assessment indicated that most respondents perceived the thermal environment of the hospital park positively. For thermal sensation, nearly half of the responses were recorded as neutral (45.8%), suggesting that the prevailing outdoor conditions were generally acceptable to park users. Nevertheless, a notable proportion of respondents reported feeling hot (24.0%), followed by slightly warm (10.4%) and warm (5.2%), indicating a tendency toward warmer thermal perceptions. In contrast, only a small percentage of respondents perceived the environment as cold (5.7%), slightly cool (2.6%), or very hot (3.9%). Consistent with these findings, almost half of the respondents (48.9%) expressed no preference for thermal change, while 27.7% preferred cooler conditions and 17.4% desired much cooler conditions. Only a minority preferred warmer conditions, with 3.2% indicating a preference for a hotter environment.

The overall thermal comfort responses further demonstrated a generally favourable perception of the hospital park environment. More than half of the respondents (53.4%) rated the environment as comfortable, while an additional 24.0% considered it very comfortable. Approximately one-fifth (19.8%) reported a neutral level of comfort, whereas only a small proportion perceived the environment as uncomfortable (2.3%). Collectively, these findings suggest that despite a tendency for some respondents to perceive the environment as warm, the majority considered the outdoor therapeutic spaces to be thermally comfortable. The high proportion of respondents reporting comfort and no desire for thermal modification indicates that the thermal conditions were generally acceptable and supportive of outdoor use within the hospital park setting.

4. Discussion

The present study evaluated the content validity of a newly developed questionnaire designed to assess outdoor thermal comfort in therapeutic parks within rehabilitation hospital settings. Overall, the findings demonstrate excellent content validity, with an overall S-CVI/Ave exceeding the commonly recommended threshold of 0.80, indicating strong expert consensus regarding the relevance of the questionnaire content. Nevertheless, the validation process also identified several opportunities to improve respondent comprehension and questionnaire usability without compromising its theoretical integrity. These findings highlight that questionnaire validation should

be viewed not merely as a statistical exercise, but as an iterative process of refining the balance between scientific precision and respondent accessibility.

Three principal observations emerge from the findings, each with implications that extend beyond the immediate validation process. The first concerns the divergence between the relevance, simplicity, and clarity indices. While the questionnaire achieved excellent S-CVI/Ave values of 0.94 for both relevance and simplicity, the comparatively lower clarity index of 0.83 suggests that the instrument was conceptually well constructed but, prior to refinement, relatively expert-oriented in its wording. This distinction is important because content validity encompasses not only whether an item adequately represents the intended construct, but also whether respondents can interpret that construct consistently during data collection. Items that are theoretically relevant but linguistically ambiguous may introduce measurement error through inconsistent interpretation rather than deficiencies in the underlying construct itself.

At the item level, the I-CVI and modified kappa statistic ranged from 0.67 to 1.00 and 0.565 to 1.00, respectively. Four items (Q5–Q8) received I-CVI and kappa values of 0.67 and 0.565, prompting revisions based on expert recommendations to improve wording and presentation. Importantly, the lower agreement was not related to the conceptual appropriateness of these items but rather to the manner in which they were expressed. This reflects a broader challenge frequently encountered in environmental and thermal comfort research, where scientifically important variables such as clothing insulation (Clo), metabolic rate (Met), and mean radiant temperature are fundamental determinants of thermal perception but are seldom familiar to lay respondents. Consequently, questionnaire development in this field requires careful translation of technically accurate concepts into language that remains meaningful and understandable without sacrificing scientific validity. The fact that relevance and clarity diverged most noticeably around Q5–Q8 reinforces this interpretation. Experts consistently agreed that the construct representing multiple sources of outdoor discomfort was appropriate, while simultaneously recognising that improvements in wording were necessary to facilitate respondent understanding. This finding illustrates the broader methodological challenge of balancing theoretical precision with practical usability when developing instruments for multidisciplinary environmental health research.

The second observation concerns the important role of qualitative expert feedback as a structural diagnostic of the questionnaire. Beyond identifying problematic items, the comments provided by experts revealed that the primary issue lay not in the content itself but in the organisation and presentation of related questions. Rather than recommending item deletion, the feedback consistently suggested restructuring the questionnaire to improve clarity while preserving construct coverage. This distinction is methodologically significant because removing theoretically important items solely to improve statistical indices may weaken the conceptual completeness of the instrument. In contrast, restructuring allows theoretically meaningful constructs to be retained while simultaneously improving respondent usability.

In particular, the recommendation to consolidate Q5–Q8 into a matrix-style question incorporating a “not applicable” response option addresses two methodological concerns simultaneously. First, it accommodates respondents who may experience only selected environmental discomfort factors rather than all factors simultaneously. Second, it facilitates direct comparison across multiple discomfort sources using a common response format, thereby strengthening subsequent statistical analysis. Matrix-based question formats have been shown to reduce redundancy, improve response consistency, and simplify respondent decision-making when multiple related constructs are evaluated using identical response scales. Within adaptive thermal comfort research, where several environmental drivers including solar radiation, wind, humidity, and surrounding environmental conditions often influence perception simultaneously, such a matrix structure more closely reflects the manner in which individuals naturally describe their outdoor thermal experiences. Consequently, the proposed restructuring represents an improvement in

questionnaire architecture rather than content, preserving theoretical breadth while enhancing measurement quality.

The third observation concerns the behavioural orientation of the instrument. Unlike many conventional thermal comfort questionnaires that focus primarily on thermal sensation or thermal preference, the present instrument extends beyond perceptual measurement by incorporating items addressing adaptive actions (Q9), environmental facilities (Q10), and open-ended recommendations (Q11). This broader scope reflects one of the principal concepts underpinning adaptive thermal comfort theory, namely that individuals are active participants in achieving thermal comfort rather than passive recipients of environmental conditions (de Dear and Brager 1998; Nikolopoulou and Steemers 2003). Behavioural adaptations, such as seeking shade, modifying activity patterns, increasing hydration, or adjusting clothing, represent important mechanisms through which individuals regulate their thermal experience. By capturing these adaptive responses alongside subjective comfort perception, the questionnaire provides a more comprehensive understanding of how users interact with outdoor therapeutic environments.

This behavioural dimension is particularly relevant within rehabilitation hospital settings, where users differ substantially in age, physical mobility, medical condition, and thermal tolerance. Patients undergoing rehabilitation may possess limited ability to modify their environment or respond behaviourally to thermal stress compared with healthy individuals. Consequently, understanding not only whether discomfort occurs but also how individuals attempt to adapt provides valuable information for interpreting comfort-related outcomes and identifying barriers to effective use of therapeutic landscapes. In this respect, the present instrument contributes beyond conventional thermal comfort assessment by linking environmental perception with adaptive behaviour, thereby aligning more closely with the conceptual foundations of adaptive comfort theory.

The practical implications of the validated questionnaire extend across several stakeholder groups. For healthcare administrators and facility managers, the instrument offers a systematic and evidence-based approach for evaluating whether therapeutic parks remain usable across different times of day and varying weather conditions. Rather than relying solely on engineering standards or environmental measurements, the questionnaire captures users' lived experiences of outdoor comfort and identifies environmental features requiring improvement. Responses related to environmental facilities and adaptive actions provide direct evidence regarding where additional shade structures, vegetation, seating, drinking water stations, misting systems, or cooling devices may be most beneficial. Repeated administration of the questionnaire before and after environmental modifications may also assist healthcare facilities in monitoring whether interventions produce measurable improvements in patient experience.

For landscape architects and environmental designers, the instrument supports both pre-occupancy and post-occupancy evaluation of therapeutic landscapes. The same questionnaire can be administered before and after the implementation of design interventions such as tree planting, installation of shade structures, modification of paving materials, or enhancement of natural ventilation to determine whether these changes improve perceived comfort and adaptive capacity. Such evidence-based evaluation provides valuable feedback for refining climate-responsive landscape design in healthcare environments.

The questionnaire also offers significant value for researchers investigating outdoor thermal comfort in tropical climates. Pairing subjective questionnaire responses with simultaneously measured microclimatic variables including air temperature, relative humidity, wind speed, globe temperature, and mean radiant temperature would enable future studies to triangulate perceived thermal comfort with objectively measured environmental conditions. Such integration represents an important direction within adaptive thermal comfort research because discrepancies frequently exist between measured environmental conditions and occupants' subjective thermal perceptions. Combining subjective and objective data therefore has the potential to improve understanding of

adaptive processes and contribute to the growing body of evidence supporting climate-responsive healthcare design.

Several methodological decisions warrant further reflection. First, the decision to prioritise S-CVI/Ave over S-CVI/UA reflects both the exploratory nature of this instrument development and established recommendations within content validation methodology. The universal agreement index is intentionally conservative, particularly for expert panels comprising five or more reviewers, because a single disagreement is sufficient to reduce the overall score substantially. Consequently, S-CVI/Ave provides a more balanced representation of overall expert consensus while the I-CVI and modified kappa statistic remain available to identify specific items requiring revision. This combined approach allows both overall instrument quality and individual item performance to be evaluated without disproportionately penalising isolated disagreement.

Second, the deliberate decision to retain rather than eliminate Q5–Q8 despite their relatively lower clarity scores reflects a theoretically informed judgement rather than a purely statistical one. These items assess multidimensional sources of outdoor discomfort, a construct that lies at the core of adaptive thermal comfort theory and is therefore essential to the conceptual integrity of the questionnaire. Removing these items solely to improve statistical indices would reduce construct coverage and limit the instrument's ability to capture the complex environmental interactions experienced within outdoor therapeutic settings. Instead, revising the wording and restructuring the response format represented a more appropriate solution, preserving theoretical completeness while improving respondent comprehension.

Several limitations should be acknowledged. The expert panel comprised six reviewers, which is consistent with established recommendations for content validity assessment but inevitably limits the diversity of disciplinary perspectives represented. Inclusion of additional experts from clinical rehabilitation, occupational therapy, landscape architecture, environmental psychology, and patient advocacy in future validation studies would strengthen confidence in the content evaluation. Furthermore, the present study focused exclusively on content validity. Other psychometric properties, including construct validity, internal consistency reliability, test–retest reliability, and criterion validity, have yet to be established through empirical testing with larger respondent samples. Consequently, although the findings demonstrate that the questionnaire possesses strong conceptual validity, additional validation stages remain necessary before routine application in broader healthcare settings. Finally, the instrument was developed specifically within the Malaysian context and therefore reflects local climatic conditions, healthcare environments, and language. Its applicability to different cultural, linguistic, or climatic contexts should therefore be interpreted cautiously until appropriate cross-cultural adaptation procedures have been undertaken.

Future research should pursue several complementary directions. First, administration of the questionnaire to a larger and more diverse respondent population would permit exploratory and confirmatory factor analyses to establish the underlying latent structure of the instrument and determine whether items load onto the conceptual domains proposed during development. Second, internal consistency and test–retest reliability should be evaluated to establish measurement stability over time. Third, cross-cultural adaptation using established translation and back-translation procedures should be undertaken before application in non-Malay-speaking populations to ensure conceptual equivalence across languages and cultures. Finally, future studies should integrate subjective questionnaire responses with detailed microclimatic measurements, including air temperature, relative humidity, wind speed, globe temperature, mean radiant temperature, and thermal comfort indices such as PET or UTCI. Such multidisciplinary investigations would allow direct comparison between perceived and objectively measured thermal conditions, thereby strengthening the contribution of the instrument to the broader evidence base supporting adaptive thermal comfort research in tropical healthcare environments.

Overall, the present validation study demonstrates that the questionnaire possesses excellent conceptual content validity while identifying targeted refinements that improve respondent

comprehension without compromising theoretical coverage. Rather than revealing weaknesses in the underlying conceptual framework, the validation process confirmed that the principal challenges related to communication and questionnaire structure rather than construct definition. By integrating perceptual, behavioural, and environmental dimensions within a single instrument, the questionnaire provides a robust foundation for evaluating outdoor thermal comfort in therapeutic parks and offers a practical tool for researchers, healthcare practitioners, and designers seeking to develop more climate-responsive rehabilitation environments. As rising temperatures and climate change continue to influence the usability of outdoor healthcare spaces, validated instruments of this nature will become increasingly important for generating evidence that supports patient-centred environmental design and effective adaptation strategies.

5. Conclusion

This study presents the development and validation of an 11-item adaptive outdoor thermal comfort questionnaire designed for therapeutic parks in tropical hospital environments. The instrument achieved strong S-CVI/Ave values for relevance (0.94) and simplicity (0.94), and acceptable clarity (0.83). Expert feedback proved indispensable in moving the instrument from a technically robust draft to a respondent-accessible tool, particularly through the simplification of clothing and activity items, the standardisation of Malay terminology, the introduction of a not applicable response category, and the structural consolidation of discomfort items into a matrix format.

The validated questionnaire is offered as a practical and theoretically grounded instrument for evaluating whether hospital therapeutic parks function as supportive outdoor environments in tropical climates. It is positioned to assist researchers in advancing evidence on adaptive comfort, administrators in auditing the usability of existing landscapes, and designers in evidencing the impact of microclimatic interventions on patient, visitor, and staff experience.

Declarations

Author contributions. Noraishah Mohammad Sham: Conceptualization, Methodology, Investigation, Formal analysis, Data curation, Writing (original draft), Writing (review and editing), Visualization, Validation, Project administration, Resources, Funding acquisition. Siti Syakirin Sazali: Formal analysis, Data curation, Writing (review and editing), Visualization, Validation. Nurnida Elmira Othman: Investigation, Writing (review and editing). Farah Nurhanis Hassan Sadzli: Investigation, Formal analysis. Rohaida Ismail: Conceptualization. Rabiatul Adawiyah Nasir: Methodology, Writing (original draft), Writing (review and editing), Validation.

Funding. Funded by Ministry of Health Malaysia grant (NMRR ID-24-01689-XOI)

Conflicts of interest. The authors declare no competing interests.

Data availability. The data that support the findings of this study are available from the corresponding author upon reasonable request.

Ethics. MREC Ministry of Health Malaysia

Acknowledgements. Many thanks to Director General of MOH Malaysia for approval and supporting the the publication.

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HOW TO CITE THIS PAPER

Mohammad Sham, N., Sazali, S. S., Othman, N. E., Hassan Sadzli, F. N., Ismail, R. and Nasir, R. A. (2026). Validation of an Adaptive Outdoor Thermal Comfort Questionnaire for Therapeutic Park in Hospital Environments: Evidence from Content Validity. In: *Proceedings of the 22nd International Conference on Sustainable Energy Technologies (SET2026)*, Kuala Lumpur, Malaysia, 13 to 15 August 2026. Caravel Press, pp. 482–495. ISBN 978-1-995850-00-9. ISSN 2978-4387. https://doi.org/10.65582/set.2026.039

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