

The Influence of Childhood Outdoor Recreation Experience on Visitors' Attitude and Emotion towards Recreational Forests in Malaysia

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Childhood outdoor recreation experiences play a critical role in mitigating the modern "extinction of experience" by shaping lifelong human–nature relationships. This study investigated the structural relationships between Childhood Outdoor Recreation Experience (CORE), adult attitudes, and emotional responses at the Sungai Sedim Recreational Forest (SSRF) in Malaysia. Utilizing a quantitative survey design, data was analyzed from a clean sample of 382 active visitors. Exploratory Factor Analysis (EFA) via Principal Component Analysis with Direct Oblimin rotation confirmed four CORE dimensions (Societal/Cultural, Interpersonal, Environmental, and Individual Influence), two Attitude components (Forest Amenities; Accessibility and Restorative Experience), and three distinct Emotion subscales (Joy, Love, and Positive Surprise). Latent constructs showed strong internal consistency (Cronbach's $\alpha = .695$ to $.950$). Simultaneous multiple regression models showed that proximal Interpersonal Influence was the most powerful predictor of both adult cognitive attitudes ($\beta = .504$, $p < .001$) and emotional attachment ($\beta = .353$, $p < .001$), supporting Bronfenbrenner's Ecological Systems Theory. Individual influence also positively predicted attitude ($\beta = .098$) and emotion ($\beta = .103$), with the full structural models explaining 33.9% and 25.0% of variance, respectively. Demographic variations were generally limited, except for significant differences based on marital status and ethnicity. Crucially, bootstrapping path analysis verified that adult attitude fully mediates the relationship between early childhood memories and current emotions (indirect effect = $.1905$, 95% bias-corrected CI $[.1147, .2669]$). Forest management and ecotourism policies must prioritize family-inclusive, socially supportive environments to build favorable adult cognitive values that secure generation-spanning emotional commitments to conservation.

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Introduction

Childhood experiences in natural environments play an important role in shaping individuals' perceptions, attitudes, and emotional relationships with nature later in life (Chawla, 2024). Direct engagement with natural environments during childhood provides opportunities for exploration, recreation, learning, and emotional development, which contribute to stronger connections with nature and more positive perceptions of natural environments in adulthood (Franco et al., 2023). As opportunities for children to engage with nature increasingly decline because of urbanization and changing lifestyles, understanding the long-term influence of childhood outdoor experiences has become increasingly important (Gaston et al., 2024). Malaysia is endowed with extensive forest resources and diverse natural landscapes that provide opportunities for recreation, tourism, environmental education, and psychological restoration (Norfadhilah et al., 2023). Recreational forests are particularly important because they provide accessible natural environments where people can participate in activities such as hiking, camping, picnicking, nature appreciation, and river-based recreation (Roslan et al., 2023). These environments therefore provide valuable opportunities for individuals to develop direct and meaningful experiences with nature. However, rapid urbanization has transformed the environments in which many Malaysian children grow up (Ahmad et al., 2025). A large proportion of Malaysia's population now lives in urban areas, potentially reducing children's regular opportunities for direct contact with natural environments (Zulkifli et al., 2026). At the same time, the increasing prevalence of screen-based entertainment and indoor lifestyles may further restrict opportunities for outdoor play and nature-based recreation (Huda Farhana et al.,

2017). Previous research has established that childhood experiences with nature can contribute to environmental awareness, nature connectedness, pro-environmental behaviour, and psychological well-being (Lumber et al., 2022). Repeated and meaningful interaction with natural environments during childhood may also contribute to positive perceptions and emotional attachment to nature that persist into adulthood (Nisbet et al., 2024). Nevertheless, much of the existing research has concentrated on environmental attitudes, conservation behaviour, and general nature connectedness (Collado et al., 2023). Comparatively less attention has been given to the long-term influence of childhood outdoor recreation experiences specifically on adults' attitudes and emotional responses toward recreational forests (Martin et al., 2024). This gap is particularly relevant in the Malaysian context. Much of the existing evidence concerning childhood nature experiences has emerged from Western countries and highly urbanized settings, while empirical research examining these relationships within Malaysian recreational forest environments remains limited (Ismail & Kamarudin, 2023). Recreational forests in Malaysia provide an important setting for nature-based recreation and tourism; therefore, understanding the factors that shape visitors' attitudes and emotional responses toward these environments may provide useful implications for forest management, recreation planning, environmental education, and tourism development (Aziz et al., 2024). In particular, childhood outdoor recreation experiences may influence how individuals evaluate and emotionally respond to recreational forests when they encounter such environments as adults (Rosa & Collado, 2025). Individuals who had meaningful recreational experiences in natural environments during childhood may develop more favourable attitudes toward forests and subsequently experience stronger positive emotions when visiting them (Kals & Müller,

2023). However, the mechanism through which childhood outdoor recreation experiences influence adult emotional responses remains insufficiently understood (Zhang & Oh, 2025). Visitors' attitudes may represent an important psychological pathway through which early-life experiences are translated into emotional responses toward recreational forest environments (White et al., 2023). Therefore, this study examines the influence of Childhood Outdoor Recreation Experience (CORE) on visitors' attitudes and emotions toward recreational forests in Malaysia, with particular reference to Sungai Sedim Recreational Forest (SSRF). The study further investigates the mediating role of visitors' attitudes in the relationship between childhood outdoor recreation experiences and emotional responses toward recreational forests. By examining these relationships, the study seeks to extend understanding of the long-term influence of childhood outdoor recreation experiences and provide empirical evidence concerning how early-life experiences may shape adult perceptions and emotional connections with recreational forest environments in the Malaysian context.

1.1. Problem Statement

The extinction of experience (EOE) describes the gradual decline in direct interaction between people and natural environments due to urbanization, technological development, and changing lifestyles (Pyle, 1978). Increasing reliance on digital technologies, reduced outdoor play, and greater engagement in indoor activities have further limited children's opportunities to experience nature during their formative years (Bento & Dias, 2024; Charan et al., 2024; Yin et al., 2022). This trend is particularly relevant in Malaysia, where urbanization increased from 26.1% in 1960 to 76.9% in 2024 (Statista, 2026). Declining visitation to recreational forests also raises concerns about reduced engagement with nature; in Kedah, visitor numbers decreased from 1,175,428 in 2011 to 242,852 in 2020 (Government of Malaysia, 2023). Reduced

contact with nature may weaken individuals' appreciation and concern for natural environments (Soga et al., 2025), while urbanization and screen-based leisure can further contribute to disconnection from nature (Chen et al., 2025). Although previous studies have examined childhood nature experiences, environmental attitudes, and outdoor recreation participation (Asah et al., 2019; Pensini et al., 2016; Rosa et al., 2018), most evidence comes from Western contexts. Limited research has examined how childhood outdoor recreation experiences influence adults' attitudes and emotional responses toward recreational forests, particularly in Malaysia (Marzuki et al., 2024). Moreover, the role of visitors' attitudes as a potential mechanism linking childhood experiences with adult emotional responses remains insufficiently understood. From the perspective of Bronfenbrenner's Ecological Systems Theory (Bronfenbrenner, 1979), childhood experiences are shaped by interactions between individuals and their surrounding environmental systems. However, limited research has applied this perspective to examine the long-term influence of childhood outdoor recreation experiences on adults' attitudes and emotions toward recreational forests. Therefore, this study investigates the influence of Childhood Outdoor Recreation Experience (CORE) on visitors' attitudes and emotions toward recreational forests in Malaysia, with particular reference to Sungai Sedim Recreational Forest (SSRF), and examines the mediating role of visitors' attitudes.

1.2. Research Objectives

This study examines the long-term influence of Childhood Outdoor Recreation Experience (CORE) on visitors' attitudes and emotions toward recreational forests in Malaysia. Specifically, the study aims to:

1. identify the recreational forest activities experienced by visitors during childhood;

2. examine differences in visitors' attitudes and emotions toward recreational forests across socio-demographic characteristics;
3. examine the relationships among childhood outdoor recreation experience, visitors' attitudes, and emotions toward recreational forests;
4. identify the factors influencing visitors' attitudes and emotions toward recreational forests; and
5. examine the mediating role of visitors' attitudes in the relationship between childhood outdoor recreation experience and emotions toward recreational forests.

1.3. Significance of Study

Research on nature-based recreation has largely focused on national parks, urban forests, and other forest environments, particularly in Western and African contexts. In comparison, empirical research on recreational forests in Malaysia, especially in northern Malaysia, remains limited (Hashim et al., 2025). Moreover, findings from other geographical and cultural contexts may not be directly transferable to Malaysia because of differences in environmental conditions, cultural practices, and recreational behaviours (Suki & Suki, 2023). This study addresses this gap by providing context-specific evidence from Sungai Sedim Recreational Forest (SSRF) on the relationship between childhood outdoor recreation experiences, adult attitudes, and emotional responses toward recreational forests. The findings may contribute to the literature on childhood experiences and recreational forest research while providing useful insights for forest managers, recreation planners, and policymakers seeking to encourage meaningful engagement with natural environments across the lifespan.

2. Methodology

2.1 Instrument Development, Validity, and Reliability

The primary survey instrument was engineered as a highly structured questionnaire and developed

in both English and Bahasa Melayu utilizing a rigorous back-to-back translation procedure. This approach was explicitly maintained to guarantee linguistic consistency, regional structural cross-comparability, and conceptual equivalence across both demographic target groups. Prior to launching field actions, the initial pool of indicators was subjected to a thorough content and face validity audit by an independent panel of several academic experts with direct expertise in environmental psychology, domestic ecotourism frameworks, and tropical forestry management. The experts systematically evaluated each item for clarity, practical relevance, situational suitability, and comprehensiveness. Their qualitative recommendations were integrated into a final revision of the instrument to maximize the precision of the indicators in capturing the target latent constructs. Following expert refinement, a pilot study was carried out to assess the practical clarity, interpretability, and internal consistency of the revised questionnaire. The pilot test involved an intercept sample of 40 adult visitors ($N = 40$) who possessed verified prior experience visiting recreational forest environments. Field operations for the pilot work were executed at the Sungai Sedim Recreational Forest (SSRF) from 26 May to 8 June 2023. This preparatory phase allowed the researchers to identify and resolve minor structural problems related to indicator wording, cross-language translation variations, and respondents' interpretation before investing resources into the macro-level survey. Internal consistency and scale stability were formally checked by calculating Cronbach's alpha coefficients, using a threshold value of .70 or above to retain indicators (Hair & Brunsveld, 2019). The psychometric properties derived from the pilot run demonstrated excellent structural reliability, with alpha coefficients returning at .915 for the 21 indicators of the Childhood Outdoor Recreation Experience (CORE) scale, and .893 for the 16 items comprising the Attitude construct. The three subscale dimensions of Emotion also achieved strong configurations, returning scores of .968 for Joy, .917 for Love,

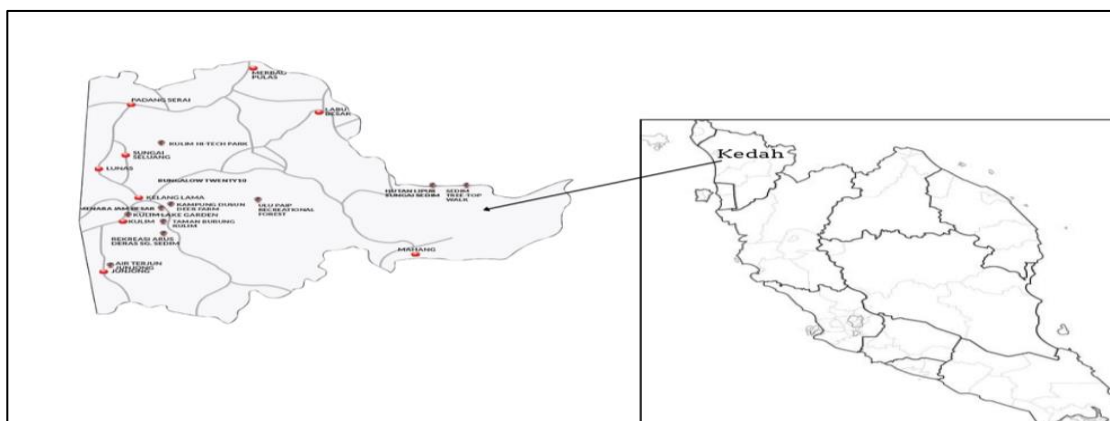
and .888 for Positive Surprise. Although the Joy subscale hit a high initial alpha value, raising potential questions regarding item redundancy, the indicators were retained and closely monitored during the primary data collection phase to check for common-method and acquiescence biases. The complete socio-demographic parameters and behavioral recreation backgrounds of the pilot cohort are omitted here for space conservation and are indexed separately in the appendix (see Supplementary Information, Tables S35 and S36).

2.2 Study Site Selection

This empirical investigation was conducted at the Sungai Sedim Recreational Forest (SSRF), geographically positioned at approximately 5.4071° N, 100.66146° E within the northern region of Peninsular Malaysia (Hashim et al., 2025). Administered within Compartment 15 of the Gunung Inas Forest Reserve, the site features a natural forest landscape characterized by mountainous terrain, low-lying river systems, and diverse tropical vegetation profiles. These specific environmental features support a

wide range of nature-based recreational opportunities, including a structural canopy walkway, managed camping grounds, river-based water sports, and extreme outdoor recreation services (Ismail & Kamarudin, 2023). The SSRF was selected as the research site because of its regional popularity, high accessibility, and diverse visitor pool. According to administrative records from the Kedah State Forestry Department, the complex received 32,739 registered visitors between January and June 2023, representing a substantial, active population from which participants could be drawn. Furthermore, the forest sits within driving distance of major northern population hubs, including Kulim, Alor Setar, Penang, and Perak. This structural proximity ensures a diverse cross-regional demographic sample, making SSRF a highly suitable setting for exploring the long-term relationships among childhood nature memories, adult attitudes, and emotional affinity (Marzuki et al., 2024). The geographic positioning and regional layout configurations of the selected reserve area are illustrated in Figure 1 below.

Figure 1: Geographical Location Map of the Sungai Sedim Recreational Forest (SSRF) within Kedah, Peninsular Malaysia.



2.3 Data Collection Procedures

Following the validation and scale adjustments completed during the pilot phase, the main face-to-face field survey was executed at the primary entrance points of the SSRF between September 2023 and January 2024. The sampling window covered weekdays, weekends, public holidays, and school holidays to capture a representative

sample across varying visitation intensities. Due to periods of heavy monsoon rain and temporary safety closures mandated during peak rainy intervals, the data collection timeline was extended over a five-month span to achieve the target volume (Omar et al., 2025). A purposive intercept sampling approach was utilized. Researchers approached visitors at the primary

entry gates and invited them to participate in the study. To ensure sample eligibility, a brief screening procedure was carried out based on three criteria: The participant must be a Malaysian citizen aged 18 years or older; They must have visited the SSRF at least once within the preceding 12 months; and They must have experienced visiting a recreational forest environment during their childhood formative years. Before completing the questionnaire, respondents were fully informed about the study's scientific purpose, the confidential nature of the data, and voluntary participation rules. The questionnaire was supplied in an A5-sized booklet in the respondent's preferred language (English or Bahasa Melayu). The face-to-face approach permitted researchers to provide real-time clarifications when participants encountered confusing terms, minimizing non-response rates and preventing missing data gaps. A total of 390 completed questionnaires were retrieved and retained for subsequent screening and data preparation.

2.4 Data Analysis Framework

The collected survey responses were numerically coded, cross-checked for data entry errors, and analyzed utilizing Microsoft Excel, IBM SPSS Statistics Version 27, and Hayes' PROCESS Macro Version 4.2. The analysis followed a structured, multi-step statistical workflow (Figure 2).

Data Cleaning and Residual Diagnostics:

The dataset was initially screened using an invariance audit to remove straight-lining cases. Multivariate outliers were then identified by computing Mahalanobis squared distances against a conservative chi-square threshold ($p < .001$). Normal distribution parameters were confirmed by calculating univariate and multivariate skewness and kurtosis values, while multicollinearity was assessed using tolerance values and Variance Inflation Factors (VIF).

Psychometric Factor Validation: Exploratory Factor Analysis (EFA) using Principal Component Analysis (PCA) with Direct Oblimin

oblique rotations was carried out across indicators. Component retention was guided by the Kaiser criterion (eigenvalues > 1.0), scree plot analysis, and a factor loading cutoff of 0.30. Scale reliability was subsequently re-evaluated using Cronbach's alpha coefficients (Hair & Brunsveld, 2019).

Descriptive and Inferential Variable Testing:

Mean scores and standard deviations were calculated to assess baseline trends across latent components. Identity-based group differences were evaluated using independent-samples t-tests for two-group configurations and one-way Analysis of Variance (ANOVA) for multi-category indicators, paired with post-hoc Tukey's Honestly Significant Difference (HSD) tests to isolate specific group splits (Pallant, 2020).

Predictive and Mediation Path Modeling:

Pearson product-moment correlation coefficients were calculated to establish initial linear relationships (Davis, 1971). Two separate simultaneous multiple linear regression equations were then calculated to determine the relative predictive value of demographics and CORE dimensions on adult Attitude and Emotion. Finally, path mediation verification was carried out utilizing Hayes' PROCESS Macro Model 4 (Hayes, 2022). The significance of the indirect path was evaluated using 5,000 bootstrap resamples; mediation was supported when the resulting 95% bias-corrected confidence interval completely excluded zero.

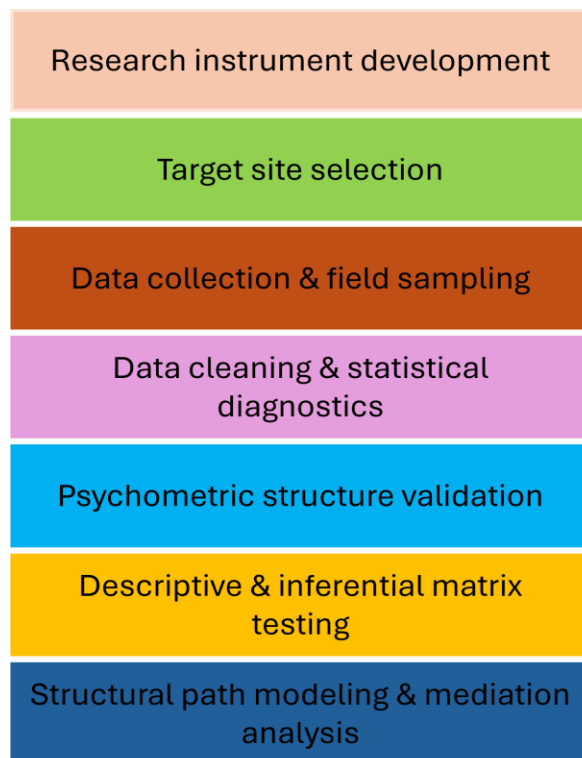


Figure 2 Research Methodology and Analysis Workflow

3. RESULTS AND DISCUSSIONS

3.1 Data Cleansing, Diagnostics, and Preliminary Screening

To establish a rigorous and methodologically sound foundation for structural hypothesis testing, the raw field dataset was subjected to a comprehensive two-phase psychometric and statistical data screening protocol. Initially, a pool of 410 structured questionnaires was personally administered and distributed to active visitors across the primary entry and recreation zones of the Sungai Sedim Recreational Forest (SSRF) between September 2023 and January 2024. Of these distributed instruments, a total of 390 completed questionnaires were successfully recovered from participants, representing a robust raw response rate of 95.1% (see Supplementary Information, Table S1). The field distribution was carefully executed across a balanced mixture of weekdays, weekends, public holidays, and school holidays to prevent temporal sampling bias (see Supplementary Information, Table S2). The raw survey data was subsequently

clean-coded into IBM SPSS Statistics Version 27 based on a nominal and ordinal assignment framework (see Supplementary Information, Table S3). To neutralize potential common-method variance and response acquiescence biases within the psychometric scales, five negatively worded item indicators mapping the Emotion (Joy) construct were subjected to a reverse-coding transposition before calculating composite subscale indices (see Supplementary Information, Table S4). Following data transformation, the dataset was screened using a sequential two-phase statistical cleaning strategy to manage invalid entries and extreme cases:

Invariance Response Audit: A strict visual and algorithmic pattern uniformity scan was conducted to detect non-differentiation in responses. This audit successfully identified and removed three straight-lining cases (Cases 115, 273, and 354) where respondents provided invariant values across separate instruments.

Multivariate Outlier Screening: Mahalanobis squared distances were computed across the remaining 387 active cases. Using a conservative significance threshold ($p < .001$), five extreme multivariate outliers (Cases 4, 214, 242, 303, and 304) were identified, with statistical distances spanning an anomalous range from 13.78 to 28.21 ($p = 0.0000$), and were purged from the master analytical pool (see Supplementary Information, Table S5).

Consequently, the final clean analytical sample size was established at $N = 382$ valid cases, yielding an effective data retention rate of 93.2% based on the initial distribution pool. Comprehensive distribution diagnostics confirmed that univariate skewness parameters fell safely below the absolute threshold value of 1.0, while multivariate skewness (0.576596) and kurtosis (14.390239) values sat well within the recommended guidelines for structural covariance models. Residual scatterplots confirmed homoscedasticity and linearity, and multicollinearity assessments yielded strong safety margins, with tolerance parameters exceeding 0.501 and all Variance Inflation

Factors (VIF) staying safely below 2.05 (see Supplementary Information, Table S6).

3.2 Participant Profiles and Behavioral Characteristics

The descriptive properties of the final sample ($N = 382$) are compiled in Table 1, which consolidates current socio-demographic configurations side-by-side with retrospective childhood profiles. The data highlights a heavily urbanized sample: 58.6% of respondents currently reside in urban zones, 23.0% in suburban areas, and 18.3% in rural communities. Gender distribution is balanced, showing a slight

male majority (52.1%) relative to female participants (47.9%). The sample is young, with 61.5% of the active visitor pool falling between 18 and 31 years of age. Ethnically, the sample is predominantly Malay (85.3%), with Chinese (11.5%) and Indian (3.1%) cohorts making up the remainder. The employment status shows high economic activity, with 69.1% of the sample employed and 57.3% reporting a middle-class monthly income between RM1,000 and RM5,000. Academic qualifications are strong; 66.2% of the respondents hold higher education credentials, including college diplomas, Bachelor's degrees, or postgraduate honors.

Table 1 Consolidated Socio-Demographic and Retrospective Childhood Profile ($N = 382$)

Demographic Dimension	n	%	Childhood Background	n	%
Current Community Type			Developmental Community Type		
Urban	224	58.6	Urban	191	50.1
Suburban	88	23.0	Suburban	76	19.9
Rural	70	18.3	Rural	115	30.1
Gender Identity			Childhood Travel Companions		
Female	183	47.9	Alone	4	1.0
Male	199	52.1	With Friends	133	34.8
Age Group Cohort			With Parents or Family	222	58.1
18–24	108	28.3	School or Club Excursion	23	6.0
25–31	127	33.2	Childhood Nature Activities		
32–38	70	18.3	Picnicking	289	75.7
39–45	40	10.5	Swimming	160	41.9
46–52	25	6.5	Camping	148	38.7
53–59	10	2.6	Hiking	77	20.2
60 and Above	2	0.5	Adult Recreation Importance		
Marital Status			Very Important	184	48.2
Single	190	49.7	Important	129	33.8

Married	182	47.6	Somewhat Important	65	17.0
Divorced	7	1.8	Not Important	4	1.0
Widowed	3	0.8	Primary Transportation		
Household Income Bracket			Private Car	329	86.1
No Income	84	22.0	Adult Travel Companions		
Under RM1,000	12	3.1	With Friends	167	43.7
RM1,000–RM5,000	219	57.3	With Children or Family	151	39.5
RM5,001–RM10,000	53	13.9	Adult Activities		
Above RM10,000	14	3.7	Picnicking	269	70.4
Formal Education Level			Swimming	139	36.4
Primary	4	1.0	Camping	132	34.6
Secondary	84	22.0	Hiking	96	25.1
Certificate	41	10.7			
Diploma	88	23.0			
Bachelor's Degree	141	36.9			
Postgraduate	24	6.3			

Note. Financial metrics are listed in Malaysian Ringgit (RM). Multiple-response items do not sum to 100%.

Contextually, Table 1 outlines that outdoor recreation holds high value for participants: 82.0% rate it as either very important (48.2%) or important (33.8%). Private cars are the primary mode of travel to the forest (86.1%). Adult trips are highly social, with respondents traveling with friends (43.7%) or family members (39.5%). Picnicking is the most common adult activity (70.4%), followed by swimming (36.4%), camping (34.6%), and hiking (25.1%).

Retrospective calculations tracking childhood experiences show that 50.1% grew up in urban environments. Early childhood forest visits were predominantly family-centric, with 58.1%

accompanied by parents or family members (Cordell et al., 2023). Picnicking was the main childhood activity (75.7%), followed by swimming (41.9%), camping (38.7%), and hiking (20.2%). This close alignment between childhood and adult activity patterns points to a potential generational continuation of outdoor recreation styles within Malaysian families (Skar & Krogh, 2024).

3.3 Psychometric Scale Architecture and Latent Variable Assessment

To confirm the dimensional structure of the latent variables, three separate Exploratory Factor Analyses (EFAs) were performed using Principal Component Analysis (PCA) with Direct Oblimin oblique rotations.

- The 21 indicators of the Childhood Outdoor Recreation Experience (CORE) scale settled into four factors (Societal and Cultural Influence, Interpersonal Influence, Environmental Influence, and Individual Influence) that explained 63.28% of the total cumulative variance (see Supplementary Information, Tables S6, S7, and S8).
- The 16 items measuring adult Attitude yielded two components (Forest Amenities and Accessibility and Restorative Experience) explaining 64.50% of the variance (see Supplementary Information, Tables S9, S10, and S11).
- The 15 items mapping current Emotion produced three components (Joy, Love, and Positive Surprise) explaining 79.61% of the cumulative variance (see Supplementary Information, Tables S12, S13, and S14).

Table 2 Measurement Scale Properties and Latent Descriptives

Construct / Component	Dimension	Items	Cronbach's Alpha	Mean	SD	Strength	Interpretation
Childhood Experience (CORE)							
Societal and Cultural Influence	6	0.837	3.42	0.98	Very Good		
Interpersonal Influence	7	0.909	3.78	0.86	Excellent		
Environmental Influence	6	0.805	3.95	0.81	Very Good		
Individual Influence	2	0.695	3.88	0.99	Moderate		
Adult Attitude							
Forest Amenities	13	0.945	4.31	0.64	Excellent		
Accessibility and Restorative Exp.	3	0.765	3.99	0.78	Good		
Adult Emotion Metrics							
Joy (Reverse-Coded Baseline)	5	0.950	4.32	0.67	Excellent		
Love	5	0.930	4.21	0.78	Excellent		
Positive Surprise	5	0.869	4.08	0.71	Very Good		

As detailed in Table 2, internal consistency reliability was strong across scales based on standard psychometric benchmarks (Hair & Brunsveld, 2019; see Supplementary Information, Table S15), with Cronbach's alpha values ranging from 0.695 to 0.950. While Individual Influence sat slightly at the edge of the standard alpha threshold (0.695), this outcome is expected given the constraint of its brief two-item structure, remaining mathematically acceptable for

exploratory research (Larson et al., 2024). Notably, the main study alpha value for the Joy subscale score settled at 0.950. This represents a slight decline from its pilot-test value of 0.968, indicating that the introduction of the reverse-coded items successfully minimized agreement bias and improved scale diversity.

Item-level descriptive patterns show distinct trends within constructs. For Societal and

Cultural Influence, parental time availability recorded the highest mean (see Supplementary Information, Table S16; $M = 3.81$, $SD = .935$), whereas infrastructure proximity was lowest ($M = 3.20$, $SD = 1.172$). Under Interpersonal Influence, active parental support scored highest (see Supplementary Information, Table S17; $M = 4.03$, $SD = .896$), while family cultural background was lowest ($M = 3.49$, $SD = 1.049$). For Environmental Influence, local weather conditions were highest (see Supplementary Information, Table S18; $M = 4.17$, $SD = 0.809$), and gender equality was lowest ($M = 3.78$, $SD = .926$). Individual Influence was highest for friend group behaviors (see Supplementary Information, Table S19; $M = 4.06$, $SD = 0.890$).

Regarding adult Attitude, cleanliness returned the highest value (see Supplementary Information, Table S20; $M = 4.52$, $SD = .671$), while food and drink stalls scored lowest ($M = 4.18$, $SD = 0.861$). For Accessibility and Restorative Experience, natural water features scored highest (see Supplementary Information, Table S21; $M = 4.23$, $SD = .776$), whereas urban proximity was lowest

($M = 3.71$, $SD = .984$). Across emotional vectors, mean values were positive: Joy indicators spanned between 4.28 and 4.34 (see Supplementary Information, Table S22), Love tracked from 4.12 to 4.25 (see Supplementary Information, Table S23), and Positive Surprise ranged between 3.60 and 4.24 (see Supplementary Information, Table S24).

3.4 Inferential Group Variance Frameworks

To address Research Objective 2, independent-samples t-tests and one-way Analyses of Variance (ANOVA) were computed across participant demographic markers (Pallant, 2020). Gender comparisons revealed no significant differences for Forest Amenities or Accessibility and Restorative Experience (see Supplementary Information, Table S25; $p > .05$), nor across Joy, Love, or Positive Surprise (see Supplementary Information, Table S26; $p > .05$), illustrating that gender socialization does not alter environmental processing in this context. The minimum requirement of 30 cases for approximate residual normality was safely fulfilled across groupings (Field, 2024).

Table 3 Significant Socio-Demographic Group Variances (One-Way ANOVA Matrix)

Source Predictor	Dependent Dimension	df	F-Value	p-value	Post-Hoc Comparison
Marital Status	Forest Amenities	3, 378	3.796	.011	Married > Single ($p < .05$)
	Positive Surprise	3, 378	2.926	.034	Non-significant
Ethnic Background	Love	2, 379	4.019	.019	Non-significant
	Positive Surprise	2, 379	5.935	.003	Malay > Chinese ($p < .01$)

Note. Non-significant predictors (Gender, Age, Income, Education, Employment, Community Type) are omitted for space conservation (see Supplementary Information, Table S27).

In contrast, the significant group splits captured via one-way ANOVAs are consolidated in Table 3. Forest Amenities differed significantly by marital status ($F(3, 378) = 3.796$, $p = .011$). Tukey's HSD test located a distinct pairwise difference ($p = .032$), demonstrating that married

individuals ($M = 4.39$) gave significantly higher scores to amenities than single visitors ($M = 4.22$). This indicates that family-oriented visitors look more favorably upon managed facility components, likely because their recreation styles depend on child safety and accessibility infrastructures (Izenstark & Ebata, 2022).

Furthermore, a significant difference was observed for Positive Surprise based on self-reported ethnicity ($F(2, 379) = 5.935$, $p = .003$).

Tukey's HSD tracking pinpointed that Malay visitors ($M = 4.13$) reported a significantly higher sensation of awe compared to Chinese visitors ($M = 3.76$, $p = .003$). This ethnic differentiation aligns with localized findings showing varying cultural interpretations of landscape restorative properties among Malaysian ethnic cohorts (Suki & Suki, 2023). While the overall ANOVA models for marital status on Positive Surprise ($p = .034$) and ethnicity on Love ($p = .019$) were significant, post-hoc checks did not find isolated group-to-group configurations, pointing to diffused variances across those subgroups. All remaining demographics showed complete statistical uniformity (see Supplementary Information,

Table S27; $p > .05$), matching standard baseline frameworks (see Supplementary Information, Table S28), while primary linear dependencies are archived separately (see Supplementary Information, Tables S29 and S30).

3.5 Structural Regression Analysis

Two separate simultaneous multiple linear regression models were calculated to determine the relative predictive value of the independent variables. Multicollinearity diagnostics confirmed the models were stable, with VIF metrics falling safely below the conservative boundary (VIF less than or equal to 2.05).

Table 4 Simultaneous Multiple Linear Regression Matrix for Attitude and Emotion Formations

Predictor Element	Model 1: Adult Attitude (Beta)	Model 1: t-value	Model 1: p-value	Model 2: Adult Emotion (Beta)	Model 2: t-value	Model 2: p-value
Community Type	0.004	0.10	.920	-0.089	-1.92	.055
Gender Identity	-0.075	-1.73	.085	-0.057	-1.23	.220
Ethnic Background	-0.004	-0.08	.936	-0.113	-2.36	.019*
Marital Status	0.052	0.99	.322	0.015	0.27	.786
Employment Status	0.053	0.93	.352	0.006	0.10	.921
Income Level Bracket	0.113	1.88	.060	0.071	1.10	.270
Formal Education Level	0.102	2.25	.025*	0.126	2.61	.009**
CORE Dimensions:						
Societal & Cultural Influence	-0.030	-0.49	.625	0.020	0.30	.762
Interpersonal Influence	0.504	9.98	.000***	0.353	6.57	.000***
Environmental Influence	-0.046	-0.77	.443	-0.158	-2.47	.014*
Individual Influence	0.098	2.00	.046*	0.103	1.98	.049*

Model	R² = .339	Adj. = .317	R² F = 15.742*	= R² = .250	Adj. = .226	R² F = 10.262*	=
Diagnostics							

Note. Multi-variable models fit within safe bounds (Tolerance greater than 0.489; VIF less than 2.046). Diagnostics for overall models: $F(12, 369) = 15.742$, $p < .001$ for Attitude; $F(12, 369) = 10.262$, $p < .001$ for Emotion. Significance levels: * $p < .05$, ** $p < .01$, *** $p < .001$.

As detailed in the combined matrix in Table 4, Model 1 treated adult Attitude as the primary dependent variable and was highly significant (see Supplementary Information, Table S31; $F(12, 369) = 15.742$, $p < .001$), explaining 33.9% of the variance. Interpersonal Influence emerged as the dominant positive predictor ($\beta = .504$, $t = 9.979$, $p < .001$), demonstrating that children who regularly visited natural forests with parents or family develop much stronger positive evaluations of forest amenities as adults. Individual Influence ($\beta = .098$, $p = .046$) and Education Level ($\beta = .102$, $p = .025$) also served as significant positive predictors (see Supplementary Information, Table S33).

Model 2 treated adult Emotion as the dependent variable (see Supplementary Information, Table S32; $F(12, 369) = 10.262$, $p < .001$), explaining 25.0% of the variance. Interpersonal Influence again served as a highly positive predictor ($\beta = .353$, $t = 6.570$, $p < .001$), paired alongside

Individual Influence ($\beta = .103$, $p = .049$) and Education Level ($\beta = .126$, $p = .009$), showing that peer interactions and childhood outdoor play maintain long-term significance (Wang & Zhang, 2026).

Interestingly, Environmental Influence acted as a significant negative predictor ($\beta = -.158$, $t = -2.465$, $p = .014$). This negative link suggests that childhood outdoor memories dominated by external structural conditions such as bad weather restrictions or heavy dependency on mass media portrayals rather than direct physical immersion can depress adult emotional connection during visits (see Supplementary Information, Table S34; Truong et al., 2024). Finally, Ethnicity showed a significant negative weight ($\beta = -.113$, $p = .019$), capturing the baseline drop in emotional scores among minority cohorts observed in the earlier ANOVA checks.

3.6 Structural Path Mediation Verification

To test the central structural hypothesis H3, path verification using Hayes' PROCESS Macro (Model 4) was executed with 5,000 bootstrap resamples (Hayes, 2022).

Table 5 Structural Path Mediation and Bootstrapped Structural Parameters

Trajectory Relationship	Path Unstandardized Coefficient (B)	Standard Error (SE)	t-value	p-value	Empirical Result
CORE to Attitude (Path a)	0.3182	0.0321	9.9128	< .001	Supported
Attitude to Emotion (Path b)	0.5987	0.0416	14.3918	< .001	Supported
CORE to Emotion (Total Effect c)	0.1751	0.0637	2.7502	.0062	Supported

CORE to Emotion (Direct Effect c')	-0.0154	0.0534	-0.2884	.7732	Non-significant
Mediation Mechanism Type	Effect Size	Boot SE	95% Lower CI	95% Upper CI	Mediation Status
Indirect Path: CORE to ATT to EMO	0.1905	0.0393	0.1147	0.2669	Full Mediation

Note. Bootstrapping parameters rely on 5,000 extraction runs. The exclusion of zero within the confidence limit indicates supported mediation ($p < .05$).

The structural path estimates detailed in Table 5 reveal a highly structured psychological chain. First, the impact of childhood outdoor experiences on adult attitudes (Path a) is positive and highly significant ($\beta = 0.3182$, $p < .001$). Second, controlling for early childhood memories, the direct relationship between adult attitude and current emotional response (Path b) is likewise highly positive and meaningful ($\beta = 0.5987$, $p < .001$). The total statistical effect of CORE on adult emotions (Path c), calculated without entering the mediator, is clearly significant ($\beta = 0.1751$, $p = .0062$).

Crucially, however, once adult Attitude is introduced as the intentional mediator, the direct effect of early childhood recreation experience on adult emotions (Path c') drops to near zero and

completely loses significance ($\beta = -0.0154$, $p = .7732$).

This complete loss of direct statistical significance confirms the presence of full mediation within the model. The bootstrap analysis confirms a strong indirect effect size of 0.1905 (Boot SE = 0.0393), with a 95% bias-corrected bootstrap confidence interval spanning safely from 0.1147 to 0.2669. Because this interval completely excludes zero, the mediation mechanism is statistically supported, confirming that early childhood nature play influences adult emotions primarily through the development of favorable cognitive attitudes toward recreational forests (Dadvand et al., 2024; Hartig & Staats, 2025). The conceptual layout of this structural mechanism, detailing the pathways between the independent variable, the cognitive mediator, and the dependent emotional vectors, is visualized in Figure 3

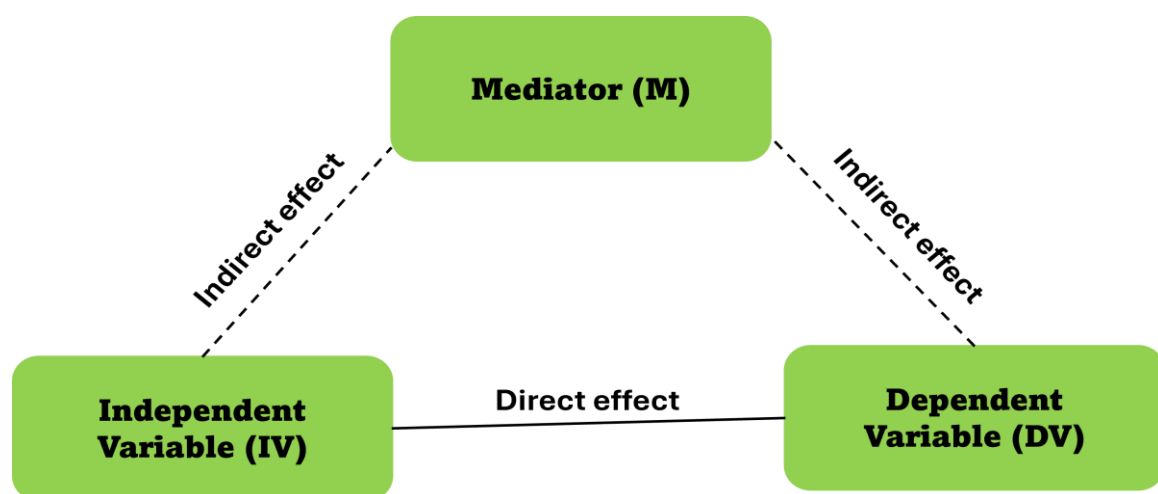


Figure 3: The Mediator Variable Conceptual Model Framework.

Furthermore, the validated statistical path framework displaying the calculated unstandardized path coefficients alongside the direct versus total effect drops is illustrated in Figure 4.4 below.

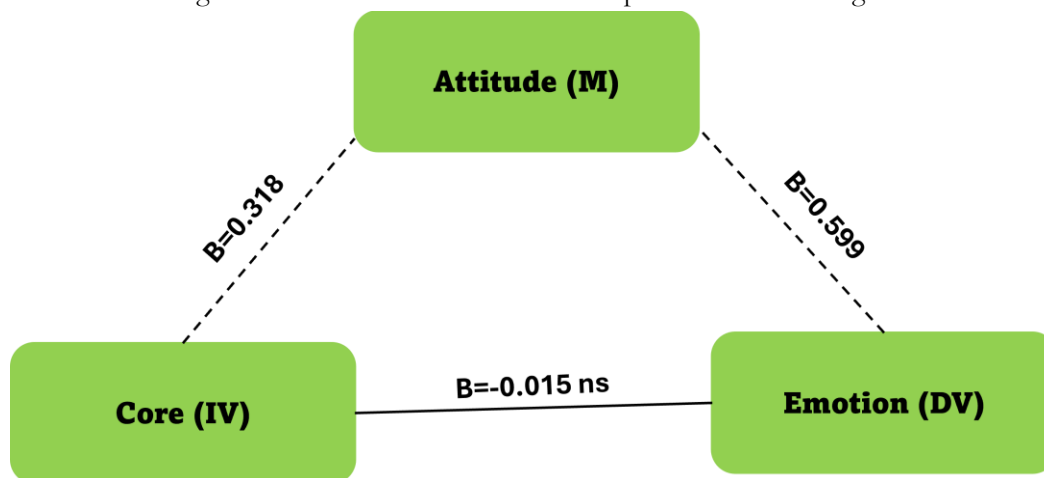


Figure 4 Mediating role of Attitude between CORE and Emotion with Statistical Coefficients.

Post-Mediation Path Interpretations and Theoretical Alignment. The empirical confirmation of full mediation as illustrated in the path models carries profound implications for both theoretical environmental psychology and the operational management of recreational forest areas. Statistically, the complete reduction of the direct effect trajectory (Path c to non-significance ($\beta = -0.0154$, $p = .7732$)) demonstrates that early childhood nature play does not function as an automatic, linear generator of adult emotional affinity. Instead, the psychological translation of early-life experiences into adulthood occurs through a complex cognitive restructuralization process. Formative interactions within childhood microsystems such as family picnicking, peer swimming, and school excursions—must first be processed, stored, and successfully converted into stable, positive adult cognitive evaluations regarding forest infrastructure security, amenity availability, and restorative capacity. It is this consolidated positive attitude that ultimately acts as the necessary psychological catalyst required to release positive emotional responses, such as joy, love, and environmental awe, during subsequent adult visits. This complete mediation mechanism provides strong empirical support for

Bronfenbrenner's Ecological Systems Theory, particularly emphasizing the profound developmental power of proximal processes occurring within an individual's micro- and mesosystems. The interpersonal support systems, parental role modeling, and peer group dynamics experienced during childhood nature interactions do not remain isolated memories. Rather, they establish a cognitive baseline a perceptual filter through which natural landscapes are evaluated decades later. When adults encounter an environment like the Sungai Sedim Recreational Forest, their immediate emotional response is governed by how well the current physical landscape matches the positive cognitive constructs built during childhood. Consequently, if childhood outdoor recreation fails to foster favorable attitudes toward park infrastructure, accessibility, and environmental cleanliness, the direct emotional connection to nature in adulthood is significantly weakened. Furthermore, these findings align directly with the contemporary "extinction of experience" literature, which warns that rapid urbanization and indoor, screen-based lifestyles are severing these critical developmental trajectories (Gaston & Soga, 2020; Soga et al., 2025). When children are deprived of

unstructured, socially supported contact with natural forest reserve assets, they fail to build the necessary cognitive attitudes that view natural areas as safe, welcoming, and restorative spaces. This lack of positive cognitive framing creates a psychological barrier, preventing the development of adult environmental empathy, emotional attachment, and protective behaviors. By explicitly mapping adult attitude as the full mediator between early memory and current emotion, this model clarifies the precise psychological pipeline through which early-life exposure protects individuals against modern landscape alienation. It provides a robust, empirical framework proving that long-term environmental attachment is a product of early cognitive value construction.

4. Conclusions

This study explored the long-term impact of Childhood Outdoor Recreation Experience (CORE) on adult attitudes and emotional alignments at the Sungai Sedim Recreational Forest (SSRF) in Malaysia. Retrospective profiles confirmed that early childhood exposure was family-centric and dominated by unstructured play, notably picnicking (75.7%) and swimming (41.9%). Inferential group matrices showed that broad socio-demographic factors like gender, age, and income do not systematically alter adult viewpoints. However, marital status significantly influenced facility appreciation, and ethnic background predicted variations in environmental awe, proving that specific micro-system cultural and family frameworks do shape selected aspects of forest recreation (Muñoz et al., 2023; Pouso et al., 2025).

Simultaneous regression models identified proximal Interpersonal Influence as the single most powerful positive predictor of both adult cognitive attitudes ($\beta = .504, p < .001$) and current emotional states ($\beta = .353, p < .001$). This confirms the validity of Bronfenbrenner's Ecological Systems Theory, where immediate

family role modeling, peer group play, and school excursions serve as the foundational root of lifelong environmental attachment. Conversely, a significant negative path emerged for Environmental Influence ($\beta = -.158, p = .014$), illustrating that restrictive early conditions, such as weather issues or heavy media reliance instead of raw natural immersion, can reduce adult emotional spontaneity.

Crucially, path mediation testing confirmed that adult Attitude fully mediates the relationship between childhood play and adult emotions, yielding a highly significant indirect effect size of 0.1905 (95% Bootstrap CI [0.1147, 0.2669]). This finding addresses a key missing link in environmental psychology: early childhood exposure does not automatically yield adult emotional bonds (Ulrich et al., 2024). Instead, childhood play is processed and built into positive cognitive value systems regarding forest amenities, safety, and restorative accessibility, which then trigger positive emotional responses during adult visits (Zhang & Oh, 2025).

For forest managers, ecotourism planners, and policymakers, these results give a clear direction. To fight the modern "extinction of experience" brought on by rapid urbanization, managed forests must look beyond survival or wilderness maintenance alone (Ramlee & Rahman, 2024). Planners should prioritize family-inclusive infrastructures, safe river access zones, clean basic facilities, and joint family-school nature activities (Ismail & Kamarudin, 2023). Transforming early physical nature play into lasting cognitive attitudes will help forest management ensure enduring emotional commitments to environmental conservation across generations.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data will be provided on demand

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