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Development and Validation of the Healthy Lifestyle Scale (HLS) for Regions with Icy Winters and Dry Summers

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Abstract The present study aimed to develop and validate the Healthy Lifestyle Scale (HLS), a culturally and environmentally specific instrument designed to assess health-promoting behaviors in populations residing in climatically extreme and geographically isolated regions such as Jammu, Kashmir, and Ladakh. These areas experience long, cold winters, frequent snowfall, and dry summers, which pose significant challenges to maintain a healthy lifestyle. Existing lifestyle assessment tools are often developed for temperate urban contexts and fail to account for behaviors influenced by seasonal adaptation, isolation, limited access to fresh food, and restricted mobility. The HLS was constructed through a mixed-method approach involving literature review, expert consultation, and pilot testing, followed by rigorous psychometric evaluation to address this gap. A sample of 517 participants from the target regions completed the initial scale. Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) supported a nine-factor model encompassing physical activity, healthy diet, stress management, hydration, substance use avoidance, preventive health, personal hygiene, environmental responsibility, and social well-being. The model demonstrated good fit indices (CFI = 0.93, IFI = 0.92, CMIN/DF = 3.645); all standardized factor loadings exceeded 0.50. The scale exhibited high test-retest reliability ($r = 0.855$, $p < 0.001$), indicating strong temporal stability. Expert review ensured content and criterion validity were confirmed via significant correlations with established health behavior instruments such as the HPLP-II, CSI, PEBS, DAST, and SSQ ($r = 0.64$ to 0.82, $p < 0.001$). Regression analysis supported predictive validity, with HLS scores significantly predicting real-world behaviors across multiple domains ($\beta = 0.39$ to 0.56, $p < 0.001$). The relevance of this scale is further reinforced by existing studies emphasizing region-specific interventions to promote health behavior, such as a health literacy initiative in Northern Thailand and research highlighting the role of healthy lifestyles in reducing anxiety during the COVID-19 pandemic. These findings underscore the importance of culturally responsive tools in guiding public health interventions. The HLS emerges as a reliable, valid, and practical tool for researchers, health professionals, and policymakers working in underserved or ecologically

sensitive environments. Its future use may extend to other regions with similar challenges, supporting global efforts in personalized health promotion and sustainable lifestyle interventions.

Keywords Healthy Lifestyle, Scale Development, Cold Climate, Health Behavior, Physical Activity, Healthy Diet, Stress Management, Preventive Health, Substance Use Avoidance, Environmental Responsibility, Social Well-Being

1. Introduction

Certain regions, such as those with harsh climates, pose significant challenges for residents striving to maintain a healthy lifestyle. For instance, areas like Jammu and Kashmir, Ladakh, and Manali in India, which experience long, snowy winters and hot, dry summers, undergo dramatic seasonal changes that impact physical activity, dietary patterns, mental well-being, and overall quality of life. The remote location and limited accessibility of these regions during certain times of the year further exacerbate daily life and health issues. Consequently, there is a growing need for culturally and environmentally responsive assessment tools that account for such regions' unique socioeconomic, climatic, and behavioral contexts to evaluate and promote sustainable healthy living practices effectively.

Existing health behavior assessment scales, largely developed in urban or temperate settings, fall short when applied to cold-climate regions. For example, standard tools do not capture context-specific behaviors like snow shoveling, seasonal dietary shifts, or reduced mobility due to weather, which are critical to daily life in regions such as Kashmir and Ladakh. These limitations hinder the design of effective, evidence-based public health interventions. Therefore, a tailored approach to lifestyle assessment is essential for these communities [1].

Informed by both public health needs and contextual realities, this study introduces the Healthy Lifestyle Scale (HLS)—a culturally grounded and climate-sensitive measurement tool designed to assess key domains of healthy living. The development of the HLS draws upon multiple theoretical frameworks. The Health Belief Model (HBM) underpins domains such as preventive health, substance use avoidance, and stress management, highlighting perceived susceptibility and barriers to health-promoting behaviors. The Social Ecological Model and Health Promotion Theory informs domains like social well-being and environmental responsibility by recognizing that interpersonal, community, and environmental influences shape individual health behaviors. Meanwhile, health literacy theory guides the design of scale items for hydration, diet, and hygiene—ensuring accessibility for individuals with diverse educational backgrounds.

The researchers, themselves residents of regions with prolonged winters and dry summers, designed the HLS to reflect everyday health behaviors across multiple phases: physical activity, nutrition, stress management, preventive health, substance abuse, social well-being, and environmental adaptation. The World Health Organization's emphasis on context-sensitive health treatment and intervention supports the essential requirements of such a region-specific tool [2], [3].

Physical activity in these regions often differs from that in milder climates, necessitating adaptations like snowshoeing, ice skating, or skiing. Analysis has recommended that integrating traditional winter activities—such as snowboarding, tobogganing, and snowmobiling—can enhance physical fitness, strength, and comfort [4]. Similarly, high-energy diets and limited access to fresh produce in winter months demand consideration in nutritional assessments. Studies indicate that such nutritional adaptations are essential in maintaining health and well-being [5]. However, due to prolonged blizzard snowfall, ease of access to these areas remains suspended from the city, prompting residents to rely on nonseasonal dried foods, often leading to nutritional deficiencies. In addition, elongated winters and reduced sunlight contribute to distress, emotional instability, and seasonal affective disorders. Addressing these issues requires proactive strategies such as structured routines and community-level engagement [6], [7].

Social interactions—through meaningful conversations, traditional events, and volunteering—play a critical role in maintaining mental and emotional well-being. Community gatherings and cultural traditions offer essential opportunities for resilience and social bonding. Furthermore, environmentally adaptive behaviors, such as acclimatization to high altitudes, energy conservation, and sustainable waste management, are vital in ecologically sensitive regions [8], [9], [10], [11].

The HLS was developed using a mixed-method approach that included focus group discussions and interviews with residents, health professionals, and community leaders across Jammu, Kashmir, Ladakh, and Manali to ensure ecological and cultural validity. The resulting scale integrates traditional practices with modern health recommendations, making it a practical tool for researchers, policymakers, and health professionals.

Ultimately, the Healthy Lifestyle Scale (HLS) contributes to improved health status and supports region-specific public health policies by bridging the gap between global health assessment tools and the unique challenges of cold and parched regions. This study contributes to the growing body of research on tailored health interventions and provides a framework for future investigations and policy development in similar climatic zones.

2. Materials and Methods

The development and validation of the Healthy Lifestyle Scale (HLS) followed a structured Research and Development (R&D) approach, comprising four essential phases: (1) identifying the problems and contextual needs of the target population, (2) creating and auditing the scale through expert consultation, (3) trialing the model through pilot evaluation, and (4) evaluating the instrument through large-scale statistical validation. This multi-phase framework ensured the development of a psychometrically robust and context-sensitive instrument, particularly tailored for regions with harsh climates.

2.1. Research Design

This study adopted a cross-sectional, mixed-method design conducted in accordance with the four-step R&D framework. In the first step, the researchers conducted an extensive needs assessment through a literature review and consultations with regional stakeholders to identify context-specific healthy lifestyle challenges. A scale prototype model was created in the second step, followed by an expert audit and revision. The third step involved pilot testing the instrument with a small population to assess clarity and feasibility. In the fourth and final step, the model underwent summative evaluation using advanced statistical methods to confirm its structure and reliability.

2.2. Research Type and Duration

The study was conducted over a period of 34 months and was divided into three sequential phases. Phase 1, lasting six months, focused on literature review and initial item generation. Phase 2 spanned four months and involved expert validation and pilot testing. Phase 3 was the longest, extending over 24 months, and included large-scale data collection, statistical validation, and refinement of the final scale.

2.3. Inclusion and Exclusion Criteria

Participants were selected based on defined inclusion and exclusion criteria to ensure appropriate representation. Eligible individuals were adults between the ages of 18 and 55 residing in the cold and dry regions of Jammu and Kashmir, Ladakh, or similar geoclimatic areas. Participants were required to have basic literacy skills to complete the questionnaire independently and to provide informed consent voluntarily. Individuals with cognitive impairments or severe medical conditions requiring close supervision were excluded from the study to avoid confounding influences on data quality.

2.4. Participants

The study included a sample of 517 participants, randomly selected from a range of occupational and demographic backgrounds, including university students, government and private sector employees, and members of the general population from Jammu, Kashmir, and Ladakh. The diversity of the sample ensured the broad applicability of the scale. A follow-up survey was conducted with the same participants after a four-week interval to assess test-retest reliability. Of the original group, 397 individuals completed the retest. The decrease in sample size was due to attrition caused by participant unavailability at the time of follow-up.

2.5. Data Collection

Data were collected using a self-administered questionnaire comprising 43 items, each aligned with one of the nine predefined lifestyle domains: Physical Activity, Healthy Diet and Nutrition, Hydration, Stress Management, Personal Hygiene, Sleep and Rest, Environmental Responsibility, Social Well-being, and Substance Use Avoidance & Preventive Health. Each item was phrased as a Yes/No statement, scoring 1 for Yes and 0 for No. This format was intentionally selected to simplify comprehension and promote inclusion across varying literacy levels.

2.6. Scale Development

Domain identification was guided by a comprehensive review of literature accessed through ShodhGanga, ResearchGate, PubMed, Scopus, and Google Scholar. This review led to the selection of six central themes: Physical Activity, Balanced and Seasonal Nutrition, Stress Awareness and Coping Mechanisms, Healthy Choices and Responsible Health Practices, Daily Health and Hygiene Practices, and Eco-Conscious Lifestyle. Additional context-relevant dimensions such as social engagement, climate adaptability, and emotional well-being were incorporated to enhance cultural appropriateness.

Item generation was conducted collaboratively by a multidisciplinary team of public health professionals, physical education specialists, and psychologists. A modified Delphi technique involving three iterative rounds of expert review was employed to refine item clarity and relevance. The Yes/No format was maintained throughout for accessibility.

Expert validation followed, with five senior health and behavioral sciences professionals evaluating the 43-item draft. Items were retained based on an Item Content Validity Index (I-CVI) threshold of 0.78 or higher, and the overall scale demonstrated a scale-level CVI of 0.85. Expert suggestions led to minor revisions, including incorporating regional references, such as local dietary habits and traditional physical activities.

A pilot test involving 50 participants was then carried out to assess the instrument's clarity, ease of understanding, and time required for completion. Feedback from this stage

was used to make minor wording adjustments.

2.7. Statistical Analysis

Descriptive statistics, including mean, standard deviation, skewness, and kurtosis, were computed for all items to assess response variability and distribution characteristics. Exploratory Factor Analysis (EFA) was employed using Principal Axis Factoring and Oblimin rotation. The Kaiser-Meyer-Olkin (KMO) measure yielded a value of 0.696, and Bartlett's test of sphericity was significant ($\chi^2 = 3561.295$, df = 903, $p < 0.001$), confirming the adequacy of the data for factor analysis. Items were grouped into coherent factors aligning with the nine lifestyle domains.

Confirmatory factor analysis (CFA) was conducted using Structural Equation Modeling (SEM) to confirm the structure identified in EFA. The model adopted a reflective measurement model structure, where observed variables were seen as manifestations of underlying latent constructs. Error terms were modeled for each observed variable, and the structure included both endogenous and exogenous variables. Model fit was evaluated using multiple indices: the chi-square/df ratio (CMIN/DF = 3.645), the Comparative Fit Index (CFI = 0.93), the Incremental Fit Index (IFI = 0.92), the Normed Fit Index (NFI = 0.87), and the Parsimony Ratio (PRATIO = 0.83). These results indicated that the model was acceptable to fit with the observed data well.

Reliability analysis was performed through a test-retest approach due to limitations in computing Cronbach's alpha for single-item domains. Pearson's correlation coefficient ($r = 0.855$, $p < 0.01$) demonstrated excellent consistency over time.

To address multicollinearity, Variance Inflation Factor (VIF) and Tolerance values were calculated both before and after regression analyses. All values were within acceptable limits (VIF < 10, Tolerance > 0.1), indicating the absence of multicollinearity among the independent variables.

Validity testing was conducted on three fronts. Content validity was confirmed through expert consensus. Criterion validity was assessed by correlating HLS scores with existing validated subscales from the Health-Promoting Lifestyle Profile-II (HPLP-II) [12], Coping Strategies Inventory (CSI) [13], Pro-Environmental Behavior Scale (PEBS) [14], Drug Abuse Screening Test (DAST) [15], and Social Support Questionnaire (SSQ) [16]. The correlations ranged from $r = 0.64$ to 0.82, all statistically significant at $p < 0.001$. Predictive validity was evaluated through regression analysis, which showed that HLS scores were significant predictors of actual health behaviors ($p < 0.001$).

2.8. Ethical Considerations

The study received ethical approval from the institutional review board. All participants provided informed consent and were briefed on the voluntary nature of their involvement. Confidentiality and anonymity were strictly maintained throughout the study.

3. Results

This section deals with the statistical analysis of the data, their results, and their interpretation.

1. Descriptive Analysis of the Scale Items

The initial phase of data analysis involved assessing the distribution and variability of responses to each of the 43 items of the Healthy Lifestyle Scale (HLS). Table 1 presents the descriptive statistics for all items, including mean, standard deviation, skewness, and kurtosis values.

The mean scores across items ranged from 0.30 to 0.74, indicating moderate endorsement levels. Most items centered around the 0.5 mark, which suggests a balanced distribution of responses, avoiding ceiling or floor effects. The standard deviations, consistently close to 0.5, reflect adequate variability in participant responses, which is desirable for scale development.

In terms of univariate normality, the skewness values for all items fall within the acceptable range of −1 to +1, indicating no severe asymmetry. The kurtosis values, while mostly negative, suggest platykurtic (flatter-than-normal) distributions, which are typical in dichotomous (yes/no) data but not problematic for exploratory factor analysis (EFA).

Furthermore, the distribution patterns across items suggest that the scale captures a broad range of health-related behaviors without over-representing any single domain. These initial findings support the psychometric adequacy of the item pool and justify proceeding to multivariate analyses, including factor analysis and model validation.

2. Exploratory Factor Analysis (EFA)

In order to uncover the underlying latent structure of the Healthy Lifestyle Scale (HLS), an Exploratory Factor Analysis (EFA) was conducted on the 43-item dataset. Prior to extraction, sampling adequacy and data suitability for factor analysis were assessed.

The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.696, which falls within the acceptable range (≥ 0.60), suggesting sufficient intercorrelations among variables to proceed with factor analysis. Additionally, Bartlett's Test of Sphericity yielded a highly significant result ($\chi^2 = 3561.295$, df = 903, $p < 0.001$), indicating that the correlation matrix was not an identity matrix and that factor analysis was appropriate. These results are summarized in Table 2.

The factor analysis employed Principal Axis Factoring (PAF) as the extraction method, suitable for non-normally distributed data, and Oblimin rotation to allow for correlated factors, which is appropriate given the interrelated nature of lifestyle domains.

Table 1. Descriptive Statistics for the Healthy Lifestyle Scale Items

Item no.	Item Description	Mean	SD	Skewness	Kurtosis
1	I engage in at least 30 minutes of moderate physical activity most days of the week, such as brisk walking, trekking, traditional games, or household chores.	0.59	0.49	-0.36	-1.88
2	I participate in vigorous physical activities (e.g., jogging, cycling, or home workouts) that elevate my heart rate for at least 20 minutes three days a week.	0.48	0.50	0.08	-2.00
3	I include flexibility exercises thrice weekly in my routine, such as stretching or yoga.	0.41	0.49	0.37	-1.87
4	I perform muscle-strengthening exercises, like bodyweight exercises or resistance training, at least twice a week	0.42	0.49	0.33	-1.90
5	I eat three balanced meals every day, including a healthy breakfast.	0.60	0.49	-0.40	-1.85
6	I include foods from all major food groups in my daily diet (vegetables, fruits, grains, proteins, and dairy).	0.46	0.50	0.14	-1.99
7	I avoid eating too many fried or high-fat foods.	0.55	0.50	-0.19	-1.97
8	I eat the right amount of food based on how active I am and avoid overeating.	0.47	0.50	0.12	-1.99
9	I prefer seasonal and locally available foods in my meals.	0.64	0.48	-0.58	-1.67
10	I drink enough water every day to stay hydrated.	0.60	0.49	-0.40	-1.85
11	I can recognize what causes me stress in daily life.	0.58	0.49	-0.33	-1.90
12	I take short breaks during the day to relax and recharge.	0.40	0.49	0.41	-1.84
13	I make time to spend with family and friends or do activities that make me happy.	0.64	0.48	-0.58	-1.67
14	I use stress-relief techniques like deep breathing, yoga, or mindfulness to stay calm.	0.63	0.48	-0.53	-1.73
15	I seek support from friends, family, or mental health professionals when feeling overwhelmed.	0.73	0.45	-1.02	-0.96
16	I do not use tobacco products (such as cigarettes, chewing tobacco, or hookah).	0.45	0.50	0.18	-1.97
17	I avoid consuming alcohol, or if I do, I ensure it is within safe limits.	0.53	0.50	-0.10	-2.00
18	I do not misuse prescription medications or illegal drugs.	0.30	0.46	0.87	-1.25
19	I use over-the-counter medications carefully and only as directed.	0.51	0.50	-0.06	-2.00
20	I follow vaccination schedules to protect against preventable diseases.	0.34	0.47	0.67	-1.56
21	I brush my teeth at least twice a day and floss daily.	0.68	0.47	-0.75	-1.44
22	I get enough sleep each night to feel well-rested and energized during the day.	0.61	0.49	-0.47	-1.79
23	I wash my hands frequently with soap and water, especially before meals and after using the restroom.	0.60	0.49	-0.40	-1.85
24	I maintain personal hygiene, including clean clothes, grooming, and regular showers.	0.74	0.44	-1.13	-0.74
25	I recycle materials like paper, glass, and aluminum.	0.74	0.44	-1.07	-0.86
26	I actively engage in practices that are good for the environment, such as conserving water, carpooling, or reducing plastic waste.	0.64	0.48	-0.60	-1.64
27	I use reusable bags, bottles, and containers to minimize waste.	0.62	0.49	-0.51	-1.75
28	I try to limit energy consumption in my home (turning off lights when not in use and using energy-efficient appliances).	0.65	0.48	-0.62	-1.62
29	I participate in community events or cultural activities that promote health and social bonding	0.65	0.48	-0.63	-1.61
30	I maintain strong and healthy relationships with my family, friends, and neighbors.	0.56	0.50	-0.25	-1.94
31	I volunteer for community service initiatives that contribute to collective well-being	0.58	0.49	-0.32	-1.91
32	I make efforts to connect with others, such as through local support groups or clubs	0.49	0.50	0.04	-2.01
33	I take steps to stay active even during extreme weather conditions (like snow or heat).	0.42	0.49	0.34	-1.89

Table 1 continued

34	I adjust my lifestyle to cope with limited sunlight or isolation during long winters.	0.35	0.48	0.61	-1.63
35	I dress appropriately for the weather to ensure warmth and comfort.	0.54	0.50	-0.16	-1.98
36	I take extra precautions, such as hydration, during extreme heat or dryness.	0.65	0.48	-0.61	-1.63
37	I engage in activities that promote mental relaxation and self-care, such as reading, hobbies, or meditation.	0.57	0.50	-0.29	-1.93
38	I use techniques like deep breathing, counting to ten, or writing to calm myself when I feel upset, angry, or stressed.	0.59	0.49	-0.36	-1.88
39	I seek professional help when feeling overwhelmed by stress, anxiety, or depression.	0.66	0.47	-0.68	-1.55
40	I focus on maintaining a positive outlook and setting realistic goals for my mental well-being.	0.66	0.48	-0.66	-1.57
41	I incorporate cultural practices that promote physical and mental health into my daily routine.	0.56	0.50	-0.25	-1.95
42	I adopt community-specific health behaviors, such as traditional physical activities or localized diet practices	0.56	0.50	-0.23	-1.95
43	I respect and follow indigenous practices unique to my region for well-being.	0.55	0.50	-0.19	-1.97

Table 2. KMO and Bartlett's Test Results for the Suitability of Factor Analysis

Test	Value
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	0.696
Bartlett's Test of Sphericity (Approx. Chi-Square)	3561.295
Df	903
Sig.	0.000

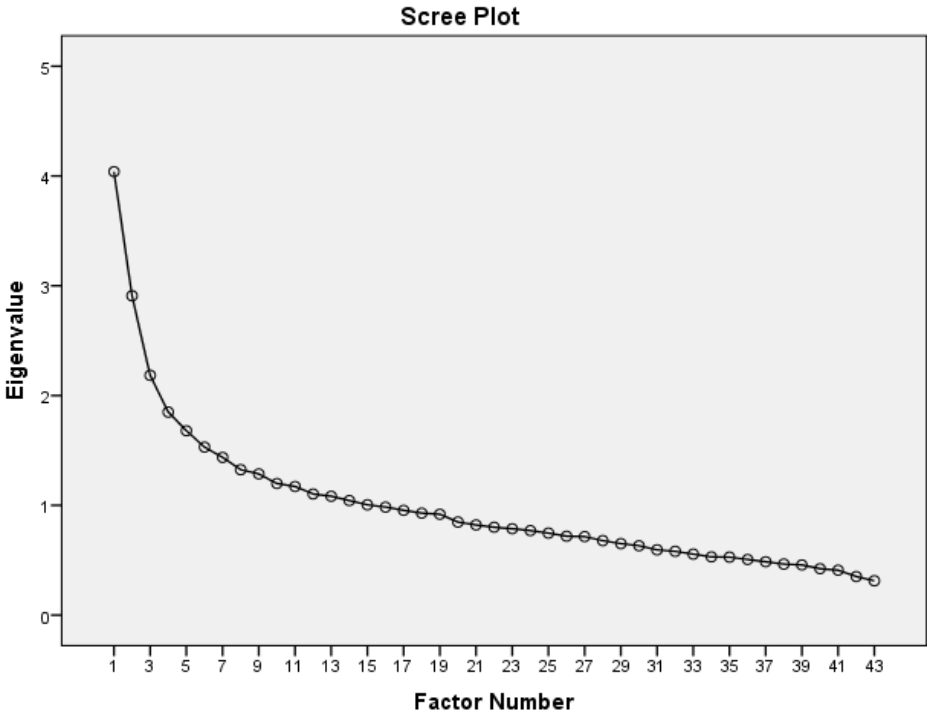

Figure 1. Scree Plot Indicating Factor Retention for the Healthy Lifestyle Scale

The initial solution revealed five factors with eigenvalues greater than 1.0, consistent with Kaiser's criterion. The scree plot (Figure 1) also revealed a distinct elbow at the fifth factor, supporting the decision to retain five factors. The rotation converged in 49 iterations.

These five retained factors collectively explained a substantial proportion of the total variance (to be added once Table 3 is shared), offering empirical support for the

multidimensionality of the scale and the theoretical foundations of the healthy lifestyle domains.

The results from the EFA provided the basis for constructing a valid and interpretable factor structure, guiding the refinement of the scale and its subsequent validation through Confirmatory Factor Analysis (CFA).

Table 3 presents the communalities for each item, representing the proportion of variance in each item explained by the extracted factors. Communality values above 0.30 are generally considered acceptable, indicating that the item is sufficiently represented in the factor solution.

Table 3. Communalities

Item	Extraction
I engage in at least 30 minutes of moderate physical activity most days of the week, such as brisk walking, trekking, traditional games, or household chores.	.349
I participate in vigorous physical activities (e.g., jogging, cycling, or home workouts) that elevate my heart rate for at least 20 minutes three days a week.	.362
I include flexibility exercises thrice weekly in my routine, such as stretching or yoga.	.501
I perform muscle-strengthening exercises, like bodyweight exercises or resistance training, at least twice a week	.270
I eat three balanced meals every day, including a healthy breakfast.	.533
I include foods from all major food groups in my daily diet (vegetables, fruits, grains, proteins, and dairy).	.569
I avoid eating too many fried or high-fat foods.	.418
I eat the right amount of food based on how active I am and avoid overeating.	.440
I prefer seasonal and locally available foods in my meals.	.174
I drink enough water every day to stay hydrated.	.380
I can recognize what causes me stress in daily life.	.307
I take short breaks during the day to relax and recharge.	.270
I make time to spend with family and friends or do activities that make me happy.	.512
I use stress-relief techniques like deep breathing, yoga, or mindfulness to stay calm.	.523
I seek support from friends, family, or mental health professionals when feeling overwhelmed.	.272
I do not use tobacco products (such as cigarettes, chewing tobacco, or hookah).	.225
I avoid consuming alcohol, or if I do, I ensure it is within safe limits.	.351
I do not misuse prescription medications or illegal drugs.	.244
I use over-the-counter medications carefully and only as directed.	.369
I follow vaccination schedules to protect against preventable diseases.	.386
I brush my teeth at least twice a day and floss daily.	.233
I make sure to get enough sleep each night to feel well-rested and energized during the day.	.594
I wash my hands frequently with soap and water, especially before meals and after using the restroom.	.572
I maintain personal hygiene, including clean clothes, grooming, and regular showers.	.297
I recycle materials like paper, glass, and aluminum.	.329
I actively engage in practices that are good for the environment, such as conserving water, carpooling, or reducing plastic waste.	.426
I use reusable bags, bottles, and containers to minimize waste.	.351
I try to limit energy consumption in my home (turning off lights when not in use using energy-efficient appliances).	.232
I participate in community events or cultural activities that promote health and social bonding	.883
I maintain strong and healthy relationships with my family, friends, and neighbors.	.264
I volunteer for community service initiatives that contribute to collective well-being	.432
I make efforts to connect with others, such as through local support groups or clubs	.603

Table 3 continued

I take steps to stay active even during extreme weather conditions (like snow or heat).	.317
I adjust my lifestyle to cope with limited sunlight or isolation during long winters.	.256
I dress appropriately for the weather to ensure warmth and comfort.	.271
I take extra precautions, such as hydration, during extreme heat or dryness.	.233
I engage in activities that promote mental relaxation and self-care, such as reading, hobbies, or meditation.	.158
I use techniques like deep breathing, counting to ten, or writing to calm myself when I feel upset, angry, or stressed.	.487
I seek professional help when feeling overwhelmed by stress, anxiety, or depression.	.367
I focus on maintaining a positive outlook and setting realistic goals for my mental well-being.	.296
I incorporate cultural practices that promote physical and mental health into my daily routine.	.195
I adopt community-specific health behaviors, such as traditional physical activities or localized diet practices	.555
I respect and follow indigenous practices that are unique to my region for well-being.	.132

Extraction Method: Principal Axis Factoring.

The majority of items demonstrated adequate communalities, ranging from 0.30 to 0.60, with several items exceeding 0.50—suggesting strong associations with the underlying constructs. Notably, the item "I participate in community events or cultural activities that promote health and social bonding" had the highest communality at 0.883, indicating excellent alignment with the latent factors.

However, a few items fell below the 0.30 threshold, including:

- "I respect and follow Indigenous practices unique to my region for well-being" (0.132),
- "I engage in activities that promote mental relaxation and self-care" (0.158),
- "I incorporate cultural practices that promote physical and mental health into my daily routine" (0.195),
- "I prefer seasonal and locally available foods in my meals" (0.174), among others.

These lower communalities suggest that these items were less strongly associated with the extracted factors in the current sample and may reflect contextual uniqueness or limited variability in responses.

Given the theoretical importance of cultural and contextual elements in the target regions (e.g., Indigenous practices, seasonal diet, and mental self-care), these items were retained in the current version of the scale. Their inclusion supports cultural sensitivity and ecological validity, even if their statistical contribution is modest. Nonetheless, these items will be closely monitored in future validations for possible revision or removal if they continue to show low explanatory power.

Overall, the communalities demonstrate that most items in the Healthy Lifestyle Scale are well represented in the factor structure, supporting the reliability of the item pool and the multidimensional construct of healthy lifestyle behavior.

Table 4 displays the total and rotated variance explained by the factors extracted using Principal Axis Factoring. Based on the Kaiser criterion (i.e., retaining factors with eigenvalues greater than 1), five factors were extracted. These five factors accounted for a cumulative variance of 22.70% in the unrotated solution.

Although the individual variance contributions appear modest (with Factor 1 explaining 7.97%), this level of explained variance is acceptable in behavioral and social science research, especially when measuring complex, multidimensional constructs like lifestyle. This is further supported by the fact that oblique rotation was applied, which allows for intercorrelations among factors and tends to distribute variance more evenly.

The rotation sums of squared loadings (which cannot be cumulatively added when factors are correlated) help clarify the contribution of each factor after rotation. The first rotated factor accounted for the largest share of variance (2.179), followed by others ranging from 1.438 to 1.588. These rotated values indicate a balanced structure across multiple factors, supporting the multidimensionality and internal consistency of the scale.

Together with the scree plot and communalities, these results provide a statistically sound justification for the retention of five core factors, each representing a distinct domain of healthy lifestyle behavior as conceptualized in the initial scale framework.

Table 5 presents the rotated pattern matrix derived from the Principal Axis Factoring method with Oblimin rotation (allowing for correlated factors). The rotation converged successfully in 49 iterations, indicating a stable and interpretable factor solution.

A factor loading threshold of ±0.30 was used to determine significant item contributions to each factor. Items with loadings ≥ 0.30 were considered meaningful indicators of their respective latent dimensions. Overall, the factor structure revealed distinct clusters of items, confirming the multifactorial nature of the Healthy Lifestyle Scale (HLS).

Table 4. Total Variance Explained

Factor	Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings
	Total	% of variance	Cumulative %	Total
1	3.429	7.974	7.974	2.179
2	2.349	5.462	13.436	1.438
3	1.608	3.740	17.177	1.772
4	1.298	3.018	20.194	1.894
5	1.077	2.505	22.700	1.588
6	.933	2.170	24.869	1.192
7	.884	2.055	26.924	.803
8	.768	1.785	28.709	1.004
9	.659	1.532	30.241	1.348
10	.595	1.383	31.624	1.346
11	.547	1.273	32.897	1.508
12	.531	1.235	34.132	1.231
13	.459	1.068	35.200	1.097
14	.409	.952	36.152	1.344
15	.390	.906	37.058	.780

Extraction Method: Principal Axis Factoring.

a. When factors are correlated, sums of squared loadings cannot be added to obtain a total variance.

Table 5. Pattern Matrix

Item no.	Factor														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	-.005	-.044	.006	.019	-.051	-.158	.078	.359	.089	.129	-.142	-.145	-.173	-.184	.100
2	-.088	-.007	.310	.013	.075	.147	.096	.103	-.004	-.373	.116	-.015	-.073	.065	.131
3	.005	.043	-.011	.050	-.053	.039	-.031	.716	.038	.043	.031	-.008	.073	.002	-.018
4	.022	-.006	.010	.015	.032	.074	.014	.334	-.040	-.221	.010	.017	.019	.233	-.084
5	.090	-.003	-.049	-.015	-.001	.092	.022	-.006	-.050	-.030	-.687	-.028	.067	-.034	.007
6	.002	.034	.010	-.020	-.005	.704	-.044	-.045	.089	-.028	-.255	.021	-.016	.067	.055
7	.048	.007	.000	.006	.008	.309	-.043	-.014	.002	-.024	.015	.094	-.557	-.063	-.069
8	-.033	.022	-.063	-.007	-.079	.556	.066	.124	-.027	.041	.167	-.138	-.169	-.094	-.056
9	.119	-.050	-.040	-.090	.139	-.086	.023	.042	.068	.033	-.060	-.070	-.178	-.063	.110
10	.004	.061	.031	-.564	.050	-.021	.080	.001	.178	-.011	-.055	-.010	.029	-.143	-.017
11	.308	.012	-.044	-.040	.162	-.044	-.018	.109	.088	.113	-.100	-.047	-.142	-.121	.120
12	.183	.104	-.051	-.051	-.031	-.010	.185	.171	-.131	-.179	.016	.044	-.194	.161	.011
13	.448	-.108	.041	-.044	.095	-.116	-.065	.003	-.018	-.044	-.194	-.234	-.175	.109	-.015
14	.651	-.057	-.034	-.015	.016	-.032	.003	.067	-.078	.078	-.092	.149	-.002	-.082	-.111
15	.420	.008	.038	-.135	-.023	-.012	.036	-.040	-.068	.052	-.043	-.050	.023	.065	.044
16	.067	.072	.125	.019	.086	.060	.234	-.013	-.081	.324	.008	-.025	.108	-.016	.084
17	-.027	-.027	-.005	-.049	.494	.045	.077	.013	-.055	.097	-.103	.219	-.003	.101	-.075
18	-.096	.035	.002	-.084	.090	.052	.312	.078	-.047	.033	.051	.147	.124	.187	.033
19	-.195	.082	-.006	.021	-.149	-.048	.047	-.089	-.074	-.103	.042	.123	-.208	.346	.142

Table 5 continued

20	-.079	-.045	.100	.066	.060	.086	-.102	.007	.002	-.105	.061	.047	.119	.477	.178
21	.308	.031	.028	.038	.188	.137	.064	-.068	.017	.074	-.099	-.099	.040	-.063	.080
22	.025	.061	-.082	.030	.761	-.093	-.011	-.073	.063	-.071	.067	-.182	-.022	-.033	.027
23	-.047	.752	-.017	-.004	.036	.044	.054	.023	-.100	-.016	.021	.043	.064	-.047	.004
24	-.002	-.024	-.026	-.085	.095	.104	.011	.081	-.089	-.035	-.108	-.429	.101	-.045	-.057
25	.000	-.003	.009	-.037	.032	.031	.106	-.109	-.279	.243	-.032	-.194	-.224	.096	-.129
26	.086	-.053	.024	.006	.088	.020	.019	.051	.056	.585	.012	.063	-.025	.050	.117
27	-.189	.331	.110	-.021	-.035	.010	-.150	.049	-.013	.065	-.239	.004	-.201	.131	-.030
28	.021	.138	-.029	-.152	.099	-.071	.008	-.002	-.201	.052	-.105	-.087	-.077	.151	-.009
29	-.001	-.080	.007	-.956	-.107	.035	-.078	-.072	-.039	-.041	.084	.034	.020	.065	-.067
30	.203	.128	-.025	-.109	.027	.029	-.220	-.023	-.108	.044	.042	.115	-.029	-.020	.302
31	.084	.003	.620	-.020	-.079	.026	.062	-.080	.024	.096	.119	-.101	.085	.032	.005
32	-.077	-.139	.571	.024	.181	.020	-.012	.103	-.048	-.006	-.076	.315	.077	-.212	.084
33	.016	-.007	-.024	.028	.031	-.013	.534	-.005	.036	.011	-.004	-.037	-.032	-.116	.047
34	-.062	-.045	.002	.096	-.025	-.015	.117	-.011	.056	.030	-.013	.016	.033	.017	.454
35	.054	.133	-.029	.057	-.011	-.014	-.020	.043	.126	.104	.007	-.019	.011	.450	-.125
36	.270	.089	.014	-.047	-.016	.092	-.049	-.026	-.038	-.028	-.052	-.205	-.089	.003	-.061
37	-.052	-.044	.037	.001	.161	-.019	-.205	.067	-.191	.077	.104	-.035	.015	-.055	.019
38	.074	.363	.490	-.067	.034	.000	-.045	.005	.118	-.063	.030	-.123	-.047	.092	-.039
39	.063	.166	.033	-.036	-.018	-.045	-.005	.000	-.516	-.125	-.071	-.072	.116	-.134	.032
40	.081	.035	.033	.057	-.002	.001	-.027	-.033	-.526	.003	.004	.040	-.055	-.011	-.040
41	-.058	-.045	.003	-.076	.024	.054	-.069	-.034	-.239	.126	-.032	-.123	.049	.074	.184
42	-.050	.002	.693	-.024	-.110	-.094	-.080	.024	-.108	-.058	-.078	.070	-.115	.003	-.053
43	-.039	-.062	.024	-.089	.047	.061	-.070	.103	-.159	.122	-.017	-.049	-.068	-.007	.100

Extraction Method: Principal Axis Factoring.

Rotation Method: Oblimin with Kaiser Normalization.

a. Rotation converged in 49 iterations.

Note: Item numbers correspond to the item statements listed in the Descriptive Statistics table.

Each factor was interpreted and labeled based on the conceptual similarity of the items that loaded strongly onto it:

- Factor 1: Stress Management and Emotional Coping

  Included items related to mindfulness practices, deep breathing, seeking social support, and maintaining a positive outlook.

- Factor 2: Personal Hygiene and Health Practices

  Represented by items such as handwashing, tooth brushing, and general cleanliness habits.

- Factor 6: Healthy Diet and Nutrition

  Comprised items on balanced eating, consuming all major food groups, and avoiding unhealthy foods.

- Factor 8: Physical Activity and Flexibility

  Included moderate and vigorous physical activities, as well as flexibility-enhancing exercises such as yoga.

- Factor 10: Environmental Responsibility

  Included behaviors like energy conservation, sustainable practices, and minimizing waste.

- Factor 5: Sleep and Rest

  Captured behaviors such as adequate sleep and daily relaxation practices.

Several additional factors contained smaller clusters or distributed loadings. For example:

- Factor 3 showed moderate loadings related to community engagement.
- Factor 4 and Factor 9 included a few items with potential cross-loadings or weaker specificity.

Low-loading and Cross-loading Items:

Some items demonstrated weaker or dispersed loadings, including:

- Item 43 ("I respect and follow Indigenous practices…") — consistently low across all factors, with a highest loading of only .100.
- Item 9 ("I prefer seasonal and locally available foods…") — had a weak communality (.174) and minimal loading strength. These items were retained in the current structure due to their cultural relevance and potential importance for ecological validity, as discussed in earlier sections.

The factor structure emerging from this analysis provides empirical support for the scale's multidimensional design and its alignment with health behavior theory. The identified factors are consistent with the original theoretical domains—such as physical activity, stress management, hygiene, environmental responsibility, and dietary behaviors—affirming both the construct validity and practical utility of the HLS in diverse, climate-sensitive populations.

Table 6. Final Factors Table

Item	Factor	Factor Loading
I engage in at least 30 minutes of moderate physical activity most days of the week, such as brisk walking, trekking, traditional games, or household chores.	Physical Activity	0.36
I participate in vigorous physical activities (e.g., jogging, cycling, or home workouts) that elevate my heart rate for at least 20 minutes three days a week.		0.31
I include flexibility exercises, such as stretching or yoga, at least thrice weekly in my routine.		0.72
I perform muscle-strengthening exercises, like bodyweight or resistance training, at least twice weekly.		0.33
I take steps to stay active even during extreme weather conditions (like snow or heat)		0.53
I eat three balanced meals every day, including a healthy breakfast.	Healthy Diet	0.69
I include foods from all major food groups in my daily diet (vegetables, fruits, grains, proteins, and dairy).		0.70
I avoid eating too many fried or high-fat foods.		0.31
I drink enough water every day to stay hydrated.	Hydration	0.56
I can recognize what causes me stress in daily life.	Stress Management	0.31
I use stress-relief techniques like deep breathing, yoga, or mindfulness to stay calm.		0.65
I seek support from friends, family, or mental health professionals when feeling overwhelmed.		0.42
I adjust my lifestyle to cope with limited sunlight or isolation during long winters.		0.454
I use techniques like deep breathing, counting to ten, or writing to calm myself when I feel upset, angry, or stressed.		0.490
I seek professional help when feeling overwhelmed by stress, anxiety, or depression.		0.516
I brush my teeth at least twice a day and floss daily.	Personal Hygiene	0.31
I wash my hands frequently with soap and water, especially before meals and after using the restroom.		0.75
I get enough sleep each night to feel well-rested and energized during the day.	Sleep	0.76
I actively engage in practices that are good for the environment, such as conserving water, carpooling, or reducing plastic waste.	Environmental Responsibility	0.59
I use reusable bags, bottles, and containers to minimize waste.		0.331
I dress appropriately for the weather to ensure warmth and comfort.		0.450
I do not use tobacco products (such as cigarettes, chewing tobacco, or hookah)	Substance Use Avoidance	0.32
I avoid consuming alcohol, or if I do, I ensure it is within safe limits.		0.49
I do not misuse prescription medications or illegal drugs.		0.312
I use over-the-counter medications carefully and only as directed.		0.346
I follow vaccination schedules to protect against preventable diseases.	Preventive Health	0.477
I participate in community events or cultural activities that promote health and social bonding.	Social Well-being	0.956
I maintain strong and healthy relationships with my family, friends, and neighbors.		0.302
I volunteer for community service initiatives that contribute to collective well-being.		0.620
I adopt community-specific health behaviors like traditional physical activities or localized diet practices.		0.693

Table 6 presents the finalized factor structure of the Healthy Lifestyle Scale (HLS), established through Exploratory Factor Analysis and guided by theoretical alignment. The resulting model comprises nine distinct factors, each representing a key dimension of healthy lifestyle behavior:

1. Physical Activity
2. Healthy Diet
3. Hydration
4. Stress Management
5. Personal Hygiene
6. Sleep
7. Environmental Responsibility
8. Substance Use Avoidance
9. Social Well-being

(+ Preventive Health as a subdomain)

Item retention was based on a minimum factor loading threshold of 0.30, consistent with established psychometric standards. All retained items met this criterion and demonstrated conceptual alignment with their respective factors. Notably, the item "I participate in community events or cultural activities that promote health and social bonding" displayed an exceptionally strong loading (0.956) under Social Well-being, reinforcing its role as a core behavioral indicator.

The final structure closely mirrors the initial theoretical framework proposed during scale development. While some domains originally considered broader (e.g., mental health) became more refined through the factor analysis process (e.g., separating Stress Management and Sleep), this refinement improved the conceptual clarity and specificity of the instrument.

A separate factor, Preventive Health, emerged with a distinct item regarding vaccination adherence, underlining the relevance of proactive health behaviors in a culturally and climatically sensitive context.

Overall, the finalized factor solution provides both statistical robustness and theoretical depth, validating the multidimensional nature of the Healthy Lifestyle Scale. This structure will be subjected to Confirmatory Factor Analysis (CFA) in the next phase to test its fit and construct validity further.

3. Reliability Testing

The reliability of the Healthy Lifestyle Scale was evaluated through test-retest reliability using Pearson's correlation. The results demonstrate strong reliability across all domains. Test-retest correlations for all domains were significant ($p < 0.01$).

In order to evaluate the temporal stability of the Healthy Lifestyle Scale (HLS), test-retest reliability was assessed using Pearson's correlation coefficient. A subsample of 397 participants from the original group of 517 completed the scale a second time after a four-week interval. This time gap was chosen to balance memory effects with behavioral consistency.

Table 7 presents the domain-wise test-retest reliability coefficients. The correlation values ranged from r = .675 (Social Well-being) to r = .970 (Substance Use Avoidance), with all values statistically significant at $p < .01$. The overall test-retest correlation for the full scale was r = .855, indicating excellent reliability across the instrument.

Table 7. Domain-Wise Test-Retest Reliability

Domain	Test-Retest Correlation (r)	Sig. (2-tailed)
Physical Activity	.844**	0.00
Healthy Diet	.764**	0.00
Hydration	.862**	0.00
Stress Management	.723**	0.00
Personal Hygiene	.804**	0.00
Sleep	.850**	0.00
Environmental Responsibility	.822**	0.00
Substance Use Avoidance	.970**	0.00
Preventive Health	.749**	0.00
Social Well-being	.675**	0.00
Healthy lifestyle (overall scale)	.855**	0.00

N: Test = 517; Retest = 397.

All correlations are significant at the $p < .01$ level (2-tailed).

Domains such as Hydration (r = .862) and Sleep (r = .850) showed particularly strong consistency, reflecting stable self-reported behaviors in these areas. The slightly lower, though still acceptable, correlation for Social Well-being (r = .675) may reflect natural fluctuations in social engagement due to external factors like weather, access, or cultural events.

Cronbach's alpha was not reported for all domains, as several factors contained fewer than three items, making internal consistency statistics less reliable. However, the consistently high test-retest correlations provide robust evidence that the HLS demonstrates strong temporal reliability and can be confidently used in both cross-sectional and longitudinal studies of health behavior.

4. Content Validity

Expert reviews were used to calculate each item's Content Validity Index (I-CVI). The items with I-CVI scores of 0.78 or higher were retained**.**

Content validity (table 8) was evaluated using the Item Content Validity Index (I-CVI), which quantifies expert agreement on the relevance and clarity of each item. The I-CVI is calculated as the proportion of experts rating an item as either "quite relevant" or "highly relevant" (typically 3 or 4 on a 4-point scale). In this study, a panel of five domain experts from public health, psychology, and physical education assessed each item.

Table 8. Content Validity Index (I-CVI) for Healthy Lifestyle Scale

Domain	Item Statement	I-CVI
Physical Activity	I usually engage in at least 30 minutes of moderate physical activity (e.g., brisk walking or household chores).	1.00
	I participate in vigorous physical activities (e.g., jogging and cycling) for at least 20 minutes three days a week.	1.00
	I include flexibility exercises (e.g., stretching or yoga) at least thrice weekly in my routine.	1.00
	I perform muscle-strengthening exercises (e.g., bodyweight or resistance training) at least twice weekly.	1.00
	I take steps to stay active regardless of weather conditions (e.g., snow or extreme heat).	0.916
Healthy Diet	I eat three balanced meals daily, including a healthy breakfast.	0.833
	I include foods from all major food groups (vegetables, fruits, grains, proteins, and dairy) in my diet.	0.916
	I avoid excessive consumption of fried or high-fat foods.	0.916
Hydration	I drink adequate water daily to stay hydrated.	1.00
Stress Management	I can recognize what causes me stress in daily life	0.833
	I use stress-relief techniques (e.g., deep breathing or mindfulness) to stay calm.	0.916
	I seek support from friends, family, or professionals when overwhelmed.	0.833
	I adjust my lifestyle to cope with limited sunlight or isolation during long winters.	0.833
	I use techniques like deep breathing, counting to ten, or writing to calm myself when I feel upset, angry, or stressed	0.833
	I seek professional help for stress, anxiety, or depression if needed	0.916
Personal Hygiene	I brush my teeth twice a day and floss regularly.	0.833
	I wash my hands frequently with soap, especially before meals and after using the restroom.	0.916
Sleep	I ensure adequate sleep every night to feel well-rested and energized.	1.00
Environmental Responsibility	I engage in eco-friendly practices (e.g., conserving water or reducing plastic waste).	0.916
	I use reusable bags, bottles, and containers to minimize waste	0.833
	I dress appropriately for weather conditions to ensure comfort and warmth.	0.833
Substance Use Avoidance	I do not use tobacco products (such as cigarettes, chewing tobacco, or hookah)	1.00
	I avoid consuming alcohol, or if I do, I ensure it is within safe limits	1.00
	I do not misuse prescription or illegal drugs	0.916
	I use over-the-counter medications only as directed.	0.833
Preventive Health	I follow recommended vaccination schedules for myself and my family members to prevent diseases.	1.00
Social Well-being	I participate in community events that promote health and bonding.	0.833
	I maintain strong, healthy relationships with family, friends, and neighbors	0.833
	I adopt culturally appropriate health practices (e.g., traditional diets or physical activities).	0.833

According to the standard guideline by Lynn (1986), an I-CVI score of ≥ 0.78 is considered acceptable for item retention when five or more experts are involved. As shown in Table 8, most items received I-CVI values ranging from 0.833 to 1.00, indicating strong expert consensus on their suitability.

One item—"I volunteer for community service initiatives that contribute to collective well-being"—received an I-CVI of 0.66, which fell below the cutoff and was therefore excluded from the final scale. This decision aligned with the scale development protocol to retain only those items that demonstrated strong content relevance.

The expert review process also resulted in minor wording refinements to enhance clarity and cultural sensitivity. Overall, the content validation process played a critical role in ensuring that the scale items were contextually appropriate, theoretically grounded, and aligned with the lived experiences of populations residing in cold, remote, and resource-constrained environments.

5. Confirmatory Factor Analysis (CFA)

The CFA results confirmed the factor structure of the Healthy Lifestyle Scale, with all items showing adequate factor loadings (greater than 0.50), indicating good construct validity.

To verify the factor structure identified in the exploratory analysis, a Confirmatory Factor Analysis (CFA) was performed using standardized loadings. CFA is used to test the degree to which observed variables (items) represent the number of latent constructs (factors) hypothesized. The analysis confirmed that all items demonstrated acceptable factor loadings, with values ≥ 0.50, indicating good construct validity for the scale.

Table 9 presents the standardized factor loadings for each item across the final set of nine conceptual domains: Physical Activity, Healthy Diet, Stress Management, Environmental Responsibility, Substance Use Avoidance, Preventive Health, Personal Hygiene, Sleep, and Social Well-being. All items loaded meaningfully onto their respective factors, reinforcing the structural coherence and multidimensional nature of the Healthy Lifestyle Scale (HLS).

Table 9. Factor Loading Table for CFA

Factor	Item Statement	Factor Loading
Physical Activity	Most days, I engage in at least 30 minutes of moderate physical activity (e.g., brisk walking or household chores).	0.75
	I participate in vigorous physical activities (e.g., jogging and cycling) for at least 20 minutes three days a week.	0.73
	I include flexibility exercises (e.g., stretching or yoga) at least thrice weekly in my routine.	0.69
	I perform muscle-strengthening exercises (e.g., bodyweight or resistance training) at least twice weekly.	0.65
	I take steps to stay active regardless of weather conditions (e.g., snow or extreme heat).	0.64
Healthy Diet	I eat three balanced meals daily, including a healthy breakfast.	0.73
	I include foods from all major food groups (vegetables, fruits, grains, proteins, and dairy) in my diet.	0.88
	I avoid excessive consumption of fried or high-fat foods.	0.66
Stress Management	I can recognize what causes me stress in daily life	0.79
	I use stress-relief techniques (e.g., deep breathing or mindfulness) to stay calm.	0.76
	I seek support from friends, family, or professionals when overwhelmed.	0.78
	I adjust my lifestyle to cope with limited sunlight or isolation during long winters.	0.86
	I use techniques like deep breathing, counting to ten, or writing to calm myself when I feel upset, angry, or stressed	0.84
	I seek professional help for stress, anxiety, or depression if needed	0.66
Environmental Responsibility	I engage in eco-friendly practices (e.g., conserving water or reducing plastic waste).	0.86
	I use reusable bags, bottles, and containers to minimize waste	0.79
	I dress appropriately for weather conditions to ensure comfort and warmth.	0.74
Substance Use Avoidance	I do not use tobacco products (such as cigarettes, chewing tobacco, or hookah)	0.86
	I avoid consuming alcohol, or if I do, I ensure it is within safe limits	0.68
	I do not misuse prescription or illegal drugs	0.74
	I use over-the-counter medications only as directed.	0.68
Preventive Health	I follow recommended vaccination schedules for myself and my family to prevent diseases.	0.94
	I drink adequate water daily to stay hydrated	0.68
	I ensure adequate sleep every night to feel well-rested and energized.	0.92
	I brush my teeth twice a day and floss regularly.	0.58
	I wash my hands frequently with soap, especially before meals and after using the restroom.	0.54
Social Well-being	I participate in community events that promote health and bonding.	0.66
	I maintain strong, healthy relationships with family, friends, and neighbors	0.58
	I adopt culturally appropriate health practices (e.g., traditional diets or physical activities).	0.64

The Physical Activity and Stress Management domains exhibited consistently strong loadings (e.g., 0.64–0.86), underscoring their internal consistency and theoretical alignment. Similarly, Healthy Diet and Environmental Responsibility showed high item loadings (e.g., 0.66–0.88), confirming these as distinct and reliable lifestyle constructs.

The revised Preventive Health factor emerged as a robust domain integrating items related to vaccination adherence, hydration, and sleep—with loadings ranging from 0.68 to 0.94. This reconceptualization helped consolidate previously dispersed items, enhancing internal coherence.

While a few items from Personal Hygiene and Social Well-being domains had marginally lower loadings (0.54–0.58), their inclusion was retained due to their high content validity scores and relevance to culturally embedded health behaviors. Their conceptual necessity in a comprehensive lifestyle framework balances their slightly lower statistical contributions.

These results confirm that the final structure derived from EFA is statistically supported and conceptually sound. The CFA findings reinforce the validity and utility of the HLS for use in health behavior research, especially in climate-sensitive and culturally unique populations.

The SEM in Figure 2 confirms the theoretical structure of the Healthy Lifestyle Scale. The seven latent constructs (e.g., Physical Activity, Healthy Diet, Preventive Health) are measured through clearly defined observed variables. Including error terms ensures the model accounts for variability not explained by the latent factors.

The model's inter-factor correlations suggest that components of a healthy lifestyle are interrelated. For instance, effective stress management may contribute to better social well-being or adherence to preventive health practices.

In conclusion, this structural model provides a robust framework for understanding and measuring healthy lifestyle behaviors, with the revised Preventive Health factor enhancing the model's comprehensiveness. Further analysis, such as goodness-of-fit indices, will solidify the model's empirical validation.

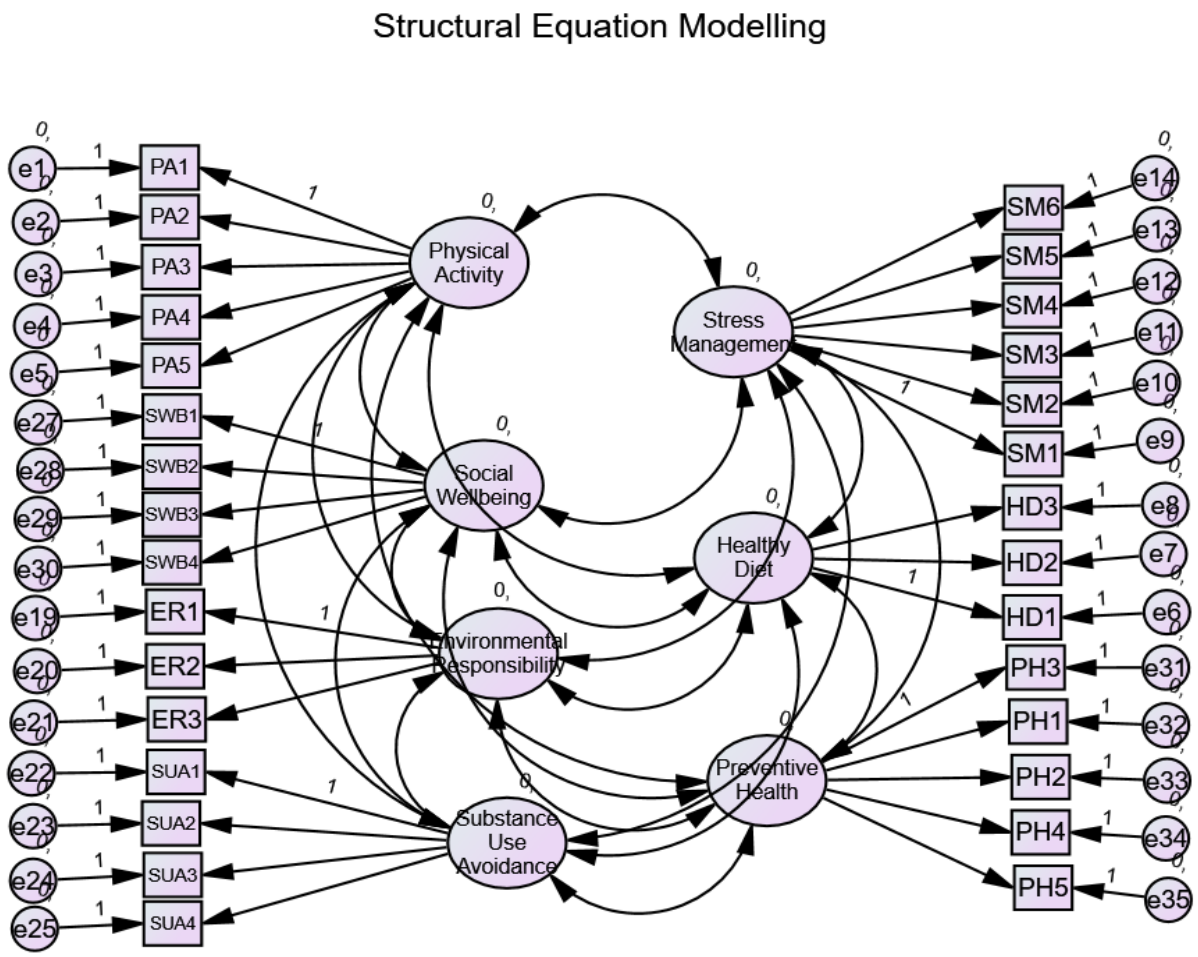

Figure 2. Structural Equation Modelling of the Healthy Lifestyle Scale

6. Model Fit Indices for the Healthy Lifestyle Scale

The results of the Model Fit Indices confirmed that the model shows a good overall fit with the data, reinforcing the model's empirical validation.

In order to evaluate the overall structural validity of the Healthy Lifestyle Scale, a Structural Equation Modeling (SEM) approach was applied, and model fit was assessed using multiple indices. Table 10 presents the key model fit statistics and their interpretations.

The Chi-square/df ratio (CMIN/DF) was 3.645, which falls below the accepted upper threshold of 5.0, indicating an acceptable fit between the hypothesized model and the observed data. While values below 3.0 are often considered ideal, ratios below 5.0 are commonly accepted for models with a large number of observed variables.

The Comparative Fit Index (CFI) was 0.93, and the Incremental Fit Index (IFI) was 0.92, exceeding the recommended threshold of 0.90, indicating a strong comparative fit relative to a baseline model. These indices suggest that the hypothesized model substantially improves over a null model with no specified relationships.

The Normed Fit Index (NFI) was 0.87, which is slightly below the conventional threshold of 0.90. However, it is still within an acceptable range, particularly when other fit indices (CFI, IFI) demonstrate good model performance.

The Parsimony Ratio (PRATIO) was 0.83, which reflects an efficient and well-structured model with an appropriate balance between goodness-of-fit and complexity.

The model fit indices confirm that the Healthy Lifestyle Scale exhibits a good overall structural fit, supporting its factorial validity. The results prove that the scale's latent constructs are well-defined and appropriately measured, reinforcing the instrument's applicability for future research and practical health assessments.

7. Criterion Validity

The results of the criterion validity demonstrated strong positive correlations between well-established validated scales

Criterion validity assesses the extent to which a new scale correlates with established instruments that measure similar constructs. To evaluate the criterion validity of the Healthy Lifestyle Scale (HLS), correlations were calculated between each HLS domain and validated subscales from widely used instruments, including the Health-Promoting Lifestyle Profile II (HPLP-II), the Coping Strategies Inventory (CSI), the Pro-Environmental Behavior Scale (PEBS), the Drug Abuse Screening Test (DAST), and the Social Support Questionnaire (SSQ).

As shown in Table 11, all domains of the HLS showed statistically significant correlations with corresponding validated subscales ($p < 0.001$), supporting the scale's criterion validity.

Table 10. Model Fit Indices for the Healthy Lifestyle Scale Structural Equation Model

Fit Index	Value	Interpretation	Acceptable Range	Remarks
CMIN/DF (Chi-square/DF ratio)	3.645	Ratio between chi-square and degrees of freedom	<5.0	This model shows a reasonable fit (value < 5.0)
CFI (Comparative Fit Index)	0.93	Measures how well the model fits compared to a baseline	>0.90 (Good)	This value indicates a good fit
NFI (Normed Fit Index)	0.87	Assesses model fit relative to the baseline model	<0.90	This value is slightly less than the ideal
IFI (Incremental Fit Index)	0.92	Compares the target model with a baseline model	>0.90 (Good)	This value indicates a good fit
PRATIO (Parsimony Ratio)	0.83	Measures the trade-off between model complexity and fit	>0.80 (Good)	Acceptable ratio, suggesting an efficient model

Table 11. Correlation between Healthy Lifestyle Scale and Validated Scales

Healthy Lifestyle Scale Domain	Validated Scale	Sample Size (N)	Pearson's correlation (r)	p-value
Physical Activity	HPLP-II (Physical Activity Subscale)	240	0.79	<0.001
Healthy Diet	HPLP-II (Nutrition Subscale)	240	0.82	<0.001
Stress Management	HPLP-II (Stress Management Subscale)	240	0.74	<0.001
	CSI (Coping Strategies Subscale)	240	0.76	<0.001
Environmental Responsibility	PEBS (Pro-Environmental Behavior)	240	0.68	<0.001
Substance Use Avoidance	DAST (Drug Use Screening)	240	-0.72	<0.001
Preventive Health	HPLP-II (Health Responsibility Subscale)	240	0.68	<0.001
Social Well-being	HPLP-II (Interpersonal Relations Subscale)	240	0.66	<0.001
	SSQ (Social Support Questionnaire)	240	0.64	<0.001

- Physical activity showed a strong positive correlation (r = 0.79) with the HPLP-II Physical Activity subscale, confirming the scale's ability to assess physical activity behaviors.
- Healthy diet exhibited the strongest correlation (r = 0.82) with the HPLP-II Nutrition subscale, indicating that dietary habits captured by HLS are well aligned with validated nutritional behavior measures.
- Stress Management correlated strongly with both the HPLP-II Stress Management subscale (r = 0.74) and the CSI (r = 0.76), supporting its effectiveness in assessing coping-related behaviors.
- Environmental responsibility correlated moderately (r = 0.68) with the Pro-Environmental Behavior Scale (PEBS), validating the ecological behavior component of the HLS.
- Substance Use Avoidance demonstrated a strong inverse correlation (r = -0.72) with the DAST, indicating that higher HLS scores are associated with lower substance use risk.
- Preventive Health correlated positively (r = 0.68) with the HPLP-II Health Responsibility subscale, validating the inclusion of vaccination and routine health monitoring behaviors.
- Social Well-being showed moderate positive correlations with both the HPLP-II Interpersonal Relations subscale (r = 0.66) and the SSQ (r = 0.64), confirming its alignment with established social health constructs.

These findings collectively confirm that the HLS domains are highly consistent with existing validated tools, thereby demonstrating strong criterion validity. The robust and statistically significant correlations across domains underscore the utility of the Healthy Lifestyle Scale as a valid measure for assessing health-promoting behaviors across physical, emotional, social, and environmental domains.

8. Face Validity

Face validity refers to the extent to which a measurement instrument appears on the surface to assess the construct it claims to measure. To assess face validity for the Healthy Lifestyle Scale (HLS), 15 experts from the fields of public health, sports sciences, psychology, and nutrition independently reviewed the scale items.

Experts were asked to evaluate whether the items were clear, appropriate, and relevant for measuring health-promoting behaviors in diverse and climatically sensitive populations. The panel reached a strong consensus that the scale adequately covered essential lifestyle domains, including physical activity, healthy eating, stress management, preventive health practices, substance use avoidance, environmental responsibility, and social well-being.

Based on their feedback, minor wording refinements were made to enhance clarity and regional appropriateness. This expert agreement supports the conclusion that the HLS items possess high face validity, reflect real-world behaviors, and ensure relevance for both academic research and public health interventions.

9. Predictive Validity

Predictive validity assesses how well a scale can forecast future or concurrent behaviors related to its underlying constructs. To evaluate the predictive validity of the Healthy Lifestyle Scale, linear regression analyses were conducted using HLS total scores as the predictor variable and relevant lifestyle behaviors as outcome variables.

As shown in Table 12, HLS scores significantly predicted a wide range of health-related behaviors:

- Moderate to vigorous physical activity ($\beta = 0.56$, $R^2 = 0.29$, $p < 0.001$)
- Healthy diet practices ($\beta = 0.52$, $R^2 = 0.26$, $p < 0.001$)
- Stress management behaviors ($\beta = 0.47$, $R^2 = 0.24$, $p < 0.001$)
- Pro-environmental behaviors ($\beta = 0.43$, $R^2 = 0.23$, $p < 0.001$)

Table 12. Predictive Validity – Regression Analysis of Healthy Lifestyle Scale (HLS)

Predictor (Independent Variable)	Dependent Variable (Outcome from HLS Domain)	β (Standardized Coefficient)	t	p-value	R^2
HLS Total Score	Frequency of Moderate to Vigorous Physical Activity	0.56	7.42	<0.001	0.29
	Healthy Diet Score (Balanced Meals, Food Groups)	0.52	7.36	<0.001	0.26
	Stress Management Practices (Relaxation, Coping Strategies)	0.47	7.30	<0.001	0.24
	Engagement in Pro-Environmental Behaviors	0.43	7.25	<0.001	0.23
	Avoidance of Substance Use (Tobacco, Alcohol, Drugs)	-0.56	-7.4	<0.001	0.19
	Preventive Health Actions (Vaccinations, Hygiene, Health Check-ups)	0.48	6.80	<0.001	0.20
	Social Well-being Score (Participation in Community, Relationships)	0.39	6.68	<0.001	0.21

- Avoidance of substance use ($\beta = -0.56$, $R^2 = 0.19$, $p < 0.001$)
- Preventive health actions ($\beta = 0.48$, $R^2 = 0.20$, $p < 0.001$)
- Social well-being behaviors ($\beta = 0.39$, $R^2 = 0.21$, $p < 0.001$)

All regression models were statistically significant ($p < 0.001$), with moderate R^2 values (0.19–0.29), indicating that the HLS reliably explains a meaningful proportion of variance in actual lifestyle behaviors.

These findings confirm that the HLS not only aligns with established measures (criterion validity), but also effectively predicts relevant health behaviors, reinforcing its practical utility for health promotion programs, policy planning, and behavioral interventions.

4. Discussion

The present study developed and validated the Healthy Lifestyle Scale (HLS) tailored to populations residing in cold and remote regions such as Jammu, Kashmir, Ladakh, and Manali. The final instrument, derived through rigorous psychometric testing, demonstrated strong validity (content, construct, criterion, predictive) and reliability, confirming its suitability for assessing lifestyle behaviors across physical, psychological, social, and environmental domains.

The results from Exploratory and Confirmatory Factor Analyses revealed a robust multidimensional structure encompassing physical activity, diet, stress management, substance use avoidance, environmental responsibility, and social well-being. These domains are particularly salient for populations facing climatic and geographical challenges, as traditional lifestyle assessments often fail to capture culturally and environmentally specific behaviors, such as seasonal adaptability, snow-related activity, or isolation-related coping strategies [1], [4].

Importantly, the scale showed strong criterion validity, correlating well with established instruments like HPLP-II, CSI, PEBS, and DAST. These findings are consistent with existing literature highlighting that localized lifestyle interventions yield more accurate and relevant data than generalized tools [5], [7]. Additionally, the predictive validity results confirm that higher HLS scores reliably forecast healthy behaviors in physical activity, diet, and preventive health—key indicators for disease prevention and long-term wellness [6], [10].

The study aligns with global public health perspectives emphasizing contextualized health literacy and behavior change. Similar to the findings by Juwa et al. [17] in Northern Thailand, this study emphasizes that tools targeting region-specific barriers and cultural practices are more effective in promoting sustainable health outcomes among geographically and socially constrained populations. Moreover, the current work resonates with Gumilar et al. [18], who demonstrated that healthy lifestyle behaviors significantly reduce psychological distress, particularly during vulnerable periods like the COVID-19 pandemic. This supports the argument that stress management, social engagement, and preventive health—as captured in the HLS—are vital in safeguarding both mental and physical well-being during seasonal or situational stressors [6], [7].

The strength of this study lies in its holistic and culturally responsive approach, integrating qualitative insights with rigorous statistical validation. The involvement of local experts, use of mixed-methods, and inclusion of climate-adapted behaviors make the HLS a pioneering tool for assessing health behaviors in underserved or remote populations.

However, the study is not without limitations. While the sample was large and diverse, it was confined to regions within India, which may affect generalizability to other international contexts with similar climates. Moreover, longitudinal studies are needed to establish further the scale's sensitivity to change over time and intervention impact.

Future research should explore cross-cultural adaptation of the HLS, translation into regional languages, and integration into digital health surveillance platforms. Additionally, researchers may consider incorporating technology-based tracking to validate self-reported behaviors and enhance precision.

In conclusion, the Healthy Lifestyle Scale presents a valid, reliable, and context-specific instrument capable of evaluating and promoting health-supportive behaviors in populations affected by harsh climate and limited accessibility. Its incorporation into public health policy, especially in ecologically sensitive or resource-poor regions, holds potential to drive personalized health promotion, preventive care, and community resilience in alignment with global health goals.

5. Conclusions

This study introduced and validated the Healthy Lifestyle Scale (HLS)—a context-specific instrument designed to assess health-related behaviors in regions characterized by cold winters, snowfall, and arid summers, such as Jammu, Kashmir, and Ladakh. These environmental and cultural conditions present distinct challenges to maintain a healthy lifestyle, requiring a tailored assessment tool that captures localized behaviors and adaptations.

The HLS demonstrated strong psychometric properties, including high internal consistency, robust construct and content validity, and significant criterion and predictive validity. Expert input ensured the scale's cultural and environmental relevance, while statistical analyses confirmed its structural integrity and behavioral alignment.

Importantly, the HLS correlates with established health behavior measures and predicts real-world practices across domains such as physical activity, nutrition, stress management, preventive health, and social well-being.

Given its comprehensive and climate-responsive design, the HLS offers a valuable resource for researchers, health practitioners, and policymakers seeking to evaluate and promote sustainable lifestyle behaviors in underserved and geographically challenging regions. It provides a practical framework for identifying health behavior gaps, guiding community-level interventions, and shaping public health policies tailored to region-specific needs.

Future research should examine the cross-regional adaptability of the HLS, its utility across diverse cultural contexts, and its responsiveness to longitudinal health interventions. Expansion into digital health platforms and integration with public health surveillance systems could further enhance its applicability and impact.

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Conflict of Interest

The authors declare no conflicts of interest.

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