



## Environmental and Socio-cultural Factors Associated with HIV/AIDS Vulnerability in Gombe State, Nigeria: A Multivariate Factor Analytic Approach

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### KEYWORDS

HIV/AIDS,  
Environmental Factors,  
Socio-Cultural Factors,  
Exploratory Factor Analysis.

### ABSTRACT

HIV/AIDS remains a significant public health challenge in sub-Saharan Africa, where vulnerability profiles are shaped by environmental and socio-cultural settings. This paper investigates environmental and socio-cultural variables linked to HIV/AIDS vulnerability in Gombe State, Nigeria, using exploratory factor analysis. A cross-sectional design with purposive sampling was employed, involving 384 participants' people living with HIV and medical practitioners—across the 11 Local Government Areas (LGAs). Data were collected electronically via Kobo Toolbox and analysed using descriptive statistics, Kaiser-Meyer-Olkin (KMO) measure, Bartlett's test of sphericity, maximum-likelihood exploratory factor analysis, and Cronbach's alpha. HIV prevalence in 2024 ranged from 0.29 to 8.89 per 10,000 population across LGAs. KMO values were 0.56 (environmental) and 0.58 (socio-cultural), indicating weak but acceptable sampling adequacy. The Kaiser criterion retained four environmental factors (eigenvalues > 1) explaining 48.75% of total variance, and four socio-cultural factors explaining 52.34%. Environmental loadings included climate, safe drinking water, noise pollution, sanitation, and greenery; socio-cultural loadings included cultural beliefs, condom attitudes, media exposure, community support, and gender roles. Cronbach's alpha was low for both domains (0.386 and 0.373), indicating heterogeneity among dimensions rather than a homogeneous construct. The findings support multi-dimensional frameworks for HIV prevention that integrate environmental and socio-cultural factors alongside biomedical interventions.

### CITATION

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### INTRODUCTION

Human Immunodeficiency Virus (HIV) and Acquired Immunodeficiency Syndrome (AIDS) continue to pose significant public health challenges worldwide, particularly in sub-Saharan Africa, which bears a disproportionate share of the global HIV burden (UNAIDS, 2023). In Nigeria, efforts to prevent, test for, treat, and suppress the virus have resulted in measurable reductions in some settings. Nevertheless, notable sub-national

variations persist, likely driven by interactions between health system access, environmental conditions, socio-cultural factors, knowledge, stigma, and behaviour (WHO, 2022; NACA, 2021).

Environmental conditions can influence HIV vulnerability indirectly by shaping access to health services and the broader living environment. Lack of safe drinking water, inadequate sanitation facilities, poor infrastructure, and limited proximity to health facilities may create barriers to

HIV testing, treatment, and prevention, particularly in rural and hard-to-reach areas (Awofala & Ogundele, 2018; World Bank, 2020). Such environmental barriers can delay diagnosis, interrupt treatment adherence, and reduce the uptake of prevention services, thereby sustaining transmission within vulnerable communities.

Socio-cultural factors also play a critical role in shaping HIV/AIDS knowledge, attitudes, disclosure, health-seeking behaviour, and the uptake of prevention measures. These factors include cultural beliefs, gender roles, stigma and discrimination, social support systems, and mass media communication (Airhihenbuwa et al., 2009; Mahajan et al., 2008; Parker & Aggleton, 2003). Gender inequality, social expectations, and cultural practices can further affect individuals' ability to negotiate preventive measures and access services. The involvement of these variables aligns with behavioural models in which attitudes, perceived norms, knowledge, and the social environment influence health behaviour (Ajzen, 1991; Bandura, 2004; Gupta et al., 2008).

Although socio-cultural and environmental factors have been widely recognised as significant determinants of HIV vulnerability, the extant Nigerian literature has predominantly emphasised biomedical and demographic factors. Few studies have examined the combined structure of environmental and socio-cultural indicators within the context of Local Government Areas (LGAs). In Gombe State, located in the North-East geopolitical zone, HIV prevalence varies across the 11 LGAs, yet the underlying environmental and socio-cultural dimensions of vulnerability remain underexplored. Previous studies in Nigeria have focused on national or regional patterns (Okolie et al., 2020; Amobi et al., 2021), leaving a gap in sub-state, LGA-level analysis that integrates environmental and socio-cultural domains.

This study was therefore designed to explore the underlying dimensions of environmental and socio-cultural factors associated with HIV/AIDS vulnerability in Gombe State using exploratory factor analysis. Specifically, the study aims to:

- i. Identify the underlying environmental factors associated with HIV/AIDS vulnerability across the 11 LGAs of Gombe State.
- ii. Identify the underlying socio-cultural factors associated with HIV/AIDS vulnerability across the 11 LGAs of Gombe State.
- iii. Assess the internal consistency and dimensionality of the environmental and socio-cultural indicators.

The significance of this study lies in its potential to inform multi-dimensional HIV prevention and service delivery frameworks in Gombe State. By identifying distinct environmental and socio-cultural dimensions, the findings can guide policymakers, health agencies, and community programmes in designing targeted, context-specific interventions. The study also contributes to the broader

literature on HIV vulnerability in low-prevalence, sub-national settings, where composite measures may obscure important heterogeneity.

The scope of this study is limited to Gombe State, covering all 11 LGAs. It focuses on environmental and socio-cultural indicators as measured through a structured questionnaire administered to people living with HIV and medical practitioners involved in HIV service delivery. The study does not evaluate clinical outcomes or treatment efficacy, nor does it attempt to establish causal relationships; rather, it explores the dimensional structure of vulnerability factors.

## MATERIALS AND METHODS

### Research Design

A cross-sectional survey design was employed to evaluate the environmental and socio-cultural determinants of HIV/AIDS vulnerability at a single point in time. The study adopted a quantitative approach, using exploratory factor analysis (EFA) as the primary analytical technique. Because of the cross-sectional design, the relationships identified are considered associations and not cause-and-effect relationships.

### Study Location

The study was conducted in Gombe State, located in the North-East geopolitical zone of Nigeria. Gombe State comprises 11 Local Government Areas (LGAs): Akko, Balanga, Billiri, Dukku, Funakaye, Gombe, Kaltungo, Kwami, Nafada, Shongom, and Yamaltu-Deba. The state has an estimated population of over four million people, with considerable variation in population density, infrastructure, and socio-cultural practices across LGAs. These variations make Gombe State suitable for examining the dimensional structure of environmental and socio-cultural factors associated with HIV/AIDS vulnerability.

### Target Population

The target population comprised two groups: (i) people living with HIV (PLHIV) and (ii) medical practitioners directly involved in HIV service delivery across the 11 LGAs of Gombe State. Eligible respondents were those aged 18 years and above who were either living with HIV or professionally engaged in HIV management.

### Sample Size Determination

The sample size was determined using the Krejcie and Morgan (1970) table as a guideline for minimum sample size, which specifies 384 respondents for a population exceeding one million at a 95% confidence level and 5% margin of error. The formula is given as:

$$S = \frac{\chi^2 NP(1-P)}{d^2(N-1) + \chi^2 P(1-P)} \quad (1)$$

Where:

$S$  S = required sample size

$N$  N = total population size of the study area

$P$   $P$  = population proportion assumed to possess the attribute of interest ( $P = 0.50$ , which gives the maximum sample size)

$\chi^2$  = chi-square value for 1 degree of freedom at the selected confidence level;  $d$  = the accepted margin of error

### Sampling Procedure

Purposive sampling was used to select eligible respondents. Only individuals living with HIV and medical practitioners directly involved in HIV management were invited to participate. Because HIV status is sensitive and not publicly disclosed, random selection was not feasible; purposive sampling was therefore used to recruit eligible respondents through HIV service delivery points across all 11 LGAs. The questionnaire was deployed electronically via KoboToolbox, and the link was shared with qualified respondents. A total of 384 valid responses were collected and analysed. The use of purposive sampling is acknowledged as a limitation in Section 4.

### Instrument for Data Collection

A structured questionnaire was used to collect information across four domains: socio-economic factors, demographic factors, environmental conditions, and socio-cultural characteristics. Each item was measured on a five-point Likert scale (1 = strongly disagree to 5 = strongly agree). For this manuscript, only the environmental (10 items: C1–C10) and socio-cultural (9 items: D1–D9) domains were analysed. Respondents' LGA of residence was also recorded to allow for geographic disaggregation.

### Data Collection Procedure

Data were collected digitally using KoboToolbox. Respondents completed the questionnaire on mobile devices or computers. The digital platform reduced missing entries and allowed real-time monitoring of submissions. Ethical clearance was obtained from the Gombe State Ministry of Health. Participation was voluntary, and respondents were informed of confidentiality and their right to withdraw at any time. No personally identifying information was collected.

### Data Preparation and Screening

Prior to analysis, the data set was examined for missing data, outliers, normality, multicollinearity, and correlation adequacy among variables. Only those variables with pairwise correlation coefficients higher than 0.30 were included in the factor analysis. The resulting data set consisted of 384 valid cases.

### Model Specification

Exploratory factor analysis (EFA) was employed to reduce a set of observed indicators of environmental and socio-

cultural dimensions into a smaller number of underlying latent factors. The general factor model is expressed as:

$$X = \Lambda F + \epsilon \quad (2)$$

Where:

$X$   $X$  = vector of observed variables

$\Lambda$   $\Lambda$  = matrix of factor loadings

$F$   $F$  = vector of latent factors

### Factorability Estimation and Evaluation

Before factor extraction, the suitability of the dataset was assessed using the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity.

Kaiser-Meyer-Olkin (KMO) measure:

$$KMO = \frac{\sum_{i \neq j} r_{ij}^2}{\sum_{i=j}^2 r_{ij}^2 + \sum_{i \neq j} u_{ij}^2} \quad (3)$$

Where:

$r_{ij}$  = correlation coefficient between variables  $i$  and  $j$

$u_{ij}$  = partial correlation coefficient between variables  $i$  and  $j$

KMO values were interpreted using Kaiser's (1974) descriptors: 0.90–1.00 (marvellous), 0.80–0.89 (meritorious), 0.70–0.79 (middling), 0.60–0.69 (mediocre), 0.50–0.59 (miserable), and below 0.50 (unacceptable).

Bartlett's Test of Sphericity

$$\chi^2 = -\left(n-1 - \frac{2p+5}{6}\right) \ln|R| \quad (4)$$

Where:

$n$   $n$  = sample size

$p$   $p$  = number of observed variables

$R$   $R$  = correlation matrix

$R$  A significant Bartlett's test ( $p < 0.05$ ) indicates that the correlation matrix is not an identity matrix and that sufficient correlations exist among variables to justify factor analysis.

### Number of Factors

For the determination of the number of factors, the Kaiser method was applied. Factors whose eigenvalues were equal to or more than 1.00 were selected for analysis. These factors were further analyzed using the maximum-likelihood factor loadings and factor structure as shown in the results section.

### Reliability Analysis

Internal consistency was assessed using Cronbach's alpha coefficient, which measures the extent to which items purportedly measuring the same construct are correlated. The coefficient is expressed as:

$$\alpha = \frac{k}{k-1} \left( 1 - \frac{\sum \sigma_i^2}{\sum \sigma_T^2} \right) \quad (5)$$

Where

$k$  is the number of the observed variables included in the Scale

$\sigma_i^2$  is the variance of each observed variables

$\sigma_T^2$  is the variance of the total score of all observed variables

$\alpha$  is the Cronbach's Alpha coefficient (Reliability Index)

Alpha values were interpreted as follows:  $\geq 0.70$  (acceptable), 0.60–0.69 (questionable), 0.50–0.59 (poor), and  $< 0.50$  (unacceptable) (Nunnally, 1978). Given the heterogeneous nature of the environmental and socio-cultural indicators, low alpha values were anticipated.

## RESULTS AND DISCUSSION

This section presents the HIV burden across LGAs and the results of the exploratory factor analysis for environmental and socio-cultural domains. The analysis describes the dimensional structure of the indicators and does not imply causal relationships.

**Table 1: HIV/AIDS Burden (Prevalence) by Local Government Area, 2024**

| S/N   | L.G.A         | Population at Risk | People Living with HIV | HIV Prevalence per 10,000 people |
|-------|---------------|--------------------|------------------------|----------------------------------|
| 1     | Akko          | 595,601            | 107                    | 1.80                             |
| 2     | Balanga       | 374,703            | 37                     | 0.99                             |
| 3     | Billiri       | 356,360            | 117                    | 3.28                             |
| 4     | Dukku         | 365,255            | 15                     | 0.41                             |
| 5     | Funakaye      | 416,198            | 58                     | 1.39                             |
| 6     | Gombe         | 472,457            | 420                    | 8.89                             |
| 7     | Kaltungo      | 264,091            | 85                     | 3.22                             |
| 8     | Kwami         | 344,291            | 10                     | 0.29                             |
| 9     | Nafada        | 243,606            | 12                     | 0.49                             |
| 10    | Shongom       | 267,115            | 67                     | 2.51                             |
| 11    | Yamaltu –Deba | 626,267            | 63                     | 1.01                             |
| Total |               | 4,325,944          |                        |                                  |

HIV prevalence ranged from 0.29 per 10,000 in Kwami LGA to 8.89 per 10,000 in Gombe LGA. All LGAs remained below 0.1% prevalence when expressed as a percentage, indicating a low-burden setting. Gombe LGA recorded the highest prevalence (8.89 per 10,000), followed by Billiri (3.28), Kaltungo (3.22), and Shongom (2.51). These differences suggest areas of interest for future surveillance and service delivery, but they do not establish a relationship between environmental or socio-cultural factors and the observed differences.

The low overall prevalence is consistent with national estimates for Gombe State, which has historically

recorded lower HIV prevalence than the national average (NACA, 2021). The concentration of cases in Gombe LGA likely reflects its urban status, higher population density, and greater availability of testing services, which may increase case detection rather than true prevalence. This finding aligns with Okolie et al. (2020), who noted that urban LGAs in Nigeria often record higher HIV prevalence due to better surveillance and reporting infrastructure. However, the absence of a clear spatial gradient across LGAs suggests that environmental and socio-cultural factors may operate at finer spatial scales than the LGA level, a limitation acknowledged in Section 4.

**Table 2: Summary Statistics for Environmental Indicators (C1–C10). Based on 384 valid observations**

| Variable                       | Mean | Median | GMD   |
|--------------------------------|------|--------|-------|
| Access to Safe Drinking Water  | 3.54 | 3.5    | 1.261 |
| Sanitation Facilities          | 3.55 | 3.5    | 1.236 |
| Waste Disposal System          | 3.69 | 4.0    | 1.239 |
| Air Quality                    | 3.60 | 3.5    | 1.239 |
| Proximity to Health facilities | 3.56 | 3.5    | 1.263 |
| Climate                        | 3.55 | 3.5    | 1.203 |
| Natural Disasters              | 3.56 | 3.5    | 1.250 |
| Green Infrastructure           | 3.68 | 4.0    | 1.250 |
| Noise Pollution                | 3.47 | 3.5    | 1.294 |
| Access to HIV                  | 3.52 | 3.5    | 1.303 |

The KMO value of 0.56 is barely above the minimum threshold of 0.50 and falls within Kaiser's (1974) "miserable" range, indicating weak but sufficient sampling adequacy for exploratory factor analysis. Bartlett's test of sphericity was statistically significant ( $\chi^2 = 94.14$ ,  $df = 45$ ,  $p$

$= 0.0046$ ), indicating that the correlation matrix was not an identity matrix. These results provide adequate empirical justification for proceeding with exploratory factor analysis, despite the weak KMO value.

The low KMO value is consistent with the heterogeneous nature of environmental indicators, which measure distinct constructs (water, sanitation, climate, infrastructure) rather than a single underlying dimension. This finding aligns with Field (2018), who noted that KMO

values below 0.60 are common when indicators are conceptually diverse. The significant Bartlett's test confirms that sufficient correlations exist among subsets of variables to justify factor extraction.

Table 3: KMO and Bartlett’s Test for Environmental Indicators

| Test                          | Statistic               | Value  |
|-------------------------------|-------------------------|--------|
| Kaiser-Meyer-Olkin            | Overall MSA             | 0.56   |
| Bartlett’s Test of Sphericity | $\chi^2$                | 94.14  |
|                               | Degrees of Freedom (df) | 45     |
|                               | Significance (p-value)  | 0.0046 |

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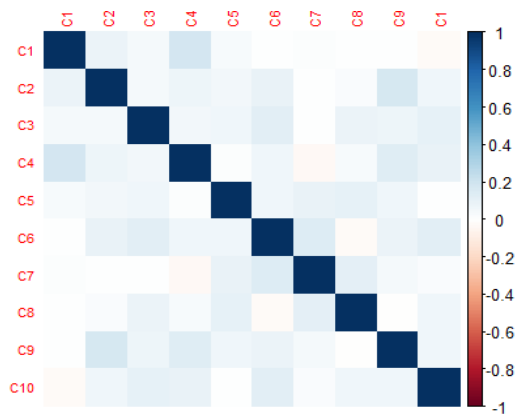


Figure 1: Correlation matrix of environmental indicators

The correlation matrix for environmental variables demonstrated a combination of weak and moderate correlations. The fact that correlations exceed 0.30, along with a significant Bartlett’s test, proves that there is shared

variance among some groups of indicators. However, the lack of a high correlation among all indicators fits well into the heterogeneous character of the environmental sphere.

Table 4: Eigenvalues and Percentage of Variance Explained for Environmental Indicators

| Factor    | Eigenvalue | Var. Explained (%) | Cumulative var.(%) |
|-----------|------------|--------------------|--------------------|
| Factor 1  | 1.557      | 15.57              | 15.57              |
| Factor 2  | 1.195      | 11.95              | 27.52              |
| Factor 3  | 1.089      | 10.89              | 38.41              |
| Factor 4  | 1.034      | 10.34              | 48.75              |
| Factor 5  | 0.984      | 9.84               | 58.59              |
| Factor 6  | 0.938      | 9.38               | 67.97              |
| Factor 7  | 0.877      | 8.77               | 76.74              |
| Factor 8  | 0.866      | 8.66               | 85.4               |
| Factor 9  | 0.772      | 7.72               | 93.12              |
| Factor 10 | 0.688      | 6.88               | 100.00             |

Four factors had eigenvalues greater than 1.00 (1.557, 1.195, 1.089, and 1.034), collectively explaining 48.75% of the total variance. The remaining six factors had eigenvalues below 1.00 and did not satisfy the Kaiser criterion.

**Table 5: Retained Environmental Factors Based on the Kaiser Criterion**

| Factor   | Eigenvalue | Var. Explained (%) | Cumulative var.(%) |
|----------|------------|--------------------|--------------------|
| Factor 1 | 1.557      | 15.57              | 15.57              |
| Factor 2 | 1.195      | 11.95              | 27.52              |
| Factor 3 | 1.089      | 10.89              | 38.41              |
| Factor 4 | 1.034      | 10.34              | 48.75              |

The four-factor solution explaining 48.75% of variance is consistent with the multidimensional nature of environmental determinants of HIV vulnerability. The first factor (15.57%) likely represents water and sanitation infrastructure, the second (11.95%) may reflect climate and natural disasters, the third (10.89%) may capture healthcare access, and the fourth (10.34%) may represent green infrastructure and waste management. This

structure aligns with Folorunso et al. (2019), who found that water, sanitation, and hygiene are distinct but interrelated environmental determinants of HIV vulnerability in Ekiti State. The cumulative variance of 48.75% is acceptable for exploratory factor analysis in public health research, where indicators are often heterogeneous (Hair et al., 2010).

**Table 6: Maximum-Likelihood Factor Loadings for Environmental Indicators**

| Variable                       | ML1   | ML2   | ML3   | ML4   | Interpretation         |
|--------------------------------|-------|-------|-------|-------|------------------------|
| Climate                        | 0.998 | –     | –     | –     | Strong loading         |
| Access to Safe drinking water  | –     | 0.998 | –     | –     | Strong loading         |
| Noise Pollution                | –     | –     | 0.526 | –     | Strong loading         |
| Sanitation Facilities          | –     | –     | 0.302 | –     | Weak loading           |
| Green Infrastructure           | –     | –     | –     | 0.591 | Strong loading         |
| Waste disposal system          | –     | –     | –     | –     | No substantial loading |
| Air Quality                    | –     | –     | –     | –     | No substantial loading |
| Proximity to Health facilities | –     | –     | –     | –     | No substantial loading |
| Natural Disasters              | –     | –     | –     | –     | No substantial loading |
| Access to HIV                  | –     | –     | –     | –     | No substantial loading |

**Table 7: Rotated Environmental Factor Loadings and Variance Explained**

| Factor | SS Loadings | Proportion Var (%) | Cumulative (%) |
|--------|-------------|--------------------|----------------|
| ML1    | 1.041       | 10.4%              | 10.4%          |
| ML2    | 1.032       | 10.3%              | 20.7%          |
| ML3    | 0.453       | 4.5%               | 25.6%          |
| ML4    | 0.482       | 4.8%               | 30.4%          |

After varimax rotation, ML1 to ML4 contributed 10.4%, 10.3%, 4.5%, and 4.8% to the total variance, respectively, with a cumulative rotated variance of 30.4%. Factors 1 and 2 had the highest contributions. Some indicators (waste disposal, air quality) showed no substantial loading on any retained factor.

The strong loading of climate and safe drinking water on the first two factors is consistent with Awofala and Ogundele's (2018) observation that environmental infrastructure shapes HIV service access in Nigeria. However, unlike Folorunso et al. (2019), who found water and sanitation to be dominant determinants in Ekiti State,

our analysis found that waste disposal and air quality showed no substantial loading. This discrepancy likely reflects the weak factor structure indicated by the low KMO (0.56) and Cronbach's alpha (0.386), rather than a substantive null finding. These null loadings should be interpreted as measurement artefacts, not as evidence that waste disposal and air quality are irrelevant to HIV vulnerability. The moderate loading of noise pollution and green infrastructure on separate factors suggests that these environmental dimensions may operate independently of water and sanitation.

**Table 8: Reliability Statistics for Environmental Indicators**

| Reliability Measure                 | Value |
|-------------------------------------|-------|
| Cronbach's Alpha (Raw)              | 0.386 |
| Cronbach's Alpha (Standardized)     | 0.386 |
| Average inter- variable correlation | 0.059 |
| Number of Variables                 | 10    |

The Cronbach's alpha for the 10 environmental indicators was 0.386 (standardized alpha = 0.386), with an average inter-item correlation of 0.059. This low internal consistency indicates that the environmental indicators do not form a single homogeneous scale.

The low alpha is expected given the heterogeneous nature of environmental indicators, which measure distinct constructs (water, sanitation, climate, infrastructure). This finding is consistent with Nunnally's (1978)

recommendation that alpha values below 0.50 indicate unacceptable internal consistency for a unidimensional scale. However, low alpha does not invalidate the use of factor analysis, which is designed to identify multiple dimensions within heterogeneous indicator sets. The finding supports the interpretation that environmental determinants of HIV vulnerability are multidimensional rather than unidimensional.

**Table 9: Summary Statistics for Socio-Cultural Indicators (D1–D9)**

| Variable                       | Mean | Median | GMD   |
|--------------------------------|------|--------|-------|
| Cultural Belief about HIV/AIDS | 3.62 | 3.5    | 1.266 |
| Social Norms                   | 3.57 | 3.5    | 1.232 |
| Stigma and Discrimination      | 3.60 | 3.5    | 1.141 |
| Knowledge and Awareness        | 3.66 | 4.0    | 1.263 |
| Attitude towards Condom        | 3.67 | 4.0    | 1.206 |
| Sexual Norms                   | 3.55 | 3.5    | 1.227 |
| Gender Roles                   | 3.62 | 3.5    | 1.171 |
| Community Support System       | 3.59 | 3.5    | 1.173 |
| Media Exposure                 | 3.57 | 3.5    | 1.247 |

Mean scores ranged from 3.55 (sexual norms) to 3.67 (attitude towards condoms), with medians between 3.5 and 4.0. The GMD values (1.14–1.27) indicate moderate variability in responses

The relatively high mean scores for knowledge and awareness and attitude towards condoms suggest that respondents perceive these socio-cultural factors as relatively favourable, while sexual norms scored lowest. This pattern is consistent with Airhihenbuwa et al. (2009),

who noted that HIV knowledge and condom attitudes are often more amenable to change than deeply embedded sexual norms and gender roles. The moderate variability in responses indicates heterogeneity in socio-cultural conditions across LGAs.

**Table 10: KMO and Bartlett's Test for Socio-Cultural Indicators**

| Test                          | Statistic               | Value  |
|-------------------------------|-------------------------|--------|
| Kaiser-Meyer-Olkin            | Overall MSA             | 0.58   |
| Bartlett's Test of Sphericity | $\chi^2$                | 76.56  |
|                               | Degrees of Freedom (df) | 36     |
|                               | Significance (p-value)  | 0.0071 |

The KMO value of 0.58 is barely above the minimum threshold of 0.50 and falls within Kaiser's (1974) "miserable" range, indicating weak but sufficient sampling adequacy. Bartlett's test of sphericity was statistically significant ( $\chi^2 = 76.56$ ,  $df = 36$ ,  $p = 0.0071$ ), indicating that the correlation matrix differed from an identity matrix.

The low KMO value is consistent with the heterogeneous nature of socio-cultural indicators, which measure distinct constructs (beliefs, norms, stigma, knowledge, attitudes) rather than a single underlying dimension. The significant Bartlett's test confirms that sufficient correlations exist among subsets of variables to justify factor extraction.

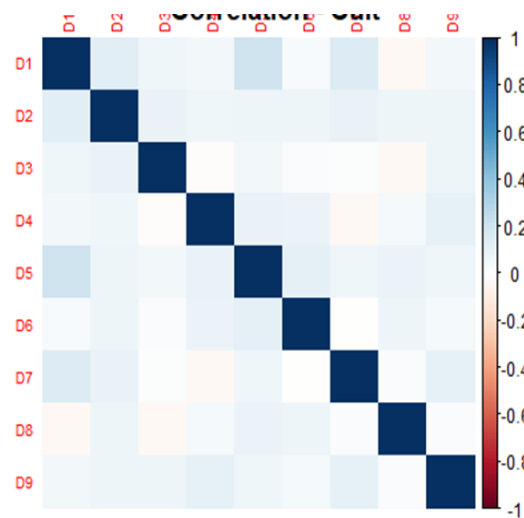


Figure 2: Correlation matrix of socio-cultural indicators

The socio-cultural correlation matrix showed generally weak to moderate associations, with several coefficients above 0.30. This pattern indicates limited but meaningful shared variance among subsets of indicators, while the absence of very high correlations suggests that severe pairwise multicollinearity was not evident.

The mixed correlation pattern suggests that socio-cultural factors cluster into distinct subgroups for example, cultural beliefs and condom attitudes may correlate with each other but not with media exposure. This pattern supports the use of factor analysis to identify latent groupings.

Table 11: Eigenvalues and Percentage of Variance Explained for Socio-Cultural Indicators

| Factor   | Eigenvalue | Var. Explained (%) | Cumulative var (%) |
|----------|------------|--------------------|--------------------|
| Factor 1 | 1.539      | 17.10              | 17.10              |
| Factor 2 | 1.141      | 12.68              | 29.78              |
| Factor 3 | 1.023      | 11.37              | 41.15              |
| Factor 4 | 1.007      | 11.19              | 52.34              |
| Factor 5 | 0.984      | 10.93              | 63.27              |
| Factor 6 | 0.905      | 10.06              | 73.33              |
| Factor 7 | 0.889      | 9.88               | 83.21              |
| Factor 8 | 0.786      | 8.73               | 91.94              |
| Factor 9 | 0.726      | 8.06               | 100.00             |

Four factors had eigenvalues greater than 1.00 (1.539, 1.141, 1.023, and 1.007), collectively explaining 52.34% of the total variance. The remaining five factors had eigenvalues below 1.00 and did not satisfy the Kaiser criterion.

Table 12: Retained Socio-Cultural Factors Based on the Kaiser Criterion

| Factor   | Eigenvalue | Var. Explained (%) | Cumulative var.(%) |
|----------|------------|--------------------|--------------------|
| Factor 1 | 1.539      | 17.10              | 17.10              |
| Factor 2 | 1.141      | 12.68              | 29.78              |
| Factor 3 | 1.023      | 11.37              | 41.15              |
| Factor 4 | 1.007      | 11.19              | 52.34              |

The four-factor solution explaining 52.34% of variance is consistent with the multidimensional nature of socio-cultural determinants of HIV vulnerability. The first factor (17.10%) likely represents cultural beliefs and condom attitudes, the second (12.68%) may reflect media exposure, the third (11.37%) may capture community

support, and the fourth (11.19%) may represent gender roles. This structure aligns with Airhihenbuwa et al. (2009), who argued that cultural beliefs and condom attitudes are central to HIV prevention in Nigeria. The cumulative variance of 52.34% is acceptable for exploratory factor analysis in public health research.

**Table 13: Maximum-Likelihood Factor Loadings for Socio-Cultural Indicators**

| Variable                       | ML1   | ML2   | ML3   | ML4   | Interpretation         |
|--------------------------------|-------|-------|-------|-------|------------------------|
| Cultural Belief about HIV/AIDS | 0.600 | –     | –     | –     | Strong loading         |
| Attitude towards Condom        | 0.363 | –     | –     | –     | Weak loading           |
| Media Exposure                 | –     | 0.547 | –     | –     | Strong loading         |
| Community Support System       | –     | –     | 0.451 | –     | Moderate loading       |
| Gender Roles                   | –     | –     | –     | 0.427 | Moderate loading       |
| Social Norms                   | –     | –     | –     | –     | No substantial loading |
| Stigma and Discrimination      | –     | –     | –     | –     | No substantial loading |
| Knowledge and Awareness        | –     | –     | –     | –     | No substantial loading |
| Sexual Norms                   | –     | –     | –     | –     | No substantial loading |

The strong loading of cultural beliefs and condom attitudes on the first socio-cultural factor aligns with Airhihenbuwa et al. (2009), who argued that cultural beliefs about HIV shape prevention behaviours in Nigeria. Similarly, Mahajan et al. (2008) identified stigma as a central barrier to HIV service uptake—although in our analysis stigma and discrimination showed no substantial loading. This may be because stigma operates through complex pathways not

captured by a single Likert item, or because the weak factor structure ( $KMO = 0.58$ ;  $\alpha = 0.373$ ) limited our ability to detect it. The moderate loading of community support and gender roles on separate factors supports Parker and Aggleton's (2003) framework that HIV vulnerability is shaped by multiple, intersecting social structures rather than a single construct.

**Table 14: Reliability Statistics for Socio-Cultural Indicators**

| Reliability Measure                 | Value |
|-------------------------------------|-------|
| Cronbach's Alpha (Raw)              | 0.373 |
| Cronbach's Alpha (Standardized)     | 0.371 |
| Average inter- variable correlation | 0.062 |
| Number of Variables                 | 9     |

The Cronbach's alpha for the 9 socio-cultural indicators was 0.373 (standardized alpha = 0.371), with an average inter-item correlation of 0.062. This low internal consistency indicates that the socio-cultural indicators do not form a single homogeneous scale.

The low alpha is expected given the heterogeneous nature of socio-cultural indicators, which measure distinct constructs (beliefs, norms, stigma, knowledge, attitudes, media, gender). This finding is consistent with Nunnally's (1978) recommendation that alpha values below 0.50 indicate unacceptable internal consistency for a unidimensional scale. However, low alpha does not invalidate the use of factor analysis, which is designed to identify multiple dimensions within heterogeneous indicator sets.

## CONCLUSION

From the exploratory factor analysis, it can be concluded that both the environmental and socio-cultural domains consist of more than one dimension each, rather than being single constructs. In the environmental domain, four factors were extracted, explaining 48.75% of the total observed variance. In the socio-cultural domain, four factors were extracted, explaining 52.34% of the observed variance. The highest factor loadings were found for climate and safe drinking water in the environmental domain, and for cultural beliefs, attitudes toward condom

use, media exposure, community support, and gender roles in the socio-cultural domain.

The results imply that HIV prevention and service delivery programmes in Gombe State need to address multiple dimensions within the environmental and socio-cultural domains, rather than relying on a composite construct. However, because this is a cross-sectional study, the findings can only be interpreted as evidence of association and not causality.

## Limitations

Several limitations should be considered when interpreting the findings of this study:

- Sampling: The use of purposive sampling limits the generalisability of the findings to the entire population of Gombe State, as respondents were recruited through HIV service delivery points, which may introduce selection bias.
- Study design: The cross-sectional design precludes any conclusion about temporal or causal relationships between environmental and socio-cultural factors and HIV vulnerability.
- Measurement: The low KMO values (0.56 and 0.58) and poor internal consistency (Cronbach's alpha = 0.386 and 0.373) require caution in interpreting the factor analysis results. Variables showing "no

substantial loading" may reflect weak factor structure rather than substantive null findings.

- iv. Factor retention: The decision to retain factors was based on the Kaiser criterion alone; other criteria such as parallel analysis and scree plots were not applied and could yield different factor solutions.

## RECOMMENDATIONS

Based on the findings, the following recommendations are made:

- i. Implement community-based HIV education, testing, and treatment adherence programmes across all 11 LGAs, with particular attention to LGAs showing relatively higher prevalence (Gombe, Billiri, Kaltungo, and Shongom).
- ii. Improve access to HIV-related services in rural and hard-to-reach LGAs by strengthening health infrastructure and reducing environmental barriers such as distance to health facilities and lack of safe drinking water.
- iii. Design culturally competent interventions that address stigma, misconceptions, and gender barriers, engaging community leaders, religious institutions, and media to improve HIV knowledge and condom attitudes.
- iv. Apply parallel analysis alongside the Kaiser Criterion in future factor-analytic studies, and consider longitudinal or probability-based designs to improve generalisability and determine trends over time.

## Policy Implications

These results advocate an integrated approach to HIV prevention and care where health care service accessibility and availability are taken into consideration in addition to the environment and socio-cultural factors. First, health agencies should improve access to health services, especially to those areas and LGAs with relatively higher observed prevalence of HIV. Second, community programs should target reducing the stigma, misconceptions and gender issues together with improving community education. Thirdly, there should be continued development of infrastructure and improved access to health facilities, along with keeping track of the differences in HIV prevalence at a local level. Fourthly, the programme data and sound spatial analysis could help with strategic allocation of HIV prevention and treatment resources.

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