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Assessment of Knowledge Attitude and Practices of Rural Population Towards Infectious Diseases and Their Prevention

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ABSTRACT

Introduction: Understanding the etiological agents, reservoirs, and transmission dynamics of infectious diseases is crucial for developing effective prevention and control strategies, particularly in rural settings where healthcare access and awareness may be limited. Past pandemics, such as COVID-19 and historical influenza pandemics, have highlighted the diverse nature of infectious diseases and underscored the critical importance of public health awareness, particularly in underserved rural communities. This study aimed to assess the knowledge, attitudes, and practices (KAP) of a rural population regarding infectious diseases and their prevention. **Methods**: This cross-sectional study included adults aged 18 years and older residing in rural areas of Eastern Uttar Pradesh, India. Data were collected using a questionnaire validated through expert review and pilot testing. Descriptive statistics were used to summarize demographic variables. Continuous variables were summarized as mean ± standard deviation, and categorical variables as frequencies and percentages. Associations between categorical variables were assessed using the Chi-square test, while correlations between ordinal or non-normally distributed continuous variables were evaluated using Spearman's rank correlation test. Data were analyzed using SPSS version 26. **Results**: The study included 1,714 participants, with 56.2% males and 43.8% females. The majority of participants (52.8%) were young adults aged 18–25 years. A majority of participants (58.8%) had attained or were pursuing college-level education or higher. Most respondents (84.2%) lacked knowledge of endemic diseases, and 82% lacked knowledge of vaccine-preventable diseases in the study region. Significant gaps were observed in participants' knowledge of disease transmission modes and preventive practices. Employed participants demonstrated significantly higher attitude and practice scores compared to unemployed participants and students ($P < 0.05$). A weak positive correlation was observed between knowledge and practice scores ($r = 0.202$; $P < 0.001$). No significant associations were observed between knowledge and attitude ($r = 0.035$, $P = 0.704$) or between attitude and practice ($r = 0.099$; $P = 0.274$). **Conclusion**: The study highlights significant gaps in knowledge about infectious diseases among the rural population, particularly regarding endemic and vaccine-preventable diseases. The weak correlation between knowledge and practice underscores the need for targeted, behavior-focused health interventions. Community-based programs, such as village workshops, school campaigns, and mobile health outreach, should be integrated with existing national disease control efforts to address the significant knowledge gaps identified and improve preventive practices. Future research should assess the impact of such interventions on health-seeking behaviors in rural communities.

INTRODUCTION

Infectious diseases pose a persistent global health threat, disproportionately affecting resource-limited settings. Despite medical advancements, they remain a leading cause of morbidity and mortality worldwide. These diseases can lead to pandemics, such as the recent COVID-19 pandemic, which placed immense strain on healthcare systems worldwide. Infectious diseases are transmitted through diverse routes, including airborne, droplet, waterborne, and vector-borne pathways. Diseases such as tuberculosis (*Mycobacterium tuberculosis*) and malaria (*Plasmodium* spp.) are prevalent in many rural areas [1]. The COVID-19 pandemic underscores the urgent need for public health interventions, including enhanced sanitation, vaccination programs, and community education on preventive practices [2]. Infectious diseases have caused some of the most devastating pandemics in history, including the Black Death and COVID-19, highlighting their global impact [3].

Respiratory diseases, transmitted through airborne or droplet routes, include tuberculosis, influenza, and coronaviruses such as SARS-CoV and SARS-CoV-2. These diseases have posed significant global threats, causing substantial morbidity, mortality, and socioeconomic disruption worldwide [1, 4]. The vector-borne disease plague (*Yersinia pestis*) has caused several major pandemics throughout history, including the Plague of Justinian (541–549 CE) and the Black Death (1346–1353 CE), significantly impacting affected populations. These pandemics led to widespread mortality, with estimates suggesting tens of millions of deaths [5]. Vector-borne diseases, such as dengue, chikungunya, and Zika, have caused significant outbreaks, particularly in tropical and subtropical regions, resulting in substantial morbidity and mortality [1, 6]. Cholera, a waterborne disease caused by *Vibrio cholerae*, has led to several global pandemics, contributing significantly to morbidity and mortality [7].

In 2022, the Centers for Disease Control and Prevention (CDC) highlighted the global threat of infectious diseases, including the monkeypox outbreak in the United States. The CDC also emphasized the ongoing risk of Ebola virus disease, as demonstrated by outbreaks in the Democratic Republic of the Congo, including the 2018–2020 North Kivu outbreak [8]. These outbreaks underscore the importance of understanding diverse transmission routes, such as contact with bodily fluids [9].

Evidence suggests that rural populations often bear a disproportionate burden during infectious disease outbreaks, potentially due to factors such as limited healthcare access and specific occupational exposures. For example, a cross-sectional study by Liu *et al*. (2013) in rural Zhejiang, China, found that rural residents had limited knowledge of infectious disease transmission and prevention. Furthermore, factors such as agricultural work, which often involves close contact with animals or exposure to environmental pathogens and underlying health conditions, can increase susceptibility to infectious diseases in rural populations [10].

India has a predominantly rural population, with a significant proportion of its citizens living in rural areas and engaged in agricultural activities. Limited access to healthcare services in rural India, particularly for the early diagnosis, treatment, and management of complications related to infectious diseases, contributes to increased disease prevalence, morbidity, and mortality [11, 12].

Communicable infectious diseases are prevalent in Eastern Uttar Pradesh, India. The prevalence of tuberculosis in Uttar Pradesh is around 26% of total tuberculosis cases in India [13]. The vector borne diseases like filariasis and Japanese encephalitis are endemic in our study region [14, 15]. The presence of all dengue serotypes has also been reported in this region [16].

To address the specific challenges faced by rural populations in accessing healthcare and preventing infectious diseases, a KAP study was conducted. The study focused on rural communities in rural areas of Eastern Uttar Pradesh, India, which are served by a tertiary care hospital. This study aimed to assess the KAP regarding common infectious diseases in our region *e.g.* Dengue, malaria, filariasis, Japanese encephalitis (vector borne), Cholera (water borne), and tuberculosis (droplet/airborne). The findings of this study can help address health disparities by informing the development of targeted public health interventions. Specifically, the results can identify knowledge gaps and guide the design of educational initiatives tailored to the needs of this rural population.

MATERIAL AND METHODS

Study design. A cross-sectional study design was used.

Study location. Data were collected from rural areas of the Basti district in Eastern Uttar Pradesh, India.

Inclusion criteria. The study included adult participants aged 18 years or older who had resided in the study area for at least one year.

Exclusion criteria. Healthcare workers and individuals who did not provide informed consent were excluded.

Sampling method. All 1,038 villages in the study region were enumerated. Among these, 150 villages were selected using simple random sampling. From each village, six houses were systematically selected. The sampling interval for each village was calculated by dividing the total number of houses in the village by six. The first house was selected randomly, and every subsequent kth house was selected, where k represents the calculated sampling interval. If a village had fewer than six houses, all households were included, with up to two adults per household randomly selected for participation. Using this approach, 900 households were included in the study, with a maximum of two adults interviewed per household. If more than two adults were present, two were randomly selected for participation in the interview. Two persons volunteered from 823 households, one individual from 68 households, and there were no volunteers from nine households. The survey achieved a response rate of 95.2%.

Data collection. Due to the COVID-19 pandemic, an online survey was developed in both English and Hindi. Data were collected between May 1 and July 15, 2022, using the Google Forms platform. Forty healthcare volunteers underwent standardized training on survey distribution, participant consent, anonymity, and data integrity to ensure consistent data collection. To minimize potential order effects, the sequence of some question blocks was randomized, while the knowledge, attitude, and practice questions were presented in a fixed order. Participants voluntarily completed the survey online using their personal smartphones or other internet-enabled devices.

Collection instrument. A questionnaire containing a total of 18 questions, including five questions related to demographic data and 13 questions on KAP, was designed based on the WHO document, A Guide to Developing Knowledge, Attitude and Practice Surveys [17]. The questionnaire consisted of two parts: the first part collected participants' demographic details, such as age, sex, educational status, marital status, and employment, while the second part assessed knowledge, attitudes, and practices related to infectious diseases and their prevention.

Participants' knowledge of infectious diseases and pandemics was assessed using seven questions, while attitudes and practices were assessed using two and four questions, respectively. The seven knowledge questions assessed general knowledge about infectious diseases, modes of disease transmission, the definition of a pandemic, past pandemic diseases, endemic diseases in the study region, vector-borne diseases, methods of preventing infections transmitted via droplets, and vaccine-preventable diseases.

The attitude questions were designed to assess participants' attitudes towards a hypothetical outbreak of an unknown disease and their anticipated emotional response if they were to contract COVID-19.

The practice questions assessed participants' past practices related to COVID-19 prevention (specifically droplet precautions), prevention of Japanese encephalitis (JE, a vector-borne disease endemic to the region), healthcare-seeking behavior, and practices related to tuberculosis prevention and care.

Questions with multiple correct options were included to comprehensively assess various aspects of infectious diseases while minimizing the total number of questions. The primary objective of the questionnaire was to assess participants' knowledge of infectious agents, their modes of transmission, and effective prevention strategies. The diseases included as answer choices in the questions were either those that have caused global pandemics or those endemic to the study region (Supplementary file).

Efforts were made to avoid leading questions, following the recommendations outlined in the WHO document on KAP studies [17]. Each question was scored based on the number of correct responses, with one point awarded per correct answer. Participants scoring above 50% on the knowledge questions were categorized as having 'adequate knowledge,' while those scoring 50% or below were categorized as having 'inadequate knowledge,' based on standard KAP survey thresholds to distinguish basic understanding. We adopted this scoring strategy to categorize the population into people lacking basic knowledge and having basic knowledge of infectious diseases, and further analyze to make separate policies to educate and improve the knowledge of these two groups. Similarly, for attitudes, scores above 50% were categorized as 'positive attitude,' while scores of 50% or below were categorized as 'negative attitude.' For practices, scores above 50% were categorized as 'adequate practice,' while scores of 50% or below were categorized as 'inadequate practice.'

Questionnaire validation

Content validity. To ensure content validity, experts from the departments of Clinical Microbiology, General Medicine, and Community Medicine reviewed and validated the final questionnaire. The experts were faculty members from their respective departments, each holding an MD degree and possessing more than five years of research experience.

Pilot testing. A pilot study was conducted with 53 randomly selected participants who met the inclusion and exclusion criteria of the study. In the pilot study, participants were initially presented with 13 knowledge-based questions, 3 attitude-based questions, and 5 practice-based questions. Based on the pilot study results, the questionnaire was revised to enhance clarity and content. Ultimately, 13 questions (7 knowledge-based, 2 attitude-based, and 4 practice-based) were selected for the main study. Internal consistency was evaluated using Cronbach's alpha. The Cronbach's alpha coefficient was 0.814 for the 7-item knowledge section, 0.398 for the 2-item attitude section, and 0.340 for the 4-item practice section. Cronbach's alpha, commonly used to assess internal consistency, has notable limitations as a reliability estimate. It is more frequently applied as a measure of a test's internal consistency rather than its overall reliability. Therefore, we conducted a test-retest reliability assessment. [18].

Test-retest reliability. To assess test-retest reliability, the questionnaire was re-administered to participants (N=14) after a 5-day interval. Spearman's rank correlation coefficient (rho) was used to evaluate the correlation between test and retest (the same set of questionnaire was provided in the retest as was given in the test) scores for knowledge, attitudes, and practices. The Spearman's rho values were 0.808 ($P < 0.001$) for knowledge, 1.000 ($P < 0.001$) for attitudes, and 0.950 ($P < 0.001$) for practices, indicating statistically significant correlations between test and retest scores for all three domains.

Statistical analysis. Categorical variables (gender, age group, marital status, educational qualification, and employment status) were described using frequencies and percentages (%), while the continuous variable (age) was described using the mean ± standard deviation (SD). Differences in knowledge, attitude, and practice scores

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across demographic groups were analyzed using Mann-Whitney U tests (for two groups) or Kruskal-Wallis tests (for more than two groups). Relationships between variables were assessed using Spearman's correlation coefficient. All statistical analyses were conducted using SPSS version 26 (IBM Corp., Armonk, NY, USA). A *P*-value of < 0.05 (two-tailed) was considered statistically significant, corresponding to a significance level (α) of 0.05.

Ethical approval statement. The present study was conducted as an online survey involving the general population. All participants were aged 18 years or older and provided informed consent to participate in the study. The study included only healthy volunteers from the general population. The study was approved by the Institutional Ethics Committee, Maharshi Vashishtha Autonomous State Medical College, Basti (approval number: ASMC/ETHICS/004; date: April 7, 2022).

RESULTS

Sociodemographic characteristics. A total of 1,714 individuals participated in this study. The mean age of the participants was 28.33 years (±11.96 SD). Most participants (52.8%) were aged 18–25 years. Male participants were 964 (56.2%). Of the participants, 755 (44.1%) were college students. A larger proportion (58.8%) had attained or was pursuing higher education (college or postgraduate studies), while 3.8% had no education. The majority of participants (67%) were unmarried (Table 1).

Table 1. Demographic characteristics of participants (n=1714)

Characteristic	n (%)
Age (years)	
Range	18-78
Mean (SD)	(28.33±11.96)
Gender	
Male	964 (56.2)
Female	750 (43.8)
Age group (years)	
18-25	905 (52.8)
26-45	644 (37.6)
>45	165 (9.6)
Education	
High school or less	641 (37.4)
College graduate or more	1007 (58.8)
No education	66 (3.8)
Employment status	
Employed	662 (38.6)
Unemployed	297 (17.3)
Student	755 (44.1)
Marital Status	
Married	566 (33.0)
Unmarried	1148 (67.0)

Knowledge about infectious diseases. Half of female participants (50%) demonstrated adequate knowledge, compared to 44% of male participants, indicating a statistically significant gender disparity in overall knowledge scores (*P* < 0.05). Similarly, married participants exhibited higher knowledge scores than unmarried participants (50.4% vs. 44.7%). However, no significant association was observed between overall knowledge of infectious diseases and participants' education level (*P* = 0.149) or employment status (*P* = 0.844).

Participants aged above 45 years demonstrated significantly higher knowledge of disease transmission modes compared to the <45 years age group participants (*P* < 0.001). Females compared to males (*P* = 0.000), unmarried participants compared to married (*P* < 0.001), those with higher education compared to basic education (*P* = 0.001), and students compared to employed people (*P* = 0.001) demonstrated significantly better understanding of the pandemic definition. Females compared to males (*P* = 0.001) and participants with higher education compared to basic education (*P* < 0.001) exhibited greater knowledge of past pandemics. Most participants (84.2%) had below-average knowledge of endemic diseases in the study region, and 81.6% were unaware of vaccine-preventable diseases. Approximately 64.2% of participants were aware of diseases (COVID-19, pulmonary tuberculosis and swine flu) preventable by wearing facemasks. Awareness of vector-borne diseases was relatively high, with approximately 60.8% of participants exhibiting adequate knowledge (Table 2).

Attitude towards infectious diseases. Female participants exhibited a significantly more positive attitude compared to males (*P* = 0.006), and married participants showed a more positive attitude than unmarried ones (*P* < 0.001). Employed participants demonstrated a significantly more positive attitude than both unemployed participants and students (*P* < 0.001). However, no significant association was found between educational level and attitude toward infectious diseases (*P* = 0.131). A majority of participants (72.3%) expressed a positive attitude toward COVID-19, as indicated by their responses to attitude-related questions. Approximately 48.8% of participants exhibited a positive attitude toward a hypothetical disease outbreak scenario, with females (57.1%) showing a significantly higher positive attitude than males (42.4%) (*P* = 0.0001), as detailed in Table 3.

Table 2. Knowledge of participants related to infectious disease

Variables	Gender			Age				Marital status			Education				Employment status			
	Male N (%)	Female N (%)	*P*	18-25 N (%)	26-45 N (%)	>45 N (%)	*P*	Married N (%)	Unmarried N (%)	*P*	Basic N (%)	Higher N (%)	Illiterate N (%)	*P*	Employed N (%)	Unemployed N (%)	Student N (%)	*P*
Mode of disease transmission																		
A	441 (45.7)	323 (43)	0.226	428 (47.3)	237 (36.8)	99 (60)	<0.00001	270 (47.7)	494 (43)	0.672	313 (48.8)	440 (43.7)	11 (16.7)	<0.00001	295 (44.6)	132 (44.4)	337 (44.6)	0.99
B	523 (54.3)	427 (57)		477 (52.7)	407 (63.2)	66 (40)		296 (52.3)	654 (57)		328 (51.2)	567 (56.3)	55 (83.3)		367 (55.4)	165 (55.6)	418 (55.4)	
Definition of pandemic																		
A	654 (67.8)	567 (75.6)	0.0004	642 (70.9)	469 (72.8)	110 (66.7)	0.28	356 (62.9)	865 (75.3)	<0.00001	457 (71.3)	731 (72.6)	33 (50)	0.00046	473 (71.5)	187 (63)	561 (74.3)	0.00122
B	310 (32.2)	183 (24.4)		263 (29.1)	175 (27.2)	55 (33.3)		210 (37.1)	283 (24.7)		184 (28.7)	276 (24.4)	33 (50)		189 (28.5)	110 (37)	194 (25.7)	
Past pandemic diseases																		
A	466 (48.3)	424 (56.6)	0.00075	475 (52.5)	339 (52.6)	77 (46.7)	0.35	306 (54.1)	584 (50.9)	0.213	282 (44)	586 (58.2)	22 (33.3)	<0.00001	343 (51.8)	132 (44.4)	415 (55)	0.008
B	498 (51.7)	326 (43.4)		430 (47.5)	305 (47.4)	88 (53.3)		260 (45.9)	564 (49.1)		359 (56)	421 (41.8)	44 (66.7)		319 (48.2)	165 (55.6)	340 (45)	
Endemic diseases in study region																		
A	114 (11.8)	157 (21)	<0.0001	112 (12.4)	105 (16.3)	55 (33.3)	<0.00001	125 (22.1)	147 (12.8)	<0.0001	102 (15.9)	159 (15.8)	11 (16.7)	0.981	127 (19.2)	44 (14.8)	101 (13.4)	0.010
B	850 (88.2)	593 (79)		793 (87.6)	539 (83.7)	110 (66.7)		441 (77.9)	1001 (87.2)		539 (84.1)	848 (84.2)	55 (83.3)		535 (80.8)	253 (85.2)	654 (86.6)	
Vector borne diseases																		
A	520 (53.9)	515 (68.7)	<0.0001	517 (57.1)	386 (59.9)	132 (80)	<0.00001	406 (71.7)	629 (54.8)	<0.0001	470 (73.3)	532 (52.8)	33 (50)	<0.00001	435 (65.7)	220 (74.1)	380 (50.3)	<0.00001
B	444 (46.1)	235 (31.3)		388 (42.9)	258 (40.1)	33 (20)		160 (28.3)	519 (45.2)		171 (26.7)	475 (47.2)	33 (50)		227 (34.3)	77 (25.9)	375 (49.7)	

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Prevention of infections by droplet transmission A & B	591 (61.3) 373 (38.7)	504 (67.2) 246 (32.8)	0.011	541 (59.8) 364 (40.2)	411 (63.8) 233 (36.2)	143 (86.7) 22 (13.3)	<0.00001	421 (74.4) 145 (25.6)	674 (58.7) 474 (41.3)	<0.0001	437 (68.2) 204 (31.8)	614 (60.9) 393 (39.1)	44 (66.7) 22 (33.3)	0.0109	426 (64.4) 236 (35.6)	209 (70.4) 88 (29.6)	460 (60.9) 295 (39.1)	0.015
Vaccine preventable diseases A B	181 (18.8) 783 (81.2)	135 (18) 615 (82)	0.6811	204 (22.5) 701 (77.5)	90 (14) 554 (86)	22 (13.3) 143 (86.7)	0.00002	112 (19.8) 454 (80.2)	204 (17.8) 944 (82.2)	0.310	114 (17.8) 527 (82.2)	191 (19) 816 (81)	11 (16.7) 55 (83.3)	0.776	93 (14) 569 (86)	55 (18.5) 242 (81.5)	168 (22.3) 587 (77.7)	0.0003
Knowledge score total A B	424 (44) 540 (56)	375 (50) 375 (50)	<0.05	417 (46.1) 488 (53.9)	291 (45.2) 353 (54.8)	91 (55.2) 74 (44.8)	0.065	285 (50.4) 281 (49.6)	514 (44.8) 634 (55.2)	<0.05	311 (48.5) 330 (51.5)	465 (46.1) 542 (53.9)	24 (35.7) 42 (64.3)	0.149	313 (47.3) 349 (52.7)	140 (47.1) 157 (52.9)	346 (45.8) 409 (54.2)	0.844

A: Appropriate knowledge, B: Below average; Chi-square test applied. *P* <0.05 was considered statistically significant.

Table 3. Attitude towards infectious diseases

Variables	Gender			Age				Marital status			Education				Employment status			
	Male N (%)	Female N (%)	*P*	18-25 N (%)	26-45 N (%)	>45 N (%)	*P*	Married N (%)	Unmarried N (%)	*P*	Basic N (%)	Higher N (%)	NO N (%)	*P*	Employed N (%)	Unemployed N (%)	Student N (%)	*P*
Attitude towards unknown disease outbreak P O	409 (42.4) 555 (57.6)	428 (57.1) 322 (42.9)	0.0001	443 (49) 462 (51)	306 (47.5) 338 (52.5)	88 (53.3) 77 (46.7)	0.408	319 (56.4) 247 (43.6)	518 (45.1) 630 (54.9)	0.000012	326 (50.9) 315 (49.1)	489 (48.6) 518 (51.4)	22 (33.3) 44 (66.7)	0.024	357 (53.9) 305 (46.1)	154 (51.9) 143 (48.1)	326 (43.2) 429 (56.8)	0.00014
Attitude towards COVID-19 P O	703 (72.9) 261 (27.1)	536 (71.5) 214 (28.5)	0.503	613 (67.7) 292 (32.3)	494 (76.7) 150 (23.3)	132 (80) 33 (20)	0.000035	438 (77.4) 128 (22.6)	801 (69.8) 347 (30.2)	0.000929	437 (68.2) 204 (31.8)	758 (75.3) 249 (24.7)	44 (66.7) 22 (33.3)	0.0024	533 (80.5) 129 (19.5)	231 (77.8) 66 (22.2)	475 (62.9) 280 (37.1)	0.00001
Attitude score total P O	556 (57.7) 408 (42.3)	482 (64.3) 268 (35.7)	<0.05	528 (58.3) 377 (41.7)	400 (62.1) 244 (37.9)	110 (66.7) 55 (33.3)	0.078	379 (66.9) 187 (33.1)	659 (57.4) 489 (42.6)	<0.05	382 (59.5) 259 (40.5)	623 (61.9) 384 (38.1)	33 (50) 33 (50)	0.131	445 (67.2) 217 (32.8)	193 (64.8) 104 (35.2)	401 (53) 354 (47)	<0.05

P: Positive attitude; N: Negative attitude; Chi-square test applied. *P* <0.05 was considered statistically significant.

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Practice related to infectious diseases. Employed participants and those with higher education demonstrated significantly better practices ($P < 0.05$). This was also true for practices related to accessing healthcare services and taking precautions for diseases such as tuberculosis ($P < 0.05$). Out of 1714 participants, 87.6% reported appropriate practices related to COVID-19. Only 17.3% of participants reported appropriate tuberculosis prevention practices, such as wearing masks and isolating patients from healthy individuals. Regarding Japanese encephalitis (Flavivirus genus), a vector-borne disease endemic to the study region, 54.6% of participants failed to adopt appropriate preventive measures (Table 4).

Correlation between knowledge, attitude and practice. The mean scores for the study population were 9.42 out of 14 for knowledge, 1.39 out of 2 for attitude, and 4.40 out of 8 for practice. A statistically significant but weak positive correlation was observed between knowledge and practice (r = 0.202, $P < 0.001$). However, no statistically significant correlations were observed between knowledge and attitude (r = 0.035, $P = 0.704$) or between attitude and practice (r = 0.099, $P = 0.274$) (Table 5).

Table 4. Practice towards infectious diseases

Variables	Gender			Age				Marital status			Education				Employment status			
	Male N (%)	Female N (%)	*P*	18-25 N (%)	26-45 N (%)	>45 N (%)	*P*	Married N (%)	Unmarried N (%)	*P*	Basic N (%)	Higher N (%)	NO N (%)	*P*	Employed N (%)	Unemployed N (%)	Student N (%)	*P*
Prevention of COVID-19 G P	830 (86.1) 134 (13.9)	672 (89.6) 78 (10.4)	0.028	782 (86.4) 123 (13.6)	555 (86.2) 89 (13.8)	165 (100) 0 (0)	0.00001	532 (93.9) 34 (6)	970 (84.5) 178 (15.5)	0.00001	574 (89.5) 67 (10.4)	873 (86.7) 134 (13.3)	55 (83.3) 11 (16.7)	0.127	595 (89.9) 67 (10.1)	264 (88.9) 33 (11.1)	643 (85.2) 112 (14.8)	0.0207
Prevention from JE G P	419 (43.5) 545 (56.5)	359 (47.9) 391 (52.1)	0.69	450 (49.7) 455 (50.3)	262 (40.7) 382 (59.3)	66 (40) 99 (60)	0.00006	273 (48.2) 293 (51.7)	505 (44) 643 (56)	0.96	313 (48.8) 328 (51.2)	443 (44) 564 (56)	22 (33.3) 44 (66.7)	0.021	300 (45.3) 362 (54.7)	143 (48.1) 154 (51.9)	335 (44.4) 420 (55.6)	0.54
Healthcare facility seeking behavior G P	544 (56.4) 420 (43.6)	428 (57.1) 322 (42.9)	0.79	595 (65.7) 310 (34.3)	311 (48.3) 333 (51.7)	66 (40) 99 (60)	0.00001	286 (50.5) 280 (49.4)	686 (59.8) 462 (40.2)	0.00028	376 (58.7) 265 (41.3)	574 (57) 433 (43)	22 (33.3) 44 (66.7)	0.0003	393 (59.4) 269 (40.6)	99 (33.3) 198 (66.7)	480 (63.6) 275 (36.4)	0.00001
Practice towards tuberculosis G P	136 (14.1) 828 (85.9)	160 (21.3) 590 (78.7)	0.00008	139 (15.4) 766 (84.6)	135 (21) 509 (79)	22 (13.3) 143 (86.7)	0.00594	79 (13.9) 487 (86)	217 (18.9) 931 (81.1)	0.0108	44 (6.9) 597 (93.1)	252 (25) 755 (75)	0 (0) 66 (100)	0.00001	172 (26) 490 (74)	11 (3.7) 286 (96.3)	113 (15) 642 (85)	0.000010
Practice score total G P	482 (50) 482 (50)	405 (54) 345 (46)	0.100	492 (54.3) 413 (45.7)	316 (49) 328 (51)	79 (47.8) 86 (52.2)	0.069	293 (51.7) 273 (48.3)	594 (51.8) 554 (48.2)	0.992	327 (51) 314 (49)	535 (51.9) 472 (48.1)	25 (37.5) 41 (62.5)	0.050	365 (55.1) 297 (44.9)	129 (43.5) 168 (56.5)	393 (52) 362 (48)	<0.05

G: good practice; P: poor practice; Chi-square test applied. *P* <0.05 was considered statistically significant.

Table 5. Correlation between knowledge, attitude, and practice scores

Correlation	Correlation coefficient (r)	*P*-value
Knowledge Score *vs*. Attitude Score	+0.035	0.704
Attitude score *vs*. Practice score	+0.099	0.274
Practice score *vs*. Knowledge score	+0.202	<0.001*

* Correlation is significant at the 0.05 level. Knowledge, attitude and practice score represents the total number of correct responses on the respective section of the questionnaire

DISCUSSION

This study assessed the knowledge, attitudes, and practices of a rural population regarding infectious diseases and their modes of transmission. COVID-19 pandemic likely contributed to increased public awareness of general infection control measures, as evidenced by high adherence to COVID-19 preventive practices (87.6%) [19]. However, our findings indicate that awareness of other prevalent infectious diseases, such as tuberculosis and malaria, remains limited in this population. This gap in knowledge must be addressed through targeted interventions, as these diseases continue to significantly burden rural communities. In this study, 52.8% of participants belonged to the younger age group (18–25 years), 58.8% reported having higher education (Bachelor's, Master's, or Ph.D.), and 67% were unmarried.

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These findings align with those of a similar study conducted in Sudan, which also reported a high proportion of younger, educated, and unmarried participants [20]. The higher participation rate among younger individuals and students may have led to their overrepresentation in our sample, potentially reflecting their greater accessibility or willingness to engage in such surveys.

Female participants demonstrated significantly higher knowledge regarding infectious diseases compared to male participants ($P < 0.05$). Similar findings were reported in a rural population in Tanzania for malaria ($P < 0.008$) [21]. However, studies conducted in rural China [22] and Northern India [23] reported that males had better knowledge regarding tuberculosis ($P < 0.001$) and COVID-19 ($P < 0.05$) in their respective populations. These discrepancies may stem from regional cultural differences influencing health-seeking behaviors or variations in public health campaigns tailored to specific genders, as suggested by Manderson and Mark (1997) [24]. While our results indicate higher knowledge among females, this finding may be influenced by unexamined factors such as educational access, caregiving roles, or exposure to health information [24]. Further research is needed to explore the sociocultural factors contributing to gender-based differences in health knowledge.

Unmarried participants compared to married, and graduate or postgraduate students compared to basic education recruits, demonstrated significantly higher knowledge scores regarding infectious diseases, consistent with findings from a study in Egypt ($P = 0.021$) [25]. The higher knowledge scores among unmarried participants may reflect their advanced educational backgrounds, which likely provide greater exposure to health-related information. However, further research is needed to determine whether higher education, despite being associated with higher knowledge scores in this study ($P = 0.001$), leads to actionable behavior changes in rural settings where traditional beliefs and limited healthcare access may hinder preventive practices.

Our study revealed limited overall knowledge about the modes of transmission of infectious diseases. This finding aligns with several studies reporting knowledge gaps in the general population about diseases such as tuberculosis [26-28], swine flu [29], Japanese encephalitis [30], filariasis [31, malaria [32, 33] and waterborne diseases [34, 35]. While many studies have reported poor knowledge about transmission modes, others have identified better understanding of influenza [36], tuberculosis [10, 37], COVID-19 [25], malaria [38], and vector-borne diseases [21]. These gaps may result from persistent challenges, including poverty, limited access to education and healthcare, poor hygiene practices, and insufficient public health outreach in rural areas, all of which reduce exposure to accurate health information. While some studies have reported better knowledge about influenza, tuberculosis, COVID-19, malaria, and other vector-borne diseases, these variations may reflect more targeted public health campaigns. Alternatively, recent outbreaks, such as COVID-19, may have temporarily heightened public awareness.

In our study, 84.2% of participants lacked awareness of endemic diseases in their region, which may delay the adoption of timely preventive measures. This lack of awareness aligns with findings from studies on diseases such as filariasis [39] and leishmaniasis [40], where participants also showed limited knowledge about local disease risks. This poses a major obstacle to disease control, as awareness of endemic diseases is essential for symptom recognition, timely healthcare access, and preventive behavior adoption. Addressing this gap requires community-level health education programs tailored to endemic disease awareness, particularly in high-risk areas. These programs could involve community health workers, local media campaigns, and culturally relevant educational materials.

Additionally, 81.6% of participants in our study were unaware of vaccine-preventable diseases, underscoring a significant gap in public health knowledge with potential implications for disease prevention. This finding aligns with studies conducted in Eastern Uttar Pradesh, India [30], and Ethiopia [41], where awareness of vaccines, including those for *Japanese encephalitis*, was similarly low. Low awareness of vaccine-preventable diseases (81.6%) poses significant public health risks, such as reduced vaccination rates, particularly in rural settings where limited healthcare access and rapid disease spread exacerbate vulnerabilities. The low awareness in these settings may stem from inadequate healthcare infrastructure, limiting access to information and services; low literacy rates, hindering comprehension of health information; and cultural beliefs that discourage vaccination. To improve vaccination rates and public health outcomes, increasing vaccine literacy through culturally sensitive and accessible education campaigns is essential. These campaigns should address common misconceptions, disseminate accurate information on vaccine safety, efficacy, and benefits, and be delivered through trusted community channels.

Liu *et al*. (2013) reported generally low awareness of certain infectious diseases among a rural Chinese population [10]. Hogan *et al.* (2024) [33] and Al-Ashwal *et al.* (2024) [40] also noted knowledge gaps for malaria and leishmaniasis, respectively, among the rural population. Similarly, our findings indicate that only 50% of participants demonstrated adequate knowledge about past pandemics. This aligns with observations from the H1N1 pandemic in China, where public awareness remained inadequate [42]. These trends highlight a recurring issue with pandemic preparedness and awareness in rural areas. Despite the global nature of such outbreaks, rural populations remain particularly vulnerable to rapidly spreading infectious diseases.

These knowledge gaps may stem from limited access to information, especially in remote areas; lower literacy levels, which impede comprehension of health information; and insufficient public health infrastructure.

Less than half of our participants demonstrated a positive attitude toward outbreak response, including willingness to follow public health guidelines or seek medical care when necessary. This aligns with the findings of Sørensen *et al*., (2012) who highlighted the critical role of health literacy and public attitudes in shaping societal responses and outbreak control [43]. In rural settings, where access to timely and accurate health information is often limited, these attitudes may stem from misinformation, creating fear and confusion; cultural beliefs conflicting with recommended health practices; or a lack of trust in healthcare systems, leading to reluctance to seek care or follow official advice. This underscores the need for targeted health education campaigns that inform and foster positive health-seeking attitudes in rural populations. These campaigns should address common misconceptions, build trust in the healthcare system, and empower individuals to adopt preventive measures and seek timely care during outbreaks.

Despite these attitude gaps, the majority of participants in our study adopted appropriate preventive practices related to COVID-19, such as mask-wearing and social distancing. This aligns with findings from other studies reporting high adherence to COVID-19 preventive measures [23, 25]. However, for vector-borne diseases such as JE, more than half of the participants reported insufficient adoption of preventive measures. This contrasts with findings from Mazigo *et al*., (2020) who reported widespread use of mosquito nets for malaria prevention among rural Tanzanian participants [21]. The difference in practices may stem from varying levels of public health interventions, such as targeted campaigns promoting mosquito net use, or the perceived severity of diseases, leading individuals to prioritize prevention for those they consider more immediate or dangerous. It is crucial to investigate the barriers to universal adoption of preventive measures, even among individuals who are aware of them. Factors such as cost, accessibility, comfort, and cultural norms likely influence adoption and warrant further investigation.

More than half of the participants demonstrated positive healthcare-seeking behavior, which is an encouraging finding. Similar positive healthcare-seeking behaviors for malaria were reported by Mazigo *et al*. (2010) [21] and Wang *et al*. (2008) [22]. However, Easwaran *et al*. (2015) [26], and Kasozi *et al.* (2024) [28] reported suboptimal healthcare-seeking behavior for tuberculosis. In our study, tuberculosis prevention practices were notably inadequate. This highlights a marked contrast with the participants' relatively appropriate COVID-19 practices and suggests limited understanding of tuberculosis prevention. A study among an Omani population reported more effective tuberculosis prevention practices [44]. This suggests that regional differences in healthcare access, disease perception, and the intensity of public health campaigns significantly influence public health behaviors. The marked difference in practices between COVID-19 and tuberculosis indicates gaps in rural populations' understanding of the basic principles of disease prevention and control. This underscores the need for comprehensive health education addressing a wide range of infectious diseases, beyond those that dominate media coverage.

In our study, we found a significant positive correlation between knowledge of infectious diseases and practice ($P < 0.001$). However, knowledge was not significantly correlated with attitude ($P = 0.704$), and attitude also showed no significant correlation with practice ($P = 0.274$). While many studies have reported a positive correlation between knowledge, attitude, and practice [45, 46], our findings align with those of Khalili *et al*. (2022) who also found a positive correlation between knowledge and attitude but no significant correlation between attitude and practice [44]. These discrepancies highlight an important point: increased knowledge and positive attitudes do not always lead to the adoption of appropriate health practices.

This weak positive correlation between knowledge and practice in our study suggests that additional barriers, such as limited healthcare access or cultural beliefs, may hinder the application of knowledge into preventive actions. Factors such as limited healthcare access, cultural beliefs conflicting with recommended practices, resistance to behavioral change, and the perceived relevance of preventive measures may all contribute, particularly in rural populations. Limited healthcare access, for instance, can restrict opportunities to adopt preventive measures. For example, despite understanding disease transmission modes, individuals may not adopt recommended preventive practices due to a lack of trust in healthcare systems, financial constraints limiting access to resources like mosquito nets or vaccines, or adherence to traditional health practices that may be ineffective or harmful.

Yap *et al*. (2010) observed similar findings, noting a disconnection between knowledge and practice and concluding that education alone is insufficient to promote behavioural change [47]. This underscores the need for public health interventions that not only impart knowledge but also address barriers to behavioural change. Interventions should address underlying behavioural, cultural, and infrastructural barriers that hinder the adoption of healthier practices. These barriers are often more pronounced in rural settings. Programs that integrate education with practical demonstrations such as proper use of mosquito nets or handwashing community engagement through local leaders and trusted figures, and support for behavioural modification such as access to

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affordable preventive tools are likely to bridge the gap between knowledge and practice more effectively.

This study has some limitations. First, involving local community leaders could have enhanced the sample's representativeness by ensuring broader participation and cultural relevance. Second, the migration of many young and middle-aged individuals (18-45 years) to larger cities for employment may limit the generalizability of the findings to the entire rural population.

The limited number of questions restricted our ability to explore participants' knowledge in depth. Specifically, we could not thoroughly assess knowledge of common infectious diseases such as malaria, JE, filariasis, and tuberculosis, as well as other waterborne and foodborne diseases. Furthermore, we were unable to assess participants' understanding of seasonal variations in infectious diseases, which is critical for effective prevention and control. Our study did not explore social customs, myths, and misconceptions related to diseases, which are significant factors influencing attitudes and practices.

Our study concludes that the rural population studied has insufficient knowledge about the transmission, prevention, and control of infectious diseases. A significant proportion of participants showed limited understanding of disease transmission modes, endemic diseases, and vaccine-preventable diseases, potentially undermining prevention and control efforts.

Although this study did not cover all aspects of infectious diseases, further research with a more comprehensive questionnaire including well-defined open-ended questions and a larger sample size could provide deeper insights into the knowledge gaps within this population.

These programs should focus on high-burden diseases such as tuberculosis, malaria, and diarrheal illnesses, incorporating interactive sessions through village health camps, local health workers, and radio broadcasts. Educational materials, including pictorial booklets and audiovisual content, should be designed for easy comprehension, especially for populations with low literacy levels. Additionally, integrating infection control education into routine antenatal care visits and school health programs could target vulnerable groups, such as women and students, to address the low knowledge scores observed.

These campaigns should provide a comprehensive overview of major infectious diseases, emphasizing their transmission mechanisms and routes. Educational materials should be designed for easy comprehension by the target population. They should clearly demonstrate how simple habits, such as handwashing and using mosquito nets, can protect against a variety of contagious diseases. Future control efforts can leverage the study's findings to address knowledge gaps. Since programs to eradicate tuberculosis and malaria are already in place, this study can inform the development of more effective awareness campaigns.

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CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest associated with this manuscript.

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