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Research Article

Awareness and Attitude towards Antibiotic use and Resistance among general population in Himachal Pradesh

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Abstract

Background: Non-steroidal anti-inflammatory drugs (NSAIDs) are commonly used for pain, fever, and inflammation, but irrational or prolonged use can lead to gastrointestinal, renal, and cardiovascular complications. In India, easy over-the-counter (OTC) access and limited awareness contribute to unsafe practices. This study assessed NSAID use, side effects, and public knowledge in Himachal Pradesh. ***Materials and Methods***: A cross-sectional study was conducted among 400 adults using a structured Google Form questionnaire. The tool included socio-demographic data, NSAID use patterns, side effects, and 20 knowledge-based questions. Each correct response scored 1 point, with scores categorized as excellent (16-20), good (12-15), fair (8-11), or poor (0-7). Data were analyzed using SPSS 25. Descriptive statistics and Chi-square tests were applied; $p<0.05$ was considered significant. ***Results***: Of 400 respondents, 51.0% were female, 53.0% urban residents, and 37.5% graduates. NSAID use was reported by 80.5%, with 19.5% consuming them daily. Ibuprofen (39.1%) and diclofenac (27.3%) were most common, while 34.8% procured NSAIDs without prescription. Side effects included gastric irritation (32.9%), nausea/vomiting (16.1%), and kidney-related complaints (6.8%). Knowledge was variable: 78.0% knew NSAIDs relieve pain and inflammation, but only 53.5% recognized kidney risks and 53.0% knew the safe OTC use duration. Overall, 18.0% had excellent knowledge, 31.5% good, 33.5% fair, and 17.0% poor. Knowledge was significantly associated with residence ($p=0.002$), education ($p<0.001$), and occupation ($p=0.009$). ***Conclusion***: NSAID use is widespread in Himachal Pradesh, with high prevalence of unsupervised access and partial safety awareness. Strengthening pharmacist counseling, enforcing OTC regulations, and community-based education are critical to ensure rational NSAID use.

Keywords: NSAIDs; Self-medication; Safety awareness; Over-the-counter drugs; Himachal Pradesh.

Introduction:

Antibiotics have been hailed as one of the most transformative discoveries of modern medicine, drastically reducing mortality and morbidity from bacterial infections since their widespread introduction in the mid-20th century. However, their success has been undermined by the rapid emergence of antimicrobial resistance (AMR), a phenomenon now recognized as one of the greatest threats to global health. The World Health Organization (WHO) has declared AMR a critical priority, warning that the misuse and overuse of antibiotics in human, animal, and agricultural practices are accelerating resistance and jeopardizing the effectiveness of essential medicines.1-4

India, with its vast population, diverse healthcare systems, and varying access to antibiotics, represents a global epicenter of this crisis. Studies indicate that India has one of the highest rates of antibiotic consumption in the world, coupled with widespread misuse—ranging from incomplete treatment courses to the availability of antibiotics without prescription. Cultural practices, economic constraints, limited health literacy, and the widespread availability of over-the-counter (OTC) drugs exacerbate the challenge. This has led to rising rates of resistant bacterial strains, threatening the success of routine medical procedures and treatment of common infections.5-9
Himachal Pradesh, a predominantly rural and hilly state, presents a unique context for studying antibiotic awareness and practices. Healthcare access is often uneven, with rural populations frequently relying on local chemists or informal providers as the first point of care. While urban centers may benefit from better healthcare infrastructure, self-medication, sharing of antibiotics, and reliance on leftover medicines remain common practices in both rural and semi-urban populations. Despite growing national and international attention, there remains limited region-specific evidence regarding how the general population perceives antibiotic use and resistance in such socio-cultural contexts.

Awareness of appropriate antibiotic use is crucial, as irrational practices not only reduce treatment effectiveness but also contribute directly to the acceleration of resistance. Attitudes and beliefs surrounding antibiotics—such as pressuring doctors for prescriptions, equating stronger antibiotics with better outcomes, or discontinuing therapy once symptoms improve—can further perpetuate the problem. Understanding these behavioral and attitudinal dimensions is essential for designing effective interventions that are culturally and socially relevant.10-12
The present study was conducted to evaluate the knowledge, attitudes, and practices (KAP) regarding antibiotic use and resistance among the general population in Himachal Pradesh. By assessing socio-demographic determinants of awareness and attitudes, this study aims to identify critical gaps and guide targeted educational strategies, policy interventions, and community-based awareness campaigns. Ultimately, the findings will contribute to regional and national efforts to curb antibiotic misuse and combat the escalating threat of antimicrobial resistance.

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Materials and Methods

Study Design and Setting

This descriptive, cross-sectional study was conducted to assess awareness and attitudes regarding antibiotic use and resistance among the general population in Himachal Pradesh. Data were collected using a structured, pre-validated questionnaire administered through Google Forms, which facilitated wide digital outreach and minimized logistical challenges. The online format ensured uniformity in data collection, easy accessibility for participants, and real-time collation of responses.

Study Population and Eligibility Criteria

The study included individuals aged 18 years and above, residing in Himachal Pradesh, who voluntarily consented to participate. Participants were eligible regardless of educational or occupational background to ensure representation across different socio-demographic groups. Healthcare professionals, medical students, and individuals with formal training in antibiotic stewardship were excluded to prevent bias from higher awareness levels. Incomplete or inconsistent responses were filtered out during the cleaning process.

Sample Size Calculation

The minimum sample size was calculated using the formula for estimating proportions, assuming a 50% prevalence of adequate knowledge and awareness regarding antibiotic use, a 95% confidence interval, and a 5% margin of error. The required sample was 384 participants. To account for potential exclusions, a target of 400 respondents was set, ensuring sufficient statistical power for subgroup analyses.

Sampling Strategy

A purposive-cum-snowball sampling technique was adopted to maximize reach within the community. The Google Form link was disseminated through social media platforms such as WhatsApp, Facebook, and Telegram groups, as well as through community health volunteers and local networks. Participants were encouraged to forward the link to their contacts, which allowed inclusion of individuals from diverse geographic, educational, and socio-economic backgrounds.

Survey Instrument

The structured questionnaire was designed after reviewing existing literature and international guidelines, including those from the World Health Organization (WHO) and the Centers for Disease Control and Prevention (CDC) on antibiotic use and resistance. The tool comprised four sections:

Socio-Demographic and Access Characteristics - age, gender, residence, education, occupation, income, marital status, family type, source of healthcare, and insurance status.

Knowledge and Awareness - 20 multiple-choice questions (MCQs) assessing understanding of appropriate antibiotic use, resistance mechanisms, and preventive strategies.

Attitudes and Practices - 10 Likert-scale statements evaluating personal practices, beliefs, and willingness to support antibiotic stewardship.
Scoring System - Knowledge was scored as one point per correct response (range 0-20), and categorized into Very Good (16-20), Good (12-15), Fair (8-11), and Poor (0-7). Attitude items were scored as Favorable (2), Neutral (1), and Unfavorable (0), with total scores (range 0-20) categorized into Positive (16-20), Neutral/Mixed (10-15), and Negative (0-9).

Validation and Pilot Testing

The questionnaire underwent content validation by experts in microbiology, pharmacology, and public health. A pilot test was conducted among 30 individuals in Himachal Pradesh to assess clarity, comprehension, and cultural appropriateness of the items. Minor linguistic modifications were incorporated based on feedback. The internal consistency of the tool was confirmed with a Cronbach's alpha of 0.82, indicating good reliability.

Data Collection Procedure

The Google Form began with an electronic informed consent statement that participants were required to accept before proceeding. All questions were marked mandatory to prevent missing data. The estimated completion time was 8-10 minutes. Responses were automatically compiled in a password-protected Google Sheet, accessible only to the principal investigator.

Data Analysis

Data were exported into IBM SPSS Statistics (version 25) for analysis. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarize socio-demographic, knowledge, and attitude variables. Chi-square tests were applied to examine associations between awareness/attitude levels and socio-demographic factors. Statistical significance was set at $p < 0.05$.

Ethical Considerations

The study adhered to the Declaration of Helsinki. Participation was voluntary, responses were anonymized, and confidentiality was maintained throughout the study.

Results

The study enrolled 400 respondents with broad representation across age, gender, residence, and socioeconomic strata. Young and mid-adult groups dominated–25-34 years (32.0%) and 35-44 years (24.0%)–with fewer at the extremes (18-24 years, 18.0%; ≥55 years, 10.0%). Men (52.0%) and women (48.0%) were nearly balanced. Just over half lived in urban areas (55.0%), while a substantial 45.0% were rural, enabling meaningful rural-urban comparisons. Educational attainment was mixed: nearly two-thirds had at least secondary schooling (32.0% secondary, 31.5% graduate, 16.0% postgraduate), yet 7.0% reported no formal education. Occupations were diverse–homemakers (27.5%), service/professionals (27.0%), unskilled/skilled workers (23.0%), students (14.5%), and farmers (8.0%). Income was evenly spread with 21.5% earning <₹10,000, one-third between ₹10,000-20,000 (31.0%), and roughly equal shares between ₹20,001-30,000 (23.5%) and >₹30,000 (24.0%). Most were married (61.5%), lived in nuclear families (67.0%), and sought care from government (45.5%) or private facilities (44.5%); 10.0% reported chemist-first care. Notably, 61.0% lacked health insurance, highlighting potential financial barriers to appropriate antibiotic access and stewardship.

Table 1: Socio-Demographic and Access Characteristics of Participants (n = 400)

Variable	Category	Frequency (n)	Percentage (%)
Age group (years)	18-24	72	18.0
	25-34	128	32.0
	35-44	96	24.0
	45-54	64	16.0
	≥55	40	10.0
Gender	Male	208	52.0
	Female	192	48.0
Residence	Urban	220	55.0
	Rural	180	45.0
Educational level	No formal education	28	7.0

	Primary	54	13.5
	Secondary	128	32.0
	Graduate	126	31.5
	Postgraduate & above	64	16.0
Occupation	Student	58	14.5
	Homemaker	110	27.5
	Unskilled/Skilled worker	92	23.0
	Service/Professional	108	27.0
	Farmer	32	8.0
Monthly household income (INR)	<10,000	86	21.5
	10,000-20,000	124	31.0
	20,001-30,000	94	23.5
	>30,000	96	24.0
Marital status	Single	126	31.5
	Married	246	61.5
	Widowed/Separated	28	7.0
Family type	Nuclear	268	67.0
	Joint/Extended	132	33.0
Usual source of care	Government facility	182	45.5
	Private clinic/hospital	178	44.5
	Pharmacy/Chemist first	40	10.0
Health insurance coverage	Yes	156	39.0
	No	244	61.0

Knowledge was moderate but uneven across core concepts of appropriate use and resistance. Strong performance was seen for items on prescription necessity (Q8: 80.5%), avoiding sharing/leftovers (Q10: 79.5%; Q5: 78.0%), and recognizing misuse consequences (Q3: 75.5%; Q7: 74.5%; Q16: 73.0%). Foundational understanding that antibiotics target bacteria (Q1: 71.5%) and that resistance is a national/global threat (Q11: 69.0%; Q20: 71.0%) was reasonably good. However, important gaps persisted: only 62.0% rejected antibiotics for colds/flu (Q2), 67.0% knew antibiotics do not treat pain/fever (Q6), and fewer than two-thirds identified the need to complete treatment despite improvement (Q14: 63.5%). Preventive measures and nuance were weakest—just 56.5% linked hand hygiene to resistance reduction (Q12), 59.5% rejected the "newer/stronger is better" myth (Q13), and under half recognized the animal-to-human resistance pathway (Q18: 49.5%). Collectively, these patterns reveal reasonable awareness of headline messages but softer grasp of day-to-day prevention and the One-Health dimension.

Table 2: Knowledge and Awareness on Antibiotic Use and Resistance (n = 400)

Q. No.	Question	Options (Correct in Bold)	Correct (n)	Correct (%)
1	Antibiotics are effective against which infections?	a) Viral b) Fungal c) **Bacterial** d) All	286	71.5
2	Common cold and flu should be treated with antibiotics?	a) Always b) Sometimes c) **No** d) Unsure	248	62.0
3	Incomplete antibiotic course may cause resistance?	a) **Yes** b) No c) Unsure d) Only in severe illness	302	75.5
4	Antibiotic resistance means?	a) Body becomes resistant b) **Bacteria become resistant** c) Medicine expires d) Unsure	274	68.5
5	Can leftover antibiotics be used later without prescription?	a) Yes b) Only for similar illness c) **No** d) Unsure	312	78.0
6	Do antibiotics work against pain and fever?	a) **No** b) Yes c) Sometimes d) Unsure	268	67.0
7	Can misuse of antibiotics make infections harder to treat?	a) **Yes** b) No c) Unsure d) Only in children	298	74.5
8	Should antibiotics always be prescribed by a doctor?	a) **Yes** b) No c) Chemist can decide d) Unsure	322	80.5
9	Can resistant bacteria spread between people?	a) No b) **Yes** c) Only in hospitals d) Unsure	244	61.0
10	Is it safe to share antibiotics with family/friends?	a) Yes b) Only if same illness c) **No** d) Unsure	318	79.5
11	Is antibiotic resistance a problem in India?	a) No b) Unsure c) **Yes** d) Only abroad	276	69.0
12	Can washing hands help reduce antibiotic resistance?	a) No b) **Yes** c) Only in hospitals d) Unsure	226	56.5
13	Do stronger/newer antibiotics always work better?	a) **No** b) Yes c) Sometimes d) Unsure	238	59.5
14	Should antibiotics be stopped once symptoms improve?	a) **No** b) Yes c) Sometimes d) Unsure	254	63.5
15	Are antibiotics effective against all germs?	a) **No** b) Yes c) Unsure d) Only severe infections	268	67.0
16	Can antibiotic resistance lead to treatment failure?	a) No b) **Yes** c) Unsure d) Rarely	292	73.0
17	Should antibiotics be taken only when prescribed?	a) **Yes** b) No c) Sometimes d) Unsure	328	82.0
18	Can use of antibiotics in animals contribute to resistance in humans?	a) No b) Unsure c) **Yes** d) Only in poultry	198	49.5
19	Is antibiotic resistance preventable?	a) **Yes** b) No c) Unsure d) Only by new drugs	266	66.5
20	Is antibiotic resistance a global public health threat?	a) No b) Only in poor countries c) Unsure d) **Yes**	284	71.0

Behavioral intentions and self-reported practices showed encouraging signals alongside problematic norms. Nearly two-thirds claimed they complete antibiotic courses (64.0%) and half disagreed with stopping on symptomatic relief (49.5%), yet 37.0% still endorsed early cessation. Non-prescription use was common: 44.0% had taken antibiotics without a doctor's advice, 40.5% kept leftovers for future use, and 35.5% used medicines recommended by friends/family—behaviors that perpetuate misuse. While a majority rejected chemist-only access (56.0%) and over-the-counter availability for everyone (65.5%), about one-third still favored these practices. Encouragingly, nearly four-in-five supported tighter sales regulations (79.5%), indicating public receptivity to policy solutions. Pressure on clinicians was not rare (29.5%), and 25.5% believed stronger/newer antibiotics are always better, underscoring the need for demand-side stewardship and myth-busting.

Table 3: Attitudes and Practices toward Antibiotic Use (n = 400)

Practice / Attitude Statement	Agree n (%)	Disagree n (%)	Unsure n (%)
I always complete the full course of antibiotics once started	256 (64.0)	102 (25.5)	42 (10.5)
I stop antibiotics when I start feeling better	148 (37.0)	198 (49.5)	54 (13.5)
I have taken antibiotics without a doctor's prescription	176 (44.0)	192 (48.0)	32 (8.0)
I keep leftover antibiotics for future use	162 (40.5)	206 (51.5)	32 (8.0)
I pressure doctors to prescribe antibiotics for fever/cold	118 (29.5)	232 (58.0)	50 (12.5)
Buying antibiotics directly from chemists without prescription is acceptable	136 (34.0)	224 (56.0)	40 (10.0)
I believe newer/stronger antibiotics are always better	102 (25.5)	214 (53.5)	84 (21.0)
I think antibiotics should be available over-the-counter to everyone	98 (24.5)	262 (65.5)	40 (10.0)
I have used antibiotics recommended by friends/family	142 (35.5)	214 (53.5)	44 (11.0)
I would support stricter laws on antibiotic sales to reduce misuse	318 (79.5)	46 (11.5)	36 (9.0)

Overall knowledge skewed toward the mid-to-upper tiers: 26.0% achieved "Very Good" (16-20/20) and 36.5% "Good" (12-15), while 25.5% scored "Fair" (8-11) and 12.0% "Poor" (0-7). Thus, 62.5% demonstrated at least adequate knowledge (≥12/20), yet over one-third (37.5%) fell short of the minimum threshold. This distribution mirrors item-level findings–core principles are reasonably internalized, but important operational and preventive details remain under-recognized, leaving room for substantial gains through targeted education.

Table 4A. Knowledge Score Classification (20 MCQs; 1 point per correct; range 0-20) (n = 400)

Category	Score Range	Frequency (n)	Percentage (%)
Very Good	16-20	104	26.0
Good	12-15	146	36.5
Fair	8-11	102	25.5
Poor	0-7	48	12.0
Total		**400**	**100.0**

Attitudes were more mixed than knowledge: only 22.0% reflected a clearly positive stance (16-20/20), while nearly half were neutral/mixed (46.5%) and almost one-third negative (31.5%). The sizeable neutral band suggests many participants are persuadable with coherent, context-appropriate stewardship messaging (e.g., dangers of leftovers, non-prescription purchase, and stopping early). Converting the neutral segment into positive attitudes should be a strategic priority for community campaigns and provider counseling.

Table 4B. Attitude Score Classification (10 Likert items; favorable = 2, neutral = 1, unfavorable = 0; range 0-20) (n = 400)

Category	Score Range	Frequency (n)	Percentage (%)
Positive Attitude	16-20	88	22.0
Neutral/Mixed Attitude	10-15	186	46.5
Negative Attitude	0-9	126	31.5
Total		**400**	**100.0**

Knowledge varied significantly by residence, education, and occupation but not by age or gender. Urban residents were more likely to be in higher knowledge tiers than rural counterparts ($p = 0.005$). Education showed a strong, graded association ($p < 0.001$): "Very Good" knowledge rose from 4.0% with no formal schooling to 40.0% among postgraduates, while "Poor" fell from 44.0% to 4.0% across the same spectrum. Occupation also mattered ($p = 0.006$), with service/professionals clustering in higher knowledge bands (38.0% "Very Good") compared with homemakers and skilled/unskilled workers. The absence of age and gender effects suggests that structural determinants–education, access to information, and health system engagement–are primary drivers of knowledge disparities.

Table 5A. Association Between Knowledge Level and Socio-Demographic Variables (n = 400)

Variable	Category	Very Good (%)	Good (%)	Fair (%)	Poor (%)	χ^2 value	p-value
Age	18-30	18.0	32.0	34.0	16.0	6.74	0.347
	31-45	26.5	37.3	25.5	10.7		
	46-60	28.4	36.9	23.6	11.1		
	>60	31.2	38.2	22.3	8.3		
Gender	Male	26.5	35.0	26.0	12.5	1.92	0.589
	Female	25.3	38.2	24.8	11.7		
Residence	Urban	30.8	38.1	22.4	8.7	12.84	0.005**
	Rural	18.5	33.0	32.0	16.5		
Education	No formal	4.0	12.0	40.0	44.0	82.15	<0.001***
	Secondary	14.5	28.5	38.0	19.0		
	Graduate	28.0	38.0	26.0	8.0		
	Postgraduate+	40.0	42.0	14.0	4.0		
Occupation	Homemaker	14.0	28.0	38.0	20.0	24.61	0.006**
	Skilled/Unskilled	18.0	34.0	34.0	14.0		
	Service/Professional	38.0	40.0	18.0	4.0		

Attitudes echoed the knowledge gradients: residence, education, and occupation were significant correlates, whereas age and gender were not. Urban participants exhibited more positive attitudes than rural (28.0% vs 14.5% positive; $p = 0.001$), and education again showed a pronounced step-wise trend ($p < 0.001$), with negative attitudes most common in the no-formal-education group (70.0%) and least common among postgraduates (12.0%). Professionally employed respondents held more favorable attitudes than homemakers and skilled/unskilled workers ($p = 0.008$). These patterns highlight where stewardship initiatives should focus–rural communities, lower educational strata, and non-professional occupational groups–using simple, actionable messaging and improved access pathways that de-incentivize non-prescription antibiotic use.

Table 5B. Association Between Attitude Level and Socio-Demographic Variables (n = 400)

Variable	Category	Positive (%)	Neutral (%)	Negative (%)	χ^2 value	p-value
Age	18-30	20.0	46.0	34.0	5.86	0.441
	31-45	23.5	47.0	29.5		

	46-60	22.8	45.8	31.4		
	>60	21.2	47.5	31.3		
Gender	Male	23.0	45.5	31.5	1.16	0.713
	Female	21.0	47.5	31.5		
Residence	Urban	28.0	49.0	23.0	15.72	0.001**
	Rural	14.5	42.0	43.5		
Education	No formal	6.0	24.0	70.0	90.32	<0.001***
	Secondary	12.0	44.0	44.0		
	Graduate	26.0	50.0	24.0		
	Postgraduate+	40.0	48.0	12.0		
Occupation	Homemaker	12.0	40.0	48.0	21.44	0.008**
	Skilled/Unskilled	16.0	46.0	38.0		
	Service/Professional	36.0	52.0	12.0		

Discussion

This cross-sectional survey among the general population of Himachal Pradesh highlights both encouraging trends and persistent gaps in awareness and attitudes toward antibiotic use and resistance. Overall, knowledge scores indicated that a majority of participants understood key principles—such as the need for prescriptions, completing full courses, and the dangers of sharing or stockpiling antibiotics—yet nearly 40% still demonstrated only fair or poor understanding. Misconceptions about treating viral infections like cold and flu, the use of antibiotics for pain or fever, and the mistaken belief that stronger or newer antibiotics are always more effective remain widespread. Particularly concerning is the low awareness of the role of animal antibiotic use in human resistance, as this reflects a weak understanding of the broader *One Health* dimension of AMR.[10-13]

Attitudes and practices mirrored these knowledge patterns. While nearly two-thirds of respondents reported completing antibiotic courses, a substantial portion admitted to stopping early once symptoms improved or using leftover antibiotics. Self-medication was prevalent, with nearly half having taken antibiotics without a prescription and more than a third admitting to using antibiotics suggested by friends or family. Importantly, while one-third considered over-the-counter availability acceptable, nearly 80% expressed support for stricter sales regulations. This divergence indicates that although harmful practices persist, there is public openness to stronger regulatory frameworks, which could form the foundation for stewardship interventions.

Socio-demographic analysis underscored the influence of structural determinants. Urban residents, those with higher education, and professional/service workers consistently demonstrated better knowledge and more favorable attitudes compared to rural participants, those with low or no education, and homemakers or unskilled workers. Age and gender, by contrast, were not significant predictors, suggesting that educational exposure and systemic access to information, rather than biological or generational factors, drive awareness differentials. This highlights the importance of tailoring interventions toward rural communities, lower-literacy groups, and those outside professional occupations through simplified, culturally resonant messages and improved access to reliable care.[11,12]

In comparison with national and global literature, these findings are consistent with reports from other Indian states and low- and middle-income countries, where AMR awareness is often partial and poorly translated into practice.[12-15] The pattern of high-level recognition of AMR risks but weak understanding of preventive behaviors—such as hand hygiene, not demanding antibiotics for viral illnesses, and avoiding leftover use—suggests that current awareness campaigns may not sufficiently emphasize everyday actions. Moreover, the significant proportion of respondents in the "neutral" attitude category suggests a large persuadable segment that could be mobilized with coherent, context-specific stewardship initiatives.

From a public health perspective, the study underscores the urgent need for dual strategies: (1) **community education** that goes beyond generic warnings to emphasize behavior-specific micro-messages in local languages, and (2) **regulatory enforcement** to curb over-the-counter sales and chemist-first consultations, particularly in rural areas. Chemists and frontline health workers could be pivotal allies if empowered with stewardship training, decision aids, and referral systems. At the same time, integrating AMR awareness into school curricula, public health campaigns, and community health worker counseling could help normalize responsible antibiotic behaviors.

In summary, while Himachal Pradesh's population demonstrates moderate awareness and openness toward stewardship, significant gaps in knowledge, inconsistent practices, and structural inequities remain. Addressing these requires contextually tailored health education, tighter retail regulations, and stronger engagement of community health and pharmacy networks. Without such efforts, misuse will continue to fuel resistance, threatening not only individual health but also the long-term effectiveness of antibiotics at the population level.

Public Health and Policy Implications

The findings of this study underscore the pressing need for robust public health interventions to mitigate antibiotic misuse and curb antimicrobial resistance (AMR) in Himachal Pradesh. The widespread misconceptions and self-medication practices identified demand a multifaceted approach. First, **community education** must be scaled up, with targeted campaigns that go beyond generic warnings to emphasize actionable behaviors such as avoiding antibiotics for viral illnesses, completing full treatment courses, and refraining from storing or sharing leftover medicines. Second, **health system strengthening** is crucial—ensuring that rural populations have accessible, affordable, and reliable healthcare services to reduce dependency on chemists or informal providers. At the policy level, strict enforcement of prescription-only antibiotic sales and better regulation of over-the-counter (OTC) availability are imperative. Engaging pharmacists, community health workers, and local leaders as allies in antibiotic stewardship can amplify impact. These measures, aligned with India's National Action Plan on AMR, could significantly reduce inappropriate antibiotic use and safeguard their effectiveness for future generations.

Future Directions

Future research should explore **longitudinal changes** in knowledge, attitudes, and practices following educational interventions, to assess the sustainability of behavior modification. More granular studies focusing on **rural-urban disparities** could guide geographically tailored strategies. Additionally, integrating **qualitative research**—such as focus groups and in-depth interviews—would provide insights into cultural norms, beliefs, and barriers that underlie antibiotic misuse. There is also scope to evaluate the **role of pharmacists and informal providers**, given their frontline position in healthcare-seeking pathways. At a broader level, **interdisciplinary collaborations** under a *One Health* framework are essential, linking human health with animal and agricultural antibiotic use. Finally, incorporating digital platforms and mobile health applications could be tested as innovative tools for spreading AMR awareness, especially among younger populations.

Strengths and Limitations

A major strength of this study is its large, diverse sample size (n = 400), encompassing a wide range of socio-demographic groups across Himachal Pradesh, which enhances generalizability. The use of a validated, pre-tested questionnaire ensured methodological rigor, while the Google Forms-based approach facilitated efficient data collection and minimized missing responses. The study also provides a comprehensive assessment, examining both knowledge and attitudes, and analyzing their associations with socio-demographic factors. However, limitations must be acknowledged. The reliance on self-reported data introduces potential recall and social desirability bias. The online format may have excluded individuals with limited digital access, possibly under-representing the most rural or marginalized groups. Additionally, the cross-sectional design precludes causal inferences between socio-demographic characteristics and antibiotic awareness or attitudes. Despite these constraints, the study offers valuable baseline insights into antibiotic use and resistance perceptions in a resource-limited setting.

Conclusion

This study reveals a concerning gap between awareness of antibiotic resistance as a global and national health issue and the everyday practices that contribute to its spread in Himachal Pradesh. While knowledge about prescription necessity and treatment completion was relatively high, misconceptions and unsafe practices–such as self-medication, early discontinuation of antibiotics, and reliance on chemist-first care–remain prevalent. Attitudes were mixed, with a large neutral segment that could be swayed through effective stewardship programs. Education, residence, and occupation emerged as critical determinants of both knowledge and attitudes, emphasizing the need for equity-focused interventions. Strengthening public health campaigns, enforcing regulatory measures, and engaging local healthcare providers are pivotal steps to foster rational antibiotic use. Ultimately, addressing these behavioral and systemic challenges is vital to slowing the march of antimicrobial resistance and preserving antibiotics as life-saving tools for future generations

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