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Original Article

Alcohol Use in a Tribal Rural Population of India: Prevalence, Social Determinants, and Impact of a Community-Based Health System-Integrated Intervention

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Abstract

Background: Alcohol consumption is an overlooked public health concern in tribal populations of India. Culturally and systemically rooted factors contribute to neglect in engagement and treatment, even with prohibition policies in place. Therefore, this study analyzed the prevalence and sociodemographic factors associated with alcohol consumption in a tribal rural district of India and evaluated the effects of a health system-integrated, community-based intervention on knowledge, attitudes, and practices (KAP) concerning abstinence.

Method: A total of 269 community members and 81 healthcare workers participated in this quasi-experimental study. The KAP survey and Alcohol Use Disorders Identification Test (AUDIT) were used, and sociodemographic details were noted. Tailored to local cultural settings, a 3-month community mobilization and provider training intervention was carried out. Statistical analyses, including logistic regression, Cox regression, and structural equation modeling, were performed.

Findings: The prevalence of alcohol use was 111 (41.3%). The significant predictors were identified as male sex, education level, and family history (adjusted odds ratios = 2.73, 1.96, and 2.83, respectively). Following the intervention, community participant KAP scores (4.60 to 8.53, $P<0.001$) and healthcare worker KAP scores (15.0 to 22.3, $P<0.001$) improved significantly. Of the 111 alcohol users, 81(73%) started treatment. Abstinence rates were 63(77.8%) at 1 month and 39 (48.1%) at 3 months. Those aged over 40 years who had low income and those with unstable employment faced the highest relapse risk.

Conclusion: Using community-specific approaches within broad systemic frameworks improves intervention outcomes for alcohol use among tribal populations. To maintain long-term effectiveness, concurrent support from socioeconomic systems is essential.

Keywords: Alcohol dependence, Community-based participatory research, Health knowledge, Attitudes, Practice

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Introduction

Alcohol use disorder (AUD) is one of the main risk factors for early death and morbidity; it leads to more than 3 million deaths annually and is responsible for about 5.1% of the global disease burden.[1] Low- and middle-income (LMIC) countries experience more noticeable harmful effects related to alcohol, because their healthcare systems frequently lack the tools necessary to treat substance use disorders efficiently. Alcohol not only affects individuals with alcohol use disorder but also has an impact on the entire community and economy, as mentioned in the Global Status Report on Alcohol and Health published by the World Health Organization (WHO). [1,2]

Due to the sharp increase in alcohol consumption over the past 20 years, India is currently third in the world. The average person's alcohol intake has doubled (from 2.5 liters to 5.7 liters) between 2005 and 2016 in India.[3] Although national averages mask notable state-to-state variations, research shows that alcohol use is consistently higher in tribal and rural areas. According to the National Family Health Survey-5 (NFHS-5, 2019–21), 18.8% of adult males and 1.3% of women engaged in alcohol consumption, but for rural adult males, this figure was 19.9%.[4] Even though alcohol use is prohibited by state law, it is frequently culturally embedded, easily accessible through local brewing methods, and poorly regulated in tribal belts like Gujarat's Chhota Udepur district. Studies by Ray et al. (2018) and Rose et al. (2021) in tribal parts of India recently showed the prevalence of alcohol use to be between 40% and more than 70%.[5,6]

Dangerous drinking is encouraged by socioeconomic marginalization, cultural tolerance, and a lack of adequate public health facilities. Studies that have linked alcohol consumption in India to male gender, low income, low

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education, and a family history of substance use have established a pattern of intergenerational and structural risk.[7,8] In these communities, the negative impacts of alcohol include economic hardship, domestic violence, and poor child health outcomes, with women and youth being disproportionately affected.[9] Local brewing has allowed informal alcohol markets to flourish despite statewide prohibition, complicating enforcement efforts. This paradox highlights the discrepancy between the intention of policies and their actual application in culturally different settings.

Community-based interventions, which incorporate peer engagement, culturally relevant education, and health system integration, have proven effective in changing substance use behaviors in LMICs.[10,11] However, in India, such efforts remain to a large extent limited to urban or installation settings. As per the National Mental Health Survey (NMHS, 2016), there is a more than 85% treatment gap for AUD, and most people with AUD never seek formal help for deaddiction.[12] Even after the integration of mental health in Ayushman Bharat and the "Nasha Mukt Bharat" campaign, community-level AUD prevention and treatment strategies are still underdeveloped and poorly executed in rural and tribal areas.

India has a primary healthcare network, but there is a significant gap in its proper utilization. Accredited Social Health Activists (ASHAs) and Auxiliary Nurse Midwives (ANMs) are the frontline workers, and they also have community trust. However, there is a lack of proper training and resources to tackle alcohol abuse.[13] Thus, there is an unmet requirement to empower these providers. They should be given the necessary knowledge and skills to detect alcohol abuse early, provide brief intervention, and utilize referral mechanisms. This will form a bridge between communities and limited specialist services.[14] The WHO Mental Health Gap Action Program (mhGAP) also recommends integration of substance use management into primary care, but evidence on this kind of decentralized model, particularly for tribal areas, is absent. [14,15]

Considering the high prevalence of alcohol consumption in tribal areas compared to the national prevalence,[5,6] this study was designed to address the concerns about the increase in alcohol consumption and the low coverage of interventions in tribal areas in Gujarat, India. We used a multi-tiered intervention consisting of community mobilization and training of health workers to try to change behaviors based on the Knowledge, Attitude, and Practice (KAP) model. Even though the KAP model is often critiqued for being too simplistic, in this case, it was helpful in creating targeted health interventions. Tribal communities are already known to be marginalized in the public health literature, and this study was designed to address the gaps in these culturally rich but resource-limited areas.

This study had the following specific objectives: (1) To estimate the prevalence and determinants of alcohol use in a rural adult population, (2) To assess the KAP related to alcohol among both community members and primary healthcare workers (HCWs), (3) To implement a structured short community-based intervention (CBI) and evaluate its effectiveness in improving KAP outcomes, (4) To assess the impact of a health worker training program on provider competence in alcohol screening and counseling, (5) To examine treatment-seeking behavior and relapse outcomes among individuals with harmful alcohol use post-intervention, and (6) To model behavioral transformation using structural equation modeling (SEM) of the KAP pathway and assess theoretical fit within a rural tribal context.

Method

Study design

This was a quasi-experimental, community-based intervention study using a pre-post intervention design (without a control group). The study was divided into three parts: baseline assessment, followed by a three-month intervention, and a three-month follow-up. Due to ethical and logistical barriers to randomizing a non-beneficiary arm in a high-risk population, a non-randomized single-group design was used. Participants acted as their own controls and were assessed at baseline, immediately after intervention, and 3 months post-intervention. This pre-post model upholds the implementation science focus on ecological validity and ethical flexibility even in high-need settings. The study had two synergistic components: (1) A community-based behavior change communication (BCC) program targeting rural adults, and (2) an HCW training module aimed at strengthening alcohol screening, brief intervention, and referral capacity within the existing health system.

Study setting

The intervention was implemented in the Chhota Udepur district of Gujarat, a predominantly rural and tribal area characterized by low literacy, subsistence farming, and extensive informal alcohol production and consumption. The region was selected because it is mainly served by a decentralized primary health care system, which consists of primary health centers (PHCs), community health centers (CHCs), and sub-centers, supported by frontline workers such as ASHA and ANM. Therefore, this infrastructure was strategically used for the distribution of the discretionary mandate.

Study population and sample

Community participants

The study included eligible participants aged 18–65 years who had lived in selected villages for at least six months and who were able to give informed consent, excluding persons with serious psychiatric illness (e.g., psychosis),

cognitive impairment affecting participation, or acute intoxication during the evaluation. Participants from the community were extracted through convenience sampling, which ensured that all qualified individuals from the designated villages were given a chance to take part. This sampling technique was employed for its ease within a given practical context, where randomization is not possible.

Healthcare workers

A total of 81 public-sector HCWs were enrolled, comprising medical officers (MOs), staff nurses, ANMs, ASHAs, and Anganwadi workers. Inclusion criteria were a minimum of six months of service in the area and willingness to participate in the training and evaluation processes. Recruitment was facilitated via the District Health Officer's endorsement.

Data collection tools

The study employed three principal assessment tools for community members. First, sociodemographic variables (age, sex, education, income, and family type) and alcohol use patterns (onset age, frequency, quantity, duration, and treatment history) were collected using a structured proforma. Second, the KAP questionnaire for Alcohol use utilized in this investigation was modified from Ganavadiya's instrument with his permission.[16] As the original instrument had questions about both alcohol and tobacco use, we omitted the tobacco-related questions for this research. This was to make sure that the instrument focused exclusively on alcohol-related behaviors because the intervention targeted alcohol use in this tribal community setting. Pilot testing was done in 30 participants for this modification to assure its validity in measuring alcohol-related health/legal knowledge (Cronbach's $\alpha = 0.81$), personal/societal attitudes ($\alpha = 0.74$), and consumption/treatment-seeking practices ($\alpha = 0.78$). Third, the Alcohol Use Disorders Identification Test (AUDIT) screened hazardous drinking (Gujarati version, $\alpha = 0.86$), which showed 90% sensitivity and 80% specificity at cutoff ≥ 8.[17,18] A customized KAP tool assessed the clinical competencies of healthcare workers (HCWs) (e.g. A. AUDIT use, withdrawal recognition), attitudes toward patient interactions, referral procedures, and training obstacles. Reliability testing and cultural adaptation for rural Gujarat were performed on all instruments. Ethyl glucuronide (EtG) testing in urine samples should be used for biological validation in future implementations to supplement self-reported abstinence data, especially in Gujarat's prohibition context, where there is a higher chance of underreporting.

Intervention and outcome variable details

Community intervention components

The multifaceted community program included: 1) Awareness sessions for groups of 20 to 30 participants in Gujarati, using culturally appropriate materials (flipcharts, posters, and local narratives) to address the health, social, and financial costs of alcohol use; 2) Peer education delivered by trained local volunteers who offered informal counseling and reinforced important messages in community settings; 3) Information, education, and communication (IEC) dissemination, including posters, and pamphlets with prevention-focused messaging; 4) Systematic screening using shortened AUDIT tools followed by quick (5–10 minutes) motivational interviewing conducted by certified facilitators; and 5) Improved referral pathways with a compiled directory of de-addiction services with active follow-up support. To maximize community participation and message retention, the intervention was implemented using an escalating engagement model, with four to five structured sessions per village spread over three months. Figure 1(a) shows the investigator providing awareness sessions for community members.

Healthcare worker intervention components

The training program for frontline providers included three intensive one-day workshops conducted at CHCs to optimize skill acquisition and clinical implementation. It included 1) Basic knowledge of alcohol-related morbidity trends and evidence-based treatment approaches; 2) practical competency training in AUDIT-based standardized screening and brief intervention delivery based on the FRAMES (feedback, responsibility, advice, menu, empathy, and self-efficacy) motivational framework;[19] 3) Clinical skill development through supervised role-playing exercises and simulated case scenarios that mimicked typical presentations; 4) provision of practical job aids like laminated pocket algorithms and structured referral checklists; 5) operational guidance for integrating alcohol screening into existing service platforms (e.g. non-communicable diseases clinic). To monitor fidelity and handle implementation issues, the post-training support system included a systematic logbook review process, monthly on-site supervision visits, and digital mentorship through moderated WhatsApp discussion groups. Figure 1(b) shows the investigator providing training to the nursing staff and ANMs.

This research carried out a multi-level intervention approach to mitigate the problem of alcohol use disorder in a rural tribal area. The intervention consisted of two synergistic components: a community-based behavior change communication (BCC) program and a training module for HCWs. The design of the intervention was more integrated than insular and aimed at the multiple levels of influence, which were the individual, community, and health system. Similarly, we used multiple outcome variables: 1) KAP score change, which reflected the community's and HCWs' understanding, attitudes, and

Figure 1. (a) shows the investigator providing awareness sessions for community members, (b) shows the investigator providing training to the nursing staff and ANMs

alcohol-related behaviors. These scores were important for measuring the success of the intervention in shifting the community's behaviors toward healthier practices; 2) Treatment engagement as an outcome aimed to capture the number of alcohol users who commenced treatment post-intervention. This was critical for determining how well the intervention improved gateway access to alcohol treatment services; 3) For the purpose of assessing

the long-term success of the intervention, abstinence and relapse rates were measured 1 and 3 months post-intervention. These outcomes further measured the extent to which the behavior changes achieved were maintained over a period; 4) The study also explored the pathways and the resultant involvement of the HCWs in the treatment referrals, as they were central to the appropriate placement of alcohol users into specialized services. Monitoring these referral processes helped assess the effectiveness of the HCWs in the management of AUDs; 5) Lastly, KAP behavioral pathways examined using structural equation modeling (SEM) were implemented to understand the impact of knowledge and attitude change on alcohol-related practices.

Data collection and ethical considerations

Principal investigators conducted all data collection proficiently in the local language. Privacy was ensured during interviews; female staff were deployed for interviewing women to reduce social desirability bias. Ethical approval (SVIC/ON/MEDI/BNPG23/JUNE/24/196) was obtained from the Institutional Ethics Committee, and informed consent (written or verbal with a witnessed thumbprint) was secured from all participants. After acquisition of consent, all the screened AUD patients were provided treatment as per the *Clinical Practice Guidelines for Alcohol Use Disorders* by the Indian Psychiatric Society under the District Mental Health Program (DMHP) in either the district hospital or, if necessary, at the tertiary care center of the investigators. Treatment at both locations is free under Ayushman Bharat.

Statistical analysis

All statistical analyses were conducted using IBM SPSS Statistics version 26.0,[20] JASP (Version 0.19.3) [21] and Microsoft Excel 2019, with a significance threshold set at $P < 0.05$. A post-hoc power analysis using the Cochrane sample size formula revealed 80% power to detect Cohen's $d \geq 0.5$ at $\alpha = 0.05$, though prospective calculations would strengthen future designs.[22] The impact of the intervention and its behavioral pathways were quantitatively analyzed using a multi-method technique: (1) descriptive statistics were used for baseline demographics. Continuous variables were measured by means (±SD) and categorical variables were measured by percentages; (2) Wilcoxon signed-rank tests were used for pre-post comparisons of KAP scores for non-parametric distributions, and paired *t*-tests were used for within-subjects normal distributions, with magnitude determined by Cohen's d effect sizes (interpreted as small [0.2], medium [0.5], and large [0.8]); (3) To estimate baseline alcohol use predictors while adjusting for sociodemographic covariates, determinant modeling using multivariable logistic regression was performed; (4) Kaplan-Meier survival curves with log-rank tests were used for censoring and truncating relapse analysis, and Cox proportional hazards regression was used to model relapsed users ($n = XX$) in order to evaluate time-to-relapse dynamics at the three-month follow-up; (5) The KAP theory was tested using pathway analysis by SEM, which included attitude as a mediator. The results showed that SEM supported the proposed pathways and had a good model fit (CFI = 0.96, RMSEA = 0.04, 90% CI: 0.03–0.05, SRMR = 0.03) and reinforced its mediating role ($\beta = 0.63$, $P < 0.001$, 95% CI: 0.52–0.74).

Results

A total of 269 community members and 81 HCWs were enrolled in the study. Table 1 summarizes their baseline characteristics. The community sample had a mean age of 42.3 years (±15.2), with 173 (64.3%) males. In contrast, the HCWs were predominantly female ($n = 74$, 91.4%), reflecting the gender profile of staff nurses, ASHAs, and ANMs, and had a mean age of 33.2 years (±10.4). Educational attainment was markedly lower in the community sample, with 152 (56.5%) not having completed high school.

Baseline prevalence and determinants of alcohol use

Prevalence of current alcohol use in the community was 111 (41.3%, 95% CI: 35.4–47.4%). Multivariable logistic regression revealed four significant independent predictors of alcohol use, as shown in Table 2. Male gender (aOR = 2.73), low education (aOR = 1.96), low income (aOR = 2.25), and family history of substance use (aOR = 2.83) were significantly associated with alcohol use (all $P < 0.05$). There were no significant demographic differences between pre- and post-intervention cohorts, and attrition was minimal, enhancing internal validity.

Effect of intervention on KAP score

The community intervention brought about distinct

Table 1. Demographic characteristics of (a) general population participants ($n = 269$) and (b) healthcare workers ($n = 81$)

Characteristics	(a) General population ($n = 269$)	(b) Healthcare workers ($n = 81$)
Gender	Male: 173 (64.3%) Female: 96 (35.7%)	Female: 74 (91.4%) Male: 7 (8.6%)
Marital Status	Married: 194 (72.1%) Unmarried: 64 (23.8%) Divorced/widow: 11 (4.1%)	N/A
Education	<10th standard: 152 (56.5%) ≥10th standard: 117 (43.5%)	Medical officers: 47 (58.0%) Staff nurses & ANMs: 21 (25.9%) ASHA workers: 13 (16.1%)
Occupation	Skilled: 131 (48.7%) Semi-skilled: 89 (33.1%) Unskilled: 49 (18.2%)	N/A
Monthly income (INR)	<10,000: 171 (63.6%) ≥10,000: 98 (36.4%)	N/A

changes in all KAP domains for both general population participants and HCWs. As provided in Table 3, total KAP scores within the community increased significantly from 16.43 to 27.85, an average increase of more than 11 points, which is nearly double. The practice domain showed powerful effects ($\Delta + 3.3$, $d = 0.71$, $P < 0.001$). HCWs ($n = 81$) also showed parallel improvements, recording total scores of 15.0 to 22.3 out of a possible 30, which further corroborates the improved screening procedures ($\Delta + 2.6$), lower associated stigma ($\Delta + 2.2$), and enhanced clinical knowledge ($\Delta + 2.5$) claimed by the workforce. All changes were statistically significant ($P \leq 0.009$), with effect sizes ranging from moderate ($d = 0.52$-0.55 for attitude changes) to large ($d = 0.65$–0.71 for knowledge/practice).

The intervention produced remarkable improvements in KAP for all HCW categories on a 30-point scale, with medical officers ($n = 47$) exhibiting the largest increases (21.6 ± 4.5 to 29.4 ± 5.7, $\Delta + 7.8$, $P < 0.001$). This was followed by staff nurses, ANMs ($n = 21$; 20.1 ± 4.2 to 25.5 ± 5.1, $\Delta + 5.4$, $P = 0.006$), and ASHA workers ($n = 13$; 15.3 ± 3.6 to 18.9 ± 4.2, $\Delta + 3.6$, $P = 0.02$). Baseline knowledge was positively associated with knowledge improvement ($r = 0.41$, $P = 0.01$). The MOs performing near ceiling (29.4/30) indicated their clinical preparedness, and ASHAs, more modest (18.9/30), underscored training gaps and the effect of baseline knowledge, which suggests targeted modular community-tailored specialized instruction and adaptations.

Comprehensive outcomes of alcohol intervention: Treatment engagement, relapse predictors, and KAP pathways

Table 4 presents comprehensive intervention outcomes. Treatment engagement data included participants who initiated behavior change and enrolled for deaddiction ($n = 81/111$). For all comparisons pertaining to engagement, self-reported alcohol users were used as the reference group because of their higher baseline engagement (91%) and larger sample size (67). The 3-month abstinence rates (37.5% vs. 49.2%, $P = 0.04$) and treatment engagement were significantly lower for family-identified alcohol users than for self-reported users (66.7% vs. 91%, $P = 0.005$). Despite being a small group ($n = 7$), the neighbor-identified group showed numerically higher 1-month abstinence (100%) and 3-month sustainability (75%). However, these differences were not statistically significant ($P > 0.12$), most likely because of limited power. The overall difference in engagement patterns between the groups was statistically significant ($P = 0.008$). All models were adjusted for education and gender. No matter how the user was identified, the SEM pathways remained stable (CFI = 0.96, RMSEA = 0.04). The SEM analysis, while theoretically informative, may be underpowered given the sample size of 269 participants relative to model complexity, risking over-fitting despite acceptable fit indices. Potential recall bias in self-reported outcomes and small subgroup sizes for neighbor-reported cases are two important limitations.

Table 2. Adjusted predictors of current alcohol use ($n = 269$)

Predictor	Adjusted odds ratio (aOR) [95% CI]	*P*-value	Interpretation
Male gender	2.73 (1.5–4.9)	<0.001	2.7-fold higher odds
Low education (<10th)	1.96 (1.1–3.5)	0.020	Nearly double the odds
Low income (<₹10k/month)	2.25 (1.2–4.2)	0.010	2.3-fold increased likelihood
Family history of use	2.83 (1.4–5.7)	0.004	Strongest predictor

Footnote: Model adjusted for age, marital status, and occupation; Hosmer–Lemeshow goodness-of-fit: $\chi^2 = 6.32$, $P = 0.61$; Area under ROC curve = 0.78 (95% CI: 0.72–0.84); No significant multicollinearity detected (all VIFs < 2.0)

Table 3. Pre-post intervention changes in KAP scores

A. General population ($n = 269$)						
Domain	**Pre-intervention (mean ± SD)**	**Post-intervention (mean ± SD)**	**Mean difference (95% CI)**	***t*-value**	***P*-value**	**Cohen's *d* (95% CI)**
Knowledge	6.53 ± 2.1	12.25 ± 3.2	+5.72 (4.91–6.53)	24.51	<0.001	0.65 (0.52–0.78)
Attitude	5.10 ± 1.8	7.50 ± 2.4	+2.40 (1.85–2.95)	13.12	0.003	0.52 (0.39–0.65)
Practice	4.80 ± 1.5	8.10 ± 2.1	+3.30 (2.89–3.71)	20.97	<0.001	0.71 (0.58–0.84)
Total	16.43 ± 3.1	27.85 ± 4.9	+11.42 (10.2–12.6)	32.30	<0.001	1.02 (0.88–1.16)
B. Healthcare workers ($n = 81$)						
Domain	**Pre-intervention (mean ± SD)**	**Post-intervention (mean ± SD)**	**Mean difference (95% CI)**	***t*-value**	***P*-value**	**Cohen's *d* (95% CI)**
Knowledge	6.40 ± 1.8	8.90 ± 2.4	+2.50 (1.92–3.08)	7.50	<0.001	0.65 (0.47–0.83)
Attitude	4.90 ± 1.6	7.10 ± 2.1	+2.20 (1.55–2.85)	7.50	0.009	0.55 (0.37–0.73)
Practice	3.70 ± 1.3	6.30 ± 1.9	+2.60 (2.01–3.19)	10.16	0.007	0.71 (0.53–0.89)
Total	15.0 ± 3.2	22.3 ± 4.1	+7.30 (6.12–8.48)	12.63	<0.001	0.71 (0.53–0.89)

Footnotes: All analyses used paired t-tests with Bonferroni correction ($\alpha = 0.017$). Effect size interpretation: 0.2 = small, 0.5 = medium, 0.8 = large

Table 4. Comprehensive intervention outcomes analysis

Category	Subgroup/ measure	Engagement baseline	Statistical results	Overall significance
Treatment engagement	Total engaged	81/111 (73.0%)	63 (77.8%) 1-month abstinent; 39 (48.1%) sustained at 3 months	-
	Self-reported ($n=67$)	61 (91.0%)	49 (80.3%) 1-month abstinent; 30 (49.2%) sustained at 3 months	-
				-
	Family-identified ($n=24$)	16 (66.7%)	10 (62.5%) 1-month abstinent; 6 (37.5%) sustained at 3 months	-
				-
	Neighbor-identified ($n=7$)	4 (57.1%)	4 (100%) 1-month abstinent; 3 (75.0%) sustained at 3 months	-
				-
Engagement rates	Self vs. Family-identified	91% (61/67) vs. 66.7% (16/24)	$\chi^2(df)=7.89$ (1)	$P=0.005$
	Self vs. neighbor-identified	91% (61/67) vs. 57.1% (4/7)	$\chi^2(df)=5.12$ (1)	$P=0.024$
	Family vs. Neighbor	66.7% (16/24) vs. 57.1% (4/7)	$\chi^2(df)=0.32$ (1)	$P=0.572$
3-Month abstinence	Self *vs. family-identified	49.2% (30/61) vs. 37.5% (6/16)	$\chi^2(df)=4.17$ (1)	$P=0.041$
	Self vs. neighbor-identified	49.2% (30/61) vs. 75% (3/4)	$\chi^2(df)=2.94$ (1)	$P=0.086$
Relapse predictors	Age > 40 years	-	HR = 1.8 (95% CI: 1.1–2.9)	$P=0.02$
	Low income (<₹10k/mo)	-	HR = 2.2 (95% CI: 1.3–3.7)	$P=0.003$
	Unstable employment	-	HR = 1.6 (95% CI: 1.1–2.3)	$P=0.01$
KAP pathways (SEM)	Knowledge (K)→Attitude (A)	-	$\beta=0.51$	$P<0.001$
	Attitude→Practice(P)	-	$\beta=0.42$	$P<0.001$
	Indirect effect (K→A→P)	-	$\beta=0.63$	$P<0.001$

Footnotes: Dashes (-) indicate data not collected/not applicable for that group; only individuals who engaged in any intervention activity and were available for follow-up were included. The denominator for abstinence/relapse percentages is based on group-wise treatment engagement numbers (not total baseline users); * Reference group for comparisons: self-reported users; SEM model fit: $\chi^2=15.2$ ($P=0.12$), CFI = 0.96, RMSEA = 0.04.

In addition, both populations saw a significant increase in referrals for alcohol treatment to CHCs, district hospitals, and tertiary hospitals following the intervention. Healthcare workers ($n=81$) showed a 24.1% absolute increase in the percentage of HCWs actively involved in patient referrals ($43.2 \pm 5.1\%$ to $67.3 \pm 4.8\%$, $P=0.004$). After community intervention in those villages, the general population's monthly referrals increased from a negligible 1.5 ± 0.6 to 27.4 ± 3.2 ($\Delta + 25.9$, $P<0.001$, $d=2.17$), representing a 1660% increase. At the 3-month follow-up, both groups' referral rates remained steady (HCWs: $64.1 \pm 5.3\%$, population: 25.7 ± 4.1/month).

Discussion

This study is a quasi-experimental study examining the short-term effectiveness of a community-based intervention designed to reduce alcohol consumption within a tribal community in Gujarat, India. The baseline estimate of alcohol consumption (41.3%) exceeds the national rural average reported in the NFHS-5 of 19.9% for men.[4] This further demonstrates the high intensity of alcohol use disorder in the tribal belts of India, where the uncontrolled production of the traditional drinks mahua and tadi defy prohibition laws.[5,6,23] The study also corroborates the NFHS-5 data that showed that rural, socioeconomically disadvantaged, and less educated males, who are unskilled or daily wage workers, had a predominant dangerous drinking pattern.[4,5,6,23] Family history was the strongest predictor of alcohol consumption (aOR = 2.83), embodying the intergenerational normative culture of drinking.[7,8] It is imperative to note that the prevalence among this tribal population is nearly double the average for the country, indicating the need for targeted strategies for these regions.[24]

Intervention-related changes in KAP showed significant improvement, with total KAP scores among community members nearly doubling. The influence of knowledge on behavioral practices through attitudes ($\beta = 0.63$) was validated by SEM.[25] While critiqued as simplistic, KAP-based interventions do serve a purpose when paired with community mobilization in low-literacy environments, as illustrated by informal enforcement, like village mandates against public intoxication, which reduced stigma and fostered collective responsibility [23.] These findings, corroborated by evidence from participatory approaches for social norm change, are more effective than punitive approaches.[8,25,26]

The integration of primary healthcare with intervention led to parallel changes in HCW competencies. A section in the WHO's mhGAP focused on screening and referral showed improvement, exemplified by a 24.1% absolute increase in referrals.[27,28] Gains were most pronounced among medical officers ($\Delta + 7.8$ KAP scores), while ASHAs, despite modest improvements (18.9/30), showed promise in task-shifting within constrained resource settings.[28] This aligns with mhGAP's decentralized care models, which

support greater interventional roles for non-specialist providers in the management of substance use disorders.[27] Pathways for referral were also strengthened informally through the inclusion of assessment or questioning specifically about alcohol use at primary health centers, demonstrating grassroots implementation adaptability.

The community-clinic collaboration offers frameworks for alcohol harm reduction that could be used elsewhere. However, the high abstinence rate (77.8%) on the first follow-up is not explained by the model. The results of the randomized controlled study Counseling for Alcohol Problems (CAP), which used lay counselors to provide advice and increase the rate of abstinence, were noticeably better than those of conventional alcohol addiction treatment.[9] Similarly, local leadership mobilization and women's groups highlight another outcome that parallels "communitarian resilience." Collective action is a phenomenon that has been documented in faith-based programs in the United States and Nigeria for the treatment of substance use disorders.[29,30] In addition to clinical intervention, these networks provided social support, and decreased relapse triggers. Peer-led support programs were found to have significantly maintained 6-month abstinence rates in a systematic review of various alcohol addiction studies conducted in Africa. This suggests that formalizing these structures in the Indian community may have improved outcomes.[31]

Relapse dynamics exposed the interaction of some underlying systemic weaknesses. The abstinence rate fell from 77.8% at 1-month follow-up to 48.1% at 3-month follow-up, reflecting the international patterns of relapse where the majority of incidents happen within the first 3–6 months.[32] Cox regression showed that older age, low income, and unstable employment were critical predictors of the outcome, consistent with previous data about alcohol relapse.[33,34,35] These findings illustrate the problem of using individual, self-contained approaches in tackling the issue; the lack of financial stability, coupled with mental health problems, calls for a holistic approach that blends abstinence frameworks with employment training or cash transfers with stipulations.[36] Similar to this model, a client-centric model implemented in Brazil in the form of care management suggests good outcomes.[37] Such approaches underscore the findings from the systematic review, where structured deaddiction programs, including residential care, decreased the relapse rate significantly.[38]

Strengths and limitations

Employing the validated tools like AUDIT, KAP, and SEM, this study demonstrates methodological rigor by achieving an 80% follow-up rate despite logistical difficulties. This is achieved through real-world participatory design alongside concurrent community and health system engagement. However, the inability to determine causation due to the lack of a control group is problematic, and the three-month follow-up period may not be sufficient to provide information on the long-term impact. Results may not be generalizable as the study is limited to a tribal population. Furthermore, the use of self-reporting data in the study introduces social desirability bias, which a biomarker assessment (e.g., EtG urine testing) could help address. While there are issues of scale due to the intervention's high resource intensity, this assessment may be remarkable for India's tribal populations. Although the single-group design was guided by ethical considerations, taking this study as a pilot study, future studies could consider randomization to a cluster of strata to maintain ethical integrity while allowing controlled comparisons through a series of interventions across villages.[39]

Policy implications

It is recommended that ASHA and ANM staff performing frontline health functions in Ayushman Bharat and the National Program for the Prevention and Control of Cancers, Diabetes, Cardiovascular Diseases and Stroke (NPCDCS) should be trained in the identification of alcohol abuse. For this reason, short, digitally scalable tools like AUDIT-C can be used for training using digital health and eSanjeevani frameworks. Active, incentive-based monitoring should be supported through community participation through the Panchayat schemes and the self-help groups linked to the Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS). Integrated models based on longitudinal studies such as Clustered Randomized Control–Randomized Control Trials (CRC–RCTs) should be planned. They may concentrate on 12- to 24-month sustainability, cost-effectiveness assessment, and mixed-method investigation of youth interventions that are ethnographically adapted for tribal and non-tribal dynamics, which are different from current Western paradigms. Diversity in approach could be assessed for comparative heterogeneity through RE-AIM frameworks.

Conclusion

This study fills a crucial gap in alcohol use research among rural and tribal populations in India by demonstrating that a quasi-experimental, community-based intervention integrated with primary healthcare can rapidly improve alcohol-related KAPs. High initial abstinence rates, grassroots mobilization, and enhanced healthcare worker capacity show that behavior change is most effective when reinforced at multiple levels. The use of KAP with SEM sheds light on community behavior dynamics, but enduring poverty and job instability underscore the need for more comprehensive systemic supports for sustainable recovery. The results offer a complementary framework for integrating the alcohol harm reduction template model into India's and other LMICs' rural healthcare systems. It also contributes to informing national policies such as Nasha Mukt Bharat and Ayushman Bharat. Randomized

designs with longer follow-up are needed to evaluate the long-term impact and cost-effectiveness.

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Competing Interests
Non declared.

Data Accessibility Statement
Data can be made available on request.

Ethical Approval
All data collection was conducted by principal investigators proficient in the local language. Privacy and confidentiality were ensured. Ethical approval (SVIC/ON/MEDI/BNPG23/JUNE/24/196) was obtained from the institutional ethics committee, and informed consent (written or verbal with witnessed thumbprint) was secured from all participants.

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