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RESEARCH ARTICLE

Determinants of alcohol use among young males in two Indian states: A population-based study

Jan M. Heijdra Suasnabar[1,2] | **Abhijit Nadkarni**[3,4] | **Benjamin Palafox**[2]

[1]Department of Biomedical Data Sciences, Leiden University Medical Centre, The Netherlands

[2]Faculty of Public Health and Policy, London School of Hygiene and Tropical Medicine, UK

[3]Department of Population Health, Faculty of Epidemiology and Population Health, London School of Hygiene and Tropical Medicine, UK

[4]Addictions Research Group, Goa, India

Correspondence
Jan M. Heijdra Suasnabar, Department of Biomedical Data Sciences, Leiden University Medical Centre, Albinusdreef 2, Leiden, The Netherlands
Email: j.m.heijdra_suasnabar@lumc.nl

Abstract

Objectives: There is insufficient evidence about the determinants of alcohol use amongst young people in India and other low-and middle-income countries, despite alcohol's high contribution to disease burden and increasing consumption in this population. We aimed to identify and estimate the determinants of alcohol use in a representative sample of 2716 young men from Bihar and Uttar Pradesh who participated in the 'Understanding the Lives of Adolescents and Young Adults' (UDAYA) study.

Methods: First, we developed an exploratory conceptual framework of potential alcohol use determinants in the study settings based on available literature. We then estimated the effects of 35 potential alcohol use determinants identified in the conceptual framework (including 14 latent factors identified through exploratory factor analysis) on any alcohol use in the past 3 years and regular alcohol use amongst past three-year drinkers, using mixed-effects logistic models. The determinants explored were operationalised using longitudinal data from the UDAYA study.

Results: Our adjusted models identified 18 determinants for past 3-year alcohol use and 12 determinants for regular use. Distal determinants (e.g., socioeconomic status), intermediate determinants (e.g., parental alcohol use, media use), and proximal determinants (e.g., emotional regulation, early tobacco use) were identified. Geographical variations in both outcomes indicate potential differences in unmeasured community-level determinants (e.g., alcohol availability and acceptability).

Conclusions: Our findings extend the generalizability of several known determinants across settings, yet highlight the importance of addressing alcohol use in young people as a complex and context-dependent issue. Many identified determinants (e.g., education, media use, poor parental support, early tobacco use) are amenable to intervention through multi-sectoral prevention programs/policies. Such determinants should be the focus of ongoing policy/intervention development efforts in the region, and our revised conceptual framework may inform further research in India or similar South Asian settings.

KEYWORDS
adolescents, alcohol use, determinants, mental health, prevention, young adults

INTRODUCTION

Alcohol use is the second-largest risk factor by attributable disability-adjusted life-years (DALYs) amongst people aged 10–24 globally [1]. Depending on the pattern/frequency of use, alcohol consumption is associated with short-and long-term consequences, including mental and neurological disorders, risky sexual behaviours, injuries and non-communicable diseases (NCDs) [2–4]. Alcohol use further incurs social and economic losses [5].

Whilst stable or declining in most regions, alcohol consumption per capita has been rising in the WHO South-

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East Asia region, most notably in India [4, 6]. India is the world's third-largest alcohol market [7], with a high proportion of heavy episodic drinkers [4], and a growing population of young drinkers (under 20 years) [8, 9]. Such indicators are likely driven by policies that facilitate alcohol availability, incoherent control/prevention policies (a responsibility devolved to states), and an increasingly globalised youth and middle-class targeted by industry [7]. Given these trends, understanding the local determinants of alcohol use in young people is crucial to improve responses in the form of preventive policy decisions and contextualised interventions. This is especially significant now given India's ongoing epidemiological transition that has greatly increased the burden due to NCDs, for which alcohol use is a key risk factor [10, 11].

Whilst 'adolescence' and 'early adulthood' are often considered distinct developmental stages, their distinction becomes particularly blurred in many low-and middle-income countries (LMICs) where transitions into adult roles occur earlier or later than in western high-income countries (HICs) [12, 13]. Such differences in the contexts and transitions of young people reflect a need for local evidence and interpretations of key determinants of alcohol use. The prevalence of alcohol use amongst young people also differs widely across LMICs, reflecting differing policies and sociocultural norms [9].

An analysis of the patterns and consequences of alcohol use in young people using data from 68 LMICs found that young males were more likely than females to have been intoxicated and experienced alcohol-related problems/consequences [14]. This is in line with findings from a recent Indian review [15] and a Global Burden of Disease analysis which found that harmful consumption was concentrated amongst young males [16].

Although research from HICs has identified various risk and protective factors of alcohol use and misuse in young people, the effects of these determinants are less well-known in LMICs [17–19]. Existing frameworks and theories have also been largely based on information from HICs [20–22], limiting their applicability to the contexts and transitions of young people in LMICs. Two recent reviews focused on South Asian youth reported that, despite an increased research interest on the topic in recent years, several gaps currently limit the development of evidence-based interventions and policies. Such gaps include limited generalizability due to small non-representative samples, the omission of key/emerging exposures such as media use, and the dominance of cross-sectional (over longitudinal) analyses [15, 23].

This study sought to address these gaps using longitudinal data from a large representative sample of Indian youth in Bihar and Uttar Pradesh collected by the 'Understanding the Lives of Adolescents and Young Adults' (UDAYA) project. Specific objectives were to: 1) develop a comprehensive and contextually-appropriate exploratory conceptual framework (CF) of potential alcohol use determinants, and 2) estimate the effect of these determinants on alcohol use in the past 3 years and regular (i.e., weekly) alcohol use amongst young Indian males.

METHODS

Exploratory CF development

This study's first aim was to develop a CF of potential alcohol use determinants in young people to inform the selection of relevant exposure variables for the modelling of determinants (i.e., this study's second aim). Emphasis was placed on developing a CF that sufficiently considered the Indian and LMIC context. The CF was informed by a systematic search of publications on PubMed and PsycINFO (Appendix S5), reference-tracing, and a recent Indian systematic review [15]. Given the exploratory aim of the literature review, most types of peer-reviewed publications were considered, however, to ensure sufficient validity, determinants were only considered relevant if there was empirical evidence for their association with alcohol use/misuse or if they were highlighted within existing theories/frameworks, including broader LMIC-focused youth development frameworks [13].

Synthesising evidence from approximately 50 sources, largely from two systematic reviews [19, 24], three theoretical frameworks [13, 21, 22], and the Lancet series 'Substance use in young people' [2, 25, 26], Figure 1 illustrates the comprehensive set of potential determinants according to their likely proximity and effect on the risk of alcohol use. For example, there have been mixed findings about the influence of rural/urban residency (a distal factor) on alcohol use, which may be further influenced by other proximal (e.g., family) factors. Appendix S1 contains full descriptions and references for the hypothesised determinants. Determinants were classified as 'distal', 'intermediate' or 'proximal' based on existing frameworks and reviews [22, 25, 27]. The CF also includes a box on 'associated increased risks' to highlight alcohol use itself as a risk factor and acknowledge potential sources of reverse causality that may arise in cross-sectional analyses. It is noted that this CF is not meant to capture the complex dynamics of alcohol use amongst youth in the study settings, which would be premature given the scarcity of evidence on the matter. This broad CF is a necessary precursor for the identification of relevant determinants, which could in turn inform further research into the development of more complex/detailed explanatory frameworks and models.

Study population, sample and design

The UDAYA study selected a representative cohort of 16,292 young people in Bihar and Uttar Pradesh who were interviewed at two time-points (wave 1 in 2015–2016 and wave 2 in 2018–2019) using structured interviews. Individual-level interviews gathered data on human assets (e.g., health, academic/vocational skills, attitudes/beliefs); social assets (e.g., access to friends/mentors); financial assets/literacy; and physical assets [28]. Additionally, household interviews were conducted to capture the participants' living environments. It is noted that relative to national averages, Bihar and Uttar Pradesh lag on

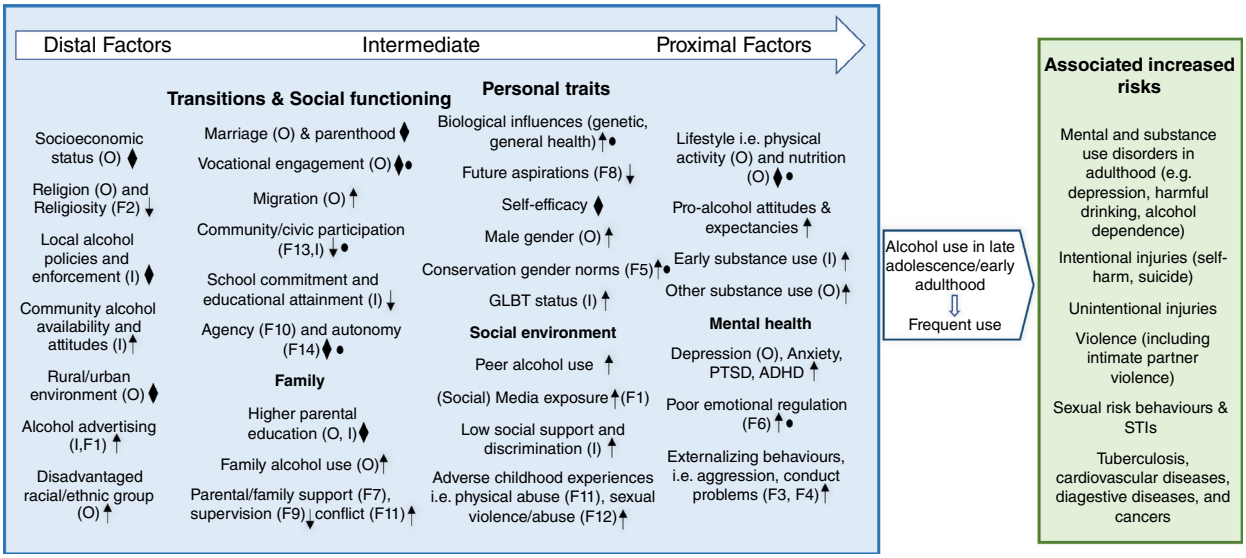

FIGURE 1 Exploratory conceptual framework of risk and protective factors for alcohol use in adolescents and young adults, and their mapping to UDAYA data. (↑↓) the directionality of a determinant's hypothesised effect on the risk of alcohol use according to the reviewed literature. (◆) Findings or theories on the directionality of the association are mixed, complex, or inconclusive. (●) Few studies identified exploring this association empirically. (O) Directly observed in UDAYA (see Appendix S2). (F1–F14) Factors identified through exploratory factor analysis. (I) Partially or indirectly accounted for using UDAYA data (see Appendix S2).

several sociodemographic indicators (e.g., literacy, income, see Appendix Table S1) [28, 29].

This analysis is based on a sub-sample of the UDAYA cohort, including 2716 young males aged 17–23 years at Wave 2 who also took part in Wave 1. Due to the multi-stage probability-proportional-to-size (PPS) sampling process followed, this sub-sample is representative of the young male population in both states (i.e., sample weights were calculated for this sub-sample, see Appendix S3 and S4) [28]. A multi-stage systematic sampling procedure was followed in the UDAYA study where 75 primary sampling units (PSUs) were selected with PPS each from rural and urban strata in both states (i.e., 300 PSUs in total). Within selected villages (rural PSUs) and a randomly selected census enumeration area within wards (urban PSUs), complete lists of households served as the random sampling frame for 90 households containing a boy and 150 households containing an unmarried girl in each PSU [28]. This sub-sample was chosen (as opposed to a combined sex sub-sample) given the much higher prevalence of alcohol use amongst males (22.3%) than females (0.5%) and because exploratory factor analysis (EFA), a method central to this study, requires a homogeneous sample to yield internally valid factors [30]. The UDAYA datasets are accessible upon request to the Population Council via the Harvard Dataverse (DOI: 10.7910/DVN/RRXQNT).

To identify likely predictors of alcohol use whilst minimising bias from reverse causality, this secondary analysis of longitudinal data uses wave 1 data to operationalise determinants (exceptions include lifetime exposures and when wave 1 data was unavailable) and wave 2 data to measure two alcohol use outcomes.

Outcome variables

The primary binary outcome was any alcohol use during the past 3 years at wave 2. The secondary conditional binary outcome was regular alcohol use, defined as drinking at least once per week [25], amongst past 3-year drinkers.

Exposure variables

The exploratory nature of this study, the multi-dimensional character of many determinants in the CF, and the vast amount of potentially correlated variables available suggested EFA as an appropriate data-reduction and exploratory technique. Specifically, EFA allowed us to maximise the use of data and identify underlying latent constructs that could operationalise many of the hypothesised determinants. Compared to using single variables as proxies for broader multi-dimensional constructs (e.g., parental support), EFA is empirically-driven and minimises loss of information whilst producing quantifiable variables representing these constructs that can be used in further analyses [31].

We used factor loadings, eigenvalues, factor rotations, and interpretability as criteria to guide our factor selection process to achieve a 'simple structure' (i.e., a set of quantitatively-distinct, interpretable factors) [30]. Factor loadings of ≥0.32 were considered salient [30] and cross-loading variables were dropped across iterations except when doing so considerably diminished interpretability [32]. We retained factors with eigenvalues of ≥1 as these account for more variance than individual loading variables (i.e., they are an improvement over the factor's constituent variables), and preferred oblique

TABLE 1 Final factor solution from exploratory factor analysis.

Factor *n* (construct)	Component variables	Factor loading
Factor 1 (Media use)	Frequency of social media use	0.920
	Frequency of internet use	0.907
	Frequency of film-watching	0.603
	Frequency of tv-watching	0.556
Factor 2 (religiosity)	Would not mix freely with people from a different religion	0.955
	Would not mix freely with people from a different caste	0.877
	Would not eat with someone from a different caste/religion	0.736
Factor 3 (Externalising behaviours–sexual)	Ever forced sex on a girl/woman	0.825
	Ever forced touching/kissing on a girl/woman	0.728
	Number of sex partners	0.688
Factor 4 (Externalising behaviours-Aggression)	Was involved in a physical fight in the past 12-months	0.831
	Teased or beat younger/weaker boy in past 12-months	0.789
Factor 5 (Conservative gender norms)	Believes it is more important that girls get married instead of completing education[a]	0.830
	Believes it is more important to educate boys than girls[a]	0.709
	Believes that child bathing/feeding are women's responsibilities only	0.421
Factor 6 (Poor emotional regulation)	Frequency of cutting/biting himself when agitated/angry/sad in the past 12 months.	0.964
	Frequency of pulling his own hair when agitated/angry/sad in the past 12 months.	0.821
Factor 7 (Poor parental support)	Does not feel he could talk to parents about personal things and they would listen	0.861
	Parents do not know what he does in his free time	0.755
	Has not discussed his friendships with any parent in the past year	0.587
Factor 8 (Lack of aspirations)	Participates in a community club or community sports club	−0.846
	Would not attend vocational-training course even if supported	0.591
	Reported not having a vocational aspiration	0.544
Factor 9 (Parental control)	Is not allowed to leave ward (urban) or village (rural) alone	0.961
	Is not allowed to attend a program inside ward/village alone	0.755
Factor 10 (Agency)	Level of certainty that he can choose how to spend his free time[a]	0.774
	Level of certainty that he can choose what type clothing to wear[a]	0.700
	Level of certainty that he could participate in non-family/school activities[a]	0.641
	Level of certainty that he can talk freely to parents/in-laws about aspirations[a]	0.539
Factor 11 (Domestic violence)	Father ever beat participant's mother	0.884
	Father ever beat participant after 10 years of age	0.478
Factor 12 (Sexual abuse)	Has ever been forced to sex	0.867
	Has ever been forcefully touched/kissed	0.851
Factor 13 (Civic participation)	Voted in the last state elections	0.759
	Is a member of a political party	0.640
	Is involved in political activities	0.630
Factor 14 (Autonomy)	Has savings	0.816
	Can solely decide whether to work or stay at home	−0.606
	Has and operates a bank account in his name	0.377
Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy		0.649

[a]From Wave 2 data.

over orthogonal factor rotations for interpretability, simplicity of structure and inter-factor correlations [30, 32]. To appropriately handle different variable types, the EFA was based on a matrix of polychoric and Pearson correlations (for categorical and continuous data, respectively) [30]. Appendix S4 contains methodological details about the EFA.

Guided by the CF, we selected 56 survey variables for the first EFA iteration, of which 39 were retained in the final 14-factor solution (Table 1) after six iterations (Appendix S9 contains the first and last solutions, as well as a scree plot). The research team named these 14 factors according to their component variables and the CF determinants to which they

TABLE 2 Summary of participant characteristics.

	Bihar N = 1281 (total %)	Uttar Pradesh N = 1435 (total %)	Combined states N = 2716 (total %)
Age[b]			
17–18 years old[c]	377 (29.43)	310 (21.60)	687 (25.29)
19 years old	332 (25.92)	330 (23.00)	662 (24.37)
20 years old	240 (18.74)	302 (21.05)	545 (20.07)
21 years old	221 (17.25)	274 (19.09)	495 (18.23)
22–23 years old[c]	111 (8.67)	219 (15.26)	330 (12.15)
Urban/rural status[a]			
Rural	605 (47.23)	813 (56.66)	1418 (52.21)
Urban	676 (52.77)	622 (43.34)	1298 (47.79)
Wealth quintile[a]			
Poorest	89 (6.95)	99 (6.90)	188 (6.92)
Poorer	192 (14.99)	188 (13.10)	380 (13.99)
Medium	275 (21.47)	270 (18.82)	545 (20.07)
Richer	423 (33.02)	380 (26.48)	803 (29.57)
Richest	302 (23.58)	498 (34.70)	800 (29.46)
Religion[a]			
Hindu	1133 (88.45)	1172 (81.67)	2305 (84.87)
Muslim	148 (11.55)	263 (18.33)	411 (15.13)
Completed years of education[b]			
0–7 years	147 (11.48)	214 (14.91)	361 (13.29)
8–12 years	890 (69.48)	834 (58.12)	1724 (63.48)
13–17 years	244 (19.05)	387 (26.97)	631 (23.23)
Alcohol use[b]			
Past 3 years	311 (24.28)	319 (22.23)	630 (23.20)
At least once per week	52 (4.06)	68 (4.74)	120 (4.42)

[a]Wave 1 data.
[b]Wave 2 data.
[c]Combined into one category due to small numbers.

mapped (Appendix S2 describes this interpretative step further). Factors were parametrised as standardised factor scores and categorised into tertiles representing lower/moderate/higher levels of each construct for use in our modelling exercise [31].

A total of 35 variables (i.e., the 14 EFA-derived factors and 21 survey variables) were used to operationalise the determinants in the CF for regression modelling. In Figure 1, the letters 'O' (directly observed by survey variable), 'I' (indirectly or partially observed, see below), and 'F' (latent factors derived via EFA) indicate how we account for each potential determinant. No data were available for personal alcohol attitudes/expectancies, peer alcohol use, biological influences, and self-efficacy. Detailed descriptions about the selected variables are provided in Appendix S2, and Appendix S6 contains details of all the variables analysed/generated throughout this study.

Modelling approach

Multi-level, mixed-effect logistic regression models were developed to assess the determinants of each outcome (using Stata version 16.1). First, we analysed crude associations between the set of exposure variables and each outcome, controlling for age a priori as a known confounder for many exposures [19, 23].

We then constructed fully-adjusted models using a backward stepwise approach (Appendix S4) [33, 34]. Wealth, age, urban/rural status, and alcohol or tobacco use at wave 1 were included throughout as commonly cited confounders or key predictors of alcohol use. We included a random effect at the PSU level (i.e., villages/census wards in rural/urban areas) to indirectly test and adjust for variation attributable to geographically dependent determinants in the CF which were not directly observed (i.e., distal determinants labelled 'I' in Figure 1) [28, 35]. Finally, we included a fixed-effect for state to control for state-level differences, including the alcohol ban passed in Bihar in April 2016 [36]. Multicollinearity in regressions was assessed using variance inflation factor values, which were within acceptable ranges (Appendix S4 and S7) [37].

We assessed interactions using the 'cumulative-risk' hypothesis [38] and the 'risk-protective' model [39] to inform a priori hypotheses of potential bivariate interactions

TABLE 3 Determinants of past 3-year drinking at wave 2, crude (age-adjusted) and fully-adjusted estimates.

	Category total, *N* = 2716 (%)	Past 3-year consumption, *N* (row %)	Crude OR[e] (95% CI)	Wald *p*-value	Fully adjusted OR[f] (95% CI)	Wald *p*-value
Ever drug use[a]						
No	2692 (99.1)	613 (22.8)	1		-	
Yes	24 (0.9)	17 (70.8)	7.74 (2.32–25.86)	0.001	-	
Ever tobacco use[a]						
No	2216 (81.6)	396 (17.9)	1		1	
Yes	500 (18.4)	234 (46.8)	4.35 (3.14–6.03)	0.001	3.78 (2.54–5.63)	<0.001
Ever alcohol use[a]						
No	2522 (92.9)	513 (20.3)	1		1	
Yes	194 (7.1)	117 (60.3)	4.35 (2.86–6.61)	<0.001	1.35 (0.81–2.24)	0.25
Mental health[d]						
No depression	2440 (89.8)	554 (22.7)	1		-	
Mild to severe depression	276 (10.2)	76 (27.5)	1.34 (0.91–1.97)	0.141	-	
Poor emotional regulation[a]						
Lower	906 (33.4)	233 (25.7)	1		-	
Moderate	905 (33.3)	203 (22.4)	0.72 (0.53–0.98)	0.038	-	
Higher	905 (33.3)	194 (21.4)	0.75 (0.54–1.05)	0.091	-	
Externalising aggression[a]						
Lower	906 (33.4)	172 (19.0)	1		-	
Moderate	905 (33.3)	207 (22.9)	1.34 (0.99–1.82)	0.058	-	
Higher	905 (33.3)	251 (27.7)	1.55 (1.11–2.17)	0.01	-	
Externalising Sexual behaviour[a]						
Lower	906 (33.4)	199 (22.0)	1		1	
Moderate	905 (33.3)	205 (22.7)	0.95 (0.70–1.30)	0.766	1.12 (0.79–1.57)	0.535
Higher	905 (33.3)	226 (25.0)	1.35 (0.97–1.87)	0.071	1.44 (1.00–2.07)	0.047
Number of healthy foods consumed daily[a]						
0	165 (6.1)	40 (24.2)	1		-	
1	668 (24.6)	175 (26.2)	1.16 (0.66–2.05)	0.594	-	
2	999 (36.8)	209 (20.9)	0.76 (0.45–1.26)	0.283	-	
3	648 (23.9)	147 (22.7)	0.78 (0.43–1.43)	0.425	-	
4	208 (7.7)	53 (25.5)	0.84 (0.44–1.60)	0.594	-	
5	28 (1.0)	6 (21.4)	0.3 (0.08–1.14)	0.076	-	
Physical activity[a]						
No activity	562 (20.7)	136 (24.2)	1		-	
1–2 times per month	184 (6.8)	47 (25.5)	1.18 (0.64–2.18)	0.596	-	
Once per week	246 (9.1)	56 (22.8)	1.02 (0.61–1.69)	0.95	-	
More than once per week	713 (26.3)	160 (22.4)	0.93 (0.62–1.38)	0.712	-	
Daily	1011 (37.2)	231 (22.9)	1 (0.70–1.43)	0.996	-	
Parental alcohol use[a]						
No	2047 (75.4)	425 (20.8)	1		-	
Yes	669 (24.6)	205 (30.6)	1.87 (1.38–2.55)	<0.001	-	
Mother's education level[a]						
No education	1731 (63.7)	426 (24.6)	1		-	
1–7 years	324 (11.9)	73 (22.5)	0.76 (0.50–1.16)	0.208	-	
8–9 years	258 (9.5)	59 (22.9)	0.9 (0.53–1.53)	0.695	-	
≥10 years	403 (14.8)	72 (17.9)	0.82 (0.58–1.18)	0.284	-	

TABLE 3 (Continued)

	Category total, $N = 2716$ (%)	Past 3-year consumption, N (row %)	Crude OR[e] (95% CI)	Wald p-value	Fully adjusted OR[f] (95% CI)	Wald p-value
Domestic violence[c]						
Lower	906 (33.4)	178 (19.65)	1		1	
Moderate	905 (33.3)	205 (22.65)	1.47 (1.04–2.07)	0.029	1.47 (1.00–2.16)	0.053
Higher	905 (33.3)	247 (27.29)	1.85 (1.38–2.48)	<0.001	1.67 (1.16–2.4)	0.006
Parental control[a]						
Lower	906 (33.4)	251 (27.7)	1		-	
Moderate	905 (33.3)	208 (22.98)	0.93 (0.67–1.31)	0.694	-	
Higher	905 (33.3)	171 (18.9)	0.62 (0.45–0.85)	0.003	-	
Parental support[a]						
Higher	906 (33.4)	150 (16.56)	1		1	
Moderate	905 (33.3)	209 (23.09)	1.39 (0.99–1.94)	0.059	1.41 (0.95–2.09)	0.09
Lower	905 (33.3)	271 (29.94)	1.95 (1.37–2.77)	<0.001	1.59 (1.08–2.35)	0.02
Social-support seeking[a]						
Yes	2280 (83.9)	534 (23.4)	1		-	
No	436 (16.1)	96 (22.0)	1.17 (0.86–1.58)	0.314	-	
Number of friends[a]						
0–1 friends	346 (12.7)	83 (24.0)	1		-	
2–4 friends	1347 (49.6)	281 (20.9)	0.86 (0.61–1.08)	0.466	-	
≥5 friends	1023 (37.7)	266 (26.0)	1.1 (0.72–1.66)	0.678	-	
Media use[a]						
Lower	906 (33.4)	175 (19.3)	1		1	
Moderate	905 (33.3)	220 (24.3)	1.32 (0.94–1.85)	0.108	1.21 (0.78–1.88)	0.397
Higher	905 (33.3)	235 (26.0)	1.4 (0.96–2.06)	0.082	1.78 (1.17–2.73)	0.008
Sexual abuse[c]						
Lower	906 (33.4)	172 (19.0)	1		-	
Moderate	905 (33.3)	182 (20.1)	1.28 (0.94–1.76)	0.121	-	
Higher	905 (33.3)	276 (30.5)	1.91 (1.36–2.67)	<0.001	-	
Marriage status[b]						
Unmarried	2521 (92.8)	566 (22.5)	1		-	
Married	195 (7.2)	64 (32.8)	1.56 (1.03–2.37)	0.038	-	
Ever done paid work[a]						
No	1893 (69.7)	334 (17.6)	1		1	
Yes	823 (30.3)	296 (36.0)	2.18 (1.60–2.98)	<0.001	1.53 (1.09–2.15)	0.015
Migrated[b]						
No	2386 (87.9)	526 (22.1)	1		1	
Yes	330 (12.2)	104 (31.5)	1.75 (1.21–2.54)	0.003	1.45 (0.93–2.26)	0.098
Civic participation[a]						
Lower	906 (33.4)	217 (24.0)	1		1	
Moderate	905 (33.3)	194 (21.4)	1.08 (0.81–1.43)	0.604	1.45 (1.03–2.02)	0.031
Higher	905 (33.3)	219 (24.2)	0.94 (0.67–1.33)	0.739	1.13 (0.72–1.77)	0.601
Years of education[b]						
0–7 years	361 (13.3)	124 (34.4)	1		1	
8–12 years	1724 (63.5)	386 (22.4)	0.68 (0.47–0.99)	0.043	0.84 (0.58–1.24)	0.383
13–17 years	631 (23.2)	120 (19.0)	0.31 (0.19–0.49)	<0.001	0.46 (0.28–0.74)	0.002

(Continues)

TABLE 3 (Continued)

	Category total, $N = 2716$ (%)	Past 3-year consumption, N (row %)	Crude OR[e] (95% CI)	Wald p-value	Fully adjusted OR[f] (95% CI)	Wald p-value
Autonomy[a]						
Lower	906 (33.4)	213 (23.5)	1		-	
Moderate	905 (33.3)	199 (22.0)	0.93 (0.68–1.28)	0.662	-	
Higher	905 (33.3)	218 (24.1)	0.95 (0.72–1.27)	0.74	-	
Future aspiration[a]						
Higher	906 (33.4)	190 (21.0)	1		-	
Moderate	905 (33.3)	187 (20.7)	1 (0.73–1.37)	0.984	-	
Lower	905 (33.3)	253 (28.0)	1.6 (1.18–2.17)	0.002	-	
Agency[b]						
Higher	906 (33.4)	230 (25.4)	1		1	
Moderate	905 (33.3)	209 (23.1)	0.82 (0.60–1.14)	0.237	0.74 (0.52–1.05)	0.093
Lower	905 (33.3)	191 (21.1)	0.83 (0.57–1.22)	0.34	0.64 (0.42–0.99)	0.046
Conservative gender norms[c]						
Lower	906 (33.4)	211 (23.3)	1		-	
Moderate	905 (33.3)	206 (22.8)	0.95 (0.70–1.29)	0.752	-	
Higher	905 (33.3)	213 (23.5)	0.84 (0.61–1.15)	0.263	-	
Same sex intimacy[c]						
No	2650 (97.6)	599 (22.6)	1		1	
Yes	66 (2.4)	31 (47.0)	2.03 (1.20–3.42)	0.008	2.08 (1.13–3.85)	0.019
Wealth[a]						
Poorest	188 (7.0)	58 (30.9)	1		1	
Poorer	380 (14.0)	97 (25.5)	0.61 (0.38–0.99)	0.046	0.55 (0.30–1.01)	0.052
Medium	545 (20.1)	137 (25.1)	0.69 (0.43–1.11)	0.125	0.81 (0.44–1.49)	0.5
Richer	803 (29.6)	170 (21.2)	0.62 (0.38–1.20)	0.059	0.69 (0.39–1.23)	0.213
Richest	800 (29.5)	168 (21.0)	0.55 (0.38–0.91)	0.019	0.77 (0.42–1.40)	0.386
Religiosity[a]						
Lower	906 (33.4)	208 (23.0)	1		-	
Moderate	905 (33.3)	214 (23.6)	1.15 (0.85–1.54)	0.351	-	
Higher	905 (33.3)	208 (23.0)	1.21 (0.84–1.74)	0.296	-	
Religion[a]						
Hindu	2305 (84.9)	590 (25.6)	1		1	
Muslim	411 (15.1)	40 (9.7)	0.32 (0.19–0.54)	<0.001	0.21 (0.12–0.37)	<0.001
Age[b]						
17–18 years	687 (25.3)	124 (18.1)	1		1	
19 years	662 (24.4)	140 (21.2)	1.63 (1.11–2.38)	0.012	1.43 (0.95–2.16)	0.088
20 years	545 (20.1)	132 (24.2)	2.25 (1.52–3.32)	<0.001	1.79 (1.15–2.77)	0.009
21 years	495 (18.2)	139 (28.1)	2.16 (1.45–3.21)	<0.001	1.67 (1.03–2.71)	0.036
22–23 years	330 (12.2)	95 (28.8)	2.48 (1.58–3.88)	<0.001	1.9 (1.04–3.46)	0.036
Place of residence[a]						
Rural	1418 (52.2)	301 (21.2)	1		1	
Urban	1298 (47.8)	329 (25.4)	1.19 (0.91–1.54)	0.195	1.8 (1.31–2.49)	<0.001
Social/ethnic group[a]						
Regular	521 (19.2)	88 (16.9)	1		1	
Backward/scheduled caste/tribe	2195 (80.8)	542 (24.7)	1.69 (1.08–2.63)	0.024	1.56 (0.97–2.51)	0.069

TABLE 3 (Continued)

	Category total, $N = 2716$ (%)	Past 3-year consumption, N (row %)	Crude OR[e] (95% CI)	Wald p-value	Fully adjusted OR[f] (95% CI)	Wald p-value
State[a]						
Uttar Pradesh	1435 (52.8)	319 (22.2)	1		1	
Bihar	1281 (47.2)	311 (24.3)	1.17 (0.88–1.54)	0.274	1.13 (0.82–1.56)	0.446
Variance estimate (95% CI) for two-level random intercept at PSU level: 0.49 (0.32–0.76)						<0.001[g]
Constant (95% CI): 0.07 (0.03–0.18)						<0.001

[a]Wave 1 data.
[b]Wave 2 data.
[c]Based on data from wave 1&2.
[d]Based on cut-offs for the PHQ-9.
[e]Age-adjusted.
[f]Adjusted for all other variables in the fully-adjusted model.
[g]Comparing the random-intercept model to corresponding simple logistic model.

(i.e., between risk-to-risk factor or risk-to-protective factor combinations). Appendix S4 contains further details on how/which interactions were assessed [40]. We note that although our CF suggests distal/proximal determinants may be modelled using hierarchical approaches, adopting such approaches was not considered feasible nor timely due to the many determinants of interest and the scarcity of information about the interrelationships between determinants that is necessary for such approaches [41].

Importantly, there was a 30% loss-to-follow-up between waves from our sample (i.e., $n = 3885$ at Wave 1). Although the probability-based sampling weights used adjusted for loss-to-follow-up, it was not possible to directly assess its impact on results as we could not access the baseline data of those lost to follow up. We highlight the potential limitations of loss-to-follow-up in the Discussion, drawing on information from a related study that did have baseline data of those lost to follow-up [42].

Ethics

Written ethical approval for this study was granted by the Research and Ethics Committee of the London School of Hygiene and Tropical Medicine (ref no. 25428). The UDAYA study was approved by the Institutional Review Board of the Population Council. All participants (including parents when necessary) gave informed consent to participate in the UDAYA study [28].

RESULTS

Sample characteristics

Table 2 summarises the key participant characteristics (see Table 3 for all frequency distributions). Approximately 23% of young males consumed alcohol at least once in the past 3 years, of whom 19% reported drinking at least once per week; 23% completed more than 12 years of education, and 21% were in the poor or poorest wealth quintiles.

Determinants of alcohol use in the past 3 years

Table 3 presents the crude (age-adjusted) associations between our independent variables and past 3-year alcohol use, as well as fully-adjusted odds ratios (aORs) and 95% confidence intervals (CI) for determinants in our final model for this outcome.

The fully-adjusted mixed-effect model included 18 determinants (Table 3) and provided a significantly better fit than the standard logit model ($p < 0.001$). The improved fit of the mixed-effects model indicates a PSU-level (i.e., community level) variation in the baseline odds of past three-year alcohol use. In terms of risk factors, there was evidence ($p < 0.05$) of an association between any alcohol use in the past 3 years and prior tobacco use (aOR: 3.78, CI 2.54–5.63), intimacy with the same sex (aOR: 2.08, CI 1.13–3.85), urban residency (aOR: 1.8, CI 1.31–2.49), age, higher media use (aOR: 1.78, CI 1.17–2.73), higher domestic violence (aOR: 1.67, CI 1.16–2.4), lower parental support (aOR: 1.59, CI 1.08–2.35), having worked at wave 1 (aOR: 1.53, CI 1.09–2.15), higher levels of externalising sexual behaviours (aOR: 1.44 CI 1.00–2.07), and having moderate civic participation levels (aOR: 1.45, CI 1.03–2.02). There was only weak evidence ($p < 0.1$) of an association between alcohol use and belonging to a backward caste/tribe (aOR: 1.56, CI 0.97–2.51), and migration in the past 3 years at wave 2 (aOR: 1.45, CI 0.93–2.26). In terms of protective effects, there was evidence ($p < 0.05$) of an association for the highest education level (aOR: 0.46, CI 0.28–0.74, *cf* 0–7 years), lower agency levels at wave 2 (aOR: 0.64, CI 0.42–0.99), and being Muslim (aOR: 0.21, CI 0.12–0.37). There was some evidence that those in the second-poorest wealth quintile had a lower risk compared to the poorest quintile (aOR: 0.55, CI 0.30–1.01, $p = 0.052$).

TABLE 4 Determinants of regular alcohol use at wave 2 among past 3-year drinkers, crude (age-adjusted) and fully adjusted estimates ($n = 630$).

	Category total, $N = 630$ (%)	Regular alcohol use, N (row %)	Crude OR[e] (95% CI)	Wald p-value	Fully-adjusted OR[f] (95% CI)	Wald p-value
Ever drug use[a]						
No	613 (97.3)	115 (18.8)	1		-	
Yes	17 (2.7)	5 (29.4)	3.64 (0.76–17.30)	0.104	-	
Ever tobacco use[a]						
No	396 (62.9)	60 (15.2)	1		1	
Yes	234 (37.1)	60 (25.6)	1.61 (0.94–2.75)	0.084	1.5 (0.69–3.27)	0.303
Ever alcohol use[a]						
No	513 (81.4)	94 (18.3)	1		1	
Yes	117 (18.6)	26 (22.2)	1.40 (0.67–2.93)	0.363	0.92 (0.36–2.36)	0.870
Mental health[d]						
No depression	554 (87.9)	108 (19.5)	1		-	
Mild to severe depression	76 (12.1)	12 (15.8)	1.00 (0.42–2.35)	0.997	-	
Poor emotional regulation[a]						
Lower	233 (37.0)	44 (18.9)	1		1	
Moderate	203 (32.2)	27 (13.3)	0.58 (0.26–1.29)	0.181	0.49 (0.2–1.21)	0.120
Higher	194 (30.8)	49 (25.3)	1.81 (0.91–3.58)	0.088	2.72 (1.24–5.97)	0.012
Externalising aggression[a]						
Lower	172 (27.3)	37 (21.5)	1		-	
Moderate	207 (32.9)	32 (15.5)	0.50 (0.27–0.95)	0.034	-	
Higher	251 (39.8)	51 (20.3)	0.80 (0.42–1.54)	0.500	-	
Externalising sexual behaviour[a]						
Lower	199 (31.6)	41 (20.6)	1		-	
Moderate	205 (32.5)	32 (15.6)	0.80 (0.40–1.60)	0.520	-	
Higher	226 (35.9)	47 (20.8)	0.57 (0.31–1.05)	0.072	-	
Number of healthy foods consumed daily						
0–2	424 (67.3)	91 (21.5)	1		-	
3–5	206 (32.7)	29 (14.1)	0.81 (0.41–1.61)	0.547	-	
Physical activity[a]						
No activity	136 (21.6)	31 (22.8)	1		1	
1–2 times per month	47 (7.5)	3 (6.4)	0.11 (0.02–0.55)	0.007	0.11 (0.01–0.87)	0.036
Once per week	56 (8.9)	8 (14.3)	0.45 (0.14–1.44)	0.177	0.51 (0.12–2.15)	0.359
More than once per week	160 (25.4)	33 (20.6)	0.58 (0.26–1.30)	0.187	0.67 (0.24–1.85)	0.443
Daily	231 (36.7)	45 (19.5)	0.88 (0.41–1.89)	0.738	1.33 (0.51–3.45)	0.559
Parental alcohol use[a]						
No	425 (67.5)	65 (15.3)	1		1	
Yes	205 (32.5)	55 (26.8)	2.31 (1.40–3.82)	0.001	2.11 (1.03–4.3)	0.041
Mother's education level[a]						
No education	426 (67.6)	87 (20.4)	1		-	
1–7 years	73 (11.6)	13 (17.8)	0.56 (0.24–1.31)	0.179	-	
8–9 years	59 (9.4)	10 (17.0)	0.90 (0.34–2.38)	0.835	-	
≥10 years	72 (11.4)	10 (13.9)	0.80 (0.34–1.89)	0.615	-	
Domestic violence[c]						
Lower	178 (28.3)	28 (15.7)	1		-	
Moderate	205 (32.5)	36 (17.6)	0.76 (0.35–1.66)	0.495	-	
Higher	247 (39.2)	56 (22.7)	1.22 (0.65–2.28)	0.527	-	
Parental control[a]						
Lower	251 (39.8)	48 (19.1)	1		-	
Moderate	208 (33.0)	45 (21.6)	0.84 (0.41–1.70)	0.625	-	
Higher	171 (27.1)	27 (15.8)	0.72 (0.38–1.37)	0.317	-	

TABLE 4 (Continued)

	Category total, $N = 630$ (%)	Regular alcohol use, N (row %)	Crude OR[e] (95% CI)	Wald p-value	Fully-adjusted OR[f] (95% CI)	Wald p-value
Parental support[a]						
Higher	150 (23.8)	28 (18.7)	1		-	
Moderate	209 (33.2)	44 (21.1)	1.65 (0.81–3.35)	0.165	-	
Lower	271 (43.0)	48 (17.7)	1.84 (0.99–3.40)	0.053	-	
Social-support seeking[a]						
Yes	534 (84.8)	100 (18.7)	1		-	
No	96 (15.2)	20 (20.8)	1.39 (0.69–2.81)	0.353	-	
Number of friends[a]						
0–1 friends	83 (13.2)	15 (18.1)	1		-	
2–4 friends	281 (44.6)	56 (19.9)	1.43 (0.58–3.53)	0.441	-	
≥5 friends	266 (42.2)	49 (18.4)	1.30 (0.52–3.25)	0.567	-	
Media use[a]						
Lower	175 (27.8)	38 (21.7)	1		1	
Moderate	220 (34.9)	43 (19.6)	1.22 (0.63–2.35)	0.551	1.55 (0.63–3.8)	0.343
Higher	235 (37.3)	39 (16.6)	1.15 (0.54–2.46)	0.722	2.35 (0.89–6.23)	0.085
Sexual abuse[c]						
Lower	172 (27.3)	28 (16.3)	1		1	
Moderate	182 (28.9)	29 (15.9)	1.45 (0.63–3.30)	0.378	1.09 (0.41–2.88)	0.857
Higher	276 (43.8)	63 (22.8)	2.52 (1.27–5.01)	0.009	2.08 (0.87–4.95)	0.097
Marriage status[b]						
Unmarried	566 (89.8)	104 (18.4)	1		-	
Married	64 (10.2)	16 (25.0)	1.71 (0.70–4.23)	0.240	-	
Ever done paid work[a]						
No	334 (53.0)	51 (15.3)	1		-	
Yes	296 (47.0)	69 (23.3)	1.97 (1.05–3.69)	0.035	-	
Migrated[b]						
No	526 (83.5)	99 (18.8)	1		-	
Yes	104 (16.5)	21 (20.2)	1.13 (0.55–2.33)	0.745	-	
Civic participation[a]						
Lower	217 (34.4)	42 (19.4)	1		-	
Moderate	194 (30.8)	44 (22.7)	1.15 (0.62–2.13)	0.650	-	
Higher	219 (34.8)	34 (15.5)	0.81 (0.39–1.68)	0.570	-	
Years of education[b]						
0–7 years	124 (19.7)	33 (26.6)	1		1	
8–12 years	386 (61.3)	77 (20.0)	0.62 (0.30–1.30)	0.203	0.82 (0.32–2.08)	0.671
13–17 years	120 (19.1)	10 (8.3)	0.14 (0.05–0.42)	<0.001	0.09 (0.02–0.38)	0.001
Autonomy[a]						
Lower	213 (33.8)	43 (20.2)	1		-	
Moderate	199 (31.6)	35 (17.6)	0.85 (0.47–1.54)	0.597	-	
Higher	218 (34.6)	42 (19.3)	0.92 (0.53–1.60)	0.758	-	
Future aspiration[a]						
Higher	190 (30.2)	25 (13.2)	1		-	
Moderate	187 (29.7)	35 (18.7)	1.30 (0.64–2.61)	0.465	-	
Lower	253 (40.2)	60 (23.7)	1.84 (0.90–3.73)	0.092	-	
Agency[b]						
Higher	230 (36.5)	42 (18.3)	1		-	
Moderate	209 (33.2)	38 (18.2)	1.08 (0.60–1.95)	0.794	-	
Lower	191 (30.3)	40 (20.9)	1.00 (0.56–1.80)	0.991	-	

(Continues)

TABLE 4 (Continued)

	Category total, $N = 630$ (%)	Regular alcohol use, N (row %)	Crude OR[e] (95% CI)	Wald p-value	Fully-adjusted OR[f] (95% CI)	Wald p-value
Conservative gender norms[c]						
Lower	211 (33.5)	35 (16.6)	1		-	
Moderate	206 (32.7)	38 (18.5)	1.73 (0.94–3.19)	0.078	-	
Higher	213 (33.8)	47 (22.1)	2.04 (1.13–3.69)	0.019	-	
Same sex intimacy[c]						
No	599 (95.1)	110 (18.4)	1		-	
Yes	31 (4.9)	10 (32.3)	1.97 (0.43–3.36)	0.731	-	
Wealth[a]						
Poorest	58 (9.2)	16 (27.6)	1		1	
Poorer	97 (15.4)	27 (27.8)	1.05 (0.42–2.61)	0.913	1.13 (0.31–4.1)	0.852
Medium	137 (21.8)	23 (16.8)	0.47 (0.19–1.15)	0.098	0.38 (0.11–1.32)	0.128
Richer	170 (27.0)	24 (14.1)	0.30 (0.12–0.74)	0.009	0.27 (0.07–0.98)	0.046
Richest	168 (26.7)	30 (17.9)	0.57 (0.23–1.41)	0.221	0.6 (0.17–2.13)	0.432
Religiosity[a]						
Lower	208 (33.0)	47 (22.6)	1		-	
Moderate	214 (34.0)	29 (13.6)	0.46 (0.23–0.91)	0.026	-	
Higher	208 (33.0)	44 (21.2)	0.99 (0.55–1.79)	0.986	-	
Religion[a]						
Hindu	590 (93.7)	114 (19.3)	1		-	
Muslim	40 (6.4)	6 (15.0)	0.44 (0.14–1.37)	0.158	-	
Age[b]						
17–18 years	124 (19.7)	26 (21.0)	1		1	
19 years	140 (22.2)	24 (17.1)	0.75 (0.32–1.74)	0.495	0.46 (0.16–1.28)	0.137
20 years	132 (21.0)	25 (18.9)	0.62 (0.31–1.27)	0.190	0.76 (0.28–2.05)	0.583
21 years	139 (22.1)	31 (22.3)	1.15 (0.52–2.56)	0.728	1.46 (0.49–4.37)	0.501
22–23 years	95 (15.1)	14 (14.7)	0.67 (0.29–1.58)	0.364	0.52 (0.14–1.88)	0.318
Place of residence[a]						
Rural	301 (47.8)	59 (19.6)	1		1	
Urban	329 (52.2)	61 (18.5)	0.96 (0.59–1.56)	0.856	1.56 (0.72–3.37)	0.257
Social/ethnic group[a]						
Regular	88 (14.0)	13 (14.8)	1		-	
Backward/scheduled caste/tribe	542 (86.0)	107 (19.7)	1.36 (0.62–2.86)	0.471	-	
State[a]						
Uttar Pradesh	319 (50.6)	68 (21.3)	1		1	
Bihar	311 (49.4)	52 (16.7)	0.91 (0.50–1.66)	0.751	0.75 (0.36–1.57)	0.439
Variance estimate (95% CI) for two-level random intercept at PSU level: 1.82 (0.79–4.18)						<0.001[g]
Constant (95% CI): 0.14 (0.03–0.81)						0.028

[a]Wave 1 data.
[b]Wave 2 data.
[c]Based on data from wave 1&2.
[d]Based on cut-offs for the PHQ-9.
[e]Age-adjusted.
[f]Adjusted for all other variables in the fully-adjusted model.
[g]Comparing the random-intercept model to corresponding simple logistic model.

Determinants of frequent alcohol use

Table 4 contains crude (age-adjusted) associations between our independent variables and regular alcohol use amongst past 3-year drinkers, as well as fully-adjusted ORs and CIs for variables included in our final model for this outcome.

The final mixed-effect fully-adjusted model included 12 independent variables (Table 4), and provided a significantly better fit than the equivalent standard logit model ($p < 0.001$). There was evidence ($p < 0.05$) of an association between frequent alcohol use and poor emotional regulation (aOR: 2.72, CI 1.24–5.97) and parental alcohol use (aOR:

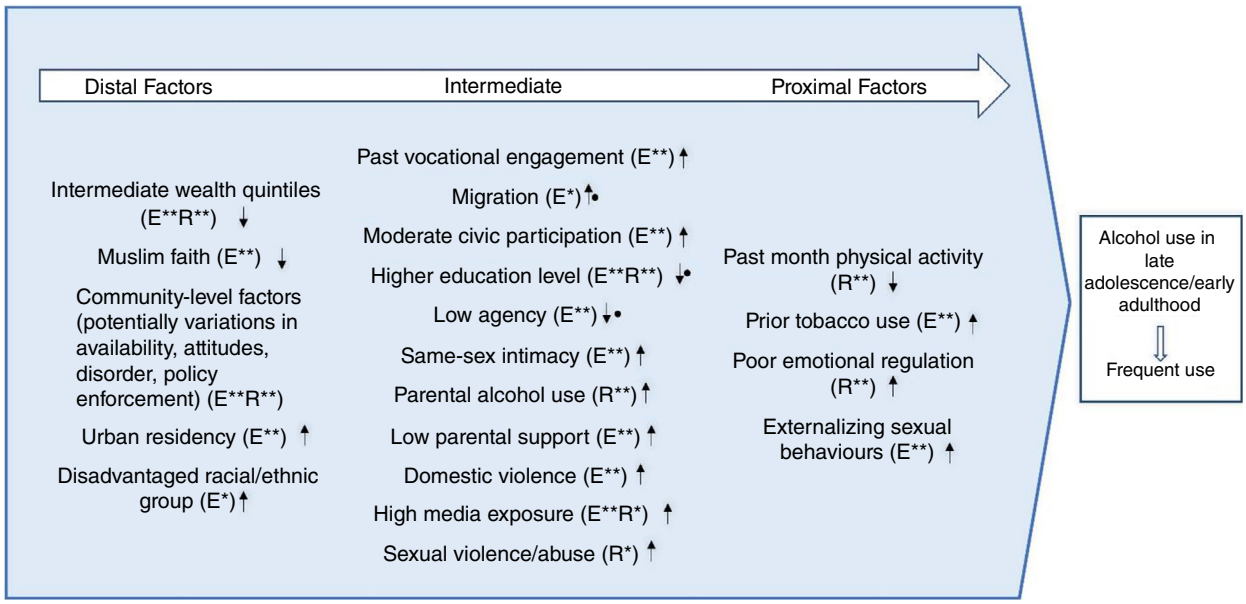

FIGURE 2 Revised conceptual framework based on results from fully-adjusted models. (E) Associated with ever use in the past 3 years. (R) Associated with regular use among past 3-year drinkers. (**) p-value <0.05. (*) p-value <0.1. (↓) Decreased odds. (↑) Increased odds. (●) Wave 2 data (otherwise wave 1).

2.11, CI 1.03–4.3). There was only weak evidence ($p < 0.1$) of an association between regular alcohol use and higher media use (aOR: 2.35, CI 0.89–6.23) and higher levels of sexual abuse (aOR: 2.08, CI 0.87–4.95). In terms of protective factors, there was evidence ($p < 0.05$) of an association for sporting once or twice in the past month (aOR: 0.11, CI 0.01–0.87, *cf*., not at all), having completed 12–17 years of education (aOR: 0.09, CI 0.02–0.38), and being in the richer wealth quintile (aOR: 0.27, CI 0.07–0.98).

Finally, we identified an interaction between level of parental support and early tobacco use for the past 3-year drinking outcome ($p = 0.05$, Table S2, Appendix). Lower parental support was associated with greater risk of alcohol use amongst tobacco users and non-users, but significantly more so amongst users (aOR: 5.82, CI 3.28–10.33 for users with low parental support and aOR: 2.11, CI 1.14–3.89 for users with high support, *cf*. non-users with high parental support).

DISCUSSION

Our findings make an important contribution to the evidence-base on the determinants of alcohol use amongst young people in India and LMICs, a topic for which most of the current evidence reflects western-HICs contexts [5, 25]. The UDAYA study enabled us to address key evidence gaps using high quality, representative data to identify potential alcohol use determinants amongst young males in Bihar and Uttar Pradesh, which account for a quarter of India's population [43]. Whilst our findings extend the generalizability of several known risk/protective factors, they also highlight the importance of understanding alcohol use as a complex and context-dependent issue.

Figure 2 presents an updated version of our CF summarising our findings, which could help to inform further research and control efforts in similar contexts. This updated CF should be developed further into a more detailed explanatory model through qualitative/quantitative research.

We discuss the potential implications of our findings for local interventions and decision-making in general, with the intent to provide starting points for more specific/tailored prevention approaches and further research into the development of contextually-appropriate interventions [44, 45].

Proximal factors

In line with existing literature, prior tobacco use was a strong predictor of past three-year alcohol use [19], but not for regular use. However, contrary to findings from HICs [19], neither prior drug nor alcohol use were relevant predictors in our adjusted models. This could be due to the higher prevalence and acceptability of tobacco use in India compared to alcohol or other substances [8, 46], which may deter/delay progressions in substance use trajectories.

Other proximal determinants were externalising sexual behaviours, emotional regulation, and engaging in physical activity 1–2 times per month, all of which represent potential avenues for intervention [26, 47, 48]. The strongest predictor of regular alcohol use was poor emotional regulation, in line with existing literature describing emotion-regulation as a determinant of risky behaviours [2, 49]. Therefore, intervention developers in India should consider incorporating/strengthening evidence-based social–emotional learning (SEL) components into school-based, family-based and integrated health interventions/programs, such as Rashtriya Kishor Swasthya Karyakram [48, 50]. Importantly, the effect

of emotional regulation should be explored further using validated instruments.

We found no evidence of the 'paradoxical' positive association between physical activity and alcohol use that has been reported predominantly in HICs [51]. Although participants who exercised 1–2 times per month at wave 1 were less likely to drink regularly than those who did not, this finding did not extend to higher activity levels. Nevertheless, it may indicate that physical activity-based prevention interventions may be acceptable and/or effective in Bihar and Uttar Pradesh [51].

Intermediate factors

As determinants of both drinking outcomes, media use and education should play central roles in ongoing control strategies in Bihar and Uttar Pradesh [26]. Contrary to what is commonly reported in studies on college students in western-HICs, having a higher education was not a risk factor in this study [19]. This could be due to the comparatively stronger drinking culture in HICs, and/or because we adjusted for migration (including for education). Several mechanisms could explain education's highly protective effect: more years in education reflect academic commitment, reduced drinking opportunities, and increased probability of engaging in preventive/alternative activities [23, 26]. Thus, efforts to increase educational attainment through state-level secondary education programs (e.g., Samagra Shiksha) should be strengthened and seen as important components of a multi-sectoral approach to prevention.

The increased risk of alcohol use amongst frequent media users may be partly attributable to alcohol advertising [52, 53]. This would corroborate concerns raised by the WHO about industry targeting of LMIC markets with low alcohol consumption, particularly amongst youth [7, 53]. Regarding social media use, the strongest-loading variable on the 'media use' factor, the increased risk may be attributable to social learning through user-generated alcohol-related content or industry campaigns, as has already been reported in India [7, 52, 54]. Indian health authorities should investigate the influence of media platforms on young people's drinking behaviours, especially as social media becomes an increasingly promising tool for nationwide prevention efforts [53, 55, 56].

Amongst family-related determinants, higher domestic violence, parental alcohol use, and lower parental support were risk factors for alcohol use, whilst lower agency was seemingly protective (Figure 2). We discuss agency as a family related construct because the factor reflects high levels of parental control. We also cautiously discuss lifetime sexual abuse as a family-related determinant of regular use because in India, perpetrators often are close to or part of victims' families [57]. Together, these findings reflect various streams through which family-level factors influence drinking outcomes; equally, they highlight the importance of involving families in prevention efforts, equipping parents with effective communication and monitoring skills, and raising awareness about domestic/sexual abuse [48].

Other intermediate risk factors for past 3-year use were same-sex intimacy, having worked by wave 1, moderate (not high) levels of civic participation, and (potentially) migration between waves 1–2. Except for civic participation, which should be investigated further, these findings are consistent with the reviewed literature [22, 58, 59]. The increased risk in those who migrated or worked is reasonable considering that these determinants represent stressors and transitions into more adult/independent roles [22, 58]. Regarding same-sex intimacy, the risk may be attributable to homophobic discrimination and the fact that 'normal stressors' like identity development 'may be compounded for LGB teenagers' [59].

Distal factors

The non-linear effect of wealth on both outcomes is somewhat consistent with previously-reported findings where poverty and higher income levels were associated with higher alcohol use, and middle income with comparatively lower use [19]. These findings might indicate a need to differentiate between alcohol use determinants in higher versus lower-income populations. Additionally, given that alcohol use patterns and burden may also differ by SES-level [60, 61], future studies and interventions in the region would benefit from being adapted to address socioeconomic differences and inequalities.

Other distal determinants of past 3-year use included urban residency, belonging to a disadvantaged or scheduled caste/tribe, and Muslim faith; all consistent with the reviewed literature (Appendix S1). Despite the current alcohol ban in Bihar, there were no significant state-level differences in either outcome. This finding may indicate limited impact of the ban, perhaps due to inadequate enforcement of the ban or, as has already been reported in the region, continued/increased consumption of unrecorded/illegal alcohol [62]. However, this study was not designed to assess the effectiveness of the alcohol ban in Bihar, and an appropriately designed impact evaluation should be conducted to investigate further. Finally, the community-level variation (i.e., at the PSU level) in outcomes indicate that unobserved community-level factors (e.g., alcohol availability/attitudes) likely influence alcohol use in these settings.

Limitations

The binary outcome of past three-year use may be a limited indicator of current use. However, given the evidence of decreasing proportions of lifetime abstainers in India, the primary outcome was considered a relevant indicator in this setting [4, 63]. Whilst the available sample size is likely to be sufficient for the primary outcome, the sample for the conditional secondary outcome may not provide sufficient power to detect all true associations. Nonetheless, the findings for the regular drinking outcome do still identify determinants that are consistent with the literature and could be considered 'strong' determinants given that they were identified in an

underpowered analysis. Future larger studies on the identified determinants of regular alcohol use could provide more precise effect estimates.

Our subsample represents 70% of those originally interviewed at Wave 1. Although we could not access baseline data from those lost to follow up, according to an analysis of the larger UDAYA cohort [42], migration was the main reason for being lost to follow up. Therefore, we may have underestimated the effects of migration. The remaining differences between those lost to follow up and retained were small and unlikely to have biased our estimates in important ways [42]. That said, possibility that loss to follow-up may have introduced some selection bias should be acknowledged. We attempted to minimise this impact through the use of sampling probability weights that account for loss to follow up (Appendix S3 pg. 10 contains the derivation of weights).

The cumulative-risk hypothesis and our CF suggests that we probably should have found more interactions. Despite our exhaustive assessment, the absence of more interactions may be due to our homogeneous sample, limited power, and our focus on multiplicative-scale interactions, thus warranting further research, possibly using other methods [40]. Further research should also ideally include more precise panel/time-to-event data.

Other limitations may be related to the various methodological decisions/interpretations inherent to EFA [30]. Factor solutions depend on which variables are fed into an EFA; relevant variables, if omitted, may prevent factor detection [30]. Also, in the absence of better data, we attempted to operationalise the construct of religiosity using the variables that loaded on factor 2, however, these variables reflect a limited/contentious representation of religiosity, which may still be relevant if explored using more accurate indicators.

No data were available for alcohol attitudes/expectancies, peer drinking, biological influences and refusal self-efficacy. This, along with the fact that some variables could not fully/discretely account for determinants in our CF, may have resulted in residual confounding or type II errors. Nonetheless, we were able to account for most determinants in our CF and minimise omitted-variable bias through simultaneously adjusting for several determinants, although the latter may have resulted in a slight over-adjustment or underestimation of effect sizes. Especially the effects of distal determinants may have been underestimated in this analysis as their influence on the drinking outcomes is likely mediated (and in our models was adjusted for) other more intermediate/proximal factors [41]. Given the scarcity of evidence about the dynamics/roles of the hypothesised determinants in the study settings, and our focus on many potential determinants, it was not feasible to directly account for the hierarchical classifications (from our CF) in our models [41]. We therefore note that our exploratory and revised CFs should not be viewed as 'final' explanatory frameworks but rather be used to inform further research to build models that further explore and account for the interrelationships of the identified determinants.

As a robustness check of our findings, we fitted a smaller 'individual-level' model (Appendix S10) on the primary outcome which included a smaller set of individual-level variables. In that model, the effect estimates of the determinants that were not included in our fully-adjusted model (Table 3) all tended towards the null, indicating that their inclusion in an adjusted model is not warranted. Of the variables that were included in both the new 'individual model' and the fully-adjusted model (Table 3), the results remained largely the same as in the fully-adjusted model, indicating that these estimates are more likely to represent true independent effects and that overadjustment was not likely to have been an issue.

Finally, our findings are generalizable only to Bihar, Uttar Pradesh and potentially states or countries with similar sociodemographic characteristics. Given between-state differences in alcohol availability, policies, and use patterns [7, 61], the effect of determinants will likely vary across states. We refer readers to discussions about state/regional differences in India [11, 64, 65] and between-state differences of alcohol use and policies [7, 61].

Conclusions

This study provides representative estimates of various alcohol use determinants amongst young males in Bihar and Uttar Pradesh. Many of the identified determinants are amenable to intervention through multi-sectoral and integrated programs/policies. Our findings and revised CF could inform future research and interventions in India and other LMIC settings. Considering India's alcohol use trajectory, research on key determinants amongst young Indians should be scaled-up and used to inform contextually-appropriate strategies. Ideally, prevention interventions should be multi-sectoral (e.g., involving schools, families and professionals), multi-component (e.g., involving socioemotional learning, health and parenting education, physical activity) and responsive to the characteristics and needs of different sub-populations. Policies to prevent exposure to alcohol advertising through media should be strengthened. Community-level determinants should be further explored, and the (unintended) effects of the Bihar alcohol ban should be evaluated. Finally, future research on this topic should focus on female populations and investigate socioeconomic differences in the burden and use of alcohol.

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DATA AVAILABILITY STATEMENT

The data used and analysed for this study are restricted but available by request from the Population Council via the Harvard Dataverse (DOI: 10.7910/DVN/ZJPKW5). Methodological

and statistical details necessary to reproduce the analyses are provided in Appendix S4 and Appendix S6.

REFERENCES

1. Abbafati C, Machado DB, Cislaghi B, Salman OM, Karanikolos M, McKee M, et al. Global burden of 87 risk factors in 204 countries and territories, 1990–2019: a systematic analysis for the global burden of disease study 2019. Lancet. 2020;396(10258):1223–49.
2. Hall WD, Patton G, Stockings E, Weier M, Lynskey M, Morley KI, et al. Why young people's substance use matters for global health. The Lancet Psychiatry [Internet]. 2016;3(3):265–79. https://doi.org/10.1016/S2215-0366(16)00013-4
3. Patton GC, Sawyer SM, Santelli JS, Ross DA, Afifi R, Nicholas B, et al. Our future: a lancet commission on adolescent health and wellbeing. Lancet. 2016;387(10036):2423–78.
4. Fleischmann A, Gehring E, Poznyak V, Rekve D. Global status report on alcohol and health 2018 [Internet]. Geneva: World Health Organization; 2018 Available from: https://www.who.int/publications/i/item/9789241565639
5. World Health Organization. Working document for development of an action plan to strengthen implementation of the global strategy to reduce the harmful use of alcohol. Geneva: World Health Organization; 2020. https://www.who.int/publications/m/item/working-document-towards-an-action-plan-on-alcohol
6. Shield K, Manthey J, Rylett M, Probst C, Wettlaufer A, Parry CDH, et al. National, regional, and global burdens of disease from 2000 to 2016 attributable to alcohol use: a comparative risk assessment study. Lancet Public Heal [Internet]. 2020;5(1):e51–61. https://doi.org/10.1016/S2468-2667(19)30231-2
7. Gururaj G, Gautham MS, Arvind BA. Alcohol consumption in India: a rising burden and a fractured response. Drug Alcohol Rev. 2021;40(3):368–84.
8. Institute for Health Metrics and Evaluation. GBD compare, visualization hub [Internet]. Available from: https://www.thelancet.com/lancet/visualisations/gbd-compare
9. Ma C, Bovet P, Yang L, Zhao M, Liang Y, Xi B. Alcohol use among young adolescents in low-income and middle-income countries: a population-based study. Lancet Child Adolesc Hea. 2018;2(6):415–29. https://doi.org/10.1016/S2352-4642(18)30112-3
10. Yadav S, Arokiasamy P. Understanding epidemiological transition in India. Glob Health Action. 2014;7:7.
11. Dandona L, Dandona R, Kumar GA, Shukla DK, Paul VK, Balakrishnan K, et al. Nations within a nation: variations in epidemiological transition across the states of India, 1990–2016 in the global burden of disease study. Lancet. 2017;390(10111):2437–60.
12. Juárez F, Gayet C. Transitions to adulthood in developing countries. Annu Rev Sociol. 2015 Mar;2014(40):521–38.
13. National Research Council and Institute of Medicine. Growing up global: the changing transitions to adulthood in developing countries. In: Lloyd C, editor. Social Sciences. Washington, DC: The National Academies Press; 2005.
14. Leung J, Chiu V, Connor JP, Peacock A, Kelly AB, Hall W, et al. Alcohol consumption and consequences in adolescents in 68 low and middle-income countries—a multi-country comparison of risks by sex. Drug Alcohol Depend. 2019 Jan;205:107520. https://doi.org/10.1016/j.drugalcdep.2019.06.022
15. Nadkarni A, Tu A, Garg A, Gupta D, Gupta S, Bhatia U, et al. Alcohol use among adolescents in India: a systematic review. Glob Ment Heal. 2022;9:1–25.
16. Bryazka D, Reitsma MB, Griswold MG, Hassen Abate K, Abbafati C, Abbasi-Kangevari M, et al. Population-level risks of alcohol consumption by amount, geography, age, sex, and year: a systematic analysis for the global burden of disease study 2020. Lancet [Internet]. 2022;400(10347):185–235. Available from: http://www.thelancet.com/article/S0140673622008479/fulltext%0Ahttp://www.thelancet.com/article/S0140673622008479/abstract%0Ahttps://www.thelancet.com/journals/lancet/article/PIIS0140-6736(22)00847-9/abstract
17. Bryden A, Roberts B, Petticrew M, McKee M. A systematic review of the influence of community level social factors on alcohol use. Heal Place [Internet]. 2013;21:70–85. https://doi.org/10.1016/j.healthplace.2013.01.012
18. Marshall EJ. Adolescent alcohol use: risks and consequences. Alcohol Alcohol. 2014;49(2):160–4.
19. Stone AL, Becker LG, Huber AM, Catalano RF. Review of risk and protective factors of substance use and problem use in emerging adulthood. Addict Behav [Internet]. 2012;37(7):747–5. https://doi.org/10.1016/j.addbeh.2012.02.014
20. Ennett ST, Foshee VA, Bauman KE, Hussong A, Faris R, Cai L, et al. The social ecology of adolescent alcohol misuse. Child Dev. 2008;79(6):1777–91.
21. Petraitis J, Flay BR, Miller TQ. Reviewing theories of adolescent substance use: organizing pieces in the puzzle. Psychol Bull. 1995;117(1):67–86.
22. Sudhinaraset M, Wigglesworth C, Takeuchi DT. Social and cultural contexts of alcohol use: influences in a social–ecological framework. Alcohol Res Curr Rev. 2016;38(1):35–45.
23. Athauda LK, Peiris-John R, Ameratunga S, McCool J, Wickremasinghe R. Factors influencing alcohol use among adolescents in South Asia: a systematic review. J Stud Alcohol Drugs. 2020;81(5):529–42.
24. Grigsby TJ, Forster M, Unger JB, Sussman S. Predictors of alcohol-related negative consequences in adolescents: a systematic review of the literature and implications for future research. J Adolesc [Internet]. 2016;48:18–35. https://doi.org/10.1016/j.adolescence.2016.01.006
25. Degenhardt L, Stockings E, Patton G, Hall WD, Lynskey M. The increasing global health priority of substance use in young people. Lancet Psychiatry [Internet]. 2016;3(3):251–64. https://doi.org/10.1016/S2215-0366(15)00508-8
26. Stockings E, Hall W, Lynskey M, Morley K, Reavley N, Strang J, et al. Prevention, early intervention, harm reduction, and treatment of substance use in young people. Lancet Psychiatry [Internet]. 2016 cited 2019 May 13;3:280–96. https://doi.org/10.1016/S2215-0366(16)00002-X
27. Viner RM, Ozer EM, Denny S, Marmot M, Resnick M, Fatusi A, et al. Adolescence and the social determinants of health. Lancet. 2012 Apr 28;379(9826):1641–52.
28. Santhya K, Acharya R, Pandey N, Singh SK, Rampal S, Zavier AJF, et al. Understanding the lives of adolescents and young adults (UDAYA) in Bihar. New Delhi: Population Council; 2017. p. 1–351.
29. United Nations and NITI Aayog. SDG India Index & Dashboard [Internet]. SDG State Scores: Mumbai; 2020 Available from: https://sdgindiaindex.niti.gov.in/#/ranking
30. Watkins M. A step-by-step guide to exploratory factor analysis with R and RStudio. A Step-by-Step Guide to Exploratory Factor Analysis with R and RStudio: Routledge; 2020.
31. DiStefano C, Zhu M, Mîndrilă D. Understanding and using factor scores: considerations for the applied researcher. Pract Assessment Res Eval. 2009;14(20):1–11.
32. Bandalos DL. In: Little TD, editor. Measurement theory and applications for the social sciences. Guilford Press: New York; 2018.
33. Henley SS, Golden RM, Kashner TM. Statistical modeling methods: challenges and strategies. Biostat Epidemiol. 2020;4(1):105–39.
34. Henderson D, Denison D. Stepwise regression in social and psychological research. Psychol Rep. 1989;64(1):251–7.
35. Merlo J, Chaix B, Ohlsson H, Beckman A, Johnell K, Hjerpe P, et al. A brief conceptual tutorial of multilevel analysis in social epidemiology: using measures of clustering in multilevel logistic regression to investigate contextual phenomena. J Epidemiol Community Health. 2006;60:290–7.
36. Tewary A. Bihar to impose prohibition from April 2016. Hindu [Internet]. 2016;(Apr 1): Available from: https://www.thehindu.com/news/national/other-states/bihar-cm-nitish-kumar-announces-liquor-ban-from-april-1/article7919152.ece
37. Thompson CG, Kim RS, Aloe AM, Becker BJ. Extracting the variance inflation factor and other multicollinearity diagnostics from typical regression results. Basic Appl Soc Psych. 2017;39(2):81–90.
38. Zufferey A, Michaud PA, Jeannin A, Berchtold A, Chossis I, van Melle G, et al. Cumulative risk factors for adolescent alcohol misuse

and its perceived consequences among 16 to 20 year old adolescents in Switzerland. Prev Med. 2007;45(2–3):233–9.
39. Appleyard K, Egeland B, Van DMHM, Sroufe LA. When more is not better : the role of cumulative risk in child behavior outcomes. J Child Psychol Psychiatry. 2005;46(3):235–45.
40. Kleinbaum DG, Klein M. Modeling strategy for assessing interaction and confounding. Logistic regression: A self–learning text. 2002;191–226. https://link.springer.com/chapter/10.1007/978-1-4757-4108-7_7
41. Victoria CG, Huttly SR, Fuchs SC, Olinto M. The role of conceptual frameworks in epidemiological analysis: a hierarchical approach. Int J Epidemiol. 1997;26:224–7.
42. Patel SK, Santhya KG, Haberland N. What shapes gender attitudes among adolescent girls and boys? Evidence from the UDAYA longitudinal study in India. PLoS One [Internet]. 2021;16(3):1–20. Available from: 10.1371/journal.pone.0248766
43. Government of India. Office of the Registrat General & census commissioner, India [Internet]. Population Enumeration Data (Final Population). 2011; Available from: https://censusindia.gov.in/2011census/population_enumeration.html
44. Nadkarni A, Costa S, Gupta D, Fernandes D, Catalano A, Velleman R, et al. The systematic development of a mobile phone–delivered brief intervention for hazardous drinking in India. J Subst Abuse Treat [Internet]. 2021;126(February):108331 Available from: 10.1016/j.jsat.2021.108331
45. De Silva MJ, Breuer E, Lee L, Asher L, Chowdhary N, Lund C, et al. Theory of change: a theory-driven approach to enhance the Medical Research Council's framework for complex interventions. Trials. 2014;15(267):1–6.
46. Singh A, Ladusingh L. Prevalence and determinants of tobacco use in India : evidence from recent global adult tobacco survey data. PLoS One. 2014;9(12):1–18.
47. Simonton AJ, Young CC, Johnson KE. Physical activity interventions to decrease substance use in youth: a review of the literature. Subst Use Misuse [Internet]. 2018;53(12):2052–68. Available from: 10.1080/10826084.2018.1452338
48. Griffin K, Botvin G. Evidence-based interventions for preventing substance use disorders in adolescents. Child Adolesc Psychiatr Clin N Am. 2010;19(3):505–26.
49. Jakubczyk A, Trucco EM, Kopera M, Suszek H, Fudalej S, Brower KJ, et al. The association between impulsivity, emotion regulation, and symptoms of alcohol use disorder. J Subst Abuse Treat. 2018;91-(February):49–56.
50. Greenberg MT, Domitrovich CE, Weissberg RP, Durlak JA. Social and emotional learning as a public health approach to education. Future Child. 2017;27(1):13–32.
51. Leasure JL, Neighbors C, Henderson CE, Young CM. Exercise and alcohol consumption: what we know, what we need to know, and why it is important. Front Psych. 2015;6(156):1–13.
52. Moreno M, Whitehill J. Influence of social media on alcohol use in adolescents and Young adults. Alcohol Res. 2013;36(1):91–100.
53. World Health Organization. Global strategy to reduce the harmful use of alcohol [Internet]. Geneva: World Health Organization; 2010 [cited 2019 May 13] Available from: https://www.who.int/publications/i/item/9789241599931
54. Gupta H, Lam T, Pettigrew S, Tait RJ. The association between exposure to social media alcohol marketing and youth alcohol use behaviors in India and Australia. BMC Public Health. 2018;18(1):1–11.
55. Flaudias V, De Chazeron I, Zerhouni O, Boudesseul J, Begue L, Bouthier R, et al. Preventing alcohol abuse through social networking sites: a first assessment of a two-year ecological approach. J Med Internet Res. 2015;17(12):1–9.
56. Moreno M, D'Angelo J, Whitehill J. Social media and alcohol: summary of research, intervention ideas and future study directions. Media Commun. 2016;4(3):50–9.
57. Choudhry V, Dayal R, Pillai D, Kalokhe AS, Beier K, Patel V. Child sexual abuse in India: a systematic review. PLoS One. 2018;13(10):1–32.
58. Juárez F, LeGrand T, Lloyd CB, Singh S, Hertrich V. Youth migration and transitions to adulthood in developing countries. Ann Am Acad pol Soc Sci. 2013;648(1):6–15.
59. Marshal MP, Friedman MS, Stall R, King KM, Miles J, Gold MA, et al. Sexual orientation and adolescent substance use : a meta-analysis and methodological review. Addiction. 2008;103:546–6.
60. Probst C, Kilian C, Sanchez S, Lange S, Rehm J. The role of alcohol use and drinking patterns in socioeconomic inequalities in mortality: a systematic review. Lancet Public Heal [Internet]. 2020;5(6):e324–32. Available from: 10.1016/S2468-2667(20)30052-9
61. Kumar K, Kumar S, Singh AK. Prevalence and socio-demographic correlates of alcohol consumption: survey findings from five states in India. Drug Alcohol Depend. 2018;185(February):381–90.
62. Agarwal N, Kumar CM, Chandramani S, Shahi AK. Assessment of implications of alcohol prohibition in Bihar. Indian J Community Fam Med. 2017;3(1):61.
63. World Health Organisation. Global status report on alcohol and health 2014 [Internet]. Luxembourg; 2014. Available from: https://www.who.int/publications/i/item/global-status-report-on-alcohol-and-health-2014
64. Azam M, Blom A. Progress of participation in tertiary education in India from 1993 to 2004 [Internet]. World Bank Policy Research Working Paper; 2008. p. 125–67 Available from: https://elibrary.worldbank.org/doi/abs/10.1596/1813-9450-4793
65. Joseph M. Northern states versus southern states: a comparative analysis [Internet]. Delhi: Indian Council for Research on International Economic Relations; 2004 Available from: www.icrier.res.in

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