

# Paternal Alcohol Consumption and Childhood Malnutrition: A Community-based Participatory Case-control Study among Adivasis in Rural South India

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## Abstract

**Background:** Childhood malnutrition in India remains among the highest in the world. Adult alcohol consumption and severe malnutrition have increased among indigenous people in South India. However, the association between them is poorly understood. **Objectives:** We aimed to evaluate this association, which could help design better intervention strategies. **Methods:** This case-control observational study was conducted in the Nilgiri district in South India. Cases included children aged 1–5 years with moderate malnutrition. Controls were defined as children in the same age group with normal weight-for-age. A questionnaire was used to collect data on demographics, socioeconomic status (SES), and parental education. The WHO Alcohol Use Disorders Identification Test (AUDIT) questionnaire was used to estimate parental alcohol use. Health-care workers collected data from within the community. **Results:** The baseline demographics of the children in the control ( $n = 250$ ) and case groups ( $n = 177$ ) were similar. Paternal age and AUDIT scores were not different in the two groups. SES was lower in the malnourished group, while maternal education among cases was significantly lower. Maternal and paternal education were associated with childhood malnutrition (odds ratio [OR]: 0.728 [95% confidence interval (CI): 0.583–0.903] and OR: 0.753 [95% CI: 0.589–0.957], respectively). After adjustment for covariates, paternal alcohol use was associated with a higher risk of malnutrition (OR: 1.56 [95% CI: 1.00–2.47]), which SES partly mediated. **Conclusion:** Paternal alcohol consumption is associated with childhood malnutrition, partially mediated by lower SES. Furthermore, lower SES appeared to be strongly associated with paternal alcohol consumption.

**Key words:** Childhood malnutrition, Nilgiri district, paternal alcohol consumption, socioeconomic status, South India

## INTRODUCTION

Childhood malnutrition is a critical determinant of morbidity. In 2020, childhood malnutrition affected more than 150 million children under 5 years of age worldwide, with the highest prevalence in Southeast Asia and Africa.<sup>[1,2]</sup> India's childhood malnutrition is among the highest globally, with approximately 60 million underweight children.<sup>[3]</sup> Despite tremendous economic growth in the country in the past several decades, child and infant mortality rates in the context of high malnutrition rank among the worst 50 nations.<sup>[4,5]</sup> High malnutrition rates have significantly impacted human development, economic growth, and child mortality in the country.

Grade 3 malnutrition rates among the Adivasis (indigenous people) of the Gudalur valley in South India have risen from 3% to 8% from 2000 to 2010. Made up of predominantly four tribes, the Paniyas, Bettakurumbas, Mullakurumbas, and Kattunayakans, this population of about 20,000 individuals is

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the original inhabitants of this forested region.<sup>[6]</sup> They have been marginalized by persecution, exploitation, and systematic racism and have lived on the periphery of society.

Over the past 40 years, systematic efforts targeting maternal and child health have impacted outcomes. The success of these interventions is evident in that the childhood grade 3 malnutrition rates decreased dramatically from 25% to 2% between 1990 and 2005 (unpublished observations). However, since 2005, there has been an alarming increase in severe malnutrition in children under 5 years of age despite persistent preventive efforts.

In parallel with this rise in malnutrition rates, the annual revenue from state-controlled liquor sales has increased by roughly 20% since 2003.<sup>[7]</sup> Alcohol use has increased tremendously among the Adivasi community over the same period. The prevalence of alcohol use is much higher among Adivasi males, a previously alcohol-naïve population.<sup>[8]</sup> Alcohol sales are government controlled, and the establishment of depots in the vicinity of Adivasi hamlets in Tamil Nadu has contributed to this rising burden.<sup>[8,9]</sup> In addition, household income has increased by 300% since 2005, especially for male daily wage laborers who comprise the bulk of the working population, contributing to increased alcohol use. Increasing food prices in India are associated with higher under-five mortality rates and childhood malnutrition.<sup>[5]</sup> Increasing alcohol use in the Adivasi community is likely to interfere with families' ability to provide protein-rich and nutritious food, contributing to the increase in malnutrition rates.

There is strong evidence that alcohol consumption has a detrimental effect on aboriginal communities, from Native Americans to Australian aborigines, including the Nicobarese communities in India.<sup>[10,11]</sup> Prior studies have also shown a higher incidence of malnutrition among children of alcoholics than children of nonalcoholic parents.<sup>[12]</sup> Despite the known health burden of chronic alcohol use, the evidence demonstrating its impact on childhood malnutrition, particularly in resource-poor countries, has never been comprehensively studied.

Maternal health also significantly contributes to childhood malnutrition. Maternal mental health disorders, particularly maternal depression, have been demonstrated as a risk factor for poor growth in young children.<sup>[13]</sup> Moreover, depression rates have been reported to be much higher among Adivasi communities.<sup>[14]</sup> Whether this finding is related to the increased rates of alcohol consumption in these areas is unknown. Anecdotal evidence suggests that male alcohol consumption contributes to depression among Adivasi women. However, the association between alcohol consumption and maternal mental health disorders with childhood malnutrition is poorly understood.

Community-based participatory research as a methodology has been extensively studied, with several advantages over conventional research approaches.<sup>[15]</sup> This is especially true in marginalized indigenous communities, where an in-depth knowledge of local customs, culture, and context is critical to obtaining sound data.<sup>[16]</sup> The Adivasi community generated the

research question through extensive meetings and focus-group discussions. Parental alcohol use and its impact on childhood malnutrition were the most pressing issues. Once the research question was identified, the study was designed.

Public health guidelines address poor antenatal care, infectious diseases, and nutritional support in combating childhood malnutrition. However, the efficacy of these interventions could be improved in the presence of unaddressed social and environmental factors, such as parental alcohol consumption and underlying psychological disorders. Therefore, this study aimed to identify an association between parental alcohol intake and malnutrition in their children and hypothesize potential mediators of this association, such as socioeconomic status (SES), which could help design future intervention strategies.

## MATERIALS AND METHODS

### Study design

The study was conducted in the Nilgiris district of Tamil Nadu in South India. The Adivasi community generated the aim and hypothesis through community leaders and village health workers. The study was designed as a case-control study. The study sample was selected from all members of an Adivasi health network. Children with severe malnutrition ( $z$  scores  $< -3$  standard deviations [SDs] weight-for-age of the WHO child growth standards median), birth weight  $< 2.5$  kgs, and those outside the defined age range at the time of the study were excluded. Cases were defined as children aged one to 5 years with moderate malnutrition, defined by the WHO as those with  $z$  scores between  $-3$  SDs and  $-2$  SDs weight-for-age of the WHO child growth standards median as on two separate weight measurements at least 3 months apart.<sup>[17]</sup> Controls were defined as children in the same age group with standard weight-for-age  $z$  scores. A total of 177 of 444 children of the appropriate age met the case eligibility criterion. Among the 444 children eligible as controls, 250 were randomly selected.

Adivasi health workers were trained in a 3-day workshop on research methodology. Data collection tools were developed with input from the Adivasi community. A structured questionnaire was used to collect demographic and socioeconomic information, including parental education, chronic health conditions, and tobacco use. Parental alcohol use and depression were assessed using validated questionnaires. A feasibility pilot study was performed on 10 mock cases, and the questionnaire was modified to address difficulties that arose. Data were collected on paper forms and electronically entered using Microsoft Access. Two separate researchers with  $>95\%$  agreement performed data entry independently.

### Exposures and their measurement

Parental alcohol intake was estimated by using the WHO's Alcohol Use Disorders Identification Test (AUDIT) questionnaire. The ten-item questionnaire is easy to administer and has been validated extensively to determine problem drinking in India.<sup>[18]</sup> Each question is scored from 0 to 4, with a maximum possible score of 40 points. A score cutoff of 8

and above is associated with “hazardous” alcohol consumption and has been used as a target for intervention. Scores between 8 and 15 are most appropriate for simple interventions focused on reducing hazardous drinking, scores between 16 and 19 for brief counseling and continued monitoring, and scores of 20 or above for further diagnostic evaluation for alcohol dependence.<sup>[19]</sup> For this study, an AUDIT score >7 was coded as a positive AUDIT score.

The modified Patient Health Questionnaire-9 (PHQ-9) questionnaire, validated in India, was used to screen for parental depression.<sup>[20]</sup> Scoring was categorized by: <4 (no depression), 5–15 (mild-moderate depression), and >15 (moderate-severe depression). For this study, a PHQ-9 score >4 was coded as a positive PHQ-9 score.

### Covariates and their measurement [Table 1]

Covariates, including age, sex, maternal and paternal education, day-care attendance, use of nutritional supplements, and SES measured by the Uday Pareek scale<sup>[21]</sup> are listed in Table 1.

### Outcomes and their measurement

Current weight was assessed at the time of the survey with a Salter-type hanging balance scale for children weighing above 10 kg and a pediatric bench weighing scale for those below 10 kg. Weight was plotted on the WHO pediatric growth chart, with children classified as moderate malnutrition if *z* scores were between –3 SDs and –2 SDs weight-for-age of the WHO child growth standards median. Birth weight was collected from historical hospital records. We developed directed acyclic graphs and had a principled *a priori* approach to confounder identification, which we employed in our variable selection for univariate analysis and in the “full model.”

### Statistical analysis

Unadjusted univariate analysis was performed for all covariates and exposures with malnutrition as the dependent variable. In addition, included in the supplemental section is a table of univariate analyses with each exposure (depression and alcohol use) measured against each covariate [Supplementary Table 1]. To test our hypothesis of the effect of alcohol consumption on childhood malnutrition, we ran mediation analysis. We determined appropriate covariates for this analysis through backward selection with the “MASS” package in R. Selected variables were included as covariates for the mediation analysis. Mediation statistics, including indirect effect and mediation percent, were calculated using the “mediation” package. The Uday Pareek Category was recoded for the mediation analysis into a binary variable to calculate the odds ratio (OR). All data preparation and statistics were completed using RStudio Team (2020). RStudio: Integrated Development for R. RStudio, PBC, Boston, MA.

## RESULTS

The characteristics of the children in the control and malnourished groups were largely similar, with little difference based on gender, age group, or remoteness of the village [Table 2].

**Table 1: Covariates and their measurement**

| Covariate                     | Measurement   |
|-------------------------------|---|
| Age                           | Age was measured in years, ranging from 1 to 4 years old  |
| Sex                           | Sex was assigned as either male or female   |
| Day-care attendance           | Day-care attendance is a binary variable: Yes or no   |
| Nutritional supplement use    | There were four options for nutritional supplements: None, multivitamin, sathumavu, or both multivitamin and sathumavu. For analysis nutritional supplement use was recoded into a binary variable: Multivitamin (multivitamin or both) versus no multivitamin (sathumavu or none)  |
| Maternal education            | Level of education achieved by mother. For analysis, maternal education was defined as on a scale from 1 to 4 corresponding to the following categories: No education, primary school, secondary school, higher secondary/college   |
| Paternal education            | Level of education achieved by father. For analysis, paternal education was defined as on a scale from 1 to 4 corresponding to the following categories: No education, primary school, secondary school, higher secondary/college   |
| Uday Pareek status            | Scale used to assess the SES for rural populations, was used to stratify the SES of the study population. This scale integrates nine factors into a score that is interpreted as reflecting social class, with a score of >43 categorized as Grade 1 or upper class, and a score <13 being categorized as Grade 5 or lower class. For analysis, Uday Pareek was defined as on a scale from 1 to 4: Lower class, lower-middle class, upper-middle class, upper class |
| Weekly salary                 | Weekly salary was recorded in INR per week. For analysis, weekly salary was recoded as a binary variable: >3000 INR per week  |
| Weekly expenditure on alcohol | Weekly expenditure on alcohol was recorded in INR per week. For analysis, weekly expenditure on alcohol was recorded as a binary variable: >500 INR per week  |

SES: Socioeconomic status

Children in the malnourished group were more likely to be taking Sathumavu (a nutritional supplement) alone without multivitamins (69.1% vs. 53.1%). In contrast, they were less likely to be taking both multivitamins and Sathumavu (16.6% vs. 33.7%). Fewer children in the malnourished group attended day care than children in the control group (30.4% vs. 41.5%). Maternal/paternal age, alcohol use disorder (AUDIT score), and depression scores (PHQ12) were largely similar between the malnourished and control groups. Mothers of malnourished children appeared less likely to have attended college than mothers of nonmalnourished children (6.6% vs. 15.1%). Weekly income and money spent on alcohol per week were also similar for malnourished and nonmalnourished children, though the social class was lower in the malnourished group.

Both maternal and paternal education levels were lower in malnourished children versus nonmalnourished children (OR: 0.728 95% confidence interval [CI]: 0.583–0.903, and OR: 0.753, 95% CI: 0.589–0.957). Higher paternal alcohol use was associated with higher odds of being malnourished versus nonmalnourished (OR: 1.55, 95% CI: 1.012–2.394),

**Table 2: Study subject characteristics**

|                                   | Control (n=258), n (%) | Malnourished (n=181), n (%) | Overall (n=439), n (%) |
|-----------------------------------|------------------------|-----------------------------|------------------------|
| Sex                               |                        |                             |                        |
| Male                              | 115 (44.6)             | 89 (49.2)                   | 204 (46.5)             |
| Female                            | 143 (55.4)             | 92 (50.8)                   | 235 (53.5)             |
| Age group (months)                |                        |                             |                        |
| 12–24                             | 64 (24.8)              | 43 (23.8)                   | 107 (24.4)             |
| 25–36                             | 67 (26.0)              | 48 (26.5)                   | 115 (26.2)             |
| 37–48                             | 68 (26.4)              | 51 (28.2)                   | 119 (27.1)             |
| 49–60                             | 53 (20.5)              | 35 (19.3)                   | 88 (20.0)              |
| Remoteness of village             |                        |                             |                        |
| Distant                           | 79 (30.6)              | 52 (28.7)                   | 131 (29.8)             |
| Intermediate                      | 100 (38.8)             | 70 (38.7)                   | 170 (38.7)             |
| Proximal                          | 79 (30.6)              | 59 (32.6)                   | 138 (31.4)             |
| Immunization status               |                        |                             |                        |
| Fully immunized                   | 254 (98.4)             | 171 (94.5)                  | 425 (96.8)             |
| Partially immunized               | 3 (1.2)                | 9 (5.0)                     | 12 (2.7)               |
| No immunization                   | 1 (0.4)                | 1 (0.6)                     | 2 (0.5)                |
| Vitamin/supplement status         |                        |                             |                        |
| None                              | 14 (5.4)               | 16 (8.8)                    | 30 (6.8)               |
| Multivitamins                     | 20 (7.8)               | 10 (5.5)                    | 30 (6.8)               |
| Sathumavu                         | 137 (53.1)             | 125 (69.1)                  | 262 (59.7)             |
| Both                              | 87 (33.7)              | 30 (16.6)                   | 117 (26.7)             |
| Day-care attendance               |                        |                             |                        |
| Yes                               | 107 (41.5)             | 55 (30.4)                   | 162 (36.9)             |
| No                                | 151 (58.5)             | 126 (69.6)                  | 277 (63.1)             |
| Maternal age, mean (SD)           | 27.4 (5.08)            | 27.7 (5.30)                 | 27.5 (5.17)            |
| Maternal AUDIT score, mean (SD)   | 0.262 (2.08)           | 0.528 (2.45)                | 0.372 (2.24)           |
| Maternal education                |                        |                             |                        |
| No education                      | 43 (16.7)              | 44 (24.3)                   | 87 (19.8)              |
| Primary school                    | 117 (45.3)             | 86 (47.5)                   | 203 (46.2)             |
| Secondary school                  | 55 (21.3)              | 38 (21.0)                   | 93 (21.2)              |
| Higher secondary/college          | 39 (15.1)              | 12 (6.6)                    | 51 (11.6)              |
| Maternal depression score (PHQ12) |                        |                             |                        |
| Minimal or none (0–4)             | 208 (80.6)             | 140 (77.3)                  | 348 (79.3)             |
| Mild (5–9)                        | 34 (13.2)              | 25 (13.8)                   | 59 (13.4)              |
| Moderate (10–14)                  | 12 (4.7)               | 15 (8.3)                    | 27 (6.2)               |
| Moderately severe (15–19)         | 2 (0.8)                | 0                           | 2 (0.5)                |
| Unknown                           | 2 (0.8)                | 1 (0.6)                     | 3 (0.7)                |
| Father age, mean (SD)             | 31.6 (5.97)            | 32.0 (5.94)                 | 31.8 (5.95)            |
| Father AUDIT score, mean (SD)     | 9.82 (7.37)            | 10.8 (7.33)                 | 10.2 (7.36)            |
| Paternal education                |                        |                             |                        |
| No education                      | 51 (19.8)              | 46 (25.4)                   | 97 (22.1)              |
| Primary school                    | 102 (39.5)             | 74 (40.9)                   | 176 (40.1)             |
| Secondary school                  | 51 (19.8)              | 32 (17.7)                   | 83 (18.9)              |
| Higher secondary/college          | 22 (8.5)               | 6 (3.3)                     | 28 (6.4)               |
| Unknown                           | 32 (12.4)              | 23 (12.7)                   | 55 (12.5)              |
| Paternal depression score (PHQ12) |                        |                             |                        |
| Minimal or none (0–4)             | 188 (72.9)             | 129 (71.3)                  | 317 (72.2)             |
| Mild (5–9)                        | 36 (14.0)              | 23 (12.7)                   | 59 (13.4)              |
| Moderate (10–14)                  | 4 (1.6)                | 5 (2.8)                     | 9 (2.1)                |
| Moderately severe (15–19)         | 0                      | 1 (0.6)                     | 1 (0.2)                |
| Unknown                           | 30 (11.6)              | 23 (12.7)                   | 53 (12.1)              |
| Weekly income (INR)               |                        |                             |                        |
| 0–1000                            | 13 (5.0)               | 20 (11.0)                   | 33 (7.5)               |
| 1001–3000                         | 159 (61.6)             | 111 (61.3)                  | 270 (61.5)             |

*Contd...*

**Table 2: Contd...**

|                                       | Control (n=258), n (%) | Malnourished (n=181), n (%) | Overall (n=439), n (%) |
|---------------------------------------|------------------------|-----------------------------|------------------------|
| 3001–5000                             | 65 (25.2)              | 38 (21.0)                   | 103 (23.5)             |
| >5000                                 | 21 (8.1)               | 12 (6.6)                    | 33 (7.5)               |
| Money spent on alcohol per week (INR) |                        |                             |                        |
| 0–200                                 | 106 (41.1)             | 75 (41.4)                   | 181 (41.2)             |
| 201–500                               | 60 (23.3)              | 31 (17.1)                   | 91 (20.7)              |
| 501–1000                              | 62 (24.0)              | 51 (28.2)                   | 113 (25.7)             |
| >1000                                 | 30 (11.6)              | 24 (13.3)                   | 54 (12.3)              |
| Uday Pareek category                  |                        |                             |                        |
| Lower class                           | 38 (14.7)              | 54 (29.8)                   | 92 (21.0)              |
| Lower middle class                    | 184 (71.3)             | 120 (66.3)                  | 304 (69.2)             |
| Middle class                          | 35 (13.6)              | 7 (3.9)                     | 42 (9.6)               |
| Upper middle class                    | 1 (0.4)                | 0                           | 1 (0.2)                |

PHQ12: Patient Health Questionnaire 12, AUDIT: Alcohol use disorders identification test, SD: Standard deviation

**Table 3: Exploratory univariate analysis**

|                                      | OR (95% CI)         |
|--------------------------------------|---------------------|
| Age                                  | 1.004 (0.839–1.2)   |
| Sex of child (male)                  | 1.203 (0.822–1.762) |
| Day-care attendance                  | 0.616 (0.41–0.918)  |
| Nutritional supplement: Multivitamin | 0.400 (0.258–0.611) |
| Maternal education                   | 0.728 (0.583–0.903) |
| Maternal AUDIT $\geq$ 8              | 2.172 (0.612–8.603) |
| Maternal PHQ12 $\geq$ 5              | 0.808 (0.505–1.298) |
| Paternal education                   | 0.753 (0.589–0.957) |
| Paternal AUDIT $\geq$ 8              | 1.55 (1.012–2.394)  |
| Paternal PHQ12 $\geq$ 5              | 0.946 (0.56–1.615)  |
| Uday Pareek class                    | 0.407 (0.276–0.589) |
| Weekly salary >3000 INR              | 0.763 (0.501–1.154) |
| Weekly alcohol expenditure >500 INR  | 1.277 (0.864–1.887) |

Exploratory univariate analysis of variables of interest using logistic regression and malnutrition as the dependent variable. OR: Odds ratio, PHQ12: Patient Health Questionnaire 12, AUDIT: Alcohol use disorders identification test, CI: Confidence interval

while maternal alcohol use had a stronger association and a much wider CI (OR: 2.172, 95% CI: 0.612–8.603). Day-care attendance (OR: 0.616, 95% CI: 0.41–0.918), SES measured by Uday Pareek category (OR: 0.407, 95% CI: 0.276–0.589), and multivitamin use (OR: 0.400, 95% CI: 0.258–0.611) were associated with decreased odds of malnutrition [Table 3].

The first model, named “full model,” demonstrates significant independent associations of Uday Pareek class and nutritional supplement use on malnutrition [Table 4]. The second model, which used backward selection, shows an additional association between day-care attendance and malnutrition. The mediation analysis depicted by the three final models demonstrates an indirect effect of 0.034 (95% CI: 0.007–0.060). The Uday Pareek class mediates 32.6% of the association of paternal alcohol use with child malnutrition, although the CI is not significant.

## DISCUSSION

The impact of parental alcohol consumption and unaddressed psychosocial factors on childhood malnutrition in the

aboriginal population in the Indian subcontinent has previously not been comprehensively studied. Our findings demonstrate that a paternal AUDIT score of over seven, a proxy for hazardous drinking, is associated with a 1.56 (95% CI: 1.012–2.394) times increase in the odds of malnutrition in children. Nutritional supplements, day-care attendance, and SES were independently associated with lower odds of childhood malnutrition. Contrary to our initial assumption, maternal depression was not independently associated with increased odds of malnutrition. This study highlights the detrimental effect of paternal alcohol use and lower SES on childhood malnutrition. The mediation effect of SES on the relationship between paternal alcohol consumption and childhood malnutrition implies that interventions targeting socioeconomic factors, may have a dual benefit of not only impacting childhood malnutrition but also attenuating the influence of paternal alcohol consumption on this health outcome. It can inform the development of effective future intervention strategies to decrease malnutrition rates in these children.

Alcohol consumption among the Adivasis in the Nilgiri district is increasing. Some factors contributing to this rise include alcohol's assimilation into the culture and increasing availability, primarily through government-run outlets.<sup>[22]</sup> Tribal communities previously used to manufacture their alcohol, but since the government started to intervene to reduce illicit liquor sales, tribal men started to depend more heavily on government-owned liquor stores. The government has a monopoly on wholesale and retail vending of alcohol in the area since 2002.<sup>[8]</sup> Moreover, the age of initial exposure to alcohol is decreasing, with children and adolescents often exposed to a culture of drinking at a younger age. Alcohol abuse has led to higher rates of domestic violence, worsening mental health, and increased overall morbidity in rural populations.<sup>[22]</sup>

A large body of evidence substantiates the adverse effects of alcohol consumption on aboriginal communities. Increasing alcohol consumption among the Adivasis may have the same results over time, given many indigenous communities

**Table 4: Models**

| Predictors                          | Full model        |       |                  | Backward selection model |                  |              | Mediation analysis: Uday Pareek class mediates paternal alcohol effect on malnutrition |        |                   |                        |   |             |
|-------------------------------------|-------------------|-------|------------------|--------------------------|------------------|--------------|--|--------|-------------------|------------------------|---|-------------|
|                                     | Malnutrition      |       |                  | Malnutrition             |                  |              | Total effect model   |        |                   | Effect on mediator     |   |             |
|                                     | OR (95% CI)       | P     | Malnutrition     | OR (95% CI)              | P                | Malnutrition | OR (95% CI)  | P      | Malnutrition      | Relative risk (95% CI) | P | OR (95% CI) |
| Intercept                           | 3.06 (0.82–11.78) | 0.100 | 3.03 (1.29–7.31) | 0.012                    | 0.50 (0.26–0.94) | 0.033        | 5.40 (2.45–12.55)  | <0.001 | 1.00 (0.46–2.21)  | 0.993                  |   |             |
| Age                                 | 1.17 (0.93–1.46)  | 0.175 | 1.16 (0.95–1.43) | 0.147                    | 1.17 (0.94–1.45) | 0.153        | 1.08 (0.83–1.40)   | 0.586  | 1.19 (0.96–1.48)  | 0.120                  |   |             |
| Sex of child                        | 1.38 (0.88–2.16)  | 0.161 | 1.24 (0.82–1.86) | 0.302                    | 1.48 (0.96–2.29) | 0.076        | 0.73 (0.43–1.23)   | 0.238  | 1.43 (0.92–2.23)  | 0.109                  |   |             |
| Paternal AUDIT ≥8                   | 1.24 (0.73–2.11)  | 0.421 |                  |                          | 1.56 (1.00–2.47) | 0.053        | 0.35 (0.18–0.64)   | 0.001  | 1.38 (0.87–2.20)  | 0.173                  |   |             |
| Uday Pareek category                | 0.42 (0.25–0.70)  | 0.001 | 0.44 (0.30–0.65) | <0.001                   |                  |              |  |        | 0.42 (0.24–0.72)* | 0.002                  |   |             |
| Day-care attendance                 | 0.6 (0.36–1.01)   | 0.058 | 0.63 (0.39–0.99) | 0.045                    | 0.52 (0.31–0.84) | 0.009        | 1.99 (1.07–3.81)   | 0.033  | 0.56 (0.34–0.92)  | 0.022                  |   |             |
| Nutritional supplements             | 0.43 (0.26–0.70)  | 0.001 | 0.45 (0.29–0.71) | 0.001                    | 0.39 (0.24–0.62) | <0.001       | 1.97 (1.08–3.75)   | 0.031  | 0.42 (0.25–0.67)  | <0.001                 |   |             |
| Maternal education                  | 1.04 (0.77–1.41)  | 0.800 |                  |                          |                  |              |  |        |                   |                        |   |             |
| Maternal AUDIT ≥8                   | 0.83 (0.16–4.77)  | 0.827 |                  |                          |                  |              |  |        |                   |                        |   |             |
| Maternal PHQ12 ≥5                   | 0.92 (0.52–1.65)  | 0.779 |                  |                          |                  |              |  |        |                   |                        |   |             |
| Paternal education                  | 0.94 (0.69–1.27)  | 0.690 |                  |                          |                  |              |  |        |                   |                        |   |             |
| Paternal PHQ12 ≥5                   | 0.98 (0.55–1.76)  | 0.944 |                  |                          |                  |              |  |        |                   |                        |   |             |
| Weekly salary >3000 INR             | 0.94 (0.58–1.52)  | 0.794 |                  |                          |                  |              |  |        |                   |                        |   |             |
| Weekly alcohol expenditure >500 INR | 1.18 (0.71–1.95)  | 0.531 |                  |                          |                  |              |  |        |                   |                        |   |             |
| Observations (n)                    | 369               |       | 429              |                          | 376              |              | 376  |        | 376               |                        |   | 376         |

\*Uday Pareek category was recoded into a binary variable: Lower class versus all other classes. OR: Odds ratio, PHQ12: Patient Health Questionnaire 12, AUDIT: Alcohol use disorders identification test, CI: Confidence interval

have marked socioeconomic and cultural similarities. The mediation analysis in this paper suggests that SES may partially mediate the relationship between paternal alcohol use and childhood malnutrition. These results must be interpreted carefully, as this study cannot distinguish between mediation and confounding. In addition, the percent mediated CI contains zero, suggesting poor certainty of the results. Regardless, SES helps explain the association between paternal alcohol intake and malnutrition. Within this community, alcohol use was more common among those of lower SES and lower levels of education. Although we did not observe a direct effect of alcohol consumption on childhood malnutrition, SES, parental education, and overall well-being may exert indirect effects. Our findings that maternal and paternal education levels were lower in malnourished children versus nonmalnourished children support previous research showing that paternal and maternal education are similarly important in reducing rates of childhood undernutrition in low- and middle-income countries.<sup>[23]</sup> Given our findings and the interrelated nature of these contributing factors, increasing parental alcohol consumption possibly affects child health over time.

The use of nutritional supplements, immunization, and day-care attendance in our study was independently associated with lower odds of childhood malnutrition. Children are provided with a meal at day care, and attendance is free. Therefore, encouraging families to use these facilities and helping to address the barriers that prevent them from doing so will likely improve outcomes. In addition, vitamins and immunization are cost-effective measures for reducing malnutrition.

Contrary to our hypothesis, maternal depression was not associated with childhood malnutrition. Perspectives from the Adivasi community, particularly women, have previously highlighted the detrimental effects of alcohol abuse in the family, including increased depression and stress.<sup>[8]</sup> Stigma about disclosing symptoms related to maternal depression may have influenced the willingness of participants to report depressive symptoms accurately, causing measurement error that would bias estimated associations toward the null. The prevalence of depression in our study is lower than other estimates for the same population, substantiating this hypothesis.

This study reaffirms the volume of work suggesting that community-based participatory research can generate relevant research hypotheses, collect high-fidelity data, and report results to the community to create action plans for change. Socially pertinent topics that are difficult to approach for outsiders are often better handled by community members. In this instance, the Adivasi community generated the hypothesis based on a felt need, participated in the study design, collected field data, and reported the data back to the community. Interventions are currently being designed through community leaders, health workers, and research support staff. Research questions that originate at the grassroots increase

participation and are more likely to have a favorable outcome when implementing interventions.

Our study has several limitations. First, children with severe malnutrition were excluded, as several had significant medical comorbidities contributing to their nutritional status, which could confound results. However, we may have inadvertently excluded children who were severely malnourished due to nonmedical reasons, i.e., purely due to undernutrition. Second, data were collected by trained Adivasi health workers and cross-checked by trained research staff. As the Adivasi community is relatively small, data collectors were sometimes familiar with the research subjects, predisposing them to observer bias. Furthermore, given the constraints of working in a remote rural population, we could not use independent research staff who were naïve to the local population. However, despite these constraints, the authors believe that the benefits of community-based participatory research, by using locally trained members to collect data, have the potential to enhance both the quality and validity of data collected and outweigh the effect of potential biases. Third, while data were complete for the most part, we had difficulty with specific subsets of our questionnaire, especially assessing parental depressive symptoms. Mood disorders are a sensitive topic, especially among the Adivasi population. Reporting on the PHQ-9 questionnaire in our study suggests a lower prevalence of depression compared to more extensive studies in this community, likely due to the underreporting of symptoms. Lastly, alcohol consumption was assessed using the AUDIT score, which is prone to underreporting due to the questionnaire's sensitive nature. This is likely the case in our study as well.

Our study contributes to the understanding of the complex interplay between childhood malnutrition, parental alcohol consumption, and SES among the Adivasi community in South India. The association between paternal alcohol consumption and its association with increased risk of malnutrition in children is a crucial finding. Importantly, we observed that lower SES partly mediated this association, highlighting the multifaceted nature of the relationship. This suggests that addressing socioeconomic disparities may serve as a mitigating factor in the impact of paternal alcohol consumption on childhood malnutrition. The findings of our study offer practical insights for the development of targeted and effective intervention strategies. Future directions should include large-scale prospective studies to better define the relationship between alcohol use and childhood nutrition in vulnerable populations. The government controls the sale of alcohol in several parts of India and is counterproductive to the government's role in promoting health. Advocacy for changing governmental policy and restricting the promotion of alcohol among these communities is most likely to have a significant effect. Targeting parental education and implementing measures to alleviate the impact of paternal alcohol consumption through improved SES could ultimately help reduce childhood malnutrition in this population. Finally,

promoting and utilizing the strong community dynamic among the Adivasis for education and health promotion will most likely have long-lasting effects.

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### Conflicts of interest

There are no conflicts of interest.

## REFERENCES

- Black RE, Victora CG, Walker SP, Bhutta ZA, Christian P, de Onis M, *et al.* Maternal and child undernutrition and overweight in low-income and middle-income countries. *Lancet* 2013;382:427-51.
- World Health Organization. Joint Child Malnutrition Estimates 2020. Available from: <https://www.who.int/data/gho/data/themes/topics/joint-child-malnutrition-estimates-unicef-who-wb>. [Last accessed 2023 Oct].
- Gragnotati MS, Das Gupta M, Bredenkamp C, Lee YK. HNP discussion paper series. In: *India's Undernourished Children: A Call for Reform and Action*. Washington, DC: World Bank; 2005. Available from: <https://openknowledge.worldbank.org/handle/10986/13644>. [Last accessed 2023 Oct].
- Lozano R, Wang H, Foreman KJ, Rajaratnam JK, Naghavi M, Marcus JR, *et al.* Progress towards millennium development goals 4 and 5 on maternal and child mortality: An updated systematic analysis. *Lancet* 2011;378:1139-65.
- Fledderjohann J, Vellakkal S, Khan Z, Ebrahim S, Stuckler D. Quantifying the impact of rising food prices on child mortality in India: A cross-district statistical analysis of the district level household survey. *Int J Epidemiol* 2017;46:1082.
- Association for Health Welfare in the Nilgiris ASHWINI; 2016. Available from: <https://ashwini.org/>. [Last accessed 2023 Oct].
- Hindu T. Revenue from Liquor Sales Rises 16%, Crosses INR 30,000-cr. Mark; 2019. Available from: <https://www.thehindu.com/news/national/tamil-nadu/revenue-from-liquor-sales-rises-16-crosses-30000-cr-mark/article28288178.ece>. [Last accessed 2023 Oct].
- George V. Adivasis Vote against Liquor Vends in Nilgiris PARI – People's Archive of Rural India; 2019.
- Eashwar VM, Gopalakrishnan S, Umadevi R, Geetha A. Pattern of alcohol consumption and its associated morbidity among alcohol consumers in an urban area of Tamil Nadu. *J Family Med Prim Care* 2019;8:2029-35.
- Brady M. Equality and difference: Persisting historical themes in health and alcohol policies affecting indigenous Australians. *J Epidemiol Community Health* 2007;61:759-63.
- Manimunda SP, Sugunan AP, Thennarasu K, Pandian D, Pesala KS, Benegal V. Alcohol consumption, hazardous drinking, and alcohol dependency among the population of Andaman and Nicobar Islands, India. *Indian J Public Health* 2017;61:105-11.
- Rao KN, Begum S, Venkataramana V, Gangadharappa N. Nutritional neglect and physical abuse in children of alcoholics. *Indian J Pediatr* 2001;68:843-5.
- Maternal depression and child development. *Paediatr Child Health* 2004;9:575-98.
- Rashmi R, Srivastava S, Muhammad T, Kumar M, Paul R. Indigenous population and major depressive disorder in later life: A study based on the data from longitudinal ageing study in India. *BMC Public Health* 2022;22:2258.
- O'Brien MJ, Whitaker RC. The role of community-based participatory research to inform local health policy: A case study. *J Gen Intern Med* 2011;26:1498-501.
- Ritchie SD, Jo Wabano M, Beardy J, Curran J, Orkin A, VanderBurgh D, *et al.* Community-based participatory research with indigenous communities: The proximity paradox. *Health Place* 2013;24:183-9.
- World Health Organization. WHO Child Growth Standards; 2006. Available from: [https://www.who.int/childgrowth/standards/weight\\_for\\_age/en/](https://www.who.int/childgrowth/standards/weight_for_age/en/). [Last accessed 2023 Oct].
- Pal HR, Jena R, Yadav D. Validation of the alcohol use disorders identification test (AUDIT) in urban community outreach and de-addiction center samples in North India. *J Stud Alcohol* 2004;65:794-800.
- Saunders JB, Aasland OG, Babor TF, de la Fuente JR, Grant M. Development of the alcohol use disorders identification test (AUDIT): WHO collaborative project on early detection of persons with harmful alcohol consumption – II. *Addiction* 1993;88:791-804.
- Poongothai S, Pradeepa R, Ganesan A, Mohan V. Reliability and validity of a modified PHQ-9 item inventory (PHQ-12) as a screening instrument for assessing depression in Asian Indians (CURES-65). *J Assoc Physicians India* 2009;57:147-52.
- Wani RT. Socioeconomic status scales-modified Kuppaswamy and Udai Pareekh's scale updated for 2019. *J Family Med Prim Care* 2019;8:1846-9.
- Rose A, Minz S, Manohari GP, Thavamani, George K, Arun R, *et al.* Community perspectives on alcohol use among a tribal population in rural Southern India. *Natl Med J India* 2015;28:117-21.
- Vollmer S, Bommer C, Krishna A, Harttgen K, Subramanian SV. The association of parental education with childhood undernutrition in low- and middle-income countries: Comparing the role of paternal and maternal education. *Int J Epidemiol* 2017;46:312-23.

**Supplementary Table 1: Univariate analysis of selected variables**

|                                       | <b>Paternal PHQ12 <math>\geq</math>5</b> | <b>Maternal PHQ12 <math>\geq</math>5</b> | <b>Paternal Audit <math>\geq</math>8</b> | <b>Maternal AUDIT <math>\geq</math>8</b> |
|---------------------------------------|--|--|--|--|
| Day-care Attendance                   | 0.962 (0.563-1.672)                      | 1.53 (0.931-2.571)                       | 1.326 (0.857-2.07)                       | NA                                       |
| Nutritional Supplements: Multivitamin | 0.922 (0.54-1.604)                       | 1.458 (0.878-2.485)                      | 0.731 (0.475-1.128)                      | 0.213 (0.011-1.15)                       |
| Maternal Education                    | 1.267 (0.944-1.721)                      | 1.44 (1.097-1.915)                       | 0.649 (0.51-0.82)                        | 0.276 (0.089-0.683)                      |
| Maternal AUDIT $\geq$ 8               | 0.284 (0.061-1.469)                      | 0.159 (0.04-0.569)                       | 3.479 (0.586-66.065)                     |  |
| Maternal PHQ12 $\geq$ 5               | 2.687 (1.495-4.767)                      |  | 0.564 (0.316-0.973)                      | 0.159 (0.04-0.569)                       |
| Paternal Education                    | 1.296 (0.952-1.79)                       | 1.17 (0.873-1.586)                       | 0.756 (0.593-0.961)                      | 0.175 (0.027-0.619)                      |
| Paternal Audit $\geq$ 8               | 0.47 (0.25-0.841)                        | 0.564 (0.316-0.973)                      |  | 3.479 (0.586-66.065)                     |
| Paternal PHQ12 $\geq$ 5               |  | 2.687 (1.495-4.767)                      | 0.47 (0.25-0.841)                        | 0.284 (0.061-1.469)                      |
| Uday Pareek Class                     | 1.119 (0.69-1.82)                        | 1.621 (1.055-2.51)                       | 0.375 (0.239-0.571)                      | 0.18 (0.047-0.59)                        |
| Weekly Salary > 3000 INR              | 0.847 (0.495-1.475)                      | 1.088 (0.659-1.836)                      | 1.075 (0.693-1.68)                       | 0.955 (0.203-3.492)                      |
| Weekly Alcohol Expenditure > 500 INR  | 0.819 (0.485-1.391)                      | 0.643 (0.401-1.033)                      | 8.273 (4.894-14.638)                     | 3.918 (1.073-18.378)                     |

Univariate analysis of variables compared to maternal/paternal depression and alcohol use. Data is presented as unadjusted odds ratios with uncorrected 95% confidence intervals. To correct for multiple comparisons, a Bonferroni p-value of 0.00125 was used (40/0.05).