Factors Associated with Inequality in Composite Index of Anthropometric Failure between the Paniya and Kurichiya Tribal Communities in Wayanad District of Kerala

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Abstract

Background: Tribal children in India bear a higher burden of undernutrition when compared to other communities. However, inequality within tribal communities is under-researched. Objectives: To examine the factors associated with inequality in undernutrition between Paniya and Kurichiya tribal communities in Wayanad district of Kerala. Methods: A cross-sectional analytical study was conducted during August to October 2018 among 314 children aged 2–5 years belonging to Paniya (151) and Kurichiya (163) communities. Participants were selected using multistage cluster sampling. Data were collected using structured interview schedule based on household food insecurity access scale; relevant individual, parental, and household factors were ascertained; child nutritional status was assessed based on anthropometric measurements. The composite index of anthropometric failure (CIAF) was used as an aggregate indicator of undernutrition. Statistical analysis was done using Chi-square test and univariate and multivariable logistic regression. Results: There were significant differences in the prevalence of stunting, underweight, and wasting between Paniya (52.3%, 58.9%, and 25.2%, respectively) and Kurichiya (28.2%, 31.1%, and 12.3%, respectively) tribal children. Based on the CIAF, 66.9% and 41.1% of Paniya and Kurichiya children, respectively, were undernourished. Intratribal difference was observed to exist in all three forms of anthropometric failures simultaneously. Significant factors associated with CIAF were community identity, household food insecurity, and maternal early marriage. Significant factor associated with all three forms of undernutrition was maternal experience of domestic violence. Conclusion: This study demonstrates the child nutritional inequality within the tribal communities and indicates the need for more focused policies and programs among vulnerable tribal groups to ensure food security and empowerment of women.

Key words: Food insecurity, inequality, Kerala, tribal, undernutrition

Introduction

Kerala has reported the lowest prevalence of undernutrition among under-five children in India. In 2015–2016, the state had 16.1%, 19.7%, and 15.7% of children (below 5 years) underweight, stunted, and wasted, respectively. Among the Scheduled Tribe (ST) communities in Kerala, 28.2%, 22.9%, and 20% of children were stunted, underweight, and wasted, respectively. These figures are lower than the national average for both general and ST population.[1] All the same, cross-sectional studies conducted among different tribal communities in Kerala reported that the prevalence of stunting among children under-five from the ST communities ranged from 20.2% to 85.1%, underweight from 31% to 87.7%, and wasting from 31% to 79.56%. This indicates wide nutritional inequalities among the tribal children in Kerala.[2,3] While the tribal communities in Kerala are a nutritionally vulnerable group, identifying the most vulnerable subgroups among the

Access this article online

Quick Response Code: 

Website: www.ijph.in

DOI: 10.4103/ijph.IJPH_340_19

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Submitted: 08-May-2019 Revised: 10-Dec-2019 Accepted: 17-May-2020 Published: 22-Sep-2020

How to cite this article: Sabu KU, Sundari Ravindran TK, Srinivas PN. Factors associated with inequality in composite index of anthropometric failure between the Paniya and Kurichiya tribal communities in wayanad district of Kerala. Indian J Public Health 2020;64:258-65.
tribal communities is critical for formulating better-targeted nutritional interventions.

The age-specific trend in child growth faltering in the NFHS 3 (2005–2006) data reports that the high rate of growth faltering occurs between the age of 0 and 24 months; after the age of 24 months, more consistent trend in growth faltering is reported.[4] Hence, the study focused on children in the age group of 24–60 months which showed a more consistent pattern. The measurement of stunting indicating chronic undernutrition, wasting indicating acute undernutrition, and underweight which is the composite measure of both stunting and wasting[5–7] allows the categorization of children into these specific categories. However, it does not provide a single measure of prevalence of undernutrition by single or multiple failures of anthropometric measurements.[8] The composite index of anthropometric failure (CIAF) developed by Svedberg as a new aggregated indicator of stunting, wasting, and underweight[9] addresses this limitation and provides valuable insights for the identification and prioritization of subgroups, with multiple forms of anthropometric failures. The formulation of policies and intervention with efficient targeting and prioritization is critical for the equitable achievement of nutritional outcomes.[9] Hence, the current study was undertaken to assess the child nutritional inequality using CIAF between Paniya and Kurichiya tribal communities in a district of Kerala and also to identify the associated individual, parental, and household factors for child undernutrition.

**Materials and Methods**

**Study design, area, and subjects**

A cross-sectional analytical study was conducted among Kurichiya and Paniya tribal communities in Wayanad district of Kerala from August to October 2018. The study subjects included 2–5-year-old children residing in the study area and their mothers being primary respondents.

**Sample size and Sampling**

The prevalence of underweight among the children from Paniya and Kurichiya was assumed to be 63% and 43% with a 20% difference between the groups, based on a previous study.[10,11] The sample size was calculated with significance level 0.05, with statistical power 1– β =0.8, and with allocation ratio 1:1. The calculated sample size was 97 for each group. Considering the possibilities of difference in the proportion of undernutrition between the clusters, a design effect of 1.5 was assumed, and assuming 10% as the nonresponse rate, the sample size calculated was 165 for each community (after rounding off). Thus, the total desired sample size covering both groups was estimated at 330.

The study used a multistage cluster sampling strategy. In the first stage, six Panchayats with higher proportion of Paniya and Kurichiya communities were selected out of 26 village Panchayats in the Wayanad district. As the Paniya and Kurichiya communities live in settlements, each settlement was considered as a cluster. In the second stage, a list of all Paniya (198) and Kurichiya (106) settlements with a minimum of 20 households from the six selected Panchayats were collected from the Panchayat Tribal Development Extension Office. From these, 33 (16.7%) Paniya settlements and 33 (31.1%) Kurichiya settlements were selected randomly. The number of settlements selected was proportionate to the total number of settlements in each of the selected Panchayats. All the children in the age group of 2–5 years from each of the selected settlements were included in the study. We estimated approximately five children from each settlement to achieve the calculated sample size. However, in smaller settlement, we were able to find only three children, and this was made up by selecting seven or six children from larger settlements with more than 50 households. Overall, we included 167 children from the Paniya community and 166 children from the Kurichiya community, with a total of 333.

**Data collection: Tools and techniques**

We interviewed mothers using an interview schedule that explored factors at the individual, parental, household, and community levels. We assessed household-level food insecurity using household food insecurity assessment scale (HFIAS), a nine-item scale on four frequency response using a 4-week recall period. HFIAS is reported a reliable and valid instrument to measure household food insecurity in the Indian context.[12] We assessed the nutritional status using the 1995 WHO Expert Committee recommendations.[13] Weight was measured to the precision of 100 g using a lightweight SECA 803 flat-scale having a digital monitor designed and monitored by the UNICEF (SECA Medical Scales and Measuring Systems, Birmingham, UK). The weighing scale was calibrated at the beginning of each working day. Height was also measured to the precision of 1 mm using SECA stadiometer designed and monitored by the UNICEF (SECA Medical Scales and Measuring Systems, Birmingham, UK). Weight-for-age Z-scores (WAZ), height-for-age Z-scores (HAZ), and weight-for-height Z-scores (WHZ) were computed using WHO Anthro Software as per the new 2006 WHO Child Growth Standards. Open Data Kit (ODK) Collective v1.18.2 was used in a mobile tablet for data collection, and data entry and the data were exported to Statistical Package for the Social Sciences 23.0, Armonk, NY, US: IBM Corp (SPSS, License No.: 567588dab50014edac00) for cleaning and further analysis.

**Statistical analysis**

Descriptive analysis of HAZ, WAZ, and WHZ was performed. CIAF was constructed using seven subgroup of anthropometric failures, namely A – no failure, B – only wasted, C – underweight and wasted, D – stunted, wasted, and underweight, E – stunted and underweight, F – only stunted, and Y – only underweight. Chi-square test was performed to test the statistical significance of the difference in the proportion of CIAF between children from Paniya and Kurichiya community. Finally, binary logistic regression was performed to examine the association between the CIAF and other sociodemographic variables. Multicollinearity among the predictor variables was verified using variance inflation factors (VIFs), and VIF higher than
3 was considered collinear factor and was excluded from the model.

**Ethical considerations**

The study was undertaken after getting the approval and clearance from the institutional ethics committee (IEC) of the host institution (IEC Reg No. ECR/189/Inst/KL/2013). Oral witnessed consent or informed consent with thumb impression was obtained from the participants, after explaining the objectives and purpose of the study and potential benefits and risk of participating in the study before data collection. The objectives and purpose of the study and the potential benefits and risks of participating in the study were explained to the participant in the presence of the witness. The witness then signed or registered his/her thumb impression on the informed consent form.

**RESULTS**

**Inequalities in socio-demographic characteristics**

A total of 333 mothers and children were approached, of which 322 (96.7%) consented to participate in the survey. After excluding 8 (2.5%) incomplete responses from the surveyed samples, a total of 314 respondents were included in the final analysis. Of these, 163 mothers belonged to Kurichiya and 151 belonged to Paniya communities. Significant differences in all the sociodemographic factors that were known to be associated with household food-security status were observed between Paniya and Kurichiya households [Table 1]. A majority of the mothers and fathers from the Kurichiya community were at least secondary schooleducated, whereas a majority of the mothers from the Paniya community had primary school education or below and one-third of Paniya mothers were illiterate. While two-thirds of Kurichiya mothers were engaged in some remunerated work, only one-fourths of Paniya mothers were engaged in any remunerated work. Roughly one-fourth of the mothers from Paniya community consumed alcohol (23.2%), whereas it was only 1.2% among Kurichiya mothers. Paternal alcohol consumption was observed to be high among both Paniya (75.5%) and Kurichiya (58.9%) communities. A higher proportion of households with more than nine members were observed among Paniya community (30%) as compared with Kurichiya community (5.6%). While 81.5% of Paniya households owned <10 cents of land, only 32.6% of Kurichiya households owned <10 cents of land and one-third of Kurichiya households owned more than 50 cents of land. More Paniya households (44.4%) were located near the forest area as compared to Kurichiya households (29.4%). A higher proportion of Kurichiya households (80.4%) had a ration card as compared to Paniya households (69.5%). Among Kurichiya community, 94.5% of households had toilet facilities, while it was 61.5% among Paniya. While 59.5% of the households from Kurichiya community were food insecure, as high as 85.4% of the households from Paniya community were food insecure. A higher proportion of children from Paniya community had low birth weight (41.6%), when compared with that of Kurichiya community (29.1%).

**Inequalities in nutritional status**

Table 1 also provides data on the CIAF among children from Paniya and Kurichiya communities. A higher proportion of children from Paniya community were reported to suffer at least one anthropometric failure (66.9%) as compared with that of Kurichiya community (41.1%). However, no significant difference was observed in single anthropometric failure (only stunting, only wasting, and only underweight) and double failure of underweight and wasting. All the same, there was a significant difference in the proportion of children who suffered from all three forms of anthropometric failures: Paniya (16.6%) and Kurichiya (4.3%) communities ($P = 0.0001$). Similarly, differences in double failure of underweight and stunting were also statistically significant between Paniya (29.1%) and Kurichiya (14.1%) communities ($\chi^2 = 10.54, P = 0.001$). Similarly, Z-score distribution of height for age, weight for age, and weight for height was plotted to show the differences in its overall distribution and severe cases between Paniya and Kurichiya communities [Figure 1].

Table 2 shows the result of binomial logistic regression model that examined significant factors at individual, parental, household, and community that are associated with CIAF. Although many factors were found to be significantly associated with CIAF in unadjusted logistic regression, with multivariable logistic regression, only community identity, household food insecurity, and maternal early marriage remained significantly associated with CIAF after adjusting for other variables. The children belonging to the Paniya community were 2.68 times (adjusted odds ratio [AOR] = 2.68, 95% confidence interval [CI] = 1.04–6.93) more likely to suffer at least one anthropometric deficit as compared to the children from the Kurichiya community, after adjusting all the individual, maternal, and household characteristics. Children from food insecure households had 2.10 times (AOR = 2.10, 95% CI = 1.13–3.93) greater likelihood of CIAF compared with the children from food-secure households. Similarly, children of mothers who married before the age of 18 years had a 2.56 times (AOR = 2.56, 95% CI = 1.11–5.93) higher risk of CIAF compared with children to mother who were married at the age of 18 or later.

Table 3 shows the factors associated with all three forms of anthropometric failures (stunting, wasting, and underweight). Although community identity, household land ownership, food insecurity, maternal alcoholic consumption, and maternal experience of domestic violence were significantly associated with all three forms of anthropometric failure, maternal experience of domestic violence remained as the only significant factor associated with all three types of anthropometric failures after adjusting for other variables. The children of mothers who experienced domestic violence had 2.35 times (AOR = 2.35, 95% CI = 1.02–5.39, $P < 0.05$) greater likelihood of all three forms of anthropometric failures, compared with that of mothers who did not experience domestic violence. Similarly, maternal consumption of alcohol also remained nearly significant.
Table 1: Distribution of socio-demographic variables and nutritional status between Kurichiya and Paniya tribal communities

| Variables                                      | Kurichiya (n=163) | Paniya (n=151) | Total (n=314) | χ²   | df | P    |
|------------------------------------------------|-------------------|----------------|--------------|------|----|------|
| Education of the mother                        |                   |                |              |      |    |      |
| Higher-secondary or above                      | 51 (31.3)         | 5 (3.3)        | 56 (17.8)    | 159.2| 3  | 0.0001|
| Secondary                                      | 103 (63.2)        | 36 (23.8)      | 139 (44.3)   |      |    |      |
| Primary                                        | 7 (4.3)           | 25 (16.6)      | 32 (10.2)    |      |    |      |
| Without formal education                      | 2 (1.2)           | 85 (56.3)      | 87 (27.7)    |      |    |      |
| Work status                                    |                   |                |              |      |    |      |
| Domestic, remunerated, and unremunerated work  | 39 (23.9)         | 9 (6)          | 48 (15.3)    | 69.9 | 3  | 0.0001|
| Remunerated work and domestic work             | 72 (44.2)         | 24 (15.9)      | 96 (30.6)    |      |    |      |
| Unremunerated work and domestic work           | 17 (10.4)         | 53 (35.1)      | 70 (22.3)    |      |    |      |
| Only domestic work                             | 35 (21.5)         | 65 (43)        | 100 (31.8)   |      |    |      |
| Maternal alcoholic consumption                 |                   |                |              |      |    |      |
| No                                             | 161 (98.8)        | 116 (76.8)     | 277 (88.2)   | 36   | 1  | 0.0001|
| Yes                                            | 2 (1.2)           | 35 (23.2)      | 37 (11.8)    |      |    |      |
| Maternal experience of domestic violence        |                   |                |              |      |    |      |
| No                                             | 154 (94.5)        | 99 (65.6)      | 253 (80.6)   | 41.87| 1  | 0.0001|
| Yes                                            | 9 (5.5)           | 52 (34.4)      | 61 (19.4)    |      |    |      |
| Maternal age of marriage                       |                   |                |              |      |    |      |
| 18+                                            | 155 (96.3)        | 91 (61.5)      | 246 (79.6)   | 57.49| 1  | 0.0001|
| ≤17                                            | 6 (3.7)           | 57 (38.5)      | 63 (20.4)    |      |    |      |
| Education of the father                        |                   |                |              |      |    |      |
| Higher-secondary or above                      | 24 (14.7)         | 3 (2)          | 27 (8.6)     | 91.7 | 3  | 0.0001|
| Secondary                                      | 100 (61.3)        | 39 (25.8)      | 139 (44.3)   |      |    |      |
| Primary                                        | 23 (14.1)         | 22 (14.6)      | 45 (14.3)    |      |    |      |
| Without formal education                      | 16 (9.8)          | 87 (57.6)      | 103 (32.8)   |      |    |      |
| Paternal alcoholic consumption                 |                   |                |              |      |    |      |
| No                                             | 67 (41.1)         | 37 (24.5)      | 104 (33.1)   | 9.75 | 1  | 0.002 |
| Yes                                            | 96 (58.9)         | 114 (75.5)     | 210 (66.9)   |      |    |      |
| Total number of household members              |                   |                |              |      |    |      |
| 9+                                             | 9 (5.6)           | 45 (30)        | 54 (17.3)    | 36.4 | 2  | 0.0001|
| 05-08                                          | 112 (69.1)        | 88 (58.7)      | 200 (64.1)   |      |    |      |
| ≤4                                             | 41 (25.3)         | 17 (11.3)      | 58 (18.6)    |      |    |      |
| Land ownership                                 |                   |                |              |      |    |      |
| 100+                                           | 25 (15.3)         | 1 (.7)         | 26 (8.3)     | 78.5 | 3  | 0.0001|
| 51-100 cents                                   | 30 (18.4)         | 1 (.7)         | 31 (9.9)     |      |    |      |
| 11-50 cents                                    | 49 (30.1)         | 26 (17.2)      | 75 (23.9)    |      |    |      |
| ≤10 cents                                      | 59 (36.2)         | 123 (81.5)     | 182 (58)     |      |    |      |
| Domicile                                       |                   |                |              |      |    |      |
| Nonforest                                      | 115 (70.6)        | 84 (55.6)      | 199 (63.4)   | 7.5  | 1  | 0.006 |
| Forest                                         | 48 (29.4)         | 67 (44.4)      | 115 (36.6)   |      |    |      |
| Ownership of ration card                       |                   |                |              |      |    |      |
| Yes                                            | 131 (80.4)        | 105 (69.5)     | 236 (75.2)   | 4.9  | 1  | 0.03  |
| No                                             | 32 (19.6)         | 46 (30.5)      | 78 (24.8)    |      |    |      |
| Availability of toilet facility                |                   |                |              |      |    |      |
| Yes                                            | 154 (94.5)        | 123 (81.5)     | 277 (88.2)   | 12.78| 1  | 0.0001|
| No                                             | 9 (5.5)           | 28 (18.5)      | 37 (11.8)    |      |    |      |
| Household food-insecurity status               |                   |                |              |      |    |      |
| Food secure                                    | 66 (40.5)         | 22 (14.6)      | 88 (28)      | 26.1 |    | 0.0001|
| Food insecure                                  | 97 (59.5)         | 129 (85.4)     | 226 (72)     |      |    |      |
| Sex of the child                               |                   |                |              |      |    |      |
| Female                                         | 72 (44.2)         | 79 (52.3)      | 151 (48.1)   | 2.08 | 1  | 0.15  |
| Male                                           | 91 (55.8)         | 72 (47.7)      | 163 (51.9)   |      |    |      |
| Birth weight                                   |                   |                |              |      |    |      |
| 2.5 kg+                                        | 112 (70.9)        | 80 (58.4)      | 192 (65.1)   | 5.04 | 1  | 0.03  |
| <2.5 kg                                        | 46 (29.1)         | 57 (41.6)      | 103 (34.9)   |      |    |      |

Contd...
According to the NFHS 4 (2015–2016), the overall prevalence of stunting, underweight, and wasting in India among children (below 5 years) was 38.4%, 35.7%, and 21%, respectively. Among the tribal communities, 44%, 45%, and 27% of children were stunted, underweight, and wasted. The current study reported that 39.8%, 43.9%, and 18.5% of children from the Paniya and Kurichiya tribal communities combined to be stunted, underweight, and wasted. This shows a lower prevalence of stunting and wasting among tribal children in Kerala, when compared to the national average for tribal children. However, community-wise nutritional status shows that children from the Paniya community had a much higher prevalence of stunting and underweight and comparable levels of wasting (52.3%, 58.9%, and 25.2%, respectively) to the national average for tribal children. This indicates to the need for going beyond averages for the tribal community as a whole and characterizing nutritional status of specific tribal communities. Other cross-sectional studies conducted among the Paniya communities have reported a large difference in stunting, underweight, and wasting among Paniya children (82.9%, 83.6%, and 82%, respectively) as compared to Kurichiya children (20.2%, 31%, and 31%, respectively).[13]

Comparing the overall magnitude of undernutrition using the CIAF also found significant differences between Paniya and Kurichiya children. The working paper by Rajpal et al.[9] based on the NFHS 4 (2015–2016) reported that 55% of the children

**Table 1: Contd...**

| Variables | Kurichiya (n=163) | Paniya (n=151) | Total (n=314) | χ² | df | P   |
|-----------|------------------|----------------|--------------|----|----|-----|
| Only wasting |                  |                |              |    |    |     |
| No        | 161 (98.8)       | 149 (98.7)     | 310 (98.7)   | 0.006 | 1  | 1   |
| Yes       | 2 (1.2)          | 2 (1.3)        | 4 (1.3)      |     | 1  | 1   |
| Underweight and wasting |          |                |              |    |    |     |
| No        | 152 (93.3)       | 140 (92.7)     | 292 (93)     | 0.035 | 1  | 1   |
| Yes       | 11 (6.7)         | 11 (7.3)       | 22 (7)       |     | 1  | 1   |
| Underweight, wasting, and stunting |          |                |              |    |    |     |
| No        | 156 (95.7)       | 126 (83.4)     | 282 (89.8)   | 12.9 | 1  | 0.0001 |
| Yes       | 7 (4.3)          | 25 (16.6)      | 32 (10.2)    |     | 1  | 0.001 |
| Underweight and stunted |         |                |              |    |    |     |
| No        | 140 (85.9)       | 107 (70.9)     | 247 (78.7)   | 10.54 | 1  | 0.001 |
| Yes       | 23 (14.1)        | 44 (29.1)      | 67 (21.3)    |     | 1  | 0.2  |
| Only stunted |              |                |              |    |    |     |
| No        | 147 (90.2)       | 141 (93.4)     | 288 (91.7)   | 1.05 | 1  | 0.8  |
| Yes       | 16 (9.8)         | 10 (6.6)       | 26 (8.3)     |     | 1  | 0.8  |
| Only underweight |          |                |              |    |    |     |
| No        | 155 (95.1)       | 142 (94)       | 297 (94.6)   | 0.17 | 1  | 0.8  |
| Yes       | 8 (4.9)          | 9 (6)          | 17 (5.4)     |     | 1  | 0.8  |
| CIAF      |                  |                |              |    |    |     |
| No        | 96 (58.9)        | 50 (33.1)      | 146 (46.5)   | 20.95 | 1  | 0.0001 |
| Yes       | 67 (41.1)        | 101 (66.9)     | 168 (53.5)   |     | 1  | 0.0001 |

Figures in parenthesis indicate percentages (column-wise). CIAF: Composite index of anthropometric failure

**Figure 1:** Differences in Z-score distribution between Paniya and Kurichiya communities.
Table 2: Multivariable logistic regression model for factors associated with composite index of anthropometric failure at the individual, parental, and household level

| Variables                          | CIAF deficit | OR (95% CI)          | Unadjusted OR | Adjusted OR |
|------------------------------------|--------------|----------------------|---------------|-------------|
| Total number of household members  |              |                      |               |             |
| ≤4                                 | 33 (56.9)    | 25 (43.1)            | Reference     | Reference   |
| 5-8                                | 95 (47.5)    | 105 (52.5)           | 1.46 (0.81-2.63) | 1.85 (0.91-3.75) |
| 9+                                 | 17 (31.5)    | 37 (68.5)            | 2.87 (1.32-6.23)** | 1.77 (0.83-3.75) |
| Consumption of any fruits or vegetables |          |                      |               |             |
| Yes                                | 127 (51.4)   | 120 (48.6)           | Reference     | Reference   |
| No                                 | 19 (28.4)    | 48 (71.6)            | 2.67 (1.49-4.81)*** | 1.95 (0.82-4.63) |
| Household land ownership           |              |                      |               |             |
| ≤10                                | 73 (40.1)    | 109 (59.9)           | 2.05 (1.12-3.75)** | 0.89 (0.38-2.06) |
| ≥10                                | 40 (53.3)    | 35 (46.7)            | 1.20 (0.60-2.41) | 1.05 (0.46-2.41) |
| Toilet facility at home            |              |                      |               |             |
| Yes                                | 135 (48.7)   | 142 (51.3)           | Reference     | Reference   |
| No                                 | 11 (29.7)    | 26 (70.3)            | 2.25 (1.07-4.73)* | 1.10 (0.43-2.81) |
| Food security                      |              |                      |               |             |
| Food secure                        | 53 (60.2)    | 35 (39.8)            | Reference     | Reference   |
| Food insecure                      | 93 (41.2)    | 133 (58.8)           | 2.17 (1.31-3.58)*** | 2.10 (1.13-3.93)* |
| Education of the mother            |              |                      |               |             |
| Higher-secondary or above          | 36 (64.3)    | 20 (35.7)            | Reference     | Reference   |
| Secondary                          | 62 (44.6)    | 77 (55.4)            | 2.23 (1.18-4.24)** | 1.38 (.66-2.90) |
| Primary                            | 17 (53.1)    | 15 (46.9)            | 1.59 (0.66-3.84) | 0.36 (0.11-1.20) |
| Without formal education           | 31 (35.6)    | 56 (64.4)            | 3.25 (1.61-6.55)** | 0.54 (0.16-1.79) |
| Maternal age at marriage           |              |                      |               |             |
| 18+                                | 124 (50.4)   | 122 (49.6)           | Reference     | Reference   |
| ≤17                                | 18 (28.6)    | 45 (71.4)            | 2.54 (1.39-4.63)*** | 2.56* (1.15-5.93) |
| Work status                        |              |                      |               |             |
| Domestic, remunerated, and unremunerated work | 29 (60.4) | 19 (39.6) | Reference | Reference |
| Remunerated work and domestic work | 42 (43.8)    | 54 (56.3)            | 1.96 (0.97-3.97) | 1.93 (0.86-4.33) |
| Unremunerated work and domestic work | 32 (45.7) | 38 (54.3) | 1.81 (0.86-3.12) | 0.73 (0.27-1.99) |
| Only domestic work                 | 43 (43)      | 57 (57)              | 2.02 (1.40-8)* | 1.09 (.45-2.67) |
| Maternal alcoholic consumption     |              |                      |               |             |
| No                                 | 134 (48.4)   | 143 (51.6)           | Reference     | Reference   |
| Yes                                | 12 (32.4)    | 25 (67.6)            | 1.95 (0.94-4.04) | 1.26 (0.50-3.20) |
| Experience of domestic violence    |              |                      |               |             |
| No                                 | 127 (50.4)   | 125 (49.6)           | Reference     | Reference   |
| Yes                                | 19 (30.6)    | 43 (69.4)            | 2.30 (1.27-4.16)** | 1.71 (0.78-3.73) |
| Birth weight                       |              |                      |               |             |
| 2.5+g                              | 100 (52.1)   | 92 (47.9)            | Reference     | Reference   |
| <2.500 g                           | 38 (36.9)    | 65 (63.1)            | 1.86 (1.14-3.04)** | 1.63 (0.90-2.94) |
| Frequency food consumption         |              |                      |               |             |
| ≤2 times                           | 62 (56.9)    | 47 (43.1)            | 1.60 (0.96-2.66) | 1.33 (0.72-2.45) |
| ≥3 times                           | 23 (32.9)    | 47 (67.1)            | 2.69 (1.44-5.04)** | 2.13 (0.83-5.46) |

*P<0.05, **P<0.01, ***P<0.001. Figures in parenthesis indicate percentages (row wise). CI: Confidence interval, OR: Odds ratio, CIAF: Composite index of anthropometric failure
in India suffer from CIAF, meaning that CIAF reported among Kurichiya children is 14% points lower than the national average and among the Paniya children is about 12% points above the national average. CIAF reported among Paniya community is higher than that reported in cross-sectional studies conducted in other tribal communities in Assam, West Bengal, and Tamil Nadu.

The differences in the nutritional status between Paniya and Kurichiya community were wider in the case of severe stunting and severe underweight. A pooled analysis of 10 prospective studies conducted in Asia, Africa, and North America reported that children with severe underweight had 9.40 times higher (95% CI 8.02–11.03) risk of mortality, severely wasted children had 11.63 times (95% CI 9.84–13.76) higher risk of mortality, and severe stunting had 5.48 times (95% CI 4.62–6.50) higher risk of mortality compared with its normal counterpart. Similarly, 16.6% of the children from Paniya community suffered from all three forms of anthropometric failures simultaneously. Global evidence shows that the children who suffer from all three forms of anthropometric failures have the highest risk of mortality (odds ratio = 12.3, 95% CI = 95% CI: 7.7–19.6) among the undernourished children. In addition to this, the significant differences in anthropometric deficit in two dimensions between Paniya and Kurichiya community indicate that the higher burden of severe forms of child undernutrition among the tribal communities is not uniformly distributed and there is an unfair clustering of undernutrition among some groups in tribal communities. Hence, universal access to nutritional programs needs to be ensured to the tribal communities on the one hand; at the same time, more nutritionally vulnerable groups within tribal communities need to be identified and more targeted nutritional program should be implemented for them.

The use of CIAF in this paper has the advantages of unequivocally demonstrating the inequality in the overall magnitude of undernutrition and severity of undernutrition between the two communities, which would not have been possible with the use of conventional anthropometric measurements of individual aspects of undernutrition. This is critical from the point of view of equity, for prioritizing nutritional interventions where large proportion of children experience multiple and simultaneous failures and deserve prioritized intervention. The significantly higher risk of CIAF among children from the Paniya community after controlling for household, maternal, and individual child characteristics points toward the need for more focused nutritional intervention among the Paniya community. The other significant factors associated with CIAF were household food insecurity and maternal early marriage, and the significant factor associated with all three forms of anthropometric failures was maternal experience of domestic violence. While a substantial proportion of food insecure households were reported from both the communities, a high proportion of maternal early marriage and maternal experience of domestic violence after controlling for household, maternal, and individual child characteristics points toward the need for more focused food provisioning interventions among the tribal communities in general and more specific intervention to empower the tribal women from the most marginalized tribal groups to address the high level of undernutrition.

The analysis in this study did not include community-level conditions related to water and sanitation, which are important variables affecting child nutritional status. Although there were significant differences in paternal characteristics between

### Table 3: Factors associated with three anthropometric failures (stunting, wasting, and underweight)

| Variables                        | No      | Yes     | OR (95% CI)       |
|----------------------------------|---------|---------|-------------------|
|                                  | Unadjusted | Adjusted|                   |
| Community                        |         |         |                   |
| Kurichiya                        | 156 (95.7) | 7 (4.3%)| 4.42 (1.85-10.56)*** |
| Paniya                           | 126 (83.4) | 25 (16.6%)| 1.84 (0.63-5.33) |
| Household level factors          |         |         |                   |
| Household land ownership         |         |         |                   |
| 51+ cents                        | 56 (98.2) | 1 (1.8) |                   |
| 11-50 cents                      | 68 (90.7) | 7 (9.3) | 5.76 (0.69-48.26)  |
| ≤10 cents                        | 158 (86.8) | 24 (13.2) | 8.51 (1.13-64.35)* |
| Food insecurity                  |         |         |                   |
| Food secure                      | 84 (95.5) | 4 (4.5) |                   |
| Food insecure                    | 198 (87.6) | 28 (12.4) | 2.97 (1.01-8.73)* |
| Maternal level factors           |         |         |                   |
| Maternal alcoholic consumption   |         |         |                   |
| No                               | 255 (92.1) | 22 (7.9) |                   |
| Yes                              | 27 (73) | 10 (27) | 4.29 (1.84-10.00)*** |
| Experience of domestic violence  |         |         |                   |
| No                               | 234 (92.7) | 18 (7.1) |                   |
| Yes                              | 48 (77.4) | 14 (22.6) | 3.79 (1.77-8.14)*** |

*P<0.05, **P<0.01, ***P<0.001. Figures in parenthesis indicate percentages (row-wise). CI: Confidence interval, OR: Odds ratio
the communities, these did not show any associations with nutritional outcomes. This needs to be further explored. The study was based on a relatively small sample size, and this limited the scope for analysis of very severe forms of undernutrition and multiple failures of undernutrition. Recall bias is possible in responding to the household food-insecurity scale for 1 month. Besides, there may have been under-reporting of household food security due to social and cultural stigma toward identifying oneself as belonging to a household with food insecurity. In some cases, there may have been an exaggeration of household food insecurity because of the expectation that some welfare measures would be made available to them. Finally, the cross-sectional design of the study does not allow for drawing any causal conclusion.

**CONCLUSION**

The findings from this study indicate that while overall tribal communities in Kerala have a higher burden of undernutrition, there is severe nutritional inequality within the tribal communities. Hence, nutritional programs and interventions need to be more focused to reach the most marginalized communities within the tribal groups. By implementing a common design and delivery strategy across all tribal subgroups, current food security programs may be failing the population groups that are most vulnerable to the effects of childhood malnutrition. Empowerment of tribal women to address early marriage, alcohol consumption, the experience of domestic violence could be a critical intervention to address severe forms of undernutrition.

**Financial support and sponsorship**
PNS received support from the Wellcome Trust/DBT India Alliance Fellowship number IA/CPHI/16/1/502648.

**Conflicts of interest**
There are no conflicts of interest.

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