Original Article

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

Kochupurackal Ulahannan Sabu[1], T. K. Sundari Ravindran[2], Prashanth Nuggehalli Srinivas[3]

[1]PhD Scholar, [2]Professor, Achutha Menon Centre for Health Science Studies, Sree Chitra Tirunal Institute for Medical Sciences and Technology, Thiruvananthapuram, Kerala, [3]Faculty and Wellcome Trust Alliance (Intermediate) Fellow, Health Equity Cluster, Institute of Public Health Bengaluru, Bengaluru, Karnataka, India

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

Address for correspondence: Mr. Kochupurackal Ulahannan Sabu, Achutha Menon Centre for Health Science Studies, Sree Chitra Tirunal Institute for Medical Sciences and Technology, Thiruvananthapuram - 695 011, Kerala, India.
E-mail: sabujoseph.ku@gmail.com.

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.[6] The composite index of anthropometric failure (CIAF) developed by Svedberg as a new aggregated indicator of stunting, wasting, and underweight[8] 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 $1-\beta=0.8$, 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.[7] 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 Anthropo 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)	χ^2	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...

Table 1: Contd...

Variables	Kurichiya (n=163)	Paniya (n=151)	Total (n=314)	χ^2	df	P
Differences in composite index of anthropometric failures						
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)			
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)			
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)			
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)			
Only stunted						
No	147 (90.2)	141 (93.4)	288 (91.7)	1.05	1	0.2
Yes	16 (9.8)	10 (6.6)	26 (8.3)			
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)			
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)			

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

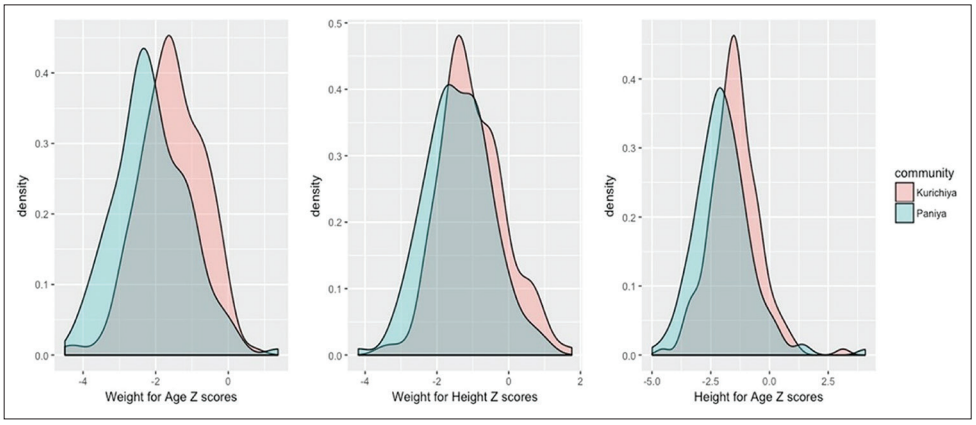

Figure 1: Differences in Z-score distribution between *Paniya* and *Kurichiya* communities.

Discussion

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 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)	
	No	Yes	Unadjusted OR	Adjusted OR
Community				
Kurichiya	96 (58.9)	67 (41.1)	Reference	Reference
Paniya	50 (33.1)	101 (66.9)	2.89 (1.83-4.59)***	2.68 (1.04-6.93)*
Household factors				
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(.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				
51+	33 (57.9)	24 (42.1)	Reference	Reference
11-50	40 (53.3)	35 (46.7)	1.20 (0.60-2.41)	1.05 (0.46-2.41)
≤10	73 (40.1)	109 (59.9)	2.05 (1.12-3.75)*	0.89 (0.38-2.06)
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)*
Maternal level factors				
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* (1.11-5.93)
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 (1-4.08) *	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)
Individual-level factors				
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				
4≥ times			Reference	Reference
3 times	62 (56.9)	47 (43.1)	1.60 (0.96-2.66)	1.33 (0.72-2.45)
≤2 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

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%)		
Paniya	126 (83.4)	25 (16.6)	4.42 (1.85-10.56)***	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)	3.13 (0.35-28.31)
≤10 cents	158 (86.8)	24 (13.2)	8.51 (1.13-64.35)*	3.32 (0.38-29.15)
Food insecurity				
Food secure	84 (95.5)	4 (4.5)		
Food insecure	198 (87.6)	28 (12.4)	2.97 (1.01-8.73)*	1.42 (0.45-4.50)
Maternal level factors				
Maternal alcoholic consumption				
No	255 (92.1)	22 (7.9)		
Yes	27 (73)	10 (27)	4.29 (1.84-10.00)***	2.46 (0.976-6.21)
Experience of domestic violence				
No	234 (92.7)	18 (7.1)		
Yes	48 (77.4)	14 (22.6)	3.79 (1.77-8.14)***	2.35 (1.02-5.39)*

*P<0.05, **P<0.01, ***P<0.001. Figures in parenthesis indicate percentages (row-wise). CI: Confidence interval, OR: Odds ratio

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,[14] West Bengal,[15] and Tamil Nadu.[16]

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 severely 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.[17] 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.[18] 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 were reported from *Paniya* community alone. This indicates 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

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.

References

1. NFHS-4. National Family Health Survey. Ministry of Health and Family Welfare. Government of India; 2015.
2. Gangadharan K, Kumar VK. Why tribal children look differently? An empirical analysis of health and nutritional status of tribal children in Kerala. Asian J Res Soc Sci Humanit 2014;4:196.
3. Philip R, Vijayakumar K, Indu P, Shrinivasa B, Sreelal T, Balaji J. Prevalence of undernutrition among tribal preschool children in Wayanad district of Kerala. Int J Adv Med Health Res 2015;2:33.
4. Martorell R, Young MF. Patterns of stunting and wasting: Potential explanatory factors. Adv Nutr 2012;3:227-33.
5. Nandy S, Miranda JJ. Overlooking undernutrition? Using a composite index of anthropometric failure to assess how underweight misses and misleads the assessment of undernutrition in young children. Soc Sci Med 2008;66:1963-6.
6. Nandy S, Svedberg P. The composite index of anthropometric failure (CIAF): An alternative indicator for malnutrition in young children. In: Preedy VR, editor. Handbook of Anthropometry. New York, NY: Springer; 2012. p. 127-37. Available from: http://link.springer.com/10.1007/978-1-4419-1788-1_6. [Last accessed on 2018 Feb 03].
7. Physical status: The use and interpretation of anthropometry. Report of a WHO Expert Committee. World Health Organ Tech Rep Ser 1995;854:1-452.
8. Svedberg P. Poverty and Undernutrition: Theory, Measurement, and Policy. Oxford; New York: Clarendon Press; 2000.
9. Rajpal S, Kim R, Sankar R, Kumar A, Joe W, Subramanian S. FAQs on Child Anthropometric Failures in India: Insights from the National Family Health Survey 2015-16; 2018.
10. Ladish K. Nutritional Status of Children in Tribal Communities of Wayanad. SCTIMST; 2005. Available from: http://dspace.sctimst.ac.in/xmlui/handle/123456789/2093. [Last accessed on 2016 Oct 31].
11. Gangadharan K. Nutritional deprivation of children in Rural Kerala an inter caste analysis. IPEDR 2011;5:122-7.
12. Maitra C, Sethi V, Unisa S, Chandrasekhar S. Household Food Insecurity and Maternal and Child Undernutrition: The Case of Maharashtra, India. Experiences and Challenges in Measuring Income, Inequality, and Poverty in South Asia; 2017; New Delhi. Available from: http://www.iariw.org/India/maitra.pdf. [Last accessed on 2020 Jun 11].
13. Gangadhar K. Maternal and Child Health among Tribals in Kerala: Strategies for Rational Development of Health Infrastructure and Health Manpower. Indian Council of Medical Research; 2015.
14. Kramsapi R, Singh KH, Mondal N. Composite index of anthropometric failure (CIAF) among pre-school (2-5 years) tribal children of Assam (India). Hum Biol Rev 2018;7:1-118.
15. Das S, Bose K. Assessment of nutritional status by anthropometric indices in Santal Tribal Children. J Life Sci 2011;3:81-5.
16. Prabhakar R, Kumarasamy H, Dhanapal A. Assessment of under nutrition using composite index of anthropometric failure among under five children of tribal population. Int J Community Med Public Health 2019;6:2056-63.
17. Olofin I, McDonald CM, Ezzati M, Flaxman S, Black RE, Fawzi WW, *et al*. Associations of suboptimal growth with all-cause and cause-specific mortality in children under five years: A pooled analysis of ten prospective studies. PLoS One 2013;8:e64636.
18. McDonald CM, Olofin I, Flaxman S, Fawzi WW, Spiegelman D, Caulfield LE, *et al*. The effect of multiple anthropometric deficits on child mortality: Meta-analysis of individual data in 10 prospective studies from developing countries. Am J Clin Nutr 2013;97:8.