The Journal of Nutrition
Community and International Nutrition

Caregivers Systematically Overestimate Their Child's Height-for-Age Relative to Other Children in Rural Ethiopia

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ABSTRACT

Background: Stunting affects one-quarter of children <5 y of age, yet little is known about the accuracy of caregivers' perceptions regarding their child's linear growth. Most existing quantitative research on this topic has been conducted in high-income countries and has examined perceptions of children's weight rather than height.

Objectives: In rural Ethiopia where linear growth faltering is highly prevalent, this study aimed to better understand how caregivers perceive their child's growth. The objectives of this analysis were to *1*) assess caregivers' perceptions of their child's height; *2*) investigate whether there is a discrepancy between a child's actual height and caregivers' perceptions of their child's height; and *3*) examine the factors that influence discrepancies in estimating a child's height (secondary outcomes), including the role of the average height in the community (primary outcome).

Methods: We conducted a cross-sectional analysis using data from 808 woman caregivers of children ages 6–35 mo in the Oromia region of Ethiopia. We assessed caregivers' rankings (from 1 to 10) of their child's height relative to other children their age in their village. We then converted these rankings to *z* scores based on an age- and region-specific distribution in order to calculate their difference with the child's actual height-for-age *z* score and to determine the degree of overestimation. Lastly, we used multivariate log Poisson regressions to determine factors associated with overestimating a child's height.

Results: Forty-three percent of caregivers scored their child's height as the median; 37% overestimated their child's height relative to other children. Regression results showed caregivers who were poorer, and had children who were female, older, and stunted, were more likely to overestimate.

Conclusions: Our findings suggest that caregivers of young children in Oromia systematically overestimated their children's height, which could adversely affect child health if these misperceptions translate to insufficient care-seeking behavior or feeding choices for children. *J Nutr* 2022;152:1327–1335.

Keywords: child growth, stunting, Ethiopia, perceptions, caregiver

Introduction

In the global effort to eliminate child undernutrition, the lack of effective strategies for addressing child stunting remains a persistent challenge. More than one-fifth of all children <5 y of age are stunted worldwide (1), and an even greater number do not reach their full linear growth potential (2). Suboptimal linear growth is an indicator of chronic undernutrition and is associated with lower cognitive performance, lower lifetime earnings, and a greater risk of morbidity, mortality, and the development of chronic diseases (3).

Although there are numerous contributors to child undernutrition, nutritional awareness is necessary (but not sufficient) for initiating changes in feeding practices or seeking medical advice when necessary (4). One example of a strategy to increase nutritional awareness is the regular assessment of a child's relative growth in terms of weight. This strategy has been used for decades as part of routine pediatric care, in order to diagnose and intervene on growth faltering before it seriously jeopardizes a child's nutritional status (5). In fact, de Onis et al. (6) reported that 88% of all Ministries of Health worldwide practice some form of child growth monitoring. Growth monitoring has been shown to have some success in improving child nutritional status (depending on the context) and in improving the utilization of health services (5). Although linear growth monitoring could provide a similar benefit as

Manuscript received November 17, 2021. Initial review completed January 11, 2022. Revision accepted January 18, 2022.
First published online January 31, 2022; doi: https://doi.org/10.1093/jn/nxac015.

weight monitoring in theory, the vast majority of growth monitoring programs in low-income countries only focus on measuring weight.

Behavior change theory can help us understand how and why nutrition interventions like growth monitoring are successful in achieving their desired outcomes. According to the Health Belief Model (HBM)—one of the most commonly applied health behavior models—a sense of risk and susceptibility to a condition serves as a precursor to influencing behavioral change for the promotion of health outcomes (7). Previous research applying the HBM in Ethiopia has shown how nutrition education can improve knowledge, attitudes, and practices, and, as a result, dietary intakes (8); those improvements in knowledge, attitudes, and practices can then lead to dietary and anthropometric improvements (9).

In Ethiopia, Growth Monitoring and Promotion (GMP) is practiced through the health extension system by community health workers, but it tracks only weight measurements and not linear growth (10). This lack of length and height monitoring calls into question the level of awareness caregivers may have about their child's growth status. Given what we know from health behavior theory about how perceptions can drive behavior change, it is especially important to understand the accuracy of caregiver perceptions about their child's relative linear growth, because perceptions are all they have in the absence of routine objective measurements. And in settings like Ethiopia where linear growth faltering is pervasive, a child who is too short for their age might be perceived as neither abnormal nor unhealthy (11–13), resulting in insufficient health-seeking behavior and/or inadequate feeding practices. This logic is supported by previous evidence showing how health-seeking behavior in Ethiopia is inadequate, and that insufficient health-seeking behavior is associated with both low literacy (14) and poor health knowledge (15).

Although some research has explored the accuracy and importance of caregivers' perceptions about child growth (16, 17), critical gaps in understanding these perceptions remain—notably in areas where undernutrition is most prevalent. In contrast, parental perceptions of children's weight in the context of overweight and obesity prevention and treatment in high-income settings have been explored extensively. A meta-analysis of 69 articles found that 50.7% of parents underestimated the weight of their child who was overweight or obese and 14.3% underestimated the weight of their child who was of normal weight (18). Other research has observed that an increasing regional prevalence of obesity over time was associated with greater misperceptions of their child's weight status—a trend the authors referred to as "what is common becomes normal" (19). Although less research has explored misperceptions of chronic undernutrition, there is some literature on underweight; 1 meta-analysis of 37 articles found that approximately half of the parents of underweight children perceived their child's weight to be normal (20).

To our knowledge, no literature has quantitatively assessed the accuracy of parental perceptions of children's linear growth. There is some qualitative research exploring stunting perceptions. One such study from Bangladesh found that parents are more likely to take cues from their community, siblings, and peers than from routine growth monitoring programs; the authors found that the high prevalence of stunting in their study context made it challenging for caregivers to identify linear growth faltering and to appreciate its adverse health consequences—and that future nutrition counseling strategies should use perceptions to tailor their messaging (11). But many questions remain as to how accurate these perceptions are in Ethiopia, and what drives them. Do parents tend to underestimate height regardless of the child's relative height, or do they underestimate the presence of a problem? Does the trend of "what is common becomes normal" apply in different nutritional contexts and, in particular, those where faltering growth is common?

We aimed to fill these gaps by analyzing data from a unique survey that quantified caregiver perceptions. These data were collected in a rural part of the Oromia region of Ethiopia. Oromia faces a high prevalence of undernutrition, where ∼37% of children <5 y of age are stunted, and only 7% of children ages 6–23 mo achieve the minimum acceptable diet (21).

This article sought to achieve 3 objectives: *1*) assess caregivers' perceptions of their child's height; *2*) investigate whether there is a discrepancy between a child's actual height and caregivers' perceptions of their height; and *3*) examine the factors that influence discrepancies in estimating a child's height (secondary outcomes), including whether the role of the average height in the community influences these discrepancies (primary outcome). To accomplish these aims, we analyzed caregivers' scoring of their child's height relative to other children in their village (on a scale from 1 to 10, with 10 being the tallest) and compared this scoring to the region-specific [2016 Ethiopian Demographic and Health Survey (DHS) (21)] height-for-age distribution.

Methods

Data

This study used secondary data from a randomized controlled trial conducted in Oromia. The trial evaluated the impact of disseminating quality protein maize (QPM)—a group of maize varieties bred for superior protein availability (22)—together with interventions designed to increase children's consumption of the maize. The full study protocol has been published previously (23).

The trial focused on households in the target areas where QPM was demonstrated before the main growing season in 2015. For the study, 12 kebeles were selected: 8 from the East Wollega Zone and 4 from the Jimma zone. Households were eligible if they had ≥1 child aged 6–35 mo, 1 member who had attended a field demonstration, and provided informed consent. In addition, households in the treatment groups were excluded if the primary caregiver for the index child was not in a "one-to-five" group, because this information was used for randomization between the 2 treatments. The one-to-five groups consist of ∼5 women and are formed to help local health extension personnel with community outreach for the health and nutrition program. The study received ethical approval from the Harvard School of Public Health Institutional Review Board, and the Ethiopian Public Health Institute Scientific and Ethical Review Committee.

Based on the aforementioned inclusion criteria, all women in our analytic sample were the caregivers of a child 6–35 mo old (the

Supported by Bill and Melinda Gates Foundation grant OPP52811 (to JC), which was awarded through the Abdul Latif Jameel Poverty Action Lab (J-PAL) under their Agricultural Technology Adoption Initiative, and by NIH training grant 2T32DK007703-26 in Academic Nutrition (to SP).
Author disclosures: The authors report no conflicts of interest.
Supplemental Figures 1–7 and Supplemental Tables 1 and 2 are available from the "Supplementary data" link in the online posting of the article and from the same link in the online table of contents at https://academic.oup.com/jn/.
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Abbreviations used: DHS, Demographic and Health Survey; GMP, Growth Monitoring and Promotion; HAZ, height-for-age *z* score; HBM, Health Belief Model; PCA, principal component analysis; QPM, quality protein maize.

index child) at enrolment. During the baseline survey, caregivers were surveyed during home visits and asked about demographics, health, food consumption, and their perceptions about the growth and health of the index child. In >97% of cases, the caregiver interviewed was the biological mother of the index child; in all cases, the caregiver was female. Child anthropometry data were collected using height/length boards and electronic scales based on UNICEF standard procedures (24). This article uses only the baseline data, which were collected from July to August of 2015, before any intervention to avoid factors that might influence perceptions.

Variable definition

To address the first objective of assessing caregivers' perceptions of their child's linear growth, we used a survey question asked of caregivers about both the height and weight (as separate questions) of the index child: "Please rate [NAME's] height/weight, compared to other children his/her age, on a scale from 1 to 10, where 1 means [NAME] is shorter/lighter than all of the other children his/her age in the village, and 10 means [NAME] is taller/heavier than all other children his/her age in the village." Before data collection, enumerators were thoroughly trained in administration of these questions. Enumerators piloted the questionnaire with subjects outside of the final study sample under supervision, followed by corrections and discussions.

During data analysis, we converted these raw scores to percentiles to address our second objective: to investigate a discrepancy between caregivers' perceptions and actual child growth. To do so, we compared children's Ethiopian-specific height-for-age z scores (HAZs) with caregivers' rankings. z Scores are defined as the difference with the median of a reference population standardized through division by the SD of that population; stunting is defined as an HAZ that is >2 SDs below the age- and sex-specific reference median (25).

We assumed that caregivers interpreted the height scale from 1 to 10 in the same proportions as one would interpret height percentiles from 1 to 100, such that each score represented one-tenth of children in the population. To develop appropriate z scores corresponding to the percentiles of caregivers' scores, we calculated the month-specific medians and SDs of height from their reference population, using the Ethiopian 2016 DHS data collected from individuals residing in rural areas in the Oromia region (21). We chose to use the DHS data rather than our own village-level height data because of the small number of children within each month of age in our data set; upon examination, the distributions were quite similar (see **Supplemental Figure 1**). DHS sampling weights were applied to calculate the SDs, because these weights are representative both nationally and regionally.

The z scores of the local population were calculated for each child in the DHS using the formula: $z_{DHS} = \frac{x-\mu_{DHS}}{\sigma_{DHS}}$, where x = an individual child's height as measured during the DHS survey, μ_{DHS} = the median height in the DHS data for a child with the corresponding age in months, and σ_{DHS} = the SD of this month-specific height in the DHS data. These z scores were used to develop month-specific height-for-age percentiles at the midpoint of each interval of 10, so that the percentiles could be assigned to each height score. For example, for a score of 1, $z_{perceived\ local}$ = the z score of the child at the 5th percentile in the DHS data, a score of 2 = the z score of the child at the 15th percentile, etc., 9 = 85th, and 10 = 95th. These z scores represent an underlying range, because they are converted from a score of 1–10 to a continuous z score scale, and thus may cause reduced precision for subsequent calculations.

We defined children's actual z scores based on the local population as $z_{local} = \frac{x-\mu_{DHS}}{\sigma_{DHS}}$, where x = an individual child's height as measured during the survey, μ_{DHS} = the median height from the DHS data for a child with the corresponding age in months in rural Oromia, and σ_{DHS} = the SD of this month-specific height from the DHS data.

To assess the accuracy of caregivers' perceptions, we estimated the difference between the perceived and actual HAZs, such that $y_{local} = z_{perceived\ local} - z_{local}$. We then categorized the differences between actual and perceived scores as an underestimation, a correct estimation, or an overestimation as follows:

1) $y_{local} < -1$ = underestimate of height-for-age;
2) $-1 \le y_{local} \le 1$ = within the margin of correctness of height-for-age;
3) $y_{local} > 1$ = overestimate of height-for-age.

Based on the premise that an overestimation of a child's height might be associated with an inadequate understanding of nutritional risk, we developed a binary indicator for overestimation defined as 1 if $y_{local} > 1$, or 0 if their estimate was categorized as an underestimate or within the margin of correctness. We then categorized underestimation, correct estimation, and overestimation by a child's categorical nutritional status, which was defined as either a normal HAZ ($z_{WHO} \ge -1$), mild stunting ($-2 \le z_{WHO} < -1$), or moderate/severe stunting ($z_{WHO} < -2$). Although the WHO defines stunting as a z score < -2, we applied this broader definition in order to capture a wider range of children, because the consequences of growth faltering occur across a continuum (26, 27).

To explore the relation between overestimation of height and a set of demographic predictors, we developed a wealth index through principal component analysis (PCA) using 8 binary household wealth indicators, including having a radio, high-quality roof, electricity, improved water source, improved floor, ox plough, latrine, and improved walls. We then created wealth tertiles (with 1 being the poorest and 3 being the richest) based on the raw PCA score. We included a variable equal to 1 if a household was either moderately or severely food insecure, based on the classification of their responses to the Food Insecurity Experience Scale (28) in the previous 3 mo. Additional demographic characteristics included in our analyses were the number of household members ages 6–59 mo; the caregiver's age; whether the caregiver's BMI (in kg/m^2) was <18.5 (meaning she was underweight); whether she had ever attended school; whether she had accessed health extension services in the last year; age of the index child (mo); and whether the index child was female. We also included a categorical variable for whether the index child had a normal HAZ, mild stunting, or moderate/severe stunting, based on our hypothesis that caregivers of children who are stunted might be more likely to overestimate their child's height.

These variables were included based on established relations between demographic variables and child undernutrition in the literature (29–31). Age, sex, and undernutrition status were included because they were most likely to be related from a biological standpoint, whereas the remaining variables were hypothesized to be associated with perceptions for reasons related to the household's socioeconomic status, including wealth, access to health services, access to food, and educational attainment. A category indicating a missing value was added for categorical variables in cases where observations were missing; this included 7 observations for the wealth index and 66 for caregiver BMI. Four observations were excluded owing to missing height-for-age measures, resulting in a final analytic sample of 808 children.

To test whether local averages of HAZ drive caregivers' perceptions of their own child's relative height (i.e., the "what is common becomes normal" hypothesis), we included a variable for the median HAZ in the household's village. This median was calculated at the individual level, such that it excluded each individual child's HAZ.

Statistical methods

To examine factors associated with overestimation, we calculated the prevalence ratio of overestimation as the binary outcome of the set of demographic predictors described in the previous section using log Poisson regressions (32). We estimated multivariate models for overestimation based on the local distributions, which adjusted for complex survey design and all demographic variables simultaneously. SEs were clustered at the women's one-to-five group (the cluster) level. All prevalence ratios were exponentiated so that they can be interpreted as the proportion of increased or decreased risk of overestimation due to each factor.

The same analyses for height-for-age already described were also conducted for caregivers' relative weight-for-age scorings (**Supplemental Figures 2–6**). All analyses and graphing were conducted using Stata version 16.0 (33).

TABLE 1 Characteristics of caregiver–child pairs in the cross-sectional study sample from Oromia[1]

Characteristics	Values
Wealth indicators	
Has radio	33.6% (269)
Has ox plough	90.0% (721)
Has electricity	9.0% (72)
Has improved water source	68.7% (550)
Has latrine	81.4% (652)
Has improved floor material	2.0% (16)
Has improved wall material	94.4% (756)
Has improved roof	56.2% (451)
Missing wealth indicators	0.9% (7)
Household is moderately/severely food insecure	27.4% (221)
Household members, *n*	6.2 ± 2.0
Household members 6–59 mo old, *n*	1.5 ± 0.6
Female caregiver's age, y	28.5 ± 5.9
BMI of woman caregiver, kg/m^2	19.1 ± 2.1
BMI < 18.5	38.4% (310)
BMI ≥ 18.5	53.5% (432)
Missing BMI	8.2% (66)
Woman caregiver ever attended school	33.7% (272)
Woman caregiver accessed health extension services in the last year	55.9% (452)
HAZ of index child	− 1.3 ± 1.4
HAZ category	
HAZ ≥ −1 (not stunted)	39.2% (317)
−2 ≤ HAZ < −1 (mild stunting)	30.6% (247)
HAZ < −2 (moderate/severe stunting)	30.2% (244)
WAZ of index child	− 0.9 ± 1.1
WAZ category	
WAZ ≥ −1 (not underweight)	53.6% (433)
−2 ≤ WAZ < −1 (mild underweight)	31.6% (255)
WAZ <−2 (moderate/severe underweight)	14.9% (120)
WHZ of index child	− 0.34 ± 1.04
WHZ category	
WHZ ≥ −1 (not wasted)	82.0% (616)
−2 ≤ WHZ < −1 (mild wasting)	12.5% (94)
WHZ < −2 (moderate/severe wasting)	5.5% (41)
Index child's age, mo	19.8 ± 8.4
Index child is female	47.5% (384)

[1]Total *n* = 808 caregiver–child pairs. Values are mean ± SD for continuous measures and % (*n*) for categorical measures. HAZ, height-for-age *z* score; WAZ, weight-for-age *z* score; WHZ, weight-for-height *z* score.

Results

Table 1 presents descriptive statistics of our study sample of 808 caregiver–child pairs. Nearly 40% of women were categorized as underweight, and only 34% had ever attended school. About 56% of caregivers had accessed health extension services in the previous year. Of children <5 y of age, 30% were classified as having moderate or severe stunting, and nearly 15% were classified as being underweight. This suggests a population that is slightly healthier than average compared with the 2016 Ethiopian DHS, which showed a 38% prevalence of stunting and a 24% prevalence of underweight (21).

Figure 1 presents the distributions of the HAZs, calculated using the local (regional rural DHS) distribution and graphed against *z* scores calculated using the WHO reference population. The *z* scores in the study sample were fairly normally distributed around the mean of the DHS sample (Figure 1). In comparison, the *z* scores derived using the WHO reference population were shifted to the left, indicating the high degree of undernutrition in this sample.

Figure 2 shows the distribution of caregivers' scores of their child's height relative to other children their age in the village: 12% scored their child below the median, 43% as the median, and 45% above the median. Furthermore, 23% scored their child in the top 10 percentiles, and 7% scored their child in the bottom 10 percentiles. **Supplemental Table 1** shows correlations between actual height/weight *z* scores and caregiver scores.

Figure 3A displays the distribution of the difference between perceived HAZs and actual (local) *z* scores. A greater proportion of caregivers overestimated their child's HAZ (37%) than underestimated it (17%), and 46% of respondents estimated their child's HAZ within 1 SD of accuracy. Caregivers of children experiencing moderate/severe stunting appeared more likely to overestimate (51%) and much less likely to underestimate (7%) their child's HAZ than did caregivers of children who were not stunted, for whom 29% overestimated and 30% underestimated.

Figure 4 presents the results of regressions predicting caregivers' overestimation of HAZ, displaying prevalence ratios and 95% CIs. **Supplemental Table 2** provides the numeric values of these results as well as the bivariate associations. The wealthiest households were 27% less likely to overestimate their child's height in multivariate analyses (P value < 0.05). We found a small negative association between a child's age in months and overestimation of HAZ in the adjusted model (P value < 0.01). Caregivers were also 1.3 times (95% CI: 1.06, 1.51 times) more likely to overestimate the child's height if the index child was female (P value < 0.01).

The strongest predictor of caregivers' overestimation of HAZ was the child's undernutrition status. In the multivariate model, caregivers of children with mild stunting were 1.3 times (95% CI: 1.03, 1.68 times) more likely to overestimate HAZ, and caregivers of children with moderate/severe stunting were 2.0 times more likely to overestimate (95% CI: 1.60, 2.55 times). We did not observe any statistically significant associations with other socioeconomic variables in the adjusted analyses, including food insecurity, number of household members, female caregiver's age, BMI of the female caregiver, number of children 6–59 mo of age in the household, and whether the female caregiver had accessed health extension services in the last year.

As Figure 4 shows, we did not observe any relation between caregivers' overestimation of HAZ and the median HAZ in the village. These CIs, however, were wide (0.773, 2.270 in the multivariate regression), owing to the small sample sizes within each village. We also stratified the multivariate model by sex to observe whether these relations differed for boys and girls (**Supplemental Figures** 6 and 7). In the stratified analyses, the wealthiest households were less likely to overestimate height for girls but not for boys; the minor negative association with the child's age appeared to be significant for girls only.

Conducting this same set of analyses for weight-for-age instead of height-for-age showed largely similar patterns for scoring, overestimation, and underestimation of weight—both overall and by undernutrition status (Supplemental Figures 2-6).

Discussion

This article provides insight into caregivers' perceptions of their children's growth among rural households of Oromia,

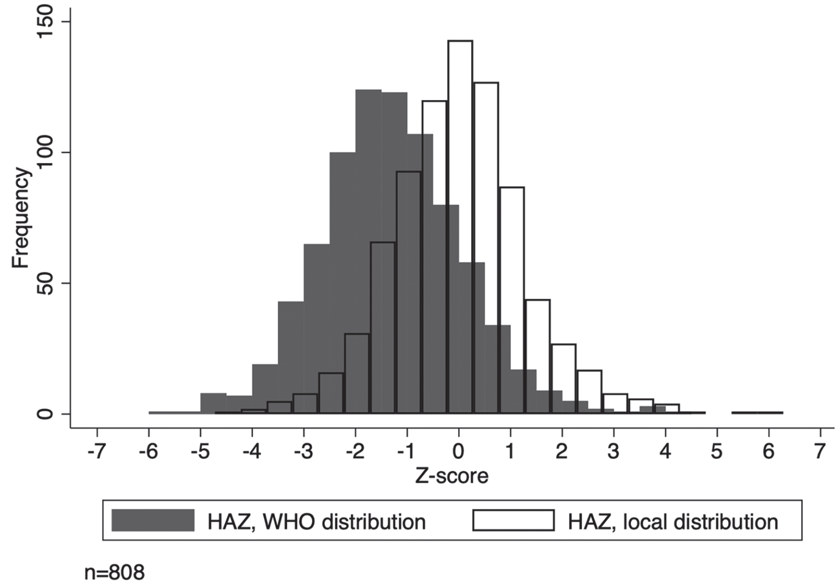

FIGURE 1 Histograms showing HAZs, based on the local and WHO distributions. The solid shading indicates the distribution of the population based on the WHO classification (25), and the transparent bars indicate the HAZ using the local (Demographic and Health Survey) population (21) as the standard. HAZ, height-for-age *z* score.

Ethiopia. To our knowledge, this research represents the first quantitative analysis on this topic for a population in Sub-Saharan Africa, with previous literature largely focusing on parental weight estimation of children among populations in Europe and North America (20, 34). Our results show how caregivers systematically overestimated their child's height-for-age. In general, most caregivers thought their child's height was either average or above average as compared with others their age in their village. This trend was substantially more pronounced if a child was stunted. Based on previous qualitative evidence showing how a child's height might not necessarily be viewed as a nutritional deficiency (11, 12), this trend raises concerns about the ability to recognize a problem among the most vulnerable children.

Although caregivers accurately estimated their child's relative height almost half of the time, we observed a systematic overestimation based on the child's undernutrition status. Caregivers of children with mild and moderate/severe stunting overestimated their child's height to a greater degree than for those with no stunting. This may in part be explained by the

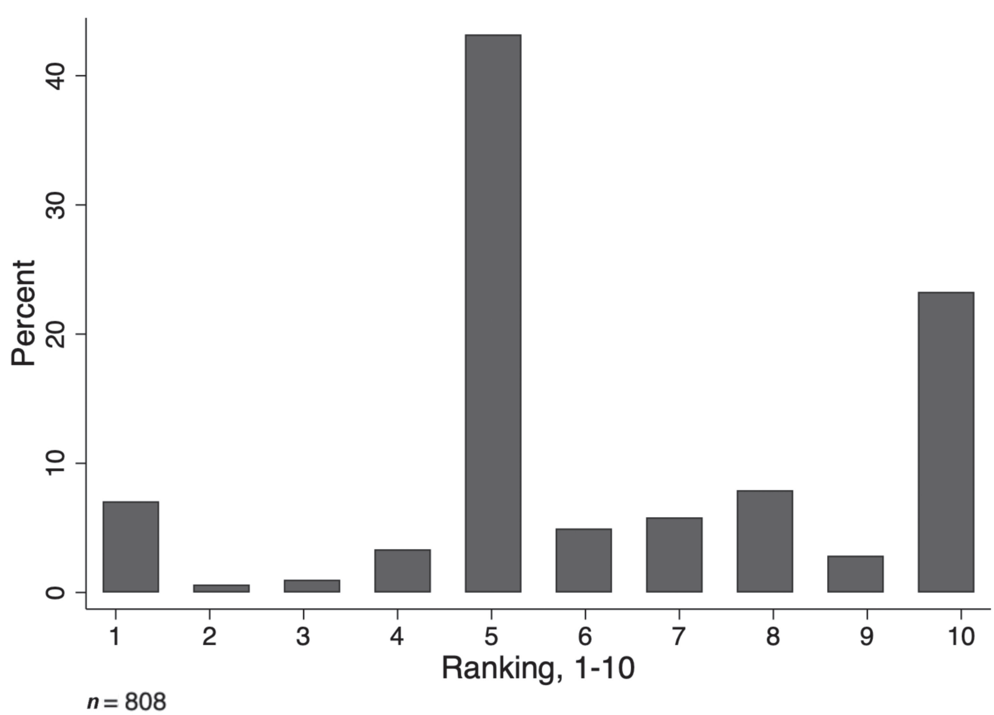

FIGURE 2 Caregivers' relative height scoring of the index child compared with other children their age in the village. This figure reports the primary woman caregiver's response when asked to rank her child's height on a scale from 1 to 10 relative to other children their age in the village.

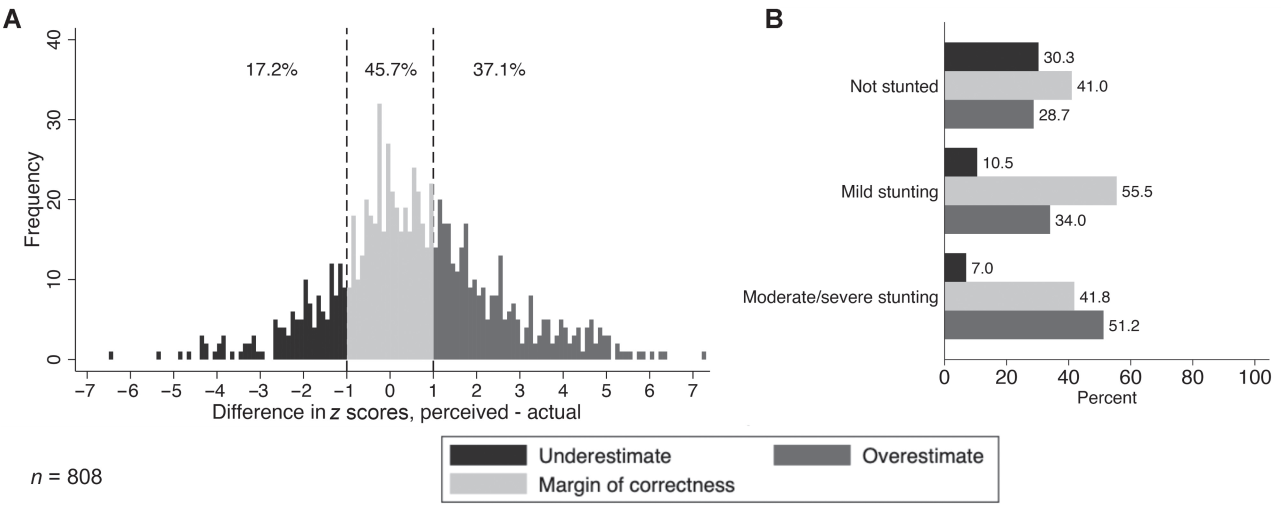

FIGURE 3 Difference in caregivers' perceived and children's actual height-for-age *z* scores, overall and by undernutrition status. (A) The difference between caregivers' perceptions of their child's height-for-age and the child's actual height-for-age, categorized into underestimates, overestimates, and a margin of correctness. (B) Categorization of caregivers' perceptions of their child's height-for-age based on whether the child is not stunted, has mild stunting, or has moderate/severe stunting.

fact that a child with a higher HAZ would have less room on the scale from 1 to 10 for overestimation. Our results could also be driven by ~40% of respondents scoring their child at the median. We are unable to tell whether this was a feature of the survey question being difficult to answer or understand, or whether caregivers actually perceived their child's height as average.

Potential drivers of the tendency for caregivers of stunted children to overestimate their child's height could be a social desirability for taller, healthier children, and/or discomfort with indicating concern that their children are not growing well. Research related to the drivers of weight misclassification has found that caregivers may be hesitant to admit their child has a low weight because it could represent an inability to provide for their child (34, 35). The same trend could potentially be true of height, leading to higher overestimation of height for children experiencing stunting. This phenomenon could have consequences for child health, because lower HAZs are

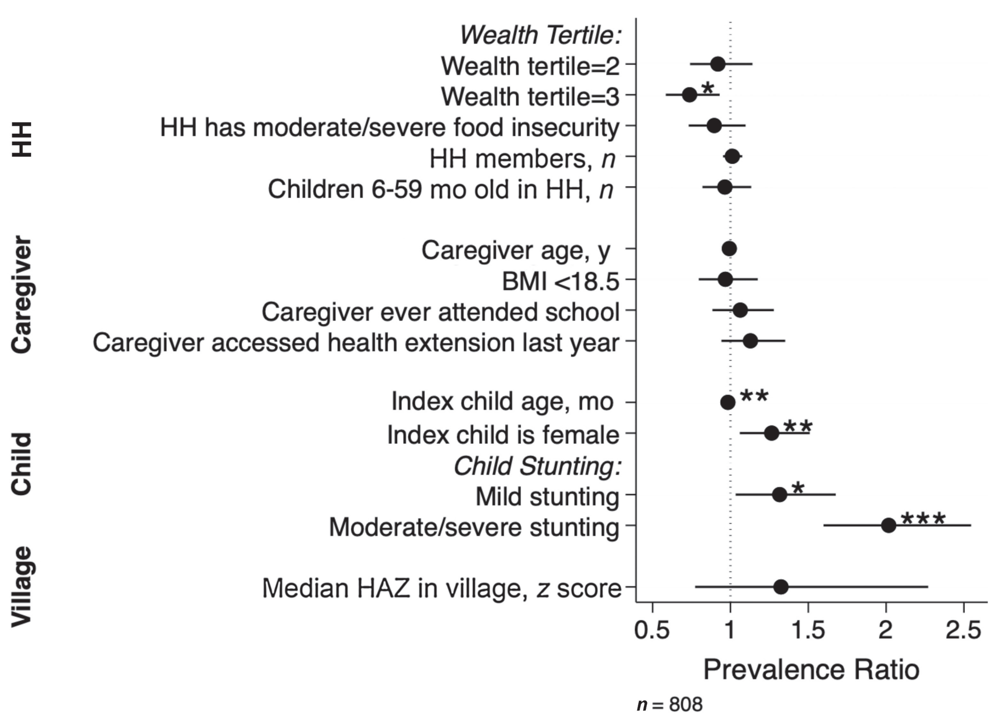

FIGURE 4 Predictors of overestimation of height-for-age in a multivariate model. Coefficients are displayed as exponentiated prevalence ratios of overestimation of the index child's height. The multivariate model included the following variables: wealth tertiles (base category is wealth tertile = 1, poorest), moderate/severe HH food insecurity, number of HH members, caregiver's age, index child's sex, caregiver is underweight (BMI < 18.5 kg/m^2), number of children 6–59 mo old in HH, caregiver has attended school, caregiver accessed the health extension system in the last year, child's category of stunting (base category is no stunting), and median HAZ in the village. *$P < 0.05$, **$P < 0.01$, ***$P < 0.001$. HAZ, height-for-age *z* score; HH, household.

associated with a higher risk of morbidity and mortality (36). Given the fact that >60% of children in our sample were classified as either mildly, moderately, or severely stunted, an underestimation of the problem could be detrimental to health, especially if it translates to insufficient nutritional behavior change or health seeking.

Unlike previous studies that have shown an influence of local averages on maternal perceptions (19), we did not observe a statistically significant relation between the average HAZ in the village and caregivers' overestimation of HAZ. This could partially be due to the wide CIs for this predictor, and/or the fact that the communities in our study uniformly experienced high rates of growth faltering, limiting the variation across communities. Even so, the direction of the association appears to be positive, such that a higher median HAZ in the village leads to a higher tendency toward overestimation. This directionality could suggest that—after controlling for factors like wealth and education—the "what is common becomes normal" hypothesis is actually not the driving force behind overestimation, but rather social pressure, cultural preferences, and other factors could be at play. Future research with a larger sample size could help to identify whether this trend is indeed true, and qualitative research could help to understand what drives this trend.

We found that overestimation was more likely for index children who were girls than for boys. This could also be supported by previous work from Sub-Saharan Africa that showed lower reporting of child illness for girls than for boys, which was also associated with higher infant mortality for girls (37). Thus, perhaps there is a higher threshold to acknowledging a nutrition or health problem for female children. Interestingly, when we stratified our analyses by sex, we found that overestimation for children who were moderately or severely stunted was higher for boys than for girls. This could be driven by a societal bias that prefers boys to be tall, resulting in overreporting (36). This finding is in spite of the fact that the prevalence of stunting was higher among boys in our sample (a prevalence of 32% moderate or severe stunting for boys compared with 28% for girls), which has been shown to be true across Sub-Saharan Africa (38).

Our findings show that caregivers living in the wealthiest households were much less likely to overestimate height, even after controlling for other factors like education. Yet, several other socioeconomic variables analyzed did not drive overestimation. Collinearity of these variables with each other and with child stunting status could partially explain this finding. But it could also suggest that unlike many other health behaviors, which vary substantially by socioeconomic status, perceptions of growth may not be as closely linked to socioeconomic status. This is consistent with findings from meta-analyses of perceptions in high-income countries (20).

We had expected that a caregiver's knowledge of growth standards would be influenced by her educational status and recent use of health services, but we saw no relation between these variables and overestimation. It is possible that there is too little variation in women's education to be able to discern a relation, with 67% of women never attending school. With such low literacy, it is also likely that respondents were not familiar with the 10-point scale, as can be seen by the results in Figure 2, which shows the grouping of responses at the center and extremes.

There is hardly any research from Ethiopia to explain caregivers' perceptions of height, although qualitative evidence from Tanzania suggests that short stature was thought to be deterministic, and not something that caregivers could influence (39). It is also possible that in Ethiopia, height is not as well recognized as a nutritional issue as weight, especially given the emphasis on weight in GMP activities. GMP is practiced in Ethiopia through the health extension system, and includes tracking on growth curves for weight but not height (10). Qualitative research from Southern Ethiopia has shown low attendance rates for GMP (∼40%), due to feelings that it promotes public shaming, that it involves weighing children like goods, and an overall lack of community conversation and counseling that might improve perceptions (40).

The results of our study highlight several important policy considerations. First, our findings emphasize the high degree of stunting in this population and the need for effective interventions to address its underlying causes. Second, it underscores the potential role of improving caregivers' access to information about child growth. One potential educational tool would be the addition of height to child growth monitoring charts at home, which currently only include weight. Community health workers could explain the implications of these numbers to caregivers during health care and household visits to spark conversation and awareness about child growth. Village-level GMP should be modified to include height and fully integrated into routine child health visits and health extension services. Previous research from Zambia has found that home- and community-based growth monitoring that provides a visual standard for assessing children's heights might be effective for improving linear growth and parental feeding behaviors among children who were stunted (41). Based on research describing the limitations of GMP (39), major improvements are needed in the design, delivery, and social acceptability of current programs to improve their impact. Although addressing perceptions alone is insufficient, it might represent one important component of multisectoral nutrition programs that simultaneously address behavior change, access to resources, and other barriers to improved nutrition.

This study had several limitations. As an observational analysis, these results are subject to confounding. Although we adjusted for a number of confounders in our multivariate models, there is always the possibility of residual confounding. In spite of thorough enumerator training, it is likely that our variable describing caregivers' perceptions suffered from nondifferential measurement error in a population with low literacy and numeracy. Future studies might benefit from using a Likert scale (out of 5 points), which may be more intuitive for respondents and easier to implement (42). There are also inherent limitations in comparing children in our sample with the DHS distribution; although we made these populations as demographically similar as possible and they were shown to have similar distributions, they do represent different underlying samples, which could induce bias. We also acknowledge that our findings might not be generalizable to the general population of Ethiopia or to other populations. However, Oromia is the largest region in Ethiopia by both population and area, and thus provides an informative example. Lastly, it is possible that caregivers' perceptions were driven by social desirability rather than by their true estimations of their child's height. Although we observed a positive relation between perceived and actual HAZ, our results should be interpreted as driven by a combination of true perceptions and social desirability.

Our study benefits from several notable strengths. We addressed measurement error related to misinterpretation of the height scale by adjusting for factors we expected were associated with differential interpretations in our multivariate model, like education and wealth. Our classification of overestimation was highly conservative in order to account for potential measurement error, because we allowed for a margin of error of ±1 SD. We also used a broader definition of stunting than the WHO definition, in order to include children who were suffering from the complications of growth faltering, but who would not be captured by the standard classification.

In conclusion, the results of our analysis shed light on an understudied issue: how caregivers perceive their children's linear growth, especially in contexts with prevalent undernutrition. Future studies could investigate how caregivers perceive their child's height relative to an ideal or global standard and explore how both male and female caregivers' perceptions influence child nutrition outcomes. Although women are generally responsible for the domain of child feeding and food preparation in Ethiopia, a father's role as the financial head of the household (43) could represent an important and unexplored dimension of behavior change related to child nutrition. In addition, more research is needed to explore how recognition of child growth deficits is related to behavior change in low- and middle-income countries, and the barriers associated with changes in behavior. Future research would benefit from experimental interventions that aim to change nutritional perceptions in order to provide a causal link between perceptions and behaviors.

Acknowledgments

The authors' responsibilities were as follows—SP, CS, KKD, WF, and MM: contributed to the design; SP: contributed to the data curation, formal analysis, visualization, writing, and final content; CS, KKD, WF, and MM: contributed to the methodology, investigation, and supervision of the analysis; JC, KD, NSG, HDG, MT, and MM: contributed to the conceptualization, administration, supervision, and funding acquisition of the project; and all authors: read and approved the final manuscript.

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