

Weighing Vietnamese children: How accurate are child weights adjusted for estimates of clothing weight?*

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Abstract

Children who are weighed for growth monitoring are frequently clothed, especially in the cold weather. Health workers commonly estimate and subtract the weight of these clothes, but the accuracy of these estimates is unknown. We assessed the accuracy of child weights adjusted for estimated clothing typical of hot, cold, and extremely cold ambient temperatures. Trained field workers weighed a sample of 212 children 6 to 42 months old from the ViSION project, adjusted the weights using a job aid describing the weights of common clothing by season and age, and then weighed the clothing to calculate the actual clothing and child weights. Fieldworker estimates of the weight of the clothing that children wore during weighing were remarkably good. In nearly all cases (207 of 212; 97.7%), the difference between the estimated and actual clothing weight was less than the precision of the child scales (± 50 g), and most (181 of 212; 84.5%) were within 25 g. Thus, the calculated child weights were, in fact, equivalent to the actual child weights. Using simulations, we found that improperly accounting for clothing weight can overestimate weight-for-age by 0.1 to 0.4 Z score. Accurate weights are possible, even under adverse conditions. Our training methods, clothing album, and job aid might benefit nutrition research and programming in Viet Nam as well as settings with colder climates.

Key words: Growth monitoring, validation, child clothing, weight estimation, Viet Nam

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Introduction

Viet Nam has dozens of child nutrition surveys annually. The National Nutrition Program weighs nearly 10 million children under five years of age at least once a year, and non-governmental organizations weigh about one million children monthly. The proper identification of children who are growth faltering, and thus the effectiveness of these programs both at the population and the individual level, rests on accurate anthropometric measurements. These, in turn, are influenced by several factors embracing the observer (e.g., training, supervision, job aids, and performance of measurer and assistants), the equipment (e.g., scale accuracy, precision, state of repair, ambient temperature), and the subject (e.g., child's age, mood, health, clothing, and caregiver support).

Reports of nutrition-related studies [1, 2] indicate that standardization of measurement has not been widely applied in Viet Nam. Indeed, it is limited to a few studies conducted by the National Institute of Nutrition and some non-governmental organizations.** Improper accounting for clothing will clearly affect weights determined by the most accurate scales, for example those with 10 g precision [3]. Manuals for less precise scales [4] suggest that either the caregiver remove the clothes and diapers or the observer subtract the weight of the clothing from the observed

* The ViSION (Viet Nam study to improve outcomes in nutrition) project evaluated the implementation and impact of an integrated nutrition program on the nutritional status, morbidity, diet of, and care for children 5 to 25 months old at baseline in rural Viet Nam, through a partnership among Save the Children/US (Hanoi and Westport, Conn., USA), the USAID-funded LINKAGES Project (Washington, D.C.), Emory University's Rollins School of Public Health (Atlanta, Ga., USA), and the Research and Training Center for Community Development (Hanoi).

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weight. However, the weight of the clothing is generally unknown.

Viet Nam has no written protocol or manual for the common operational challenge of weighing a child who is not completely undressed. The amount of clothing worn by children while they are being weighed varies by season. Viet Nam has four seasons ranging in temperature from 30 to 34°C during summer (May–July) to 6 to 16°C plus wind chill during winter (Nov–Jan) [5]. Morbidity, food availability, and growth faltering also vary by season, potentially accentuating errors in clothing weight estimates. Weighing is often conducted outside in the open air or inside an unheated house. Under such situations, the child cannot be weighed undressed in winter. Some caregivers even resist completely undressing young infants in hot weather. At best, field workers estimate the weight of the child's clothing and subtract this from the observed weight of the clothed child to calculate the child's likely actual weight.

The purpose of this study was to assess the accuracy of field workers' estimates of the weight of children's clothing against the actual weights of the same clothing and thus to assess the accuracy of the field workers' calculated weights of the children against their actual weights. Findings from this study help validate results [6] from the ViSION (Viet Nam study to improve outcomes in nutrition) project [7] from which the subjects came, raise national attention to the accuracy of calculating child weight through clothing subtraction, and propose a method to assure quality.

Methods

Subjects

We approached nearly all (98%; 235 of 240) caregiver-child pairs) from the six intervention and six control communes of the ViSION Project described elsewhere [7]. Most (90%; 212 of 235) agreed to participate. One of six field workers weighed each child.

Measurements

We used the UNICEF SECA floor scale (SECA Ltd., Birmingham, UK) (weighing capacity: 1kg to 150kg in 100g increments with ± 100 g precision). It has a solar cell on-switch (light sensitivity 15 lux) and is powered by a long-life lithium battery, good for one million weighing cycles. This electronic scale allows weighing the mother with the child, then weighing the mother alone (or vice versa), and finally automatically calculating the difference between the two measurements as the child's weight. This is helpful for struggling children or those who would resist a sling or weighing pants. This

scale zeros itself so children can be weighed quickly [8]. Adding (or subtracting) 0 to 49.9 g does not affect the SECA digital read-out. Adding (or subtracting) 50 to 149.9 g causes the SECA scale to round up (or down) 100 g. We used a Soehnle Attache scale (Montlingen, Switzerland), accurate to 1 g with battery-powered digital display, to weigh children's clothing [8].

Data collection

This study occurred in summer from June to August with ambient temperature ranging from 30 to 34°C. Field workers either requested the caregiver to stand the clothed child on the SECA scale or used the mother-child difference method described above. The weighing was repeated three times, and the results recorded on a data-gathering form for later algorithmic derivation of the weight. Next, the field worker estimated the total weight of the child's clothes and recorded her estimate on the same sheet. Then the field worker asked the caregiver to remove all the child's clothes, which the worker weighed using the Soehnle scale. She immediately recorded the results on the data collection form. A supervisor observed approximately 10% of the sample to assure that each step was followed properly, including no post-entry modification. To simulate obtaining the weight of children's clothing during a colder season, field workers asked 123 mothers to dress their children accordingly, and 100 agreed to do so. Forty-nine of these mothers dressed their children for cold temperatures (12–16°C), and 51 dressed their children for extremely cold temperatures (6–10°C). Field workers also recorded the children's sex, date of birth, and date of survey.

Field worker training

The field workers all had bachelor or nursing degrees. The Research and Training Center for Community Development (RTCCD) trained field workers to adhere to standardized weighing guidelines and to use a reference sheet of the weights and descriptions of 30 popular children's clothing items based on the child's age and season (available on request). The RTCCD weighed and recorded approximately five examples of each item to prepare the sheet.

In addition to the reference sheet, the RTCCD prepared a training album of 35 photographs of 100 different items of popular children's clothes, including jackets, sweaters, shirts, pants, hats, shoes, socks, and scarves (available on request). An accompanying note for each photograph named the item, its principle fabric and main characteristics, the appropriate age of children wearing it, and its weight (i.e., "long-sleeve thick cotton T-shirt, 12 months, 250 grams").

Statistical analysis

We calculated the mean difference (with 95% confidence intervals) between the estimated and the actual clothing weights by season or by age. In addition, we compared the raw difference between the estimated and actual clothing weights at 25-g intervals according to season. The data were entered and analyzed in Epi Info 6.0 [9] and Excel (Microsoft Corporation, Redmond, Wash., USA). We used *t* tests to compare means and considered *p* values less than or equal to 0.05 to be statistically significant.

We used the current Vietnamese two-channel road-to-health chart to assess the effect on a calculated child weight if one failed to correct for clothing weight. We visually determined weights along the road-to-health chart curve separating normal from abnormal weight-for-age over representative ages between 6 and 24 months. We then subtracted ranges of weights representative of our actual clothing weight findings (100 to 400 g) from these child weights, calculated the sex-specific weight-for-age Z score (WAZ) for each uncorrected and corrected child weight, and calculated the difference in Z score between these child weights.

Results

The 212 subjects were well distributed by age and gender (table 1). Children's ages ranged from 6 to 42 months, and 112 (53%) were boys. There were 21 (10%) children under 12 months, 95 (45%) between 12 and 24 months, and 96 (45%) were between 25 and 32 months of age. As expected, younger infants were under-represented given that this study occurred during the second half of the larger longitudinal study.

Not surprisingly, clothing weight varied by season ($82 \text{ g} \pm 34$, $192 \text{ g} \pm 78$, and $357 \text{ g} \pm 119$, for warm, cold, and very cold seasons, respectively, $p < .001$). Older boys seemed to wear heavier clothes than girls for simulated cold conditions (264 vs. 191 g, $p = .07$).

Field workers' estimations for weights of hot weather clothing were accurate (actual minus estimated weight = $0.03 \text{ g} \pm 11.9$, $p = .97$). Estimates for cold

and extreme cold weather clothing were slightly less than actual clothing weights although not statistically, and certainly not programmatically significant (actual minus estimated weight = $6.9 \text{ g} \pm 24.4$, $p = 0.05$; and $6.6 \text{ g} \pm 27.3$, $p = 0.09$, respectively). The underestimates were minimal and similar across age groups and again not significant (actual minus estimated weight = $2.7 \text{ g} \pm 14.6$, $p = 0.4$; $3.1 \text{ g} \pm 18.3$, $p = 0.1$; and $3.4 \text{ g} \pm 22.5$], $p = 0.14$ for 6 to 11, 12 to 23, and 24 months or older, respectively).

Only three children (1.4%) had 100 g incorrectly added to their actual weights, and two children (0.9%) had 100 g incorrectly subtracted from their actual weights. In other words, nearly all estimated weights (207 of 212; 97.7%) were within the precision of the scales ($\pm 50 \text{ g}$), and most (181 of 212; 84.5%) were within 25 g (fig. 1). Six children (3%) were estimated exactly correctly.

Underestimating or neglecting to account for the weight of clothing such as those we measured would have resulted in calculating falsely elevated weight-for-age Z scores (up to 0.09-0.40 SD and 0.08-0.38 SD for boys and girls, ages 6 to 24 months, respectively) (table 2).

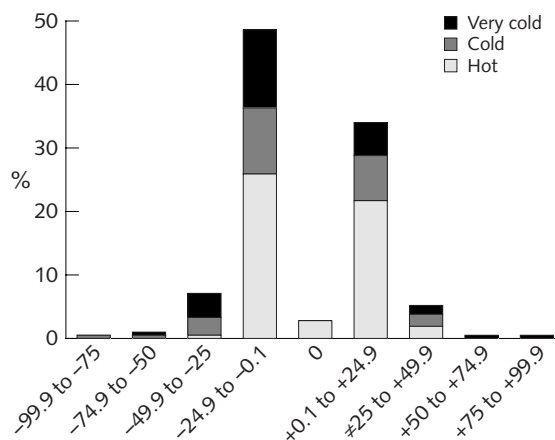


FIG. 1. Difference between actual and estimated clothing weights by season

TABLE 1. Actual weight (grams) of children's clothing by age, sex, and climate

Climate	Girls						Boys					
	6–11 mo		12–23 mo		24–32 mo		6–11 mo		12–23 mo		24–32 mo	
	<i>n</i>	Weight (g)	<i>n</i>	Weight (g)	<i>n</i>	Weight (g)	<i>n</i>	Weight (g)	<i>n</i>	Weight (g)	<i>n</i>	Weight (g)
Hot (<i>n</i> = 112)	5	67 ± 28	19	77 ± 36	30	89 ± 40	6	64 ± 34	30	81 ± 35	22	88 ± 22
Cold (<i>n</i> = 49)	2	158 ± 5	8	197 ± 85	12	191 ± 58	3	151 ± 26	14	151 ± 44	10	264 ± 104
Extreme cold (<i>n</i> = 51)	3	235 ± 29	9	331 ± 90	12	372 ± 85	2	295 ± 80	15	356 ± 153	10	413 ± 123
Total (<i>n</i> = 212)	10	136 ± 81	36	167 ± 125	54	175 ± 127	11	130 ± 97	59	168 ± 141	42	207 ± 157

TABLE 2. Effect of underestimating child weight (by 100 to 400 grams) on weight-for-age Z score

Age mo	Weight ^a kg	Male WAZ	Male d-WAZ ^b				Female WAZ	Female d-WAZ ^b			
			-100 g	-200 g	-300 g	-400 g		-100 g	-200 g	-300 g	-400 g
6	5.6	-2.30	-10	-21	-31	^c	-1.85	-11	-23	-34	^c
12	7.5	-2.61	-10	-20	-30	-40	-1.94	-09	-19	-28	-38
18	8.6	-2.43	-09	-17	-26	-34	-1.90	-09	-17	-26	-34
24	9.5	-2.53	-09	-18	-26	-35	-1.96	-08	-17	-25	-34

a. Weights visually determined from the curve demarcating normal from abnormal weight-for-age on the two-channel Vietnamese road-to-health chart in use in 2002.

b. d-WAZ, difference in weight-for-age Z score, i.e., initial male (or female) WAZ minus sex-specific WAZ when weight adjusted by 100 to 400 g.

c. These clothing weights were not observed for children age 6 to 11 mo.

Discussion

Improper correction for the weight of children's clothing can distort estimated child weights by hundreds of grams. Failure to take account of the clothing will systematically overestimate the nutritional status of a population or an individual child. Over-correction will have the opposite effect. The weights obtained in the ViSION project were accurate with regard to clothing with minimal random and no systematic error. We have suggested the training and tools (album and reference sheet) that were likely responsible for achieving this good performance.

The significance of the potential to overestimate children's weight is large. Effective child nutrition programs typically achieve an improvement in WAZ of 0.10 to 0.50 among 6 to 12 month old children [10]. Error in the range we calculated (0.1 to 0.4 Z score) could either negate an effective program (if children tended to be weighed clothed at baseline and unclothed at endline) or champion an ineffective program (if children tended to be weighed unclothed at baseline and clothed at endline). In the absence of a clear weighing protocol, one might predict greater error when baseline and endline weights were obtained in different seasons necessitating different amounts of clothing. Interpreting an individual child's growth could be equally problematic.

An unexpected observation was the tendency for these rural boys to be more warmly dressed than girls under conditions simulating cold weather. Whether this represents gender-specific style and clothing manufacture or a true difference in care between genders is not known. If the latter, then these differences might reflect varied expectations for exposure to cold (i.e., relative time inside versus outside the home), susceptibility to cold, or subtle gender preference, among others.

The study had limitations. Due to the ethical concerns about weighing undressed children in cold or extremely cold field conditions, the research team did not observe actual behavior in such settings. This

might be accomplished with another field study if an acceptably heated weighing station and open-minded caregivers were identified. Similarly, we did not assess the performance of less trained or less educated field workers typical of most programs. Whether these standards are transferable beyond a research setting remains to be seen.

In sum, we found that properly trained fieldworkers, trained with visual images of pre-weighed clothing and armed with reference sheets, can accurately calculate child weights by properly identifying clothing, estimating its total weight, and subtracting this from the child's clothed weight during a growth monitoring event. In most cases, the difference between field worker estimates and the actual clothing weight were within the precision of the child weighing scale; thus, the calculated child weights were, in fact, equivalent to the actual child weights. We suspect, however, that most growth monitoring programs have not trained field workers in a standardized, valid approach to account for clothing during weighing. Improperly accounting for clothing can lead to substantial errors in calculated child weights, misclassification, and false conclusions regarding a child's nutritional status and growth, a population's nutritional status, and a program's impact. We recommend that directors of growth monitoring programs develop locally appropriate visual aids such as those described in this paper and train fieldworkers in their use.

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