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Prevalence of malnutrition in children under five and school-age children in Milot Valley, Haiti

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ABSTRACT

Objectives: This research aims to provide child malnutrition prevalence data from Haiti's Milot Valley to inform the design and implementation of local health interventions.
Study design: This cross-sectional study measured underweight, stunting, and wasting/thinness using international growth standards.
Methods: Anthropometric measurements (height/length and weight) were taken on a convenience sample of 358 children aged 0–14 years. Participants were recruited through door-to-door field visits at five recruitment sites in the Milot Valley, including individuals in the waiting area of the Pediatric Outpatient Clinic at Hôpital Sacré Coeur. Caregivers were asked questions about the child's health history, including past and current feeding practices.
Results: Combining moderate and severe forms of malnutrition, 14.8% of children under five were stunted, 15.3% were wasted, and 16.1% were underweight. Among children 5–14 years of age, 14.1% were stunted, 7.6% were thin (low body mass index (BMI)-for-age), and 14.5% were underweight. For children under five, 42% of mothers ended exclusive breastfeeding before the recommended six months.
Conclusion: This study illustrates the local magnitude of childhood malnutrition and can serve as a resource for future child health interventions in the Milot Valley. To fight malnutrition, a multipronged, integrated approach is recommended, combining effective community outreach and monitoring, inpatient and outpatient nutrition therapy, and expanded partnerships with nutrition-related organizations in the region.

Introduction

One of the underlying causes of malnutrition is poverty, embodied in food insecurity and poor access to, and use of, health services.[1] According to the 2012 Demographic and Health Survey, approximately 22% of Haiti's children under five years of age were moderately or severely stunted (height-for-age z-score [HAZ] < −2), 5% were wasted (weight-for-height z-score [WHZ] < −2), and 11% were underweight

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(weight-for-age z-score [WAZ] < −2),[2] while 25% of infants were born with low birth weight, a major risk factor for growth failure and malnutrition.[3] In the North region, in which the Milot Valley is located, 25% of children under five years of age were moderately or severely stunted (HAZ < −2), 4% were wasted (WHZ < −2), and 14% were underweight (WAZ < −2).[2] Population-wide growth monitoring of school-age children is less common, but studies show that malnutrition in school-age children follows the prevalence distribution of children under five.[4] The recent National Program to Fight against Hunger and Malnutrition, called *Aba Grangou* ('Down with Hunger'), stated that 57% of child deaths in Haiti could be avoided with adequate nutrition.[5]

At the individual level, wasting is a manifestation of acute malnutrition, which is generally caused by caloric deficit and/or infectious disease.[6] While food shortage and infection can also lead to stunting over time, the etiologies of linear growth impairment are complex and the focus of ongoing research. The mechanisms of stunting may include micronutrient deficiencies, exposure to environmental pathogens and poor sanitation, suboptimal feeding practices, poor prenatal nutrition causing intrauterine growth retardation, impaired growth plate regulation, and disruption in the gut microbiota and immune system.[7–9]

Children who suffer from acute malnutrition are at greater risk for severe morbidity and mortality.[10] Thin school-age children may suffer from reduced work capacity, reduced muscle strength, and delayed puberty.[11] Stunting is associated with higher risks of illness and infections that can be fatal if improperly addressed.[12] Stunting has also been associated with delayed mental development, reduced motor skills, reduced intellectual achievement, higher chronic disease risk in adulthood, and increased mortality risk.[10–12] While catch up growth may be possible with improved nutrition and a growth-promoting environment during childhood up to adolescence,[13,14] stunting is considered generally irreversible after early childhood, particularly after the first two years of life.[14,15] Current global nutrition interventions focus on the importance of stunting prevention in early childhood and thinness in older children, but further research is needed to assess the nutritional status of school-age children.[10,11]

The short- and long-term consequences of childhood malnutrition emphasize the urgency to effectively prevent, identify, and treat malnutrition. There are no known studies of malnutrition prevalence specific to the Milot Valley of Haiti. This research aims to contribute to the reduction of childhood malnutrition and illness by providing local data that can be used to prioritize, design, and implement public health interventions in this region.

Methods

Study location

Milot is a rural town with a population of approximately 25,000, located in the lush, mountainous North region of Haiti, 20 km from Cap Haitien, the second largest city in Haiti, and 270 km from Port au Prince.[16]

Hôpital Sacré Coeur (HSC) is the largest private hospital in Haiti, funded by the US-based Center for the Rural Development of Milot and staffed by 250 Haitian employees.[16] Foreign volunteers provide supplemental, specialized care and services. In addition to tertiary care services, HSC runs a community health program offering vaccinations, prenatal care, basic hygiene, nutrition counseling, and treatment for infectious diseases. HSC was interested in obtaining data that could be used to prioritize, design, and implement public health interventions to reduce childhood malnutrition and illness in Milot Valley.

The largely rural population within a 12-mile radius of Milot forms the Milot Valley and catchment population of HSC (approximately 225,000 people).[16] The hospital leadership selected five recruitment sites for this study: four communes and villages in the catchment area and the Outpatient Pediatric Clinic at HSC.

Design

This cross-sectional child nutrition study was conducted in June/July 2012. The study was approved by the Tufts Medical Center/Tufts University Institutional Review Board (IRB) and HSC administration. All materials were translated into Haitian Creole for interpreter use in the field and back-translated into English prior to field use.

Protocol

A convenience sample of participants were recruited from the selected recruitment sites through door-to-door field visits, accessible by van or within walking distance of local community health centers in the four catchment area recruitment sites. Participants were also recruited from the waiting area at HSC's Pediatric Outpatient Clinic. Caregivers were approached at their homes or while waiting at the clinic and asked to participate in the study with their children. In accordance with Tufts University IRB regulations, caregivers provided verbal consent and the willingness of children over age seven to undergo anthropometric measurements represented assent to the study procedures. Each participating child was assigned a unique identifier; participants' names were not taken to ensure confidentiality.

Height and weight were measured for each child age 0–14 years. Height was measured using a self-standing stadiometer or recumbent measuring mat for children unable to stand. Weight was measured using a standing scale, and children unable to stand were measured in their caregiver's arms. Via an interpreter, caregivers of children under five were asked questions about history of breastfeeding and introduction of complementary foods. All caregivers were asked how often the child eats per day and the number of children living in the household.

Caregivers received a card listing their child's measurements. Children found to be severely acutely malnourished based on weight-for-height using World Health Organization (WHO) criteria were referred to community health nurses for follow-up. All families were given brief nutrition education to encourage a balanced diet of nutrient-rich foods based on foods found in the region.

Data analysis

Malnutrition was assessed by stunting (low height-for-age) for all children, underweight (low weight-for-age) for children under 10, wasting (low weight-for-height) for children under five, and thinness (low body mass index (BMI)-for-age) for children aged 5–14. Analysis was based on WHO growth references in the form of standard deviations from the international reference population (z-scores) for ages six months-19 years.[17,18] Severe malnutrition was defined using WHO criteria as a z-score of less than or equal to −3; and moderate malnutrition as a z-score between −3 and −2. While less frequently collected in population level nutrition surveys, mild malnutrition (z-score between −1 and −2)[19] was also calculated in this analysis to inform the hospital leadership of the prevalence of children in this category. Measurements were converted into z-scores using WHO Anthro/AnthroPlus.[19]

STATA IC-11 was used to determine the prevalence of different types and severity of malnutrition and to compare sub-groups of children. Chi-square tests were used to identify differences in malnutrition prevalence by recruitment site, age, and sex. Statistical significance was set at $p \leq 0.05$ (two-tailed).

Results

Characteristics of the children in Milot Valley

Over two months, 358 children aged 0–14 years were surveyed in the Milot Valley. Table 1 shows the sample characteristics by age, sex, and recruitment site. Height data was not available for six children who refused height measurement. Based on WHO Anthro outlier parameters, which flags any weight-related z-score above +5,[20] weight measurement for one child (WHZ = 9.1, WAZ = 6.4) was excluded from the analysis.

For children no longer breastfed, the duration of breastfeeding in infancy ranged from 2 to 24 months, with a median of 18 months (25th percentile = 11 months, 75th percentile = 18 months). The timing of early introduction to weaning foods ranged from 0 to 5 months, with a median of three months (25th percentile = two months, 75th percentile = three months).

Malnutrition prevalence of children in Milot Valley

Among children under five years of age, 14.8% were stunted (HAZ < −2), 15.3% were wasted (WHZ < −2), and 16.1% were underweight (WAZ < −2). Among children 5–14 years of age, 14.1% were stunted (HAZ < −2), 7.6% were thin (BMI-for-age z-score [BAZ] < −2), and 14.5% were underweight (WAZ < −2). Table 2 shows the data stratified by age and severity. Malnutrition prevalence was similar between infants and children aged 2–5 years. Wasting, thinness, and underweight did not significantly differ by recruitment site. When considered together, the prevalence of mild, moderate and severe stunting was significantly lower ($p = .002$) in the Pediatric Clinic (29%) than in all other recruitment sites combined (51%).

Table 1 – Characteristics of children assessed for malnutrition from Milot Valley, Haiti (June–August 2012).

	N	%
Age (years)		
<5	188	53%
5–9	118	33%
10–14	52	15%
Sex		
Male	170	47%
Female	188	53%
Recruitment site		
Thibeau	72	20%
Carrefour des Peres	91	25%
Limonade	63	18%
Milot center	74	21%
Pediatric outpatient clinic	58	16%
# of children in household		
0-1	139	39%
2-3	132	37%
4+	87	24%
Meals per day[a]		
1–1.5	36	14%
2–2.5	120	48%
3–4.0	95	39%
Breastfeeding (for children <5 years)		
Ever breastfed	184	98%
Complementary food given before six months[b]	79	42%

[a] Non-numerical responses (e.g. 'all day', 'whenever there is food') and breastfeeding infants excluded, N = 251. Responses given as ranges converted to means (e.g. '2-3 times per day' converted to 2.5).
[b] Excluding infant formula, medication, and oral rehydration solution.

Childhood malnutrition prevalence could vary between males and females due to unequal access to food and health resources.[21] However, differences between sexes were not statistically significant for stunting, wasting/thinness, or underweight ($p = .394$, $p = .079$, and $p = .170$, respectively) (Table 3).

Discussion

The present study provides local data on the prevalence of child malnutrition in the Milot Valley of Haiti. Roughly one-fifth of children under five were moderately or severely underweight, stunted, and/or wasted, putting them at increased risk for morbidity and mortality. The prevalence of moderate and severe stunting found in this study is lower than the national average. Potential reasons for this may be that this region has greater food security due to rural agriculture, or that these recruitment sites within the hospital's catchment area have greater access to health services. However, the prevalence of wasting/thinness is alarmingly high in this region, especially for children under five, and is considerably higher than the national average. Additionally, half of all children were below the 15th percentile on the WHO growth standard, indicating that malnutrition is a major health concern in the Milot Valley.

The high levels of malnutrition in children of school-age may reflect the inability to regain normal growth after early

Table 2 – Prevalence of malnutrition among children in five recruitment sites in Milot valley, Haiti, by age group (June–August 2012).

		<5 years (N = 182)		5–14 years (N = 170)		Total (N = 352)	
		%	95% CI[a]	%	95% CI	%	95% CI
Stunting (low height-for-age)	None	53.8	46.6–61.0	51.2	43.7–58.7	52.6	47.4–57.8
	Mild[b]	31.3	24.1–38.0	34.7	27.5–41.9	33.0	28.1–37.9
	Moderate	10.4	6.0–14.8	11.2	6.5–15.9	10.8	7.6–14.0
	Severe	4.4	1.4–7.4	2.9	0.4–5.4	3.7	1.7-5.7
Wasting/thinness (low weight-for-height/low BMI-for-age)[c]	None	58.8	51.6–66.0	58.2	50.8–65.6	58.5	53.4–63.6
	Mild	25.8	19.4–32.2	34.1	27.0–41.2	29.8	25.0–34.6
	Moderate	11.5	6.9–16.1	4.1	1.1–7.1	8.0	5.2–10.8
	Severe	3.8	1.0–6.6	3.5	0.7–6.3	3.7	1.7–5.7
Underweight (low weight-for-age)[d]	None	49.7	42.4–57.0	49.6	42.1–57.1	49.7	44.5–54.9
	Mild	34.2	27.3–41.1	35.9	28.7–43.1	34.9	29.9–39.9
	Moderate	11.8	7.1–16.5	12.8	7.8–17.8	12.2	8.8–15.6
	Severe	4.3	1.4–7.2	1.7	−0.2–3.6	3.3	1.4–5.2

[a] 95% confidence interval.
[b] According to WHO child growth guidelines, severity of malnutrition was categorized according to Z-scores (Z); mild ($-1 > Z \geq -2$), moderate ($-2 > Z \geq -3$), severe ($Z < -3$).
[c] According to WHO child growth guidelines (14), weight-for-height was used as an indicator of wasting in children under age five years; BMI-for-age was used as an indicator of thinness in children aged 5–14 years.
[d] Only calculated for children <10 years old (N = 304).

childhood undernutrition and/or persistent inadequate health, environmental, and food security conditions. Further, greater than one third of the children in this study are mildly malnourished in each of the three measures of malnutrition. This population is important to distinguish as they can quickly fall into moderate or severe malnutrition in the event of a shock or extended period of inadequate nutrition.[22] Considering all three levels of severity of malnutrition, roughly two-thirds (69%) of all children were affected by at least one type of malnutrition.

Table 3 – Prevalence of malnutrition among children in five recruitment sites in Milot valley, Haiti, by sex (age 0–14 years) (June–August 2012).

		Male (N = 166)		Female (N = 186)	
		%	95% CI[a]	%	95% CI
Stunting (low height-for-age)	None	47.1	39.5–54.7	55.9	48.7–63.0
	Mild[b]	36.5	29.1–43.8	28.7	22.2–35.2
	Moderate	10.6	5.9–15.3	10.6	6.2–15.1
	Severe	3.5	0.7–6.3	3.7	1.0–6.4
Wasting/thinness (low weight-for-height/ low BMI-for-age)[c]	None	63.9	56.5–71.2	53.8	46.6–60.9
	Mild	27.1	20.3–33.9	32.3	25.5–39.0
	Moderate	4.8	1.6–8.1	10.8	6.3–15.2
	Severe	4.2	1.2–7.3	3.2	0.7–5.8
Underweight (low weight-for-age)[d]	None	53.7	45.6–61.9	42.7	34.9–50.5
	Mild	29.9	22.5–37.4	39.5	31.8–47.2
	Moderate	12.2	6.9–17.6	12.1	7.0–17.2
	Severe	2.0	−0.3–4.4	4.5	1.2–7.7

[a] 95% confidence interval.
[b] According to WHO child growth guidelines, severity of malnutrition was categorized according to Z-scores (Z); mild ($-1 > Z \geq 2$), moderate ($-2 > Z \geq -3$), severe ($Z < -3$).
[c] According to WHO child growth guidelines, weight-for-height was used as an indicator of wasting in children under age five years; BMI-for-age was used as an indicator of thinness in children aged 5–14 years.
[d] Only calculated for children <10 years old (N = 304).

The prevalence of overall stunting in all children visiting the HSC Pediatric Clinic was lower than the other recruitment sites. Though not statistically significant, the prevalence of wasting and thinness, especially severe wasting and thinness, tended to be higher than the other recruitment sites. These trends may suggest that children visiting the clinic are more likely to be ill and thus more likely to demonstrate wasting or thinness as a result of illness, but less likely to be chronically malnourished, and thus stunted, as a result of greater household access to not only health services but other nutrition-related resources.

Globally, child malnutrition is largely caused by inadequate infant and young child feeding practices. Nearly half of all surveyed children under five had been introduced to complementary foods before the recommended six months, making them more vulnerable to diarrheal illness and infection. According to the Haitian National Nutrition Policy, exclusive breastfeeding for the first six months can reduce infant mortality by 23%, and should be rigorously promoted in communities.[5] However, it is also crucial to direct nutritional interventions towards a broader, life cycle approach, encompassing the health of mothers and older children who will parent the next generation.

In conclusion, childhood malnutrition remains a significant and urgent public health issue in Haiti. This study illustrates the magnitude of malnutrition in the Milot Valley. While the prevalence of malnutrition in this northern, rural region may not be representative of all regions in Haiti, this location-specific information is valuable for national nutrition policy planning. It can also serve as a resource and evidence base for informing future child health interventions in the Milot Valley. To successfully fight the high level of malnutrition locally, a multipronged, integrated approach is recommended. This approach should combine effective community

outreach and monitoring, inpatient and outpatient nutrition therapy, efforts to increase food security and improve child feeding behaviors, and expanded partnerships with other nutrition-related organizations in the region.

Malnutrition is a complex condition affected by a range of determinants, and it is difficult to conduct a study inclusive of all factors that contribute to a child's nutritional status. Follow-up studies may include more in-depth and expanded consideration of other determinants of malnutrition, qualitative research on community perceptions and behaviors related to nutrition, or longitudinal evaluations of progress and impact of future interventions initiated in this region.

Author statements

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Ethical approval

Approved by the Tufts Medical Center/Tufts University Institutional Review Board (IRB) and HSC administration. Subjects gave informed consent.

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Competing interests

None declared.

REFERENCES

1. Ajayi D. *Policy briefing: nutrition in Haiti*. Secretary of Health, Haiti; 2010.
2. *Enquête Mortalité, Morbidité et Utilisation des Services (EMMUS-V): Haiti 2012 Rapport Préliminaire*. Institut Haitien de l'Enfance (IHE) and Measure DHS/ICF International; 2012.
3. Fernandez I, Hines J, de Onis M. Prevalence of nutritional wasting in populations: building explanatory models using secondary data. *Bull World Health Organ* 2002;**80**:282–91.
4. Drake L, Maier C, Jukes M, Patrikios A, Bundy D, Gardner A, Dolan C. *School-age children: their nutrition and health*. SCN News #25. United Nations System Standing Committee on Nutrition; 2002.
5. *Protocole national de prise en charge de la malnutrition aiguë global en Haiti. Ministère de la Santé Publique et de la Population, Unité de Coordination du Programme National D'Alimentation et Nutrition (MSPP/UCPNANu)*; 2010.
6. Manary MJ, Sandige HL. Management of acute moderate and severe childhood malnutrition. *Br Med J*; 2008::337.
7. Branca F, Ferrari M. Impact of micronutrient deficiencies on growth: the stunting syndrome. *Ann Nutr Metabolism* 2002;**46**(Suppl. 1):8–17.
8. Gordon JI, Dewey KG, Mills DA, Medzhitov RM. The human gut microbiota and undernutrition. *Sci Transl Med* 2012;**4**(137):12.
9. Richard SA, Black RE, Gilman RH, Guerrant RL, Kang G, Lanata CF, Molbak K, Rasmussen ZA, Sack RB, Valentiner-Branth P, Checkley W, Childhood and Malnutrition Network. Wasting is associated with stunting in early childhood. *J Nutr* 2012;**142**(7):1291–6.
10. Black RE, Allen LH, Bhutta ZA, Caulfield LE, De Onis M, Ezzati M, Mathers C, Rivera J. Maternal and child undernutrition: global and regional exposures and health consequences. *Lancet* 2008;**371**(9608):243–60.
11. Best C, Neufingerl N, van Geel L, van den Briel T, Osendarp S. The nutritional status of school-aged children: why should we care? *Food & Nutr Bull* 2010;**31**(3):400–17.
12. Caulfield LE, Richard SA, Rivera JA, Musgrove P, Black RE. Stunting, wasting, and micronutrient deficiency disorders. In: Jamison DT, Breman JG, Measham AR, Alleyne G, Claeson M, Evans DB, Jha P, Mills A, Musgrove P, editors. *Disease control priorities in developing countries*. 2nd ed. Oxford University Press, The World Bank; 2006. p. 551–67.
13. Martorell Reynaldo. Physical growth and development of the malnourished child: Contributions from 50 years of research at INCAP. *Food Nutr Bull* 2010;**31**(1):68–82.
14. Golden Michael H. Proposed recommended nutrient densities for moderately malnourished children. *Food Nutr Bull* 2009;**30**(3):s267–342.
15. Doherty CP, Sarkar MAK, Shakur MS, Ling SC, Elton RA, Cutting WA. Linear and knemometric growth in the early phase of rehabilitation from severe malnutrition. *Br J Nutr* 2001;**85**:755–9.
16. *CRUDEM and Hôpital Sacré Coeur (HSC)*. Available at: http://www.crudem.org; 2012 (accessed 12 August 2013).
17. De Onis M. *WHO child growth standards: length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age: methods and development*; 2006.
18. De Onis M, Onyango AW, Borghi E, Siyam A, Nishida C, Siekmann J. Development of a WHO growth reference for school-aged children and adolescents. *Bull World Health Organ* 2007;**85**(9):660–7.
19. Cogill B. *Anthropometric indicators measurement guide: food and nutritional technical assistance project, academy for educational development*; 2003.
20. *WHO AnthroPlus for personal computers manual: software for assessing growth of the world's children and adolescents*. Geneva, Switzerland: World Health Organization; 2009.
21. Berti PR. Intrahousehold distribution of food: a review of the literature and discussion of the implications for food fortification programs. *Food & Nutr Bull* 2012;**33**(Suppl. 2):163S–9.
22. Bhagowalia P, Chen SE, Master WE. Effects and determinants of mild underweight among preschool children across countries and over time. *Econ Hum Biol* 2011;**9**:66–77.