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The Health of Haitian Schoolchildren: Longitudinal Effect of Annual Visits on Growth

Jamarie Geller[1], MD, MA; Mary Starrs[2], MD; Andrew Bartholomew[1], MD; Sara Kaliszak[3], MD; Jeri Kessenich[3], MD, FAAP*

[1]Department of Psychiatry, Michigan State University College of Human Medicine, East Lansing, MI, USA; [2]Department of Emergency Medicine, Michigan State University College of Human Medicine, East Lansing, MI, USA; [3]Department of Pediatrics and Human Development, Michigan State University College of Human Medicine, East Lansing, MI, USA

*jageller7@gmail.com

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Abstract

Introduction: Haiti has one of the highest rates of childhood undernutrition in the world, devastating overall health. This study focuses on the growth of children offered longitudinal healthcare by Kids Health for Haiti, using BMI to indicate developmental and nutritional status. Objectives include collecting baseline prevalence data, examining the impact of longitudinal interventions, and discussing future investigation and programming areas.

Methods: A retrospective longitudinal observational chart review on 245 students over a six-year period analyzing height, weight, and BMI. All data were collected as part of routine health provision and underwent statistical analysis using a single-subject design.

Results: 46.3%, 42%, and 37.1% of participants started in the lowest percentile groups (0-25th) for weight, height, and BMI, respectively. Among all participants, there was not a significant difference between the proportion of students that increased versus decreased percentile groups for weight ($p = 0.39$), height ($p = 0.782$), or BMI ($p = 0.064$) from first to most recent visit. Among students below the 25th percentile in each growth domain at the first visit, there was a statistically significant increase of at least one percentile group versus a decrease in weight ($p < 0.001$), height ($p < 0.001$), and BMI ($p < 0.006$).

Conclusion: These results highlight the significant burden of underdevelopment in this population and the potential for improvement with early interventions targeting general health and nutrition. Visits corresponded with improvements in growth, especially for the smallest children. Future investigations should target outcomes of specific treatments, assessing how programming can best improve growth outcomes.

Introduction

Haiti faces substantial poverty, food insecurity, disease, and limited potable water as the poorest country in the Western Hemisphere. Haiti has also sustained multiple devastating natural disasters in the last few decades. The Multidimensional Poverty Index, which documents features of health, education, and living standards, estimates almost half of the country is "multidimensionally poor" (House, 2018). Additionally, Haiti has one of the highest rates of childhood undernutrition in the Western Hemisphere, with about 30 percent suffering from malnutrition (Russell et al., 2010).

It is currently estimated that as many as one in five children in Haiti is stunted, with a height-for-age value less than two standard deviations of the WHO Child Growth Standards median (USAID, 2018). There has been an increased focus on malnutrition and stunting in Haitians under the age of five, especially following the 2010 earthquake. Still, there is a dearth of data addressing the prevalence of malnutrition and the effects of interventions on school-aged children.

The cause of delayed growth in Haitian school children is multifactorial. Among the most impactful factors are low birth weights and stunting during early life (Hernandez, 2002), ongoing caloric deficits, and infectious and chronic disease (Manary and Sandige, 2008). Children are further affected by substantial poverty (Duncan 2010), lack of education, political unrest, physical and sexual abuse, and inadequate healthcare. Armed conflict and ongoing political turmoil have allowed gangs and other types of organized violence to flourish, and sexual coercion and abuse are prevalent (Kolbe, 2013; Sumner, 2015). These dangerous conditions and a culture of conflict foster food insecurity and poor overall health.

The impact of malnutrition on health cannot be overstated. Protein-energy malnutrition (PEM) is a known risk factor for infectious diseases, including malaria, HIV/AIDS, and tuberculosis, all significant burdens to Haitian children (Schaible and Stefan, 2007). Metabolic disturbances secondary to PEM wreak havoc on the body, leading to multi-organ dysfunction, including cardiac insufficiency, dehydration, and further malabsorptive pathology (Bhan, 2003; Rossi and Zucoloto, 1982).

Micronutrient under-consumption and under-absorption are further drivers of morbidity in the malnourished. In developing nations, it is thought that deficiencies in iron, iodine, vitamin A and zinc contribute to hypothyroidism, anemia, skeletal pathology, and impaired immunity, among others (Alam et al., 2003; Müller and Krawinkel, 2005). It has also been suggested that malnutrition can contribute to psychological, emotional, and neurological impairments such as neurodisability (Black, 2003), depression (Gladstone et al., 2014), anxiety, and impairment of expressive speech and visual-spatial short-term memory (Galler et al., 2010). Mortality increases drastically with declining weight for age, which is evident even in mild to moderate malnutrition (Miranda et al., 2007). These factors likely overlie Haiti's drastically low life expectancy of 67, a full ten years less than the country with which they share an island, the Dominican Republic (Pelletier et al., 1993).

Kids Health for Haiti (KHH), a 501(c)3 organization in Grand Rapids, Michigan, has made at least biannual trips to Port-au-Prince since 2010, aiming to increase access health care for a small population of school children, grades kindergarten through ninth. The organization has provided longitudinal health care to children that live in nearby rural communities and attend the Power of Education Foundation (PEF) school.

Over the last ten years, health data has been collected and analyzed to gain insight into Haitian children's general health and to understand the impact of longitudinal health care service on growth and development. This investigation used chart abstraction and retrospective analyses to examine growth outcomes, using Body Mass Index (BMI) as a proxy for general nutritional status and development. This study was done to provide baseline prevalence data on a section of this population, gain insight into how interventions might improve outcomes, and advance the discussion on how to serve the children in this vulnerable population better.

Methods

Setting and participants

The study participants included 245 Haitian children ages five to nineteen years who attend the Power of Education Foundation (PEF) School in Port au Prince, Haiti. Inclusion criteria for the accumulated analysis required that students were present for physical examinations at least twice during the study period, and there were no exclusion criteria. Most of the children live in surrounding rural towns and commute to school daily. Enrollment at PEF is at the discretion of the principal, based on several factors, including poverty level and decreased access to education in the community. All children are sponsored to be able to attend, receiving supplies and uniforms. All analyses involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The institutional review board (IRB) of Michigan State University approved this study under IRB Number 17-986; i053930.

Study design and procedure

A retrospective longitudinal observational chart review was conducted on data collected from October 2012 to April 2018. These charts contained information collected as part of routine annual physical examinations of the students. Licensed American physicians, registered nurses, and medical students under supervision obtained all data collected over this time period. The health services provided at each physical examination included updated medical histories and physicals, anemia screening, fluoride treatment, vision and auditory testing, treatment of parasites and fungal infections, education on health care maintenance including hand and dental hygiene and safe cooking practices, and treatment of many acute and chronic medical conditions such as anemia, asthma, allergies, abdominal pain, skin conditions, and hypertension.

Data collected included age, height, weight, hemoglobin, blood pressure, known chronic disease, and physical exam notes. This information was recorded in paper charts, later abstracted to Excel documents, and aggregated into one document for analysis.

BMI measurement

At each visit, height was obtained using a measuring tape and weight with an electronic scale. Height and weight were used to calculate each child's BMI, and Quesgen's online Pediatric calculator was used to determine percentiles for weight, height, and BMI based on the child's biological sex and age. Quesgen Pediatric calculator uses the Center of Disease Control and Prevention (CDC) growth chart percentile data on children between the ages of 2 and 20 as the basis of BMI percentile calculations. The data were reported as a range based on predetermined percentile values supplied from the CDC. These predetermined ranges include <5, 5–10, 10–25, 25–50, 50–75, 75–90, and >90 percentile groups.

Statistical analysis

All data collected underwent statistical analysis using appropriate testing, including t-test, symmetry test, and the McNemar test. Summary statistics were calculated from the data, with quantitative data described as the mean ± SD, while categorical data were described as a percentage. For the summary on March 17, 2019, a t-test was run as part of quantitative data collection, and a symmetry test was run for categorical data collection. For the summary on April 22, 2019, the McNemar test was run for categorical data collection. All analyses were performed using Stat v.15.1 (StataCorp, College Station, TX). Significance was assessed at $p < 0.05$.

Results

Population

A total of 245 Haitian school-aged children were included in the analysis. 105 (57.1%) were female, and 140 (42.9%) were male. The average age of all students seen in March-April of 2017 was 11.6 ± 3.4 (years ± SD). The average age of students at their first visit was 7.1 ± 3.4 (years ± SD), and the average age of students at their latest visit was 12.6 ± 3.4 (years ± SD). The mean time in school for all students was 4.3 ± 0.6 (years ± SD).

Weight

At the first visit among all participants, 109 (46.3%) were in the 0–25th percentile group, 70 (29.8%) were in the 25th-50th percentile group, 39 (16.6%) were in the 50th–75th percentile group, and 17 (7.2%) were in the 75th–100th percentile group for weight (**Table 1**). The proportion of students below the 50th percentile for weight was 76.2% at the first visit and 73.2% at the latest visit ($p = 0.262$, **Table 1**). Among all students, 27.7% increased at least one percentile group, and 21.3% decreased at least one percentile group between the first and most recent visits ($p = 0.390$). Among students below the 25th percentile at the first visit, 37.6% increased at least one percentile group, and 15.6% decreased at least one percentile group ($p < 0.001$, **Table 2**).

Height

At the first visit among all participants, 104 (42.0%) were in the 0–25th percentile group, 59 (23.8%) were in the 25th-50th percentile group, 58 (23.4%) were in the 50th-75th percentile group, and 27 (10.9%) were in the 75th-100th percentile group for height (**Table 1**). The proportion of students below the 50th percentile for height was 65.7% at the first visit and 73.4% at the latest visit ($p = 0.020$, **Table 1**). Among all students, 31.5% gained at least one percentile group, and 24.6% decreased at least one percentile group ($p = 0.782$). Among students below the 25th percentile at the first visit, 46.2% of students increased at least one percentile group, and 14.4% decreased at least one percentile group ($p < 0.001$, **Table 2**).

BMI

At the first visit among all participants, 86 (37.1%) were in the 0–25th percentile group, 74 (31.9%) were in the 25th-50th percentile group, 53 (22.8%) were in the 50th-75th percentile group, and 19 (8.2%) were in the 75th-100th percentile group for BMI (**Table 1**). The proportion of students below the 50th percentile for BMI was 69.8% at the first visit and 62.1% at the latest visit (p =

Table 1. The proportion of students by percentile grouping for weight, height, and BMI. Percentiles determined by CDC growth curves for children age 2-20 and per gender.

	Weight		Height		BMI	
Percentile	*first visit*	*latest visit*	*first visit*	*latest visit*	*first visit*	*latest visit*
0 – <5	32 (13.6%)	20 (12.8%)	29 (11.7%)	24 (9.7%)	28 (12.1%)	19 (8.2%)
5 – <10	21 (8.9%)	21 (8.9%)	23 (9.3%)	30 (12.1%)	10 (4.3%)	20 (8.6%)
10 – <25	56 (23.8%)	50 (21.3%)	52 (21%)	51 (20.6%)	48 (20.7%)	56 (24.1%)
25 – <50	70 (29.8%)	71 (30.2%)	59 (23.8%)	77 (31.1%)	74 (31.9%)	49 (21.1%)
50 – <75	39 (16.6%)	39 (16.6%)	58 (23.4%)	41 (16.5%)	53 (22.8%)	56 (24.1%)
75 – <90	17 (7.2%)	20 (8.5%)	20 (8.1%)	17 (6.9%)	15 (6.5%)	25 (10.8%)
90 – <100	0 (0%)	4 (1.7%)	7 (2.8%)	8 (3.2%)	4 (1.7%)	7 (3%)

Table 2. The proportion of students who changed CDC percentile grouping between first and latest visit for weight, height, and BMI.

	Weight	Height	BMI
For all students			
decreased ≥1 percentile group	50 (21.3%)	78 (31.5%)	58 (25.0%)
increased ≥1 percentile group	65 (27.7%)	61 (24.6%)	71 (30.6%)
	p = 0.390	p = 0.782	p = 0.064
For students below 25th percentile			
decreased ≥1 percentile group	17 (15.6%)	15 (14.4%)	11 (12.8%)
increased ≥1 percentile group	41 (37.6%)	48 (46.2%)	33 (38.4%)
	p < 0.001	p < 0.001	p = 0.006

0.033, **Table 1**). Among all students, 30.6% gained at least one percentile group, and 25.0% decreased at least one percentile group (p = 0.064). Among students who were below the 25th percentile at the first visit, 38.4% increased at least one percentile group, and 12.8% decreased at least one percentile group (p = 0.006, **Table 2**).

Discussion

Results overview

Early intervention is essential in preventing adverse and potentially irreversible malnutrition outcomes; however, very little is known about effective interventions for addressing nutritional, cognitive, and socio-emotional development in this pediatric population. This study offers prevalence data for a group grossly underrepresented in current literature and preliminary support for the correlation of yearly wellness visits and improved growth parameters for Haitian schoolchildren.

Among all participants, a greater number moved up a percentile group than down from first visit to last visit for weight (p = 0.390). Interestingly, more students fell to a lower height percentile group than moved up (p = 0.782). For our primary outcome, BMI, more students gained a percentile group than lost (p = 0.064). Despite the many barriers to proper nutrition and growth, it is promising to have seen more overall gains than losses in weight and weight-for-height data.

In the analyses of children starting below the 25th percentile, a statistically significant number of children gained a percentile group in weight ($p < 0.001$), height ($p < 0.001$), and BMI (p = 0.006) over the treatment period. This is important as the smallest children, who were most likely to have experienced early stunting, are most at risk for correlates of poor growth and development, including malnutrition, infection, cognitive and developmental restriction, and increased mortality.

These improved outcomes, measured by the proportion of children who moved up at least one BMI percentile group compared to no change, or moving down, were expected. It is encouraging that KHH interventions coincided with an improvement in the children's developmental health who started in the lowest BMI categories.

Explanatory model

It is likely an amalgamation of factors that ultimately led to global improvements in health, and therefore the growth of these children, especially those who started the treatment period in the lowest percentile groups. Possible interventions positively impacting development for the children were yearly empiric anti-parasitic treatments, management of chronic conditions such as anemia, administration of a daily multivitamin, and education given to parents and children about healthy eating.

Among all participants, more actually moved to a lower height grouping than crossed into a higher percentile category. Since BMI is a function of weight-for-height, it is also possible some of the students have restricted vertical growth (increasing BMI without representing overall growth improvements). The implications of this finding are not clear, as the p-value suggests it is not significant but should be followed up in future studies. Further investigation should clarify which students gained and lost height percentiles over time, and how these changes interacted with each other. In part, this may be due to genetic factors and only slightly modified by nutritional status.

Specifically, it would be of value to investigate if the students who gained or lost a percentile group in one domain (height or weight) underwent similar changes in the other. As vertical growth and weight gain can have different associations with overall health, this type of analysis would allow for the opportunity to elucidate the growth patterns of this population further. Additionally, correlates to each should be investigated. Such moderating factors could include psychosocial factors, mental health and trauma, chronic disease, infection, and anemia.

Limitations

Most notably, the interpretation of outcomes of the present study is limited by the retrospective, single-group study design. Lacking prospective measures controlling for confounding variables and lacking a control group, the association of the efforts of KHH visits and improved growth can only be inferred. As it was a preliminary, general analysis, it is also not possible to conclude which, if any, of the interventions had the most significant impact on the outcomes of interest. There are also challenges to generalizing the results of this study to the population of Haitian children. These students are being sponsored and receive an education, and by virtue of attending school, receive a multivitamin and a meal.

There were drawbacks to the type of data analysis done. Although the raw numbers of children who gained or lost percentile groups are known, it is unclear how these categories of height and weight modified individual BMI percentile changes. For instance, it is not identified which participants both gained in BMI and lost in height, which would have helped assess the results. Additionally, the calculator used to determine percentile groups was not normed to this specific population.

Among the most likely confounding factors was the school's provision of one meal per day. Another probable confounder is that some students likely suffer from undetected diseases. When feasible by physical exam, infectious disease is identified, and available testing and treatment are offered where appropriate and obtainable. However, many insidious, undetected chronic and infectious diseases, such as lead poisoning and HIV, affect growth and development. Moreover, KHH teams saw children with known chronic conditions such as asthma and hypertension more frequently, which could have impacted results.

The trajectory of growth can also not be controlled for. As many determinants of future development start in-utero, changes over the treatment period were undoubtedly impacted by factors influencing health and growth far before the treatment period began. For instance, prenatal care of the participants' mothers, breastfeeding, early nutrition status, and previous trauma all likely impact the growth course and influenced the current study results. There is evidence that epigenetics also impacts growth and development (Tosh et al., 2010; Cutfield et al., 2007).

Some inconsistencies existed in measurement visit to visit, and methodological differences may limit the reliability of these measurements. In addition, children were measured with different scales and stadiometers. There were also some variations in the documentation. For instance, some groups measured height and weight in imperial and some in metric formats, although data were eventually standardized.

Loss to follow-up and missing data also limited our study's power. Some participants were absent from school the day of their visit, graduated, or were no longer enrolled. It was not possible to keep these participants in an intention to treat group, and there was no way to monitor their growth parameters.

Future directions

In general, poor health and limited growth in Haitian children are multifactorial in nature and thus necessitate a broad, community-focused intervention strategy. Based on our results, offering comprehensive services, including physical exams, screening tests, education, and empiric treatments, may benefit and could be more widely adopted.

There are also some possible program changes KHH is considering in light of these results. Early identification of and implementing interventions for the children starting in the lowest BMI categories could be a cue to introduce more aggressive monitoring and treatment planning. For instance, screening them for more serious diseases and infections, educating children and parents about nutrition and healthy eating habits, and providing more frequent empiric anti-parasitic medications.

This is the first longitudinal investigation of this kind and highlights the need for more rigorous, controlled studies to elucidate which interventions effectively improve this population's growth and overall health. More precise tailoring of programming could be accomplished with this sort of investigation, adjusting where funding and efforts could best be used. Specifically, it would be beneficial to separately examine the use of empiric anti-parasitic medication, daily vitamins, education, and treatment of specific diseases like anemia and infectious diseases. Iron levels are of particular interest to this research group, as many children have been anemic, which may impact growth (Soliman et al., 2014).

It has been suggested that community engagement and community-based service delivery platforms are most effective in nutrition-specific and nutrition-sensitive interventions implemented for children under the age of five (Hossain et al., 2017), which likely extends to school-aged children as well. The KHH model is based on the engagement of parents and staff but could expand involvement to include other community agencies and members to enhance the culture of health and nutrition (Hossain et al., 2017).

Eventually, a more comprehensive effort should be made to improve the health of children in this country. Providing potable drinking water, improving health provision and access, health literacy campaigns, and government-subsidized infectious disease prevention and treatment programs are all needed to advance healthcare in Haiti. However, scaled efforts like those of KHH and other organizations aimed at smaller populations can also have a wide-reaching impact, given the proper tools and armed with accurate, up-to-date data about what is most needed.

The most compelling and hopeful interpretation of these results is that KHH interventions improve the health and growth of these children through the variety of services offered. As there are ongoing biannual visits, a culture of trust and understanding has developed between the staff and children and the healthcare teams. The prospect that this program has created a culture of better health for these children is an exciting one.

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Informed Consent: This study used data collected in the provision of routine healthcare services and did not contain sensitive information. All data used for the purposes of this paper were properly de-identified and stored securely. The appropriate institutional review boards obtained a waiver of informed consent.

Research Data Transparency: The data used in this study are not currently available for public use. Individual researchers may send separate data inquiries to all parties involved.

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