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Research Article

Weight Trajectory in Refugee Children after Resettling in the United States: A Pilot Study

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Abstract:
Background: The objective of this study is to describe the weight trajectory of refugee children after resettlement in the US.
Methods: A pilot study was conducted, utilizing longitudinal data obtained from the electronic health record of 129 children between 2 and 18 years of age (54% female, mean age 10 years) from the 3 primary countries of origin presenting to a refugee clinic (Bhutan, N = 71;Burma, N = 36, and Iraq, N = 22).. Mixed effects model analyses were utilized to characterize weight trajectory with calculation of a per year change in BMI-z score, adjusting for baseline BMI-z score, age, and time.
Results: There was a significant increase in BMI-z (mean 0.15 units/year, p=0.04) among refugee children during their initial period after resettlement. Female children from Bhutan demonstrated the most rapid increase in weight, with a mean BMI-z gain of 1.00 units/year.
Conclusion: Female children from Bhutan demonstrated rapid weight gain after resettlement in the US. Further studies are needed to describe weight trajectory trends and evaluate possible reasons for rapid weight gain in this population.

Keywords: Nutrition; Obesity; Refugee; Resettlement

Abbreviations: BMI: Body Mass Index; US: United States

Introduction: Obesity is increasingly recognized as a health concern globally. Over the last 20 years global trends have shown an increase in the prevalence of overweight and obesity, with the prevalence of overweight and obesity approaching and in many countries exceeding the prevalence of underweight [1-3]. In the adult refugee population, studies have demonstrated prevalence rates of overweight and obesity between 27% and 52% on arrival to the United States [4,5]. Adult refugees also demonstrate weight gain after resettlement in the US that increases with length of time spent in the US [6,7]. The rapid migration, urbanization, and acculturation of refugee populations during the process of resettlement can lead to an increase in consumption of energy-dense foods, sedentary behaviors, and psychosocial stressors, all of which may contribute to weight gain [8].

These factors may also contribute to weight gain in refugee children. However, identification of weight gain and promotion of healthy nutrition is not traditionally addressed during pediatric refugee visits because of a focus on infectious disease prevention during these visits [9,10] and because of barriers to effective healthcare delivery to this patient population like language differences [11,12]. While the weight status of children in the US has been well

studied, there have only been two studies describing the weight status of refugee children at the time of resettlement [13,14] and only one study describing changes in weight status among refugee children after resettlement [15]. This study of 181 refugee children by Heney and colleagues (2014) found that prevalence of overweight and obesity increased from 17% on resettlement to 35% three years after resettlement, exemplifying why it is important to further understand the extent of this problem including the rate with which refugee children are gaining weight after resettlement. Given this, the objective of this pilot study was to describe the weight trajectory of a cohort of refugee children after resettlement in the US and describe any differences in weight gain based on demographics.

Methods:

Participants: A longitudinal cohort study of 129 refugee children was conducted. Children were included in the study if they were between the ages of 2 and 18 years and seen within one month of arrival to the US in a single refugee clinic (Philadelphia, PA) within a children's hospital system. This study was approved by the children's hospital system institutional review board.

Children were excluded if they did not have more than one recorded weight in the electronic health record (EHR, N = 33) and if they were not from one of the three primary countries of origin seen at the refugee clinic (Bhutan, Burma, or Iraq, N = 39). The number of children from each of the other 8 countries of origin was small (range 1-10 children) and also were not likely to return for follow-up visits to the clinic (represented only 8.7% of total visits). Children who were excluded were not significantly different from children included in the study cohort with respect to baseline BMI-z score and age. However, there was a smaller percentage of female children in the excluded cohort (39%) compared to the study cohort (54%).

Measures: Retrospective data was extracted from the EHR. As part of routine clinical care, weight and height were measured and entered into the EHR by a medical assistant at each visit to the refugee clinic. Weight was measured to the nearest 0.1 kg using a digital platform scale. Height was measured to the nearest 0.1 cm using a wall stadiometer. BMI, BMI percentile for age (BMI %), and BMI-z score were automatically calculated by the EHR using CDC formulas and children were classified as being underweight (BMI % < 5%), normal weight (BMI% 5-84.9%), overweight (BMI% 85-94.9%), and obese (BMI% ≥ 95%) based on CDC guidelines [16]. Child demographics including age, gender, and country of origin were extracted from the EHR. The length of time of each measurement from the date of the child's initial visit was calculated.

Analysis: Descriptive analyses were used to characterize the patient population and their weight status over time. Chi-square analyses and Kruskal-Wallis testing were used to compare baseline characteristics between groups based on country of origin. Logistic regression analyses were performed to estimate the odds ratio for comparing the prevalence of children with overweight or obesity between their initial and last visit to the refugee clinic. Student's t-tests were performed to compare mean change in BMI-z score between patient subgroups from their initial visit to a visit 3 months from the initial visit (+/- 1 month) and between patient subgroups from their initial visit to their last visit to the clinic. Because the time between visits was highly variable, mixed effects model analyses were used to evaluate the rate of change in BMI-z score. This analysis utilized every BMI-z score available in the EHR during the study period for each child. Time was included as both a fixed and random effect in the model in order to account for variability in the timing of weight measurements between patients with the estimation of a change in BMI-z score per year as the primary outcome of interest. Baseline BMI-z score was included as a fixed effect in the model to adjust for this variable. Subgroup analyses were conducted to compare groups based on country of origin, gender, weight status, and age group (pre-pubertal being defined as less than 11 years of age and post-pubertal being defined as 11 years of age or older) on arrival to the US, using these variables as fixed effects in the model. All tests were two tailed with level of significance set at 0.05. The software SAS version 9.3 (Cary, NC) was used.

Results:

Patient Population: 129 children were included in the study (Table 1). Mean age was 10.0 years (SD 4.5), with 43% being 11 years of age or older. The majority of children were female (54%), from Bhutan (55%), and normal weight on arrival to the US (76%). Mean time from the initial visit to the last visit to the refugee clinic was 0.9 years (SD 0.7). There was a significant difference in baseline characteristics between children from the three countries, with children from Bhutan being older in age and lower in weight status at their initial visit to the refugee clinic compared to children from Iraq and Burma and being followed for a longer period of time in the refugee clinic than children from Burma (Table 1).

Characteristic	Total (N = 129)	Bhutan (N = 71)	Burma (N = 36)	Iraq (N = 22)	p
Female [N (%)]	69 (53.5)	37 (52.1)	17 (47.2)	15 (68.2)	0.28
Age (years)	10.0 (4.5)	11.5 (4.2)	8.4 (7.0)	7.8 (3.4)	
Mean (SD)	10.1 (2.5-17.7)	12.4 (2.5-17.7)	7.0 (2.7-17.5)	6.9 (2.7-17.0)	0.001
Median (range)					
BMI-z at initial visit to refugee clinic	-0.5 (1.2)	-0.8 (1.2)	-0.3 (1.0)	-0.1 (1.3)	
Mean (SD)	-0.5 (-4.7-2.3)	-0.8 (-4.7-1.8)	-0.2 (-2.3-2.1)	0.1 (-2.3-2.3)	0.04
Median (range)					
Time between initial and last visit to refugee clinic (months)	20.8 (8.4)	12.0 (9.6)	6.0 (4.8)	12.0. (8.4)	
Mean (SD)	6 (1.2-27.6)	8.4 (1.2-27.6)	3.6 (1.2-14.4)	10.8 (1.2-14.4)	0.001
Median (range)					

a. Descriptive analyses were used to characterize the patient population. Chi-square analyses and Kruskal-Wallis testing were used to compare baseline characteristics between groups based on country of origin.

Table 1: Demographic and Visit Characteristics of Patients by Country

Change in Weight Category: More than 75% of children in each weight category remained in the same weight category from their initial visit to their last visit to the refugee clinic. The proportion of patients who were underweight increased by only 1.6% (Table 2). However, 14% of children who were normal weight at their initial visit to the refugee clinic had overweight or obesity by their last visit to the refugee clinic (Table 2). Overall, children were nearly two times more likely to have overweight or obesity at their last visit than at their initial visit to the refugee clinic [OR 1.98, 95% CI (0.98–4.00), a finding that reached near significance. Females from Bhutan were 9.9 (CI 1.2 – 84.0) times more likely to have overweight or obese at their last visit compared to their initial visit to the refugee clinic (Table 3).

Weight Category at Initial Visit	Underweight[b] at Last Visit [N (%)]	Normal Weight[c] at Last Visit [N (%)]	Overweight or Obese[d] at Last Visit [N (%)]
Underweight[b] (N = 17)	13 (76.5)	4 (23.5)	0 (0.0)
Normal weight[c] (N = 98)	6 (6.1)	78 (79.6)	14 (14.3)
Overweight or obese[d] (N = 14)	0 (0.0)	3 (21.4)	11 (78.6)

a. Descriptive analyses were used to characterize the weight status of patients at their initial and last visits to the refugee clinic
b. Underweight: BMI < 5% for age
c. Normal weight: BMI = 5-84.9% for age
d. Overweight or obese: BMI ≥ 85% for age

Table 2: Change in Weight Category

	Overweight or obese[a] at initial visit[b] [N (%)]	Overweight or obese[a] at last visit[b] [N (%)]	aOR[c] (95% CI)
Total	14 (10.9)	25 (19.4)	1.98 (0.98 – 4.00)
	Overweight or obese[a] at initial visit[b] [N (%)]	**Overweight or obese[a] at last visit[b] [N (%)]**	**aOR[d] (95% CI)**
Male			
Bhutan (N = 34)	3 (8.8)	3 (8.8)	1.0 (0.2 – 5.3)
Burma (N = 19)	5 (26.3)	4 (21.1)	0.7 (0.2 – 3.4)
Iraq (N = 7)	2 (28.6)	3 (42.9)	1.9(0.2 – 17.3)
Female			
Bhutan (N = 37)	1 (2.7)	8(21.6)	9.9(1.2 – 84.0)
Burma (N = 17)	1 (5.9)	1 (5.9)	1.0 (0.1 – 17.4)
Iraq (N = 15)	2 (13.3)	6 (40.0)	4.3 (0.7 – 26.5)

a. Overweight or obese: BMI ≥ 85% for age
b. Initial and last documented visit to refugee clinic (mean time between initial and last visits = 0.9 years, see Table 1)
c. Logistic regression analyses were performed to estimate the odds ratio for comparing the prevalence of children with overweight or obesity between their initial and last visit to the refugee clinic, adjusting for age, gender, country of origin, and baseline BMI-z score
d. Logistic regression analyses were performed to estimate the odds ratio for comparing the prevalence of children with overweight or obesity between their initial and last visit to the refugee clinic, adjusting for age and baseline BMI-z score

Table 3: Change in Prevalence of Overweight or Obese

Change in BMI-z Score: There was a mean gain of 0.15 (SE 0.07) BMI-z units per year among the entire cohort (p=0.04, Table 4). Children who were underweight at their initial visit had a larger increase in BMI-z score per year than children of normal or overweight status at their initial visit. Children from Bhutan (mean BMI-z gain of 0.33 units per year) demonstrated more rapid weight gain than children from Burma (mean BMI-z loss of 0.05 units per year, p=0.05). The most significant difference in gender was among children from Bhutan with those of female gender demonstrating more rapid weight gain (mean BMI-z gain of 1.00 unit per year) than those of male gender (mean BMI-z gain of 0.05 units per year, p=0.02). There was no significant difference in rate of BMI-z gain among children based on age group.

	N[b]	ΔBMI-z at 3 months [mean (SE)]	p[c]	N	ΔBMI-z at last visit [mean (SE)]	p[c]
Total	62	0.17 (0.53)		129	0.21 (0.08)	
Gender						
Male	26	0.11 (0.10)	0.5	60	0.06 (0.11)	0.1
Female	36	0.21 (0.09)		69	0.33 (0.12)	
Country of Origin						
Bhutan	32	0.38 (0.10)	0.002	71	0.38 (0.13)	0.04
Burma	21	-0.12 (0.10)		36	-0.10 (0.09)	
Iraq	9	0.06 (0.12)		22	0.16 (0.17)	

a. Student's t-tests were performed to compare mean change in BMI-z score between patient subgroups from their initial visit to a visit 3 months from the initial visit (+/- 1 month) and between patient subgroups from their initial visit to their last visit to the clinic.
b. Number of children with an anthropometric measurement recorded in the EHR at 3 months (+/- 1 month)
c. Significance level for comparison of mean change in BMI-z score between subgroups

Table 4: Mean Change in BMI-z Score at 3-Month and Last Visits

	ΔBMI-z / year [mean (SE)]	p (compared to ΔBMI-z/year = 0)[b]	p (compared to reference)
Total	0.15 (0.07)	0.04	N/A[f]
Country of Origin			
Bhutan (N = 71)	0.33 (0.10)	0.002	Ref[g]
Burma (N = 36)	-0.05 (0.16)	0.75	0.05
Iraq (N = 22)	0.01 (0.17)	0.95	0.13
Gender			
Male (N = 60)	0.07 (0.11)	0.55	Ref[g]
Female (N = 69)	0.27 (0.10)	0.01	0.2
Country of Origin by Gender			
Bhutan Male (N = 34)	0.05 (0.30)	0.87	Ref[g]
Bhutan Female (N = 37)	1.00 (0.27)	0.003	0.02
Burma Male (N = 19)	0.01 (0.16)	0.99	Ref
Burma Female(N = 17)	0.40 (0.20)	0.06	0.13
Iraq Male (N = 7)	0.17 (0.30)	0.56	Ref
Iraq Female (N = 15)	0.13 (0.16)	0.43	0.37
Weight Status at Initial Visit			
Underweight [c](N = 17)	0.27 (0.12)	0.03	0.34Ref[g]
Normal Weight [d] (N = 98)	0.12 (0.10)	0.26	Ref[g]
Overweight or Obese [e] (N = 14)	-0.10 (0.23)	0.65	0.38
Age Group at Baseline			
Age < 11 years (Pre-adolescent, N = 73)	0.181 (0.096)	0.06	Ref[g]
Age > 11 years (Post-adolescent, N = 56)	0.118 (0.113)	0.29	0.67

a. Calculated using mixed effects model analyses, adjusting for time between initial and last visits and baseline BMI-z score, and other demographic characteristics as appropriate
b. Changein BMI-z of 0 was used for comparison as one would expect a healthy child to maintain the same BMI-z score over time (e. G. gain weight at an expected rate compared to height gain by age- and sex-adjusted standards, 16)
c. Underweight: BMI < 5% for age
d. Normal weight: BMI = 5-84.9% for age
e. Overweight or obese: BMI ≥ 85% for age
f. N/A = not applicable (for analyses where no comparison was conducted)
g. Ref = Reference category

Table 4: Rate of Change in BMI-z Score[a]

Discussion: This pilot study demonstrated a rapid increase in BMI-z score over time among a subgroup of refugee children resettling in the US. This is consistent with the findings of a similar study that demonstrated a doubling of the prevalence of overweight and obesity among a cohort of refugee children three years after resettlement [15]. The current study adds to this evidence base by demonstrating that the period of most rapid weight gain might be early after resettlement and by evaluating the rate of weight change using mixed effects modeling in order to provide a greater level of detail about the rapidity of weight gain seen among refugee children after resettlement and by describing early weight change among this cohort. Furthermore, this study evaluated demographic differences in rate of weight change, with findings suggesting that children from Bhutan of female gender may be especially vulnerable to rapid increases in weight. These preliminary findings support the need for further studies evaluating the weight status of refugee children as they acculturate to life in the US, with attention paid to certain subgroups.

Traditionally the refugee population was one affected greatly by malnutrition [17], but as a result of emergency nutrition programs malnutrition has become less of a concern among this population [18]. Instead, studies have shown that there has been a rise in obesity and associated comorbidities like diabetes and cardiovascular disease among adult refugees with the prevalence of these chronic conditions now higher than that of infectious diseases [5,19-21]. In addition, studies describe a double burden of under- and over-nutrition among refugee children, resulting from malnutrition on both ends of the spectrum, even on arrival to the US [22]. Despite this, current recommendations for routine refugee health visits remain heavily focused on the assessment and treatment of communicable diseases and mental health. Even though 75% of children remained in the normal weight category, 14% of children had an increase in weight status from normal weight to overweight or obese. However, the findings in this study call attention to the need to also monitor for early rapid weight gain and counsel about healthy nutrition and other lifestyle behaviors when conducting routine pediatric refugee health exams, which may assist in the prevention of chronic diseases now being seen in the adult refugee population.

Mean weight gain in this cohort was 0.15 BMI-z units per year. While weight gain might be expected in refugee children who are initially underweight on arrival to the US, rapid weight gain was still seen among this cohort even when adjusting for baseline BMI-z scores in the mixed effects model. Furthermore, the rate of weight gain in this cohort was more rapid than=weight gain trends among US children (mean gain of 0.10 BMI-z units per year in population-based longitudinal studies) [23]. Finally, the prevalence of overweight and obesity among US children has not changed significantly since 2003 [24,25], and in the location of this particular urban refugee clinic there have even been reports of a decline in obesity among school age children [26]. The rapidity of weight gain seen in this cohort, especially during the initial months after resettlement, therefore suggests that refugee children may be a vulnerable population with a propensity for rapid weight gain or for whom rapid weight gain is not properly identified and addressed during the initial period after resettlement.

There are several reasons why refugee children may demonstrate weight gain after resettlement in the US. Rapid migration and urbanization of refugee populations often leads to an increase in sedentary behaviors and consumption of refined, energy-dense food [27]. Furthermore, many refugee households experience food insecurity [28-30], which is associated with poor diet quality [31], and increased rates of obesity [32,33]. Finally, abnormal eating behaviors like binge eating and preoccupation with food often develop after moving from environments like refugee camps with little food availability to environments with more food availability [34-36].

In this study, children from Bhutan demonstrated rapid weight gain. Children from Bhutan had the lowest weight status on arrival to the US suggesting that they may have experienced more food deprivation prior to their resettlement due to conditions in refugee camps in Eastern Nepal [37]. The more rapid weight gain seen in children from Bhutan may therefore be partly attributed to normalization of weight status, since children with underweight were also more likely to have an increase in weight in this cohort, but may also be due to the development of abnormal eating behaviors after a period of nutritional deprivation [38]. Additionally, children from Bhutan were significantly older and therefore may have been more likely to go through puberty during the study period, which can contribute to weight gain, though we tried to adjust for this factor by controlling for age group (with 11 years of age being used as a cut-off). Older children are known to engage in poor health behaviors after resettling in the US, including unhealthy eating behaviors [39]. Finally, children from Bhutan were followed for a longer period of time in the refugee clinic and therefore may have seen a more rapid increase in weight with time, consistent with adult studies demonstrating that weight gain after resettlement in the US increases with length of time spent in the US [6-8,40]. Children from Iraq also demonstrated rapid weight gain, consistent with a study by Dawson-Hahn and colleagues (2016) that found higher rates of obesity among Iraqi refugee children compared to those from Burma and Somalia [22], but this did not reach statistically significant levels likely because of the small sample size.

Finally, females from Bhutan demonstrated more rapid weight gain than males from Bhutan. There have been no studies evaluating reasons for weight gain among refugee girls, but several studies in adult refugee women have demonstrated that refugee females engage in low levels of physical activity [41] which may be due to a lack of experience with physical activity, lack of access to opportunities for physical activity, or lack of social support to

engage in physical activity [42]. Additionally, males in this cohort seemed to have a propensity to overweight and obesity on arrival to the US (10 males vs. 4 females with overweight or obesity on arrival to the US). While this difference did not reach statistical significance potentially due to small sample size, it is possible that the increase in weight status among females may be due to differences in prior nutrition in their countries of origin. These findings suggest that culturally appropriate interventions may be useful for certain subgroups of refugees to prevent excessive weight gain, as has been demonstrated in interventions to improve physical activity and nutrition among immigrant women [43].

There were several limitations to our study, which was intended as a pilot study to inform the utility of further studies evaluating weight gain among refugee children. Data was derived from extraction of clinical data from the EHR. Therefore we were unable to collect information that may have helped explain the findings, including data about the environment preceding resettlement to the US, history of past or present food insecurity, lifestyle behaviors, pubertal status (though we attempted to adjust for this variable by adjusting for age group), and history of mental illness or trauma. The sample size of our study was limited, mostly because many children were only seen in the refugee clinic once as a result of transfer of care to a clinic closer to their place of living after their initial visit to a refugee clinic. This limitation contributed to difficulty conducting subgroup analyses, for example in the Iraqi population. Additionally, the sample size is small because it represents patients seen at a singular refugee clinic within a children's health system in Philadelphia, PA. Because resettlement patterns and lifestyle behavior patterns differ in other parts of the United States, findings from this study cannot necessarily be generalized to other refugee populations resettling in other parts of the country. Finally, the time between children's initial visit and last visit to the refugee clinic was variable, but time variability was adjusted for with the use of mixed effects model analyses and calculation of a rate of BMI-z change per year. In addition, the mean time between the initial and last visit to the refugee clinic was 0.9 years and therefore a near doubling of the prevalence of overweight and obesity during this time point represents a clinically significant change over a short time period that likely would be even greater if weights were available for these patients over a longer period of time. Future studies would benefit from prospectively and systematically evaluating weight change in refugee children after resettlement throughout the US, accounting for potential factors like poor nutritional quality or food insecurity that may contribute to weight gain.

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