The Epidemiology of Stunted Growth in Refugee Patients with Chronic Burn Injuries

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The aim of this study is to identify the prevalence of stunted growth in Syrian refugee children with chronic burn injuries and to compare it to other children (±burn) of similar socioeconomic status. This is a retrospective medical chart review conducted on 142 Syrian refugee children (≤18 years of age) who have sustained war-related and nonwar-related chronic burn injuries between 2014 and 2020. Stunted growth was measured using the height-for-age *z* score. The majority of burn injuries were among children below 5 years of age. The prevalence of stunting was 9.2% in our sample, with an overall mean *z*-score of –0.491 (SD = 1.1). There was no statistically significant difference in *z*-scores between males and females. The majority of stunted patients are those who sustain their burn injuries at an early age. Early management of burn injuries is key in preventing adverse outcomes associated with stunting. Further research, planning, funding, and targeted interventions are required by stakeholders to alleviate the burden of stunting in the pediatric refugee population, along with the health and economic consequences that it entails.

Linear growth is the optimal measure of a child's overall health and well-being, as well as proof that social factors are a core determinant of health and development.[1–3] According to recent estimates for 2019, the World Health Organization (WHO) and the World Bank labeled 144M children below 5 years of age as suffering from stunted growth, with 91% of all stunted children residing in low-income or lower-middle-income countries.[4] Stunting also forms one of the six pillars of the WHO's Global Nutrition Targets for 2025: to achieve a 40% reduction in the number of children under 5 years of age who are stunted.[5]

Today, the issue of stunting is gaining traction at the public and global health levels, owing to the short- and long-term health and functional impacts that this phenomenon has on the massive number of children that are affected globally. It is often the result of poor nutrition both in utero and during early childhood owing to poor socioeconomic factors, which impacts the child's ability to reach their true height potential.[1,6] While linear growth failure is the means by which stunting most evidently presents, it is only the tip of the iceberg.

First, stunting has been associated with increased morbidity and mortality secondary to a number of infectious causes including but not limited to pneumonia, diarrheal illnesses, meningitis, hepatitis, and tuberculosis, suggesting a weakening of the immune system of stunted children.[7–9] Second, decreased linear growth during the first 2 years of life has been associated with reduced adulthood stature.[10] Not only does this have physical implications later on in life but it also has an impact on functional and economic outcomes such as poorer productivity and lower earnings.[11] In fact, the World Bank estimates that there is a 1.4% reduction in economic productivity for every 1% loss in adult height secondary to childhood stunting.[12] Third, stunting can profoundly impact the development of the child's brain and, as such, neurocognitive functioning, particularly during the first 24 months of age that are critical for brain development.[13] Finally, there is evidence linking childhood undernutrition as a risk factor for adulthood comorbidities, including hypertension, dyslipidemia, and elevated blood sugar levels.[14]

In today's world, instability and armed conflicts constitute a major barrier to achieving adequate nutrition for populations in general and children in particular. This is due to the disruption of food production and distribution systems, forced migration and the allocation of resources away from the agriculture and health sectors.[15] In addition to contributing to malnutrition, armed conflicts put children at risk of war-related injuries such as burns.[16]

In fact, major burns can lead to a profound stress response in the body, generating muscle, and bone cachexia and an increase in nutritional and caloric requirements to meet this increased metabolic demand.[17,18] Moreover, studies propose that burn injuries trigger an exponential increase in stress hormones levels such as glucagon, catecholamine, and cortisol resulting in cardiovascular changes and fluid shifts that lead to a hypermetabolic catabolic and proteolytic state.[19–22] Another explanation would be the alteration of the hypothalamic–pituitary axis including the Growth Hormone—Insulin-Like Growth Factor-1 axis that plays an essential role in growth and development.[22] Given that pediatric patients with illnesses requiring long-term nutritional support are particularly vulnerable to nutrition-related illnesses, this can contribute to or exacerbate stunting if these nutritional needs cannot be adequately met.[23] It is expected that children who suffer from major traumatic events, including burns, suffer from growth

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faltering after the event; however, if the underlying cause is corrected, this period of faltering growth should be followed by a catch-up phase, highlighting the importance of nutritional status in the recovery phase.[24–26]

American University of Beirut Medical Center is a tertiary care hospital in Lebanon that has been following up with pediatric burn patients since 2014 in collaboration with INARA (International Network for Aid, Relief and Assistance), an NGO offering pro bono care for displaced Syrian refugee children and referring them to this hospital. The patients are predominantly Syrian refugees residing in different camps in Lebanon and who otherwise cannot afford treatment. While there is sufficient research demonstrating the physiological response of the body to burns and consequences on the musculoskeletal system, as well as evidence documenting the link between malnutrition and growth stunting, there is a scarcity of statistical documentation of the interface between growth stunting, malnutrition and burn injuries.

This study aims to determine the prevalence of stunting among Syrian refugee children with chronic burn injuries so as to fill this gap and allow stakeholders—policy makers, NGOs and international organizations and agencies such as the United Nations and UNHCR—to better tailor their efforts to the needs of these patients using evidence-based policies and preventive programs.

METHODS

Study Sample

This retrospective study includes pediatric Syrian refugee patients (≤18 years of age) who have sustained war-related and nonwar-related chronic burn injuries between 2014 and 2020. These patients were referred by the NGO INARA to the American University of Beirut Medical Center, a tertiary care center, to establish care as pro bono. All patients were accompanied by a social worker and were assessed for the severity of their burn and for possible interventions—conservative or surgical. Patients with co-morbidities, syndromic features, or acute burns were excluded. Acute cases were excluded since not enough time might have elapsed for effects on linear growth to elucidate.

A total of 173 charts were reviewed, of which 142 patients had sufficient data and fit the inclusion criteria (16 had incomplete documentation of height and weight, 14 could not be considered as burn patients, and 1 had syndromic features).

Measures

Data collected from the chart review included age, gender, height, weight, BMI, comorbidities, location of burns, the age of the child at the time of the burn, time since the burn at presentation, the type of burn, organ involvement, complications, and interventions. Patients were de-identified, and there was no potential for harm during the course of the chart review. The study protocol was approved by the university's institutional review board prior to its commencement.

Stunted growth is defined as a height-for-age *z*-score (HAZ) between −2 and −3; an HAZ ≤ −3 indicates severe stunting.[27] The HAZ was calculated for all patients using the CDC calculator.

Statistical Analysis

Quantitative variables were summarized using percentages and mean ± standard deviation. Categorical variables were compared using chi-squared tests. Statistical significance was accepted for $P < 0.05$ (two tailed) and confidence intervals of 95%. Data entry and analysis occurred from March 2020 to May 2020. Analysis was performed using SPSS version 24.

RESULTS

A total of 173 patient charts were reviewed, 31 of which were excluded from the study (16 had incomplete documentation of height and weight, 14 could not be considered as burn patients, and 1 had syndromic features). Statistical analysis was therefore conducted on 142 patients.

Fifty-four patients were below 2 years of age (44.6%) at the time of injury, 34 were between 2 and 5 years of age (28.1%), 33 patients were between 5 and 18 years of age (27.3%). Twenty-one patients did not have a clearly defined age of injury in their charts. The mean age of patients at injury was 4.1 years (SD = 3.5), with a mean of 3.0 years (SD = 2.5) later until the time of presentation to the hospital for assessment. Table 1 summarizes the characteristics of the sample. The overall distribution of burns according to location is represented in Figure 1; the most commonly affected location was the upper extremity (41%), followed by the head and neck (24%) and trunk (23%). The sample consisted of 72 males (51%) and 70 females (49%).

The prevalence of stunted growth in the sample was 9.2%; no patients were severely stunted. The overall mean *z*-score

Table 1. Descriptive statistics of patient sample

	Mean or n	(SD or %)
Sex: Males	72	51%
Height, cm	117.4	25.5
Weight, kg	25.8	15.7
BMI, kg/m^2	17.1	3.3
Age at Time of Injury, Years	4.1	3.5
≤2 yo	54	44.6%
2 < Age ≤ 5 yo	34	28.1%
5 < Age ≤ 10 yo	22	18.2%
10 < age ≤ 18 yo	11	9.1%
Age at Measurement, Years	7.1	4.2
Time from Injury Till Presentation	3.0	2.5

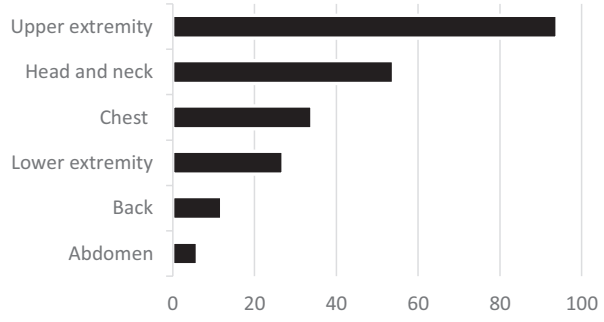

Figure 1. Classification of all burns encountered in the overall patient sample according to location.

was –0.491 (SD = 1.1). There was no statistically significant difference in *z*-scores between males and females ($P = .161$), with a mean *z*-score of –0.619 (SD = 1.0) for males and –0.359 (SD = 1.2) for females. Of the 13 patients with stunted growth, 7 (53.8%) were below 2 years of age. However, there was no difference in *z*-score according to age of injury in the overall sample ($P = .528$).

DISCUSSION

Stunted growth is considered to be a main global health concern among children.[9] The WHO in 2019 estimated 144 million children below the age of 5-years-old to be affected by stunting.[4] Poor nutrition in utero and early childhood malnutrition can lead to stunting and inadequate increase in length/height and weight from birth to 5 years. Research shows that stunting can have adverse effects on mental health such impairing cognitive development and learning capacity, it can also increase morbidity and mortality from infections.[7–9,28]

In this sample of pediatric burn patients, the majority of burn injuries occurred in early stages of life, 44.6% of the patients were younger than 2 years at the time of injury and 28.1% were between 2 and 5 years old. This finding was similar to those of other international studies, as the incidence of burn wounds was highest among children younger than 4 years.[29,30] One study showed that this higher incidence could be explained by factors such as children's impulsiveness, hyperactivity, lack of awareness, and complete dependency on parents.[31]

Reports studying the effect of burn injury on linear growth suggest that major burns can lead to a profound stress response in the body, generating muscle and bone cachexia and an increase in nutritional and caloric requirements to meet this increased metabolic demand.[17,18] Other data suggest that burn injuries cause an exponential increase in stress hormones such as glucagon, catecholamine, and cortisol resulting in cardiovascular changes and fluid shifts that lead to a hypermetabolic catabolic and proteolytic state.[19–21] Another explanation would be the alteration of the hypothalamic–pituitary axis including the growth hormone—insulin-like growth factor-1 axis that plays an essential role in growth and development.[22]

Growth stunting has gained traction at the global health scene due to its profound impacts on a number of health-related benchmarks in developing children.[5] Besides its profound impact on adulthood stature if not addressed early on[10], stunting is associated with worse outcomes related to morbidity and mortality secondary to weakened immune function and increased risk of infections.[7–9] In fact, mortality was found to be more than three times greater in undernourished and stunted children compared with well-nourished counterparts in a recent meta-analysis in low-to-middle income countries.[32] Another finding is impaired development of areas of the brain that are responsible for the development of memory, cognition, and motor skills.[28]

We estimated the prevalence of stunting among Syrian refugee children below 18 years of age who have sustained chronic burn injuries to be 9.2%. This estimate is similar to the International Organization for Migration's estimate of growth stunting in the overall population of Syrian refugee children below 5 years of age in Lebanon (9.6%).[33] While a similar prevalence of stunting in burn patients in particular and the overall population in general is unexpected, this could be explained by the fact that our patient sample included a significant number of children above 5 years of age.

In fact, the time from conception to 2 years of age is considered a critical window, within which the linear growth of the child is most susceptible to stressors and would be expected to be the age category that is most affected by stunting.[1] We demonstrated that 53.8% of the stunted patients in our sample were below 2 years of age, albeit this age category comprised 44.6% of our sample. Not only is this age category most vulnerable to stunting, but it is also most susceptible to its sequelae and impact on future outcomes related to development, education, and potential earnings.[14] This should incentivize early intervention by stakeholders and funding agencies so as to counter losses in human and financial capital that can ensue as a result of stunted growth, which is most evident in the World Bank's estimate of a 1.4% reduction of productivity for every 1% loss of adult height as a result of stunting.[12] Stunted children could earn 20% less as adults compared with their nonstunted counterparts.[34] This is notwithstanding the impact of stunting on the aforementioned health-related outcomes of children.

The mean age of patients at injury was 4.1 years. This is worsened by the fact that a mean of 3 years elapses before these children are brought to medical attention for their burns. In fact, the mean *z*-score of –0.491 falls on the negative end of the nutrition spectrum, reflecting malnourishment. These alarming numbers should prompt stakeholders—both national and international—to elucidate and deliver programs that better meet the nutritional and health needs of this subgroup of Syrian refugees.

Stunting must not be left untreated but should rather be addressed as early as possible by targeting the underlying cause and supplying adequate nutrition to avoid further growth faltering. Appropriate and early intervention should allow for a catch-up phase that enables recovery of lost height and avoidance of unwanted sequelae.[24–26,28]

It is important to note that poverty and conflict are interlinked. Reports studying this relationship show that conflict can negatively influence the livelihoods of individuals living in war settings leading to poverty.[35,36] Furthermore, the majority of Syrian refugee children were born in a time of instability and prolonged conflict that resulted in the creation of an ecology of war. This ecology of war predisposed these children to injury, infection, misery, and poverty.[37] In addition to contributing to malnutrition, low socioeconomic status, and armed conflicts settings put children at increased risk of burn injuries.[16,38] Moreover, there is a higher incidence of stunted growth in conflict settings. This can be explained by the lack of resources, nutrition, food production, and distribution that form a main barrier to proper growth and development for populations in general and children in particular.[15] With patients presenting from refugee camps throughout Lebanon, it is safe to say that the majority of these children were born in a time of instability and forced migration into a host community with poor basic infrastructure and resources that are not conducive of meeting basic nutritional demands leading to malnutrition.[39] In fact, reports show that

the nutrition situation of Syrian refugee children in Lebanon is poor.[40] Taking into consideration all the aforementioned factors, it is safe to say that stunted growth in children of conflict settings is influenced by a multitude of inseparable factors that are associated with their background and living conditions. This powerful connection makes it almost impossible to untangle these factors, and hence difficult to reveal the true cause of stunted growth in this population.

LIMITATIONS

The study's findings should be interpreted in the light of several limitations. First, it is a retrospective medical chart review without healthy controls. Second, there is no documentation of parent height in the patients' medical charts, which did not allow the calculation of mid-parental height predictions. Third, this study looks at the *z*-scores of the patients at a single time point, which is at the time of presentation. Most of our patients presented to the hospital postburn injury and hence obtaining *Z* score data pre-injury was not possible. Trending of the *z*-score of every patient during subsequent visits was not feasible given that most patients either had short follow-up periods or were lost to follow-up. Fourth, data regarding the total body surface area of the burns was not available in the majority of patient charts, albeit total body surface area is a contributor in determining the extent of stunting in burn patients.[41] Finally, in light of the ongoing Syrian civil war, several confounders such as low socioeconomic status, poverty, and lack of resources might mask the extent of burn injuries on stunted growth. Due to the complexity of this relationship, it would be difficult to find a direct link between burn injuries and stunted growth.

CONCLUSION

Several interrelated factors seem to influence growth stunting among Syrian refugee children in Lebanon. Burn injuries can contribute to stunting especially when exposure happens at an early age. Early management of burn injuries is key in preventing adverse outcomes associated with stunting. Further research, planning, funding, and targeted interventions are required by stakeholders to alleviate the burden of stunting in the pediatric refugee population, along with the health and economic consequences that it entails.

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