Fear, violence, inequality, and stunting in Guatemala

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Abstract

Background: Stunting is defined by the public health community as a length-or height-for-age < −2 SD of a growth standard or reference and is claimed to be caused by poor nutrition, repeated infection, and inadequate psychosocial stimulation.

Material and Methods: Stunting is common at all income levels in middle- and low-income countries. At the higher income levels, stunting is unlikely to be caused by nutrient deficiency or infectious disease.

Results: In Guatemala, 17% of <5-year-olds in the highest family income quintile are stunted. Guatemala has a history of violence from armed conflict, current-day social and economic inequalities, government corruption, and threat of kidnapping for the wealthiest families.

Discussion and Conclusion: The high level of persistent violence creates an ecology of fear, an extreme range of inequalities in Social-Economic-Political-Emotional resources, and biosocial stress that inhibits skeletal growth and causes stunting for people of all income levels.

1 INTRODUCTION

Nearly 50 years ago, John C. Waterlow described the deficit in height-for-age due to undernutrition over a long period as, “...nutritional growth failure, but for the sake of brevity I shall call this condition stunting” (Waterlow, 1973, p. 87). This purely anthropometric definition of nutritional status was discussed in detail in a World Health Organization (WHO) 1971 report (FAO/WHO, 1971) and was broadly accepted after publication of the proceedings of a Nestlé Nutrition Workshop (Waterlow, 1988). With these publications and with the support of the WHO, private industry (e.g., Nestlé S.A.), and prestigious medical journals (Black et al., 2008 and related articles in Lancet), the basic strategy of associating nutrition and height became entrenched in the literature, in teaching, and in the practice of public health nutrition. By the late 20th century, the terms “stunting,” “malnutrition,” and “undernutrition” were used as synonyms in the epidemiological, medical, and scientific literature. Nutritional surveillance no longer required any assessment of diet quality, food intake, energy expenditure, clinical signs of under- or malnutrition, or living conditions. Rather the only measure needed was length/height-for-age. It was acknowledged by the WHO that, “Stunting is the impaired growth and development that children experience from poor nutrition, repeated infection, and inadequate psychosocial stimulation” (https://www.who.int/news/item/19-11-2015-stunting-in-a-nutshell). Despite the reference to infection and psychosocial exposures, the “conventional wisdom” of many in the research, charitable, and nongovernmental organization (NGO) communities reduced the list of causal factors to “poor nutrition.”

The seamless and uncritical association of stunting with malnutrition may be seen in research articles such as...
as Prendergast & Humphrey (2014, p. 250) who wrote: “Linear growth failure is the most common form of undernutrition globally.” The simple equation that “stunting equals malnutrition” may be read on the websites of all relevant NGOs, for example International Relief Teams: “Guatemala has the fourth highest rate of chronic malnutrition in the world. Almost 50 percent of children under five are stunted, and in indigenous areas, 65 percent of the population is chronically malnourished” (https://www.irteams.org/project/fighting-malnutrition-in-guatemala/#:~:text=Guatemala%20has%20the%20fourth%20highest,chronically%20malnourished). This is repeated at the website of the World Bank where a girl named Sitraka, from a rural village of Madagascar, is described as, “...notably shorter and looks much younger than the others. Sitraka is stunted, a condition caused by chronic malnutrition during a child’s earliest days of development. In Madagascar, nearly 47 percent of children under the age of 5 suffer from chronic malnutrition, putting at risk their growth and development. As a result, it is not uncommon to find children there whose heights are notably below average for their age” (https://www.worldbank.org/en/news/immersive-story/2018/09/28/reducing-childhood-stunting-with-a-new-adaptive-approach). Both websites were accessed in May 2021 and the websites of many other NGOs and international governmental institutions carry the same message that “stunting equals malnutrition.”

The purpose of this article is to question the simple equation that “stunting equals malnutrition” and to question the WHO statement that stunting is due to only “undernutrition, repeated infection, and inadequate psychosocial stimulation.” To be clear, the WHO list includes some of the factors that can cause linear growth delay, but there are other causal factors. In this article, attention is focused on the impact of: (1) chronic fear of violence and (2) chronic toxic stress due to social-economic-political-emotional inequality and insecurity. The conceptual framework organizing this article is that chronic fear and toxic stress are emotions that are transduced by the neuroendocrine system into hormonal and other signaling pathways that delay, retard, or stop bone formation and growth in length/height. In this article, Guatemala provides a case study of the impact of fear and inequality on human height growth.

2 | BACKGROUND ON THE MEANING OF “STUNTING”

Since 2010, the WHO has defined stunting as a height-for-age less than two standard deviations (<−2 SD) below the WHO Child Growth Standards median. The WHO Child Growth Standards were developed to show the way that infants and children should grow. The WHO proposed that their Growth Standard should be used in place of national or international growth references, which show the way people do grow. The WHO growth standards were created to show optimal growth and are available for infants and children from birth to age 5.0 years (https://www.who.int/toolkits/child-growth-standards).

The WHO website provides information on the samples of people and the methods used to create the standards. The pros and cons of the standards are not debated here, as they have been discussed in many published articles (Khadiilkar, 2013; Novina et al., 2020).

Based on the WHO definition of stunting for infants and children under 5-years-old, the planet is divided into two worlds: (1) low and lower middle-income countries, with prevalences of 35.6 and 32.2% and (2) upper middle- and high-income countries with prevalences of 6.9 and 2.5% (UNICEF, WHO, & World Bank, 2019). Sub-Saharan Africa and southern Asia have the greatest prevalence of stunting. The notable exception for the Americas is the high prevalence in Guatemala (Figure 1).

By its own criterion (<−2 HAZ), the WHO estimated that 144 million infants and children under 5 years of age were stunted in 2020 (https://www.who.int/news/item/31-03-2020-unicef-who-wb-jme-group-new-data). The WHO and most public health agencies consider stunting to be a burden to individuals, their families, and their nations because stunting is associated with illness and mortality before age 5 years. For older survivors of stunting there are associations with delayed or reduced cognitive development, lower school achievement, lower lifetime earnings, and higher probability of adult non-communicable diseases such as diabetes, hypertension, and heart disease (Dewey & Begum, 2011).

As noted by several researchers, stunting is an important and useful indicator of risk for poor health and well-being, but there is little to no evidence that stunting is the cause of the risks to health, brain function, school performance, or earnings (Leroy & Frongillo, 2019). In addition, systematic reviews and metaanalyses find little or no evidence that interventions to improve nutrition, sanitation, or psychosocial stimulation result in a reduction in stunting (Dangour et al., 2013; Goudet et al., 2019; Grantham-McGregor et al., 2014; Sguassero et al., 2012). It is likely that these interventions fail because they are missing one or more critical links between healthy environments and linear growth.

3 | SEPE AND STUNTING

It is argued here that stunting and its associated (not causal) health and performance risks are outcomes of
living in poverty, living with the chronic fear of violence, and living with the chronic toxic stress of social–economic–political–emotional inequality and insecurity. The use of the combination “social–economic–political–emotional” (hereafter SEPE) is relatively new in the literature and defined in detail elsewhere (Bogin, 2021a, 2021b). Briefly, the SEPE concept focuses on the recurring and seamless interaction between the biology of human development and the quality of the material and moral conditions of the society. SEPE goes beyond the traditional use of socioeconomic status (SES) which is often limited to level of education and occupation of, usually, an adult male, and sometimes, female head-of-household. SEPE includes these and extends the concept of social status to the degree of dominance or subordination of a person, a family, and their communities within a society. The dominant groups of a society meet-out inequality, insecurity, and fear, while the subordinate communities suffer from these. SEPE associations with human growth in height are described in the present article in terms of Guatemalan Social history, Economic conditions of the recent past and present, Political regimes during the civil war (1960–1996), and since the war, and the Emotional suffering that most Guatemalans experienced in the past 500+ years and continue to suffer.

4 | SEPE AND THE ARBITRARY CUT-OFFS VALUES THAT DEFINE STUNTING

Before discussing the association of infant and child stunting with SEPE factors in Guatemala, it is important to explain some of the ways in which SEPE factors influence the definitions of stunting as used by different public health organizations. In public health practice, stunting is defined in relation to a cutoff value for height. The most common practice is to convert a measured height to a z-score, that is, a height-for-age-and-sex standardized value by use of a growth standard or reference. The standardized value is designated as HAZ. The use of

![Percentage (share) of infants and children under 5 years old stunted in the year 2016](Source: OurWorldInData.org/hunger-and-undernourishment/. Accessed 26 January 2021, Creative Commons BY 4.0 license)
followed an optimal patterns of growth and development. Other arbitrary cutoffs for “stunting” or “linear growth retardation/linear growth faltering” exist and the United States Centers for Disease Control (CDC) recommends a cutoff less than the fifth centile of the height distribution of a growth reference chart (https://www.cdc.gov/growthcharts/clinical_charts.htm). The difference between the WHO and CDC cutoffs are of public health importance and the decision of which to use may be influenced by SEPE factors. This was noted by de Onis and colleagues, from the WHO, when they wrote in 2007 that, “As expected, there are important differences between the WHO and CDC charts that vary by age group, growth indicator, and specific Z-score curve...Overall, the CDC charts reflect a heavier, and somewhat shorter, sample than the WHO sample. This results in lower rates of undernutrition (except during the first 6 mo of life) and higher rates of overweight and obesity when based on the WHO standards” (de Onis et al., 2007, p. 144). By the phrase, “...lower rates of undernutrition...” de Onis and colleagues mean “lower rates of stunting.”

The differences between the WHO and CDC exist, in part, because the WHO sample of infants, children and their mothers chosen to construct the growth standards is of higher and more secure SEPE status than the national United States sample used to construct the CDC growth references. This is evident in that one criterion for inclusion in the WHO sample was exclusive breastfeeding from birth to 6 months of age. In reality, the WHO sample practiced exclusive breastfeeding for a mean of 5.4 months (WHO Multicentre Growth Reference Study Group, 2006). In comparison, in the United States, only 46.9% of infants are exclusively breastfed at age 3 months and 25% are so-fed at age 6 months (https://www.cdc.gov/media/releases/2018/p0820-breastfeeding-report-card.html). Many studies report that both the initiation of breastfeeding (versus formula feeding) and the duration of exclusive breastfeeding are associated with higher maternal education (Jones et al., 2011), which is one of the strongest indicators of a higher SEPE status and greater SEPE security in any society. In turn, both the initiation and the longer duration of breastfeeding are associated via multiple biocultural pathways with greater physical, economic, cognitive, and emotional well-being in the infant and the mother (English et al., 2020; Horta et al., 2015; Martin et al., 2007; Oseid, 1979). The point of to emphasize here is that the WHO Growth Standards sample was of exceptionally high SEPE status and security and its infants and children were believed to have followed an optimal patterns of growth and development (de Onis et al., 2007). In contrast, national growth references of even the wealthiest nations, such as the United States, are based on samples of people of lower SEPE status and security.

Another reason for the lower rates of stunting detected by the WHO growth standards is a statistical artifact of the arbitrary cut-offs used by WHO and CDC. The WHO cutoff of <−2 HAZ encompasses the lowest 2.3 centiles of a normal distribution. Even if the WHO and CDC growth curves were identical in all regards, the gap from the WHO cut-off to the CDC cut-off (<5th centile) is 2.7 centiles. In a population survey, this statistical gap may equate to hundreds or thousands of short infants and children deemed “not stunted” and not eligible for assistance by the WHO cut-off. Conversely, use of the more liberal CDC cut-off may designate hundreds or thousands of additional infants and children as “stunted.” Attempting to respond to this larger stunting caseload would place enormous economic, personnel, and other logistical burdens on the public health systems of low- and-middle-income nations. The different definitions of stunting by the WHO (< −2 HAZ) and the CDC (<5th centile) are examples of SEPE factors at work as the narrower WHO cutoff could be interpreted as a Political decision to save Economic and other Social resources needed for intervention by classifying fewer people as stunted. Those left out of the intervention eligible group face further Emotional stress. Ultimately, the choice of either arbitrary cutoff is a decision with SEPE implications.

5 | STUNTING CUTOFFS IGNORE BIOLOGICAL VARIATION AND CHANGING SEPE PERCEPTIONS OF NORMALITY

All types of cutoffs are based on a static conception of human biology and health. This static conception assumes that at any given age and sex there is one distribution of height, from shortest to tallest, that reflects all people, at all times in history, and in all places on the planet. The static assumption implies a genetically determined and unchangeable range of variation in height. The static assumption is incorrect. In reality, the distribution of height in any population is dynamic over time. Human biologists have documented this dynamism and call it “secular trends” in growth. An example is given in Figure 2 for three cohorts of Swiss army conscripts over a 130-year period (Staub et al., 2015; Staub, Rühli, et al., 2011). Because of Switzerland’s policy of universal army conscription, these cohorts represent 80–100% of the total population of Swiss 18–19-year-old men alive in
In the late nineteenth century, height clustered around 163.5 cm; modern height clusters around 178.2 cm. The variance of the height distributions of the conscripts (the width of the curves) tended to remain constant but the height of the individual conscripts increased with time. This means that all social and economic segments of Swiss society increased in height by about the same amount. If height increases over time were due to better nutrition and hygiene, as claimed by the WHO, then it would be expected that the higher socioeconomic classes, who could best afford the better food and hygiene, would grow taller before the lower socioeconomic classes. However, this did not happen in Switzerland and both the poorest, least well educated, and most unhealthy people and the wealthiest, best educated, and most privileged people (and everyone in between) grew taller as one population. Iodine deficiency in some regions of Switzerland was a major public health problem for the earliest cohort and the long “tail” of short stature was due to this nutrient deficiency prior to the distribution of iodized salt beginning in 1922.

Application of a static growth standard or reference will obscure completely the dynamic change of height of the population and mis-classify many individuals at all points of the distribution. If we apply the 21st century WHO growth references for 19-year-olds to the 1884 Swiss cohort and use the third centile of height (162.8 cm) as a cut-off for stunting or very low height-for-age, then 50% of the entire population is “stunted.” For the 2008–2009 cohort, fewer than 0.2% of conscripts were shorter than the WHO growth reference third centile. The changes in height distribution with time may be due to many factors, including better nutrition, reduced infection, industrialization, and greater emotional security from a thriving economy, political democratization, improved education, and the like. It is essential to note that at all time people of the higher SEPE classes, meaning those from the dominant groups of Swiss society were taller than people from lower, subordinate SEPE communities. Curiously, people in German-speaking regions of Switzerland were shorter than people in French-speaking regions in 1884 but by 2009, this “language-to-height” relationship reversed. Italian-speakers were always the shortest (Staub, Hermanussen, et al., 2011). The French-German reversal is in keeping with the reversal of social-economic-political status and the associated emotional feelings of superiority, that is the SEPE status of the two language regions over the past 100+ years (Panczak et al., 2017).

The enormity and rapidity of the change of mean height and its distribution—14.7 cm in 124 years—of Swiss conscripts (and cases of equal or larger mean changes in height in Japan, the Netherlands, and other nations) requires rejection of claims or notions of “genetic determinism” of human height and rejection of the claim that there is one, optimal range of size for people. The Swiss history of secular trends in height demonstrates that the application of a static cutoff for stunting,
as well as a primarily nutritional/infection explanation for stunting, are inappropriate. That these large and rapid secular changes in height affect the entire population, irrespective of nutrition/infection exposure, requires the inclusion of SEPE factors, acting across the entire population, in any explanation of the regulation of height variation.

6 | GUATEMALA: OVERVIEW OF DEMOGRAPHY AND STUNTING

In the year 2020, Guatemala had an estimated population of 17.8 million, which was only 0.23% of the total world population. Guatemala is divided ethnically into two major groups: (1) non-indigenous Ladinos and (2) indigenous Maya. Ladinos are of mixed Maya and Spanish biological background, but tend to deny any indigenous roots, speak Spanish, and have European orientation in religion (i.e., Christianity), in clothing, and other cultural values. Maya are biocultural descendants of native peoples inhabiting Southern Mexico and Central America prior to European contact in the year 1500 CE. Along with cultural and social characteristics, genetic and dental studies indicate that Maya people form a definable biological population (Cucina & Tiesler, 2004; Gómez-Casado et al., 2003; Regueiro et al., 2013; Scherer, 2007; Willermet et al., 2013). Maya differ in these traits from the Mestizo and Ladino ethnic groups of Mexico and Guatemala, who show greater biological and social affinities with their Spanish ancestors. It is very important to emphasize that Maya are not a distinct “race.” The genetic and dental traits of Maya people are shared to some extent with all human beings but are expressed in a statistically higher frequency within Maya population. This reflects a Maya preference to marry other Maya.

Sociocultural traits, more than biology, distinguish Maya from the other major ethnic groups. There is a diversity of Maya communities in Guatemala and as used in this article the term “Maya” describes people who view themselves as having indigenous origins, tend to practice traditional pre-Contact religion (perhaps also European-origin religion), wear Maya-style clothing, prepare and eat Maya-style foods, and profess other Maya cultural values (Figure 3).

![Figure 3](https://mayaproject.org.uk/)

**FIGURE 3** Women and girls make tortillas on the *ko ben*, a sheet of metal placed on three stones above a wood fire. Dried corn kernels are ground to a flour, mixed with calcium carbonate, and then boiled to a paste-like consistency. The resulting mixture is dough called *masa* (corn dough, pictured on the table). Small balls of *masa* are hand-patted into disks that are cooked. The tortilla is the most commonly eaten food item of the Maya and of most Guatemalans. Photographer: Miguel Cetina. Location: San José Oriente, Yucatan, Mexico. Date: 2011. Courtesy of https://mayaproject.org.uk/
Maya communities in Guatemala make up at least 51% of the total population of Guatemala, and some estimates are more than 60% (https://minorityrights.org/minorities/maya-2/). Guatemala and Bolivia are the only nations of the Americas where the indigenous peoples constitute a majority of the population and Guatemala is the only nation where one ethnic group, Maya, does so (https://fas.org/sgp/crs/row/R46225.pdf). People identifying as Maya constitute the largest population of Native Americans (Bogin et al., 2020). The government of Guatemala recognizes officially 20 Maya languages, some of which are mutually unintelligible.

Based on the 2014 Demographic and Health Survey (DHS) for Guatemala, the estimated total prevalence of under-5 year-old stunting was 47% (Gatica-Domínguez et al., 2019). When divided by ethnicity the DHS estimated the prevalence of stunting at 61% Maya versus 34% Ladino (5% was attributed to other minority ethnic groups). The prevalence of stunting for infants and children between the ages of 6–60 months is one variable collected by Demographic and Health Surveys (DHS). These are nationally representative household surveys of a country's population. DHSs are cross-sectional and repeated approximately every 5 years in low- and middle-income countries. Complex sampling methods are used. As described in DHS documents, “Urban areas, for example, often comprise a small portion of the overall population in low-income countries but are oversampled in a DHS to ensure that there is sufficient sample size to make urban population estimates. In a typical DHS, 6,000–30,000 households will be sampled across a country. In the selected households, all women age 15–49 years old are invited to complete an interview” (http://www.populationsurveyanalysis.com/wp-content/uploads/2014/09/whatIsDHS_handout.pdf). DHSs compute a wealth index for each household based on a composite score = (floor material + water source + type of toilet + number of persons per bedroom + presence of radio, television, motorcycle, and car). The score is computed by principle components analysis. Participant households in the DHSs are grouped into wealth quintiles from lowest to highest wealth score.

The prevalence of stunting for under-5-year-olds by wealth quintile of the household for five middle-income nations is shown in Figure 4. There is, generally, less stunting as household wealth quintile increases, but even in the richest quintile there is more than 20% stunting in some countries. For Guatemala, an estimated 17% of infants and children in the richest households are stunted. In the United States, a high-income nation but with 9.2% of the population living in poverty, only 3.3% of the entire under-5-year-old population is stunted. The statistical expectation in any population is 2.3% stunting based on a normal distribution for height/length and the <-2 SD cutoff.

The high prevalence of stunting in the wealthiest quintiles of Figure 4 is unexpected and unlikely to be due primarily to the WHO determinants of stunting, that is, "poor nutrition, repeated infection, and inadequate psychosocial stimulation.” Common to the five middle-income countries of Figure 4 are violence, strong social and economic inequalities, government/business corruption, insecurities in housing, employment, and unreliable access to public infrastructure, such as sanitation, transportation, education, and health services. A 2017 study reported that for the five middle-income nations shown in Figure 4, the DHS variables “Diet Diversity Score” or “Mother’s Education” were important risks for stunting, but the greatest risk was for “Wealth Index” groups “Poorest” and “Poor” which had a statistical odds ratio
for stunting 2–3 times higher than other variables (Krishna et al., 2018). Krishna and colleagues concluded that a focus on diet and sanitation in poor communities will not result in a substantial reduction in stunting rates. Rather that will come about only if, “...greater attention [is] paid to addressing the social, economic, and political drivers of stunting with targeted efforts towards the populations experiencing the greatest disadvantage and child growth faltering” (2018, p. 1). These authors were anticipating the SEPE approach to stunting, but they do not specifically include fear of violence and the biological impact of toxic stress on height growth.

In Guatemala, the average height of boys, girls, men, and women of all ages is at the very low end of the range of variation for all nations. An analysis of 200 national and regional samples of adult heights reported for all Guatemalans current mean heights of 163.4 cm for men and 149.4 cm for women (NCD Risk Factor Collaboration [NCD-RisC], 2016). Guatemalan women have the shortest average height in this database, which also shows that Guatemala women’s mean height has not changed since 1896! Guatemalan men are the fourth shortest after East Timor, Yemen, and Lao PDR (Laos)—nations that like Guatemala have suffered histories of violence and poverty. Guatemalan Maya men and women are, on average, even shorter than these national means.

The stunting divide between Maya and Ladinos crosses all wealth tertiles, as shown by wealth tertiles in Table 1. The short stature of Maya is not “genetic” and Maya are not “Pygmies of the Americas,” as claimed by some (Bogin, 1998). There is evidence that Maya were taller in the past. Skeletal remains at the Maya archeological site of Tikal indicate that the height of men averaged 166 cm at the start of the Classic Period in 250 CE, a time of relative prosperity for Maya people. Maya men of high social status, indicated by burials within ornate tombs or pyramids, averaged 170 cm in height, and at least one man was 177 cm tall. These high-status Maya were about the same height as “tall” African populations, such as the Tutsi of Rwanda and Burundi, measured in the early twentieth century (170 cm), and taller than many Europeans at the end of the nineteenth century (Bogin, 2013). Measurements of children aged 5–12 years old, of Maya immigrants from Guatemala to the United States, found that these Maya-American school children averaged 10 cm taller than their age mates back in Guatemala. The Maya-American families were low-income, with many living in poverty, but life in the United States afforded more food, higher quality water and sanitation, and more importantly freedom from any of the SEPE fears, inequalities, and insecurities of Guatemala. The increase in mean height of the Maya-Americans occurred within a generation, making impossible a simple “genetic determination” explanation for short stature in Guatemala. However, the prevalence of stunting for the Maya-American children was 11.5% compared to 3.8% for Mexican-American, 0.7 for African American, and 0% for European-American school children of the same community (Smith et al., 2002). The persistence of greater stunting prevalence for the Maya-Americans might be due to “intergenerational inertia” due to epigenetic factors and/or continued fear and emotional stress from life in the United States as undocumented immigrants, with precarious employment for parents, and related SEPE insecurities (Loucky & Moors, 2000).

|         | Poorest | Middle | Wealthiest |
|---------|---------|--------|------------|
| Maya    | 67.1 (64.3; 69.7) | 51.5 (47.7; 55.3) | 34.8 (27.7; 42.7) |
| Ladino  | 52.9 (49.6; 56.2) | 28.9 (26.7; 31.3) | 14.3 (12.1; 16.8) |

Note: The data are presented as % (95% CI). Data from Gatica-Dominguez et al. (2019).
small-scale animal holdings (sheep, chickens, a cow, or burro) augmented by craft specialization. Ladino and other non-Maya people usually controlled market access and prices for goods and services. Maya were also employed at very low wages or work-indentured on plantations owned by non-Maya. In recent years, new practices derived from globalization have become common for many Maya, such as rural-to-urban migration, international migration, work in the service and tourism industries (usually as cleaners, gardeners and other low-paid jobs) use of mobile phones, the internet, and drinking Pepsi-Cola and Coca-Cola (Bogin et al., 2020; Leatherman & Goodman, 2005; Loucky & Moors, 2000).

8 | FEAR AND INSECURITY IN GUATEMALA

Because the Maya are so visible in terms of language, dress, religion, and other cultural traits they are easy to target for prejudice and racism. A 2019 photo essay in El País, a Guatemala newspaper, was titled, “There are two Guatemalas and this is the one that does not eat” (Hay “dos guatemalas” y esta es la que no come) (https://elpais.com/elpais/2019/10/29/album/1572353214_892610.html#foto_gal_1). The photo essay emphasizes the fear people have of food insecurity and explains that 23.4% of population suffers food insecurity, with higher rates in rural areas and the highest in indigenous Maya regions. Maya food insecurity is exacerbated by governmental policies that systematically target Maya for SEPE discrimination. This is one way that the Political component of SEPE interacts with its other components, especially the harmful Emotional factors. A brief overview of Guatemalan political events is given here to establish the Political–Emotional connections.

The second half of the 20th century was an especially brutal period in Guatemala, with a civil war that was raging between 1960 and 1996. The worst years may have been during the military dictatorship of José Efrain Ríos Montt, 1982–1983 (Figure 5). Ríos Montt’s policies were supported by the United States government and praised by US President Ronald Reagan. In 2013, after serving for years as a Guatemala congressman, a Guatemalan Court convicted Ríos Montt for murder and genocide of the Ixil Maya, whose villages were wiped-out by his military forces. One of most notorious violent attacks was committed by the Guatemalan military forces known as

**FIGURE 5** A “wanted poster” (Se Busca) for the genocide practiced during the Ríos Montt dictatorship of Guatemala, below the poster are photographs of a few victims, including priests, nuns, students, and intellectuals. Not pictured here are the thousands of murdered rural Maya adults and children.

*Source: United Nations human rights twitter feed https://twitter.com/UNHumanRights/status/981159427448467456/photo/1*
Kabilies at the village of Dos Erres in 1982. The Dos Erres slaughter was part of Ríos Montt's genocidal scorched-earth campaign against the Maya population. Soldiers entered the village and tortured the men, raped the women, and killed everyone, 300 in total including 113 children (Figure 6). Ríos Montt was sentenced to 80 years in prison. He appealed the conviction to higher courts, which decided that he could not be sentenced due to his age and deteriorating health. Ríos Montt died in Guatemala City on April 1, 2018, of a heart attack at the age of 91. The president of the government of Guatemala, Jimmy Morales, lamented his passing.

Since the dictatorship of Ríos Montt, Guatemala has had 14 heads of state or presidents; some were military dictators, including the one who over-threw Ríos Montt, and some were elected. In 1996, the civil war ended officially with the signing of peace accords which specified the election of government representatives and the president in open and free balloting. According to independent observers, such as the United Nations Human Rights Commission and the non-profit NGO Guatemala Human Rights Commission, none of the post-1996 elections were open and free.

There is a documented association between these political events and the physical growth of Maya children. The Universidad del Valle de Guatemala (University of the Valle of Guatemala) conducted its Longitudinal Study of Child and Adolescent Development between 1953 and 1999, which covered the duration of the 36 year civil war (Bogin, Camacho de Paz, & Macvean, 2018; Bogin & MacVean, 1983). The study included samples of Ladino school students between the ages of 5–18 years old from high, middle, and low SES families. SES was assessed by characteristics of the school of attendance and verified by a questionnaire that assessed parental education and occupation. Two Maya schools were added to the study in 1979 and the families of these students had significantly lower SES than any of the Ladino families. The mean HAZ of the Maya students was at all times below that of Ladino students. Relative to the high SES students the mean HAZ of Maya students increased approximately 0.4 SD between 1979 and 1999 (Mansukoski, 2019; Mansukoski et al., 2020), which may be considered a relatively modest change. The political environment of Guatemala was not the only reason for the relatively small change in HAZ, but political repression and violence were likely major parts of the SEPE ecology that delayed growth in height of Maya children and adolescents. In contrast, the mean HAZ of Maya-American boys and girls, age 5–12 years old, measured in 1999–2000 was more than 1.5 SD greater than Maya of the same ages living in Guatemala: for the years 1998–2000 HAZ = −0.5 SD in United States versus −2.0 SD in Guatemala (Bogin et al., 2002; Mansukoski et al., 2020). The Maya-American research documents height increases of more than 1 SD for siblings born in

**FIGURE 6** Upper left: The “Kabilies,” the Guatemalan Army Special Forces that carried out ethnic cleansing of the Maya in Guatemala (https://www.salon.com/2013/09/30/they_ordered_us_to_kill_all_the_people/). Right: Excavation of mass grave at the site of the Dos Erres Massacre by Guatemalan forensic anthropologists, with families of the victims watching (https://twitter.com/ffeccerelli/status/913540072036761600). Bottom left: Remains of Dos Erres victims exhumed from the mass grave (https://www.telesurenglish.net/news/ICE-Arrests-Former-Kaibiles-Linked-to-Dos-Erres-Massacre-20170110-0019.html)
Guatemala versus in the United States. Most of the Maya-American families were living in poverty or were low-income showing that the increase in height was not due to money per se but rather differences in the SEPE environments of the two countries. In terms of HAZ, being poor in the United States is "better" than being poor in Guatemala.

Political insecurity and its attendant social, economic, and emotional stress continued in Guatemala. Between 2016 and 2020, a man from a military-oligarchy family named Jimmy Morales served as President (Figure 7, left). Prior to this, he worked as a television presenter and comedian, often appearing in blackface and an afro wig as a character known as Black Pitaya, who spoke in an infantile voice and told self-deprecating jokes. As that character, Morales epitomized the worst of Latin America’s racist heritage which is usually focused on indigenous people such as the Maya. As President, Morales denied any genocide or ethnic cleansing of Maya people by past governments or the military, despite evidence from forensic excavations of mass graves and extensive eyewitness testimony to the United Nations Truth and Reconciliation Commission and the Truth Commission of the United States Institute of Peace. Soon after Morales took office, the Guatemalan National Postal Service closed due to corruption and drug trafficking by previous governments. Postal services only resumed in 2019. Morales' son and brother were accused of corruption and arrested, but the charges were eventually dropped. Morales expelled from Guatemala the international anti-corruption commission that helped to bring the charges against his family.

The current Guatemala President is Alejandro Giammattei (Figure 7, right). He won the post, in part, because the other candidates were disqualified. Prior to the Presidency, he was head of the country's prison system. That position ended with his own incarceration, spending 10 months in jail during the investigation of the murders of seven inmates. Charges against Giammattei were dismissed by a judge who was later sanctioned due to unrelated corruption charges. The political party supporting Giammattei is made up by a group of former military officers, "...reportedly associated with the sector that opposed the peace process that ended Guatemala’s 36-year civil war. Many are also associated with industries that extract resources from rural communities—often with US, Canadian and European investment—a sector Giammattei has pledged to promote. Some are active members of organizations that have promoted dozens of malicious lawsuits intended to stop the work of public prosecutors, judges, experts, and human rights defenders who contribute to ending impunity for corruption, ongoing human rights abuses, and crimes against humanity carried out during Guatemala's civil war" (http://www.ghrc-usa.org/?s=Ríos+montt&x=0&y=0).

According to a January 2021 report from the Guatemala Human Rights Commission, “2020 Breaks Record for Attacks on Human Rights Defenders,” with 1,0201904 cases documented including 15 murders and 22 attempted murders. Women defenders were the

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**FIGURE 7** Left: Jimmy Morales on the campaign trail in 2015. Elected President of Guatemala, 2016–2020. Right: Alejandro Giammattei, President of Guatemala since 2020.

Source (Left): https://www.independent.co.uk/news/world/americas/jimmy-morales-how-comedian-became-president-guatemala-a6810931.html; Source (Right): https://www.reuters.com/article/uk-health-coronavirus-guatemala-presiden/guatamelas-president-says-hes-a-high-risk-patient-after-coronavirus-diagnosis-idUKKCN26D2T9?eType=EmailBlastContent&efld=d2847601-d0bf-405c-94e7-e596702fbb8d
targets of nearly 34% of the attacks (https://ghrcusa.wordpress.com/2021/01/24/2020-breaks-record-for-attacks-on-human-rights-defenders/). Attacks on the defenders is just the tip of an iceberg of violence against community activists, especially Maya leaders and politicians, which continues unabated to this day.

9 | INEQUALITY, VIOLENCE, AND GENDER IN GUATEMALA

Guatemala is the wealthiest nation of Central America, but also the most financially unequal. The GINI coefficient—an index of income inequality—for Guatemala is 56, which ranks Guatemala as second worst, just above the Central African Republic. Union Bank of Switzerland (UBS) and the consultancy firm Wealth-X (whose headquarters are in Singapore) reported that 260 Guatemalans possess accumulated wealth of US$30 billion. This equates to 56% of the annual economy of Guatemala. In other words, 0.001% of Guatemalans have more capital than the rest of the society. As shown in Figure 3, 17% of the under-5-year-olds of the wealthiest quintile of Guatemalan families are stunted. It is not known how many of the elite 0.001% are stunted, but it is likely that some are. It has been shown in previous research that the SEPE environment affects the growth in height of all its members. This is called the “Community Effect in Height” (Bogin, 2021a; Bogin, Hermanussen, & Scheffler, 2018; Hermanussen et al., 2014). Wealth, in itself, is no barrier to the pernicious consequences of a SEPE environment of inequality, violence, and fear.

Poverty does have its own consequences and the indigenous Maya majority of Guatemala lives at the other economic extreme. Despite the wealth controlled by its 260 richest families, Guatemala is, according to the World Bank, the fifth poorest economy in Latin America and the Caribbean. The central government collects revenues (taxes) of only 9.7% of the Gross Domestic Product, with much of the other 90.3% going to those 260 wealthiest Guatemalans. One consequence is that only 40% of Guatemalan families enjoy food security. Maya people are most affected by economic inequality and its insecurities. Between 75 and 79% of Maya families live in poverty (<US$5.00 per day). The Women’ Justice Initiative (http://womens-justice.org/our-work/why-guatemala/) reports how this impacts the lives of women and girls:

- By age 18, 40% of Maya girls are married
- Guatemala ranks third lowest in Latin America on the Gender Inequality Index
- Guatemala has the third highest rate of violent deaths among women in the world

The items of this list are interrelated and work synergistically to impoverish and disempower Maya women, with harmful consequences on their health and the health of their children. One item on the list, schooling, is especially well-studied in many countries. It is known that literacy and educational status are major determinants of health, but educational opportunities are usually controlled by central governments and other institutions that lie far “upstream” from the communities of disadvantaged people such as the Maya. School buildings, books and other school supplies, and teachers in Maya regions are often of poor quality or non-existent. Overall, Guatemala has the lowest literacy rate of Central America. According to a 2006 study by the Population Council, only 39% of Maya women are literate compared to 77% Ladino women, 68% of Maya men, and 87% Ladino men (https://knowledgecommons.popcouncil.org/cgi/viewcontent.cgi?article=1057&context=departments_sbsr-pgy). Poverty, social disadvantage, gender inequality, number of years of schooling, literacy, and related education variables are often the strongest correlates of human growth in height (Scheffler et al., 2021). For more than a century in Guatemala, the upstream governmental policies of systematic under-funding for Maya education have maintained intergenerational cycles of inequality and the stagnation of Maya growth in height. The author was part of a team conducting fieldwork between 1976 and 1999 at one Maya village primary school. It was found that at school entry 55% of students were stunted. There was no biologically meaningful change in average height during the 24 years of the research. Details are given in the legend for Figure 8. Gender inequality in education was also obvious from our fieldwork. Given in Table 2 are the numbers of boys and girls enrolled at the Guatemala State primary school in the village in the year 1979 (Bogin & MacVean, 1987). Fewer girls entered school and none completed the 6 years of legally mandatory primary education.

10 | THE PEOPLE OF GUATEMALA, ESPECIALLY WOMEN, ARE INSECURE AND CHRONICALLY STRESSED BY VIOLENCE

Following the end of the civil war in 1996, there was a rise in organized crime and corruption related to drugs and human trafficking. The crime and gang violence
were, and still are, symptoms of much larger structural problems in the government and society, “...including deepening economic inequalities, the erosion of political and social infrastructures and disparate access to healthcare and education” (Thomas & Benson, 2008, p. 39). The insecurities wrought by these SEPE stressors have increased violence focused on girls and women. Between 1991 and 2001, the murder rate for Guatemalan women was about 200 murders per year. The number of killings of women tripled to just over 600/year by 2006, according to a 2007 study by UN Rapporteur Philip Alston. As of 2018, the murder rate of women in Guatemala was the third highest in the world with an average of 755 violent deaths/year of women (2014–2016) (https://www.theguardian.com/healthcare-network/2018/mar/07/health-workers-stop-thousand-women-killed-guatemala-femicide). To place these numbers in global perspective, The World Bank reports the intentional homicide rate for Guatemalan women was 7.6 per 100,000 women in the population in the year 2015. In contrast the rate in Afghanistan in 2018, a nation often considered violent, was 0.8/100,000 women. The rates in 2018 for a few other countries were: United States 2.2, Germany 0.9, and Singapore 0.3 (https://data.worldbank.org/indicator/VC.IHR.PSRC.FE.P5?most_recent_value_desc=false).

The UN Rapporteur report noted that, “...the death toll is only the beginning of the cost, for a society that lives in fear of killing is unable to get on with its life and business in the ways that it wants” (Sanford, 2008, p. 21). Life and business in Guatemala have been insecure for everyone due to crime at the highest levels of government. In 2015, the Guatemalan president Otto Pérez Molina and vice-president Roxana Baldetti (a former Miss Guatemala beauty queen) were arrested for crimes of corruption. They had used the Guatemalan National Postal Service for money laundering, which was one reason for the suspension of postal services when Morales was elected President. Baldetti was sentenced to 15 years in jail, based largely on evidence provided by the International Commission against Impunity in Guatemala, known by its Spanish-language acronym Cicig. Pérez Molina awaits trial but is likely to go free because his successor, Jimmy Morales, expelled Cicig from Guatemala. Cicig was investigating Morales and his family for fraud. These actions reduce some fear of retribution against the ruling elite but create even more fear and stress for the majority population of the country. Another reason that Pérez Molina is likely to go free is because he is a retired Army General and former head of military intelligence and has powerful supporters among Guatemala’s ruling elite. Pérez Molina helped negotiate the 1996 peace accords that ended the civil war but reneged on his promise to address the tremendous injustices, including genocide against the Maya people, that took place during the conflict. Pérez Molina has been accused of participating in the genocide, the murder of Roman Catholic Bishop Juan José Gerardi (a Guatemalan human rights defender) and other atrocities.
As of 2017, Guatemala ranked 14th highest nation for its total murder rate, at 26.1/100,000 population and number 1 in extortion. According to InSight Crime, Guatemala’s criminal organizations are among the most sophisticated and dangerous in Central America. Some of them have been in operation for decades. They include former members of the military, intelligence agencies and active members of the police...Guatemala's multitude of criminal groups range from violent street gangs to trafficking groups that serve as intermediaries for Colombian and Mexican cartels. The violent MS13 and Barrio 18 gangs both have a foothold in the country, controlling extortion activities in Guatemala City's urban neighborhoods. Long-time smuggling groups also have operations in the country's porous border regions. These groups often have links to corrupt officials, ranging from local politicians to high-level security and government officials (https://www.insightcrime.org/guatemala-organized-crime-news/).

Guatemala is a kidnapping “hot spot” of the world. The Latin America Herald Tribune reported in February 2020 that, “At least eight of the kidnapping gangs operating in Guatemala are made up primarily of current and former members of the national police, the press reported on Monday, citing sources in the judiciary” (http://www.laht.com/article.asp?ArticleId=329337&CategoryId=23558). Kidnappings are a constant source of fear, insecurity, and stress for all Guatemalans. The targets for kidnappings include wealthy families, both adults and their children, for the ransoms paid to return loved ones. Since the onset of the COVID-19 pandemic there has been an upsurge of kidnappings and murders of girls and women (https://www.telesurenglish.net/news/Guatemalan-Girls-Demand-An-End-to-Violence-Against-Children-20210215-0003.html). In the first 4 months of 2021, at least 160 women were murdered in Guatemala, more than one per day, and the government received more than 20,000 complaints of violence against women and girls. Only 12% of such complaints are investigated and 99% of murders are unpunished. The government promotes the fear and violence against women and girls. “A year ago, as one of his first acts in office, President Alejandro Giammattei slashed the budget of the so-called Presidential Secretariat for Women, which is meant to protect women's rights” (https://www.dw.com/en/in-guatemala-women-fear-for-their-lives/a-57397987).

Kidnappings plague all economic levels of the population. The wealthiest families employ armed guards for home security and during routine travel, and have their children taken to school in armored cars accompanied by armed personnel. Even so, the wealthy live with the daily fear of kidnapping and violence. Low-income people, even those in poverty, are kidnapped for personal retribution or, more often, for intimidation. The poor may be exploited for their land or because they might testify against the wealthy or military. Low-income kidnap victims are often tortured and murdered. Maya families are regular targets of kidnapping and murder, as documented in a 2017 photo essay by John Moore (https://time.com/4674482/guatemala-boys-murder-school-funeral/). This spreads the fear against any resistance or complaint of exploitation.

11 | ADVERSE CHILDHOOD EXPERIENCES, TOXIC STRESS, AND STUNTING

Insecurities from endemic corruption, violence, and kidnappings are forms of inadequate and inappropriate psychosocial stimulation, which is one of the three primary determinants of stunting as defined by the WHO. However, in pediatric and public health practice, the focus of psychological stimulation is more on encouraging play activities and language skills and less attention is focused on fear and emotional insecurity (e.g., Daniel et al., 2017). The history of Guatemala since the Conquest documents that for more than 500 years Guatemalans of all ages have been exposed to the near constant toxic emotional stress of fear, violence, and insecurity. The young are especially susceptible, and the public health community uses the phrase “adverse childhood experiences” (ACEs) to emphasize their vulnerability (Hughes et al., 2017; Nelson et al., 2020, see also https://developingchild.harvard.edu/ACEs for a concise explanation and infographic of ACEs). This type of stress takes a toll on human health, including growth in height, as much or more so than food shortages and infection. ACEs and toxic emotional stress in infancy and childhood are associated with susceptibility to immune system derangement (Johnson et al., 2013), pediatric and adult disease (Chrousos & Gold, 1998; Johnson et al., 2013), dysregulated gene expression (Slavich & Cole, 2013), altered DNA methylation, other epigenetic change (Nelson et al., 2020), and low birthweight (Varea et al., 2016).

The “C” in ACEs places emphasis on the childhood phase of life but toxic stress impacts people of all ages and persists across generations. Several researchers with a focus on Maya people and on Guatemala noted the effect of toxic stress on pregnant and lactating women
and their newborns. This research group collected and interpreted biocultural data using anthropological fieldwork methodology of participant-observation, newer methods of participatory action research and socio-ecological frameworks to construct questionnaires (Chomat et al., 2015). The research was based on a sample of 155 Maya women living in rural communities in the Western Highlands of Guatemala. Women were enrolled during pregnancy and followed for between 6 and 9 months. Mother-infant dyads were assessed between 0 and 6 weeks after birth (early postpartum) and again at 9 months. Mother-infant dyads were assessed between longitudinal and cross-sectional cohorts.

The researchers collected information on household and social factors, including a DHS-style index of household wealth, the mother’s nutritional and infectious disease status, the mother’s obstetric history and care during pregnancy; place and type of delivery, and psychosocial stressors of the mother assessed from the perspective of the researchers and as reported by the mothers in their local idioms of distress. By “local idioms of distress” the researchers meant that the women used their own Maya language and meaning to describe and interpret illness and emotional status. The researchers also collected newborn and infant characteristics such as birthweight and length. The researchers’ interpretation of findings was based on a sociocultural model that distinguished three broad categories of stressors—(1) nutrition, (2) infection, and (3) psychological—that, “...cumulatively impact the health of the maternal-infant dyad” (Chomat et al., 2015, p. 417, see their Figure 1 for details of the model). Subsistence farming of maize (corn), potatoes, black beans and broad beans characterized the livelihood of 99% of the families. Extreme poverty characterized 68% of families and an additional 19% lived in poverty. Based on a 24-h diet recall, only 20% of women had a sufficient diet diversity score during pregnancy and early postpartum and only 9.9% had adequate diet diversity by later postpartum. Only 38% of mothers reported food security. Most women (81%) reported low maternal autonomy, 70% reported high paternal support, but 22% of women also reported experiences of domestic violence. In general, the women’s social support networks were small (mean of 2.7 ± 1.3 individuals). While the women reported high trust in family (88%), trust in community-based institutions was moderate (61–65%), and trust in government services was low (6%).

The mean height of the mothers was 146.5 ± 5.2 cm, and 33% were < 145 cm which the authors designated as adult stunting. Low birth weight (LBW) was reported for 8.6% of the longitudinal sample, which received frequent antenatal care visits (7.5 ± 3.8), but LBW was 21.6% for the later postpartum cross-sectional sample. Premature birth (<37 weeks gestation) was 21.7% for the longitudinal sample. Infant stunting (< −2 HAZ) was common, at 33.8% for the longitudinal sample despite the frequent antenatal care visits. The researchers noted that these data contradict the “conventional wisdom” in the literature is that there is little to no growth retardation in length at birth and that such growth restriction is believed to occur after age 6 months (Solomons et al., 2015). The conventional belief is based on the fact that few reliable measurements of length growth are available prior to age 6 months. This is one reason why the WHO length growth standards begin at age 6 months. The authors’ research found that for their Maya participants growth delay began in utero. The infants’ small size at birth seems to be related to a combination of short gestation length, mother’s short-stature, and maternal stress during pregnancy. The stress likely includes physical environmental insults such as recurrent infection and exposure to indoor wood-fire smoke, but also persistent psychological and emotional stress.

Maya mothers reported on three types of stress disorders defined by local idioms of distress. These were susto, enojo, and nervios. The researchers explain that: “Susto is believed to result from a frightening or startling experience, ranging from an accidental fall or physical trauma to witnessing an accident or human suffering, which, sometimes only after a significant time lapse, affects the normal equilibrium of the human body and manifests as a diverse array of symptoms and pathologies. Enojo is described as an anger that upsets the body’s equilibrium and leads to headaches, stomach pains, weakness or fatigue, and chronic illness. Nervios is an illness due to experiencing strong emotions, particularly anxiety, grief, and sorrow...” (Chomat et al., 2015, p. 424). Susto or enojo were reported by 69% of women during pregnancy and by 52% during later postpartum. Less than 5% of women reported nervios at any time. Susto was always the most common complaint. Mothers reported that their infants also suffered from susto. Mother state that infants with susto have poor appetite, discoloration, irritability, and fatigue. Some Maya mothers state that susto may be transferred from the mother during pregnancy or via breast milk and these women are less likely to breastfeed their infants (Wren et al., 2015) and the infant may suffer poor growth. These traditional Maya beliefs have support in western science and biomedicine in terms of the intergenerational transmission by epigenetic processes (reviewed in Bogin 2021a, pp. 372–375; Bogin 2021b).
12 | HOW STRESS GETS INTO THE SKELETON AND DELAYS GROWTH

The Maya women’s use of susto and enojo as a local idiom of distress, and their explanation that susto is transferrable to their fetus and infant, are both accommodated by western biomedicine’s concerns with infection, nutrition, and physiological stress. One member of the research team in Guatemala, Noel Solomons, has long proposed that infections, more than inadequate nutrition, are primary causes of growth failure in Guatemalan infants and children (Solomons et al., 1993). Solomons and colleagues based their proposal on the “dirty chicken” hypothesis, that, “...continuous activation of the acute-phase [immune] response with the consequent mediation of catabolic and antitrophic metabolic processes is responsible for the antibiotic-responsive growth impairment of chicks raised in unhygienic environments” (p. 327). Subsequent research by Solomons and others in Guatemala reports that breastfeeding Maya women with subclinical mastitis (an inflammatory condition of the breast) produce milk with proinflammatory cytokines and dysregulated mineral content (Li et al., 2018). The infection, the cytokines, and other hormonal signaling factors—due to the chronic toxic stresses of susto, enojo, and their underlying causes in poverty, insecurity, and violence—may be transferred from mother to infant via breastfeeding (Solomons, 2019). Coupled with deficits or excesses in minerals and other nutrients the outcome may be growth faltering in infant length (Wren-Atilola et al., 2019).

Whether called susto or ACEs, the impacts of stress and illness begin to act early in life and have powerful, persistent correlations with poor outcomes later in life, including dramatically increased risk of heart disease, diabetes, obesity, depression, substance abuse, smoking, poor academic achievement, time out of work, and early death. Too often exposure to ACEs and toxic emotional stress in Guatemala is exacerbated by food shortages, infection, and other health problems, a combination that is especially harmful—even deadly (Bogin, 2021a, pp. 423–425).

In a recent AJHB Commentary article related to the COVID-19 pandemic, we reviewed evidence that maternal stress before and during pregnancy lowers birth weight (Bogin & Varea, 2020). We noted that, “Dysregulation of the maternal hypothalamic-pituitary-adrenal (HPA) axis... (often) leads to an increased transfer of glucocorticoids from mother to fetus, resulting in lower birth weight and shorter gestational age at delivery” (p. 6). The findings of LBW and premature birth for Guatemala Maya (Solomons, 2019; Wren-Atilola et al., 2019) are consistent with maternal HPA dysregulation.

Living in poverty is, itself, a toxic stress and increases the exposure of young people to ACEs (Brisson et al., 2019). Young people in poverty households have shallower increases of testosterone, in both boys and girls, at all stages of growth (Barch et al., 2020). Reduced testosterone may slow both skeletal growth and the development of the hippocampus, the latter being an important region of the brain for emotion regulation. Based on a longitudinal study of participants aged from 3-to-19 years old, Barch and colleagues reported that those experiencing early life poverty had, “...disruptions in developmental testosterone trajectories and hippocampal volume growth across school age and adolescent development, as well as...greater emotion dysregulation and depression in adolescence” (Barch et al., 2020, p. 1).

These SEPE-hormonal associations may explain differences in height between human communities. Toxic stress and ACEs impact the epigenetic regulation of glucocorticoid receptor (GR) expression (Nelson et al., 2020). GR is an important mechanism of adaptation to stress and is expressed in almost every cell in the body, regulating genomic activity related to growth, development, metabolism, and immune response (Liu & Nusslock, 2018). Pathological responses to ACEs include the increased production of cortisol, the catecholamines dopamine, norepinephrine, and epinephrine (adrenalin), and glucagon. These “stress hormones” have an antagonistic effect on the growth hormone/insulin-like growth factor-1 axis (GH/IGF-1 axis, see Bogin et al., 2015 and Figure 9). Early life toxic stress damages the IGF-2 antisense RNA promotor gene, which may result in suppressed cell growth (Rotwein, 2018). IGF-1 closely interacts with the mechanistic Target of Rapamycin Complex 1 (mTORC1) signaling pathway. Research on this metabolic pathway was reviewed by Saxton and Sabatini (2017) who reported that mTORC1 is a master growth regulation pathway that is sensitive to the requirements for cell growth in terms of both hypertrophy and hyperplasia. IGF-1 and other growth promoting factors stimulate mTORC1 activity which promotes greater size of body cells, tissues, organs, and height. Various forms of stress, including nutrient and oxygen deficits as well as cortisol and other stress hormones, block the action of mTORC1 and inhibit cell enlargement and division. Moreover, active mTORC1 blocks cell autophagy, the self-destruction of body cells. Under stress mTORC1 is inactive and there is an increase in catabolism, including autophagy.

In sum, chronic stress slows or stops skeletal growth, which has been well-known from more than a three centuries of studies of psychosocial growth delay (Bogin, 2021a, pp. 405–410; Rogol, 2020; Widdowson, 1951). Johnson and Gunnar (2011) reviewed the causes of psychosocial short
stature, a type of growth failure in height that cannot be explained by nutritional deficiency, physical abuse, or clinical disease. They confirmed the antagonistic action between elevated stress hormones, especially corticotrophin-releasing hormone and somatostatin, and inhibition of GH/IGF-1. Johnson and Gunnar concluded that chronic exposure to social stress was a major determinant of short stature of institutionalized children and acted independently of other insults such as poor nutrition and health care.

Recent experimental evidence with rodents and clinical observations with human patients indicate that various types of physical and emotional stress also cause a rapid rise in osteocalcin (OC) release into the blood stream. The only source of OC is from osteoblast cells in skeletal tissue, but this hormone has only minor effects on bone mineralization and density. OC is known to be an endocrine mediator for several physiological processes and one of these is that OC is needed for the acute stress response (Berger et al., 2019). Higher serum levels of OC and the “traditional” stress hormones induce a hypermetabolic state of catabolism—the breakdown body cells to liberate amino acids, fatty acids, and glucose from body cells and tissues for a response to the stress. This hypercatabolic state is called the acute stress response (ASR). In the short term, the catabolism of the ASR may be beneficial for immune response, wound repair, and dieting for weight loss. In the long term the consequences are harmful because a chronic ASR results in permanent loss of tissue and growth stunting (Arlt & Stewart, 2005; Christiansen et al., 2007; Matthews & Battezzati, 1993). The relationship of toxic stress and ACEs to delayed bone growth is illustrated in Figure 10. The prevalence of stunting in Guatemala across all wealth quintiles is hardly surprising given the widespread and endemic nature of fear, violence, and emotional stress.

Also shown in the figure is the impact of stress on accelerated adipose tissue deposition and body fatness. Chronic toxic stress due to ACEs results in a human phenotype of short stature with over-fatness. In the public health literature this phenotype is often described as the “nutritional dual-burden.” But the combination of short stature with over-fatness is not necessarily due to diet, or foods, rather it may be a result of the emotional stress imposed by harmful SEPE factors, including constant violence and economic inequality (Bogin, 2021a, pp. 502–503 provides more detail). The phenotype of short stature with over-fatness is associated with high risk for several serious health problems, but the cause is not primarily nutritional, and non-nutritional interventions are needed.

The physiology and metabolism of stress are well studied in living people in both the wealthy and poorer nations and have also been noted in skeletal and dental remains. Julia Beaumont and colleagues have confirmed the catabolic effects of chronic nutritional, infectious, and emotional stress in medieval archeological populations and in living people with low SEPE resources, such as low-income families in the United Kingdom (Beaumont et al., 2018). Another analysis of infant and child skeletal remains is based on ~300 victims of the Great Irish Famine (1845–1852). The skeletons were excavated from the mass burial ground of the workhouse in the city of Kilkenny and were deposited between 1847 and 1851 (Geber, 2014). It was found that starvation and infectious diseases were likely to have greatly contributed to infection and skeletal pathology, growth stunting, and death of these 1–5-year-olds.

![FIGURE 9](image-url) Some of the variables that influence levels of insulin-like growth factor-1 in blood serum. Variables in the color red, such as chronic stress, inhibit IGF-1 and variables in the color green stimulate IGF-1. This original figure was prepared by Professor Werner Blum and published in (Bogin et al., 2015). It is reprinted here with kind permission of Professor Blum.
addition, Geber emphasized that, “...the psychosocial stress relating to institutionalization in the workhouse should not be underestimated as a substantial causative factor for skeletal stress in this population” (p. 149).

13 | CONCLUSION

The scholarly and popular publications of Amartya Sen (Sen, 2002), Kate Pickett and Richard Wilkinson (Pickett & Wilkinson, 2017; Wilkinson & Pickett, 2009), and Michael Marmot (Marmot, 2015; Marmot & Bell, 2012) elegantly and passionately make the case for the pernicious effects of poverty, especially its social and economic inequalities, on health. Based on his analysis of gradients in social disadvantage, Marmot writes that, “The gradient in health in rich countries makes clear that we are discussing social inequalities more than absolute amounts of money” (33, p. 2444). Marmot uses the word “pollutant” to describe the impact of inequality and social disadvantage on human well-being. When applied to the lower-income nations, the pollutions of poverty and inequality are magnified and concentrated on the least advantaged, such as Maya people.

In this view, the pollutants of inequality and social disadvantage disempower people from the SEPE resources needed for their own healthy growth and development and for the health and good growth of their children. The poor suffer from poverty (low income), and like all people in modern nation-states exist along a gradient of access to resources that is regulated by social, educational, and occupational status as much, or more, than by income. The social and educational differences not only influence employment, income, and wealth, but also decisions and behaviors related to diet, health care seeking, smoking, alcohol consumption, sexual activities, and other similar variables that are associated with physical growth and emotional well-being. Economists such as Sen, public health researchers such as Pickett, Wilkinson, and Marmot, and many anthropologists, including the present author, agree that promoting greater equality is the most effective way to narrow the social gradient, reduce the need for violence, and improve the well-being of all members of society.

This article shows that stunting (length-for-age < −2SD) is common at all income levels in middle- and low-income countries. In Guatemala, 17% of <5-year-olds in the highest family income quintile are stunted, but in the United States, only 11.5% of low-income, Maya-American children are stunted. Some of the Maya-Americans may have suffered from conventional explanations for stunting: poor nutrition, repeated infection, and/or lack of psychological stimulation. At the highest income level in Guatemala, stunting is unlikely to be caused by nutrient deficiency or infectious disease, but rather the ACEs imposed by the Social–Economic–Political–Emotional environment of Guatemala. Without doubt, some percentage of the stunting measured for Guatemala's low-income population is due to poor nutrition and repeated infection. However, it may be hypothesized that at least 17% of stunting for infants and children of Guatemala’s poor and poorest families is
due to chronic, toxic stress imposed by SEPE inequalities. It is likely that 17% is a minimal estimate and that chronic, toxic stress accounts for an even greater prevalence of stunting in Guatemala and other nations with high levels of SEPE inequality, violence, and fear.

In Guatemala and many other nations high level of persistent violence creates an ecology of fear, an extreme range of inequalities in SEPE resources, and biosocial stress that inhibits skeletal growth and causes stunting for people of all income levels.

ACKNOWLEDGMENTS
Sincere thanks to Dr. Noel Solomons, Dr. Liina Mansukoski, two anonymous reviewers, and the AJHB Editor for their very supportive and insightful comments that improved the presentation of this article. Thanks also to PD Dr. Christiane Scheffler and Prof. Dr. Michael Hermanussen for discussion of ideas that underlie most aspects of this article. The final content of the article is the author’s responsibility.

CONFLICT OF INTEREST
The author declares no conflict of interest.

AUTHOR CONTRIBUTIONS
Barry Bogin developed the concept and wrote the article.

DATA AVAILABILITY STATEMENT
All data described in the paper are available in the literature cited. Data for research conducted by the author is available. Please contact the author.

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How to cite this article: Bogin, B. (2021). Fear, violence, inequality, and stunting in Guatemala. American Journal of Human Biology, e23627. https://doi.org/10.1002/ajhb.23627