HEALTH AND PROPORTIONALITY: A STUDY OF UNDOCUMENTED MIGRANTS FROM THE TEXAS-MEXICO BORDER

by

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DEDICATION

To my beloved parents, Ramón and Carmen,

Thanks for all your support and continuous care.

To *las abuelas*, Alicia and Doris, and *madrina,*

I am very grateful for all your check-up calls and always worrying about me.

To my dear and loving husband, Emanuel,

Thank you for your patience, friendship and humor.

To all of my friends,

Your support and friendship gave me strength when I felt weak the most.

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LIST OF ABBREVIATIONS

Abbreviation	Description
ANOVA	Analysis of variance statistical test
AW	American White
CBP	United States Customs and Border Protection
CI	Crural index
DOHaD	Developmental Origins of Health and Disease Hypothesis
EH	Enamel hypoplasia
EP	Ectocranial porosis
FACTS	Forensic Anthropology Center at Texas State
FPL	Femoral physiological length
GEFARL	Grady Early Forensic Anthropology Research Laboratory
LA	Latin American
OpID	Operation Identification project
ORPL	Osteology Research and Processing Laboratory
PH	Porotic hyperostosis
RLL	Relative leg length
SES	Socioeconomic status
TCH	Talus and calcaneus height
TL	Tibial length
UCL	Untreated caries lesions

ABSTRACT

Many undocumented migrants cross the Texas-Mexico border in search for a better, safer place every year. Although we cannot determine with certainty what motivates the migrants to risk their lives crossing the border, we can use skeletal methods to establish their nutritional and health status. Numerous studies have demonstrated that populations living in favorable socioeconomic environments in the early years of life show fewer stress markers in the adult skeleton. Thus, this study evaluated the health and socioeconomic status (SES) of 34 migrant remains found along the Texas-Mexico border by using relative leg length (LL*100/ST), crural index (TL*100/FPL) and the presence or absence of pathological conditions such as enamel hypoplasia, pathological ectocranial porosis and untreated caries lesions. This study has implications for understanding childhood and adult health histories, and why these migrants risked their lives crossing the border.

Skeletal remains of these 34 undocumented migrants and 99 documented American Whites from low, middle and upper social class were measured using the revised Fully technique by Raxter and colleagues (2006). Descriptive statistics show mean differences in relative leg length by sex; American White males having the highest RLL (53.84cm) and female Latin American migrants having the least (52.53cm). Still, the ANOVA and Tukey post-hoc test results revealed that the significant differences lie between the male Latin American migrants and middle class American White males alone. For crural index, the male and female Latin American migrants have the highest means for crural index within each sex group (84.9mm and 83.2mm, respectively). ANOVA and Tukey post-hoc test results show no significant differences in crural indices across groups. Chi-square results for the three pathological conditions show that stress decreases with higher SES regardless of sex, in general. Several explanations are proposed including the Buffering Hypotheses, the Developmental Origins of Health and Disease (DOHaD) Hypothesis and the Parental Investment Theory. Finally, I recommend a follow-up study where the migrants are compared with non-migrant populations from different countries in Latin America. Such analysis may facilitate positive identification of the migrant remains in the future.

I. INTRODUCTION

Since 2013, the Forensic Anthropology Center at Texas State (FACTS) has received the remains of 87 undocumented migrants that were exhumed in Brooks County, Texas (Spradley, 2014). The Operation Identification Project (OpID) – housed within FACTS is responsible for processing and analyzing these skeletal remains to facilitate identification and subsequently, their repatriation. The migrant remains consist of both males and females between the estimated ages of 16 to 60. It is very likely that many of these migrants traveled from Guatemala, El Salvador and Honduras as the latest United States Customs and Border Protection (2016) report indicates based on apprehension rates. The same report (United States Customs and Border Protection, 2016) shows that the majority of Central Americans are apprehended in Texas Border Patrol Sectors such as the Rio Grande Valley Sector, El Paso Sector, Del Rio Sector and Laredo Sector. Recent positive identifications of some of the OpID skeletal remains also suggest that these migrants are coming from Guatemala, El Salvador and Honduras. But, for the majority of individuals, the actual place of origin is still unknown, and positive identification is still pending.

Recent inquiries hypothesize that socioeconomic problems and increasing violence has motivated these individuals to flee their country, sometimes crossing the border through very dangerous zones, risking their lives (Anderson, 2008; Birkby et al., 2008; Aquino Moreschi, 2012; De Leon, 2012). In fact, ‘push factors’ such as gang-related crime and poverty have been found to be the most cited reasons for migrants leaving their home countries (Lawler, 2014). Changes in income are also used to explain the fluctuating migration among Central Americans (Lawler, 2014). For OpID individuals, the real reason for their migration may remain unknown until positive identification occurs, but the skeletal evidence could help us understand the childhood and adult health histories of the migrants, and possibly consider why they risked their lives crossing the border.

Because the skeleton of the OpID individuals (hereafter Latin American migrants) at FACTS are mostly complete, it is possible to analyze the skeletal remains for pathologies such as enamel hypoplasia, pathological ectocranial porosis and untreated caries lesions in order to better learn about childhood stress. Stature can also be estimated with greater accuracy when the skeleton is complete, and developmental stress can be assessed by comparing stature between groups living under different socioeconomic conditions. The purpose of this study is to employ anthropological methods to establish the socioeconomic status (SES) of the Latin American migrant remains found along the Texas-Mexico border. This study has wide-reaching implications for understanding childhood and adult health histories, and why these migrants risked their lives crossing the border.

The estimation of stature from skeletal remains has been important to forensic anthropologists and skeletal biologists since the mid-19th century. Unquestionably, stature is useful in the identification of human remains, because an accurate estimate of height can narrow down a missing persons list. Also, anthropological research has shown that better socioenvironmental conditions correlate with greater stature (Bogin and Loucky, 1997; Bogin et al., 2002; Kemkes-Grottenhaler, 2005). This is based on the assumption that people living in a better socioeconomic environment will have better access to healthcare and food. In fact, many studies have shown that nutrition and diseases (Bogin et al., 1992; Steckel et al., 2002; Franzen and Smith, 2009; Pomeroy et al., 2014), low SES (Bogin et al., 1992; Padez et al., 2009; Azcorra et al., 2013; Fujiwara et al., 2014), social strife, psychological stress and social discrimination (Gravlee et al., 2005; Clarkin, 2008; Mashal et al., 2008; Gravlee, 2009) can potentially affect the skeletal growth of any individual.

However, the use of stature as a proxy for nutrition and health can be problematic. Studies have demonstrated that height declines with age, most likely due to degenerative processes such as the thinning of the vertebral discs, that affects the bones of individuals 45 years old and over (Galloway, 1988; Yamanaka et al., 2010; Azcorra et al., 2013). For this reason, recent research suggests the use of relative leg length in lieu of stature for better estimations of childhood nutrition and health (Frisancho, 2007; Padez et al., 2009; Bogin and Varela-Silva, 2010; Yamanaka et al., 2010; Azcorra et al., 2013). Relative leg length is the length of the leg multiplied by 100 and then divided by stature (LL*100/ST) (Azcorra et al., 2013). The legs tend to grow relatively faster than the upper body between birth and puberty, which suggests that populations living in healthier and more advantageous environments in the early years of life will have more rapid leg growth than those in poor environmental conditions (Bogin and Varela-Silva, 2010; Azcorra et al., 2013). Thus, populations affected by environmental conditions that are non-conducive to health will attain a low relative leg length and hence a low adult stature in comparison to healthier populations.

For example, Azcorra and colleagues (2013) studied a sample of 109 triads of contemporary Maya children, their mothers, and grandmothers from Merida, Mexico to test the hypothesis that leg length relative to stature is a more sensitive indicator of nutrition and health than is total height or sitting height. The authors selected this region because in the last decade economic growth and employment opportunities have increased in Merida City, thus attracting the Maya people into the area (Azcorra et al., 2013). However, the Maya migrants have continued to settle in the southern region of the city, which has been historically marginalized from economic development. The authors argued that years of exploitation, poverty, and restricted access to education and health services can be reflected in the health and nutritional status of the Maya (Azcorra et al., 2013). The results showed that 11% of the children were stunted; 29% showed short leg length; and 7% presented short sitting height. On the other hand, 71% of the mothers were classified as short or stunted, the deficit of growth being more severe in leg length (54%) than in sitting height (50%). The grandmothers were shorter in stature than their daughters, but the deficit of growth was more pronounced in the sitting height (83%) than in leg length (69%). In summary, the deficit of growth was evident in the three generations, adult women showing the highest growth deficit for leg length – and sitting height than their children.

An association between relative leg length and body fat has also been found. Frisancho (2007) used data from a cross-sectional study conducted between 1988 and 1994, which included a total of 21,021 subjects ranging in age from 2 to 90 years to determine whether differences in relative leg length are related to differences in body fat. The data retrieved from the third National Health and Nutrition Survey (NHANES II) also included the anthropometric information and poverty income ratio for all participants. Of the total number of male and female participants, 7,810 were American Whites, 8,134 were American Blacks and 6,237 were Mexican American (Frisancho, 2007). After comparing all three ethnic groups across socioeconomic status, males and females with a low relative leg length were generally associated with increased body fat, whereas those with a high relative leg length had less body fat (Frisancho, 2007). The authors hypothesized that low relative leg lengths are a result of poor environmental conditions leading to growth delay. Growth delayed individuals may then respond through "inter-related mechanisms oriented with improving energetic efficiency and low oxidation of fat," promoting fat storage (Frisancho, 2007, p. 709).

Researchers have shown that short relative leg length is also correlated to coronary diseases, diabetes, certain cancers, longevity, and a low degree of attractiveness (Kemkes-Grottenhaler, 2005; Sorokowski and Pawloski, 2008; Bogin and Varela-Silva, 2010). In addition, overly short or excessively long legs may signify some type of biological maladaptation. Males and females with short leg length in relation to stature may have weak immune responses to adverse environmental factors acting during childhood and adolescence (Sorokowski and Pawloski, 2008). Similarly, females that have excessively long legs with small torsos may have insufficient space for the proper development of a fetus and, therefore, have complications during childbirth (Sorokowski and Pawloski, 2008). Consequentially, nutritional deprivation and unhealthy lifestyles from in utero to later stages of growth and development may affect the growth of the individual.

Although the heritability of height can be upwards of 75% to 90%, environmental factors such as poor nutrition, limited health care and low SES may contribute to reduce growth velocity (Bogin and Loucky, 1997; Bogin et al., 2002; Kemkes-Grottenthaler, 2005; Larsen, 2006; Clarkin, 2008; Batty et al., 2009; Lewis, 2012). Otherwise, individuals who are healthy throughout their infancy and childhood will reach their genetic growth potential. Longer leg length is generally associated with better environments, better nutrition, higher SES, and better general health regardless of the specific leg measure taken. The goal of this study is to use relative leg length as a proxy for the nutritional and health status of the Latin American migrant remains found in the Texas-Mexico border. FACTS does not have detailed knowledge about these individuals, and my research will help shed light on whether these individuals are from a low SES.

The crural index is used in conjunction with relative leg length as it reflects the relative length of the distal leg segment as well (Holliday, 1999; Garcia, 2015). The crural index is the tibial length multiplied by 100 and then divided by the femoral physiological length (TL*100/FPL) (Auerbach and Sylvester, 2011). Allometric analyses show that longer legs inherently have higher crural indices. Stated differently, taller individuals should have higher crural indices due to positive allometry in the tibia (Auerbach and Sylvester, 2011; Garcia, 2015). If the individual has a relatively short tibia in relation to their leg length, however, they will have a low crural index. Like relative leg length, this index can be potentially influenced by childhood nutritional and stress factors, although there are also strong correlations between crural indices and thermoregulation, locomotion, and ancestry (Bogin et al., 2002; Auerbach and Sylvester, 2011; Garcia, 2015).

In addition to relative leg length and crural indices, I will utilize the presence of stress indicators such as enamel hypoplasia, pathological ectocranial porosis and untreated caries lesions as evidence for poor health and low SES. First, the presence of enamel hypoplasia is related to childhood stress. The enamel of adult teeth forms during childhood and do not remodel like the rest of the skeletal system (Goodman and Rose, 1990; Hillson and Bond, 1997; Starling and Stock, 2007; Hillson, 2008). Under intense periods of nutritional stress and disease, the amelogenesis or enamel formation is interrupted causing a reduction of enamel thickness, or hypoplasia (Goodman and Rose, 1990; Hillson and Bond, 1997; Starling and Stock, 2007; White et al., 2011; Hammerl, 2013; Mukhopadhyay et al., 2014; Wilson, 2014), although these may also be produced by heredity and trauma (Suckling, 1989; Goodman and Rose, 1990; Ensor and Irish, 1995).

Enamel hypoplasia appear as horizontal grooves or furrows, and occasionally as pits on the surface of the tooth, which can often be seen with the naked eye (Goodman and Rose, 1990; Hillson and Bond, 1997; Starling and Stock, 2007). The most commonly affected area of the dentition is the anterior, that is, the incisors and canines. However, if the conditions are severe enough, it can affect the premolars and molars as well. The size and prominence of the grooves vary according to the duration of the stressful event (Hillson, 2008; White et al., 2011; Mukhopadhyay et al., 2014; Wilson, 2014). Studies on subsistence transition have demonstrated that episodes of dietary deficiency, fevers and infectious diseases during childhood led to high frequencies of enamel hypoplasia in populations (Goodman et al., 1980; Lanphear, 1990; Starling and Stock, 2007; Shuler et al., 2012; Wilson, 2014; Merrett et al., 2015).

Secondly, pathological ectocranial porosis may reflect the living conditions of an individual during childhood and adulthood. Normal ectocranial porosis refers to porosity found in the parietals, occipital and frontal bones of a human skull without dense bone formation (Mann and Hunt, 2012). Many normal skulls exhibit ectocranial porosis, especially in middle-aged adults (Mann and Hunt, 2012). However, the pathological form of ectocranial porosis, that is porotic hyperostosis, occurs as a result of nutritional deficiency. In fact, studies have shown links between porotic hyporostosis and anemia (iron-deficiency), rickets (calcium and vitamin D deficiency) and scurvy (vitamin C deficiency) (Stuart-Macadam, 1985, 1992; Larsen, 1997; Ortner, 2003; Walker et al., 2009; Vercellotti et al., 2010).

Porotic hyperostosis is identified when thickened bone formation and porosity is observed in the cranial vault, commonly on the parietal and frontal bones, and less frequently on the occipital bone (Mann and Hunt, 2012). The porosity in the cranial vault is induced by the expansion of the diploë (the spongy bone separating the inner and outer layers of the compact cranial bone) in response to increased hematopoietic or blood cell requirements during infancy or childhood (Goodman et al., 1980; Stuart-Macadam, 1985, 1992; Ortner, 2003). The degree of porous lesions on the skull can vary from mild to severe (Ortner, 2003; Vercellotti et al., 2010; Mann and Hunt, 2012), and it is argued that the majority of adult remains may show healed porotic hyperostosis making diagnosis difficult (Larsen, 1997).

Finally, untreated dental caries lesions inform us about the health of the individual at the time of death. Dental caries, also known as cavities, are caused by built-up plaque in the mouth (Ortner, 2003; Hillson, 2008; Hammerl, 2013). The plaque, which contains saliva and food residue, can form in the grooves and pits of the back teeth, between teeth, near the gum line, and around dental restorations (Ortner, 2003; Hillson, 2008, Hammerl, 2013). The bacteria in the plaque produce acid that slowly destroys the tooth enamel and without intervention can also destroy the underlying dentin and root forming a cavity. If the infection is left untreated, it will grow and the cavity will be visible to the naked-eye, or may appear in dental X-rays (Hillson, 2008; Hammerl, 2013). A high frequency of caries has been associated with a diet rich in carbohydrates (Ortner, 2003; Hillson, 2008; Hammerl, 2013). However, caries may be treated and tooth decay prevented if the individual can afford dental care and has access to professional treatment.

The collective evaluation of these pathological conditions with relative leg length and crural index can provide a more holistic assessment of health across populations, and potentially of the undocumented migrants found in the Texas-Mexico border. Mainly, this research investigates whether the Latin American migrants have been under physiological stress as a result of poor nutrition and inadequate health during their early years of life. I hypothesize that if the migrants were malnourished and had poor health care in their childhood, they will show low relative leg lengths, low crural indices, and a higher frequency of pathological conditions.

In order to test this hypothesis, skeletal data from the Latin American migrant group are compared with a well-documented sample of American White males and females with self-reported low, middle and upper SES. By comparing the Latin American migrants with the American White groups, I will be better equipped to show the similarities and differences among them based on SES, and subsequently explore why we are seeing these similarities and differences in the populations.

In summary, this research addresses the following questions:

1. Do males and females from the Latin American migrant and American White groups show differences in relative leg length and crural index?

2. Is the distribution of the pathological conditions (i.e. enamel hypoplasia, pathological ectocranial porosis and untreated caries lesions) across groups consistent with the findings of question #1?
3. Is there enough evidence to suggest that the Latin American migrants come from a low SES?

II. MATERIALS AND METHODS

Materials

This study utilized skeletal remains from two sources, the Texas State University Donated Skeletal Collection and the Operation Identification Project (OpID). The Texas State University Donated Skeletal Collection is a growing collection that includes skeletal remains with documented demographic, occupational, and health information. The collection includes the donated remains of American Whites, American Blacks, and American Hispanics that willed their body or were donated by a family member to the Forensic Anthropology Center at Texas State (FACTS) for scientific research purposes. This skeletal collection is located at the Grady Early Forensic Anthropology Laboratory (GEFARL) in San Marcos, Texas.

The remains from Operation Identification are located at the Osteology Research and Processing Laboratory (ORPL) of FACTS. The Operation Identification project began as an effort to facilitate the positive identification of presumed Latin American migrants exhumed in Brooks County, Texas, in 2013. Several of these remains have now been positively identified, but the majority remain unidentified. Therefore, the goal is to identify these individuals and return them to their families.

The personal effects, geographic location and biological markers of the OpID individuals fit within the biological and cultural profiles for undocumented border crossers (Anderson, 2008; Birkby et al., 2008). All their personal belonging (e.g. change of clothes, shoes, etc.) are kept in the laboratory to aid in the identification process. It is important to remember that although forensic anthropologists at FACTS have constructed the biological profile for many of these Latin American migrants and described their personal belongings, positive identification of the majority of individuals is still pending. Also, we do not know the country of origin of the majority of the OpID individuals. As mentioned, it is likely that the majority of the migrants traveled from Guatemala, El Salvador, and Honduras based on the latest United States Customs and Border Protection (2016) report and on several positive identifications.

Samples

The inclusion of any case in the study depended on the following criteria: (1) the cranium, vertebrae, sacrum, femur, tibia, talus and calcaneus were present; (2) the individual was an adult, as indicated by complete epiphyseal fusion of the majority of the skeletal elements; and (3) the skeleton was in good condition to allow for accurate measurements. A total of 34 OpID individuals and 99 American Whites were measured. After ensuring that all cases meet the stated criteria, the sample size for the OpID and American Whites decreased to 32 and 85, respectively. For all OpID individuals, sex has been estimated via pelvic assessment. Table 1 shows the sex distribution by group. The estimated age range of the Latin American migrants is between 16 and 60 years, while the age range for the American White group is documented between 18 and 102 years.

FACTS keeps a record of the childhood socioeconomic status (SES) of its donations, given either by the donor or family member. Based on their perception of their socioeconomic standing, donors select one of the following SES categories: lower, lower-middle, middle, upper-middle, and upper. For the purposes of current research, the categories were collapsed into low, middle and upper categories. The resulting sample number for low, middle and high SES American White groups was 34, 38 and 13, respectively. Table 2 shows the SES distribution by sex for the American White group. It is crucial to remember that the majority of the migrants remain unidentified, thus we do not have information about their SES.

Table 1: The group and sex distribution of the samples

Group	Males	Females	Total
Latin American migrant	16	16	32
American White	51	34	85

Table 2: The socioeconomic status (SES) distribution of the American White group

American White	Low SES	Middle SES	High SES
Males	21	24	6
Females	13	14	7
Total	34	38	13

Methods

Data Collection

Skeletal Measurements

A total of 29 measurements were obtained using GPM sliding calipers, Paleotech spreading calipers, and the osteometric board following Raxter and colleagues' (2006) definitions. The revised Fully technique by Raxter et al. (2006) included the measurements of basion to bregma height of the cranium, maximum height of each vertebral body (2nd cervical vertebra through 5th lumbar vertebra), anterior height of the first sacral vertebra, physiological length of the femur, maximum length of the tibia without the spine, and the articulated height of the talus and calcaneus (Appendix A).

Where applicable, the measurement was estimated in the best possible manner. For example, extra bone growth caused by degenerative processes in any of the skeletal remains was avoided to ensure accuracy. The left side was measured, and when unavailable, was substituted with the right side. After summing these measurements to obtain skeletal height, the following equation was applied to obtain living stature in centimeters:

$$\text{Living stature} = 0.996 \times \text{skeletal height} \times 11.7$$

Relative leg length (RLL) was calculated by adding the length of the femur, tibia, and the height of the talus and calcaneus, dividing it by living stature and multiplying it by 100. The results are presented in centimeters.

$$RLL = \frac{FPL + TL + TCH}{\text{living stature}} \times 100$$

The crural index (CI) was calculated by multiplying the tibial length by 100, and dividing it by the femoral physiological length. The results are presented in millimeters.

$$CI = \frac{TL \times 100}{FPL}$$

Pathologies

Pathology data was collected from the original sample of 34 OpID individuals and 99 American Whites. The presence or absence of enamel hypoplasia, pathological ectocranial porosis and untreated caries lesions was examined independently from one another. The *Photographic regional atlas of bone disease: A guide to pathologic and normal variation in the human skeleton* by Mann and Hunt (2012) aided in the macroscopic identification of these pathologies. The criteria are as follows:

For the presence of enamel hypoplasia, the mandibular canines were examined first as they tend to be more frequently affected than maxillary canines (Goodman and Rose, 1990; Mukhopadhyay et al., 2014). However, the mandibular canines were substituted with the maxillary canines when unavailable. Ectocranial porosis (EP) refers to porosity found in the parietals, occipital and frontal bone without dense bone formation (Mann and Hunt, 2012). If thickened bone is present, then the name "porotic hyperostosis (PH)" is applied (Ortner, 2003; Mann and Hunt, 2012). Sometimes it is difficult to distinguish between normal EP and PH. Therefore, any cranium that potentially had PH was noted as EP. Individuals that had one or more untreated caries lesions were counted. On the other hand, individuals missing teeth due to antemortem (before death) or postmortem (after death) processes were not counted. Similarly, the individual was not counted if the skull was stained or sun bleached to a degree that made clear examination for ectocranial porosis impossible. Figures 1 through 3 show examples of the pathologies observed in the Latin American migrant group. See Appendix B for data collection spreadsheet samples.

Figure 1: Example of enamel hypoplasia (EH) observed in the Latin American migrant group

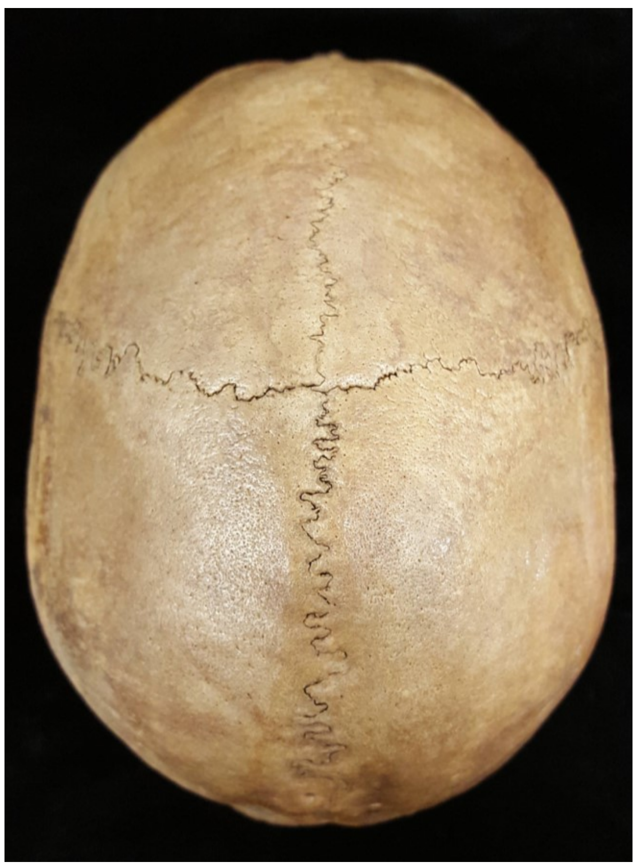

Figure 2: Example of ectocranial porosis (EP) observed in the Latin American migrant group

Figure 3: Example of untreated caries lesions (UCL) observed in the Latin American migrant group

Statistical Analyses

Skeletal Measurements

Descriptive statistics (i.e., mean, standard deviation and outliers) were run by sex for American Whites with low, middle and high SES as well as the Latin American migrants. The relative leg length (RLL) and crural index (CI) of American Whites by SES were compared with the RLL and CI of the Latin American migrants using an analysis of variance (ANOVA). The ANOVA is a statistical test that analyses the differences between group means and determines how significantly different they are from one another (Madrigal, 2012). If a significant difference was detected in the ANOVA, a Tukey Post-hoc test was then run to find which of the pairwise comparisons was responsible for the difference.

Pathologies

For each sample group, the frequency of each pathology was calculated by dividing the number of individuals that show the pathology by the total number of individuals examined. The frequencies were graphed and interpreted. Then, a Chi-square test was used to find out whether significant differences in counts existed within and between the sample groups. The test was run for each group separately by sex. If no significant differences were found, males and females were analyzed together in the subsequent chi-square tests.

III. RESULTS

Descriptive Statistics

Stature, relative leg lengths and crural indices were calculated for each group. Descriptive statistics for each group by sex are listed in Tables 3 and 4.

Table 3: Descriptive statistics for female Latin American migrants and female American Whites with lower, middle and upper socioeconomic status (SES)

		Stature (cm)	Relative leg length (cm)	Crural Index (mm)
Group	N	Mean (SD)	Mean (SD)	Mean (SD)
Latin American migrant	16	148.2 (5.9)	52.5 (1.2)	83.2 (3.1)
American White				
Lower SES	13	161.2 (3.9)	53.4 (0.8)	82.5 (2.4)
Middle SES	14	161.9 (3.7)	52.9 (0.9)	83.1 (1.7)
Upper SES	7	161.8 (6.4)	53.4 (1.7)	83.0 (2.5)

Table 4: Descriptive statistics for male Latin American migrants and male American Whites with low, middle and upper socioeconomic status (SES)

		Stature (cm)	Relative leg length (cm)	Crural Index (mm)
Group	N	Mean (SD)	Mean (SD)	Mean (SD)
Latin American migrant	16	160.6 (7.9)	53.1 (1.1)	84.9 (3.2)
American White				
Lower SES	21	173.7 (7.7)	53.8 (0.8)	82.9 (1.8)
Middle SES	24	173.9 (5.5)	54.3 (0.9)	83.0 (1.7)
Upper SES	6	171.3 (5.5)	54.0 (1.3)	84.7 (2.1)

Outliers

Two individuals from the donated collection were marked as outliers. One of the outliers is a male (D03-2009) from the middle SES group that has the lowest relative leg length value (52.0 cm) in the group. The other is a female (D12-2011) from the lower SES group, and she has the highest crural index (89.0 mm) in the group. The ANOVA tests were run with and without the outliers. The outliers did not affect the final results. Therefore, the outliers were included in the analyses below.

Relative Leg Length and Crural Index ANOVA Test

Females

The results of the analysis of variance for females show that there are no significant differences at alpha level of 0.05 between the groups for both relative leg lengths and crural indices (Table 5 and 6).

Table 5: Relative leg length ANOVA results for female Latin American migrants and female American Whites with low, middle and upper socioeconomic status (SES)

Source of variation	SS	df	MS	F	P value
Between Groups	7.55	3	2.52	1.96	0.134
Within Groups	59.19	46	1.29		
Total	66.74	49			

Table 6: Crural index ANOVA results for female Latin American migrants and female American Whites with low, middle and upper socioeconomic status (SES)

Source of variation	SS	df	MS	F	P value
Between Groups	3.81	3	1.27	0.21	0.892
Within Groups	283.93	46	6.17		
Total	287.74	49			

Males

The results of the analysis of variance for males show that there are significant differences at alpha level of 0.05 between the groups for both relative leg lengths and crural indices (Table 7 and 8).

Table 7: Relative leg length ANOVA results for male Latin American migrants and male American Whites with low, middle and upper socioeconomic status (SES)

Source of variation	SS	df	MS	F	P value
Between Groups	14.42	3	4.81	5.14	0.003
Within Groups	58.90	63	0.94		
Total	73.32	66			

Table 8: Crural index ANOVA results for male Latin American migrants and male American Whites with low, middle and upper socioeconomic status (SES)

Source of variation	SS	df	MS	F	P value
Between Groups	50.36	3	16.79	3.45	0.022
Within Groups	306.87	63	4.87		
Total	357.23	66			

Relative Leg Length and Crural Index Tukey Test

The results of the Tukey post-hoc test for the relative leg lengths show significant differences between the male Latin American migrants and the male middle SES American Whites (Table 9).

Table 9: Relative leg length Tukey test results for males

	LA migrant	AW Low SES	AW Middle SES	AW Upper SES
LA migrant	-			
AW Low SES	Not sig.	-		
AW Middle SES	Sig. ∗	Not sig.	-	
AW Upper SES	Not sig.	Not sig.	Not sig.	-
∗ = significant at $P < 0.05$; LA = Latin American; AW = American White				

The results of the Tukey post-hoc test for the crural indices between the Latin American migrant and the low SES American White male groups approach significance, meaning that the p-value is less than or equal to 0.05 (Table 10).

Table 10: Crural index Tukey test results for males

	LA migrant	AW Low SES	AW Middle SES	AW Upper SES
LA migrant	-			
AW Low SES	Sig. ∗	-		
AW Middle SES	Not sig.	Not sig.	-	
AW Upper SES	Not sig.	Not sig.	Not sig.	-
∗ = significant at $P \leq 0.05$; LA = Latin American; AW = American White				

Pathology Counts and Frequencies

The presence of enamel hypoplasia (EH), ectocranial porosis (EP) and untreated caries lesions (UCL) were counted for males and females. Table 11 shows the counts for each pathology by sample group. Tables 12 through 15 show the pathology frequencies by group. Figures 1 through 3 show a summary of the pathology frequencies by sample group.

Table 11: The presence and absence of enamel hypoplasia (EH), ectocranial porosis (EP) and untreated caries lesions (UCL) in each sample group

Groups	Sex	EH Present	EH Absent	EP Present	EP Absent	UCL Present	UCL Absent
Latin American migrant	Females (*N*=17)	3	11	7	8	7	6
	Males (*N*=17)	5	10	10	7	11	4
	Total	8	21	17	15	18	10
American White							
Low SES	Females (*N*=15)	3	6	2	13	5	5
	Males (*N*=24)	2	13	7	17	9	6
	Total	5	19	9	30	14	11
Middle SES	Females (*N*=16)	0	10	1	15	1	10
	Males (*N*=26)	1	18	4	22	6	14
	Total	1	28	5	37	7	24
Upper SES	Females (*N*=8)	0	6	0	8	2	4
	Males (*N*=10)	0	6	0	10	2	3
	Total	0	12	0	18	4	7

Latin American migrants

Males show a higher frequency of EH, EP and UCL than females (Table 12). In general, the Latin American migrant group shows a high frequency of UCL, followed by EP and EH.

Table 12: Frequency of enamel hypoplasia (EH), ectocranial porosis (EP) and untreated caries lesions (UCL) in the Latin American migrants

	Frequency (%)		
Sex	EH	EP	UCL
Females	21.43 (3/14)	46.67 (7/15)	53.85 (7/13)
Males	33.33 (5/15)	58.82 (10/17)	73.33 (11/15)
Total	27.59 (8/29)	53.13 (17/32)	64.29 (18/28)

American Whites with low SES

Males show a higher frequency of EP and UCL than females. However, females show a relatively higher frequency of EH than males (Table 13). Overall, the lower SES American White group shows a high frequency of UCL, followed by EP and EH.

Table 13: Frequency of enamel hypoplasia (EH), ectocranial porosis (EP) and untreated caries lesions (UCL) in American Whites with low SES

	Frequency (%)		
Sex	EH	EP	UCL
Females	33.33 (3/9)	13.33 (2/15)	50.00 (5/10)
Males	13.33 (2/15)	29.17 (7/24)	60.00 (9/15)
Total	20.83 (5/24)	23.08 (9/39)	56.00 (14/25)

American Whites with middle SES

Males show a relatively higher frequency of EH, EP and UCL than females (Table 14). Similar to the previous groups, the middle SES American White group shows a high frequency of UCL, followed by EP and EH.

Table 14: Frequency of enamel hypoplasia (EH), ectocranial porosis (EP) and untreated caries lesions (UCL) in American Whites with middle SES

	Frequency (%)		
Sex	EH	EP	UCL
Females	0.00 (0/10)	6.25 (1/16)	9.09 (1/11)
Males	5.26 (1/19)	15.38 (4/26)	30.00 (6/20)
Total	3.45 (1/29)	11.90 (5/42)	22.58 (7/31)

American Whites with upper SES

Males show a relatively higher frequency of UCL than females (Table 15). However, there seems to be no differences in EH and EP frequencies.

Table 15: Frequency of enamel hypoplasia (EH), ectocranial porosis (EP) and untreated caries lesions (UCL) in American Whites with upper SES

	Frequency (%)		
Sex	EH	EP	UCL
Females	0.00 (0/6)	0.00 (0/8)	33.33 (2/6)
Males	0.00 (0/6)	0.00 (0/10)	40.00 (2/5)
Total	0.00 (0/12)	0.00 (0/18)	36.36 (4/11)

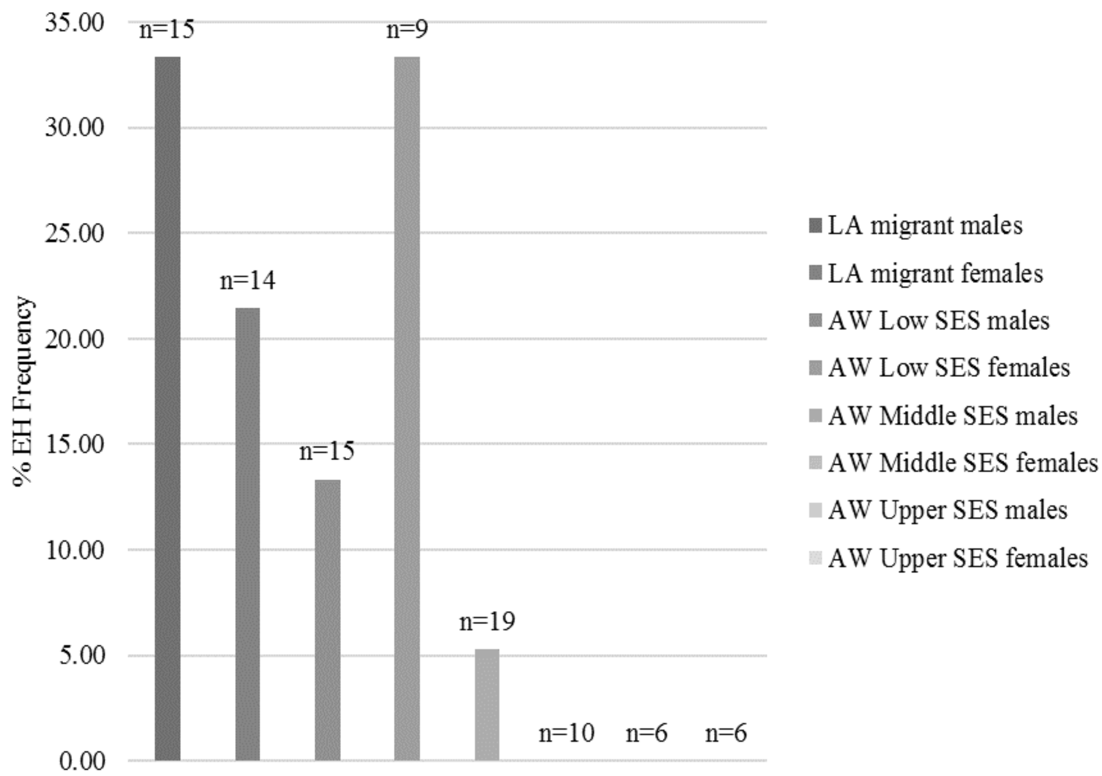

Figure 4: Summary of enamel hypoplasia (EH) frequency by sample group

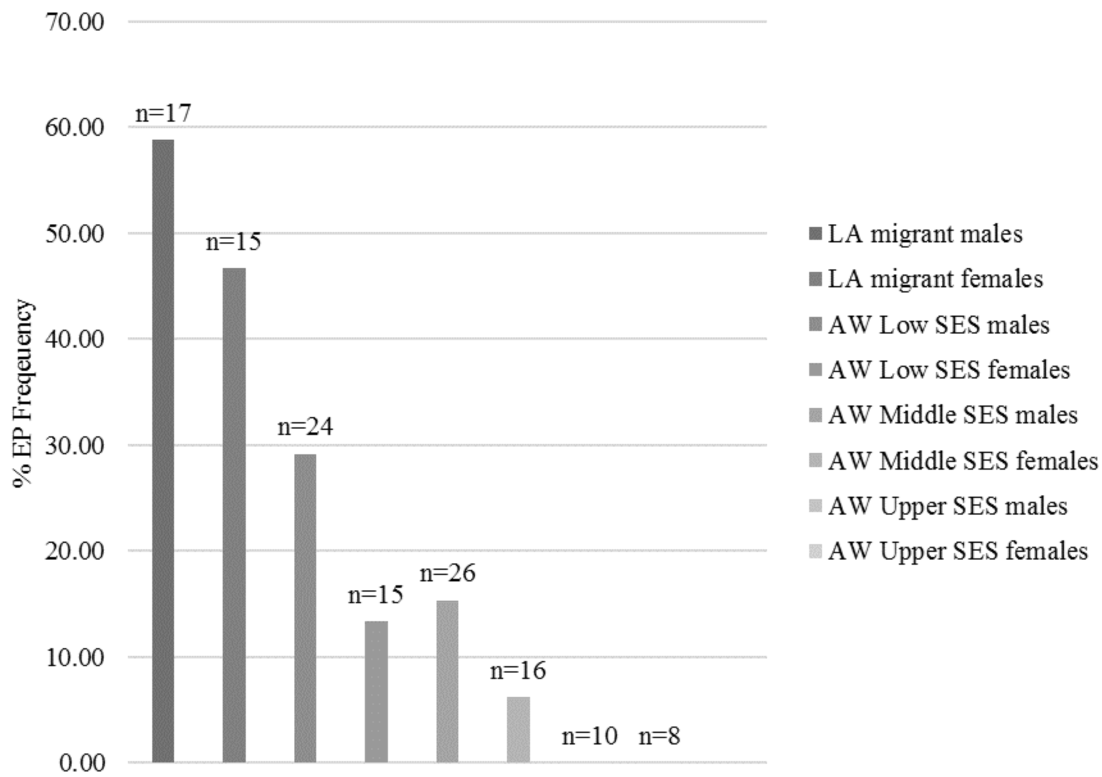

Figure 5: Summary of ectocranial porosis (EP) frequency by sample group

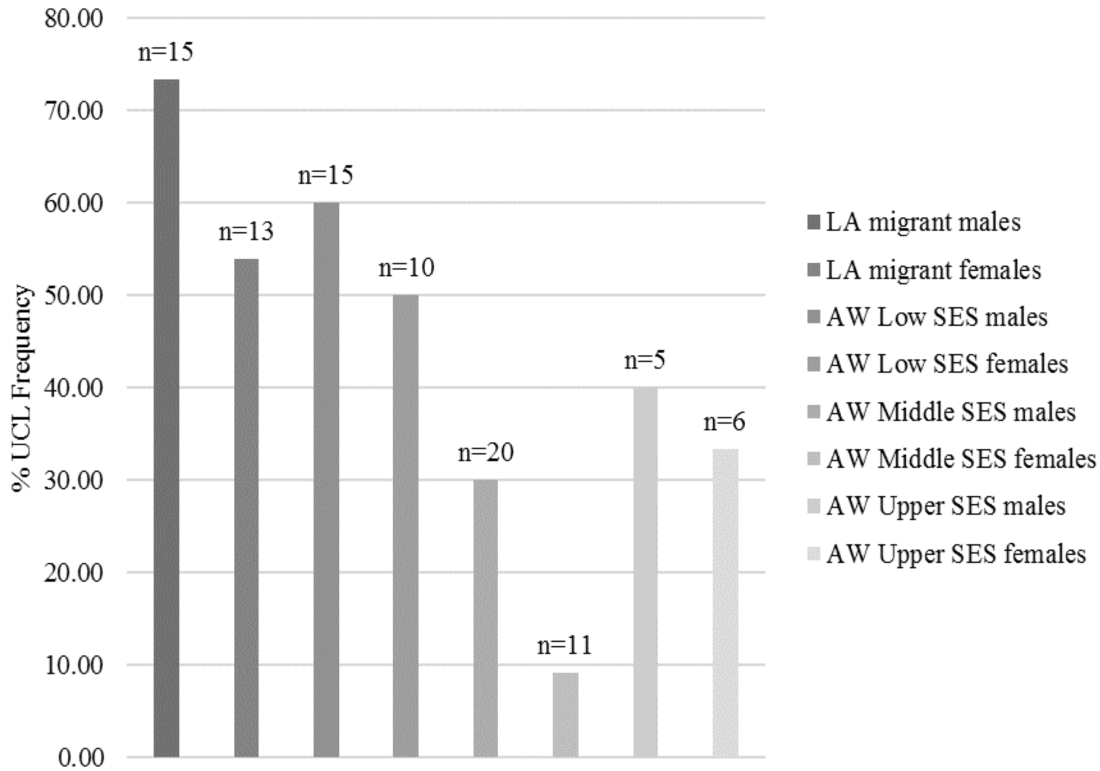

Figure 6: Summary of untreated caries lesions (UCL) frequency by sample group

Pathology Chi-Square Results

The chi-square results for males and females of each group show that there are no significant differences among them. Therefore, males and females were grouped together for analysis.

Enamel hypoplasia (EH)

The chi-square results for EH show significant differences between the Latin American migrant and the middle SES American White groups, the Latin American migrant and the upper SES American White groups, and the low SES and middle SES American White groups (Table 16).

Table 16: Chi-square results for EH counts

	LA migrant	AW Low SES	AW Middle SES	AW Upper SES
LA Migrant	-			
AW Low SES	Not sig.	-		
AW Middle SES	Sig. ∗	Sig. ∗	-	
AW Upper SES	Sig. ∗	Not sig.	Not sig.	-
∗ = significant at $P < 0.05$; LA = Latin American; AW = American White				

Ectocranial porosis (EP)

The chi-square results for EP show that the Latin American migrants are significantly different from the low, middle and upper SES American White groups. The low SES American White group also appears to be significantly different from the upper SES American White group (Table 17).

Table 17: Chi-square results for EP counts

	LA migrant	AW Low SES	AW Middle SES	AW Upper SES
LA Migrant	-			
AW Low SES	Sig. ∗	-		
AW Middle SES	Sig. ∗	Not sig.	-	
AW Upper SES	Sig. ∗	Sig. ∗	Not sig.	-
∗ = significant at $P < 0.05$; LA = Latin American; AW = American White				

Untreated caries lesions (UCL)

The chi-square results for UCL show significant differences between the Latin American migrants and the middle SES American White groups, and the low SES and middle SES American White groups (Table 18).

Table 18: Chi-square results for UCL counts

	LA migrant	AW Low SES	AW Middle SES	AW Upper SES
LA Migrant	-			
AW Low SES	Not sig.	-		
AW Middle SES	Sig. ∗	Sig. ∗	-	
AW Upper SES	Not sig.	Not sig.	Not sig.	-
∗ = significant at $P < 0.05$; LA = Latin American; AW = American White				

IV. DISCUSSION

This study utilizes body proportions and pathological conditions as proxies for the nutritional and health status of the undocumented migrants found along the Texas-Mexico border, and compares them to American White individuals from lower, middle and upper classes from the Texas State University Donated Collection. Previous studies have shown that lower relative leg lengths (Kemkes-Grottenhaler, 2005; Sorokowski and Pawloski, 2008; Bogin and Varela-Silva, 2010; Azcorra et al., 2013) lower crural indices (Bogin et al., 2002; Auerbach and Sylvester, 2011), and higher number of enamel hypoplasia, ectocranial porosis and untreated caries lesions (Anderson, 2008; Birkby et al., 2008; Sinclair, 2014; Merrett et al., 2015) reflect the effects of having a low socioeconomic status (SES). Based on numerous studies claiming that U.S.-Mexico migrants tend to belong to a lower SES (Anderson, 2008; Birkby et al., 2008; Aquino Moreschi, 2012; De Leon, 2012; Buehn and Eichler, 2013), it was expected that the migrants found along the Texas-Mexico border would present the highest frequency of stress markers of the four samples.

The results for three out of the five variables (enamel hypoplasia, ectocranial porosis and untreated caries lesions) indicate significantly higher physiological stress experienced by the Latin American migrant sample as compared with the American White group, which confirms the original hypothesis. However, the relative leg lengths and crural indices of almost every group do not appear to be significantly different from each other with the exception of the Latin American males and middle SES American White males in relative leg length, and the Latin American males and low SES American White males in crural index.

Relative Leg Length

The ANOVA test results for relative leg lengths show no significant differences between the female samples of the American White and Latin American migrant groups, but do show significant differences between the Latin American migrant and American White male groups. However, the Tukey-test results revealed that the significant difference lies between the Latin American migrant and middle SES American White male samples alone. The average relative leg length for the Latin American migrants and the middle SES American White male samples are 53.1cm and 54.3cm, respectively. In other words, the Latin American migrant males have legs that are in average 1.2cm shorter than middle-class American White males, while it appears to be closer in length to lower and upper-class American Whites.

Social and physiological explanations could potentially describe the differences observed among males and females in terms of relative leg length. The Female Buffering Hypothesis states that females tend to adapt better under physiological stress than males (Stini, 1969; Frayer and Wolpoff, 1985; Stinson, 1985). In other words, females may be less susceptible to nutritional or developmental stress because of their reproductive demands. The Stress-Buffering Hypothesis could also explain the differences observed among the sexes in relative leg length. The Stress-Buffering Hypothesis states that family support may protect or “buffer” individuals – in this case females – from stressful situations (Cohen and Wills, 1985; Farmer and Sundberg, 2010; Moskowitz et al., 2013; Raffaelli et al., 2013). This significant difference in males is important because it may highlight the existence of differences in support among the individual’s family members that might be embedded in their cultural practices. The Stress-Buffering Hypothesis could possibly explain the similarities observed between the majority of the Latin American migrant and the American White samples as well. For example, if we assume that the Latin American migrants left their country of origin because of gang-related crimes and an overall increase in violence rather than their SES (Anderson, 2008; Birkby et al., 2008), then the relative leg length of these individuals will reflect relative better health.

The Parental Investment Theory and the Developmental Origins of Health and Disease Hypothesis (DOHaD) may also explain the similarities or differences observed among the groups. The Parental Investment Theory states that parents living under conditions of constraint will allocate the scarce resources within their hierarchy of goals for the benefit of their children (Fisher, 1930; Bogin and Loucky, 1997). Assuming the Latin American migrants found along the Texas-Mexico border were subjected to stressful events during their first years of life, it is possible that the parents did everything they could to secure the wellbeing of their children resulting in catch-up growth.

The DOHaD Hypothesis states that poor nutrition and lack of health care until early childhood may have significant impacts on the developmental health and wellbeing of adults (Waterland and Michels, 2007; Barker, 2012; Gowland, 2015). Thus, considerable post-natal care including food provisioning and protection of the children may result in an increase of their height or catch-up growth (Adair, 1999; Golden, 1994; Clarkin, 2008; Azcorra et al., 2013). Similarly, individuals may recover from a growth deficit if the environmental conditions improve significantly over time (Bogin and Loucky, 1997; Bogin et al., 1992; Bogin et al., 2002; Azcorra et al., 2013).

Although the Buffering Hypotheses, the Parental Investment Theory and the DOHaD Hypothesis may explain the similarities observed between the groups and differences in sex in regards to relative leg length, it may be possible that relative leg length is not sensitive enough to discriminate between socioeconomic conditions. Indeed, short relative leg length may be a shared characteristic in a group regardless of the living environment. For example, Padez and colleagues (2009) collected anthropometric data from males and females between the ages of 9 and 17 from different living environments in Mozambique, Africa. Even though the authors found that the mean stature was greater for adolescents from the center of the city than for those living in slums on the periphery, relative leg length did not differ. In fact, they all showed relatively shorter legs than the African American sample they were compared to. Padez et al. (2009) hypothesized that civil conflicts in Mozambique's past could have possibly affected all groups in the country regardless of socioeconomic background. However, in order to state that relative leg length is not sensitive enough to discriminate between socioeconomic conditions among the sample groups of this study, I recommend a follow-up study where the Latin America group is compared to non-migrant populations with known SES from Latin America.

Crural Index

Similar to relative leg length, the ANOVA test results for crural indices show no significant differences between the female samples, but do show significant differences between the Latin American migrant and American White male groups. Although the ANOVA test results show significant differences among male groups, the Tukey-test results clearly show that the difference between the Latin American migrants and the lower SES American White group in crural index is not necessarily significant, but instead approaches significance ($P \leq 0.05$). In other words, the male migrants are more similar to the middle and upper SES American White groups than to the low SES American White group in the crural index. Considering that all the sample groups (males and females) are statistically similar to one another, the fact that the males are closer to becoming significantly different from each other suggest once again that males are more susceptible to environmental stressors, while females are buffered from the same conditions (Cohen and Wills, 1985; Farmer and Sundberg, 2010; Raffaelli et al., 2013).

Previous studies have shown that taller individuals tend to have higher crural indices due to positive allometry in the tibia (Auerbach and Sylvester, 2011; Garcia, 2015). However, results from this study do not support this theory. The female and male Latin American migrants have the highest crural indices, that is 83.2mm and 84.9mm, respectively, but are the shortest in stature of the groups (females are 148.2cm tall and males are 160.6cm tall). This unexpected finding may suggest that the crural indices of the female and male Latin American migrants are not an indicator of the socioeconomic conditions they experienced over time.

Further analysis would help determine what may be affecting the Latin American migrants to deviate from the allometric expectations. It is possible however, that ancestry has an important role in the maintenance of high intra-limb indices in the migrants regardless of their short stature. In fact, previous studies have shown that the dimensions and size of bones is in part dependent on the genetic factors of a population (Figueroa-Soto, 2012; Garcia, 2015). Population history, population size and admixture can shape a group of people, and thus make these genetically similar groups resemble one another (Roseman and Auerbach, 2015).

Pathological Conditions

In general, the frequency tables and graphs show that stress decreases with higher SES as reflected by the low pathology percentages for the middle and upper class American White individuals. For example, the Latin American migrant and low SES American White groups show the greater number of individuals with enamel hypoplasia, ectocranial porosis and untreated caries lesions, whereas the middle and upper SES American White groups show the least. This is supported further by the chi-square results where the low to high trend is observed. For instance, the chi-square results for enamel hypoplasia, ectocranial porosis and untreated caries lesions suggest that childhood stress, nutritional deficiency and lack of dental health care decrease with greater SES. The results from this study support previous research (Stuart-Macadam, 1985, 1992; Larsen, 1997; Anderson, 2008; Birkby et al., 2008; Sinclair, 2014; Merrett et al., 2015).

In addition, the statistical analyses show that the difference between males and females in pathology expression is not significant. However, the frequency graphs clearly illustrate that there is a higher frequency of affected males than females for each pathology, except for enamel hypoplasia where there are more females from a low SES than the low SES males. Once again, males seem to be more susceptible to environmental stressors. The Buffering Hypotheses, the Parental Investment Theory and the DOHaD Hypothesis may well explain the differences observed in pathology expression among the sexes.

Body Proportionality Versus Pathological Conditions

When comparing the body proportionality results with the pathological conditions present in the Latin America migrant and American White groups, the relative leg length and crural index do not seem to be sensitive enough to socioeconomic conditions, as evidenced by the pathology counts and frequencies. More specifically, the relative leg length and crural index results do not show a clear line between the different SES, whereas the pathology data clearly shows a trend where individuals from a lower class tend to have a greater number of pathologies (i.e. enamel hypoplasia, ectocranial porosis and untreated caries lesions). The fact that enamel hypoplasias, for example, are permanent and growth can change up until maturity, could explain why the pathologies are better indicators of health in the present study. Yet, in all three cases, that is relative leg length, crural index and pathological conditions, males seem to be more sensitive to environmental stressors than females.

Based on the degree of pathologies present in the Latin American migrant sample it is most likely that they grew up in a low socioeconomic environment. However, some significant improvements in the environmental conditions must have taken place in order to explain the similarities in relative leg length within and among groups, in general. It is possible that relative leg length is not as good an indicator of socioeconomic conditions altogether. Further analysis should be conducted to explore the relative leg length hypothesis in detail.

Limitations and Recommendations for Future Research

This research encountered some limitations. First, the sample size of the upper-class American White individuals is small. Unfortunately, this was the only sample with a known upper SES available at the time. Second, the childhood SES information is self-reported. When people self-report their childhood SES it is possible that they are underestimating or overestimating their past socioeconomic position. Third, differentiating between normal cranial porosity and pathological ectocranial porosis was a challenge. Underestimation rather than overestimation was employed to minimize overrepresentations of the pathology across the sample groups. Fourth, even though most of the migrants are most likely from El Salvador, Honduras or Guatemala, they may not be representative of all the individuals in their country. Central Americans are biologically diverse and groups residing in one region may not have the same environmental conditions as other groups. Therefore, any interpretation or assumption about their SES should be taken with precaution. Finally, the relative leg length may not be a sensitive indicator of nutritional status in populations. For example, relative leg lengths do not differ among low, middle and upper SES American White samples in the current research.

It is recommended that a follow-up study be conducted where living Latino groups with a known SES are compared with the Latin American migrants found along the Texas-Mexico border. If the migrants are originally from El Salvador, Honduras and Guatemala, it will not be surprising if the relative leg lengths, crural indices and pathological conditions are similar to other residents living in these countries. This follow-up study will most likely produce more meaningful results that could potentially be used in a forensic context to assist with positive identification.

V. CONCLUSION

Economic crises and high rates of unemployment in countries like Mexico has motivated many individuals to cross the border for a better life in the United States (Marcelli and Cornelius, 2001; De Leon, 2012; Buehn and Eichler, 2013; Ryo, 2013). But similarly it has been hypothesized that increasing gang-related crimes in Central America has motivated many well-standing individuals to leave their countries in search for a better, safer place (Anderson, 2008, Birkby et al., 2008). Although we cannot determine with certainty what factor(s) motivated undocumented migrants to cross the Texas-Mexico border, this study has identified some interesting points regarding these individuals' nutritional and health status as measured by stature and skeletal pathology.

In general, the Latin American migrant sample shows higher levels of developmental stress than low, middle and upper-class American Whites from the Texas State University Donated Collection. However, there is not much variation in relative leg lengths and crural indices across sample groups. The low variation in relative leg length may indicate two things: (1) significant improvements in the environmental conditions facilitated by parental care allow the migrant individuals to fulfill their genetic growth potential; or (2) relative leg length is not sensitive enough to different socioeconomic environments. On the other hand, the crural index may not be affected by socioeconomic environments. Rather, the results of this study show that the crural index of the Latin American migrants was the highest of all groups reflecting perhaps some ancestral predisposition to this form. For these reasons, interpretations about nutritional status and health should never be based on relative leg length and crural indices alone. Further analysis includes the comparison of the Latin American migrant group with non-migrant population from different countries in Latin America. Such analysis may facilitate in the future positive identification of the Texas-Mexico border migrant remains.

APPENDIX SECTION

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B. DATA COLLECTION SPREADSHEET SAMPLES..44

APPENDIX A: REVISED MEASUREMENTS OF THE FULLY (1956) TECHNIQUE

1. **Cranial height**: *Spreading calipers*; maximum length between bregma (at the confluence of the coronal and sagittal sutures) and basion (at the anteroinferior margin of the foramen magnum, between the occipital condyles). This measure can be taken with the calipers placed either laterally or posteriorly, relative to the cranium. (Raxter et al., 2006)
2. **Second cervical vertebra**: *Sliding calipers*; most superior point of the odontoid process (dens) to the most inferior point of the antero-inferior rim of the vertebral body. (Raxter et al., 2006)
3. **3rd–7th cervical vertebrae**: *Sliding calipers*; maximum height of the vertebral body, measured in its anterior third, medial to the superiorly curving edges of the centrum. (Raxter et al., 2006)
4. **Thoracic vertebrae**: the maximum height of the vertebral body, anterior to the rib articular facets and pedicles. (Raxter et al., 2006)
5. **Lumbar vertebrae**: *Sliding calipers*; maximum height of the vertebral body, anterior to the pedicles, not including any swelling of the centrum due to the pedicles. (Raxter et al., 2006)
6. **First sacral vertebra**: *Sliding calipers*; maximum height between the anterior-superior rim of the body (i.e., the sacral promontory) and its point of fusion/articulation with the second sacral vertebra. This most commonly occurs in the midline. Measure with the calipers parallel to the anterior surface of S1. (Raxter et al., 2006)

7. **Femoral physiological length**: *Osteometric board; p*lace the condyles on the stationary end of the osteometric board, flat against the horizontal plane. Set the mobile end against the most superior aspect of the femoral head, parallel to the stationary end. Measure at maximum length. (Raxter et al., 2006)
8. **Tibial length**: *Osteometric board; p*lace the medial malleolus on the stationary end of the osteometric board, with the shaft of the tibia parallel to the long axis of the board. Set the mobile end against the most superior aspect of the lateral condyle of the tibia, parallel to the stationary end. We recommend that a trackless osteometric board be used to take this measure, to allow the freedom of the mobile end's placement. (Raxter et al., 2006)
9. **Talus-calcaneus height**: *Osteometric board*; articulate the talus and the calcaneus, using the right hand for the left tarsals and vice versa. Use one hand to stabilize the articulation, point the distal articulations away from your palm, with a thumb holding the bones together superior to the peroneal tubercle (where the talus and calcaneus meet), an index finger on the opposite side lateral to the trochlea of the talus, and a middle finger in the sustentacular sulcus. Place the trochlea against the stable end of the osteometric board, with both lateral and medial edges of the trochlea contacting the board. Position the trochlea of the talus so that the stable end of the board forms a tangent to the midpoint of the trochlear surface. Place the mobile end of the osteometric board against the most inferior point of the calcaneal tuber, parallel to the stable end. (Raxter et al., 2006)

APPENDIX B: DATA COLLECTION SPREADSHEET SAMPLES

Measurements for each individual **1 out of 4**

Case #	Group	Sex	SES	Ba-b height	Vertebral body height (C2-L5)	1st Sacral vertebra height	Femur length	Tibia length (w/o spine)	Articulated height of the talus and calcaneus

Measurements for each individual

C2	C3	C4	C5	C6	C7	T1	T2	T3	T4	T5	T6	T7	T8	T9	T 10	T 11	T 12	L1	L2	L3	L4	L5	Extra

Measurements for each individual

Case #	Group	Sex	SES	Skeletal Height (cm)	Living Stature (cm)	Relative leg length (cm)	Crural Index (mm)

Presence or absence of stress-related pathologies in each individual **4 out of 4**

				Enamel hypoplasia on mandibular canine*		Ectocranial porosis		Untreated caries lesions	
Case #	Group	Sex	SES	Present	Absent	Present	Absent	Present	Absent

* Right mandibular canine examined whenever left mandibular canine was unavailable.

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