Available online at www.sciencedirect.com
SCIENCE DIRECT®

ELSEVIER

Economics and Human Biology 1 (2003) 145–160

ECONOMICS
AND
HUMAN BIOLOGY

www.elsevier.com/locate/ehb

Economic and anthropological assessments of the health of children in Maya immigrant families in the US

Patricia K. Smith [a,*], Barry Bogin [b], Maria Inês Varela-Silva [b], James Loucky [c]

[a] *Department of Social Sciences, University of Michigan–Dearborn, Dearborn, MI 48128, USA*
[b] *Department of Behavioral Sciences, University of Michigan–Dearborn, Dearborn MI 48128, USA*
[c] *Department of Anthropology, Western Washington University, Bellingham, WA, USA*

Received 19 December 2002; received in revised form 19 December 2002; accepted 19 December 2002

Abstract

Immigration from developing countries to the US generally increases access to health care and clean water, but it also introduces some unhealthy lifestyle patterns, such as diets dense in energy and little regular physical activity. We present a transdisciplinary model of child health and examine the impact of immigration on the physical growth and health of Maya children in Guatemala and the US. Maya-American children are much taller and have longer legs, on average, than their counterparts in Guatemala. This suggests that immigration to the US improves their health. However, the Maya-American children also are much heavier than both Guatemalan Maya and White American children, and have high rates of overweight and obesity. Quantile regression analysis indicates that Maya are shorter except in the upper tail of the stature distribution, and have higher Body Mass Index (BMI) in the tails, but not in the middle of the BMI distribution. Leisure time spent in front of a television or computer monitor tends to raise BMI in the middle and lower tail of the distribution, but not in the upper tail.

JEL classification: I10; I31; J15

Keywords: Maya-American children; Anthropological assessments; Health; Immigration

* Corresponding author.
E-mail addresses: pksmith@umich.edu (P.K. Smith), bbogin@umich.edu (B. Bogin), inesvs@umd.umich.edu (M.I. Varela-Silva).

1570-677X/03/$ – see front matter
doi:10.1016/S1570-677X(02)00032-1

1. Introduction

Immigration from low-income countries to the US generally increases immigrants' nutritional intake, access to health care and clean water, but it also introduces some unhealthy lifestyle patterns, such as diets dense in energy, especially fat, and little regular physical activity. Popkin and Udry (1998) report that second generation Asian–American and Hispanic adolescents are over twice as likely to be obese as first generation immigrants. This raises concern because obesity is a risk factor for childhood hypertension and diabetes, and foreshadows health problems in adulthood. It is second only to tobacco consumption as a cause of preventable deaths in the US (McGinnis and Foege, 1993).

The Maya of Guatemala are the cultural descendants of a complex civilization that occupied southern Mexico and central America before the arrival of the Spanish in the early 16th century. The Maya have a traditional clothing style, observe collective religious practices and communicate in a Maya language, 22 of which are still in use in Guatemala. The Guatemalan Maya began migrating to the US, mostly from rural villages, in record numbers in the 1980s (Burns, 1993). Since the onset of civil war there in 1978, as many as half a million Guatemalan Maya have come to the US (Loucky and Moors, 2000). Because health is a biocultural phenomenon we employ a transdisciplinary approach to examine how immigration from Guatemala to the US affects the health of children in Maya immigrant families. We use anthropometric measures of physical growth as indicators of child health and analyze their covariates.

Height, weight, and body composition are widely used indicators of nutritional and health status. The physical growth and development of children, in particular, are sensitive indicators of the quality of the social, economic, and political environment in which they live (Bogin, 1999; Fogel, 1986; Komlos, 1994; Steckel, 1995; Tanner, 1986). Poor environments result in poor growth, and growth retarded children are more likely to become adults handicapped by poor health, impaired intellectual capacity, and reduced earning potential (Bogin, 1999; Brown and Pollitt, 1996). Height, weight, and body proportions may not only affect actual physical capacities, but may also influence perceptions of one's capacities. Part of the economic consequences of obesity results from discrimination in the labor and marriage markets (Loh, 1993; Pagan and Davila, 1997).

Economists typically model child development using a household production function. Becker (1981) and Becker and Tomes (1986) develop the model of parental investment as part of the economic theory of the family. Parents are assumed to benefit from the successful development of their children and thus invest resources in their well being, purchasing food, shelter, clothing, health care and education, etc. Insofar as parental income constrains this investment, children in lower socioeconomic status (SES) families receive fewer goods and services, ceteris paribus, and thus face a higher risk of poor health. Consequently, children of immigrants from low-income countries generally have lower health status than average American children.

How and to what degree immigrants assimilate to the US also influence their children's health and growth. Immigrants may choose the classic "melting pot" type of assimilation, bicultural assimilation or may avoid assimilation (Portes, 1995; Zhou, 1997). The "melting pot" approach refers to assimilation to the US middle class. Bicultural assimilation involves social and economic development within the ethnic community to achieve economic success

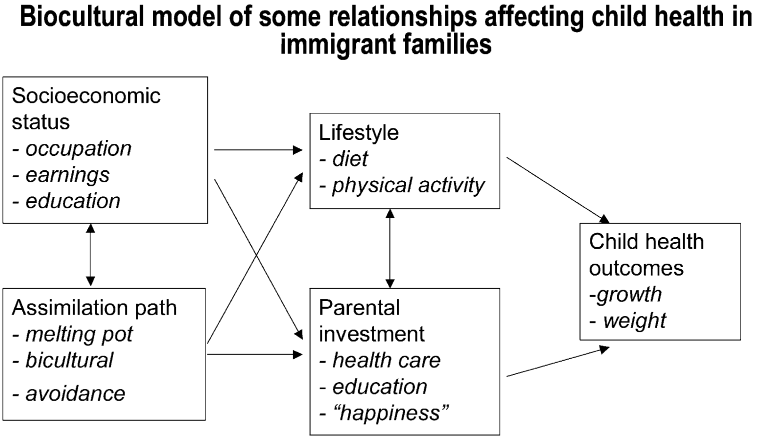

Fig. 1. Conceptual model of child health.

within the larger American society (e.g. business and health services within ethnic neighborhoods). Those that assimilate to the US middle class or take a bicultural approach tend to fare better than those who avoid assimilation or assimilate to the US underclass. While the first two assimilation trajectories improve health in terms of increased access to food and sanitation and health services, they may also pose health risks due to exposure to US lifestyle patterns of high energy diets and little regular physical activity. Compounding this, immigrants from low-income countries who retain their home perceptions about child health may believe that increased weight in children is always a sign of good health (Reddy, 1998; Stebor, 1992).

Our conceptual model of child health is outlined in Fig. 1. The "assimilation path" box represents the manner in which Maya immigrant families assimilate to an American life style. The "socioeconomic status" (SES) box represents the education level, occupation, and earnings of Maya immigrant parents. SES is influenced by the assimilation path and vice versa. Assimilation path and SES influence lifestyle and parental investment in children, which in turn affect children's health, as manifested in their physical growth.

2. Descriptive analysis

We compare three anthropometric health measures, height, leg length, and the Body Mass Index (BMI = weight (kg)/height^2 (m)), for Maya children living in Guatemala and in the US.[1] All measurements were collected following standard procedures (Cameron, 1984). Luis Rios of the Universidad Autónoma de Madrid provided the "Maya-Guate" data set, consisting of height and weight data of school-aged children in Guatemala in 1998 (660 boys and 688 girls). Two samples comprise the data for Maya children living in the US: (1)

[1] Being Maya was ascertained through self-identification.

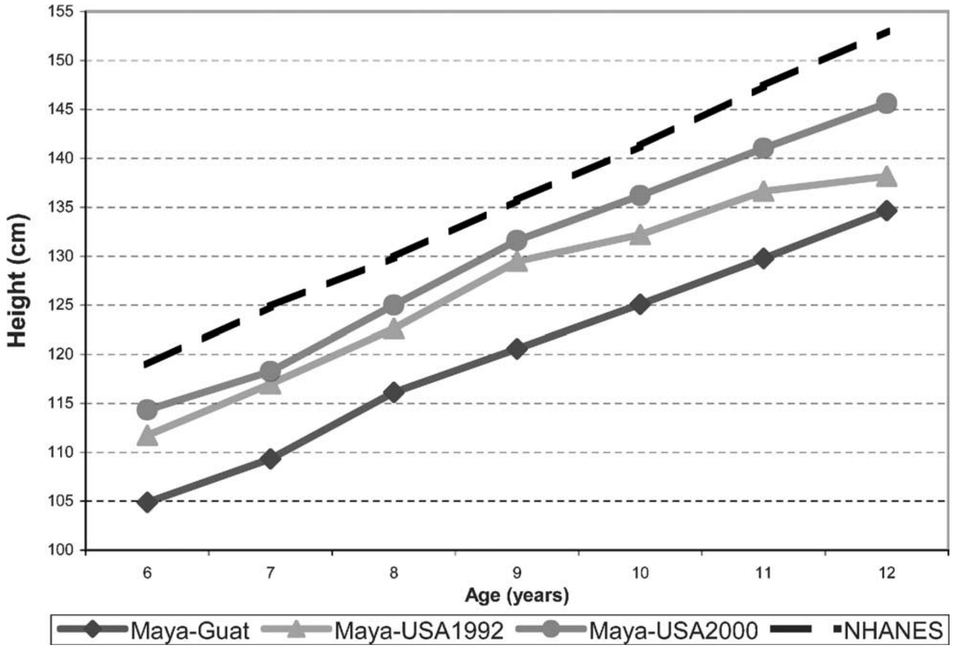

Fig. 2. Height by age of Maya children compared to US reference standards.

the “Maya-USA 1992” sample is based on anthropometric measures collected from Maya children ages 6–12 years old (87 boys and 87 girls) in Los Angeles and in Indiantown, Florida in 1992 (Bogin and Loucky, 1997); (2) the “Maya-USA 2000” sample is based on measurements of Maya children, 6–12 years old, in Los Angeles in 1999 and in Indiantown in 2000 (189 boys and 206 girls). Because boys and girls at both the Los Angeles and Indiantown sites were similar in terms of height and weight distributions we combined their records into single data sets. In both locations children have access to the Women, Infants, and Children Program (a government sponsored health and nutrition program), school lunches, and public health clinics.

The average height-by-age for the children in the three Maya data sets are compared to the National Health and Nutrition Examination Survey (NHANES) reference standards for American children (Fig. 2) (Frisancho, 1990). Although all three Maya samples fall below the US standards, the Maya living in the US are consistently taller than their Guatemalan counterparts. The children in the USA 2000 sample are, on average, 10.2 cm taller than the Maya-Guate sample; a growth gain so large and rapid that a genetic change is ruled out as a cause. Nor can selective migration for taller parents be the cause, as the entire population of some rural villages was forced to emigrate from Guatemala. Hence, these results support the prediction that the US offers a better environment for the attainment of a higher biological standard of living than rural Guatemala.

Fig. 3 compares the sitting height ratio ([sitting height/height] $\times$ 100) of the Maya children in Guatemala to the Maya immigrant children measured in the US in 2000 and to

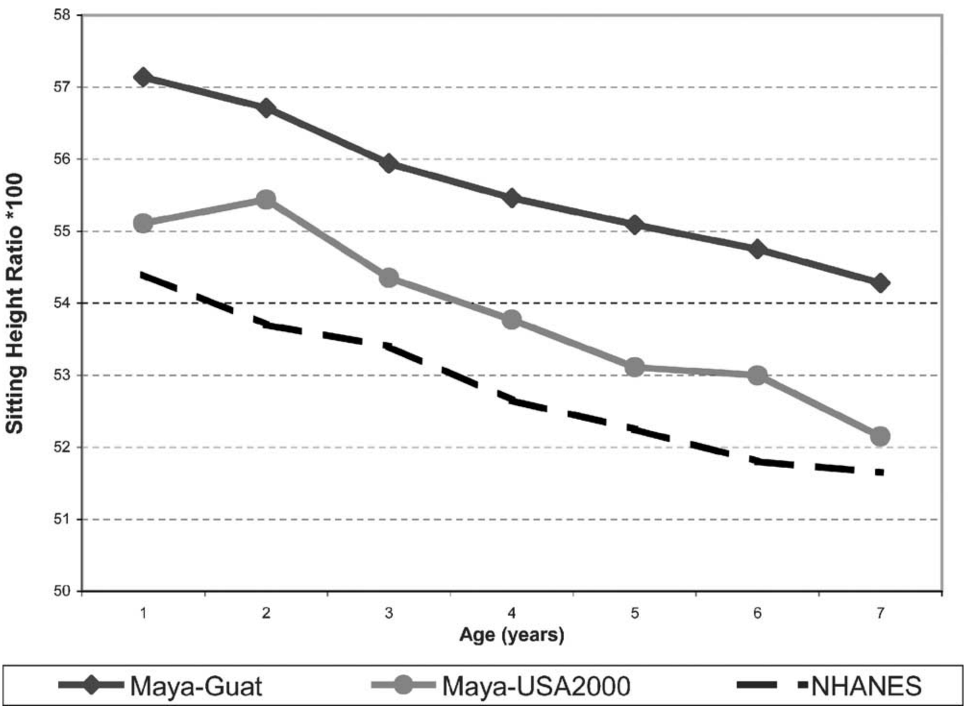

Fig. 3. Sitting height ratio by age of Maya children compared to US reference standards.

the NHANES standards (sitting height ratio was not collected in 1992). This ratio indicates leg length relative to the trunk, or body proportion, and is considered to be as sensitive, and perhaps even more sensitive, than stature as a measure of environmental quality (Bogin et al., 2001; Frisancho et al., 2001). A higher sitting height ratio indicates relatively shorter legs and longer trunks, which are associated with lower health status (Bogin, 1999). The Maya children in Guatemala have the highest average sitting height ratios, which corroborates their short stature as a sign of poor health. The Maya-American children display sitting height ratios between the Maya in Guatemala and the NHANES reference standards. About 60% of the height gain of the Maya-USA 2000 sample is due to leg growth, and this is consistent with their stature being a sign of improved well being.

The average BMIs of the Maya-American children exceed those of children in Guatemala and the NHANES reference standards (Fig. 4). Children in the most recent immigrant sample (USA 2000) are heavier on average than those in the 1992 immigrant sample. These findings suggest that immigration to the US may well also increase risks for poor health by encouraging excessive weight gain in childhood.

To better interpret the height and weight data, we consider five anthropometric indicators of poor child health: wasting, thinness, stunting, overweight, and obesity. Wasting is defined as having a gender and age standardized weight-for-stature below the fifth percentile on the Centers for Disease Control (CDC) growth charts (Kuczmarski et al., 2000) and indicates

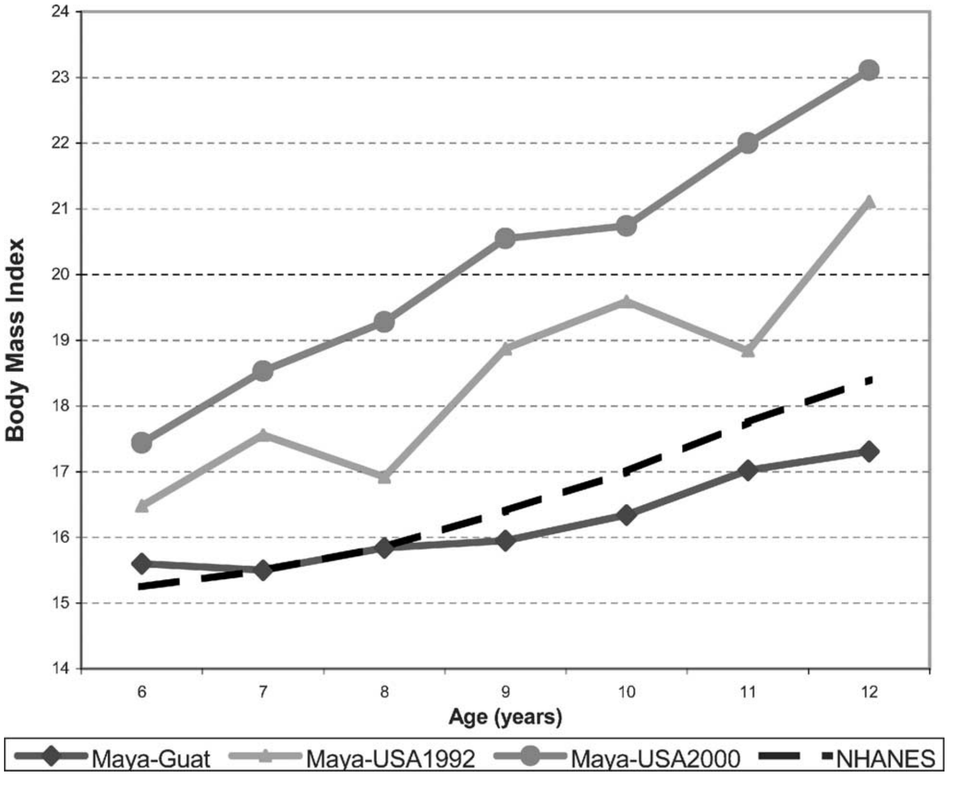

Fig. 4. BMI by age of Maya children compared to US reference standards.

current undernutrition and poor health. Thinness means having a BMI below the fifth percentile. Stunting is defined as having a height-for-age (standardized by gender) below the fifth percentile of the CDC growth charts and indicates chronic undernutrition and poor health. Overweight means that a child has a BMI (standardized by age and gender) between 85th and 95th percentiles of the CDC standards. BMIs above the 95th percentile identify a child as obese.

Table 1
Prevalence of growth problems in Maya children ages 6–12 years

	Wasted (%)	Thin (%)	Stunted (%)	Overweight (%)	Obesity (%)
Maya-Guate 1998 ($n = 1348$)	1.9 (missing 435)	6.0 (missing 55)	71.6 (missing 104)	3.5 (missing 55)	0.9 (missing 55)
Maya-USA 1992 ($n = 174$)	1.5 (missing 41)	9.2 (missing 0)	28.7 (missing 0)	15.6 (missing 0)	9.8 (missing 0)
Maya-USA 2000 ($n = 395$)	0.6 (missing 71)	1.0 (missing 0)	13.7 (missing 0)	20.5 (missing 0)	25.3 (missing 0)

The Guatemala Maya have a much higher rate of stunting, but lower rates of overweight and obesity than the Maya-American children (Table 1). These results suggest that migration from rural Guatemala to the US improves the environment for growth, but places Maya children at higher risk for overweight and obesity, with their attendant social, economic, and health problems.

3. Inferential analysis

To explore the factors that influence the likelihood of a child being stunted, overweight, or obese we use logistic and quantile regression analysis. While the former estimates the impact of an independent variable on the likelihood of a given outcome, the latter estimates the impact of an independent variable on various quantiles (percentiles) along the entire distribution of the dependent variable (Buchinsky, 1994, 1997, 1998; Koenker, 2000; Montenegro, 1998). Quantile regression estimates the median and other quantile functions[2] conditioned on the independent variables by minimizing the sum of absolute residuals[3] (Koenker and Bassett, 1978, 1982; Buchinsky, 1998; Koenker, 2000; Koenker and Hallock, 2002).

Quantile regression allows one to examine the impact of an independent variable on the dependent variable (*Y*) at any location along the distribution, not just at one particular point. In other words, quantile regression allows the impact of an independent variable to vary along the distribution of the dependent variable. Hence, one can detect if an independent variable impacts the shape of the distribution of *Y* in addition to changes in its location. This capability is especially attractive in the analysis of human growth as markers of poor health are generally defined as being in the tail of a distribution.

Children of several ethnicities were interviewed in Indiantown in 2000 regarding their diets and patterns of physical activity (Table 2). The children identified their ethnicities, which their teachers confirmed. The children reported whether they had eaten in a restaurant the week of the interview (eat out) and the number of glasses of milk they usually drink each day (milk). The hypothesis is that the children who reported eating out may have adopted some unhealthy American eating habits, such as eating higher fat "fast" foods, and are thus more likely to be overweight or obese. Eating out may also correlate with socioeconomic status. In contrast, milk consumption is associated with healthy physical development (Bogin, 1999). We also hypothesize that the children who reported watching TV or playing computer games as their favorite leisure activity are likely to be more sedentary than the children who did not (TVComp $= 1$). TV watching may also reflect greater exposure and assimilation to American culture, as well as advertisements for higher fat foods.

---

[2] A quantile function is an equation that expresses a given quantile (percentile) as a function of one or more covariates. OLS estimates a conditional mean function: the mean of Y conditional on X. Quantile regression estimates a conditional quantile function: a specific quantile (or percentile) of Y conditional on X. STATA was used for the estimates below.

[3] Specifically, this process chooses the intercept and slopes that minimize the sum of absolute deviations (LAD): $\min \sum |Y_i - X_i'\beta|$. Deaton (1997) shows that if the model includes only an intercept, the LAD estimator becomes the median of Y. Koenker and Bassett (1978, 1982) show how to use linear programming to extend the model to account for any quantile of interest. The θth quantile of the distribution of Y conditional on the covariates X is: $Q_y(\theta|X) = X'\beta_\theta$, where θ is in the interval (0,1).

Table 2
Ethnicities of children in Indiantown 2000 sample

Ethnicity	Absolute frequency	Relative frequency
Maya-American	187	0.751
Mexican–American	20	0.080
Haitian	6	0.024
Other immigrants	6	0.024
Black American	17	0.068
White American	13	0.052
Total	249	1.00

Table 3
Logistic regression on likelihood of overweight and obesity

Independent variable	*B*	S.E.	Exp(*B*)
Overweight[a]			
White	−2.408*	1.056	0.090
Mexican–American	−0.643	0.514	0.526
Haitian	0.874	0.888	2.396
Other immigrants	−0.546	0.889	0.579
Black	−0.713	0.555	0.490
Milk	−0.160	0.105	0.852
Eat out (yes = 1)	0.258	0.309	1.295
TVComp	0.224	0.317	1.251
Constant	−0.100	0.319	0.905
Obesity[b]			
White	−7.304	16.720	0.001
Mexican–American	−0.323	0.590	0.724
Haitian	−0.313	1.137	0.731
Other immigrants	0.370	0.904	1.448
Black	−0.591	0.661	0.554
Milk	−0.139	0.119	0.870
Eat out (yes=1)	0.170	0.349	1.185
TVComp	−0.329	0.374	0.720
Constant	−0.752	0.358	0.472

[a] $-2\log$ likelihood $= 323.26$ Cox and Snell $R^2 = 0.063$, Nagelkerke $R^2 = 0.085$.
[b] $-2\log$ likelihood $= 267.64$ Cox and Snell $R^2 = 0.044$, Nagelkerke $R^2 = 0.066$.
* Statistical significance at the 5% level.

The logistic regression estimates of the likelihood of overweight and obesity are reported in Table 3. Mayan ethnicity serves as the comparison group. Only the variable "White" proves statistically significant in the overweight regression: White American children face a lower probability of being overweight relative to Maya children ($p = 0.023$). None of the regressors prove to be statistically significant in the logistic regression of obesity.[4]

[4] Logistic regression on stunting also reveals no statistically significant regressors.

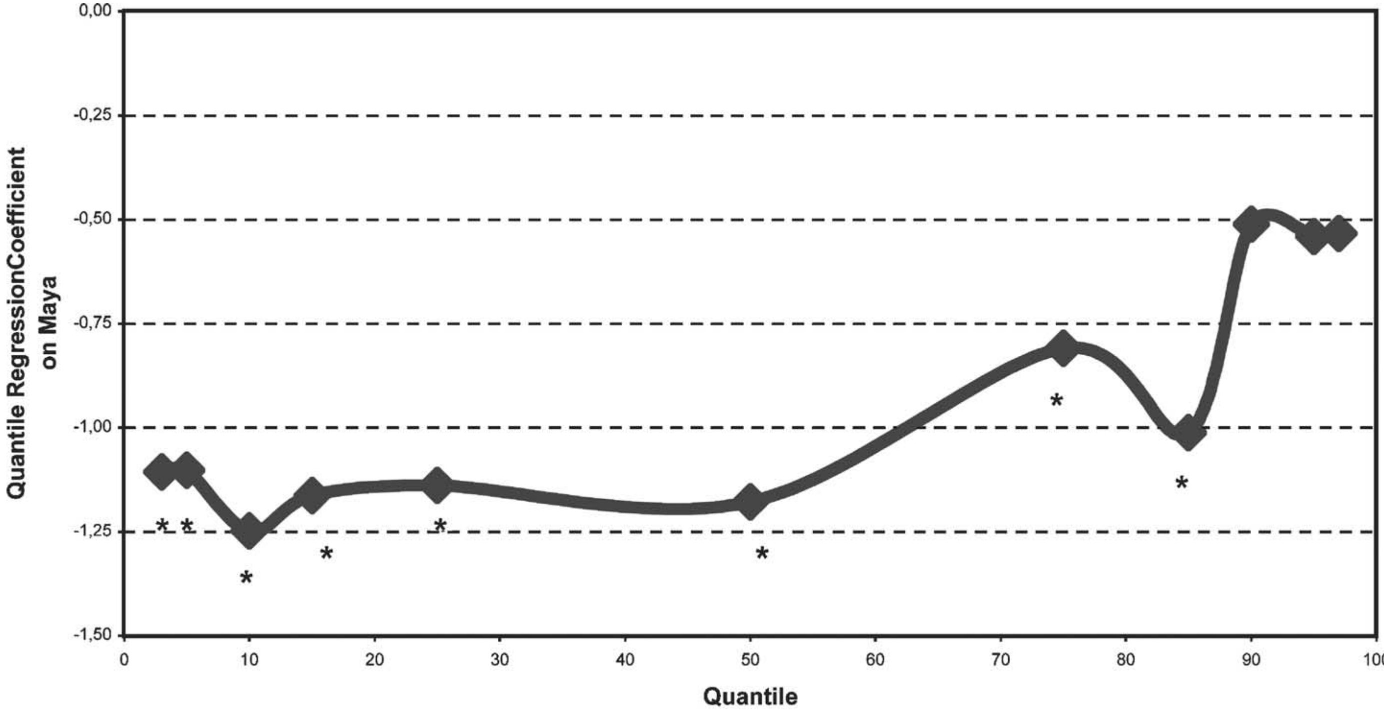

Fig. 5. Quantile regression estimates of the impact of Mayan ethnicity on height. (∗) Statistical significance at the 5% level.

Table 4
Quantile regression estimates for height

Variable	Quantile 3 (S.E.)	Quantile 5 (S.E.)	Quantile 50 (S.E.)	Quantile 95 (S.E.)	Quantile 97 (S.E.)
Constant	−0.578 (0.4617)	−0.5719 (0.4276)	0.5239 (0.2424)	1.4408 (0.5222)	1.4408 (0.5354)
Maya-American	−1.1064* (0.4727)	−1.1021* (0.4287)	−1.1785* (0.2475)	−0.541 (0.5243)	−0.5331 (0.5374)
Mexican–American	−0.783 (0.6952)	0.2422 (0.6581)	−0.2998 (0.3342)	−0.2355 (0.6534)	0.0127 (0.6059)
Haitian	1.7814* (0.6101)	1.7768* (0.5744)	1.237* (0.5157)	1.4891* (0.6267)	1.4573* (0.6557)
Other immigrants	−1.2749 (0.7337)	−1.281 (0.7027)	−0.9949 (0.7027)	−1.0891 (0.8565)	−1.113 (0.8377)
Black American	−0.5347 (0.5232)	−0.5422 (0.5201)	−0.004 (0.3293)	0.1856 (0.5003)	0.1896 (0.5225)
Milk	−0.0935 (0.0899)	−0.0949 (0.0667)	−0.0139 (0.0476)	−0.1494 (0.1298)	−0.1533 (0.1342)
Eat out (yes = 1)	−0.3351 (0.217)	−0.3337* (0.1651)	0.0326 (0.1872)	0.5024 (0.2636)	0.5262* (0.2665)
TVComp	−0.3057 (0.2417)	−0.3132 (0.255)	0.0699 (0.1533)	0.223 (0.3621)	0.2428 (0.382)

* Statistically significant at the 5% level.

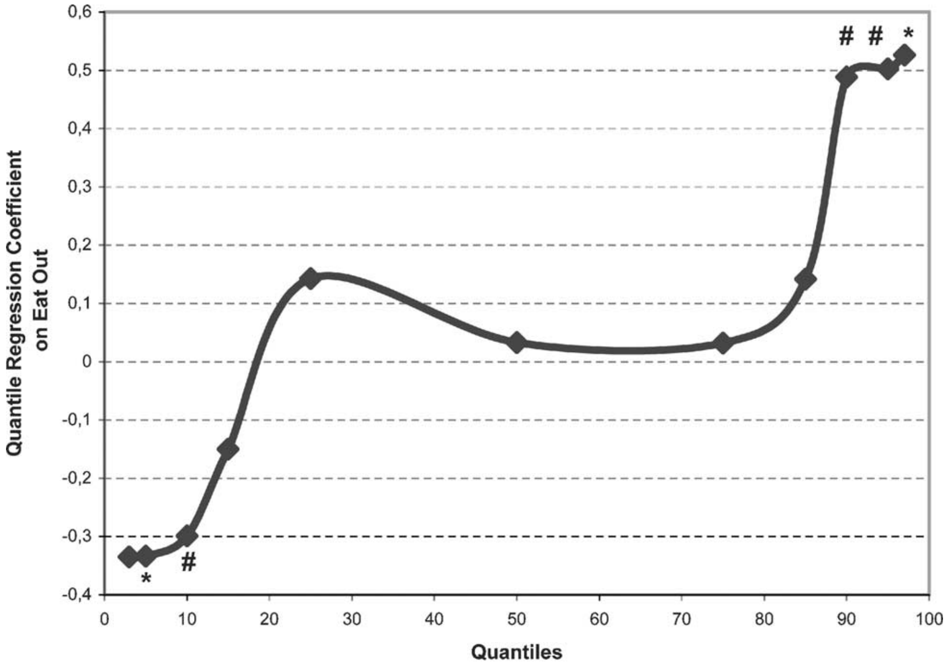

Fig. 6. Quantile regression estimates of the impact of eating out on height. (∗) Statistical significance at the 5% level; (#) statistical significance at the 10% level.

Fig. 5 presents the quantile regression coefficients for the impact of "Maya" at an array of percentiles along the height distribution.[5] Note that the third and fifth percentiles are often used to define stunting. Table 4 presents the estimates and standard errors at selected quantiles. While "Maya" has no statistically significant impact on height among the tallest children, it does lower height at the 85th and lower quantiles. That is, controlling for the three diet and lifestyle variables, the Maya height distribution is, from the 85th percentile and below, stretched to the left relative to the distribution for White American children. This result is consistent with the prediction of lower health status for children whose families emigrated from a low-income country.

The effect of "eating out" is more complex (Fig. 6). At and below the 10th percentile, eating out has a statistically significant negative impact on height, while at and above the 90th percentiles it is statistically significant and positive. Perhaps this variable partially reflects the impact of socioeconomic status on stature, and indicates that higher SES families choose different types of restaurants or meals when dining out. None of the other regressors prove significant at any quantile.

Fig. 7 and Table 5 present the relationship between "Maya" and BMI. Only at the tails of the distribution does being Maya have a statistically significant, and positive, impact on

[5] One outlier was deleted; however, the results are essentially the same when it is included.

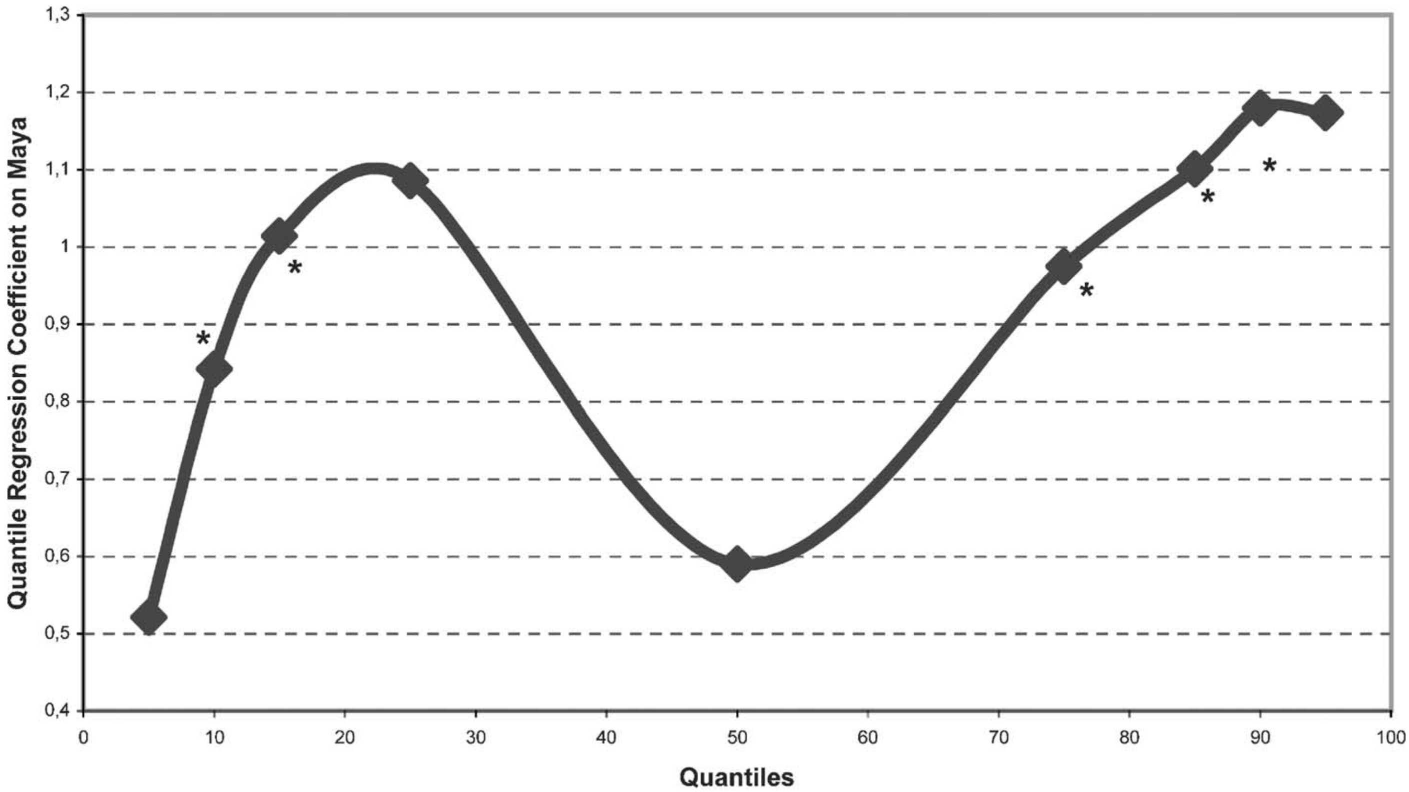

Fig. 7. Quantile regression estimates of the impact of Maya on BMI. (∗) Statistical significance at the 5% level.

Table 5
Quantile regression estimates for BMI

Variable	Quantile 5 (S.E.)	Quantile 15 (S.E.)	Quantile 50 (S.E.)	Quantile 85 (S.E.)	Quantile 95 (S.E.)
Constant	−1.8869* 0.2738)	−1.6233 (0.395)	0.1891 (0.4874)	0.7863 (0.2416)	1.1913* (0.215)
Maya-American	0.5214 (0.3412)	1.0143* (0.3921)	0.5903 (0.4483)	1.1006* (0.2249)	1.1735* (0.2125)
Mexican–American	−0.3798 (0.5486)	0.3314 (0.6018)	−0.393 (0.6711)	1.1877* (0.5696)	1.3172* (0.4029)
Haitian	−0.0036 (1.274)	−0.3698 (1.3552)	0.7497 (0.8004)	0.8883* (0.43)	0.5478 (0.5457)
Other immigrants	−1.2036 (1.3253)	−1.3893 (1.2321)	−0.4481 (1.2789)	1.8681 (1.0365)	1.846 (1.0052)
Black American	0.4989 (0.3395)	0.4989 (0.4703)	0.1915 (0.5427)	1.0166* (0.4277)	1.0523* (0.2699)
Milk	0.0543 (0.0932)	−0.0235 (0.0651)	−0.1398 (0.090)	−0.0454 (0.0642)	−0.1129 (0.2196)
Eat out (yes = 1)	0.4116 (0.2649)	0.3817 (0.2344)	0.3963 (0.2513)	0.1111 (0.1422)	0.1818 (0.2196)
TVComp	0.1729 (0.2983)	0.539 (0.3349)	0.3614 (0.2109)	−0.0052 (0.2049)	−0.1208 (0.2276)

* Statistically significant at the 5% level.

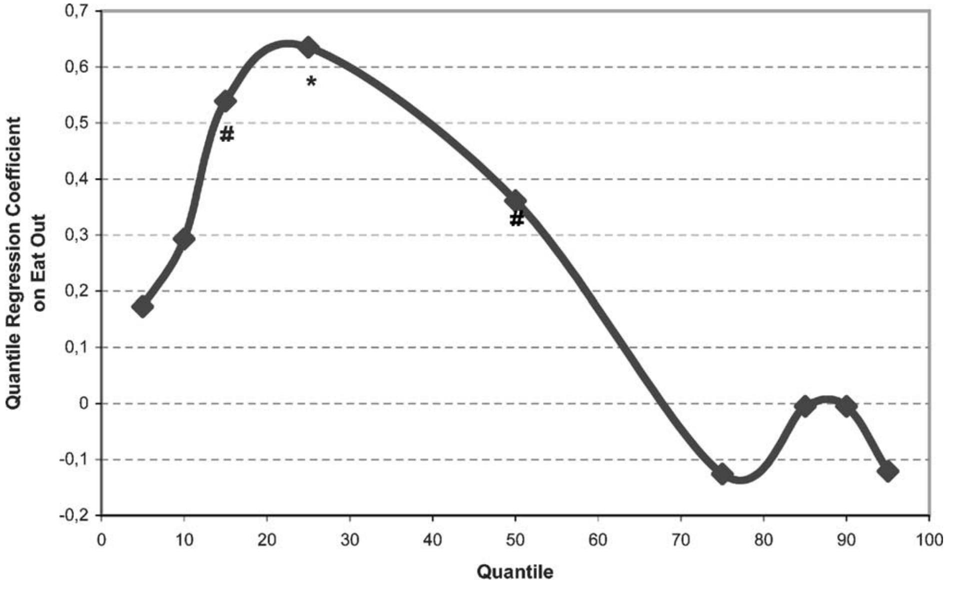

Fig. 8. Quantile regression estimates of the impact of TVComp on BMI. (∗) Statistical significance at the 5% level; (#) statistical significance at the 10% level.

BMI. This means that among the heaviest and the lightest children, being Maya increases BMI relative to White Americans. In the middle of the distribution, near the mean and median, being Maya has no impact on BMI.

The quantile regressions also show that TVComp has a statistically significant and positive impact at the 25th percentile ($p = 0.015$) (Fig. 8). TVComp also appears positive and statistically significant at the 10% level at the 15th and 50th percentiles. These results suggest that watching TV or playing computer games tends to increase the BMI of children who are relatively light. There isn't evidence that an expressed preference for TV and computer games impacts the BMI of the heaviest children.

4. Discussion

Immigration from rural Guatemala to the US improves child health: the average Maya-American child is taller, has longer legs, and fewer are stunted. However, they are considerably heavier and face an increased risk of overweight and obesity. The logistic models failed to identify statistically significant determinants of obesity in the most recent sample of Maya-American children. They did, however, indicate that being Maya raises the risk of overweight relative to White American children. Whereas OLS and logistic regression can not detect the varying effects of "Maya" at different percentiles along the height and BMI distributions, quantile regression analysis can. Being Maya lowers height, relative to White American children, in the lower tail and middle of the distribution. Being Maya raises BMI in both the upper and lower tails of that distribution. Lastly, only among children of median and lower BMI does watching TV or playing on the computer tend to increase BMI.

Health is a biocultural phenomenon, requiring a transdisciplinary approach to its study. Understanding more fully why Maya-American children exhibit such high rates of overweight and obesity requires the collection of better measures of lifestyle, parental investment, and assimilation. For example, we collected SES and language data from the parents of a small subset of the children measured in Indiantown in 2000 ($n = 40$). Our analysis of this smaller sample of children found that the children of parents who answered our questionnaire in Spanish, rather than English, were less likely to be overweight or obese (Smith et al., 2002). If we use language as an indicator of assimilation, then this result is consistent with the hypothesis that a bicultural assimilation path generally results in healthier children. It also suggests the greater assimilation to American culture may place immigrant children at risk of weight problems.

Acknowledgements

The authors thank the Maya communities of Indiantown and Los Angeles for their cooperation on this project. In particular, we thank Sister Carol Jean, Sister Marie Celeste, Antonio Silvestre, Sister Marion, Principals R. Parrish and E. Raines of Indiantown, Florida. Thanks also to J. Gaspar, M. Mendez, P. Jimenez, and F. Peñalosa for assistance in Los Angeles. We were supported by the Timothy and Jean Morbach Fund of the University of Michigan-Dearborn, the Children in Poverty Program, Center for Human Growth and Development, University of Michigan-Ann Arbor, and the Bureau for Faculty Research at Western Washington University.

References

Becker, G., 1981. A Treatise on the Family. Harvard University Press, Cambridge, MA.

Becker, G., Tomes, N., 1986. Human capital and the rise and fall of families. Journal of Labor Economics 4 (2), S1–S139.

Bogin, B., 1999. Patterns of Human Growth, second ed. Cambridge University Press, Cambridge MA.

Bogin, B., Loucky, J., 1997. Plasticity, political economy, and physical growth status of Guatemala Maya children living in the United States. American Journal of Physical Anthropology 102, 17–32.

Bogin, B., Kapell, M., Varela Silva, M.I., Orden, A.B., Smith, P.K., Loucky, J., 2001. How genetic are human body proportions? In: Dasgupta, P., Hauspie, R. (Eds.), Perspectives in Human Growth, Development and Maturation. Kluwer Academic Press, Dordrecht, The Netherlands, pp. 205–221.

Brown, J.L., Pollitt, E., 1996. Malnutrition, poverty and intellectual development. Scientific American 274 (2), 38–43.

Buchinsky, M., 1994. Changes in the U.S. wage structure 1963–1987: an application of quantile regression. Econometrica 62, 405–458.

Buchinsky, M., 1997. Women's return to education in the U.S.: exploration by quantile regression. Journal of Applied Econometrics 13, 1–30.

Buchinsky, M., 1998. Recent advances in quantile regression models: a practical guideline for empirical research. Journal of Human Resources 33 (1), 88–126.

Burns, A., 1993. Maya in Exile. Temple University Press, Philadelphia.

Cameron, N., 1984. The Measurement of Human Growth. Croom Helm, London.

Deaton, A., 1997. The Analysis of Household Surveys. Johns Hopkins University Press, Baltimore.

Fogel, R., 1986. Physical growth as a measure of the economic well being of populations: the eighteenth and nineteenth centuries. In: Falkner, F., Tanner, J. (Eds.), Human Growth, second ed., vol. 3. Plenum Press, New York, pp. 263–281.

Frisancho, A., 1990. Anthropometric Standards for the Assessment of Growth and Nutritional Status. University of Michigan Press, Ann Arbor.

Frisancho, A., Guilding, N., Tanner, S., 2001. Growth of Leg length is reflected in socioeconomic differences. Acta Medica Auxologica 33, 47–50.

Koenker, R., 2000. Quantile regression. In: Fienberg, S., Kadane, J. (Eds.), International Encyclopedia of the Social Sciences. Elsevier Science, Amsterdam.

Koenker, R., Bassett, G., 1978. Regression quantiles. Econometrica 46, 33–50.

Koenker, R., Bassett, G., 1982. Robust tests for heteroscedasticity based on regression quantiles. Econometrica 50, 43–61.

Koenker, R., Hallock, K., 2002. Quantile regression: an introduction. Journal of Economic Perspectives 15 (4), 143–156.

Komlos, J. (Ed.), 1994. Stature, Living Standards, and Economic Development. University of Chicago Press, Chicago.

Kuczmarski, R., Ogden, C., Grummer-Strawn, L., 2000. CDC Growth Charts: United States. Advance Data from Vital and Health Statistics, No. 314. National Center for Health Statistics, Hyattsville, Maryland.

Loh, E., 1993. The economic effects of physical appearance. Social Sciences Quarterly 74 (2), 420–438.

Loucky, J., Moors, M., 2000. The Maya Diaspora: Guatemalan Roots, New American Lives. Temple University Press, Philadelphia.

McGinnis, J., Foege, W., 1993. Actual causes of deaths in the United States. Journal of the American Medical Association 279 (18), 2207–2222.

Montenegro, C., 1998. The structure of wages in Chile 1960–1996: an application of quantile regression. Estudios de Economia 25, 71–98.

Pagan, J., Davila, A., 1997. Obesity, occupational attainment, and earnings. Social Science Quarterly 71 (1), 130–141.

Popkin, B., Udry, J.R., 1998. Adolescent obesity increases significantly in second and third generation U.S. immigrants: the National Longitudinal Study of Adolescent Health. Journal of Nutrition 128, 701–706.

Portes, A., 1995. Economic sociology and the sociology of immigration: a conceptual overview. In: Portes, A. (Ed.), The Economic Sociology of Immigration: Essays on Networks, Ethnicity, and Entrepreneurship. Russell Sage Foundation, New York, pp. 1–41.

Reddy, B., 1998. Body mass index and its association with socioeconomic and behavioral variables among socioeconomically heterogeneous populations of Andhra Pradesh, India. Human Biology 70, 901–917.

Smith, P., Bogin, B., Varela Silva, M.I., Orden, B., Loucky, J., 2002. Does immigration help or harm children's health? The Mayan case. Social Science Quarterly 83 (4), 994–1002.

Stebor, A., 1992. Infant Development among Guatemalan Refugee Families in South Florida, Ph.D. Dissertation. University of Florida, Gainesville.

Steckel, R., 1995. Stature and the standard of living. Journal of Economic Literature 33 (4), 1903–1940.

Tanner, J.M., 1986. Growth as a mirror for the conditions of society: secular trends and class distinctions. In: Demirjian, A. (Ed.), Human Growth: A Multidisciplinary Review. Taylor and Francis, London, pp. 3–34.

Zhou, M., 1997. Segmented assimilation: issues, controversies, and recent research on the new second generation. International Migration Review 31, 975–1008.