Diabetes and Coronary Heart Disease in Filipino-American Women

Role of growth and life-course socioeconomic factors

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OBJECTIVE — To investigate associations between adult markers of childhood growth and the prevalence of diabetes and coronary heart disease (CHD) in Filipino-American women and to determine the role of social and educational differences, including the influence of social mobility between childhood and adulthood.

RESEARCH DESIGN AND METHODS — Socioeconomic disadvantage and poor infant growth, resulting in short leg length, may contribute to the dramatically increased risk of diabetes and CHD in Filipino-American women, but this has not been investigated. This study is a cross-sectional study of 389 Filipino-American women (age 58.7 ± 9.4 years [mean ± SD]). Diabetes was defined by 1999 World Health Organization criteria and CHD by ischemic electrocardiogram changes, Rose angina, a history of myocardial infarction, or revascularization surgery. A score of social mobility (0–4) was calculated by summarizing childhood and adult financial circumstances.

RESULTS — Diabetes prevalence (31.4%) was not associated with measures of growth but was significantly lower in women with greater education, childhood and adult income, or social mobility score. Compared with Filipinas who were poorest in childhood and adulthood, respective odds ratios (95% CI) for diabetes were 0.55 (0.18–1.68), 0.19 (0.06–0.62), and 0.11 (0.03–0.42), down to 0.07 (0.01–0.51) in the most advantaged women ($P < 0.0001$). Family history of diabetes [5.14 (2.72–9.70)] and larger waist [1.07 per cm (1.03–1.10)] were also significant predictors in multiple adjusted models. In contrast, CHD prevalence (22.4%) was most strongly associated with leg length, but not trunk length; compared with individuals with the shortest legs, respective odds ratios (95% CI) for CHD were 0.60 (0.31–1.19), 0.53 (0.26–1.05), and 0.44 (0.22–0.91) in the tallest group, in age- ($P_{trend} = 0.02$) and multiple-adjusted models ($P_{trend} = 0.01$).

CONCLUSIONS — Socioeconomic disadvantage contributes to the high prevalence of diabetes in Filipinas. Factors limiting early growth of the legs may increase the risk of CHD in this comparatively short population.

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Immigrant populations and non-Caucasians, such as African Americans, Latinos, American Indians, and Native Hawaiians in the U.S., have an increased risk for obesity, type 2 diabetes, and coronary heart disease (CHD) compared with Caucasians (1). Less is known about those risks in Filipinos (2,3), the third largest immigrant population in the U.S. (4). Results from this study have recently demonstrated that Filipino-American women had sixfold greater odds of having diabetes and threefold greater odds of having the metabolic syndrome than Caucasian women, despite similar body size (5).

Early chronic or intermittent malnutrition, leading to impaired development of the endocrine system and followed by exposure to a Western diet with an abundance of food, has been suggested to be responsible for the greater levels of metabolic disorders in immigrant populations (6). In addition to genetic influences on height, early malnutrition limits growth and results in shorter adult stature, and Filipinas in the U.S. are of shorter height than Caucasian American women (7). Poor growth, particularly of the long bones of the legs in the first years of life, has been shown to be associated with insulin resistance and CHD (8–12) and may contribute to an increased risk of diabetes and CHD in Filipina Americans. Previous studies have largely consisted of Caucasians, and associations have not been investigated in other ethnic groups.

Childhood socioeconomic disadvantage influences early growth and adult health in many ways, including, but not restricted to, poor early diet (13–15). It is unclear whether the increased risk of Filipinas may originate from effects of early growth-limiting factors on the developing metabolic and cardiovascular system or potentially reflects the wider influence of early and continuing socioeconomic disadvantage on both short stature and adult disease (16). Whether poor growth and socioeconomic factors contribute to the risk of diabetes and CHD in Filipino women, a nonobese population with a high prevalence of diabetes, has not been investigated. The objectives of this study are *1*) to investigate associations between adult markers of childhood growth and the prevalence of diabetes and CHD in Filipino-American women and *2*) to determine the role of social and educational differences, including the influence of social mobility between childhood and adulthood.

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Abbreviations: CHD, coronary heart disease.

A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

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RESEARCH DESIGN AND METHODS

— Self-identified Filipinas, ages 40–86 years, were recruited between October 1995 and February 1999 for a cross-sectional study designed to estimate the prevalence of several chronic diseases. Most lived in north San Diego County, primarily Mira Mesa, a middle-class community with a high proportion of Filipino residents (all participants, except for four women, were born in the Philippines). Random sampling of the entire county was not feasible because Filipinos are not identified separately in the San Diego census, and recruitment strategies have previously been described in detail (5,17).

Measurements

Clinical evaluations took place at the University of California, San Diego Rancho Bernardo Research Clinic. All participants gave written informed consent. Standardized questionnaires were used and administered by a Philippine-born native Tagalog–speaking female nurse. All participants spoke functional English. Demographic characteristics, cigarette smoking, alcohol use, physical activity, parity, menopausal status, medication history, family history of heart disease (in either parent) and diabetes (in either a parent or in siblings after age 40 years), and other selected chronic diseases were determined using structured questionnaires. Participants who were using medications (prescription or nonprescription) or nutritional supplements in the month before the clinic visit brought their pills and prescriptions to the clinic to be verified and recorded by a nurse. Systolic and diastolic blood pressure levels were measured twice in seated resting subjects (18), and hypertension was defined as blood pressure ≥140/90 mmHg or use of antihypertensive medication (19).

Anthropometric measures

Weight was measured to the nearest 0.1 kg with participants wearing light indoor clothing and no shoes. Height was measured to the nearest 0.5 cm, using a portable stadiometer, with participants standing without shoes and with heels against the wall as tall as possible with the head in the Frankfort plane. Participants were seated upright, with their back against the vertical stand of the stadiometer, on the base plate located on a hard flat seat. Their head was in the Frankfort plane and their feet were on the floor to assess sitting height (a measure of trunk length). Leg length was quantified as the difference between standing and sitting heights. Waist circumference was measured in centimeters at the participant's natural waist, and hip measurements were measured at the iliac crest. BMI was calculated as weight (kilograms) divided by height squared (meters squared). Waist-to-hip ratio was calculated by dividing waist by hip circumference and expressed as a percentage. Percentage of total body fat, truncal fat, and leg body fat (mean, right and left leg) was determined by dual-energy X-ray absorptiometry (model QDR-2000 X-ray bone densitometers; Hologic, Waltham, MA).

CHD, diabetes, and plasma lipoproteins

Prevalence of CHD was defined as electrocardiogram abnormalities from a 12-lead resting electrocardiogram (Minnesota codes 1.1–1.2 [large Q and QS waves], 1.3 [small Q and QS], 4.1–4.4 [ST-T depression], 5.1–5.3 [flattened or inverted T waves], or 7.1.1 [complete left bundle branch block]) (20,21), a positive Rose questionnaire for angina or prolonged chest pain (22), hospitalization for coronary revascularization procedures, or reported myocardial infarction. Rose angina was defined according to standard criteria as chest pain or discomfort that was brought on by exertion (walking on flat ground or uphill), was situated in the central or left anterior chest, forced the participant to slow down or stop, and was relieved within 10 min if she did so. In 87% of CHD cases, event classification was corroborated by electrocardiogram abnormalities and/or severe angina (grade 2). Of 11 women classified as having CHD on the basis of self-reported myocardial infarction or Rose pain of possible myocardial infarction without electrocardiogram abnormalities, 2 women additionally reported a history of angioplasty, and another 5 also fulfilled criteria of having grade 1 angina.

A 75-g oral glucose tolerance test was performed in the morning after a minimum 8-h fast; blood samples were obtained by venipuncture at 0 and 2 h. Plasma glucose was measured by a glucose oxidase method, and insulin was determined by radioimmunoassay in a diabetes research laboratory. Diabetes was defined according to 1999 World Health Organization criteria (23). A person was regarded as having diabetes if the fasting plasma glucose was ≥7 mmol/l (126 mg/dl), or the 2-h glucose after the oral glucose tolerance test was ≥11.1 mmol/l (200 mg/dl), or if she was using diabetes medication (oral or insulin).

Fasting plasma lipids and lipoproteins were measured in a lipid research clinic Centers for Disease Control–certified research laboratory, as previously described (17). LDL cholesterol was calculated using the Friedewald formula. Dyslipidemia was defined as LDL cholesterol ≥160 mg/dl, HDL cholesterol <50 mg/dl, or statin use.

Childhood and adult social conditions

Information on economic position in child and adulthood was obtained from questionnaires using precoded categories. Childhood financial circumstances (0–2) distinguished individuals who were "very poor" from "average" and "well off." A total of 20 precoded categories of adult income were collapsed to form three equally sized groups (0–2) in ascending order (<\$15,000, \$15,000 to \$44,999, and ≥\$45,000, in U.S. dollars). A score of lifetime economic position (0–4) was calculated by adding up childhood financial circumstances to adult income, leading to a score between 0 (lowest group in both childhood and adulthood) up to 4 (highest category at both time points). For sensitivity analyses, an alternative score (0–4) was calculated by adding childhood financial circumstances to attained education (≤12, 13–15, and ≥16 completed years).

World War II birth cohort

Food shortages and malnutrition were pervasive during the Japanese occupation (1941–1945), and infant mortality rates in the Philippines were reportedly the highest in the world (24). To assess the potential influence of wartime fetal and infant (up to age 2 years) malnutrition, participants were stratified into birth cohorts: born *1*) before 1938, *2*) 2 years before the Japanese occupation (1938–1940), *3*) during up to 2 years after the occupation (1941–1947), or *4*) >2 years after the occupation (1947 or later).

Statistical analysis

Analyses were restricted to women with complete information on components of height, weight, socioeconomic variables, diabetes, and CHD. Logistic regression analysis was used to calculate age- and multiple-adjusted odds ratios for having diabetes or CHD across groups of all socioeconomic indicators and anthropo-

Table 1—*Characteristics of women in the Filipina study*

	n	Means and proportions (95% CI)
Age (years)	389	58.7 (57.8–59.7)
Age at immigration >45 years (%)	382	48.4 (43.4–53.5)
Born in the Philippines (%)	389	98.7 (97.6–99.8)
Years since immigration (years)	382	16.6 (15.5–17.7)
Height (cm)	389	153.2 (152.6–153.8)
Leg length (cm)	389	70.7 (70.4–71.1)
Sitting height (cm)	389	82.4 (82.1–82.8)
Weight (kg)	389	59.5 (58.5–60.5)
BMI (kg/m^2)	389	25.3 (24.9–25.6)
Obesity (%)	389	9.8 (6.8–12.7)
Waist circumference (cm)	389	80.8 (79.8–81.7)
Waist-to-hip ratio	389	0.83 (0.83–0.84)
Body fat (%), DEXA	363	33.2 (32.7–33.7)
Truncal fat (%), DEXA	363	30.9 (30.3–31.5)
Diabetes (%)	389	31.4 (26.7–36.0)
CHD (%)	389	22.4 (18.2–26.5)
Postmenopausal (%)	389	84.6 (81.0–88.2)
Current estrogen use (%)	387	16.3 (12.6–20.0)
Alcohol consumption ≥3 times/week (%)	389	1.0 (0.0–2.0)
Physical activity ≥3 times/week (%)	387	65.9 (61.2–70.6)
Current smoker (%)	387	11.4 (8.2–14.5)
Dyslipidemia (%)	389	53.2 (48.3–58.2)
Family history of diabetes (%)	389	36.0 (31.2–40.8)
Family history of heart disease (%)	370	23.5 (19.2–27.8)
Childhood family income	380	
Poor		20.7 (16.7–24.9)
Average		70.3 (65.7–74.9)
Well-off		9.0 (6.1–11.8)
Education	386	
≤12 years		31.1 (26.5–35.7)
13–15 years		17.4 (13.6–21.1)
≥16 years		51.6 (46.6–56.5)
Adult household income	330	
≤$15,000		34.2 (28.5–38.7)
$15,000 to $44,999		32.1 (27.1–37.2)
≥$45,000		33.6 (29.1–39.4)
Social mobility score	323	
0		7.1 (4.3–9.9)
1		32.8 (27.7–37.9)
2		29.1 (24.2–34.1)
3		25.1 (20.4–29.8)
4		5.9 (3.3–8.5)
Birth year	383	
Before 1938		50.1 (45.1–55.1)
1938–1940		12.3 (9.0–15.6)
1941–1947		18.8 (14.9–22.7)
After 1947		18.8 (14.9–22.7)

DEXA, dual-energy X-ray absorptiometry.

metric measures, using the most disadvantaged or shortest group as the reference category. *P* values are based on tests for trend. Multiple-adjusted models were constructed to additionally include BMI, waist circumference, family history of diabetes, smoking, exercise, employment status, and household size for models with diabetes as the outcome. Corresponding models with CHD as the outcome included BMI, waist, family history of heart disease, menopausal status, hormone replacement therapy use, hypertension, dyslipidemia, smoking, and exercise. Final models were performed simultaneously including all socioeconomic variables for diabetes models and leg length for CHD models plus all risk factors that were either significant at $\alpha < 0.20$ in multiple-adjusted earlier models or prespecified covariates (biological age and age at immigration in all models and employment status and household size in diabetes models).

RESULTS — A total of 389 women fulfilled our inclusion criteria, representing 85.7% of the total sample. Characteristics of the sample are shown in Table 1. In age-adjusted analyses, total body height and leg and trunk length all differed according to education, childhood and adult income, life-course socioeconomic position, and birth year category, with the most advantaged women and those born before the war being the tallest (data not shown). For example, women with poor childhood family income were on average 1.52 m tall, compared with 1.53 m in those with average income or 1.55 m in the well-off group ($P = 0.008$). All differences were statistically significant except for leg length by birth year or education. In contrast, education was the only measure that was strongly and significantly associated with BMI and waist circumference ($P < 0.008$ and 0.0004, respectively), with less-educated women having a greater BMI and larger waist.

Role of social and educational differences for diabetes and CHD

The odds of diabetes were significantly lower in women with better childhood financial conditions ($P_{trend} = 0.007$), greater education ($P_{trend} = 0.01$), and higher adult income ($P_{trend} = 0.0002$) in age- and multiple-adjusted analyses, including BMI, waist circumference, family history of diabetes, smoking, exercise, employment status, and household size (Table 2). Further, diabetes was significantly less common the higher the social mobility score. Compared with Filipinas who were poor in childhood and remained in the lowest income group in older adult life, respective odds ratios (95% CI) for diabetes were 0.55 (0.18–1.68), 0.19 (0.06–0.62), and 0.11 (0.03–0.42), down to 0.07 (0.01–0.51) in those who were most advantaged in childhood and in the highest income group in adult life, after adjustment for all variables mentioned above ($P_{trend} < 0.0001$; Table 2). Similar results were obtained using the alternative score (data not shown). The odds of diabetes were also associated with birth year category (Table 2); however,

Table 2—*Odds ratios (95% CIs) for diabetes and CHD in Filipino women*

	Diabetes		CHD	
	Age-adjusted*	Fully adjusted†	Age-adjusted*	Fully adjusted‡
Height				
1 Shortest (<148.6 cm)	1	1	1	1
2 (148.6–152.4 cm)	1.21 (0.64–2.27)	1.04 (0.51–2.12)	0.89 (0.45–1.76)	0.77 (0.36–1.64)
3 (152.4–157.5 cm)	1.13 (0.58–2.20)	0.59 (0.26–1.30)	0.91 (0.45–1.84)	0.82 (0.38–1.76)
4 Tallest (>157.5 cm)	1.90 (0.99–3.66)	1.16 (0.54–2.48)	0.67 (0.32–1.40)	0.45 (0.19–1.07)
P_{trend}	0.07	0.96	0.33	0.10
Leg length				
1 Shortest (<68.6 cm)	1	1	1	1
2 (68.6–70.5 cm)	0.94 (0.49–1.80)	0.76 (0.37–1.58)	0.60 (0.31–1.19)	0.52 (0.24–1.12)
3 (70.5–73.0 cm)	1.12 (0.59–2.11)	0.77 (0.36–1.63)	0.53 (0.26–1.05)	0.52 (0.24–1.11)
4 Tallest (>73.0 cm)	1.32 (0.70–2.49)	0.73 (0.35–1.55)	0.44 (0.22–0.91)	0.32 (0.14–0.74)
P_{trend}	0.32	0.45	0.02	0.01
Trunk length				
1 Shortest (<80.0 cm)	1	1	1	1
2 (80.0–82.6 cm)	0.80 (0.41–1.54)	0.67 (0.31–1.45)	0.60 (0.28–1.29)	0.56 (0.25–1.27)
3 (82.6–84.5 cm)	1.08 (0.58–2.00)	0.64 (0.31–1.33)	1.17 (0.61–2.24)	0.76 (0.36–1.62)
4 Tallest (>84.5 cm)	1.67 (0.86–3.27)	1.09 (0.50–2.35)	0.80 (0.38–1.69)	0.48 (0.20–1.13)
P_{trend}	0.13	0.94	0.95	0.16
Childhood family income				
Poor	1	1	1	1
Average	0.48 (0.28–0.83)	0.48 (0.25–0.90)	0.72 (0.40–1.32)	0.71 (0.37–1.37)
Well-off	0.34 (0.13–0.90)	0.26 (0.08–0.82)	0.47 (0.16–1.40)	0.45 (0.15–1.40)
P_{trend}	0.005	0.007	0.14	0.15
Education				
≤12 years	1	1	1	1
13–15 years	0.78 (0.40–1.51)	0.72 (0.32–1.63)	1.21 (0.55–2.66)	1.40 (0.58–3.35)
≥16 years	0.41 (0.24–0.72)	0.44 (0.23–0.84)	1.30 (0.69–2.46)	1.47 (0.71–3.06)
P_{trend}	0.001	0.01	0.43	0.32
Adult household income				
≤15,000	1	1	1	1
$15,000 to 44,999	0.58 (0.31–1.08)	0.34 (0.16–0.70)	0.69 (0.33–1.43)	0.61 (0.27–1.38)
≥45,000	0.24 (0.11–0.55)	0.16 (0.06–0.42)	0.64 (0.27–1.52)	0.78 (0.30–2.01)
P_{trend}	0.0008	0.0002	0.32	0.61
Social mobility score				
0	1	1	1	1
1	0.73 (0.29–1.85)	0.55 (0.18–1.68)	0.55 (0.20–1.53)	0.43 (0.14–1.38)
2	0.40 (0.15–1.09)	0.19 (0.06–0.62)	0.46 (0.15–1.37)	0.38 (0.11–1.27)
3	0.22 (0.07–0.68)	0.11 (0.03–0.42)	0.39 (0.12–1.30)	0.41 (0.11–1.54)
4	0.14 (0.02–0.79)	0.07 (0.01–0.51)	0.19 (0.03–1.15)	0.14 (0.02–0.96)
P_{trend}	0.0006	<0.0001	0.07	0.13
Birth year				
Before 1938	1	1	1	1
1938–1940	0.78 (0.35–1.77)	0.87 (0.35–2.18)	0.89 (0.34–2.30)	1.06 (0.38–2.96)
1941–1947	0.61 (0.24–1.54)	0.72 (0.25–2.07)	1.21 (0.43–3.41)	1.30 (0.41–4.08)
After 1947	0.25 (0.07–0.92)	0.32 (0.08–1.37)	1.11 (0.28–4.45)	1.58 (0.33–7.68)
P_{trend}	0.06	0.18	0.78	0.57

Minimum $n = 304$. *Adjusted for current age and age at immigration. †Diabetes fully adjusted model additionally includes BMI, waist, family history of diabetes, smoking, exercise, employment status, and household size. ‡CHD fully adjusted model additionally includes BMI, waist, family history of heart disease, menopausal status, hormone replacement therapy use, hypertension, dyslipidemia, smoking, and exercise.

this association was of borderline significance ($P_{trend} = 0.06$) and reduced further in multiple-adjusted models ($P_{trend} = 0.18$). In final models, simultaneously including all socioeconomic variables and other risk factors (Table 3), lower adult household income, a positive family history of diabetes, and waist circumference were each significantly and independently associated with increased odds of diabetes ($P < 0.001$ in each case), whereas associations of childhood family income with diabetes did not remain statistically significant.

CHD prevalence was not significantly associated with any of the socioeconomic indicators (Table 2); although the odds of CHD were lower the greater the social

Table 3—*Odds ratios (95% CI) for diabetes and CHD from models including all risk factors simultaneously*

	Odds ratio (95% CI)	*P*
Diabetes (*n* = 305)		
Age (years)	1.04 (0.99–1.09)	0.07
Age at immigration (years)	0.99 (0.96–1.03)	0.74
Waist circumference (cm)	1.07 (1.03–1.10)	<0.0001
Childhood family income (per category ↑)	0.66 (0.36–1.20)	0.17
Education (per category ↑)	0.72 (0.50–1.04)	0.08
Adult household income (per category ↑)	0.40 (0.24–0.66)	0.0003
Family history of diabetes (Y/N)	5.14 (2.72–9.70)	<0.0001
Current employment status (Y/N)	1.34 (0.72–2.51)	0.36
Number of household members	0.99 (0.82–1.19)	0.91
CHD (*n* = 380)		
Age (years)	1.02 (0.99–1.07)	0.22
Age at immigration (years)	0.98 (0.96–1.01)	0.17
Waist circumference (cm)	1.03 (1.01–1.06)	0.01
Hypertension (Y/N)	1.74 (0.98–3.08)	0.06
Dyslipidemia (Y/N)	1.62 (0.51–5.18)	0.42
Regular exercise (Y/N)	1.67 (0.94–2.97)	0.08
Leg length (per category ↑)	0.72 (0.56–0.91)	0.006

mobility score, with odds ratios (95% CI) ranging from 0.55 (0.20–1.53), 0.46 (0.15–1.37), and 0.39 (0.12–1.30), down to 0.19 (0.03–1.15) in the most advantaged women; these differences were not statistically significant in age- (P_{trend} = 0.07) and multiple-adjusted analyses (P_{trend} = 0.13).

Associations between adult markers of childhood growth and diabetes and CHD

Diabetes was not significantly associated with height and leg or trunk length in age- or multiple-adjusted analyses (Table 2). In contrast, the odds of CHD differed significantly across quarters of leg but not trunk length. Compared with individuals with the shortest legs, odds ratios (95% CI) for CHD were 0.60 (0.31–1.19), 0.53 (0.26–1.05), and 0.44 (0.22–0.91) in the tallest group, in age- (P_{trend} = 0.02) and multiple-adjusted models (P_{trend} = 0.01). Total body height showed a comparable but weaker association (P_{trend} = 0.10). Final models showed similar results, with shorter leg length (P_{trend} = 0.006), greater waist circumference (P_{trend} = 0.01), and hypertension (P = 0.06) showing the strongest associations with CHD (Table 3).

Adjusting for body size by including BMI, total percent body fat, waist-to-hip ratio, or waist circumference instead of weight, or excluding the four women not born in the Philippines, did not materially change the results regarding diabetes or CHD (data not shown). Likewise, findings remained unchanged in sensitivity analyses excluding 10 women with triglyceride levels >400 mmol/l (and thus potentially unreliable estimation of LDL cholesterol by the Friedewald formula) or adjusting for continuous measures of total cholesterol, HDL cholesterol, LDL cholesterol, or triglycerides alone or in combination instead of "dyslipidemia."

CONCLUSIONS — As also evident in this sample of Filipino-American women, the overall prevalence of diabetes in this population is greatly increased (5), similar to other immigrant populations (25). Unlike cohorts where diabetes prevalence is higher in migrant than native populations, the diabetes prevalence in this study is similar to that of women in the Philippines and longer-term migrants and U.S.-born Filipinas in Hawaii (26,27). Socioeconomic disadvantage from childhood to adulthood was strongly and linearly associated with diabetes in this study, in addition to the effects of family history and waist circumference. The observation of an independent association between lower adult income and type 2 diabetes is consistent with findings among Filipinas in Houston, Texas (3), despite this earlier study being limited to participants with a known history of type 2 diabetes, which comprised only 41% of all cases in this study.

Selective survival of undernutrition or starvation by individuals with efficient energy storage and greater body size may lead to increased susceptibility to diabetes when followed by a Western diet with an abundance of food (28). Contrary to this "thrifty genotype" hypothesis stands the idea of a "thrifty phenotype," where early undernutrition may lead to impaired development of the endocrine pancreas and increased susceptibility to diabetes in later life (6). Filipino women are less obese, compared with Caucasian American women, and earlier reports from this study have shown that although Filipino women have more visceral adipose tissue (by computed tomography) for a given level of body size, this does not explain their high prevalence of diabetes (29). Adult body size is thus unlikely to underlie the observed associations. Also, while education was the only socioeconomic measure significantly associated with BMI and waist, income was most strongly associated with diabetes. Although this cross-sectional study cannot rule out the potential importance of weight trajectories from early to adult life contributing to the observed associations with diabetes, our results suggest that factors associated with socioeconomic disadvantage during women's childhood that persist after migration to the U.S. and into adult life may be important for the development of diabetes. In this context, the quality of the diet may be more important than absolute caloric intake or body size in this nonobese population (30).

Many studies have reported an inverse association between height and CHD, and recent evidence from 35,000 twin pairs suggests that this association is due to environmental factors directly affecting growth and CHD (31). The few studies investigating components of height (8,9) reported that leg length, rather than trunk length, is most strongly associated with CHD, with leg length being the component of height most sensitive to early environmental influences on growth (32). In contrast with two earlier studies of British men (9) and women (11) reporting inverse associations between leg length and insulin resistance and type 2 diabetes, as well as other cardiovascular risk factors (10,33), we found no evidence for associations between components of height and diabetes or homeostasis model assessment of insulin resistance (results not shown). However, the results of the present study do support the hypothesis that factors limiting early growth of the legs increase the susceptibility to CHD in this comparatively short population. Socioeconomic indicators considered here do not appear to be the main underlying factors; first, these were not significantly associated with CHD, and, second, childhood and adult socioeconomic circumstances showed similar associations with leg and trunk length, thus being unlikely to explain their differential associations with CHD. However, it should be considered that indicators such as childhood family income may only be poor measures of early malnutrition and living conditions not just during times of war and occupation in the Philippines, but also considering that access to food may have been easier for those families with lower income but living or working on farms, for example.

Strength and limitations

An important advantage of this study is that potential residual confounding of health behaviors is unlikely to play a major role, as few Filipinas engaged in unhealthy behaviors, such as excess alcohol consumption, smoking, or sedentary lifestyle. Some limitations of the present study should be noted. This is a cross-sectional study that used opportunistic sampling to recruit. Reverse causation and selection bias may have influenced our results, and prospective studies are warranted to validate these cross-sectional results. Although the sample size was small, a significant association between leg length and CHD was observed. However, CHD was not significantly associated with any of the socioeconomic indicators, despite directions and magnitudes of associations with childhood and adult income and life-course socioeconomic position being similar compared with diabetes. The smaller number of CHD cases and thus low power may have contributed to the lack of statistical significance.

In populations at increased risk of type 2 diabetes, the age of onset may have progressively shifted toward younger ages, and this may lead to misclassification as type 1 diabetes. While cases in this study were defined based on fasting/postload hyperglycemia or drug use regardless of age at onset, siblings with onset of diabetes before age 40 years or insulin use were excluded from the definition of a positive family history. However, analyses including siblings with earlier age at onset resulted in only one additional woman being classified as having a positive family history. This is in line with previous reports showing that the dramatic increase in diabetes prevalence in Filipino women occurs after age 40 years and not before (26).

Childhood and adult income and education were self-reported and may have been misclassified; these data may also not reflect sustained income, particularly when migration occurred in mid-life. Adult income referred to current income, and many women (48%) reported not being currently employed. Although 52% had ≥16 years of education and, as such, were presumably college graduates, the lower adult income might reflect underemployment if their Philippine college degrees were not transferable to the U.S. or they elected not to join the labor force because of concerns about adjusting to a foreign culture and language at an older age (half migrated to the U.S. at the age ≥45 years). Previous studies have shown that immigrants who previously held professional occupations, particularly those who migrate in middle age, lose status (34). A total of 67% of our cohort with ≥16 years of education held jobs as professionals, managers, etc., when residing in the Philippines. Of these, half (55%) held similar positions in the U.S., and the remainder were housewives (10%) or worked in skilled manual (12%), semi-skilled (6%), or unskilled occupations (17%) in the U.S.

Generalizability of the sample

Census data did not report Asian nationalities separately in 1995; population-based sampling of all Filipinos in San Diego County was therefore not possible. Because the sampling frame is unknown, we are unable to calculate response rates and discuss the representativeness of the study population in detail. However, comparisons with 2000 U.S. Census data suggest that this cohort is representative of all Filipino Americans with regard to education (where 43.8% of all Filipino Americans ≥25 years of age are college graduates compared with 52% in this cohort). Median household income in our cohort ($25,000 to $29,999) is lower than national statistics ($65,189) for all Filipino Americans (http://www.census.gov/prod/2004pubs/censr-17.pdf); this discrepancy likely reflects underemployment or retired status in this older cohort.

In conclusion, childhood and adult socioeconomic factors contribute to the high prevalence of diabetes in Filipina-American women, a nonobese population by Western standards, independent of the strong influence of family history. Further, our results support the hypothesis that factors limiting early growth of the legs increase the risk of CHD but not diabetes; socioeconomic factors considered here do not seem to underlie this association. Prospective studies are warranted to validate these associations and attempt to explain them, given that childhood factors appear to increase the risk of both diabetes and CHD, possibly by different mechanisms.

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