Prevalence of Diabetes and Intermediate Hyperglycemia Among Adults From the First Multinational Study of Noncommunicable Diseases in Six Central American Countries

The Central America Diabetes Initiative (CAMDI)

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OBJECTIVE—The increasing burdens of obesity and diabetes are two of the most prominent threats to the health of populations of developed and developing countries alike. The Central America Diabetes Initiative (CAMDI) is the first study to examine the prevalence of diabetes in Central America.

RESEARCH DESIGN AND METHODS—The CAMDI survey was a cross-sectional survey based on a probabilistic sample of the noninstitutionalized population of five Central American populations conducted between 2003 and 2006. The total sample population was 10,822, of whom 7,234 (67%) underwent anthropometry measurement and a fasting blood glucose or 2-h oral glucose tolerance test.

RESULTS—The total prevalence of diabetes was 8.5%, but was higher in Belize (12.9%) and lower in Honduras (5.4%). Of the screened population, 18.6% had impaired glucose tolerance/impaired fasting glucose.

CONCLUSIONS—As this population ages, the prevalence of diabetes is likely to continue to rise in a dramatic and devastating manner. Preventive strategies must be quickly introduced.

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Apparent changes in access to cheap, energy-dense food, urbanization, and adoption of sedentary lifestyles in the countries of Central America have raised concerns about the rapid emergence of obesity and diabetes in the region. Diabetes and related chronic conditions in Central America have been largely neglected by epidemiologic and surveillance programs in recent decades, however, because other issues, such as under-nutrition, infectious diseases, and armed conflict, were regarded as much more pressing health threats.

The Central America Diabetes Initiative (CAMDI) is the first population-based multinational study to examine the prevalence of diabetes and risk factors in Central America. We report here the main findings from the multinational analyses of this survey.

RESEARCH DESIGN AND METHODS

The CAMDI survey was a cross-sectional survey based on a probabilistic, stratified, multistage, cluster sampling design of the noninstitutionalized population of five Central American sites. The survey sampled included the entire national population in Belize; the overall metropolitan populations in San Jose, Costa Rica; Tegucigalpa, Honduras; and Managua, Nicaragua; and was restricted to the municipalities of Santa Tecla and Villa Nueva, which are part of the metropolitan

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In each city, the primary sampling unit was a cluster of independent households within predetermined geographic areas. The primary sampling units were grouped into geographic strata (sectors and compact segments or blocks). The sample was allocated proportionally to the size of the population within each geographic stratum of each city. All eligible individuals aged 20 years or older in the randomly selected households were invited to participate. Data were weighted to account for differential selection probabilities and survey nonresponse, and weights were poststratified to the adult population of each site based on age group and sex. The total sample population was 10,822, of whom 7,234 (66.8%) underwent anthropometry measurement and laboratory tests. Data were weighted to represent the population of the sampled city, except in Belize, where data were weighted to the country's entire population. The sample represented more than 2 million inhabitants of the selected sites (Table 1).

Participants were requested to fast overnight the day they came to the examination center. Venous blood samples were collected in sodium fluoride tubes before and 2 h after a glucose load (75 g of anhydrous glucose). The cold chain was kept until the plasma was separated (2 to 4 h after extraction) and the corresponding analysis was done the same day or the next day. Glucose was determined by standard enzymatic methods. Except in El Salvador, laboratory tests included fasting blood glucose (FBG) and a 2-h oral glucose tolerance test (OGTT). In El Salvador, only fasting glucose was determined through a capillary blood sample tested in a HemoCue glucose analyzer (HemoCue AB, Ängelholm, Sweden) that reports plasma equivalent values.

The prevalence of undiagnosed diabetes was calculated using the blood sample weights and defined as FBG ≥126 mg/dL or 2-h OGTT ≥200 mg/dL. The total prevalence of diabetes was calculated by combining participants with diagnosed diabetes (interview weights) and all participants whose diabetes status was assessed by the blood sample (blood sample weights). Intermediate hyperglycemia was defined as impaired fasting glucose (IFG; FBG >100 and <126 mg/dL), or impaired glucose tolerance (IGT, 2-h glucose >140 and <200 mg/dL). Prevalence rates were standardized by the direct method using the World Segi Population (1) as standard.

RESULTS—Sixty percent of participants were young adults (20–39 years), 31.6% were middle aged (40–64 years), and only 8.4% were elderly (≥65 years; Table 1). Respondents' mean BMI was 27.1 ± 0.2 kg/m^2.

The total prevalence of diabetes across the six sites was 8.5%, but was notably higher in Belize (12.9%) and notably lower in Honduras (5.4%). Men and women had similar prevalence except in Belize, where women had a higher prevalence (17.6%) than men (8.8%). Overall, 40% of those with diabetes were undiagnosed, ranging from 53% in Honduras to 28% in Costa Rica. The prevalence of intermediate hyperglycemia varied more across the sites than diabetes. Of the screened population, 18.6% had intermediate hyperglycemia, with the highest prevalence reported in Guatemala (28.2%) and the lowest in Nicaragua (12.4%).

CONCLUSIONS—This report is the first epidemiologic study of the prevalence of diabetes in Central America to be based on a representative geographic sample. We found a combined prevalence of diabetes of 8.5% for the six-country region. Almost half of the cases of diabetes were undiagnosed.

The combined crude prevalence of diabetes in participating sites was comparable to the prevalence of 9.6% reported in the U.S. (2) (estimates for 1988–2006) (3) and 8.4% in Mexico City (4) in 2000, and higher than the prevalence of 7.2% reported in four Bolivian cities in 1998 (5). The prevalence of diabetes in Belize was comparable to the 12.5% reported in Jamaica (6) in 1999 and New York in 2008 (7). The Cardiovascular Risk Factor Multiple Evaluation in Latin America (CARMELA) study reported the prevalence of diabetes was 4.4% in Lima and 8.9% in Mexico City (8). The proportion of cases of diagnosed diabetes in the combined sample (5%) was comparable to that reported in the U.S. (5%) in 2000 and in Bolivia (5.2%) in 1998. The proportion of undiagnosed cases of diabetes was higher in Belize and Managua than in the other sites.

These prevalence estimates are particularly worrisome given the relative youth of the population. The overall age-adjusted prevalence is equivalent to the most recent 9.6% estimate from the U.S. (1988–2006) (2), with site-specific prevalence ranging from 7% in Tegucigalpa to 15% in Belize. This increased prevalence may be a related to a variety of characteristics, including genetic, demographic, and lifestyle factors, but the prevalence of obesity across the sites, and in particular among Belizean (44%) and Nicaraguan women (34%; data not shown in Table 1), was as high or higher than the most recent U.S. estimate of 35.5% among adult women (9).

The age-adjusted prevalence of diabetes was comparable among men and women in all sites except in Belize, where the prevalence of diagnosed and undiagnosed diabetes was more than twice as high among women (10.5% and 7.1%, respectively) than in men (4.7% and 3.6%, respectively). Although a full explanation of this issue merits further investigation of diabetes-related genetic and environmental risk factors, our data showed that the prevalence of obesity (BMI >29 kg/m^2), a major risk factor for diabetes, was almost twice as high among Belizean women (44.1%) as among Belizean men (23.6%; data not shown in Table 1). In general, the prevalence of obesity was higher among women than in men across all CAMDI sites, but the sex difference in the prevalence of obesity observed in Belize was the greatest.

In summary, the total prevalence of diabetes found in the combined Central America sample was greater than the prevalence reported in most Latin American countries and similar to that in the U.S. These findings are particularly noteworthy given the relatively young age of the population of Central America and the potential for a growing burden in future decades. These findings should be an

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Table 1—Sample characteristics and prevalence of diagnosed diabetes, newly diagnosed diabetes, and intermediate hyperglycemia (IGT/IFG) by sex and site

	Belize[1]	Costa Rica[2]	El Salvador[3]	Guatemala[4]	Honduras[2]	Nicaragua[2]	Total
Sample (*n*)	2,439	1,427	1,870	1,397	1,696	1,993	10,822
Sample/laboratory	1,622 (66.5)	1,146 (80.3)	1,227 (65.6)	1,034 (74.0)	1,221 (72.0)	1,704 (85.5)	7,954 (73.5)
Weighted population (*n*)	140,140	651,067	98,549	115,425	452,780	559,186	2,017,147
Female (%)	49.7	51.4	55.2	51.0	45.6	51.5	50.2
Age (years)	39.2 ± 0.18	41.5 ± 0.60	40.1 ± 0.75	37.2 ± 0.79	39.0 ± 0.79	37.6 ± 0.43	39.4 ± 0.34
BMI (kg/m^2)	28.2 ± 0.4	26.9 ± 0.2	26.9 ± 0.2	27.2 ± 0.3	26.2 ± 0.2	27.7 ± 0.2	27.1 ± 0.2
Both sexes							
Known DM	7.6 (6.1–9.3)	6.3 (4.7–8.4)	5.4 (4.0–7.3)	4.3 (3.0–6.2)	2.5 (1.5–4.3)	5.3 (4.2–6.6)	5.1 (4.1–6.3)
Newly diagnosed DM	5.3 (4.0–7.0)	2.5 (1.5–4.1)	2.2 (1.3–3.7)	2.9 (2.0–4.3)	2.9 (2.1–4.0)	4.5 (3.5–5.8)	3.4 (2.8–4.0)
Total DM	12.9 (10.9–15.2)	8.8 (6.9–11.2)	7.6 (6.0–9.7)	7.3 (5.4–9.6)	5.4 (3.6–8.1)	9.8 (8.0–12.0)	8.5 (7.2–10.0)
Total DM[5]	15.4 (13.5–17.6)	9.7 (7.8–11.9)	9.3 (7.7–11.3)	9.6 (7.3–12.4)	6.7 (4.8–9.3)	13.3 (11.0–16.1)	10.3 (9.0–11.8)
IGT/IFG	16.5 (13.7–19.8)	23.1 (19.6–26.9)	22.7 (19.8–26.0)	28.2 (23.3–33.6)	17.1 (14.9–19.6)	12.4 (10.3–14.8)	18.6 (17.1–20.2)
Males							
Known DM	4.7 (3.4–6.4)	6.9 (4.4–10.5)	6.4 (4.2–9.9)	4.2 (2.4–7.2)	2.5 (1.2–5.2)	4.9 (3.5–6.6)	4.9 (3.7–6.6)
Newly diagnosed DM	3.6 (2.3–5.7)	2.8 (1.6–4.8)	2.3 (0.9–5.9)	3.6 (2.1–6.2)	3.0 (2.0–4.5)	4.3 (2.9–6.3)	3.3 (2.6–4.2)
Total DM	8.3 (6.5–10.5)	9.6 (7.0–13.2)	8.7 (6.0–12.7)	7.8 (5.0–11.8)	5.5 (3.3–9.2)	9.1 (7.0–11.8)	8.3 (6.7–10.2)
Total DM[5]	9.9 (8.0–12.3)	10.6 (8.2–13.8)	10.8 (8.2–14.2)	10.4 (7.0–15.1)	6.7 (4.2–10.5)	12.3 (9.6–15.7)	10.1 (8.4–12.0)
IGT/IFG	16.5 (12.6–21.3)	22.7 (18.1–28.0)	27.8 (21.9–34.5)	25.4 (17.6–35.2)	19.7 (17.1–22.4)	11.1 (8.5–14.4)	18.7 (16.7–20.9)
Females							
Known DM	10.5 (8.2–13.2)	5.8 (4.3–7.7)	4.6 (3.0–7.0)	4.5 (3.0–6.9)	2.6 (1.6–4.0)	5.7 (4.2–7.7)	5.3 (4.3–6.4)
Newly diagnosed DM	7.1 (5.2–9.5)	2.3 (1.2–4.2)	2.1 (1.2–3.7)	2.2 (1.4–3.5)	2.8 (2.0–4.0)	4.8 (3.4–6.7)	3.4 (2.7–4.3)
Total DM	17.6 (14.6–20.9)	8.0 (6.1–10.6)	6.8 (4.9–9.2)	6.8 (4.8–9.4)	5.4 (3.9–7.4)	10.5 (8.0–13.6)	8.7 (7.3–10.3)
Total DM[5]	20.9 (17.9–24.2)	8.7 (6.8–11.2)	7.9 (5.8–10.6)	8.8 (6.2–12.2)	6.8 (5.4–8.6)	14.4 (11.3–18.1)	10.6 (9.2–12.1)
IGT/IFG	16.5 (13.4–20.2)	23.5 (20.1–27.2)	18.7 (15.2–22.8)	30.8 (23.8–38.8)	14.1 (12.1–16.4)	13.5 (10.5–17.3)	18.4 (16.6–20.4)

Data are presented as *n* (%), percentages (95% CI), and mean ± SE. DM, diabetes. [1]National survey. [2]Capital cities. [3]Municipality of Villa Nueva. [4]Municipality of Santa Tecla. [5]Age- and sex-standardized by the direct method using the Segui world population as the standard.

impetus to develop effective prevention and control strategies in the region.

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A.B. conducted data analysis and wrote the manuscript. E.W.G. wrote the manuscript and contributed to data analysis. R.B.G. contributed to analysis and reviewed the manuscript. R.W. and E.P.R. contributed to data analysis and reviewed and edited the manuscript. M.R.-Z. and E.C. reviewed and edited the manuscript and contributed to discussion. L.A., M.A.R., G.d.C., M.D.d.M., R.d.A., E.E., E.Gi., E.Go., V.J., P.O., R.Palm., R.Palo., M.P., R.Pe., E.P., L.Ta., L.Th., and L.V. contributed to discussion. B.R. contributed to data analysis. A.B. is the guarantor of this work and, as such, had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

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