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Prevalence of diabetes and impaired fasting glucose in Costa Rica: Costa Rican National Cardiovascular Risk Factors Survey, 2010*

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Abstract

Background: The projected rising prevalence of diabetes and impaired fasting glucose (IFG) in developing countries warrants careful monitoring. The aim of this study was to present the results of the Costa Rican National Cardiovascular Risk Factors Surveillance System, which provides the first national estimates of diabetes and IFG prevalence among adults in Costa Rica.
Methods: A cross-sectional survey of 3653 non-institutionalized adults aged ≥20 years (87.8% response rate) following the World Health Organization STEPwise approach was built on a probabilistic sample of the non-institutionalized population during 2010. Known diabetes was defined as self-reported diagnosis, the use of insulin, or hypoglycemic oral treatment as consequence of diabetes during at least the previous 2 weeks before the survey. Unknown diabetes was defined no self-reported diabetes but with venous blood concentrations of fasting glucose >125 mg/dL determined by laboratory testing. Impaired fasting glucose was defined as fasting glucose between 100 and 125 mg/dL among those without diabetes. The prevalence of diabetes and IFG prevalence was estimated according gender, body mass index (BMI), waist circumference (WC), educational level, and physical activity level.
Results: Overall diabetes prevalence was 10.8% (9.5% known and 1.3% unknown diabetes) and IFG prevalence was 16.5%. The prevalence of known diabetes was higher among women >65 years compared with men of the same age group. Both known and unknown diabetes were significantly associated with higher BMI, increased WC, and low education level ($P = 0.01$).
Conclusions: The prevalence of diabetes and IFG in Costa Rica is comparable to that in developed countries and indicates an urgent need for effective preventive interventions.

Keywords: diabetes mellitus type 2, health survey, prediabetes, prevalence.

Significant findings of the study: The prevalence of diabetes in Costa Rica was similar to that in developed countries, indicating a need for local authorities to promote preventive interventions.
What this study adds: The findings of the present study contribute to knowledge of diabetes and IFG prevalence in developing countries and are based on a population representative sample. The findings could improve estimates established by international agencies for the world and for specific regions.

Introduction

Over the past decade, the prevalence of diabetes mellitus (DM) and other glycemic-related disorders in the Central America region has been found to be as high as in developed countries, reaching more than 10% of the adult population in some countries in the region.[1] These observations are consistent with unhealthy lifestyle changes, such as a poor diet and a sedentary lifestyle, that have prompted a global rise in obesity and diabetes.[2]

During 2004, in San Jose (the capital of Costa Rica), the Central American Diabetes Initiative (CAMDI) survey documented a prevalence of diagnosed and newly diagnosed diabetes of 6.3% and 2.5%, respectively, in the adult population aged ≥20 years.[1] However, rural regions and towns outside the metropolitan area were not included in these estimates. Furthermore, there have been continuous social changes since then that may have spurred further changes in the risk of diabetes nationwide.

As a result of the high prevalence of cardiovascular risk factors reported by the CAMDI survey,[3] the Costa Rican government health institutions implemented the World Health Organization (WHO) STEPwise approach[4] for a National Cardiovascular Risk Factors Surveillance System (NCRFSS),[5] which started in 2010 with a survey focused on the national adult population.

The aim of the present study was to establish the prevalence of glucose abnormalities in the adult Costa Rican population and key subgroups based on the NCRFSS.[5]

Methods

The Costa Rican NCRFSS survey was a cross-sectional survey based on a probabilistic cluster sampling design. The NCRFSS survey was conducted during 2010 under the supervision of the Caja Costarricense de Seguro Social, a government public healthcare provider, and covers the overall adult population aged ≥20 years.

Sampling

Multistage cluster sampling was performed stratified by geographical areas, age groups (20–39, 40–64, and ≥65 years) and gender. The total sample size required was estimated by the calculation of sample size for proportions; the parameters used were an estimated prevalence of 6.0%, an error of 5.0%, a response rate of 80.0% for the three age groups and both sexes, with a design effect of 1.5.

The first sample stage was the randomized selection of the country's geographical areas as primary sample units followed by the random selection of sectors in selected areas as secondary sample units. The random selection of areas and sectors was performed with probability proportional to size; the area or sector size was determined by the population >20 years during 2009, as estimated by the Costa Rican Census and Statistics National Institute (INEC).[6]

Households were chosen through a random number generator using dwelling lists obtained from the health technician assistant in every community until all age group and gender strata sample sizes were achieved. A family dwelling was defined as a group of people who share the same table to eat. Survey participants were selected by the Kish method,[7,8] which samples participants within a household with equal probability of selection, as recommended by the WHO STEPwise methodology.[4]

To be eligible for inclusion in the study, subjects had to be ≥20 years of age, permanently residing in the selected homes, and to have provided written consent. Pregnant or lactating mothers and those who were within 6 months postpartum were excluded from the study. Each participant selected for the study was informed of the study objectives and details before agreeing to participate in the investigation. In all, 3653 non-institutionalized adults were surveyed, with an 87.8% response rate of the eligible population.

Data collection

Participants were visited in their home and a structured survey was administered over a 45–60-min interview by a trained health technician assistant. The NCRFSS survey was based on the WHO STEPwise questionnaire and included data on sociodemographic factors, health status, cardiovascular risk factors (e.g. physical activity, diet, alcohol consumption, and tobacco use), and access to medical attention and treatment for specific conditions. Physical activity information was obtained using the WHO Global Physical Activity Questionnaire (GPAQ).[9]

Anthropometry and blood pressure measurements

Following the survey, blood pressure, weight, height, and waist circumference were measured for every participant. Survey personnel were trained in anthropometric and blood pressure determinations. Anthropometric measurements were taken twice in the participant's home and the mean was used as the final value.[10] For participants with discrepancies between two measurements of >0.5 cm for height and waist circumference or >0.2 kg for weight, a third measurement was taken and the mean of the two closest measurements was used as the final value.

Blood pressure was taken twice at 5-min intervals in seated subjects, with the subject's arm laying on a flat surface at heart level.[11] If the first and second blood pressure measurements differed by >10 mmHg, a third measurement was taken. The mean (or the mean of the closest two estimates for participants with more than two measurements) was calculated and reported as the participant's blood pressure.

Biochemical determinations

Laboratory test results no more than 3 months old were obtained from participants' personal medical records. For those who did not have recent documented laboratory tests, an appointment was scheduled within 7 days of the household visit in order to obtain blood samples. Participants with specific health problems were referred for further medical attention in a medical center. A blood sample was taken after a fasting period of 14 h, collected in blood collection tubes without anticoagulant, in order to determine glycemic level and analyzed by a colorimetric test (Synchron; Beckman Coulter, Miami, FL, USA). Quality control of laboratory testing was performed by the Instituto Costarricense de Investigación y Enseñanza en Nutrición y Salud (INCIENSA).

Health technician assistants were provided with a standardized procedure manual that described each study phase in detail. The standardized procedure manual was strictly followed and enforced by survey personnel. All survey data were coded and reviewed by the interviewer and the field supervisor. The case report forms were digitalized by automatic reader software and all records were checked manually for errors by a medical reviewer.

Study definitions

Known diabetes (KDM) was defined as a self-reported diagnosis of diabetes or of any hypoglycemic treatment as consequence of diabetes; unknown diabetes (UKDM) was defined by fasting venous glucose levels >125 mg/dL among those without KDM. Impaired fasting glucose (IFG) was defined as fasting glucose values 100–125 mg/dL among participants not diagnosed with diabetes.

Weight, height, and waist circumference were used to assess obesity, which was defined based on the WHO's body mass index (BMI) classification[12] as follows: overweight, BMI 25.0–29.9 kg/m^2; obesity, BMI ≥30.0 kg/m^2. Abdominal obesity was defined as a waist circumference >102 cm in men or >88 cm in women.[13] Arterial hypertension was defined as self-reported diagnosis or when the subject reported the use of antihypertensive medications. Education was dichotomized according to whether the individual had completed secondary school (medium/high) or not (low), and physical activity levels were dichotomized into high versus low/medium levels according the standard cut-off point in the WHO GPAQ classification.[9]

Statistical analysis

Sample weights were estimated as the product of the inverse of the selection probability at every sample phase (areas, sectors, homes, and individual participants) according to age groups and gender. The non-response percentage was taken from the Costa Rican CAMDI survey results,[3] with a non-response weight estimated for each combination of age group and gender.

The prevalence of KDM, UKDM, and IFG was estimated for each combination of age group by gender and primary risk factor stratum (obesity, waist circumference, educational level and physical activity). The overall prevalence was estimated with adjusted standardized age according the WHO world population distribution.[14] Prevalence comparisons were performed by the weight-corrected Pearson Chi-squared test.

All analyses were performed in Stata 10.1 (Stata Corp., College Station, TX, USA) and accounted for the complex sample design used in the study. Significance was set at two-tailed $P < 0.05$, and 95% confidence intervals (CIs) were estimated with sample weight adjustment.

Ethical considerations

The study protocol was reviewed and approved by the Bioethics Committee of the Caja Costarricense de Seguro Social, the entity that provided the funds for the investigation and the health technicians' assistant personnel.

Results

The weighted surveyed population was approximately equally distributed between men and women. Approximately one-third (31.9%) were overweight and approximately one-third (34.5%) were obese. Most respondents (76.8%) had low education levels and low/medium (65.7%) physical activity levels (Table 1).

The prevalence of diabetes and IFG overall, and in men and women separately, according to age group is given in Table 2. The total prevalence of DM in the adult population in Costa Rica was 10.8% (95% CI 8.3%–12.6%), with 9.5% (95% CI 7.8%–11.8%) being classified as KDM and 1.3% (95% CI 0.8%–1.9%) being classified as UKDM (Table 2). The prevalence of KDM did not differ significantly between men and women overall (10.5% vs 8.4%, respectively; $P < 0.05$; Table 2). The prevalence of UKDM was not significantly different in men and women overall (1.1% vs 1.4%, respectively; $P > 0.05$; Table 2).

The prevalence of KDM increased with age, ranging from 2.9% (95% CI 1.4%–6.0%) in young adults (20–39 years), to 13.9% (95% CI 10.9%–17.5%) in middle-aged adults (40–64 years), and 24.8% (95% CI 19.1%–31.4%)

Table 1 Distribution of the adult population surveyed according to age group, gender, body mass index, educational level, and physical activity

	Age (years)			
	20–39	40–64	≥65	Overall
No. subjects	1270	1758	625	3653
Gender				
Male	51.9 (45.1–58.6)	50.0 (44.0–55.8)	47.0 (38.7–55.5)	50.6 (46.4–54.8)
Female	48.1 (41.4–54.9)	50.1 (44.2–56.0)	53.0 (44.5–61.3)	49.4 (45.2–53.6)
BMI (kg/m^2)				
<25.0	37.8 (32.7–45.1)	26.6 (22.0–31.8)	34.6 (29.2–40.3)	33.5 (29.6–37.6)
25.0–29.9	29.9 (25.8–34.5)	34.7 (31.3–38.2)	31.4 (26.4–36.8)	31.9 (29.3–34.7)
>30.0	31.3 (24.8–38.7)	38.7 (33.5–44.2)	34.1 (29.1–39.5)	34.5 (30.4–38.9)
Waist circumference[1]				
Normal	65.8 (60.6–70.6)	52.8 (47.6–57.9)	47.7 (41.3–54.1)	58.9 (55.3–62.4)
Increased	34.2 (29.4–39.4)	47.2 (42.1–52.4)	52.3 (45.9–58.7)	41.1 (37.6–44.7)
Education level[2]				
Medium/high	26.5 (21.0–32.9)	20.6 (16.2–25.9)	15.0 (10.7–20.7)	23.2 (19.8–26.8)
Low	73.5 (67.1–79.0)	79.4 (74.1–83.8)	85.0 (79.3–89.3)	76.8 (73.2–80.2)
Physical activity[3]				
High	39.3 (34.5–44.3)	30.8 (24.4–38.1)	23.0 (15.5–32.6)	34.3 (30.4–38.4)
Low/medium	60.7 (55.6–65.5)	69.2 (61.9–75.6)	77.0 (67.4–84.5)	65.7 (61.6–69.6)

Unless indicated otherwise, data show percentages in each group, with 95% confidence intervals in parentheses.
[1]Waist circumference was classified as normal if it was ≤102 cm in men or ≤88 cm in women. It was considered increased if it was >102 cm in men or >88 cm in women.
[2]Education level was classified as medium/high if the subject had completed secondary school or as low if the subject had not completed secondary school.
[3]Physical activity classifications were as per the World Health Organization Global Physical Activity Questionnaire.[9]
BMI, body mass index.

in those >65 years ($P < 0.01$). The prevalence of KDM was notably higher among women ≥65 years than among men of the same age ($P = 0.03$; Table 2).

The overall prevalence of IFG was 16.5% (95% CI 13.6%–20.0%; Table 2) and exhibited similar changes with age as KDM, increasing from 9.0% in young adults to 22.5% in middle-aged adults and 27.4% in those aged >65 years (Table 2). Although there was a tendency for IFG to be higher among women than men in the middle-aged and >65 years age groups, the differences did not reach statistical significance (Table 2).

The prevalence of IFG was higher among those with an increased versus normal waist circumference (22.1% vs 15.8%, respectively; $P = 0.03$; Table 3). Similarly, the prevalence of KDM and UKDM was significantly higher in those with an increased versus normal waist circumference ($P < 0.01$ and $P = 0.03$, respectively; Table 3). There was a significant association between IFG, KDM, and UKDM and increased BMI ($P < 0.01$ for all).

As indicated in Table 3, the prevalence of KDM and UKDM was significantly higher in the group with a low education level compared with the group with a medium/high education level ($P < 0.05$ for all). However, there was no significant difference in the prevalence of IFG between these two groups (Table 3).

The prevalence estimates of IFG were similar in the two physical activity groups (low/medium vs high physical activity levels; Table 3; $P = 0.44$). However, the prevalence of KDM and UKDM was higher among those with low/medium physical activity (Table 3; $P = 0.05$ and $P < 0.01$, respectively).

Discussion

In this first national survey of the prevalence of diabetes in Costa Rica, the overall prevalence of 10.8% (9.5 % in men and 11.9 % in women) was similar to the estimated age-standardized prevalence in the US among the same age group in 2010 (11.3%).[15] These are the first reported findings in Costa Rica since those from the CAMDI study, conducted in the capital city of San Jose in 2004, in which the overall prevalence of diabetes was estimated to be 8.8% (9.7% in men and 8.1% in women).[1] Because the target populations of the two surveys were different, it is unclear whether the differences found represent a trend or a difference in the rates of diabetes between the two populations. The proportion of overall diabetes prevalence that was due to UKDM in Costa Rica (12.0%) was lower than has been observed in the US (40.0%).[16] this may be due to the wide coverage and increasing accessibility of public and private health

Table 2 Prevalence of diabetes and impaired fasting glucose according age group and gender

	Age (years)			
	20–39	40–64	≥65	Overall[1]
Men				
No. men	331	459	233	1023
IFG	9.1 (5.2–15.3)	25.3 (19.0–32.7)	29.9 (18.7–44.1)	17.6 (13.5–22.6)
UKDM	0.0 (–)	2.6 (1.2–5.4)	1.3 (0.3–4.5)	1.1 (0.6–2.2)
KDM	3.0 (0.7–11.3)	13.2 (9.6–17.8)	18.2 (10.8–28.9)	8.4 (5.9–11.8)
Total (UKDM + KDM)	3.0 (0.7–11.3)	15.8 (11.0–19.5)	19.5 (11.2–29.9)	9.5 (6.5–12.5)
Women				
No. women	941	1297	392	2630
IFG	9.0 (5.3–14.7)	20.2 (15.4–25.9)	24.9 (16.5–35.8)	15.5 (12.3–19.4)
UKDM	0.5 (0.1–2.1)	2.1 (1.1–4.0)	2.1 (0.8–5.0)	1.4 (0.8–2.3)
KDM	2.7 (1.6–4.4)	14.6 (11.2–18.9)	30.6 (25.0–36.9)	10.5 (8.5–13.0)
Total (UKDM + KDM)	3.2 (0.2–4.6)	16.7 (12.5–20.5)	32.7 (26.5–38.1)	11.9 (9.3–13.9)
Overall				
No. subjects	1270	1758	625	3653
IFG	9.0 (5.9–13.4)	22.5 (18.4–27.3)	27.4 (18.7–38.2)	16.5 (13.6–20.0)
UKDM	0.2 (0.0–1.0)	2.3 (1.5–3.7)	1.7 (0.7–4.0)	1.3 (0.8–1.9)
KDM	2.9 (1.4–6.0)	13.9 (10.9–17.5)	24.8 (19.1–31.4)	9.5 (7.8–11.8)
Total (UKDM + KDM)	3.1 (1.5–6.1)	16.2 (12.3–19.0)	26.5 (19.9–32.5)	10.8 (8.3–12.6)

Unless indicated otherwise, data show percentages in each group, with 95% confidence intervals in parentheses.
[1]Overall prevalence estimated with adjusted standardized age according the World Health Organization world population distribution.[14]
IFG, impaired fasting glucose; UKDM, unknown diabetes; KDM, known diabetes.

services in Costa Rica, and the various detection strategies implemented in Costa Rica subsequent to the CAMDI survey.[1]

In the Cardiovascular Risk Factor Multiple Evaluation in Latin America (CARMELA) study,[17] a standardized cross-sectional study conducted between 2003 and 2005 of the adult population age 25–64 years in seven large cities of Latin America (none of which were located in Costa Rica), overall diabetes prevalence was estimated to be 7%, with a range of 4%–9% in various locations. These rates are slightly lower than those reported in the current estimates for Costa Rica, although these differences could

Table 3 Prevalence of diabetes and impaired fasting glucose according to body mass index, waist circumference, education level, and physical activity

	IFG	*P*-value	KDM	*P*-value	UKDM	*P*-value
BMI (kg/m^2)						
<25	12.8 (9.3–17.3)	<0.01	3.9 (2.6–5.7)	<0.01	0.3 (0.1–3.5)	<0.01
25 to 29.9	18.5 (14.2–23.3)		9.2 (6.0–13.9)		1.9 (1.1–3.5)	
>29.9	25.6 (20.4–32.4)		15.0 (11.4–19.5)		1.5 (0.9–2.8)	
Waist circumference[1]						
Normal	15.8 (12.5–19.7)	0.03	5.3 (4.2–6.7)	<0.01	0.8 (0.4–1.4)	0.03
Increased	22.1 (16.7–28.5)		15.7 (11.7–20.8)		1.8 (1.1–3.3)	
Education level[2]						
Low	19.1 (15.1–23.8)	0.32	10.1 (7.8–13.0)	0.02	1.5 (0.9–2.4)	0.01
Medium/high	16.1 (12.1–21.1)		6.5 (4.9–8.7)		0.3 (0.1–1.1)	
Physical activity[3]						
Low/medium	17.1 (12.7–22.7)	0.44	10.9 (8.8–13.5)	0.05	1.7 (0.1–0.3)	<0.01
High	19.2 (15.6–23.3)		6.4 (3.8–10.8)		0.5 (0.2–1.1)	

Data show percentages in each group, with 95% confidence intervals in parentheses.
[1]Waist circumference was classified as normal if it was ≤102 cm in men or ≤88 cm in women. It was considered increased if it was >102 cm in men or >88 cm in women.
[2]Education level was classified as medium/high if the subject had completed secondary school or as low if the subject had not completed secondary school.
[3]Physical activity classifications were as per the World Health Organization Global Physical Activity Questionnaire.[9]
BMI, body mass index; IFG, impaired fasting glucose; UKDM, unknown diabetes; KDM, known diabetes.

be due to a number of factors, such as the inclusion of adults >65 years in the Costa Rican survey, variations in rates between countries, trends in diabetes prevalence over time, and the fact that the CARMELA study surveyed large cities only, rather than a representative sample from each country.

The primary risk factors for diabetes observed in the present study are consistent with other prevalence studies in Latin America, the US and Europe. Previous studies in Mexico and European countries have documented an inverse relationship between education level and the prevalence of IFG and diabetes, an association that is partially explained by differences in levels of overweight and obesity and related health behaviors.[18–22] Increased KDM prevalence associated with elevated BMI and waist circumference levels is also in agreement with reports from other populations,[23,24] as well as the increased prevalence of all glycemic categories studied with regard to increased waist circumference.[25] The relationship between high physical activity and the reduced prevalence of DM is also in agreement with prior observations associating routine exercise with an overall reduction in cardiometabolic risk[26] and diabetes prevalence.[27]

In conclusion, the present study identified concerning levels of IFG and DM prevalence in Costa Rica affecting virtually all segments of the population, and particularly among women and older adults. These data provide critical information for Costa Rican policy makers to set goals and implement strategies to reduce the prevalence of chronic diseases over the coming next decades.

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Disclosure

The authors declare no conflicts of interest.

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