A Multiethnic Study of Pre-Diabetes and Diabetes in LMIC

Jia Shen*, Dimple Kondal†, Adolfo Rubinstein‡, Vilma Irazola‡, Laura Gutierrez‡, J. Jaime Miranda§,‖, Antonio Bernabé-Ortiz§, María Lazo-Porras§, Naomi Levitt¶, Krisela Steyn¶, Kirsten Bobrow¶, Mohammed K. Ali#, Dorairaj Prabhakaran†, Nikhil Tandon**

Atlanta, GA, USA; New Delhi, India; Buenos Aires, Argentina; Lima, Peru; and Cape Town, South Africa

ABSTRACT

Background: Diabetes mellitus is one of the leading causes of death and disability worldwide. Approximately three-quarters of people with diabetes live in low- and middle-income countries, and these countries are projected to experience the greatest increase in diabetes burden.

Objectives: We sought to compare the prevalence, awareness, treatment, and control of diabetes in 3 urban and periurban regions: the Southern Cone of Latin America and Peru, South Asia, and South Africa. In addition, we examined the relationship between diabetes and pre-diabetes with known cardiovascular and metabolic risk factors.

Methods: A total of 26,680 participants (mean age, 47.7 ± 14.0 years; 45.9% male) were enrolled in 4 sites (Southern Cone of Latin America = 7,524; Peru = 3,601; South Asia = 11,907; South Africa = 1,099). Detailed demographic, anthropometric, and biochemical data were collected. Diabetes and pre-diabetes were defined as a fasting plasma glucose ≥126 mg/dl and 100 to 125 mg/dl, respectively. Diabetes control was defined as fasting plasma glucose <130 mg/dl.

Results: The prevalence of diabetes and pre-diabetes was 14.0% (95% confidence interval [CI]: 13.2% to 14.8%) and 17.8% (95% CI: 17.0% to 18.7%) in the Southern Cone of Latin America, 9.8% (95% CI: 8.8% to 10.9%) and 17.1% (95% CI: 15.9% to 18.5%) in Peru, 19.0% (95% CI: 18.4% to 19.8%) and 24.0% (95% CI: 23.2% to 24.7%) in South Asia, and 13.8% (95% CI: 11.9% to 16.0%) and 9.9% (95% CI: 8.3% to 11.8%) in South Africa. The age- and sex-specific prevalence of diabetes and pre-diabetes for all countries increased with age ($p < 0.001$). In the Southern Cone of Latin America, Peru, and South Africa the prevalence of pre-diabetes rose sharply at 35 to 44 years. In South Asia, the sharpest rise in pre-diabetes prevalence occurred younger at 25 to 34 years. The prevalence of diabetes rose sharply at 45 to 54 years in the Southern Cone of Latin America, Peru, and South Africa, and at 35 to 44 years in South Asia. Diabetes and pre-diabetes prevalence increased with body mass index. South Asians had the highest prevalence of diabetes and pre-diabetes for any body mass index and normal-weight South Asians had a higher prevalence of diabetes and pre-diabetes than overweight and obese individuals from other regions. Across all regions, only 79.8% of persons with diabetes were aware of their diagnosis, of these only 78.2% were receiving treatment, and only 36.6% were able to attain glycemic control.

Conclusions: The prevalence of diabetes and pre-diabetes is alarmingly high among urban and periurban populations in Latin America, South Asia, and South Africa. Even more alarming is the propensity for South Asians to develop diabetes and pre-diabetes at a younger age and lower body mass index compared with individuals from other low and middle income countries. It is concerning that one-fifth of all people with diabetes were unaware of their diagnosis and that only two-thirds of those under treatment were able to attain glycemic control. Health systems and policy makers must make concerted efforts to improve diabetes prevention, detection, and control to prevent long-term consequences.

Diabetes mellitus is one of the leading causes of death and disability worldwide [1]. Globally, the number of people with diabetes is increasing because of population growth, aging, urbanization, increasing physical inactivity, and obesity. In 2014, the International Diabetes Federation estimated there were 387 million people with diabetes worldwide. This number is expected to rise to 592 million by 2035 [2]. Approximately 77% of people with diabetes live in low- and middle-income countries (LMICs) and these countries are projected to suffer the greatest increase in diabetes prevalence [2].

Accurate quantification of the prevalence, awareness, treatment, and control of diabetes is crucial for the planning and allocation of community and health resources in LMICs. Biochemical data from many LMICs have been lacking, and estimates of diabetes prevalence have been based largely on self-report, which may dramatically

The authors report no relationships that could be construed as a conflict of interest.
This research was supported in whole or in part by funds from the United States National Heart, Lung, and Blood Institute, National Institutes of Health, Department of Health and Human Services, under Contract Numbers HHSN268200900026C, HHSN268200900033C, and HHSN268200900029C. Additional support was received from the United Health Group (Minneapolis, MN, USA). The South African study was funded by an unrestricted grant from Servier Laboratories (South Africa), the Medical Research Council of South Africa, the Initiative for Cardiovascular Health Research in Developing Countries (IC Health) Foundation Council, and Brigham Hospital/Harvard University. The funders played no role in the study design, data collection, data analysis and interpretation, decision to publish, or preparation of the manuscript.
From the *Emory Clinical Cardiovascular Research Institute, Atlanta, GA, USA; †Public Health Foundation of India & Center for Chronic Disease Control, New Delhi, India; ‡South American Center for Cardiovascular Health, Institute for Clinical Effectiveness and Health Policy, Buenos Aires, Argentina; §CRONICAS Center of Excellence in Chronic Diseases, Universidad Peruana Cayetano Heredia, Lima, Peru; ‖School of Medicine, Universidad Peruana Cayetano Heredia, Lima, Peru; ¶Chronic Diseases Initiative for Africa, University of Cape Town, Cape Town, South Africa; #Department of Global Health, Rollins School of Public Health,

Atlanta, GA, USA; **All India Institute of Medical Sciences, New Delhi, India. Correspondence: J. Shen (jia.shen@emory.edu).

GLOBAL HEART

VOL. 11, NO. 1, 2016
ISSN 2211-8160/$36.00.
http://dx.doi.org/10.1016/j.gheart.2015.12.015

underestimate the true prevalence in countries with poor screening protocols and access to care [3]. Furthermore, prolonged untreated hyperglycemia can lead to significant microvascular and macrovascular damage resulting in neuropathy, nephropathy, retinopathy, and atherosclerosis [4-6]. Objectively collected data on diabetes treatment and control are therefore also needed to better inform health policy and medical intervention. Lastly, there is a paucity of data on the prevalence of pre-diabetes, which significantly increases the risk of future diabetes development [7]. Although the risk factors associated with diabetes and pre-diabetes are largely similar across populations, their expression and intensity may vary widely among ethnic groups and countries. Elucidation of different weight-related measures and how they relate to each other across different ethnicities contributes to the discourse regarding appropriate indicators for glucose monitoring and control.

Latin America, South Asia, and South Africa represent regions of the world undergoing rapid economic growth and social and demographic change. In addition, there is evidence that Latin Americans, South Asians, and those of African descent are more susceptible to developing diabetes [8-10]. We present data from population-based representative urban and periurban centers in the Southern Cone of Latin America (Argentina, Chile, and Uruguay), Peru, South Asia (India and Pakistan), and South Africa to quantify the prevalence of diabetes and pre-diabetes, proportions treated, and considered "controlled," and their relationship to metabolic risk factors by region.

RESEARCH DESIGN AND METHODS

The CESCAS I study is an observational prospective cohort study of 7,524 men and women, aged 35 to 74 years, recruited between February 2010 and December 2011 [11]. A 4-stage stratified sampling method was used to select a representative sample of the general population of the Southern Cone of Latin America. Participants were recruited from 4 mid-sized urban centers: Bariloche and Marcos Paz in Argentina, Temuco in Chile, and Pando-Barros Blancos in Uruguay. The overall response rate was 84.5% and was similar in men and women across different locations [11].

The CRONICAS study is a longitudinal cohort study of 3,601 men and women aged ≥35 years completed in 2010. Participants were randomly selected from 4 different geographic regions in Peru: Pampas de San Juan de Miraflores in Lima, Peru's capital and highly urban; Tumbes, a sea-level, semiurban area; and rural and urban sites in Puno, a high-altitude region 3,825 meters above sea level. Participants were identified using sex- and age-stratified sampling methods (35 to 44, 45 to 54, 55 to 64, ≥65 years). The overall response rate was 62.9% [12].

The CARRS study is a longitudinal cohort study of 14,317 men and women, aged ≥20 years, recruited from 2010 to 2011. Participants were recruited from 3 urban megacities: Chennai and New Delhi in India, and Karachi in Pakistan. Households were selected for participation using a multistage random sampling technique to achieve city-level representativeness. The overall response rate was 94.3%: Chennai, 90.9% (4,936); New Delhi, 98.9% (5,365); and Karachi, 94.3% (4,016) [13].

Finally, the CRIBSA study is a cross-sectional cohort study of 1,099 men and women, aged 25 to 74 years, from predominately black residential areas of Langa, Guguletu, Crossroads, Nyanga, and Khayelitsha in Cape Town. Between 2008 and 2009, participants were recruited using a 3-stage cluster sampling technique with pre-specified age and gender quotas to ensure at least 50 men and women were included in each gender category. The response rate was 84% in men and 87% in women [14].

We aggregated data among sites to obtain a total of 26,541 participants for analysis (Southern Cone of Latin America = 7,524; Peru = 3,601; South Asia = 14,317; South Africa = 1,099). From these 23,496 (88.5%) participants had data available for fasting blood glucose (Southern Cone of Latin America = 7,355 [97.8%], Peru = 3,135 [87.1%], South Asia = 11,907 [83.2%], South Africa = 1,099 [98.5%]).

Measurements

At all sites, comprehensive and uniform data collection instruments were used to capture measurements. A summary of all surveillance indicators, measures, methods, and instruments used in individual studies have been published in detail elsewhere [12,14-16]. Briefly, trained fieldworkers administered questionnaires to collect demographic, socioeconomic, and behavioral information and past and present health status of participants.

Anthropometric measurements included height, weight, and waist measurements using standardized techniques. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared. Waist circumference was taken at the midpoint between the lowest rib and top of the iliac crest. Three readings were taken and the mean of the 3 measurements was used. Blood pressure was recorded in the sitting position after 5 minutes of rest. In Argentina, a standardized mercury or aneroid sphygmomanometer with an adequate cuff size was used. The cuff was placed on the right arm of the participant and inflated until it reached a pressure of 30 mm Hg above the level at which the radial pulse can no longer be palpated. Three measurements were obtained with 30-second intervals between them. The average of the 3 values was used. In India, Peru, and South Africa, systolic and diastolic blood pressure were measured in triplicate using an automatic monitor OMRON HEM-780 previously validated for the adult population [17]. The average of 3 measurements was used.

Fasting blood samples were collected by venipuncture at field sites and transported in cold chain to central laboratories in their respective countries. Sample aliquots were stored in cyro-vials at −70°C to −80°C for future studies.