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REVIEW

An Epidemiologic Analysis of Diabetes in Colombia

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Abstract

BACKGROUND The burden of diabetes is a global problem, wherein the significant growth of diabetes in Colombia reflects a complex pathophysiology and epidemiology found in many other South American nations.

OBJECTIVES The aim of this study was to analyze epidemiologic data from Colombia and the South American region in general to identify certain disease drivers and target them for intervention to curb the increasing prevalence of diabetes.

METHODS A detailed search was conducted using MEDLINE, SciELO, HINARI, LILACS, IMBIOMED, and Latindex databases, in addition to clinical practice guidelines, books, manuals, and other files containing relevant and verified information on diabetes in Colombia.

FINDINGS According to the International Diabetes Federation and the World Health Organization, the prevalence of diabetes in Colombia is 7.1% and 8.5%, respectively. In contrast, a national survey in Colombia shows a prevalence ranging from 1.84% to 11.2%, depending on how the diagnosis is made, the criteria used, and the age range studied. The prevalence exclusively in rural areas ranges from 1.4% to 7.9% and in urban areas from 1% to 46%. The estimated mean overall (direct and indirect) cost attributed to type 2 diabetes is 5.7 billion Colombian pesos (US $2.7 million). Diabetes is the fifth leading cause of death in Colombia with a rate of 15 deaths per 100,000 individuals.

CONCLUSIONS Based on a clustering of factors, 4 relevant disease drivers emerge that may account for the epidemiology of diabetes in Colombia: demographic transition, nutritional transition, forced displacement/internal migration and urban development, and promotion of physical activity.

KEYWORDS Colombia, diabetes, epidemiology, global burden, hyperglycemia, incidence, prevalence

INTRODUCTION: GLOBAL EPIDEMIOLOGY OF DIABETES

The prevalence of diabetes has increased worldwide, leading to a massive social, economic, and health care burden. According to the International Diabetes Federation (IDF), 8.3% of the world's population experiences diabetes (382 million people); this figure is expected to rise to >592 million in <25 years, implying ≥175 million undiagnosed cases.[1] Diabetes is most prevalent in the Western Pacific region with 138 million cases, followed by South East Asia with 72 million, Europe with 56 million, North America and the Caribbean with 37 million, the Middle East and Northern Africa with 35 million, South and Central America (SACA) with 24 million, and Africa with 20 million cases.[1] The SACA region is comprised of 20 countries: 11 in

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South America (SA), 6 in Central America, and 3 in the Caribbean islands; all of these countries, except French Guiana, belong to what is recognized as Latin America (LA), which also includes Mexico, although Mexico is not part of SACA. It is estimated that SACA diabetes cases will increase 59.8% from 24 million in 2013 to 38.5 million in 2035.[2] In SACA, the 2 countries with the highest number of individuals with diabetes are Brazil (11.9 million) and Colombia (2.13 million), and according to the World Health Organization (WHO), the 3 countries with the highest diabetes prevalence rates in SA are (by male/female) Argentina with 9.9%/8.2%; Bolivia with 6.7%/8.5%; and Brazil with 8.5%/7.2%.[2]

In Colombia, the prevalence of type 2 diabetes (T2D) varies depending on age, the specific population studies, and diagnostic criteria. According to the IDF 2013, Colombia has a national prevalence rate of diabetes of 7.12% (referring to the adult population of 29,989,290 inhabitants aged 20-79 years), and the number of people with T2D in Colombia is 2,135,380.[1] Similarly, studies on the incidence of type 1 diabetes (T1D) in Colombia are scarce. For children aged ≤14 years by the year 1990, an adjusted incidence (for both sexes) of 3.8 per 100,000 and an estimated prevalence of 1.8 per 10,000 were found.[1] By 2000, the incidence rate was 3.7 per 100,000, and by 2013 an incidence of 1.3 per 100,000 was seen.[1-3] Few studies have been conducted in Colombia on the frequency of gestational diabetes; the incidence is low (0.34%) depending on the population studied and the diagnostic criteria used.[4] The estimated prevalence varies from 1.43% to 2.03%, but may increase to 10% to 14% if the calculation is aimed at pregnant women with risk factors for diabetes.[4,5]

METHODS

A narrative medical literature review was completed according to a strict methodology and using the information obtained from MEDLINE with the following MeSH terms: "diabetes," "diabetes mellitus," "type 2," "type 1," "epidemiology," "prevalence," "incidence," "Colombia," "global burden," and "metabolic syndrome" in combination with the words "yes" or "not" and the "also try" option. The search included data published on "any date," limiting the scope to articles that included the link "abstract" and "full text," exclusively in humans and regardless of sex. The review comprised clinical trials, cohort studies, intervention studies, meta-analyses, clinical practice guidelines, and descriptive review articles that used a systematic approach and focused on epidemiologic aspects. The search was limited to articles published in English and Spanish, regardless of age. The following databases were searched: SciELO, HINARI, LILACS, IMBIOMED, and Latindex. Additionally, reviews of clinical practice guidelines, books, manuals, and files containing relevant and verified diabetes information in Colombia were included.

Demographics of Colombia. Colombia is an SA country with a surface area of 1,141,748 km^2. The country is divided into 5 geographical regions: Andean, Caribbean, Amazon, Pacific, and Orinoco or Eastern Plains and is politically organized into 32 departments. The estimated population in 2014 was 48,929,706 people. Contrary to all expectations regarding Colombia, migration from the rural to the urban areas has not stopped but instead experienced a new impetus because of the decline of the agricultural sector, rural poverty, concentration of ownership, violence promoted by outlaws (ie, related to drug cartels, drug traffickers, urban and rural guerrillas, and criminal gangs), and the subsequent forced displacement mainly from rural areas and small villages into large cities.[4] Recently, forced displacement from neighboring countries (such as Venezuela) has affected health care access by vulnerable populations. Moreover, physical activity is greatly curtailed as a result of people's fear of violence and kidnapping, which also promoted unhealthy eating habits.

Ethnic diversity in Colombia is the result of the crossbreeding of indigenous Amerindians, Spanish settlers, and African slaves. Colombia officially acknowledges 3 ethnic minority groups: the Afro-Colombian, Indigenous, and Romani populations. The 2005 census reported that the "nonethnic population," consisting of whites and mestizos (those of mixed white European and Amerindian ancestry, including almost all of the urban business and political elite), constituted 86% of the national population. The 86% figure is subdivided into 49% mestizo and 37% white.[5]

Current status of Diabetes Care in Colombia. According to the 2007 National Health Survey (ENS 2007), 96.5% of patients with diabetes had been treated by a general practitioner and 47.4% by a medical specialist.[6] Similarly, the survey showed that 75% of patients with diabetes were advised to quit smoking and manage stress, and >80% were advised to lose weight and undergo lipid testing to regularly measure their blood or

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urine glucose levels.[6] More than 90% of patients were counseled to exercise and lower sugar intake.[6] About 80% of respondents said they did not use any method to measure their glucose levels at home.[6]

There are few studies evaluating the use of medication by people affected with diabetes in Colombia. A study with adult patients with diabetes (attending diabetes care programs) from 2001 to 2003 in the city of Medellin determined that 15.5% of the patients were not following a prescribed drug therapy; 44.2% received monotherapy, 36.2% dual therapy, 3.8% triple therapy, and 0.1% received a 4-drug regimen.[7] The most common prescribed medications were sulfonylureas (58.2%), metformin (48.2%), insulin (19.6%), and thiazolidinediones (0.2%).[7]

An analysis of a group of 7308 people with diabetes cared for by the general health care system in 2007 showed that 48% were receiving monotherapy, whereas 52% were treated with a combination of ≥2 drugs.[8] The distribution of the monotherapy prescription drugs was glibenclamide 41.6%, metformin 36.6%, and insulin 21.8%.[8] A further analysis comprising 9 cities from 2006 to 2007 indicated that 45.8% of individuals with diabetes were treated with monotherapy, with metformin being the most frequently used agent (71.5%).[9] Additionally, in Colombia, 40% to 60% of patients with T2D are well controlled (hemoglobin A1c [A1C] <7.0%).[10]

Most of the oral and injectible medications for managing diabetes are available in Colombia (except for meglitinides, α-glucosidase inhibitors, and amylin mimetics). However, there are no head-to-head trials comparing different groups of medications in terms of their efficacy, safety, and long-term costs. A study published in 2012 was designed to establish the cost-effectiveness ratio of saxagliptin versus sulfonylureas in patients with T2D who failed to realize their glycemic targets with metformin over a 20-year period. The findings indicated that the saxagliptin-treated group experienced fewer fatal and nonfatal events and fewer episodes of hypoglycemia than the sulfonylureas-treated group. Furthermore, saxagliptin therapy provided more quality-adjusted life years and life-years gained than sulfonylureas.[11]

Insulin pumps and real-time continuous glucose monitoring (CGM) devices have been available in in Colombia for several years. A study published in 2013 evaluated the use of integrated pump/CGM technology associated with A1C levels <7.0% and showed that an A1C <7.0% before sensor-augmented insulin pump therapy, when combined with the consistent use of CGM sensors and bolus estimation algorithms, led to further reductions in A1C compared with pump therapy alone.[12]

A recent study described the experience of a high-complexity center with patients with T1D undergoing simultaneous kidney-pancreas transplantation. Twenty-seven simultaneous kidney–pancreas transplants were performed between 2001 and 2012, with a patient survival rate at 1 and 2 years of 92% and 87%, respectively. The survival rate of the pancreatic graft at 1 year was 88%.[13]

In 2015, a case report described the first pancreatic islet transplantation (cadaveric donor) in Colombia, following the protocol described by the islet transplantation groups from Pittsburgh and the Diabetes Research Institute.[14] Although the experience is still limited, there are a few active study groups in Colombia.

EPIDEMIOLOGY RESULTS

National Data Based on Government Surveys and Statistics. ENS 2007 was a nationwide cross-sectional study from home interviews of people aged 18 to 69 years. In this study, the national prevalence rate of diabetes was 3.51% with the highest rates in the country found in the Department of Boyacá (6.5%).[15,16] In a subsample of capillary blood sugar measurements, the national prevalence of hyperglycemia was estimated at 2.57%.[15,16]

The 2010 National Demographic and Health Survey (ENDS 2010) asked whether a physician had ever provided a diagnosis of diabetes (among other diseases) and at what age that diagnosis was made (Table 1). The following are the percentages of people aged ≥60 years diagnosed with diabetes according to age group (in ascending order of age): 60-64 years, 9.8%; 65-69 years, 10.8%; 70-74 years, 13%; 75-79 years, 12.4%; 80-84 years, 13.1%); 85-89 years, 7.5%; 90-94 years, 9.5%; and ≥95 years, 11.7%.[16,17] The overall national percentage was 11.2% and the department with the highest percentage was Guainía (16.7%).[16,17]

The 2008 High Cost Account compiled information on chronic kidney disease and other precursor pathologies, such as hypertension and diabetes.[18] Health care providers and compensation institutions used this 2013-2014 information to describe the demographics of high-cost diseases. There were 42,815,084 living and active people

Table 1. Prevalence of Diabetes Mellitus in Colombia*

Study and year of publication	Age (y)	Prevalence of DM, based on SR or CG	Site with highest prevalence or largest number of cases	Population studied (urban or rural)
ENS 2007 (national)[15,16]	18-69	DM (SR): 3.51% DM (CG): 2.57%	Department of Boyacá: 6.5%.	Urban and rural
ENDS 2010 (national)[17]	≥60	DM (SR): 11.2%	Department of Guainía: 16.7%	Urban and rural
HCA 2014 (national)[18]	0 to ≥80	DM: 1.84%	Bogotá: 161,948 cases	Urban and rural

CG, capillary blood glucose measurement; DM, diabetes mellitus; ENDS, National Demographic and Health Survey; ENS, National Health Survey; HCA, high cost account; SR, self-report.
* National data based on government surveys and statistics.

affiliated with the Colombian health care system, of which 52.39% belonged to the subsidized regime and 47% belonged to the contributory regime (under the current health care system, the latter comprises both formal and independent workers, pensioners, and their families).[18] There were 808,101 people with diabetes, the majority of whom were females (480,723; 59%). Eighty-eight percent of patients with diabetes were ≥45 years of age, with more than 33% between ages 60 and 75 years and only 2.45% age <20 years.[18] The city with the largest number of diabetes cases was Bogotá (161,948). Furthermore, only 105,100 patients with diabetes (13.01%) were well controlled (A1C <7.0%).[18]

International Studies Evaluating Cardiovascular Risk Factors. The objectives of the CARMELA (Cardiovascular Risk Factor Multiple Evaluation in Latin America) trial were to evaluate cardiovascular risk factors in 7 LA cities (including Bogotá). Diabetes was defined as a fasting glucose of ≥126 mg/dL or patient self-report. Based on 2 diagnostic criteria, the prevalence of diabetes in Bogotá (aged 25-64 years) was 8.1%.[19] The PURE (Prospective Urban Rural Epidemiology) trial was a prospective, community-based large-scale study of cohorts in 628 urban and rural communities in 17 countries (including Colombia), with a broad range of political, sociocultural, and economic conditions. The prevalence of diabetes for Colombia (Caribbean region, Andean region, central region, and western region) in this study was 11.9%.[20,21] The IDEA (International Day for the Evaluation of Abdominal Obesity) study found the prevalence of diabetes in Colombia to be 5.8% (3795 patients from 105 primary care centers located throughout Colombia were evaluated; Table 2). Those with a body mass index (BMI) >30 kg/m^2 had a higher prevalence of diabetes (13.1% in men; 10.8% in women). Those with a BMI <25 kg/m^2 had a prevalence of diabetes of 4.6% in men and 2.2% in women.[22,23]

Regional Studies on Diabetes and Prediabetes. The studies completed between 1960 and 1990 found that the prevalence of diabetes ranged from 1% to 13.2% (Table 3).[24-30] Subsequently, more specific classification and diagnostic criteria used in the 1990s pointed to a diabetes prevalence rate of about 6% to 9% (Table 4).[31,32] From 2000 to 2010, the prevalence of diabetes was of 1% to 22% (Tables 4 and 5).[33-46] Most recently, between 2011 and 2015, the prevalence of diabetes was 2% to 28.5% (Table 6).[47-54] Each of the regional epidemiologic studies cited here were influenced by certain

Table 2. Diabetes Mellitus Prevalence Studies in Colombia, as Part of International Studies to Evaluate Cardiovascular Risk Factors

Study (city, year of publication and regional or national scope)	Age (y)	Method used to make the diagnosis of DM SR or FG	Prevalence of DM (global by sex)	Population studied (urban or rural)
CARMELA 2008 (regional)[19]	25-64	SR to FG (≥126 mg/dL)	DM: 8.1% M: 7.4%; F: 8.7%	Urban
PURE 2013 (national)[20,21]	35-70	SR or FG (≥126 mg/dL)	DM: 11.9%	Urban and rural
IDEA 2012 (national)[22,23]	18-80	SR	DM: 1.84% M: 7.2%; F: 5.2%	Urban

CARMELA, Cardiovascular Risk Factor Multiple Evaluation in Latin America; CG, capillary blood glucose measurement; DM, diabetes mellitus; FA, fasting glycemia; IDEA, International Day for the Evaluation of Abdominal Obesity; PURE, Prospective Urban Rural Epidemiology; SR, self-report.

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Table 3. Regional Studies (by year of publication) on Prevalence of DM in Colombia (before 1990) Using Different Diagnostic Criteria

Study (city, year of publication, and regional or national scope)	Age (y)	Prevalence of DM (global and by sex)	Population studied (urban or rural)
National Morbidity Survey 1969 (national)[24]	>20	DM: 13.2%	Urban and rural
Medellín 1975 (regional)[25]	Adults (males) >18 y old	DM: 1%	Urban
Medellín 1975 (regional)[26]	Adults (males) >18 y old	DM: 1.8%	Urban

DM, diabetes mellitus.

variables: age, sex, profession, diagnostic criteria used, and associated comorbidities.

Similarly, studies in school children, adolescents, and those aged <20 years reported a prevalence of T1D of 1.8% (with a 3.8% incidence in children aged ≤14 years) and a prevalence of fasting hyperglycemia between 0.7% and 11%. As in adults, these prevalence rates varied according to the age, sex, and diagnostic criteria used (Table 7).[55-59]

Mortality. According to the National Health Observatory and based on the official, although preliminary, Colombian mortality data for 2010, diabetes was the fifth leading cause of death among the general population, with a mortality rate of 15.07 per 100,000 inhabitants. An analysis of the burden of the disease completed in 2005 documented that diabetes was among the first 20 causes of death based on healthy life-years lost (HLYL). The

Table 4. Regional MD Prevalence Studies: Impaired Glucose Tolerance or Fasting Hyperglycemia in Colombia (1990-2006)

Study (city, year of publication, and regional or national scope)	Age (y)	Prevalence DM, hyperglycemia, IGT, and IFG, overall and by sex	Population studied (urban or rural)
Bogotá 1993 (regional)[31]	≥30	DM (overall): 7.4% M: 7.3 F: 7.4 IGT (overall): 5.8% M: 4.5% F: 6.6%.	Urban
Pasto 1993 (regional)[32]	>20	DM (overall): 6.5% M: 2.4% F: 3.6% IGT (overall): 5.3%	Urban
Choachí, Cundinamarca 2002 (regional)[33]	≥30	1.4%	Rural
El Retiro, Antioquia 2003 (regional)[34]	>20	Fasting hyperglycemia and age-adjusted: 12.6%.	Urban
Bogotá 2003 (regional) population with acute coronary syndrome[35]	18-80	DM: 21.3% M: 18.75% F: 27.91%	Urban
Cartagena de Indias 2006 (regional)[36]	>30	DM (age-adjusted): 8.93% IGT: 1.73% IFG: 0.88%	Urban
Bucaramanga 2006 (regional)[37]	15-64	DM: 4% M: 3.5% F: 4.4% IFG: 5.8% M: 7% F: 5.1%	Urban
Bogotá 2006 (regional) hypertensive population)[38]	>30	DM: NCEP-ATP-III: 7.45% AHA: 22.18%	Urban

AHA, American Heart Association; DM, diabetes mellitus; IFG, impaired fasting glucose; IGT, impaired glucose tolerance; NCEP-ATP, National Cholesterol Education Panel-Adult Treatment Panel.

Table 5. Regional DM Prevalence Studies: Impaired Glucose Tolerance or Fasting Hyperglycemia in Colombia (2007-2010)

Study (city, year of publication, and regional or national scope)	Age (y)	Prevalence DM, hyperglycemia and IGT, overall and by sex	Population studied (urban or rural)
Bogotá y Choachí 2007 (analysis after the Choachí study, 2002; regional)[39]	≥30	DM (urban population): M: 3.6%; F: 3% DM (rural population): M: 0.6%; F: 1.6% IGT (urban population): M: 1.7%; F: 2.7% IGT (rural population): M: 0.6%; F: 2.6%	Urban and rural
Bucaramanga 2007 (regional)[40]	22-73	DM: 3.9% M: 6%; F: 1.4%	Urban
Bogotá 2008 (prevalence among HIV/AIDS patients; regional)[41]	19-65	Prevalence of hyperglycemia based on NCEP-ATP III: 9.5% based on IDF: 45%	Urban
Medellín 2008 (only women; regional)[42]	3 age groups: <40; 40-64; ≥65	Prevalence of DM based on NCEP-ATP III: 9.2% based on IDF: 45.7%	Urban
Arjona, Bolívar 2008 (regional)[43]	18-87	Prevalence of hyperglycemia or self-report of DM: 15%	Urban
Cartagena 2008 (regional)[44]	>30	Prevalence of fasting hyperglycemia according to NCEP-ATP III: 10%; according to IDF: 13%	Urban
Database of Civil Aeronautics pilots 2010 (specific population; national)[45]	Average age: 42.6	DM: 1.3%	Mostly urban
Cartagena 2010[46]	20-44	DM: 1%	Urban

DM, diabetes mellitus; IDF, International Diabetes Foundation; NCEP-ATP, National Cholesterol Education Panel-Adult Treatment Panel.

HLYL are the result of adding the number of life-years lost due to premature death plus the life-years lost because of disability (YLD). For Colombian women aged 45 to 59 years, the HLYL was 4 per 1000; for those 60 to 69 years it was 10.3. For women aged 70 to 79 years it was 13.6; and for those ≥80 years it was 8.5.[60,61] In men aged 45 to 59 years, the HLYL was 4.1; for those 60 to 69 years, it was 9.2. For men aged 70 to 79 years the HLYL was 10.7; and for men ≥80 years, it was 5.6. An analysis of YLD in diabetes in Argentina, Chile, Colombia, and Mexico (between 2000 and 2011) found the highest number of YLD was in Mexico (1.13), with Chile harboring the largest increase of at 26.2%, followed by Mexico at 18.7%.[62] Argentina and Colombia show a reduction in the YLDs of 15.7% and 22.4%, respectively. In Colombia, the 2011 YLD for men and women were 0.19 and 0.21, respectively.[60-62]

The National Health Institute of Colombia determined the average annual raw mortality and age-adjusted mortality rates at 16.3 and 21.2 deaths per 100,000 inhabitants, respectively. Of these deaths, 3.6% were due to diabetes.[63] The highest diabetes-related mortality rates (>19 deaths per 100,000 inhabitants) were reported for the departments of Meta (highest at 27.24 per 100,000 inhabitants).[64]

COST OF DIABETES CARE IN COLOMBIA

The direct costs of diabetes care include expenses for medications, hospitalizations, consultations, and the management of complications. Indirect costs were estimated by human capital-based criteria, including the loss of revenue estimated as a result of premature death and diabetes-related disabilities. The total annual cost associated with diabetes in Colombia was approximately US $2.6 billion, with a direct cost of approximately US $415 million and an indirect cost of approximately US $2.2 billion.[65] The per-capita direct cost was US $442, and the per-capita health expenditure was US $209.[65]

The average costs of treatment of a patient with T2D in Colombia are based on extrapolations of the disease-associated direct costs, indirect costs, and consequences. A Markov model (wherein future states depend only on the current state and not on previous occurrences) was adapted for Colombia to analyze the relevant stages in disease progression with a stipulated age at time of diagnosis of 40

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Table 6. Regional DM prevalence studies: Impaired Glucose Tolerance or Fasting Hyperglycemia in Colombia (2011-2015)

Study (city, year of publication, and regional or national scope)	Age (y)	Prevalence DM, hyperglycemia and IGT, overall and by sex	Population studied (urban or rural)
Santa Rosa de Osos, Antioquia 2011 (regional)[47]	25-50	DM: 2% M: 0.7%; F: 2.8%	Urban
Medellín and neighboring municipalities (Itagüí and Copacabana) 2013 (regional)[48]	25-64	Prevalence of fasting hyperglycemia: 19.8% M: 18.4%; F: 20.4%	Urban
Cartagena 2012 (regional)[49]	20-80	Prevalence of hyperglycemia: 24% in males and 17.8% in females (according to the JIS, IDF, and AHA/NHLBI criteria) 10% in males and 7% in females (according to NCEP/ATP III) and 9% in males and 7% in females (according to WHO)	Urban
Pereira 2012 (male convicts in the regional prison and penitentiary; regional)[50]	Average age 48	DM: 3.27%	Urban
Indigenous Reservation Cañamomo-Lomaprieta, Caldas 2012 (regional)[51]	18-83	DM: 7.9%	Rural
Population with dyslipidemia treated with lipid-lowering agents, affiliated to the health care system (database) 2013 (national)[52]	>20	DM: 28.5%	Urban
Medellín 2014 (regional)[53]	60-64	DM: 12.4%	Urban
Indigenous Reservation Karmata Rúa de Cristianía, Jardín-Antioquia 2015 (regional)[54]	>14 (56.6% of the population was aged <40)	DM: 0.7% M: 0%; F: 0.9%	Rural

AHA/NHLBI (American Heart Association/National Heart, Lung and Blood Institute; DM, diabetes mellitus; IDF, International Diabetes Foundation; IGT, impaired glucose tolerance; JIS, Joint Interim Statement; NCEP-ATP, National Cholesterol Education Panel-Adult Treatment Panel; WHO, World Health Organization.

years. The mean cost per year extrapolated to the Colombian population was estimated, taking into consideration a prevalence rate of 7.5% and demographic data for 2007. Direct resources (drugs, laboratory, medical, hospital, other health care) were identified and cost was ascertained by using national price lists, international health care guidelines, and other Colombian studies or data from other countries. Indirect costs (work time lost) were calculated by using the human capital approach (ie, value based on production elements but not incorporating quality-of-life metrics). Cost and outcomes accrued after ≥1 year were discounted at an annual rate of 5%.[66]

Table 7. Prevalence Studies Among School Population, Adolescents, and Individuals <20 Years Old in Colombia

Study (city, year of publication, and regional or national scope)	Age (y)	Prevalence DM, hyperglycemia, and IGT, overall and according to sex	Population studied (urban or rural)
Type 1 DM: (DiaMond) Project Group 1990 (national)[55,56]	≤14	DM: 1.8%	Urban and rural
Medellín 2008 (regional)[57]	0-9 10-18	Fasting hyperglycemia: 0-9 y: 7.9% 10-18 y: 11.3%	Urban
Bogotá 2010 (university population; regional)[58]	15-20	GAA: 8.4% IGT: 0.8% No DM was documented	Urban
Cali 2013 (regional)[59]	10-16	Fasting hyperglycemia: criteria according to Cook et al. and Ferranti: 0.7% M: 0.8%; F: 0.5% IDF criteria: 4.5% M: 6%; F: 3%	Urban

DM, diabetes mellitus; GAA, glucagon; IDF, International Diabetes Foundation; IGT, impaired glucose tolerance.

The estimated mean overall (eg, direct and indirect) cost attributed to T2D was 5.7 billion Colombian pesos (US $2.7 million), with direct costs of 1.95 billion Colombian pesos (US $921 million) and indirect costs of 3.77 billion Colombian pesos (US $1.77 million).[66] The cost of T2D was determined by taking into consideration the perspectives of society and of the Ministry of Health as payers. The estimated lifetime cost per patient, including both direct and indirect costs (societal perspective), was 57,565,000 Colombian pesos (US $27,140).[66] This amount represents an average annual cost per patient of 1,784,000 Colombian pesos (US $845). From the perspective of the Ministry of Health as payer, the average cost of T2D projected for a patient was 19,576,000 Colombian pesos (US $9230).[66] This value amounts to an annual cost per patient of 611,750 Colombian pesos (US $288). The average indirect cost was 37,767,000 Colombian pesos (US $17,806). This value amounts to an annual cost per patient of 1,187,000 Colombian pesos (US $559).[66]

Recently, a partial economic evaluation study performed in Cartagena was designed to determine the economic cost of T2D from the viewpoint of the third payer (health care system or insurance company) during the period from 2007 to 2011. The data were collected from 123 medical records from health care provider databases. Using a market exchange rate of US $1 = 1925 Colombian pesos (May 15, 2014), the average cost per patient during the study period was US $616 (1,185,800 Colombian pesos). Finally, the total estimated cost of diabetes for Cartagena was US $2,684,528 (~5,168,000,000 Colombian pesos) based on the average cost per patient multiplied by the number of cases diagnosed for the year 2011 (4358 patients with diabetes).[67]

SPECIFIC SOCIOECONOMIC DRIVERS

According to the IDF 2013, Colombia is second only to Brazil in the SACA region for the highest number of people with diabetes.[1] To compare with previous years, a national prevalence rate of 7.12% was established for the adult population of 29,989,290 inhabitants aged 20 to 79 years, in contrast to a comparative prevalence rate of 7.27% based on the presumption that every country and region has the same age profile, which in turn is based on the age profile for the world population. The effect of this very important epidemiologic presumption is a reduced effect of age differences. Correcting for age, the Colombian national prevalence of impaired glucose tolerance was established at 8.36%, with 2,506,440 cases and a comparative prevalence of 8.48%. The number of people with diabetes identified in rural areas was 515,750, whereas in the urban areas the number was 1,619,630. The age range with the highest number of cases was 40 to 59 years, with 1,216,480 cases and an estimated number of nondiagnosed diabetes of 513,560.[68,69]

The prevalence of diabetes in Colombia depends on the following factors:

- Study period,
- Sex,
- Age range,
- Diagnostic criteria,
- Origin and background of the population (eg, urban vs rural), and
- Evaluation of special populations (eg, HIV/AIDS, metabolic syndrome, and high blood pressure).

The rise in diabetes prevalence rate may be attributable to factors that are more applicable today:

- Longer duration of diabetes,
- Increased life span even without a diabetes cure,
- Increased incidence rate,
- Forced displacement and internal migration,
- Emigration of healthy people,
- Immigration of susceptible individuals, and
- Improved and better access to diagnostic screening tests.

Based on a clustering of factors relevant to the Colombian population, 4 principal environmental/socioeconomic disease drivers emerge that might account for the diabetes prevalence rates: demographic transition, nutritional transition, forced displacement/internal migration and urban development, and promotion of physical activity. Moreover, the characteristics of the current Colombian health care system make it highly prone to corruption. Examples of these characteristics include the imbalance of information between professional entities and citizens; the complexity of the health care system and conspicuous knowledge gaps; weak institutional development with poor evaluation systems and governmental control; and lack of awareness by system users of their rights and duties.

Driver 1: Demographic Transition. One of the most important structural transformations in most LA economies during the 20th century was the

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demographic transition, that is, the transition from high to low mortality and fertility rates. Colombia is undergoing a process of demographic transition, evidenced by changes in the age distribution of the population. This process has been characterized by a contraction of the base of the population pyramid versus a widening of the middle segments; moreover, the Colombian population aged ≥60 years is expected to grow to 6,435,899 inhabitants by 2020, corresponding to 13% of the current population. This figure is indicative of population aging, defined as a sustained increase in the population aged ≥60 years, which is now exceeding 10% of the total population. Consequently, as a result of the aging population and a longer life expectancy in Colombia (72.07 years for men and 78.54 years for women during the period 2010-2015 with an estimated increase to 73.08 years for men and 79.39 for women during the period 2015-2020), the incidence of diabetes is expected to rise in the next few years.[70]

Driver 2: Nutrition Transition. In developing countries, the epidemics of obesity and increased cardiometabolic risk factors has been associated with socioeconomic inequalities, making these countries more vulnerable because of the presence of maternal malnutrition and, consequently, low birth-weight infants. These factors, in addition to modern life changes, may result in changes in eating habits and physical activity. The adaptation of these changes to the environment may predispose to excessive intake of food with a high caloric value and density, which, in addition to a sedentary lifestyle, translates into a higher susceptibility to overweight/obesity and other cardiometabolic risk factors, including diabetes.[71]

Considering the period from 2000 to 2010 in Colombia, the changes in nutrition transition in children are mainly a result of 2 factors: increase in maternal overweight/obesity and reduction in infant growth retardation.[72] This pattern was confirmed by a decrease in the percentage of the population in the "normal weight" category and an increase in the "overweight/obesity" category. Moreover, the prevalence of overweight/obesity was higher in households classified as high income versus middle-income and low-income households. Nevertheless, there was a progressive and important increase in the low-income households, showing that notwithstanding the higher prevalence of overweight/obesity among the high-income population, the high growth rate among the poorer population is also evident. Moreover, although the high prevalence rate of overweight/obesity among the urban population was demonstrated, there was an abrupt increase in the prevalence of overweight/obesity among the rural population.[73]

In Colombia, the prevalence of obesity in men aged <20 years was 4.1%, whereas the overall prevalence of overweight/obesity was 15.4%. In women aged <20 years, the prevalence of obesity was 3.6%, whereas the overall prevalence of overweight/obesity was 18.3%. In the case of men ≥20 years old, the prevalence of obesity was 14.6%, whereas the overall prevalence of overweight/obesity was 52.7%; in women ≥20 years, the prevalence of obesity was 22.6%, whereas the overall prevalence of overweight/obesity was 57%. Considering that the rise in the prevalence of obesity is evident throughout the Colombian population, a corresponding increase in the incidence and prevalence of prediabetes and diabetes is expected.[74]

Driver 3: Forced Displacement, Internal Migration, and Urban Development. Colombia is ranked second in the world in terms of the number of displaced people. Those who have been forced to displace usually leave behind their homes and possessions as well as their land, which has provided them with a livelihood. In accordance with the Sole Registry of the Displaced Population (RUPD) of Social Action in Colombia, 829,625 households have been declared as internally displaced (3,625,672 people).[75] Of this number, >80% of people have moved out individually—1 person at a time—(2,993,271 people) and the remaining 17% moved out massively—more than a single displaced person—(330,670).[75] Slightly more than half (51%) of the total forced displaced victims are males, and 49% are females.[75] With respect to the age of the population at the time of displacement, 7.2% (260,746) were in their early childhood (0-5 years), 21.5% (780,158) were children and adolescents between the ages of 6 and 14 years, and 9.8% (354,158) were young people (15-18 years).[75] Of the displaced population, 45% (1,630,788) were adults (19-59 years) at the time of their displacement and 4.9% (178,890) were ≥ 60 years.[75] Forced displacement is frequently from rural areas into large municipalities, including large capital cities.[75,76] This displacement and migratory phenomenon is associated with an increased intake of high-calorie, low-fiber foods and beverages, in addition to a higher prevalence of a sedentary lifestyle that in the long term leads to overweight/obesity. These data show that in just over 50 years, Colombia has changed from being mostly a rural to a predominantly urban country, with a growing migration

from the rural to the urban areas. The proportion of people living in the capital cities increased 12-fold, from 2.5 million in 1938 to 31.5 million in 2005.

Urban development in Colombia proceeds hand-in-hand with 3 convergent processes characteristic of the country's population dynamics: a growing urban population, increased density in municipalities, and a higher concentration of people living in urban centers; the internal migration from rural to urban areas will result in a higher incidence and increased prevalence of diabetes in Colombia in future years.[76,77]

Driver 4: Promoting Physical Activity. Regular exercise clearly plays a role in the prevention and management of T2D. Accelerated urban development, an increase in sedentary jobs, and activities associated with the use of technology (video and computer games) reduce the level of physical activity. A cross-sectional study in the urban areas of Bogotá estimated that a 53.2% prevalence of physical inactivity is associated with a population attributable risk of mortality from diabetes mellitus of 21%.[78] More recently, adherence to recommendations on physical activity and associated factors was estimated based on a secondary analysis of the National Nutrition Survey and ENDS databases.[15-17] The results indicated that the overall adherence was 53.5%, which was lower in adults in the lower socioeconomic strata and in women.[79] Consequently, because of the high prevalence of physical inactivity in the Colombian population, the incidence and the prevalence of diabetes is expected to increase.

CONCLUSION

Diabetes has reached epidemic proportions in LA. Colombia, because of its fast growth, aging population, urban development, higher intake of hypercaloric diets, and sedentary lifestyle, ranks among the countries with a higher frequency of the disease. According to the IDF and the WHO, respectively, the prevalence of diabetes in Colombia ranges between 7.1% and 8.5%. However, diabetes prevalence depends on several factors, including the year or period of time during which the study takes place, the specific population and age range evaluated, the diagnostic criteria used, and the background and origin of the individuals. The estimated mean overall (eg, direct and indirect) cost attributed to T2D was 5.7 billion Colombian pesos (US $2.7 million). Finally, diabetes is the fifth leading cause of death in Colombia, with a rate of 15 deaths per 100,000 inhabitants.

In the present study, the epidemiology of diabetes in Colombia was examined comprehensively and analyzed. Four principal drivers emerged: demographic transition, nutrition transition, forced displacement/internal migration and urban development, and promotion of physical activity. Although there are many different potential solutions to the diabetes problem in Colombia, its unique epidemiology and associated disease drivers provide important clues that can help synthesize a robust and regionally/culturally applicable disease model to guide a workable plan on a large national scale.

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