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REVIEW

Diabetes Mellitus in Peru

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Abstract

BACKGROUND Peru is an upper medium-income developing country with an increasing prevalence of chronic diseases, including diabetes.

OBJECTIVE To review and describe the epidemiology, drivers, and diabetes care plan in Peru.

METHODS The medical literature was reviewed based on systematic searching of PubMed, Scielo, and various gray literature from the International Diabetes Federation, World Health Organization, and local Peruvian agencies.

FINDINGS In Peru, diabetes affects 7% of the population. Type 2 diabetes accounts for 96.8% of outpatients visits with this condition. Type 1 diabetes has an incidence of 0.4/100,000 per year, and gestational diabetes affects 16% of pregnancies. The prevalence of glucose intolerance is 8.11% and that of impaired fasting glucose 22.4%. The prevalence of overweight, obesity, and metabolic syndrome in adults is 34.7%, 17.5%, and 25%, respectively. Metabolic syndrome prevalence is greater in women and the elderly and at urban and low-altitude locations. Diabetes is the eighth cause of death, the sixth cause of blindness, and the leading cause of end-stage kidney disease and nontraumatic lower limb amputation. In Peru, diabetes accounts for 31.5% of acute myocardial infarctions and 25% of strokes. Infections, diabetic emergencies, and cardiovascular disorders are the main causes for admissions, with a mortality rate $< 10\%$, mainly as a result of infections, chronic kidney disease, and stroke. Sixty-two percent of the population has health insurance coverage, with inequities in the distribution of health care personnel across the country. Less than 30% of treated patients have a hemoglobin A1c $< 7\%$.

CONCLUSIONS Diabetes is a major health care issue in Peru that exposes difficult challenges and shortcomings. The national strategy for tackling diabetes includes promotion of healthy lifestyles; training primary care physicians and providing them with evidence-based clinical practice guidelines, safe and effective medications, and tools for monitoring treatment; and, finally, construction of a comprehensive health care network for early referral in order to prevent, detect, and treat diabetic complications.

KEY WORDS diabetes mellitus, epidemiology, complications, treatment, Peru

INTRODUCTION

In the past 25 years, chronic noncommunicable diseases (NCD) have become increasingly prevalent, particularly in developing countries, producing a significant impact on morbidity, mortality, health care costs, and productivity.[1] Cardiovascular disease, cancer, chronic respiratory disease, and diabetes account for more than half of the deaths in nearly every region of the world; the exception is sub-

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Saharan Africa.[2] The World Health Organization (WHO) projects that diabetes will be the seventh leading cause of death worldwide in 2030.[3]

It is estimated that there are 387 million people with diabetes in the world, with 25 million living in the South and Central America (SACA) region. This is a huge and escalating prevalence, projected to increase by 53% worldwide[4] and comparably by 52% in the SACA region[5] by 2035.

Chronic hyperglycemia alters the metabolic homeostasis of the body, producing damage to the retina, kidneys, peripheral and autonomic nervous systems, and cranial, coronary, and peripheral vascular trees if not properly treated. Diabetes is the leading cause of end-stage renal disease and blindness in developed countries; 50% of patients have cardiovascular disease, and in a clinic-based population, 4%-12% have had a stroke.[6]

Intensive blood glucose treatment prevents diabetic microvascular complications in type 1 diabetes (T1D)[7] and type 2 diabetes (T2D)[8] and, in the long term, reduces cardiovascular events[9-11] and mortality in T2D.[10] Therefore, an optimal health care delivery system for patients with diabetes is a public health imperative to improve quality of life while being cost effective.[12]

DEMOGRAPHICS AND SOCIOECONOMIC INDICATORS

Peru is located in South America, along the central Pacific coast, crossed along by the Andes Mountains and extending to the Amazon jungle, with an area of 1,285,215.6 km^2. The estimated population in 2015 is 31,151,643 million people, with 6.5% $\geq$ 65 years old and 24% living in rural areas.[13] Life expectancy is 74.6 years, population growth is 1.1%, fertility rate is 2.3 children per woman, and infant mortality is 17.6 per 1000 live births.[13] Six percent of the population is illiterate, 21.9% attended primary school only, 43.8% attended higher school, and 30.1% have higher education.[13]

The gross domestic product of Peru is US$202.3 billion, with 5.8% growth in 2013 and an estimated growth of 3.9% in 2015.[14] Gross national income per capita is US$6270, and the mean family monthly income in 2012 was approximately US$447.30.[14] The Peruvian inflation rate was 3.2% in 2014.[14]

The 2010-2014 labor force participation rate for women was 68% and for men 84%. The World Bank has classified Peru as an upper middle income country with one of the best performing economies in Latin America[14]; nevertheless, 24.8%-26.8% of the population are still living in poverty and 5.5%-6.5% are living in extreme poverty.[13] Approximately 29.6% of families have phones line at home, 79.7% have mobile phones, and 20.2% have access to the Internet. Approximately 61.9% of the population has health coverage.[13]

PREVALENCE RATES

Diabetes. The 2014 International Diabetes Federation (IDF) report estimated the Peruvian diabetes prevalence in adults (20-79 years old) at 6.1%.[5] This corresponds to 1,143,600 million people with diabetes in Peru, with 317,700 of them undiagnosed.[5] The comparative frequency (calculated by assuming that every country has the age profile of the world population) is 6.5%.[5]

The National Demographic and Family Health Survey (ENDES 2014) performed from March to December 2014, over a national sample of 29,941 dwellings and 27,633 people interviewed, aged 15 years and beyond, found a prevalence rate of diagnosed diabetes of 3.2%, with 3.6% in women and 2.9% in men.[15] The prevalence of diabetes was higher in the urban population (3.5%) than in the rural population (2.0%). The highest prevalence was found in the city of Lima 4.6%, followed by the coast region, 3.4%; the jungle, 2.5%; and the Andean region, 2.0%.[15]

The 2012 PeruDiab Study[16] estimated the prevalence of diabetes in a nationwide, stratified urban and suburban population selected by random cluster sampling of 1677 people aged $\geq$ 25 years old, representative of a 10,860,000 population. The diagnosis of diabetes was based on a fasting plasma glucose $\geq$ 126 mg/dL.[16] In this study, a 7.0% (95% CI: 5.3-8.7) prevalence of diabetes was found, affecting 763,000 individuals, with 4.2% representing diagnosed diabetes and 2.8% representing new cases of diabetes.[16] The prevalence was higher in the coast region (8.2%) than either the Andean region (4.5%; $P = .033$) or the jungle (3.5%; $P = .018$).[16] The prevalence of diabetes was higher in older individuals (10.6%) and in the illiterate (18.8%).[16]

The 2005 National Indicators Survey for NCD studied a random national sample of 4206 individuals, aged $\geq$ 20 years old, with 840 from each of the following locations: city of Lima, coast region, Andean region, and the jungle. Diabetes was diagnosed by any 1 of these 3 criteria: glucose $\geq$ 100 mg/dL and self-report of diabetes, fasting plasma

glucose $\geq$ 200 mg/dL without self-report of diabetes, or pharmacological treatment for diabetes. Prevalence of diabetes was 3.4%, with 3.7% for men and 3.2% for women.[17] The prevalence was higher in those older than 60 years (11.4%).[17] The prevalence of diabetes was 5.1% in the city of Lima, 4.1% in the coast region, 2.8% in the jungle, 0.8% in the urban Andean region, and 0.4% in the rural Andean region.[17] The prevalence of self-reported cases of diabetes was 3.7%,[17] with 5.9% in Lima, 3.7% in the coast region, 1.8% in the jungle, 0.9% in urban Andean region, and 1.6% in the rural Andean region.[17]

Despite differences in sampling and diagnostic criteria, the aforementioned studies found a prevalence of self-reported diabetes of 3.2%-4.5%, with a total prevalence of 3.4%-7.0%. The diabetes prevalence is greater in the city of Lima and in the coast region, with a more westernized lifestyle than in the jungle, and Andean Region, with an indigenous diet, consuming less processed food and engaging in more physical exercise.[17] This low prevalence of diabetes in high-altitude locations has been reported previously in Peru[18] and also in the United States, where people living at altitudes between 1500-3500 m have lower odds of having diabetes after adjusting for multiple risk factors.[19] In a subanalysis of 29,806 people living at altitudes $\geq$ 3000 m in the ENDES 2014 survey, an odds ratio for diabetes of 0.51 (95% CI: 0.36-0.72) was found, which became nonsignificant after adjusting for wealth, obesity, education, sex, blood pressure, and age. The author concluded that the poverty of this underserved population may explain her findings.[20] Extending these findings, the PERU MIGRANT study on cardiovascular risk factors found diabetes prevalence rates for rural, migrant, and urban groups of the same ethnic origin of 0.8%, 3%, and 6%, respectively, concluding that urbanization is detrimental to cardiovascular health.[21]

The incidence of T1D was estimated in a study included in the WHO DiaMond Project.[22] The incidence reported in children $\leq$ 14 years old for the 1990-1991 period was 0.4/100.000 per year (0.22-0.81), 0.2/100,000 per year in boys, and 0.6 /100,000 per year in girls.[22] Estimate of ascertainment (completeness of registration using the captured-recapture method) was 88%.[22] This incidence is one of the lowest in the world, probably as a result of genetic admixture or environmental factors.[22]

There are no data about the prevalence of T2D in children other than information gleaned from limited case series.[23,24] Similarly, there are little data regarding gestational diabetes (GDM). Nevertheless, a large prospective study performed at Instituto Nacional Materno-Perinatal de Lima, using the International Association of Diabetes Pregnancy Study Group (IADPSG) criteria, found a prevalence of GDM of 16% (95% CI: 14%-18%) in 1282 women at 24-28 weeks of gestation.[25] This prevalence is close to the average among those found in the Hapo Study participating centers, 9.3%-25.5%.The prevalence of GDM in lean, overweight, and obese women was 12%, 15%, and 22%, respectively.[25] Those 35 years and older had a 1.6-fold higher prevalence of GDM than those younger than 20 years of age.[25] A positive first-degree family history of diabetes also increased the risk of GDM by 1.4 (95% CI 1.2-2.5).[25] There are no published data about secondary diabetes in Peru.

According to the Peruvian Ministry of Health, new cases of diabetes will increase from 1,435,949 in 2016 to 1,721,894 in 2024.[26] Outpatient visits for diabetes at the public hospitals have increased from 51,611 in 2005 to 110,551 in 2011.[26] Of 2959 diabetes cases reported by a network of health centers to the Epidemiological Diabetic Surveillance System in 2012, 96.8% were classified as T2D, 2.5% as T1D, and 0.7% as GDM.[27]

Impaired Glucose Intolerance and Impaired Fasting Glucose. The 2013 IDF report estimated the prevalence of impaired glucose tolerance in Peruvian adults (20-79 years old) at 8.11%. This corresponds to 1,489,480 people.[28] The comparative frequency (calculated by assuming that every country has the age profile of the world population) was 8.5%.[28]

The updated prevalence of impaired fasting glucose comes from the PeruDiab study,[16] which found 22.4% (95% CI: 19.4-25.5) nationwide, higher in the coast (26.4%; 95% CI: 22.5-30.2) than in the highlands (17.4%; 95% CI: 11.3-23.5) ($P = .028$) and the jungle (14.9%; 95% CI: 5.7-24.2) ($P = .065$).[16] Men were affected twice as often as women.[16] These data indicate that a significant proportion of the population is at risk of developing diabetes in the near future unless a planned intervention is performed.

Obesity. The ENDES 2014 national survey of people $\geq$ 15 years old found a prevalence of overweight of 34.7%, with 35.8% in men and 31.7% in women. The prevalence was relatively higher in Lima (40.2%) and the coast region (35.95%) than in the jungle (31%) and the Andean region (29.25%).[15] The prevalence of obesity was 17.5%, with 26.2%

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in men and 14.4% in women.[15] Obesity prevalence rates were higher in urban areas (21.3%) than in rural areas (6.6%).[15]

The 2009-2010 National Household Survey (ENAHO) studied a sample of 69,526 individuals.[29] The prevalence of obesity in children and adolescents was: 1.8% for age < 5 years old, 8.9% for age 5-9 years, and 3.3% for age 10-19 years.[29] The prevalence of overweight in the same age groups was 6.4%, 15.5%, and 11%, respectively.[29] In young adults age 20-29 years old, the prevalence of obesity was 8.7%, in adults younger than age 60 years 19.8%, and in those 60 years and older 10.6%.[29] The prevalence of overweight in the same age groups was 30.9%, 42.5%, and 21.7%, respectively.[29] The risk factors for overweight were not being poor, living in an urban area, and being female.[29] Like diabetes, overweight/obesity is a major public health issue in Peru.

Metabolic Syndrome. The prevalence of metabolic syndrome, defined using Adult Treatment Panel III criteria,[30] has been studied in many locations throughout Peru and ranges from 10% to 45%. Metabolic syndrome is more prevalent in women, the elderly, and those living in urban areas or at a low altitude.[31]

According to the 2005 National Indicators Survey for NCD, the prevalence of metabolic syndrome was 25.8%, with 16.6% in men and 34.3% in women.[32] Prevalence was higher in those older than 60 years old (52.1%) than in those 20-29 years old (5.1%; $P < .05$).[32] Prevalence was also higher in the city of Lima (28.8%) than in the coast region (26.2%), jungle (26%), urban Andean region (21.9%), and rural Andean Region (18.7%) ($P = .0001$).[32] The frequency of metabolic syndrome components were: abdominal obesity, 65.6%; low high-density lipoprotein (HDL) cholesterol, 54.2%; high triglycerides, 30%; arterial hypertension, 19.1%; and dysglycemia, 8%.[32] The prevalence of metabolic syndrome was higher in regions with altitude < 1000 m (19.75%) than in those > 3000 m (10.2%; $P < .001$).[33] These epidemiological data are summarized in Table 1.

Table 1. Epidemiology of Diabetes and Related Conditions in Perú

Condition/Location	Prevalence/Incidence	Reference
Diabetes mellitus	6.1%-7.0%	5,16
Coast	8.2%	16
Highland	4.5%	16
Jungle	3.5%	16
Type 1 diabetes	0.4/100,000	22
Gestational diabetes	16.0%	25
Impaired glucose tolerance	8.11%	28
Impaired fasting glucose	22.4%	16
Coast	26.4%	16
Highland	17.4%	16
Jungle	14.9%	16
Overweight	34.7%	15
Coast	35.45%	15
Highland	29.25%	15
Jungle	31.0%	15
Obesity	17.5%	15
Urban	21.3%	15
Rural	6.6%	15
Metabolic syndrome	25.8%	32
Coast	26.2%	32
Highland (urban)	21.9%	32
Highland (rural)	18.7%	32
Jungle	26.0%	32

BURDEN OF DIABETES

Impact on Mortality. In Peru, the probability of dying from 1 of the 4 main NCD (cancer, cardiovascular disease, diabetes, or chronic respiratory disease) is 11%.[34] NCD account for 66% of total deaths in Peru.[34] In 2011, diabetes was ranked as the eighth leading cause of death in the Peruvian population, accounting for 3.2% of total deaths.[35] Diabetes is also ranked as the ninth leading cause of burden of disease (about 3%) estimated as disability-adjusted life years.[36] However, this impact on disease burden is greater in those 45-59 years old (9.5%) and also in women (3.5%).[36] Moreover, 83% of the disease burden from diabetes is secondary to years lost due to disability and 17% to years of life lost.[36]

Microvascular Disease. Diabetes is the sixth leading cause of blindness in Peru (0.8%).[37] Other leading causes of blindness include unoperated cataract (58.0%), glaucoma (13.7%), and age-related macular degeneration (11.5%).[37] The prevalence of diabetic retinopathy (DR) in 1311 patients with T2D, assessed by grading digital retinal images, was 23.1% (95% CI: 20.71-25.44), where 249 patients (20.4%) had nonproliferative DR and 33 patients (2.7%) had proliferative DR.[38] The prevalence of blindness was twice as frequent in patients with DR as in those without DR (9.4% and 4.6%, respectively; $P = .001$).[38]

In 2 case reports of 50[39] and 62 patients[40] with T2D, the frequency of peripheral neuropathy using electrophysiological testing was 86% and 96.8%, respectively, and with the Michigan Neuropathy Screening Instrument, the frequency was 45%.[40]

In another cross-sectional study of 129 patients with T2D using the Semmes-Weinstein monofilament test and the 4-item diabetic neuropathy symptom score, the frequency of peripheral neuropathy was 56.6%.[41]

The frequency of cardiac autonomic neuropathy was addressed in 2 studies. One series report of 81 patients with T2D found a frequency of 41.47%, according to San Antonio Conference criteria.[42] With the same methodology, another study involving 138 patients with T2D identified cardiac autonomic neuropathy in 37%.[43] The investigators also found that pupillometry did not have sufficient accuracy for clinical use as a screening tool for cardiac autonomic neuropathy.[43]

A recent estimation of chronic kidney disease (CKD) prevalence in the city of Lima, either with proteinuria (protein/creatinine ratio $\geq$ 150 mg/g creatinine) or estimated glomerular filtration rate (eGFR) $<$ 60 mL/min/1.73 m^2, or both, found a 16.8% prevalence rate (95% CI: 13.5-20.9).[44] Among participants, the prevalence of diabetes and arterial hypertension was 19.1% and 42.7%, respectively.[44] Among 200 patients with CKD not on renal replacement therapy, in 39.5% of them, CKD was due to diabetes, 24% to arterial hypertension, and 22.5% to multiple causes; in 14%, the etiology was unknown.[45]

The national Peruvian prevalence rate (person/million people) for renal replacement therapy is 335.3, with rates for hemodialysis, peritoneal dialysis, and persons living with a functioning renal graft of 230.7, 39.1, and 65.5, respectively.[46] Diabetes accounts for 40% of patients on hemodialysis in a public hospital.[47] A study led by the Peruvian Society of Nephrology on 509 people with diabetes, out of a total of 2968 participants, found a 89.6% frequency of microalbuminuria, assessed by a semiquantitative urine test strip method with a cut-off point $>$ 20 mg/L.[48] The odds ratio of microalbuminuria with diabetes was 11.62% (95% CI: 8.55-15.78) versus an OR of 1.48 (95% CI: 1.24-1.76) for arterial hypertension.[48] Albuminuria was found in 73% of 108 patients with diabetes at their first renal evaluation (30-300 mg/day in 23% and $>$300 mg/day in 54%).[49] Among 748 patients with T2D, 59.09% had an eGFR $\geq$ 90 mL/min/1.73 m^2, 28.88% between 60-89 mL/min/1.73 m^2, 10.83% between 30-59 mL/min/1.73 m^2, and 1.21% $<$ 30 mL/min/1.73 m^2 (Jaime Villena, unpublished observations). In a subgroup of 508 patients who had also a urine protein test, 63.58% had no albuminuria, 27.95% had microalbuminuria, and 8.46% had clinical albuminuria.

Macrovascular Disease. Cerebrovascular disease, ischemic heart disease, and arterial hypertension are the main causes of death in Peru, after acute respiratory infection, accounting for 5.3%, 4.8%, and 4.4% of all deaths, respectively.[35] Diabetes is the third leading risk factor for acute myocardial infarction in Latin America.[50]

Cardiovascular risk factors are very common in people with T2D. In a large series of 1095 patients with T2D, 44.5% had overweight, 34% were obese, 62.8% had arterial hypertension, 59.6% had low-density lipoprotein (LDL) cholesterol $\geq$ 100 mg/dL, 66.6% had HDL-cholesterol $<$ 50 mg/dL, and 52.83% had triglycerides $>$ 150 mg/dL (Jaime Villena, unpublished observations). Tobacco smoking is infrequent in private and public settings, 12.9% and 11.6%, respectively.[51,52] In 2010, a report of the National Acute Myocardial Infarction Registry II, from 34 public and private medical centers in Peru, identified 1609 episodes of acute myocardial infarction, of which 31.5% occurred in patients with diabetes.[53]

The frequency of peripheral vascular disease was studied prospectively in 592 patients with T2D using the ankle–brachial pressure index. Of these, 75 patients (12.67%) had an index $\leq$ 0.9 and 44 (7.43%) had an index $>$ 1.30 (Jaime Villena, unpublished observations). As worldwide, diabetes was found to be the principal cause (42.3%) of nontraumatic amputations among 570 patients studied at the National Rehabilitation Institute from 2002 to 2007.[54]

Diabetes was the third leading cause of stroke (10.9%), after arterial hypertension (47.7%) and atrial fibrillation (12.9%), in a series of 2225 events in patients older than 18 years admitted to a public hospital from 2000 to 2009.[55] Diabetes accounted for 14.7% and 7.1% of all ischemic and hemorrhagic strokes, respectively.[55] In another large series of 1517 cases of stroke patients admitted to an EsSalud hospital from 1987 to 1998, diabetes caused 15.50% of ischemic stroke and 9.70% of hemorrhagic stroke.[56]

Morbidity and Mortality. In 2011 there were 6853 hospital admissions as a result of diabetes—2449 more admissions than in 2005, representing a 55.6% increase.[26] Fifty-nine percent of these admissions were in the coast region, 24% in the Andean Region, and 17% in the jungle.[26] Approximately 46.94% of these patients were older than 60 years.[26] From January 2001 to December 2009, of 3683 admissions to a general public hospital for diabetes in people aged 18 years and older, 94.2% had

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T2D, 3% had T1D, 0.2% had GDM, and in the remaining the type of diabetes was not specified.[57] Hospital mortality was 8.9% for the patients with T2D.[57]

In a series of 1230 admissions for T2D to a third-level public hospital during 1985-1995, 29.8% were due to infections, 14.7% to emergencies (see later), 13.7% to cardiovascular disorders, and 9.8% and 8.3% to neurologic and renal disorders, respectively.[58] Diabetic foot infection (20.5%), urinary tract infection (15.8%), tuberculosis (13.7%), cellulitis (13.7%), pneumonia (11.8%), and sepsis (7.1%) were the most common infectious causes for admissions in these patients with diabetes.[58]

Of the diabetic emergencies, ketoacidosis and hypoglycemia were the most common (21.6% each), followed by hyperosmolar hyperglycemic state (18.2%).[58] Heart failure accounted for 39.9% of emergency admissions as a result of cardiovascular disorders, followed by hypertensive emergencies (32.7%) and acute coronary syndromes (19.6%).[58] Stroke accounted for 70.8% of emergency neurologic conditions and decompensated chronic kidney disease (CKD) for 86.3% of emergency renal disorders.[57] Overall hospital mortality of admissions with diabetes was 7.6%, with infections the main cause (34%) of them.[58]

In a recent series of 424 patients with T2D admitted to a public hospital from October to April 2013, 69.6% of admissions were due to infections, 24.1% to diabetic emergencies, and 6.6% to cardiovascular disorders.[59] Urinary tract, diabetic foot, and respiratory infections were the most prevalent infections in these patients, representing 22.6%, 20.8%, and 11.8%, respectively.[59] Hypoglycemia was the most common diabetic emergency at 10.6%, followed by diabetic ketoacidosis at 7.6% and hyperosmolar hyperglycemic state at 3.5%. Mortality was 8.96%, again mainly as a result of infections (57.5%).[59] In an update of this report using multivariable models, respiratory infections (HR = 6.55, $P < .001$), stroke (HR = 7.05, $P = .003$), and acute renal failure (HR = 16.9, $P = .001$) were associated with increased risk of death.[60] Having 2 (HR = 7.75, $P < .001$) or 3 (HR = 21.1, $P < .001$) of these conditions further increased the risk of dying.[60]

It is remarkable that most reports of diabetic ketoacidosis occurred not in patients with T1D but rather in patients with T2D, accounting for 4%-5.8% of diabetic hospital admissions.[57,61] In 28.8%-42% of these patients, diabetic ketoacidosis was the presenting feature.[61,62] Infection was the most common contributing factor (20%-42.5% of episodes).[57,61,62] These patients were younger than those admitted without diabetic ketoacidosis and had poor metabolic control and a delayed access to health care.[57] Mortality from diabetic ketoacidosis varied from 0% to 9.1%, depending on the underlying conditions and hospital settings.[57,61,62]

Diabetes is a chronic disease and contributes to an average of 242,000 deaths each year in the Americas (110,000 males and 132,000 females).[63] In 2007, 22,000 deaths from diabetes (8% overall) were considered as avoidable by the Pan American Health Organization because they occurred in people younger than 50 years old.[63] The IDF estimated that there were 219,000 deaths from diabetes in South America and the Caribbean region in 2014, with 45% of them in people younger than 60 years old.[5] The adjusted mortality rate (for 2007-2009) from diabetes in Peru was 15.7 per 100,000 (16.3/100,000 for males and 15.0/100,000 for females), which is considered a relatively low rate (<25/100,000) for the region.[63] Some health impacts of diabetes in Peru are highlighted in Table 2.

DIABETES CARE

Health Care. The Peruvian health system has mixed public and private sector sources of funding from tax collection (public sector) and contributions (social security and private insurance). Approximately 31.34% of the population, primarily in the lower socioeconomic strata, is covered by the public health insurance (SIS). Those who have a steady job (24.42%) are covered by social security (EsSalud), and those working in the army and police (2.35%) are covered by their own health systems. Approximately 2.12% of the population has private health insurance, 1.90% has other type of health insurance, 0.02% has more than 1, and 38.19% has no health insurance.[35]

The national health expense as a percentage of the gross domestic product has decreased from 5.7% in 2008 to 4.8% in 2011, being the lowest in South America and below the average of the region (6.8%).[35] The IDF estimated the cost of each patient with diabetes in Peru at US$523.50.[5]

Human Resources. By 2013, there were 150,925 health personnel in Peru; 15.67% of them were physicians, 16.13% nurses, 5.61% obstetricians, 2.25% dentists, 1.03% psychologists, 0.88% social workers, and 0.70% nutritionists.[64] The public system concentrates 67% of the human health resources; this is followed by EsSalud at 23%, the

Table 2. Health Impact of Diabetes in Peru

Impact	Reference
• Eighth leading cause of death	35
• Cause of 3.2% of total deaths	36
• Ninth leading cause of burden of disease	37
• Sixth leading cause of blindness	38
• Leading cause of chronic renal disease and dialysis support therapy	45,47
• 11.2% odds ratio for microalbuminuria nationwide	48
• Affects 31.5% of people with acute myocardial infarction	53
• Accounts for 10.9%-15.5% of strokes	55,56
• Leading cause (42.3%) of nontraumatic amputation	54
• In-hospital mortality: 7.6%-8.96%:	56-58
• Adjusted mortality from diabetes: 15.7/100,000	63

Police and Army Health System at 6%, and the private sector at 4%.[64]

The WHO and Pan American Health Organization stipulate the minimum number of physicians for adequate community health care to be 10 per 10,000 inhabitants.[35] This ratio in Peru is 9.6, with heterogeneity and inequities throughout the country. For instance, it is 13.6 in Lima, 5.5 in Puno (upland plateau), 7.7 in Cusco (Andes), and 5.9 in Ucayali (jungle).[35] The human health resources density (per 10,000 inhabitants) is on average 27.9 and varies from 51.3 in Callao (coast), to 33.8 in Lima, to 14.7 in Loreto (jungle).[64]

There were 17,997 specialists in Peru in 2013, of whom 300 are registered endocrinologists. Approximately 60.35% of specialists are practicing in the city of Lima, 19.6% in 5 other populous cities, and the remaining 20% in the rest of the country.[64]

National Strategy. On July 27, 2004, the Peruvian Ministry of Health launched the National Health Strategy for the prevention of noncommunicable damages by RM No. 771-2004 and respective plan of action (RM No. 721-2005 MINSA for 2004-2012) to diminish morbidity and mortality by focusing on arterial hypertension, diabetes, cancer, and blindness. On June 16, 2005, the Congress passed the Protection Law No. 28553 to provide a legal framework for prevention, health care, treatment, monitoring, and surveillance of people with diabetes.[65] Since November 2011, there has been an Epidemiological Surveillance System of Diabetes Mellitus with a network of many notifying health centers both public and private.[27]

Despite these efforts, the WHO still does not recognize an operational multisector national policy strategy or action plan in Peru that integrates several NCD and their shared risks factors, including plans to promote physical activity and healthy diet. Furthermore, there is no national evidence-based clinical practice guideline for diabetes management through a primary care approach.[34]

Drug Treatment and Supplies. A broad array of medications are available in Peru for the management of diabetes. Oral medications include sulfonylureas (glyburide, glimepiride, and extended-release gliclazide), metformin (short acting and extended release), dipeptidyl peptidase (DPP) 4 inhibitors (sitagliptin, vildagliptin, saxagliptin, and linagliptin), thiazolidinediones (pioglitazone), and sodium-glucose cotransporter (SGLT) 2 inhibitors (canagliflozin and empagliflozin). Injectable medications include human insulins (regular and NPH), long-acting insulin analogues (glargine and levemir), rapid-acting insulin analogues (lispro, aspart, and glulisine), and glucagon-like peptide (GLP) 1 receptor agonist analogues (exenatide and liraglutide).

However, the national drug formulary for the treatment of diabetes includes only human insulin, both NPH and regular, metformin, and glyburide.[66] As a result, there is limited access in public and EsSalud hospitals to insulin analogues (primarily for patients with T1D) and the other oral agents. A wider availability of antidiabetic medications is available in the Army Health System and the private sector.

Glucose test strips are provided by private health insurances, or with some limitations by the public health insurance, for patients with T1D or patients with T2D on insulin treatment. Insulin pumps and continuous glucose monitoring devices are not covered by any health insurance and their use is very limited in the country.

Sales figures for the diabetes private market over the course of the previous 12 months indicate that metformin is the most prescribed oral agent (32%), followed by sulfonylureas at 26%, fixed-dose combinations (metformin plus sulfonylureas) at 18%, DPP-4 inhibitors at 8%, and others at 3% (Source: IMS MAT 05/2015). The private insulin market is led by long-acting insulin analogues (8%) followed by intermediate-acting insulin (2%), rapid-acting insulin (2%), and premixed insulin (1%) (Source: IMS MAT 05/2015). Oral diabetes medications have an 81% market share (Source: IMS MAT 05/2015). By law (No. 28553), diabetes medications are exempt from sales tax.

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According the ENDES survey, 70.3% of people with diabetes report taking medication for their diabetes.[15] In a series of 922 patients with T2D attending an EsSalud health center, 80% received metformin (either alone or in combination), 32% glyburide, 35% NPH insulin, 3% glargine, and 4.1% either rapid-acting insulin analogues or regular human insulin.[67] In a smaller case series report of 112 patients with T2D, 44% were treated with combination of metformin plus glyburide, 21% with either one alone, 33% with NPH insulin, and 4% with only lifestyle modification.[68]

In a cross-sectional study of diabetic retinopathy in 1287 patients with T2D,[38] 66.26% were on monotherapy (metformin, 62.7%; insulin, 19.4%; and sulfonylurea, 15.85%), 32% were on 2 medications (oral agents alone, 66.6%; insulin plus an oral agent, 33.7%), and just 1.85% were on 3 medications (insulin plus oral agents, 66.6%; 3 oral agents, 33.3%) (Jaime Villena, unpublished observations).

Quality of Diabetes Health Care. A poll conducted at a scientific meeting of the Peruvian Endocrine Society found that most endocrinologists follow the American Diabetes Association guidelines for diabetes management using an hemoglobin A1c (A1C) $< 7\%$ as an ideal target. Nevertheless, in 2 case series of 112 and 228 patients with T2D, only 25% and 12.3%, respectively, had an A1C $< 7\%$.[68,69] In the Deal Study in 9 Latin American countries, 2959 patients with T2D treated by general practitioners in private practice were observed. Only 28% of the 137 Peruvians patients in the study had an A1C $< 7\%$.[70] In the first Epidemiological Surveillance System of Diabetes Mellitus report of 2959 patients reported by 18 health centers, only 29.3% actually had an A1C tested, and of those, 66.6% had values $\geq$ 7%. In addition, only 8.9% had an albuminuria test, which was abnormal in 27%. On the other hand, 91.2% had a fasting blood glucose test, which was > 130 mg/dL in 65.4%.[27]

Finally, in a cross-sectional study of diabetic retinopathy, of 961 patients with T2D screened with an A1C available, 30.39% of them had a value $< 7\%$.[38] In this same cohort, 59.62% had an LDL-cholesterol ≥ 100 mg/dL, 52.83% had triglycerides ≥ 150 mg/dL, and 66.63% had HDL-cholesterol < 50 mg/dL. Despite this increased cardiovascular risk, only 14.89% were on statins and only 53.60% on aspirin. Regarding blood pressure, 33.64% had antecedent arterial hypertension, of whom 87.25% were on pharmacological treatment. Moreover, of this group, 44.71% had a systolic blood pressure < 140 mm Hg and 76.46% had a diastolic blood pressure < 90 mm Hg (Jaime Villena, unpublished observations). Of 1311 patients with T2D evaluated prospectively for diabetic retinopathy, 58.3% mentioned they had not had any eye examination before (Table 3).[38]

There is also a late referral pattern of patients with diabetes for renal evaluation. According a report from a public hospital, from January 2011 to January 2012, of 87 patients referred, 4.11% had stage 5 CKD, 64.38% stage 4 (the highest percentage in this relatively late stage), 21.92% stage 3, 9.59% stage 2, and none had stage 1, arguing for earlier referral of these patients.[47]

A survey of 605 people (either with diabetes or their relatives) found that only 33% considered that access to diabetes treatment and educational resources for patients were adequate in Peru. Of note, 32% indicated that community support for people with diabetes was appropriate and 27% said the quality of health care centers in their community was good. Also, 56% did not know if there is any percentage of the health budget allocated to diabetes care.[65]

Table 3. Quality of Type 2 Diabetes Care

Parameter	%	Reference
• A1C $< 7\%$	12.3-30.4	27,68-70
• LDL-cholesterol < 100 mg/dL	40.4	See text
• Triglycerides < 150 mg/dL	51.8	See text
• HDL-cholesterol < 50 mg/dL	66.6	See text
• Systolic blood pressure < 140 mm Hg	44.7	See text
• Diastolic blood pressure < 90 mm Hg	76.4	See text
• Patients with diabetes who have ever had treatment	70.3	15
• On lifestyle treatment only	4.0-11.3	68,69
• On monotherapy	18.7-41.3	62,68
• On > 1 antidiabetic agent	10.9-43.7	62,68
• On insulin (either alone or combined)	12.0-38.6	62,67-69
• Hypertensive patients on drug therapy	87.2	See text
• On aspirin prevention therapy	53.6	See text
• On statin therapy	14.9	See text

A1C, hemoglobin A1c; HDL, high-density lipoprotein; LDL, low-density lipoprotein.

Table 4. Strengths and Shortcomings in Facing the Diabetes Epidemic in Peru

• National Health Strategy for the prevention of NCD launched in 2004
• Legal framework established in 2005
• Community promotion of healthy lifestyles already started
• Training of primary care health personnel in diabetes care is in process
• Only 4.8% of gross domestic product as national health expenses
• Still 38.19% of the population without health insurance
• Inequities in the distribution of health resources across the country
• Comprehensive health care network not yet fully operative
• Evidence-based clinical practice guidelines for the primary level recently approved
• National drug formulary for the treatment of diabetes with 4 drugs only
• Lack of certified diabetic education programs

NCD, noncommunicable diseases.

CONCLUSIONS

Peru is an upper medium-income developing country undergoing a demographic, nutritional, and epidemiological transition, associated with rural-urban migration and a growing economy. These transformations have increased the prevalence of chronic diseases, such as overweight, obesity, metabolic syndrome, and diabetes, with prevalence rates of 34.7%, 17.5%, 25%, and 7%, respectively. T2D accounts for 96.8% of people with diabetes, GDM complicates 16% of pregnancies, and the prevalence of T1D is one of the lowest in the world, although this figure needs to be updated. Diabetes is the eighth leading cause of death, the sixth leading cause of blindness, and the leading cause of end-stage kidney disease and nontraumatic lower limb amputation. Diabetes accounted for 31.5% of acute myocardial infarctions and 25% of strokes. Infections, diabetes emergencies, and cardiovascular disorders are the main causes for hospital admissions. Infections, CKD, and stroke are the main causes of death in patient with diabetes in Peru.

One third of the Peruvian population does not have any health insurance coverage. Less than 30% of treated patients have an A1C $< 7\%$, and there are still disparities in the distribution of health care personnel and resources across the country.

The National Health Strategy for tackling diabetes has recently developed a national clinical practice guideline for the management of diabetes at the primary care level, and should provide trained health personnel, safe medications, tools for monitoring treatment, and a health care network for early referral to prevent, detect, and treat diabetic complications. This transformative strategic plan should promote a healthy lifestyle on a large societal scale through political and legislative action, as well as mass media involvement, to stem this growing epidemic. Some strengths and shortcomings of this ongoing process are outlined in Table 4.

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