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Characterization of Adults with Initial Diagnosis of Type 2 Diabetes Mellitus in Peru

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Abstract

Aims: To describe the characteristics of adults with an initial diagnosis of type 2 diabetes mellitus (T2D) in multiple regions of Peru.

Methods: Descriptive case series study performed at 26 centers. Subjects age >20 years with T2D debut were included. Exclusion criteria were pregnancy, use of drugs known to alter glucose metabolism, and having renal, hepatic, respiratory, or cardiac insufficiency.

Results: 581 subjects were enrolled, 48.9% were female, mean age was 53.2 years (SD ± 12.8). Mean weight was 77.3 kg (SD +/- 16.6), 39.2% were overweight and 45.1% were obese. Mean waist circumference was 100.6 cm (SD +/- 13.1). Mean blood glucose and HbA1c were 249.4 mg/dl and 8.9%, respectively. Subjects from Lima and the northern sites had higher levels of glucose and HbA1c. Subjects from high altitude sites had higher rates of fatty liver and lower levels of LDL-c and total cholesterol. Younger patients tended to have more metabolic alterations.

Conclusions: This study is among the first to describe characteristics of adults with T2D debut in Peru. People from Lima and the northern provinces as well as those diagnosed at an early age seem to be at higher risk.

Keywords: Type 2 Diabetes; Diagnosis; Cardiovascular Risk

Introduction

Both the prevalence and incidence of type 2 diabetes mellitus (T2D) is on the raise, with an estimated 425 million adults (ages 20 to 79 years) living with this medical condition, and with the bulk of the burden affecting low- and middle-income countries [1,2]. In Peru, screening studies have estimated that the prevalence of diabetes mellitus is 5,1% among those older than 35 years, and 7% among those older than 25 years [3]. Multiple factors have been associated with higher risk of T2D, including living in the northern provinces, and having migrated from a rural to an urban area [4]. In contrast, some studies have found an inverse association between living in the highlands and the incidence of T2D [5,6]. However, there is scarce data about the main clinical and laboratorial characteristics of subjects with an initial diagnosis of T2D. A study in the United States analyzed demographic characteristics of patients with initial diagnosis of T2D and reported that younger patients (ages 18 to 45 years) tended to be female, have higher body mass index (BMI), have poorer glycemic control and higher prevalence of systolic hypertension, in comparison to those who were initially diagnosed at age > 45 years [7].

Understanding the characteristics of subjects with initial diagnosis of T2D would be valuable to define strategies for earlier diagnosis and timely therapeutic interventions in order to prevent the progression of the disease and to optimize long term outcomes. Even preventive strategies could be informed should factors could be modified in order to delay the onset of the disease. The main objective of this study was to describe the main clinical and laboratorial characteristics (age, sex, BMI, abdominal waist circumference, arterial blood pressure, glucose levels, glycosylated hemoglobin, lipid profile, and presence of fatty liver) of adults who received an initial diagnosis of T2D in several regions of Peru. Given that the sites were distributed across multiple regions of the country, it was possible to explore potential differences across regions including those located at high altitude.

Subjects

Patients with the following criteria were included: a) age > 20 years, b) ambulatory, c) having received an initial diagnosis of T2D. The diagnosis of T2D was defined with the following parameters: fasting glucose ≥ 126 mg/dl, or glucose tolerance test >200 mg/dl at 2 hours, or random glucose ≥ 200 mg/dl along with classical T2D symptoms. A glycosylated hemoglobin (HbA1c) ≥ 6.5% was considered as a diagnostic element when the glycemia was borderline, that is, T2D was not diagnosed solely on the bases of elevated HbA1c. In order to reduce the likelihood of including adults with type 1 diabetes, in patients with ages between 20 and 30 years, at least one of the following additional criteria was required: body mass index (BMI) > 30, increased waist circumference, first degree family history of T2D, or acanthosis nigricans.

Subjects with use of drugs known to alter glucose metabolism (such as corticosteroids, loop diuretics, and cancer chemotherapy) were excluded. If the patient had previously used metformin for treatment of a medical condition other than diabetes, metformin would have to be discontinued for at least two weeks prior to the diagnosis of T2D. Exclusion criteria included pregnancy and having renal, hepatic, respiratory, or cardiac (NYHA class 3-4) insufficiency.

Methods

This was a descriptive case series study performed at 26 centers, primarily ambulatory, in multiple provinces of Peru. Centers located at high altitude (>1894 meters above sea level) were included. Participating investigators, largely endocrinologists, were invited to collect medical record data from adults who had been given an initial diagnosis of T2D. Data collection was performed between July 2016 and November 2017.

Information Collected

A case report form was prepared to collect the information for each patient meeting the inclusion and exclusion criteria. Information included age, sex, previous diagnosis of prediabetes, first-degree family history of T2D, weight, height, BMI, waist circumference, blood pressure and acanthosis nigricans (yes/no).

Information was collected also on laboratory tests performed within the last 30 days prior to the date of T2D diagnosis, including fasting glycemia, oral glucose tolerance test, HbA1c, triglycerides, HDL-c, LDL-c, uric acid, aspartate aminotransferase (SGOT), alanine aminotransferase (SGPT), and creatinine.

Liver ultrasound information was included, when available, to identify whether there were findings suggestive

of fatty liver. The results of liver ultrasound were included in the test was performed within the last three months prior to diagnosis up to one-month post diagnosis of T2D. Anthropometric data were measured on the day of the initial diagnosis of T2D.

The CRF also collected data about concomitant diagnosis of hypertension and dyslipidemia as well as the use of lipid lowering drugs or antihypertensive drugs. In addition, the initial treatment indicated for management of T2D was captured and categorized as: diet only (non-pharmacological treatment), metformin, sulfonylurea, DPP4 inhibitor, GLP1 receptor agonist, SGLT2 inhibitor, insulin or combinations of those.

Statistical Analyses

Stata 14 Data Analysis and Statistical Software was used for descriptive data analysis. For continuous quantitative variables, the mean was used as a measure of central tendency and the standard deviation as a measure of dispersion. Most quantitative variables were converted to categorical to describe the percentage of individuals distributed according to specific cut-off points. When necessary, formulas were made to compute values (for example, BMI).

For the bivariate analysis, the chi-square test (x^2) or Fisher's exact test was used depending on whether the sample was parametric or non-parametric. For the multivariate analysis, the Multiple Conditional Logistic Regression test was performed. Sub-analyzes were performed according to the region of the country were the patients were diagnosed and according to the age at diagnosis.

Results

Information was collected from 581 patients who had received an initial diagnosis of T2D. Females composed 48.9% of the participants. The mean age was 53.2 years (SD +/- 12.8 years). Early diagnosis of T2D (before age 40 years) was found in 18.3% of the patients. Most (54.7%) received their initial diagnosis of T2D between the ages of 41 and 60, which was considered as middle age of diagnosis, for comparison. The remaining (27%), received the initial diagnosis of T2D after 60 years of age and were considered as late onset T2D.

Most (68%) of the participants were found to have increased waist circumference according to different definitions. When the cut-off points of ≥ 94 cm for men or ≥ 90 cm for women were considered, an increase in waist circumference was found in 79.29% individuals, with no significant difference between men and women. However, when the cut-off points of ≥ 102 cm for men and ≥ 88 cm for women were used, an increase in the waist circumference was found in 68.9%, with men having 73% lower risk of having a high waist circumference in comparison to women (OR = 0.27, 95% CI 0.17 to 0.41).

Regarding the results of fasting blood glucose, the average was 249.4 ± 105.7 mg/dl and 61.7% had values above 200 mg/dl. In addition, it was observed that individuals with glycemia> 200 were more likely to be male (OR: 2.83; 95% CI 1.83 to 4.38). Regarding HbA1c, an average of 8.9 ± 2.4% was observed. Among those with HbA1c > 9 % (n = 172, 41.1%) being male had a higher odds ratio (OR: 2.21 95% CI 1.42 to 3.42). More details are shown in table 1.

Characteristic	N (%) or $\bar{x}$ ± SD
Gender (N=581)	
Female	284 (48.9%)
Age (years; N=581)	53.2 ± 12.8
<40 years (diagnosis at early age)	106 (18.3%)
41 y 60 years (diagnosis at middle age)	318 (54.7%)
>60 years (diagnosis at advanced age)	157 (27.0%)
Geographical location (N=581)	
North (Piura, Chiclayo, Chimbote)	147 (25.3%)
Lima, Huacho	219 (38.7%)
Center-South (Arequipa, Cuzco, Huancayo, Huánuco)	107 (18.4%)
Eastern (Amazonas, Loreto, San Martín)	102 (17.6%)
Weight (kg; N=581)	77.3 ± 16.6
BMI (N=581)	29.8 ± 5.6
< 20	13 (2.2%)
20 - 24	78 (13.4%)

25 - 29	228 (39.3%)
30 - 34	178 (30.6%)
35 - 39	59 (10.2%)
> 40	25 (4.3%)
Waist circumference (cm; N=456)	100.6 ± 13.1
≥102 cm males or ≥88 cm females	314 (68.9%)
≥94 cm males or ≥90 cm females	362 (79.4%)
Classical signs and symptoms present at diagnosis (N=581)	370 (63.7%)
Previous Diagnosis of Prediabetes (N=573)	94 (16.4%)
Family History (first degree) of T2D (N=570)	260 (45.6%)
Acanthosis nigricans (N=548)	195 (35.5%)
Fatty liver on ultrasound (N=299)	169 (56.7%)
Systolic blood pressure (N=551)	119.5 ± 16.0
≥140mmHg (Systolic arterial hypertension)	80 (14.5%)
Diastolic blood pressure (N=551)	73.7 ± 9.7
≥90mmHg (Diastolic arterial hypertension)	44 (8%)
Dyslipidemia under treatment (N=348)	52 (14.9%)
Total cholesterol (mg/dl; N=463)	210.2 ± 53.9
≥200 mg/dl	245 (52.9%)
LDL-C (mg/dl; N=341)	126.9 ±45.1
≥100 mg/dl	259 (72.8%)
HDL-C (mg/dl; N=356)	42.2 ± 10.9
<=40 mg/dl in males or <=50 mg/dl in females	230 (64.6%)
Triglycerides (mg/dl; N=468)	230.4±172.4
≥150 mg/dl	307 (65.6%)
Uric Acid (mg/dl; N=290)	4.8 ± 1.7
Creatinine (mg/dl; N=139)	0.85 ± 0.31
SGOT (U/l; N=308)	39.4 ± 28.1
>40 U/l	101 (32.8%)
SGPT (U/l; N=365)	50.0 ±40.9
>40 U/l	158 (43.3%)
Diagnostic assay (N=615)a	
Fasting Glucose and/or random	528 (84.9%)
Oral glucose tolerance test	87 (15.1%)
Diagnostic Glycemia* (g/dl; N=528)	249.4 ± 105.7
<150 **	119 (22.5%)
150-200	83 (15.7%)
> 200	326 (61.7%)
Glycosylated Hemoglobin (%; N=418)	8.9 ± 2.4
<7	118 (28.2%)
07-Sep	128 (30.6%)
> 9	172 (41.1%)

Table 1: Patient characteristics.

$\bar{x}$ ± SD: mean and standard deviation; BMI: body mass index; SGOT: aspartate aminotransferase; SGPT: alanine aminotransferase; *Included only values that were not part of glucose tolerance tests. ** Had HbA1c > 6.5%. a=34 had diagnosis with two assays.

Categorization by Geographical Location

An analysis was made by geographical location of the participating center, categorized into four regions: North, Lima, Central-South and East. The characteristics are presented in table 2.

Characteristics	North n(%)	Lima n(%)	Central-South n(%)	East n(%)
Gender	n=147	n=219	n=107	n=102
Female	50 (34.0)	114 (52.1)	63 (58.9)	55 (53.9)
Age*	n=147	n=219	n=107	n=102
<40 years (early age)	38(25.8)	26(11.9)	16(14.95)	24(23.5)
41- 60 years (middle age)	79(53.7)	119(54.3)	58(54.2)	60(58.8)
>60 years (advanced age)	30(20.4)	74(33.8)	33(30.8)	18(17.6)
Signs and Symptoms*	n=147	n=218	n=107	n=102
Yes	110 (74.8)	116 (53.2)	87 (81.3)	55 (53.9)
Prior diagnosis of pre-diabetes*	n=139	n=219	n=107	n=102
Yes	24 (17.3)	47 (21.5)	17 (15.9)	3 (2.9)
Family history of T2D*	n=140	n=215	n=107	n=102
Yes	83 (59.3)	101 (47.0)	42 (39.3)	30 (29.4)
Acanthosis nigricans*	n=137	n=200	n=106	n=99
Yes	49 (35.8)	83 (41.5)	38 (35.8)	23 (23.2)
Fatty liver (ultrasound)*	n=73	n=120	n=63	n=36
Yes	14 (19.2)	87 (72.5)	49 (77.8)	18 (50.0)
Dyslipidemia*	n=88	n=154	n=101	n=5
Yes	6 (6.8)	26 (16.9)	16 (15.8)	4 (80.0)
Arterial Hypertension*	n=143	n=216	n=107	n=101
Yes	27 (18.9)	64 (29.6)	35 (32.7)	12 (11.9)
BMI*	n=147	n=225	n=107	n=102
Mean	28.7 (5.0)	30.3 (5.2)	30.9 (6.8)	29.4 (5.6)
< 20	3 (2.0)	4(1.8)	1 (0.9)	5(4.9)
20 to 24	30(20.4)	19(8.4)	18(16.8)	11(10.8)
25 to 29	61(41.5)	88(39.1)	35(31.7)	44(43.1)
30 to 34	41(27.9)	77(34.2)	31(28.9)	29(28.4)
35 to 39	7(4.7)	28(12.4)	16(14.9)	8(7.8)
> 40	5(3.4)	9(4)	6(5.6)	5(4.9)
Systolic hypertension	n=131	n=213	n=106	n=101
Yes	13(9.9)	43(20.2)	13(12.3)	11(10.9)
Diastolic hypertension*	n=131	n=213	n=106	n=101
Yes	7(5.4)	16(7.5)	19(17.9)	2(1.9)
Waist circumference	59	190	107	100
Mean	101 (12.4)	101 (13.6)	103 (13.6)	98 (12.0)
≥94 cm males or ≥90 cm females	47(79.7)	154(81.1)	86(80.4)	75(75)
≥102 cm males or ≥88 cm females	40 (67.8)	129(67.9)	76(71.0)	69(69)
Hypercholesterolemia*	n=89	n=201	n=96	n=77

Yes	52(58.4)	118(58.7)	39(40.6)	36(46.7)
Hypertriglyceridemia	n=89	n=210	n=96	n=73
Yes	52(58.4)	146(69.5)	59(61.5)	50(68.5)
High LDL-C*	n=38	n-181	n=81	n=56
Yes	32(84.2%)	141(77.9%)	43(53.1%)	43(76.79)
Low HDL-C	n=38	n-181	n=81	n=56
Yes	30(78.95%)	119(65.7%)	52(64.2%)	29(51.8%)
Hemoglobin A1c*	n=110	n=189	n=80	n=39
Mean	9.6 (9.7)	8.4 (2.3)	9.0 (2.2)	8.7 (2.7)
< 7	14 (12.7%)	74(39.1%)	19(23.7%)	11(28.2%)
≥ 7 to <9	35(31.8%)	53 (28.0%)	24(30%)	16(41.0%)
≥ 9	61(55.4%)	62 (32.8%)	37(46.2%)	12(30.7%)
Glycemia*	n=147	n=183	n=96	n=102
Mean	279 (99)	213 (89)	270 (114)	250 (117)
<150 **	11(7.5%)	64(34.9%)	18(18.7%)	26(25.5%)
150 to 200	19 (12.9%)	38(20.7%)	9 (9.4%)	17(16.7%)
> 200	117(79.6%)	81(44.3%)	69 (71.9%)	59(57.8%)

Table 2: Characteristics according to geographical location.
North (Piura, Chiclayo, Chimbote), Lima (Lima and Huacho), Center-South (Arequipa, Cusco, Huancayo, Huanuco), East (Iquitos, Tarapoto). *p<0.05.

The North and East regions had a higher frequency of diabetics diagnosed at early age, while in the Central and Lima regions, a higher frequency of patients was diagnosed at advanced age. The Northern region had fewer patients with fatty liver, as per abdominal ultrasound, compared to other regions. With respect to BMI, the North and East regions presented a higher percentage of overweight subjects, while Lima had the highest percentage of persons with obesity. HbA1c greater than 9% and glycemia> 200 mg/dl were observed more often in patients from the North compared to Lima, Central-South and East (55.4 vs. 32.8, 46.2 and 30.7% and 79.6 vs. 44.3, 71.9 and 57.8%, respectively). Cholesterol levels were higher in the North and Lima regions, while hypertriglyceridemia showed no differences between regions.

Patients from high altitude sites had a higher frequency of fatty liver compared to other sites (77.8% vs. 50.8%). In addition, the level of total cholesterol and LDL-c was lower in these high-altitude sites (40.6% vs. 51.6% and 53.1% vs. 78.5% respectively). The same trend was observed when the analyses were based on means (195.1 vs. 214.2 and 111.7 vs. 131.8 respectively). Details are provided in Table 3.

Characteristic	High altitude n(%)	Low altitude n(%)
Gender*	n=107	n=474
Female	63(58.9%)	221(46.6)
Age	n=107	n=474
<40 years (early age)	16(14.9%)	99(18.9%)
41 - 60 years (middle age)	58(54.2%)	260(54.8%)
>60 years (advanced age)	33(30.8%)	124(26.2%)
BMI	n=107	n=474
< 20	1(0.9%)	12(2.5%)

20 to 24	18(16.8%)	60(12.7%)
25 to 29	35(32.7%)	193(40.7%)
30 to 34	31(28.9%)	147(31.0%)
35 to 39	16(14.9%)	43(9.1%)
> 40	6(5.6%)	19(4.0%)
Fatty Liver on ultrasound*	n=63	n=236
Yes	49(77.8%)	120(50.8%)
Waist circumference	n=107	n=349
Mean	102(13.6)	99(12.9)
≥94 cm males or ≥90 cm females	86(80.4%)	276(79.1%)
≥102 cm males or ≥88 cm females	76(71.0%)	238(68.2%)
Cholesterol	n=96	n=367
Hypercholesterolemia*	39(40.6%)	206(56.1%)
Mean*	195.1 (48.6)	214.2(54.6)
Triglycerides	n=96	n=372
Hypertriglyceridemia	59(61.5%)	248(66.7%)
Mean	208(128.9)	235.9(181.7)
LDL-C	n=81	n= 275
High*	43(53.1%)	216(78.55%)
Mean*	111.7(44.1)	131.8(44.4)
HDL-C	n=81	n=275
Low	52(64.2%)	178(64.7%)
Mean	43.4(10.6)	41.7(11.0)
Hemoglobin A1c	n=80	n=338
Mean	9.0 (2.2)	8.8(2.4)
< 7	19(23.7%)	99(29.3%)
7 to 9	9(9.4%)	71(17.1%)
> 9	69(71.9%)	257 (59.5%)
Glycemia	n=96	n=432
Mean	270 (113.6)	244 (103.4)
<150	18(18.7%)	101(23.4%)
150-200	9(9.4%)	71(17.1%)
≥200	69(71.9%)	257 (59.5%)

Table 3: Patient Characteristics according to location at high versus low altitude.
* P<0.05

Categorization by Age at Diagnosis

Patients diagnosed at advanced age were more likely to have a history of prediabetes (23.08%) compared to patients of early or middle age (11.65% and 14.65%, respectively). Patients diagnosed at an early age had higher frequencies of acanthosis nigricans, family history of diabetes and hypercholesterolemia compared to those diagnosed at middle or advanced age. Patients diagnosed at an early age were more likely to have levels of glycosylated hemoglobin above 9 (49.3% vs. 46.4% and 26.8%) and fasting glucose ≥ 200 mg/dl (73% vs. 64.9% and 46.3%) compared to those diagnosed at middle and advanced age. Further details in Table 4.

Characteristics	Early Age n (%)	Middle Age n(%)	Advanced Age n(%)
Gender	n=106	n=318	n=157
Female	61 (57.5)	164 (51.6)	72 (45.8)
Geographical location*	104	316	155
North	38(36.5)	79(25)	30(19.4)
Lima, Huacho	26(25)	119(37.7)	74(47.7)
Central-South	16(15.4)	58(18.4)	33(21.3)
East	24(23.1)	60(18.9)	18(11.6)
Signs and Symptoms	n=106	n=318	n=157
Yes	69 (65.1)	211 (66.35)	90 (57.3)
Previous Diagnosis of Prediabetes*	n=103	n=314	n=156
Yes	12(11.65)	46(14.65)	36(23.08)
Family History of Diabetes*	104	313	153
Yes	53(50.9)	155(49.5)	53(33.9)
Acanthosis nigricans	n=103	n=299	n=147
Yes	49(45.6)	116(38.8)	30(20.4)
Fatty liver on ultrasound	n=62	n=161	n=76
Yes	31(50)	92(57.1)	46(60.5)
Dyslipidemia on treatment	n=62	n=185	n=101
Yes	6(9.68)	27(14.5)	19(18.8)
Hypertension on treatment*	n=105	n=311	n=157
Yes	13(12.4)	73(23.5)	53(33.7)
Systolic hypertension*	n=99	n=299	n=153
Yes	4(4.1)	41(13.7)	35(22.9)
Diastolic hypertension*	n=99	n=299	n=153
Yes	9(9.1)	28(9.4)	7(4.6)
Waist circumference	n=79	n=247	n=130
Mean	100.7(14.4)	100.6(13.1)	100.4(12.6)
≥94 cm males o ≥90 cm females	59(74.7)	197(79.8)	106(81.5)
≥102cm males o ≥88 cm females	52(65.8)	172(69.6)	90(69.2)
Hypercholesterolemia*	n=85	n=247	n=131
Yes	50(58.8)	139(56.3)	56(42.7)
Hypertriglyceridemia	n=88	n=243	n=137
Yes	60(68.18)	163(67.08)	84(61.31)
High LDL-C	n=51	n=193	n=112
Yes	38(74.5)	150(77.7)	71(63.4)
Low HDL-C	n=51	n=193	n=112
Yes	36(70.6)	130(67.4)	64(57.1)
Hemoglobin A1c*	n=75	n=222	n=121
Mean	9.5(2.7)	9.2(2.3)	8.0(2.0)
< 7	20(26,7%)	45(20.3%)	53(43.8%)
7 to 9	18(24%)	74(33.3%)	36(29.7%)
> 9	37(49.3%)	103(46.4%)	32(26.4%)

Glycemia*	n=100	n=294	n=134
Mean	271.3(116.9)	256.5(106.1)	217.3(88.2)
<150	15(15%)	61(20.7%)	43(32.1%)
150-200	12(12%)	42(14.3%)	29(21.6%)
≥200	73(73%)	191(64.9%)	62(46.3%)

Table 4: Patient Characteristics according to age at diagnosis.
*P < 0.05

Patterns of Initial Treatment Prescribed

Regarding treatment, most patients with T2D debut received pharmacological treatment with a single drug (60.6%), while only 2.8% received a diet as the sole prescription as shown in Table 5. Most (68.3%) of the pharmacological monotherapy was with metformin.

Treatment (N=581)	n (%)
Diet only	16 (2.8%)
Monotherapy	352 (60.6%)
Dual Therapy	147 (25.3%)
Triple Therapy	66 (11.4%)

Table 5: Initial treatment prescribed.

Discussion

This study describes the main clinical and laboratorial characteristics of newly diagnosed patients with T2D at different regions of Peru, including centers located at high altitude. Most patients were middle aged with 84.4% having excess weight; the mean blood glucose and HbA1c were 249.4 mg/dl and 8.9%, respectively.

As there is no national validation of waist circumference cut off, we evaluated different definitions such as that of Aschner et. al. that was developed for Latin American population (≥ 94 cm men or ≥ 90 cm women) and a definition made for the US population (≥102 cm men or ≥88 cm women) [8,9]. Using both, an increased waist circumference was observed in more than 68% of the individuals. This high percentage in the newly diagnosed diabetic population coincides with other study published in Peru that found a frequency of abdominal obesity of 65.6% [10].

In 39.2% of the participants the BMI at diagnosis fell in the overweight category, while 45.1% fell in the obese category. Different studies in the Peruvian general population have found percentages of overweight and obesity ranging from 40% to 62% [11]. In a study published in Peru, the frequency of non-morbid obesity (BMI 30-39) and morbid obesity (BMI> 40) was estimated through different national surveys from 1975 to 2013. The authors found that non-morbid obesity increased from 8.5% to 18.5%, while morbid obesity had only a 1% increase in the same period [12]. It is important to highlight that 69.9% of this sample of diabetic patients fell in the range of overweight and mild obesity, while 14.5% had a BMI greater than 35.

Centers in the north and east had a higher percentage of overweight, while those in Lima had higher percentage of obese subjects. However, there were no significant differences in waist circumference between individuals according to geographical location. The highest values of glycemia and glycosylated hemoglobin were observed in the North and Lima. This observation is relevant to prioritize interventions to the locations showing highest risk. It has been reported that subjects living at high altitude have lower prevalence of T2D, lower frequency of obesity and shorter waist circumference [13-15]. In our study, the phenotype of the diabetics living at high altitude was similar to that of those living at sea level, except for levels of total cholesterol and LDL-c that were lower at high altitude. Such results may be due to differences in dietary habits.

In 56.7% of patients with newly diagnosed T2D who had abdominal ultrasound, findings were compatible with hepatic steatosis. In addition, there was higher frequency of fatty liver in diabetics from high altitude, while there was no difference by age at diabetes debut. There was lower percentage of fatty liver in subjects from the north of the country, in contrast to the higher rates of other risk factors observed among these patients [16-18].

Recent studies have shown that the characteristics of patients with T2D differ according to the age at which the diagnosis is made [19,20]. Our results show that the majority of patients diagnosed at an advanced age had a previous diagnosis of prediabetes (self-report), and lower frequency of first degree family history of diabetes compared to the other groups. This coincides with previous studies that have shown that patients diagnosed at an early age are more likely to have a family history of diabetes, which may reflect their genetic burden of T2D [21]. We found no significant differences in HDL-c, LDL-c or triglycerides. This coincides with a study in China that also found no difference

in these values [22]. However, it is important to note that elevated total cholesterol was more frequent in the early age group compared to the advanced age group. In addition, an important finding is that elevated glycosylated hemoglobin (greater than 10%) as well as fasting glucose levels greater than 200 mg / dL was observed more frequently in the early diagnosis group compared to those of diagnosed at middle or advanced age. This finding suggests that the metabolic involvement of these patients is more severe than in the other groups and represents an important information to guide the prioritization of interventions.

One of the limitations of the study is inherent to its design as a case series study without a control group (not diabetes). In addition to the descriptive statistics provided, different associations were explored. However, such associations could only generate hypothesis for future studies. Another limitation is the representativeness of the sample, given that convenience sampling was used. Only subjects seeking medical attention could be included. Furthermore, hospitalized subjects were not included. Ultrasound findings suggestive of liver steatosis could not be confirmed by other methods.

As a strength, this is one of the first studies focusing on newly diagnosed patients with T2D in Peru. Laboratory tests and imaging studies were included in our study, in contrast to prior epidemiological studies. The wide distribution of sites at multiple regions is a strength that provides a broad representation of the country. Of particular value was the possibility to explore associations of different variables with location at high altitude. The analysis of different characteristics allows for identification of populations at higher risk and may inform strategies for the prevention and management of this prevalent disease.

Conclusion

This is one of the first studies describing the characteristics of adults with an initial diagnosis type 2 diabetes mellitus in Peru. Subjects from Lima and the north of the country were found to have higher metabolic risk, as well as those diagnosed at an early age. These findings are relevant to inform interventions for prevention and management of this prevalent disease in Peru.

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