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Prevalence of Diabetes, Prediabetes, and Associated Risk Factors Among Agricultural Village Residents in the Dominican Republic

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Abstract. This study examined the prevalence and risk factors of prediabetes and type 2 diabetes among residents of agricultural settlement villages (*bateyes*) in the Dominican Republic. From March to April 2016, a cross-sectional, multi-stage cluster survey was conducted across the country's three agricultural regions (southwest, east, and north). At selected households, an adult completed a questionnaire to assess demographics, diabetes knowledge, and care, and two household residents of any age provided finger-prick blood samples that were analyzed for hemoglobin A1c (HbA1c). HbA1c was categorized as normal (< 5.7%), prediabetic (5.7–6.4%), or diabetic (≥ 6.5%). The prevalence rates of diabetes and prediabetes were 8.6% (95% confidence interval [CI], 6.2–11.8%) and 20.4% (95% CI, 17.9–23.2%), respectively, among all participants (*N* = 1293; median age, 35 years; range, 2–96 years), and 10.0% (95% CI, 7.2–13.8%) and 20.0% (95% CI, 17.4–23.0%), respectively, among adults 18 years or older (*N* = 730). The average age of participants with diabetes was 47.2 years. The average age of participants with prediabetes was 40.7 years. Among adult questionnaire respondents, 64.8% of all participants and 39.4% of patients with diabetes had not been tested for diabetes previously. Among patients with diabetes, 28.4% were previously diagnosed; 1.2% of prediabetes patients were previously diagnosed. Half (50.7%) of the respondents had heard of diabetes. The majority (94.1%) of patients previously diagnosed with diabetes reported using diabetes medication. Among both undiagnosed and previously diagnosed patients with diabetes, diabetes knowledge, previous diabetes testing, and diabetes care-seeking were lowest among Haitian-born participants. A high burden of undiagnosed diabetes and deficiencies in diabetes knowledge, access to care, and diagnosis exist among all *batey* inhabitants, but most acutely among Haitians. Improvements will require a multi-sectoral approach.

INTRODUCTION

Type 2 noninsulin-dependent diabetes (hereafter referred to as diabetes) is a chronic metabolic disease characterized by abnormally high levels of blood glucose.[1] Unregulated blood glucose affects nearly every organ system of the body and can cause severe medical complications, including heart attack, stroke, kidney disease, extremity amputation, nerve damage, and vision loss.[2] In 2015, the International Diabetes Foundation (IDF) estimated that 415 million adults worldwide were living with diabetes; this number is predicted to increase to 642 million by the year 2040.[1] Diabetes contributed to 1.5 million deaths in 2012.[2] Diabetes also imposes a large economic burden on health systems; in 2015, total global health expenditures attributable to diabetes were estimated as $673 billion USD and may increase to $802 billion USD in the year 2040.[1]

Most people with diabetes (75%) live in low-income and middle-income countries (LMICs), where the greatest relative increase in diabetes prevalence (161%) is expected to occur within the next 15 years.[3] Compounding matters, nearly half (46.5%) of all people with diabetes are undiagnosed, thereby placing a large number of people at risk for potentially life-threatening and expensive medical complications.[1,4] In LMICs, the economic impacts are particularly acute in terms of lost productivity. In 2015, almost three-quarters (73%) of diabetes-related deaths in LMICs occurred for people younger than 60 years.[1]

In multiple contexts, diabetes disproportionately affects socially disadvantaged groups. In the United States, individuals with low incomes, individuals with less education, and racial and ethnic minorities are more adversely affected by diabetes compared with the general population.[5–7] Similar findings have been discovered in Thailand,[8] Central America and South America,[9] India,[10] and China.[11] Furthermore, diabetes tends to cluster with other comorbidities, including human immunodeficiency virus (HIV), tuberculosis (TB), heart disease, and depression.[12,13] The clustering of these comorbidities among populations affected by poverty or social exclusion has inspired the syndemic model of health.[14] Syndemics refers to two or more diseases that concentrate among disadvantaged social groups and result from and exacerbate social inequalities.[12,15]

The Dominican Republic (population, 10.7 million) is an upper-middle-income developing country that is transitioning from having a predominance of infectious, chronic, noncommunicable diseases.[16–18] For example, in 2016, noncommunicable diseases accounted for 72% of all deaths in the Dominican Republic.[19] The diabetes prevalence in the Dominican Republic has steadily increased since 2000 to 9.3% among adults in 2016[2,18,19] compared with 11 to 16% in the Caribbean overall.[20] A lack of health insurance and high cost of medications have been implicated as important challenges to treating noncommunicable diseases in the Dominican Republic.[21]

Historically, the Dominican sugar industry has relied on a migrant workforce from neighboring Haiti. Migrants lived in *bateyes* (company towns) adjacent to agricultural plantations.

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Today, *bateyes* are some of the poorest areas of the country. Many *bateyes* lack basic water and sanitation services and display high rates of illiteracy, malnutrition, and HIV, which comprise a clustering of health and social problems that could be considered a syndemic.[22,23] Although the Dominican Republic has enshrined the universal right to health in its Constitution and has integrated chronic disease management in primary healthcare,[20] *batey* residents, which include Haitian migrants, Dominican-born persons of Haitian descent, and ethnic Dominicans, frequently have difficulty accessing those services because of the ongoing problems of poverty, discrimination, and lack of documentation.[24,25] There is a potentially large burden of undiagnosed and/or poorly controlled chronic diseases, including diabetes, within this population.

The primary goals of this study were to measure the prevalence of prediabetes and type 2 diabetes in Dominican *bateyes* and to determine the proportion of undiagnosed type 2 diabetes. The study also explored diabetes knowledge and past treatment-seeking experiences to assess possible risks for diabetes. The study findings are framed by the sociopolitical context of *bateyes* and the challenges faced by transitioning countries such as the Dominican Republic, where rapid economic change, a shift in the burden of disease, and legacies of social exclusion continue to impact human health.

METHODS

Study design. This study was nested within a prevalence survey of malaria and lymphatic filariasis (LF) in Dominican *bateyes*.[26] The target population consisted of all persons living in Dominican *bateyes*. The study design was a household-based, cross-sectional, multi-stage cluster survey conducted across three regions in the country from March 9 to April 24, 2016. This time period corresponds to the *zafra*, or annual sugar cane harvest, when most Haitian migrant workers are thought to be present in *bateyes*.

The target sample size of 1446 blood samples was based on detecting prevalence rates of malaria and LF of 5% (±2.5% with 95% two-sided significance level) in each of the three regions with a design effect of 1.5 and a 10% nonresponse rate.

The sampling frame was based on a 2012 nationwide census that identified 426 distinct *bateyes* across four regions: southwest, north, east, and the greater Santo Domingo area.[27] *Bateyes* in greater Santo Domingo were excluded because of discontinued agricultural activity. The remaining *bateyes* were categorized into three strata (regions): southwest, north, and east. To generate representative samples within each region, approximately 17 clusters (*bateyes*) per stratum were randomly selected using the probability of selection proportional to the population size. Several larger *bateyes* were selected more than once; for those cases, the *batey* comprised two (or in one case, three) clusters. Within each *batey*, 15 households were chosen by interval (systematic) selection after a random start using community maps prepared by survey teams before sampling.

Interview and blood testing. The survey consisted of two main components: a household-level questionnaire and blood sample testing. Inclusion criteria for the household questionnaire were as follows: age at least 18 years; resident of a selected house; and able to verbalize consent to participate. Nonresidents of the selected household, individuals younger than 18 years, and persons who did not provide oral informed consent were excluded. The questionnaire was administered to consenting participants in their preferred language (Haitian Kreyòl or Spanish). The questionnaire asked questions about demographics, migration history, diabetes knowledge, attitudes, and practices (KAP), and previous experiences within the healthcare system related to diabetes. Questionnaires were administered by bilingual interviewers fluent in Spanish and native speakers of Haitian Kreyòl. The original English version of the questionnaire was translated to both Haitian Kreyòl and Spanish and then back-translated to English for comparisons with the original survey. The questionnaire was then piloted among a convenience sample. Adjustments were made to ensure the comprehension and comfort of participants. Household questionnaire responses were collected using Eagle Survey (mobile v.1.3.3) software on Samsung GalaxyTab3 tablets.

Finger-prick blood samples were obtained from the questionnaire respondent and one other resident of any age within the household. Inclusion and exclusion criteria for providing a blood sample were the same as those for the household questionnaire with the exception that individuals of all ages were eligible. Children 6 to 17 years of age provided consent to participate after consent was obtained from their parent or guardian. Blood was collected in heparin-coated microtainer tubes and transported to local laboratory facilities for diagnostic testing the day of collection by laboratory scientists affiliated with the Centro Nacional para el Control de Enfermedades Tropicales (CENCET).

Glycemia was assessed by measuring hemoglobin A1c (HbA1c), which is a metabolic blood marker indicative of average glucose levels for the past 3 months, using a rapid diagnostic test (A1C Now+; Bayer, Inc.).[9] Glycemia was categorized according to the American Diabetes Association classifications as normal (HbA1c $< 5.7\%$), prediabetic (5.7–6.4%), or diabetic ($\geq 6.5\%$).[28] After providing consent,[29] questionnaire respondents with diabetic HbA1c values were subgrouped as diagnosed or undiagnosed based on whether the individual reported ever having been diagnosed with diabetes by a healthcare worker.

Human subjects protection. The study was approved by the institutional review boards (IRB) of the University of Florida, the University of Amsterdam, and the National Health Bioethics Council (CONABIOS) in the Dominican Republic; it was declared a nonresearch public health activity by the Emory University IRB. Individual informed oral consent was obtained for each survey component (household survey and blood testing). Children 6 to 17 years of age provided consent to participate in blood testing after consent was obtained from their parent or guardian. Information sheets in either Spanish or Haitian Kreyòl with study information and contact details of study coordinators were provided to participants.

Demographics. Demographic characteristics included age, sex, occupation, residency status, and ethnicity. Permanent residency was defined as having lived in the *batey* for 9 consecutive months during the previous year. Ethnicity was based on self-reporting as Haitian-born, Dominican-born with Haitian descent, or Dominican-born without Haitian descent.

Diabetes knowledge, attitudes, and care experiences. To explore knowledge of diabetes as well as general perceptions of diabetes and previous care experiences, adult questionnaire participants were asked the following: if had they ever heard of diabetes (Kreyòl, *maladi djabèt* or *sik*; Spanish, *diabetes* or *azúcar*); if they could name a symptom of diabetes; if they could name a symptom, then they were asked whether they could also name a body part affected by diabetes; if they had ever been tested for diabetes; if they had ever been told by a healthcare worker that they had diabetes; if they were ever told that they had diabetes, then they were asked whether they have ever used medicine for diabetes; and what they would do if they were ever told by a healthcare worker that they had diabetes. These questions were adapted from the National Health and Nutrition Examination Survey.[30] Item 5 was subsequently used to differentiate diagnosed and undiagnosed participants among those whose HbA1c laboratory samples fulfilled the diagnostic criteria for diabetes.

Data analysis. Electronic questionnaire data were uploaded into Excel (Microsoft Corp., Redmond, WA) and matched with laboratory data based on de-identified, individual-level code identifiers. Laboratory data were double-entered into Excel (Microsoft) by a CENCET staff member. Discrepancies between household and laboratory identification codes were reconciled by reviewing the original paper data forms used by laboratory technicians. Ten observations could not be reconciled and were excluded.

Data analyses were conducted with Stata v14.2. Weighted population estimates and 95% confidence intervals (CI) were calculated using the *svy* command to account for the complex survey design, including clustering, stratification, and sampling weights. Analyses of subgroups (HbA1c categories, ethnic groups) were performed using the *subpop* command.

Univariate logistic regression based on potential risk factors was performed to assess the odds of being prediabetic and diabetic among household questionnaire respondents. This included age, sex, migration status, and ethnicity, as well as knowledge of diabetes and having been previously tested for or diagnosed with diabetes. Individuals with normal HbA1c values served as the reference group in the univariate analyses.

RESULTS

Prevalence of diabetes and prediabetes. A total of 1418 individuals provided blood samples, although 125 had missing HbA1c results. Therefore, 1293 samples were included in this analysis. The median age of individuals providing blood for diabetes testing was 35 years (range, 2–96 years). Most individuals were female (54.3%). The overall prevalence of diabetes was 8.6% (95% CI, 6.2–11.8%), and prevalence of prediabetes was 20.4% (95% CI, 17.9–23.2%) (Table 1). Regional prevalence estimates of diabetes and prediabetes are shown in Figure 1. When stratified by age group, the prevalence rates of diabetes and prediabetes were 0.7% (95% CI, 0.3–2.0%) and 22.6% (95% CI, 15.9–31.1%), respectively, among those 2 to 17 years and 10% (95% CI, 7.2–13.8%) and 20.0% (95% CI, 17.4–23.0%), respectively, among those 18 years and older (Table 1). The average ages of patients with diabetes and prediabetes were 47.2 years and 40.7 years, respectively.

Adult household questionnaire respondent characteristics. The head-of-household questionnaire was completed by 776 adults. After excluding 46 records without matching HbA1c results, 730 respondents were included in the final analysis. Table 2 displays key demographics and diabetes knowledge and treatment results stratified by diabetes categories. The diabetic group included those who reported having been previously diagnosed with diabetes by a healthcare worker ($N = 54$; 57.4%) and those who had not been previously diagnosed ($N = 37$; 39.4%). Fewer than 2% of those in the normal (1.9%) and prediabetic (1.2%) groups reported a previous diabetes diagnosis by a healthcare worker, suggesting a high prevalence of uncontrolled diabetes.

The median age of questionnaire respondents was 43 years (range, 18–93 years). The majority of participants were female (60.8%). Diabetes was more prevalent among women (14.2%) than among men (10.8), whereas the prevalence of prediabetes was equivalent. The prevalence of diabetes and prediabetes increased with age and peaked for the group 56 to 75 years of age. The sampled *batey* population mainly comprised (89.1%) permanent residents. Prevalence estimates of diabetes and prediabetes were higher among permanent residents (13.9% and 22.3%) than among nonpermanent (migrant) respondents (5.1% and 11.4%, respectively).

Those of Haitian descent born in the Dominican Republic comprised the largest ethnic category (38.6%), followed by those born in Haiti (31.8%) and those not of Haitian descent born in the Dominican Republic (29.6%). The diabetes rate was lowest among those born in Haiti (10.4%). The diabetes rate of those of Haitian descent born in the Dominican Republic was 14.0%. The diabetes rate of those not of Haitian descent born in the Dominican Republic was 13.9%. Conversely, the rate of prediabetes was highest among Haitian-born participants (25.1%).

Most respondents (40.6%) were unemployed. Homemakers and domestic workers had the highest prevalence of diabetes (19.6%); only one construction worker had diabetes. The rate of prediabetes was highest among market vendors and street vendors (30.2%), followed by farmers (25.0%).

Half of adult questionnaire respondents reported having heard of diabetes, but most (64.8%) reported not having been

Table 1

Prevalence of diabetes and prediabetes among *batey* residents based on survey regions and age groups in the Dominican Republic in 2016

	Region			Age group (years)		
	Southwest	North	East	Age 2–17	Age ≥ 18	Total
	N = 436, %	N = 427, %	N = 430, %	N = 231, %	N = 1062, %	N = 1293, %
	(95% CI)	(95% CI)	(95% CI)	(95% CI)	(95% CI)	(95% CI)
Normal (HbA1c < 5.7%)	66.3 (60.1–72.0)	71.6 (67.4–75.5)	71.9 (65.3–77.6)	76.7 (68.3–83.4)	69.9 (64.6–74.8)	71.0 (66.3–75.3)
Prediabetes (HbA1c 5.7–6.4%)	21.9 (16.8–28.1)	20.0 (16.6–23.8)	20.2 (16.9–24.0)	22.6 (15.9–31.1)	20.0 (17.4–23.0)	20.4 (17.9–23.2)
Diabetes (HbA1c ≥ 6.5%)	11.8 (8.4–16.3)	8.4 (6.3–11.1)	7.9 (4.9–12.6)	0.7 (0.3–2.0)	10.0 (7.2–13.8)	8.6 (6.2–11.8)

Population estimates and 95% confidence intervals (CI) shown.

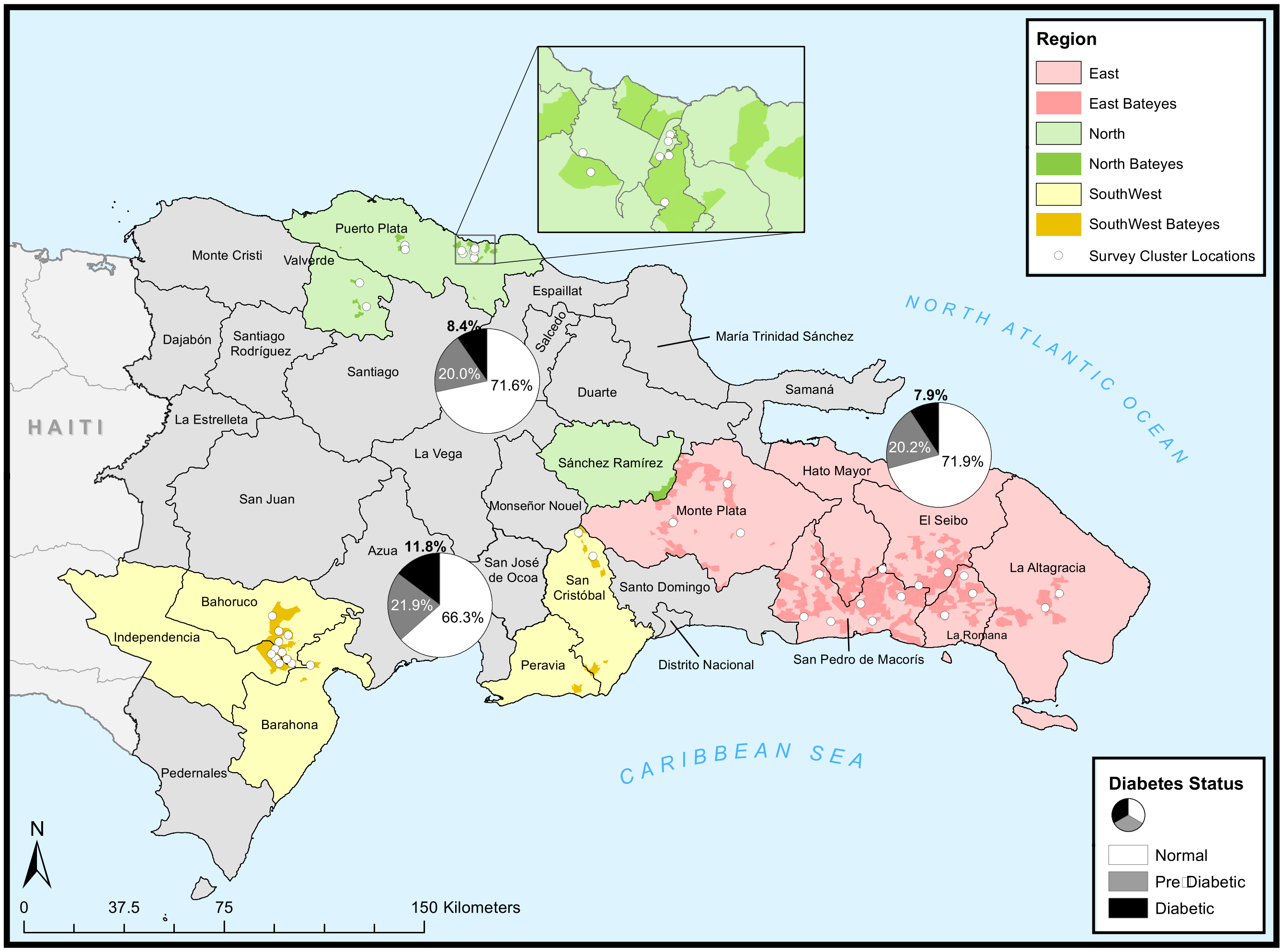

FIGURE 1. Map of the survey strata (colored areas) and *bateyes* (dark shaded areas) in the Dominican Republic. Individual survey cluster locations are indicated by white circles.

tested for diabetes. Among those tested, a greater proportion had diabetes (23.9%) compared with the proportion with diabetes who were not previously tested (7.8%). Most respondents (61.8% overall) could not name a symptom of diabetes. When asked, "What would you do if I told you had diabetes?", the most common responses were "go to a hospital/clinic" (43.0%) and "take medicine" (26.4%). Among patients with diabetes, 94.1% reported ever using medicine for diabetes; only 37.8% of prediabetes patients reported ever using medicine for diabetes.

Risk factors analysis. Table 3 shows the results of univariate logistic regression of potential risk factors for prediabetes and diabetes as independent outcomes compared with the results of participants with normal HbA1c values. Respondents between the ages of 36 and 75 years were at significantly greater risk for both prediabetes and diabetes compared with those between ages 18 and 35. Those between ages 36 and 55 years were at 2.5-times greater risk for prediabetes (95% CI, 1.5–4.2; P = 0.001) and at 2.4-times greater risk for diabetes (95% CI, 1.3–4.4; P = 0.004). Those between ages 56 and 75 years were at 3.1-times greater risk for prediabetes (95% CI, 1.6–5.8; P = 0.001) and 3.0 times greater odds of diabetes (95% CI, 1.4–6.6; P = 0.006). Sex was not significantly associated with prediabetes or diabetes.

Permanent residency was associated with a 2.9-times greater risk of prediabetes (95% CI, 1.3–6.5; P = 0.011) and a nonsignificant 5.2-times greater risk of diabetes (95% CI, 0.8–34.2; P = 0.086). Documentation status was not significantly associated with either prediabetes or diabetes. Among ethnic groups, those of Haitian descent born in the Dominican Republic were at significantly lower risk for prediabetes compared with Haitian-born individuals (odds ratio [OR], 0.4; 95% CI, 0.2–0.7; P = 0.004). Other associations between ethnic group and disease status were not significant. Compared with farmers, other occupations were not significantly associated with prediabetes or diabetes; however, there was a significantly lower risk of diabetes among construction workers (OR, 0.04; 95% CI, 0.003–0.4; P = 0.007).

There was no significant difference in the risks of prediabetes and diabetes for those who had previously heard of diabetes and those who had not. However, the risk of diabetes was 4.0-times greater among those who reported previously being tested for diabetes compared with those who had not been tested (95% CI, 1.9–8.0; P < 0.001).

Figure 2 shows a comparison of diabetes knowledge, testing, and treatment across ethnic groups. Across all indicators, Haitian-born individuals had the lowest levels of diabetes knowledge and reports of previous diagnosis

TABLE 2

Demographic data and diabetes knowledge and treatment characteristics among adult questionnaire respondents overall and by diabetic status in the Dominican Republic in 2016

	Total	Diabetic category		
		Normal	Prediabetic	Diabetic
	No. (column %)	HbA1c	HbA1c	HbA1c
	N = 730	No. (row %)	No. (row %)	No. (row %)
		N = 483	*N* = 153	*N* = 94
Age group, years				
18–35	255 (35.0)	204 (80.0)	34 (13.3)	17 (6.7)
36–55	287 (39.4)	179 (62.3)	63 (22.0)	45 (15.7)
56–75	158 (21.7)	81 (51.3)	49 (31.0)	28 (17.7)
≥ 76	29 (4.0)	18 (62.1)	7 (24.1)	4 (13.8)
Sex				
Female	444 (60.8)	287 (64.6)	94 (21.2)	63 (14.2)
Male	286 (39.2)	196 (68.5)	59 (20.6)	31 (10.8)
Residency status				
Nonpermanent/migrant	79 (10.9)	66 (83.5)	9 (11.4)	4 (5.1)
Permanent	647 (89.1)	413 (63.8)	144 (22.3)	90 (13.9)
Documentation status				
Undocumented	84 (11.6)	62 (73.8)	17 (20.2)	5 (6.0)
Documented	643 (88.5)	418 (65.0)	136 (21.2)	89 (13.8)
Ethnicity				
Haitian-born	231 (31.8)	149 (64.5)	58 (25.1)	24 (10.4)
Dominican-born and of Haitian descent	215 (29.6)	147 (68.4)	38 (17.7)	30 (14.0)
Dominican-born and not of Haitian descent	280 (38.6)	185 (66.1)	56 (20.0)	39 (13.9)
Primary occupation				
Farmer	144 (19.8)	92 (63.9)	36 (25.0)	16 (11.1)
Unemployed	296 (40.6)	196 (66.2)	58 (19.6)	42 (14.2)
Homemaker/domestic worker	97 (13.3)	61 (62.9)	17 (17.5)	19 (19.6)
Market vendor/retail/shop	86 (11.8)	52 (60.5)	26 (30.2)	8 (9.3)
Construction	28 (3.8)	24 (85.7)	3 (10.7)	1 (3.6)
Other	78 (10.7)	57 (73.1)	13 (16.7)	8 (10.3)
Ever heard of diabetes?				
No	223 (30.6)	151 (67.7)	47 (21.1)	25 (11.2)
Yes	369 (50.7)	241 (65.3)	74 (20.1)	54 (14.6)
Do not know	136 (18.7)	89 (65.4)	32 (23.5)	15 (11.0)
Ever been tested for diabetes?				
No	472 (64.8)	334 (70.8)	101 (21.4)	37 (7.8)
Yes	226 (31.0)	131 (58.0)	41 (18.1)	54 (23.9)
Do not know	30 (4.1)	16 (53.3)	11 (36.7)	3 (10.0)
Symptom of diabetes (first cited)				
Thirst/hunger	102 (14.0)	67 (66.0)	18 (17.7)	17 (16.7)
Urinary symptoms	60	37	13	10

(continued)

Table 2
Continued

	Total	Diabetic category		
		Normal	Prediabetic	Diabetic
	No. (column %)	HbA1c	HbA1c	HbA1c
	N = 730	No. (row %)	No. (row %)	No. (row %)
		N = 483	*N* = 153	*N* = 94
	(8.2)	(61.7)	(21.7)	(16.7)
Other	116 (15.9)	76 (65.5)	19 (16.4)	21 (18.1)
Do not know	450 (61.8)	301 (66.9)	103 (22.9)	46 (10.2)
If able to name symptom: Body part affected by diabetes?				
Feet	67 (24.1)	49 (73.1)	8 (11.9)	10 (14.9)
Eyes	78 (28.1)	44 (56.4)	14 (18.0)	20 (25.6)
Skin	41 (14.8)	24 (58.5)	12 (29.3)	5 (12.2)
Other	38 (13.7)	22 (57.9)	8 (21.1)	8 (21.1)
Do not know	54 (19.4)	41 (75.9)	8 (14.8)	5 (9.3)
What would you do if told you had diabetes?				
Go to hospital/clinic	313 (43.0)	210 (67.1)	69 (22.0)	34 (10.9)
Use medicine	192 (26.4)	119 (62.0)	35 (18.2)	38 (19.8)
Change my diet	31 (4.3)	20 (64.5)	9 (29.0)	2 (6.5)
Exercise	4 (0.6)	4 (100)	0 (0)	0 (0)
Other	13 (1.8)	8 (61.5)	4 (30.8)	1 (7.7)
Do not know	175 (24.0)	120 (68.6)	36 (20.6)	19 (10.9)

compared with those of Haitian descent born in the Dominican Republic and those not of Haitian descent born in the Dominican Republic. Significantly fewer Haitian-born individuals (19.6%) had heard of diabetes compared with Dominican-born individuals of Haitian descent (78.9%) and Dominican-born individuals not of Haitian descent (63.7%) (Figure 2A). Haitian-born individuals comprised the largest and statistically significant proportion unable to name a symptom of diabetes (81.9%), followed by Dominican-born individuals of Haitian descent (67.7%) and Dominican-born individuals not of Haitian descent (47.4%) (Figure 2B). Only 7.2% of Haitian-born individuals reported previously being tested for diabetes compared with 28.1% of Dominican-born individuals of Haitian descent and 45.4% of Dominican-born individuals not of Haitian descent (Figure 2C). Among patients with diabetes (HbA1c $\geq$ 6.5), only 6.5% of Haitian-born individuals reported being previously diagnosed with diabetes by a healthcare worker compared with 27.0% of Dominican-born individuals of Haitian descent and 51.8% of Dominican-born individuals not of Haitian descent (Figure 2D).

DISCUSSION

This cross-sectional survey in Dominican *bateyes* found that 20% of adult questionnaire respondents were prediabetic and 10% were diabetic. This diabetes estimate is similar to the 2016 nationwide estimate of 9.3% in the Dominican Republic.[18] Initially, this similarity may seem surprising under the assumption that *batey* residents are predominantly migrant laborers and, therefore, might have a lower prevalence of diabetes compared with the general population. However, we found that most study participants were permanent residents and unemployed, meaning that *batey* populations were more sedentary than expected. We also found that 22.6% of children aged 2 to 17 years had prediabetes. However, the prevalence rates of prediabetes were found to be 17.8% in the southern cone of Latin America, 17.1% in Peru, 24.0% in South Asia, and 9.9% in South Africa.[31] In a cross-sectional study in Northeast China, the estimated prevalence rates of diabetes and prediabetes were 9.1% and 19.8%, respectively,[32] which were similar to the results of this study.

This study observed a consistent link between permanent residency and diabetic status. According to univariate analyses, the risk for prediabetes was 2.9-times higher among permanent residents compared with migrants. In this setting, permanent residency and ethnicity are associated with each other, with Dominican-born persons more likely to be permanent residents of *bateyes* than Haitian-born *batey* inhabitants.[33] Although diabetes seemed to affect the Dominican-born population, which includes individuals of and not of Haitian descent, more than individuals who were born in Haiti, prediabetes was more common among Haitian-born individuals. These findings suggest how the epidemiologic transition manifests itself in this context:

TABLE 3
Univariate logistic regression analysis of risk factors for prediabetes and diabetes among adult questionnaire respondents (*N* = 730) in the Dominican Republic in 2016

		Prediabetes		Diabetes	
	n	Odds ratio† (95% CI)	*P* value	Odds ratio† (95% CI)	*P* value
Age group, years*					
18–35	255	ref	0.001*	ref	0.004*
36–55	287	2.5	0.001*	2.4	0.006*
56–75	158	(1.5–4.2)	0.478	(1.3–4.4)	0.545
≥ 76	29	3.1		3.0	
* Missing = 1		(1.6–5.8)		(1.4–6.6)	
		1.5		1.7	
		(0.5–4.7)		(0.3–11.0)	
Sex			0.889		0.398
Female	444	ref		ref	
Male	286	1.1		0.8	
		(0.6–1.9)		(0.4–1.4)	
Residency status*			0.011*		0.086
Nonpermanent (migrant)	79	ref		ref	
Permanent	647	2.9		5.2	
		(1.3–6.5)		(0.8–34.2)	
* Missing = 4					
Documentation status*			0.780		0.124
Undocumented	84	ref		ref	
Documented	643	1.1		3.7	
* Missing = 3		(0.5–2.6)		(0.7–20.1)	
Ethnicity*					
Haitian-born	231	ref	0.004*	ref	0.167
Dominican-born with Haitian descent	215	0.4	0.912	1.6	
Dominican-born without Haitian descent	280	(0.2–0.7)		(0.8–3.4)	0.597
* Missing = 4		1.0		1.2	
		(0.6–1.6)		(0.5–2.8)	
Primary occupation*					
Farmer	144	ref	0.523	ref	0.835
Unemployed	296	0.8	0.180	1.1	0.062
Homemaker	97	(0.4–1.6)	0.570	(0.6–2.0)	0.900
Market vendor/retail/shop	86	0.5	0.525	2.8	0.007*
Construction	28	(0.2–1.4)	0.847	(0.9–8.2)	0.593
Other	78	1.4		0.9	
* Missing = 1		(0.4–4.3)		(0.3–3.2)	
		0.6		0.04	
		(0.1–3.2)		(0.003–0.4)	
		0.9		1.5	
		(0.3–2.4)		(0.4–6.0)	
Ever heard of diabetes*					
No	223	ref	0.835	ref	0.108
Yes	369	1.1	0.787	1.7	0.568
Do not know	136	(0.6–2.0)		(0.9–3.3)	
* Missing = 2		0.9		1.4	
		(0.3–2.5)		(0.5–4.6)	
Ever been tested for diabetes*					
No	472	ref	0.517	ref	< 0.001*
Yes	226	0.8	0.432	4.0	0.785
Do not know	30	(0.5–1.4)		(1.9–8.0)	
* Missing = 2		1.6		1.2	
		(0.5–5.9)		(0.2–7.7)	

Estimates were weighted and adjusted for the survey design.
* $P < 0.05$.
† Reference group: questionnaire respondents with normal (< 5.7) HbA1c values.

Haitian-born individuals, having come from a more impoverished country where infectious disease is still a major killer, appear to be at higher risk for prediabetes. In separate analyses,[26] unemployment was lowest among the Haitian-born population, suggesting that activity from manual labor at nearby sugar plantations may exert a protective effect against diabetes. Dominican-born individuals living in a more established (although, at times, just as precarious) setting appeared to be more at risk for diabetes, perhaps because of sedentarism from unemployment.

There are notable gaps in diabetes detection, knowledge, and treatment in these communities, with additional disparities between the Haitian-born population and those born in the Dominican Republic. One of the most concerning findings is that the majority of patients with diabetes were undiagnosed. A similar proportion overall had not been tested for

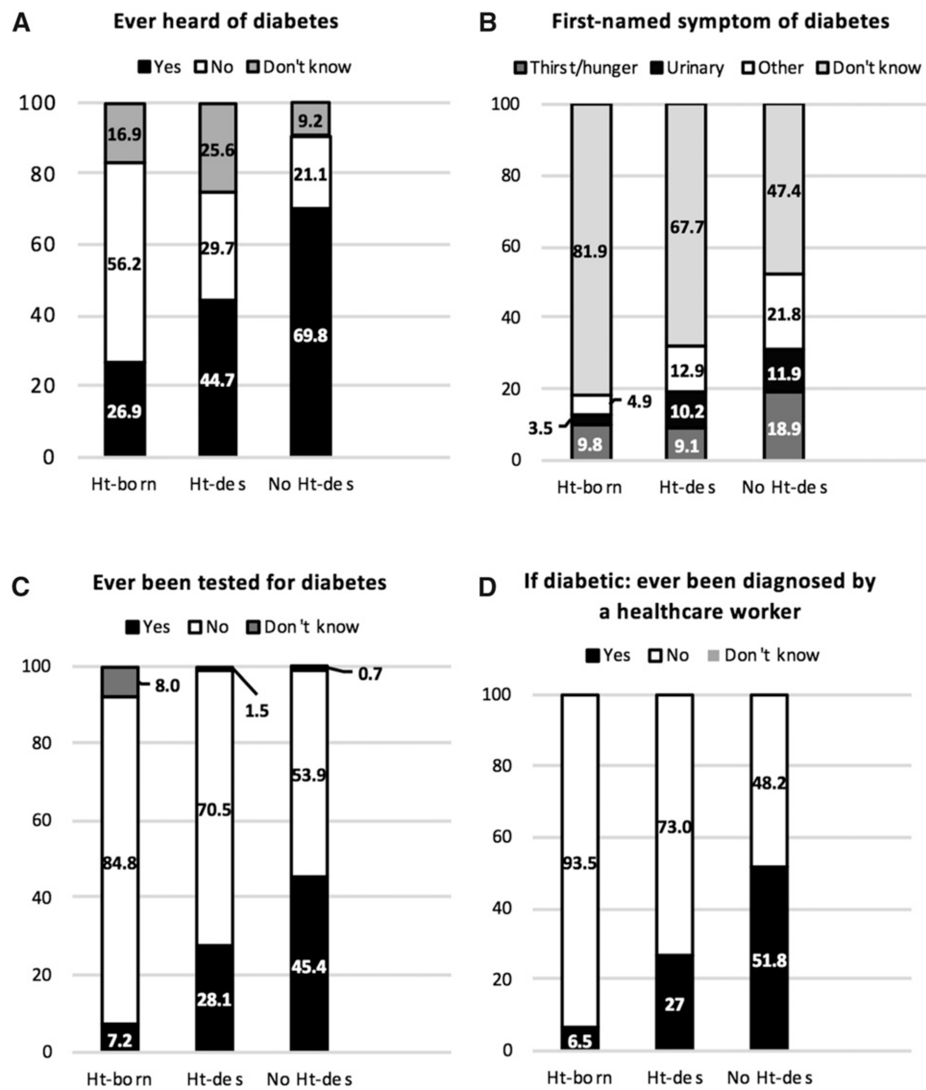

FIGURE 2. Comparisons of diabetes knowledge, testing, and treatment based on ethnicity in the Dominican Republic in 2016. Population-level estimates are shown. Ht-born = Haitian-born; Ht-des = Dominican-born and of Haitian descent; No Ht-des = Dominican-born and not of Haitian descent.

diabetes, and half of the participants had not heard of diabetes. Not surprisingly, one-quarter of respondents reported they would not know what to do if they were diagnosed with diabetes. Yet, among the small number of those who were previously diagnosed with diabetes, the majority (94.1%) reported using medicine for diabetes.

Overall, residents of *bateyes* are at considerable risk for undiagnosed diabetes, have not been adequately exposed to information about diabetes and/or how to incorporate health messages into daily life, and possibly encounter barriers to accessing health centers where they may be diagnosed. It is also possible that these findings reflect deficiencies in the diagnosis, suggesting the need for awareness and education as well as initiating and maintaining diabetes treatment at healthcare centers. This will help decrease the prevalence of diabetes and complication costs and promote better health outcomes.

When stratified by ethnic group, the proportions of undiagnosed diabetes were highest among the Haitian-born (41.1%) and Haitian-descended (37.5%) populations and lowest among those born in the Dominican Republic not of Haitian descent (21.4%). Furthermore, knowledge of diabetes appeared to be worse among the Haitian-born population compared with those born in the Dominican Republic. Finally, blood testing for diabetes was lowest among Haitian-born individuals compared with the other two groups. Together, these findings may reflect broader patterns of difficulty accessing healthcare for Haitian-born residents of *bateyes*, who may be on the verge of diabetes considering their increased risk for prediabetes. In and near *bateyes*, care is generally provided by publicly subsidized, government-controlled *unidades de atención primaria* (UNAPs), or primary care clinics; aside from transportation costs to reach these sites, the uninsured are sometimes charged user fees.[22,30] Authorized legal status is required to qualify for the nation's subsidized health insurance scheme (Spanish acronym SENASA).[34] Undocumented individuals or those whose legal status may have been limbo since the 2013 *Sentencia* likely face cost barriers. However, the problem of low insurance coverage and cost barriers is not limited to the

Haitian-born or Haitian-descended population; only 21% of the country as a whole has some form of insurance.[35] Clearly, there are deep structural problems involved with making healthcare more affordable for most of the population. This disparity poses a formidable challenge to reaching the groups that diabetes seems to disproportionately affect: the Dominican-born population, which includes individuals of and not of Haitian descent.

Despite apparent shortcomings in healthcare access, diagnosis, and treatment, it is still impressive that among previously diagnosed patients with diabetes ($N = 37$), almost all (94.1%) reported ever using medicine for diabetes. Furthermore, 65.2% of the overall population said that they would seek care at a hospital or clinic or use medicine—the two most popular responses, aside from "do not know," when asked to name where they would go or what they would do if diagnosed. These findings suggest that despite poor diabetes knowledge, the *batey* population would still seek care at healthcare centers and/or would be willing to use medication to control diabetes. Because many people would still rely on the health system for care, strengthening the clinical capacity will be a crucial component of addressing diabetes disparities. It is necessary to ensure the availability of diagnostic tests and medications and improve clinical knowledge among those who are responsible for providing care to this population on a regular basis.

LIMITATIONS

Despite conducting the survey in the evenings and on weekends, when most household members were reportedly available, selection bias could have resulted from under-enrollment of individuals working or otherwise out of the house at the time of the survey. This most likely would overestimate the population-wide prevalence estimates for prediabetes and diabetes. Reliance on isolated HbA1c values in conjunction with self-reported diagnosis can also result in overestimation of undiagnosed diabetes.[36] All surveys, including this one, are susceptible to desirability bias from respondents. To reduce bias and facilitate comprehension, survey respondents were given the option of completing the survey in the language of their choice (Spanish or Haitian Kreyòl). To the extent that this may have affected results, it is not expected to significantly differ across disease categories because participants were unaware of HbA1c test results at the time of interview. A portion of observations (8.8% of all laboratory results and 6.0% of survey questionnaires) were excluded because of missing HbA1c values. Although there was not an obvious systematic reason for their absence, this may have influenced results. Nonparticipation is another source of potential bias. Anecdotal reports indicated that refusal to participate was rare. Unfortunately, this was not formally recorded by field teams, which means we are unable to calculate the response rate for the study.

The survey did not explore diet, food insecurity, or food costs; however, this information would have provided additional insight regarding the study findings and how people may be constrained in their efforts to obtain nutritious food. For example, the finding that the prevalence of prediabetes was second-highest among farmers is possibly explained by their access to raw sugarcane in the fields; however, this warrants evaluation. Diabetes is known to be significantly associated with food insecurity,[37] and the highly globalized production, distribution, and consumption of highly processed foods have been major drivers of the epidemiologic transition in LMICs.[38,39] It would be helpful to understand what food choices are available to residents of *bateyes*, whether and to what degree they experience food insecurity, and possible associations with diabetes status. Such information could further inform public health and social policy.

CONCLUSION

There is a high burden of undiagnosed diabetes for residents of Dominican *bateyes*, a significant burden of prediabetes among *batey* youth, and deficiencies in access to diabetes care and diagnosis across all ethnic groups. This burden is most acute among Haitian-born individuals. Improvements will require a multi-sectoral approach among community health networks, the public health system, and political institutions.

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