Type 2 Diabetes Prevalence, Awareness, and Risk Factors in Rural Mali: a Cross-sectional Study

Abdoulaye Diawara
University of Sciences, Techniques and Technologies of Bamako
Djibril M. Coulibaly
University of Sciences, Techniques and Technologies of Bamako
Talib Y. Abbas
Burhani College
Cheickna Cisse
University of Sciences, Techniques and Technologies of Bamako
Jian Li
Tulane University
Mamadou Wele
University of Sciences, Techniques and Technologies of Bamako
Mahamadou Diakite
University of Sciences, Techniques and Technologies of Bamako
Kassim Traore
Campbell University
Seydou O. Doumbia
University of Sciences, Techniques and Technologies of Bamako
Jeffrey G. Shaffer (jshaffer@tulane.edu)
Tulane University

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Abstract

Diabetes is currently a crisis in sub-Saharan West Africa (SSWA) with dramatic implications for public health and national budgets prioritizing infectious diseases. There is limited recent literature about prevalence, awareness, and risk factors for type 2 diabetes (T2D) in rural parts of SSWA. This study aims to fill this gap through a field study in the rural Malian community of Nièna, which is situated in Mali's second-largest province of Sikasso. From December 2020 to July 2021, a cross-sectional study of 412 participants was conducted in Nièna. Clinical questionnaires and rapid diagnostic tests were administered, and data were collected on patient demographics, anthropometric parameters, biochemical indexes tests, and diabetes awareness. Among 412 participants, there were 143 (34.7%) and 269 (65.3%) male and female participants, respectively. The overall prevalence of T2D was 7.8% (32/412), and prevalence rates were 8.9% (24/269) and 5.6% (8/143) for females and males, respectively. Family history of diabetes, hypertension, and fetal macrosomia were significantly associated with T2D ($p < .001$, $p < .001$, and $p = .005$, respectively). Notably, 62.5% (20/32) of T2D subjects were unaware of their diabetic status before the study. Among those previously diagnosed with T2D, only 29.4% (5/17) reported receiving routine care, treatment, or blood glucose control. This study suggests that diabetic unawareness and uncontrolled diabetes are disturbingly common. T2D would have devastating consequences in rural parts of Africa, where they often lack adequate resources, health care facilities, and qualified staff. Future studies are needed to determine whether the results presented here are generalizable to urban parts of Mali and, more broadly, to other parts of SSWA.

Introduction

According to the International Diabetes Federation (IDF), approximately 425 million people worldwide have diabetes [1,2]. The IDF predicts that there will be 622 million diabetics worldwide by 2040 [3,4]. Over the past three decades, reported type 2 diabetes (T2D) cases have risen dramatically and now account for approximately 90% of all diabetes cases worldwide [5]. Undiagnosed or inadequately controlled T2D poses risks of incapacitating and irremediable complications such as damage to the heart, eyes, kidneys, and nerves. Diabetes is a major cause of blindness, kidney failure, heart attacks, stroke, and lower limb amputation [6,7]. Diabetic complications may also lead to an increased risk of limb amputation, loss of vision, and early death [1].

While premature mortality from most major noncommunicable diseases (NCDs) has diminished over the past few decades, premature deaths from diabetes increased by 5% between 2000 and 2016 [1]. Populations with increased proportions of diabetes pose significant impediments for attaining goals such as those set forth by the United Nations Sustainable Development Goals for reducing premature mortality from NCDs [1]. Global studies have also shown an increased risk of severe illness and death among patients with coronavirus disease 2019 (COVID-19) [8,9]. A recent study showed that 18.3% of COVID-19 deaths in Africa were among people with diabetes, and nearly 20% of COVID-19 deaths were linked with diabetes [8–10].

Diabetes is now widely considered a crisis in Africa [11]. Already maintaining the world's most considerable burden of HIV/AIDS and malaria, Africa is now faced with alarming increases in diabetes [10,12]. Poverty, social inequality, lack of and limited access to quality health care have exasperated the diabetes epidemic in Africa. Through the middle of the 1980s, diabetes was considered rare in sub-Saharan Africa, where reported prevalence rates in a number of countries were less than 1% [13]. Africa has experienced a six-fold increase since the 1980s, rising from 4 million cases in 1980 to 25 million cases in 2014 [5,8]. The prevalence of diabetes in sub-Saharan West Africa (SSWA) has particularly increased rapidly over the past decade, affecting people in all sectors of society with substantial economic effects [6,7,10]. Many health systems in SSWA have inadequate capacity for mitigating the current burden of diabetes and its complications [11,14,15]. A study in Kenya revealed that 60% of people diagnosed with diabetes were not receiving treatment [16].

Few recent studies have quantified the prevalence of diabetes in rural African communities, but those conducted have generally shown increased occurrence and high unawareness levels. For instance, a population-based cross-sectional study among adults in 24 communities from Zambia and South Africa reported age-standardized prevalence of diabetes rates of 3.5% and 7.2%, respectively [12]. This study also revealed that, among those confirmed with diabetes, 34.5% in Zambia and 12.7% in South Africa were unaware of their diabetic status. In Zambia, diabetic awareness was higher among individuals with better education and higher household socioeconomic position [12]. In Nigeria, a systematic review provided a comprehensive report on the epidemiology of T2D since its last nationwide survey of NCDs in 1997. Age-adjusted prevalence rates of T2D in Nigeria among persons aged 20–79 years increased from 2.0% in 1990 (874,000 cases) to 5.7% in 2015 (4.7 million cases) [17]. In addition to this observed increase, many persons living with T2D were undiagnosed, and few reportedly received treatment [16,17]. T2D increases in Africa may be associated with factors such as urbanization, adaptative lifestyle behaviors (obesity, alterations in eating habits, and reduced physical activity), genetics [17], hypertension, changing age demographics, and pregnancy rates [18,19]. It has been estimated that 59.7% of diabetes cases are undiagnosed in Africa (the highest percentage of undiagnosed cases in the world) and that higher proportions of undiagnosed cases are found in low-income countries than in middle-income countries [20].

In Mali, diabetes prevalence was reported by the IDF as 2.4%, but it is widely believed to be grossly underestimated. Studies have reported T2D prevalence rates ranging from 0.4–5.0% through field studies between 1976 and 2017. In 1976, the prevalence of diabetes was reported as 1.4% in Bamako, which was subsequently reported as 3.0% in 2017 among patients consulted through general medicine clinics [18,21]. In a study performed in 1987 at a referral center in Bamako, 0.9% of subjects with T2D resided in rural areas [14,16,22]. In 2017, a similar study reported T2D prevalence as 5.5% [18].

The potential impact of T2D is substantial in Mali, with dramatic implications for public health and national budgets that largely prioritize infectious diseases [14,23]. The paucity of literature and field studies in rural parts of the country have led to significant challenges in fighting the rise in T2D. To date, nationwide health surveys on diabetes have not been routinely performed in Mali. For this reason, it is vital to determine and monitor the burden of diabetes in Mali to facilitate appropriate health resource allocation, advocacy, and planning. While alarming increases in diabetes have been observed in other parts of Africa, it is unknown whether these trends occur in Mali's rural parts [21]. Insight is needed on the epidemiological aspects of T2D in rural communities to facilitate and provide better preventive and targeted therapeutic approaches. For these reasons, this study aimed to determine the prevalence, risk factors, and awareness for T2D in the rural Malian community of Nièna.

Methods And Materials

Ethics statement

The study was approved by the Ethics Committee at the University of Sciences, Techniques and Technologies of Bamako (USTTB, reference number: 2021/164/CE/USTTB). Each study participant was at least 20 years of age and provided oral informed consent.

Study site

Nièna is a rural commune in Mali, located in the Sikasso Circle along a national road (Highway RN7) connecting Bamako, Sikasso, and its neighboring country of Côte d'Ivoire [24]. Niéna has an area of 1,040 square kilometers and includes 45 villages and a population of 51,086 (population density = 51,086/1,040 = 49.1 people per square kilometer). Nièna's capital city of Ganadougou was inhabited in the sixteenth century by the Peul (Peulh) and Bambara People [25]. The Gana (Ganadougou) People were attracted to the Nièna primarily because of its agricultural and pastoral activities [25]. Nièna is shown in terms of its proximity to Bamako in Fig. 1.

Study design

This cross-sectional study was carried out between December 2020 and July 2021. Sample sizes were determined according to the estimated proportion of the population with T2D or pre-diabetes. The study sample size was determined based on a single proportion, specifically

$$n = \left(z_{1-\alpha/2}\right)^2 \cdot p\,(1-p)/d^2,$$

where *n* is the minimum sample size, α is the type I error rate, $z_{1-\alpha/2}$ is the $1-\alpha/2\,th$ percentile for the standard normal distribution curve, and *d* is the margin of error. Assuming that the population living with T2D or pre-diabetes was 6.0%, for a type I error rate of 5.0%, a margin of error of 5.0%, and a 10.0% non-response rate, the sample size was determined as a minimum of 406 study subjects.

Inclusion criteria were residents of the Nièna community aged at least 20 years. Participants were recruited randomly through public health campaigns in Nièna and its surrounding communities of Dougoukolobougou and Banzana. To foster community engagement and maximize study participation, outreach study personnel coordinated meetings with leaders from villages, neighborhoods, religious groups, local health facilities, and administrative personnel prior to enrollment activities. Selected participants were consulted about the purpose of the study and informed of its potential risks. Those subjects interested in participating in the study provided oral informed consent. All activities were undertaken in accordance with local community policies, regulations, and procedures.

Data collection

Data was collected through individual interviews and clinical questionnaires, which captured information on sociodemographic characteristics (age, sex, occupation), ethnicity, and family health history of diabetes. Blood pressure and anthropometric characteristics were measured and recorded, including height, body weight, and waist circumference. Blood tests were performed using finger pricks with Accu-Chek (Roche Diabetes Care, Inc., Indianapolis, IN) glucometers. Testing was based on fasting glycemia for participants fasting 8 to 12 hours before testing.

Definitions

Diabetic status was defined according to the World Health Organization (WHO) Advisory Group Report and IDF criteria. Fasting plasma glucose of at least 126 mg/dL was considered positive for T2D. Pre-diabetic status was considered as fasting plasma glucose level between 111 mg/dL and 125 mg/dL. Fasting plasma glucose levels under 110 mg/dL were considered non-diabetic. Participants with blood sugar levels of at least 126 mg/dL or between 111 mg/dL and 125 mg/dL were invited to complete a second test. Participants were categorized into four groups according to body mass index (BMI) measurements. BMI breakpoints were set at: greater than or equal to 30.0 kg/m^2 (obese), between 25.0 kg/m^2 and 29.9 kg/m^2 (overweight), between 18.5 kg/m^2 and 24.9 kg/m^2 (normal), and less than 18.5 kg/m^2 (underweight). Abdominal obesity was defined as a waist circumference of at least 80 cm. and 90 cm. for females and males, respectively. Hypertension was defined as systolic blood pressure at least 140 mmHg, diastolic blood pressure of at least 90 mmHg, or current use of antihypertensive drugs. For family history of diabetes, immediate family members (father, mother, sister, or brother) were considered first-degree family members. Subject occupations were classified according to physical activity: light (such as sitting office work or retirement activities), moderate (occupations involving standing and walking such as store assistants or teachers), and active (occupations with walking, lifting, heavy manual labor).

Statistical analysis

All data were analyzed using SPSS for Windows (version 26, IBM Corp., Armonk, NY). Univariate analyses were performed on the following predictors: sex, age, occupation, hypertension, family history of diabetes, BMI, waist circumference, and ethnicity. Pearson's chi-square tests were used to test hypotheses for relationships between two categorical variables. Pairwise comparisons between categorical predictors were performed using logistic regression with multiple comparisons. Statistically significant risk factors in univariate analyses were included in multivariate logistic regression analyses. The type I error threshold was set at 5%.

Results

Study population

A total of 412 subjects were enrolled, with 87.9% (362/412) classified as non-diabetic. The overall prevalence rates for pre-diabetes and diabetes were 4.4% (18/412) and 7.8% (32/412), respectively (Table 1).

Table 1
Baseline characteristics for a cross-sectional study on type 2 diabetes in Nièna municipality, 2020.

Characteristic	Diabetic status			P value	
Age group, years	Non-diabetes (n = 362)	Pre-diabetes (n = 18)	Diabetes (n = 32)	General differences[6]	Non-diabetes vs. Diabetes[7]
20–29	37 (10)	0 (0)	1 (3)	.159	.169
30–39	72 (20)	3 (17)	2 (6)		
40–49	58 (16)	6 (33)	7 (22)		
50–59	80 (22)	5 (28)	10 (31)		
≥ 60	115 (32)	4 (22)	12 (38)		
Sex				.464	.238
Female	234 (65)	11 (61)	24 (75)		
Male	128 (35)	7 (39)	8 (25)		
Physical activity[1]				.916	.741
Light	53 (15)	3 (17)	4 (13)		
Moderate	15 (4)	5 (28)	4 (13)		
Active	294 (81)	10 (56)	24 (75)		
Ethnicity				.700	.967
Peulh	157 (43)	6 (33)	14 (44)		
Bambara	149 (41)	8 (44)	11 (34)		
Other	56 (16)	4 (22)	7 (22)		
Family history of T2D[2]				< .001	< .001
No	331 (91)	10 (56)	12 (38)		
Yes	31 (9)	8 (44)	20 (62)		
BMI (kg/m^2)[3]				.011	.202
< 18.5	21 (6)	1 (6)	0 (0)		
18.5–24.9	187 (52)	2 (11)	13 (42)		
25.0–29.9	85 (24)	8 (44)	9 (29)		

Characteristic	Diabetic status			P value	
≥ 30.0	64 (18)	7 (39)	9 (29)		
Hypertension[4]				< .001	< .001
No	289 (80)	11 (61)	17 (53)		
Yes	73 (20)	7 (39)	15 (47)		
Waist circumference[5]				.086	.038
Normal	159 (94)	6 (44)	8 (25)		
High	203 (6)	12 (56)	24 (75)		

Note. The numbers in individual cells represent the number of subjects, and the corresponding percentages are shown in parentheses. BMI = body mass index; T2D = type 2 diabetes.

[1]Physical activity was classified as light (sitting office work or retired, moderate [work involving standing or walking], and active [work involving walking, lifting or heavy manual labor]).

[2]Based on immediate family members (father, mother, sister, or brother).

[3]BMI values were missing for five subjects in the non-diabetes group and one subject in the diabetes group.

[4]Hypertension classified as hypertensive (prior diagnosis of hypertension or systolic blood pressure greater than or equal to 140 mmHg or diastolic blood pressure of at least 90 mmHg or use of antihypertensive drugs).

[5]Normal defined as less than 80 cm. and 90 cm. for females and males, respectively. High was defined as at least 80 cm. and 90 cm. for females and males, respectively.

[6]Based on Pearson's chi-square test for general differences among the diabetic status classifications.

[7]Based on Pearson's chi-square test comparing the non-diabetes and diabetes status classifications.

Sex and diabetic status

Participating subjects were 65.3% (269/412) female and 34.7% male (143/412). The skew toward females was partially attributable to high female participation rates in the Nièna community. Approximately 56.8% (234/412) of participating subjects were non-diabetic females. The distribution of the sampled population by diabetic status and sex group is shown in Fig. 2.

Diabetes was more commonly observed in females than in males (8.9% [24/269] and 5.6% [8/143], respectively). Pre-diabetes was slightly more common among males than females (4.9% [7/143] and 4.1% [11/269], respectively). However, neither of these differences was statistically significant ($p = .760$ and $p = .237$, respectively).

Age by diabetic status

Approximately 31.8% (131/412) of the sample population were at least 60 years old. Pre-diabetes was mainly observed among subjects aged between 40 and 49 years, while diabetes was most commonly observed in subjects aged 50 to 59 years (33.3% [6/18] and 31.3% [10/32], respectively, Fig. 3).

Diabetes prevalence rates ranged from 9.2–10.5% in subjects aged at least 40 years (9.9% [7/71], 10.5% [10/95], and 9.2% [12/131] for the 40–49, 50–59, and 60 + age groups, respectively). The proportion of pre-diabetics declined with increasing age among subjects aged at least 40 years (8.5% [6/71], 5.3% [5/95], 3.1% [4/131] for the 40–49, 50–59, and 60 + age groups, respectively). A sharp uptick in the percentage of the sampled population testing positive for diabetes was observed in subjects aged at least 40 years (2.6% [2/77] for the 30–39 year age group versus 9.9% [7/71] for the 40–49 year age group). An uptick in the proportion of pre-diabetics was also observed in subjects aged at least 40 years (3.9% [3/77] for subjects aged 30–39 years versus 8.5% [6/71] for subjects aged 40 to 49 years). The age by sex distributions for the pre-diabetic and diabetic groups are provided as supplemental material (Supplemental Figs. 1 and 2). Approximately 44.4% (4/9) of male diabetic subjects were aged at least 60 years. A stratified (by pre-diabetic and diabetic groups) presentation of age-specific prevalence rates is provided in Supplement Fig. 3.

BMI by diabetic status

Overall, 19.4% (80/412) of subjects had a BMI of at least 30.0 kg/m^2, which was the threshold considered here for overweight status. Approximately 5.3% (22/412) of subjects were underweight (less than 18.5 kg/m^2). No underweight subjects were observed in the diabetes group (0.0%, [0/32]). Approximately 5.8% [21/362] of non-diabetic subjects were underweight, while 56.3% [18/32] of T2D subjects were classified as overweight (Fig. 4).

BMI was statistically associated with diabetic status ($p = .011$). Interestingly, BMI was not statistically related to diabetic status after excluding pre-diabetics ($p = .202$). However, it is worth mentioning that the percentage of diabetics was higher among subjects classified as overweight and obese. For this reason, this finding may be an artifact of the sample sizes for each diabetic classification.

Diabetic status awareness and treatment

Among T2D subjects, 62.5% (20/32) were unaware of their diabetic status before the screening performed in this study (Fig. 5).

Among subjects previously diagnosed with T2D (and therefore aware of their diabetic status), only 29.4% (5/17) reported receiving routine care or treatment. Alternatively stated, 71.6% (12/17) of subjects aware of their diabetic status were not receiving regular diabetic treatment.

Prevalence of fetal macrosomia

Newborn deliveries weighing over 4 kg. were classified as macrosomic. The prevalence of fetal macrosomia in the non-diabetic population was 11.9% (32/269). Among T2D women, 37.5% (9/24) reported previously having at least one newborn delivery weighing over 4 kg. (Fig. 6).

Fetal macrosomia was significantly related to diabetic status among women ($p < .001$). Diabetic subjects were 4.5 times more likely to have at least one newborn weighing over 4 kg. than non-diabetic subjects (95% CI: 2.9, 6.9).

Multivariable analyses

Bivariate analyses revealed that family history of T2D and hypertension were significantly associated with T2D (Table 1). Multivariable logistic regression analyses were performed modeling T2D against these two predictors (Supplemental Fig. 3). These predictors were jointly associated with T2D (Table 2).

Table 2
Factors associated with T2D using multivariable logistic regression models.

Risk factor	OR	95% CI	P value
Family history of diabetes[1]	14.4	6.4, 32.2	< .001
Hypertension[2]	3.2	1.4, 7.3	.005

Note. OR = odds ratio, CI = confidence interval, T2D = type 2 diabetes.

[1]Based on immediate family members (father, mother, sister, or brother).

[2]Hypertension classified as hypertensive (prior diagnosis of hypertension or systolic blood pressure greater than or equal to 140 mmHg or diastolic blood pressure of at least 90 mmHg or use of antihypertensive drugs).

After controlling for hypertension status, subjects with a family history of diabetes were 14.4 times more likely to have T2D than non-hypertension subjects (95% CI: 6.4, 32.2). Controlling for family history of diabetes, hypertensive subjects were 3.2 times more likely to have T2D than non-hypertensive subjects (95% CI: 1.4, 7.3).

Discussion

This study revealed that the prevalence of T2D is likely higher in rural Mali than previously reported by agencies such as the IDF. The findings here support the notion that T2D is rapidly becoming a crisis in West Africa. However, it is largely unknown whether the current situation is related to factors such as improved detection, population aging, or the mitigation of competing infectious diseases. The improved detection and increased explanation are supported by early studies dating back to the 1970s, which suggested that T2D likely occurred in up to 10% of Mali's population [21]. Other factors that likely contributed to the high T2D diabetes prevalence rates observed in this study follow.

Diabetic awareness and control

Notably, a significant proportion of subjects meeting the definition of diabetes were unaware of their diabetic status before the study screenings. Additionally, control measures for participants previously diagnosed with T2D were deficient in this study, which may be related to access to treatment options and awareness regarding potential T2D complications.

Health seeking behavior

In light of the COVID-19 pandemic, health-seeking behaviors have changed significantly, resulting in the lack of presentation to clinics for routine care [26]. One advantage of this study was that it employed active case detection. While the nature of the cross-sectional study did not permit assessing longitudinal patterns over time, we believe that the high prevalence rates here are not a recent phenomenon.

Diabetes risk factors

The results here linked T2D with hypertension and a family history of diabetes. T2D primarily occurred in middle-aged subjects aged at least 40 years, consistent with other studies [27]. T2D increases were more discernable in females than males, partly attributable to the higher sample sizes for female participants. T2D symptoms may take years to develop and be prolonged due to a lack of detection, particularly for asymptomatic subjects. Because symptoms may not manifest in noticeable ways, screening based on quantitative measures like blood pressure is needed. It has been broadly established that high blood pressure is common in T2D subjects, which was confirmed by the findings in this study. This study also revealed a strong link between T2D and the familiar history of T2D, suggesting that genetics may play a role in T2D incidence in the communities studied here.

Fetal macrosomia

It has been reported that fetal macrosomia may occur in 12% of newborns in the general population and 15–45% among mothers with gestational diabetes mellitus (GDM) [28]. This study supported these findings as diabetic women were considerably more likely to encounter fetal macrosomia deliveries than non-diabetic women. The high rates of fetal macrosomia observed here may be at least partially attributable to increased insulin resistance. It has been established that, among those with GDM, higher amounts of blood glucose pass through the placenta into the fetal circulation. Consequently, extra glucose in the fetus is stored as body fat, causing macrosomia.

Strengths and limitations

A particular strength of this study is that it is the first to our knowledge to characterize diabetes prevalence and its risk factors in Niѐna, Mali. The study applied WHO criteria to classify diabetic status. Many previous diabetes studies in Mali were performed based on general medicine consultations, which may yield self-reporting bias. The potentially increased morbidity rate with increasing ages in diabetic patients may have impacted the age distribution and subsequently affected the ability to detect stronger links between BMI and diabetic status. Another limitation of this study is that it applied only fasting blood sugar measurements to evaluate diabetic control status. In future studies, we intend to include glycated hemoglobin measurements to assess the glycemic levels of diabetics.

Conclusion

Field studies play a crucial role in accentuating diabetes prevalence, particularly in rural areas in low-resource settings where routine testing is not routinely performed. Knowledge about the prevalence of T2D in rural areas where data systems are often weak is a step toward improving resource allocation and targeted prevention strategies. The recent studies showing the crisis of T2D in Africa and the results in this work accentuate the urgency for increased diabetic awareness and control measures. The findings here provide a resource to better understand, treat, and mitigate T2D in Mali and, more broadly, in West Africa.

Abbreviations

BMI: body mass index

COVID-19: coronavirus disease 2019

GDM: gestational diabetes mellitus

IDF: International Diabetes Federation

NCD: noncommunicable disease

OR: odds ratio

SSWA: sub-Saharan West Africa

T2D: type 2 diabetes

WHO: World Health Organization.

Declarations

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Conflict of interest

The authors declare that they have no competing interests.

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Author contributions

Data collection and analyses: AD, DMC; Validation and verification: TYA, MD; Conceptualization and methodology: AD, JGS, MD, TYA, CC, MW, KT; Writing – original draft preparation: AD, JGS; Writing – review and editing: AD, JGS, KT, MW, JL, SOD. All of the authors reviewed and approved the manuscript.

Availability of data and materials

Data for this study are provided within the article through the frequencies in Table 1.

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Figures

Figure 1

Geographic location of the study site in Niéna, Mali. Nièna is situated west of the Sikasso Region and southeast of the capital city of Bamako.

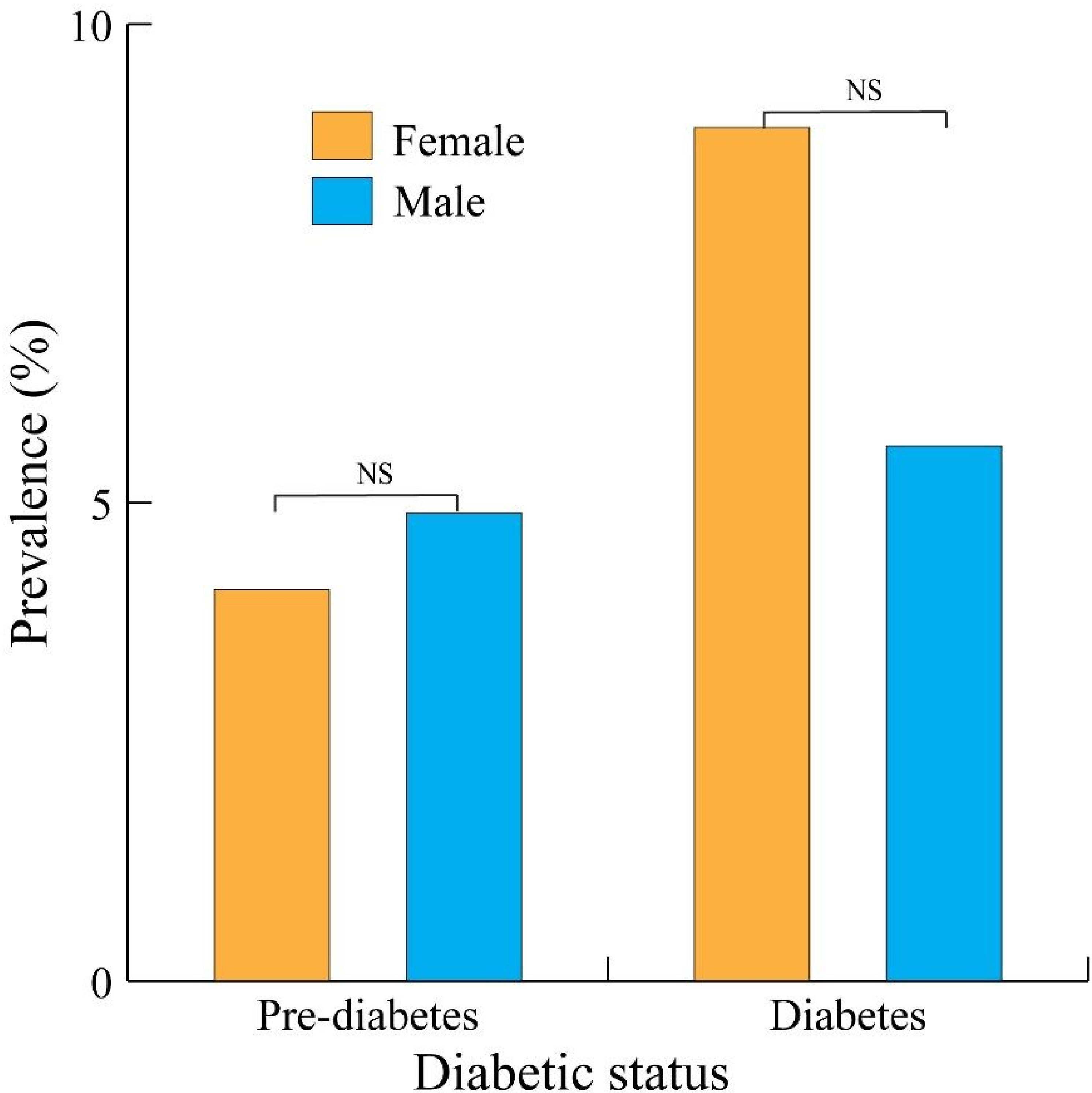

Figure 2

Type 2 diabetes prevalence by sex, Nièna, Mali, 2021. The first and second columns show the prevalence rates for the sampled female and male populations, respectively. Prevalence rates did not statistically differ by sex for either the pre-diabetic or diabetic groups.

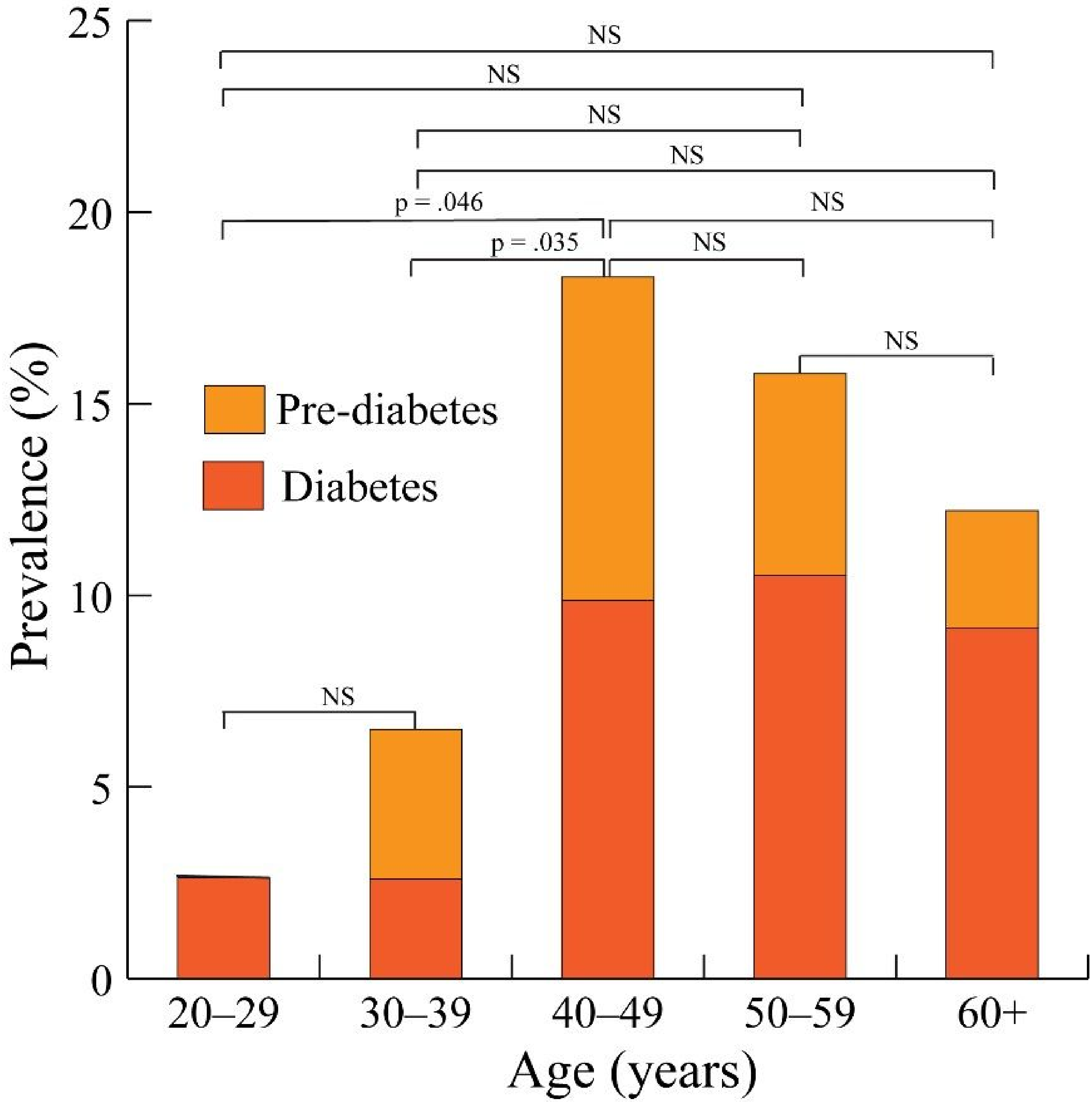

Figure 3

Prevalence of pre-diabetes and diabetes by subject age, Nièna, Mali, 2021. The bottoms and tops of the stacked columns represent diabetes and pre-diabetes groups, respectively. Significant differences were observed for the 20–29 versus 40–49 and 30–39 versus 40–49 age group comparisons.

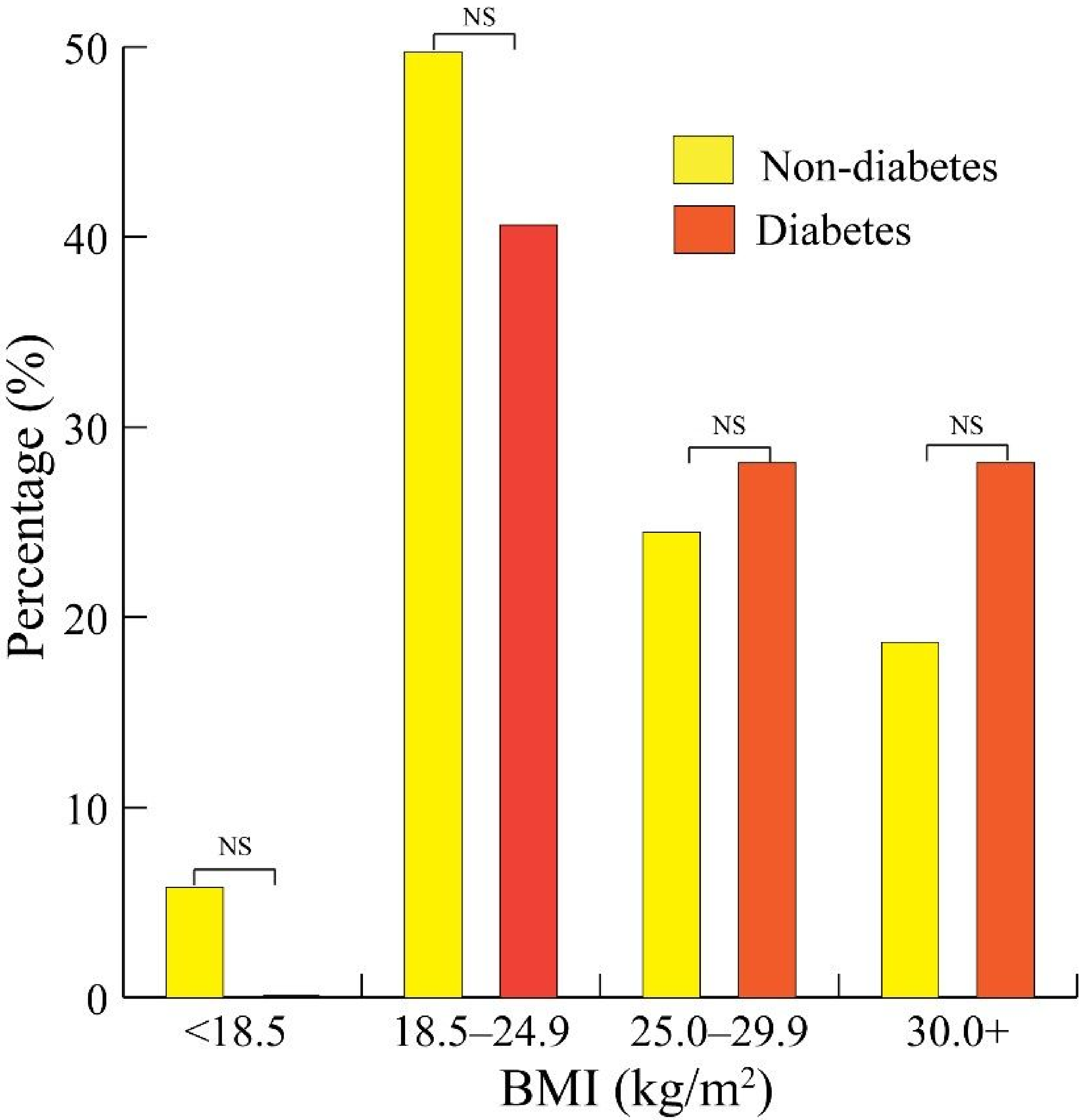

Figure 4

Body mass index by diabetic status, Nièna, Mali, 2021.

The first and second columns show the percentage of non-diabetes and diabetes subjects, respectively for each body mass index (BMI) classification. The percentages of non-diabetic and diabetic subjects did not statistically differ within the BMI classifications.

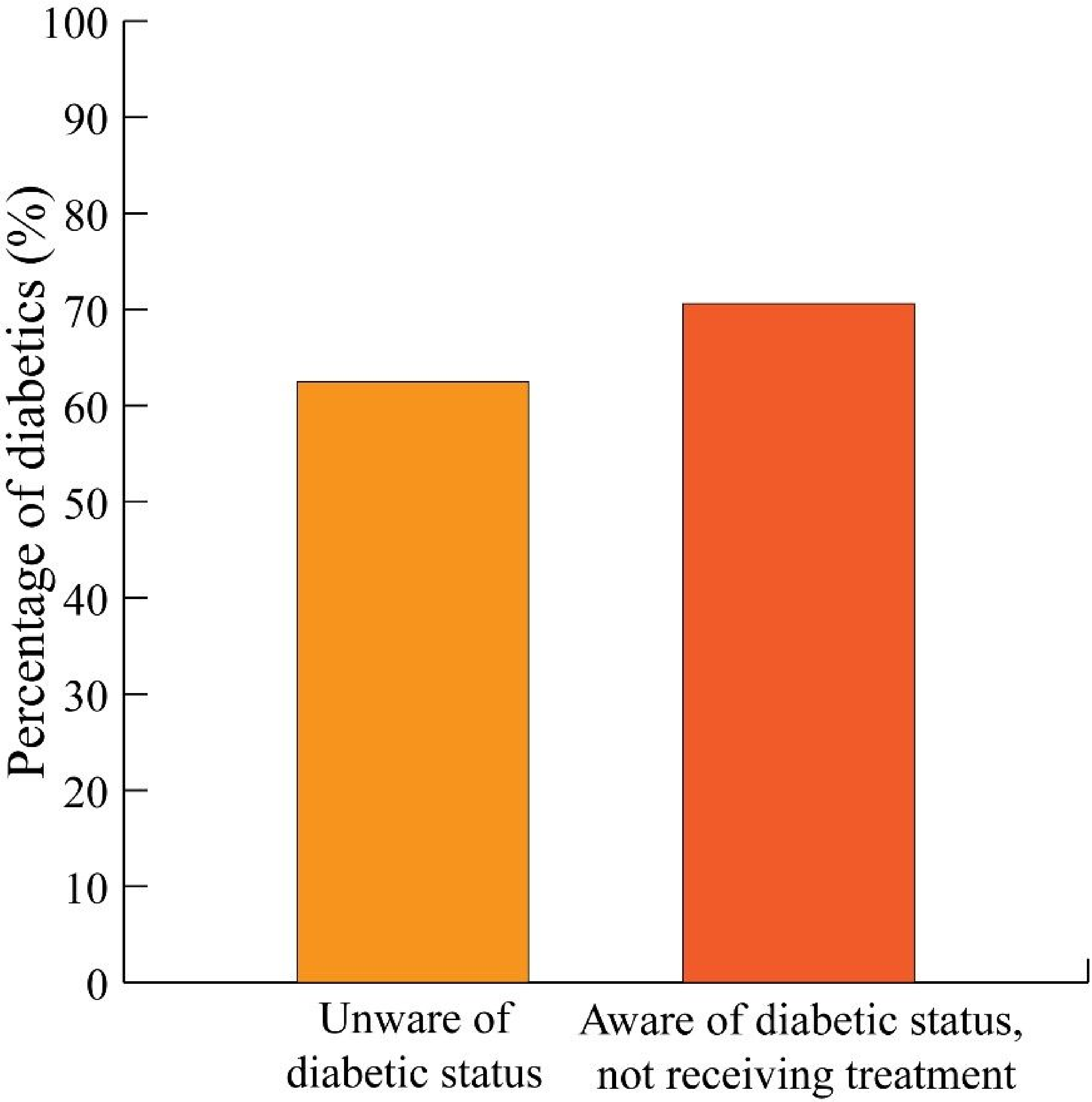

Figure 5

Undiagnosed diabetics among rural residents over 20 years old in Nièna municipality. Among T2D subjects, 67.5% (20/32) of subjects that tested positive for diabetes were unaware of their diabetic status, and 70.6% (12/17) of subjects previously aware of their diabetic status reported were not receiving routine care or treatment.

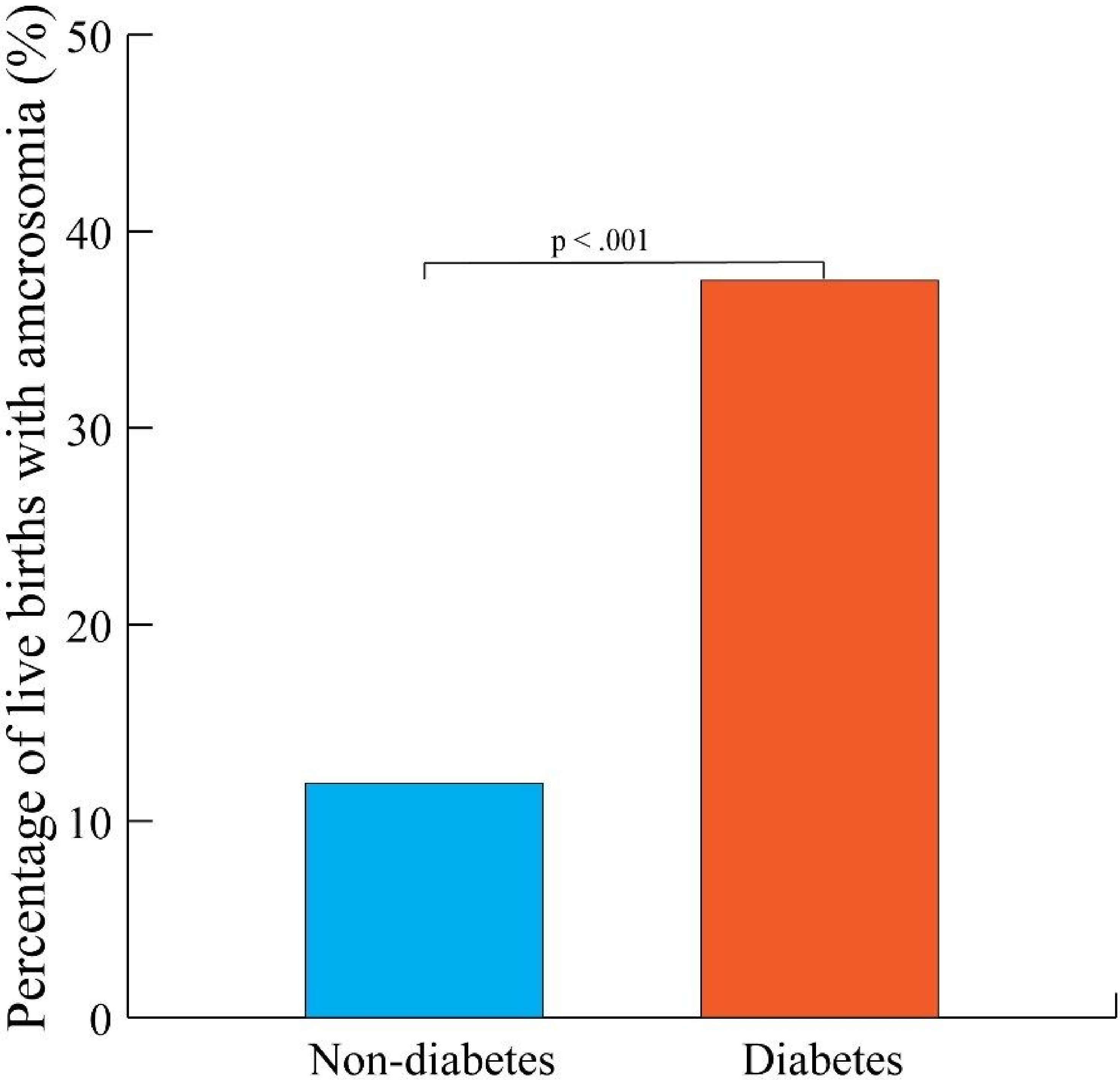

Figure 6

Observed fetal macrosomia prevalence in the samples among rural residents over 20 years old in Nièna, Mali, 2021. Fetal macrosomia prevalence was statistically different between the non-diabetes and diabetes comparison groups ($p < .001$).

Supplementary Files

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