Original Research Article

Prevalence and factors associated with diabetes in Côte d'Ivoire: a cross-sectional study in the country's adult population.

ABSTRACT

Objectives: To estimate the current prevalence of diabetes and identify associated factors in Côte d'Ivoire.
Methodology: This was a cross-sectional, descriptive and analytical study of 3198 adults aged 20-79 years. Risk factors were identified by stepwise ascending binary logistic regression. Successive models were compared using the likelihood ratio test.
Results: The survey population was predominantly female (55%) and lived in urban areas (55.38%). The prevalence of diabetes in Côte d'Ivoire was 6.2% [95% CI: 5.34 - 7.20]. Men (6.40%) and women (6.06%) have almost the same prevalence of diabetes, while urban areas (7.36%) have a higher prevalence than rural areas (4.56%). Factors significantly associated with this prevalence were age 60-79 years (AOR 1.61; P=0.028), male sex (AOR 1.56; P=0.020), high blood pressure (AOR 1.39; P=0. 048), family history of diabetes (AOR 2.5; P=0.000), abdominal obesity (waist circumference) (AOR 1.56; P=0.042), elevated triglycerides (AOR 3.30; P=0.000) and elevated LDL cholesterol (AOR 2.01; P=0.000). However, moderate and frequent alcohol consumption (AOR 0.63; P=0.009) was protective against diabetes.
Conclusion: The prevalence of diabetes in Côte d'Ivoire is relatively high and continues to increase. Age at 60 years and above, alcohol consumption, hypertension, family history of diabetes, abdominal obesity through waist circumference, high Triglycerides and LDL-cholesterol are the factors associated with this prevalence. Interventions targeting associated modifiable risk factors are needed to reduce this increasing prevalence.

Keywords : [Diabetes, prevalence, risk factors, Côte d'Ivoire]

1. INTRODUCTION

In recent decades, low- and middle-income countries (LMICs) have experienced a dramatic increase in non-communicable diseases (NCDs), while infectious diseases, parasitic diseases and nutritional deficiencies still persist [1]. Diabetes is among the diseases that contribute to NCD deaths [2]. According to World Health Organization (WHO) statistics in 2014, 422 million adults aged 18 and over (8.5%) had diabetes worldwide. In 2019, diabetes was the direct cause of 1.5 million deaths [3] and the International Diabetes Federation estimates that 536.6 million people

(9.8%) will be living with diabetes in 2021. If the situation remains unchanged, the number of diabetics could reach 643 million in 2030 and 783.2 million in 2045 [4].

In the lower end of the LMICs, the rate of premature mortality due to diabetes has increased over the period 2000-2019. The prevalence of diabetes has increased more rapidly in low- and middle-income countries than in high-income countries [3]. Indeed, diabetes is the 9th leading cause of death in low- and middle-income countries [5] and an estimated 3 out of 4 people with diabetes live in low- and middle-income countries [6]. Africa is experiencing a meteoric 134% increase in the number of diabetes cases to 24 million by 2021. Forecasts estimate that the number of diabetics could reach 33 million by 2030 and 55 million by 2045 [4].

The increasing prevalence of diabetes worldwide is due to a complex interplay of socio-economic, demographic, environmental and genetic factors. This continued increase is largely attributable to a surge in type 2 diabetes and related risk factors, including increasing rates of obesity, poor diet and widespread physical inactivity [7]. Increasing urbanisation and the development of obesity, reduced physical activity as a result of lifestyle changes (higher calorie intake, increased consumption of processed foods, sedentary lifestyle) are major contributors to the increasing prevalence of type 2 diabetes in sub-Saharan Africa [3], [7], [8].

Côte d'Ivoire is one of the countries in sub-Saharan Africa where non-communicable diseases are currently on the rise. However, the only available national data on prevalence of diabetes date from 1979 and indicated a high level of 5.7% of diabetic morbidity [9]. Furthermore, current hospital data reflect the number of diabetics seen rather than the actual prevalence [10]. Apart from WHO estimates which indicated a prevalence of 6.9% of diabetes in 2014 [11], Côte d'Ivoire has no recent epidemiological data on the prevalence of diabetes and its associated risk factors in the general population. The present study is therefore initiated to fill this gap.

2. DATA AND METHODS

2.1. Sample

The data for this study come from the PREVADIA-CI 2017 survey [12], a cross-sectional survey of people aged 20-79 years to collect information on the national prevalence and characteristics of diabetes in Côte d'Ivoire. The household survey was conducted from 25 November to 22

December 2017 and covered all the districts that made up the 20 health regions in the country in 2017. Participants were selected using a three-stage stratified random sampling. At the first stage, localities/neighbourhoods or clusters were selected in each health district using an random sample with probability proportional to size. In the second stage, 10 households were selected in a systematic random fashion after an exhaustive enumeration of all households in each previously selected cluster. In the third stage, in each selected household, the selection of the subject to be surveyed was done randomly using the KISH selection method [13]. In total, the final primary survey sample comprised 3198 respondents representative of the Ivorian population. All these respondents were included in the present study.

2. 2 Flow chart of participants

For this study, we excluded participants whose biological test results were not available in the database. The diagram below shows the flow of participants (Figure 1).

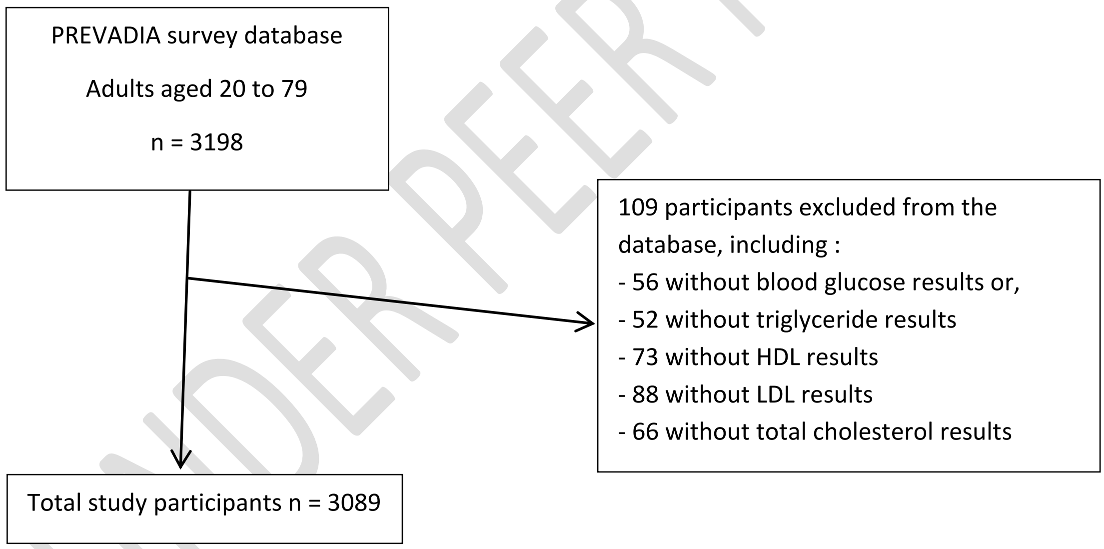

Figure 1: Flow chart of participants

2.3. Variables

The dependent variable was diabetes. Diabetes were determined from the interview and fasting blood glucose levels measurement, using the American Diabetes Association cut-off points [14]. Any known diabetic subject who was treated or had a fasting blood glucose level greater than or equal to 1.26g/l or a haemoglobin-glycaemia level greater than or equal to 6.50% (norm 4-6%) was considered diabetic. A subject with a fasting blood glucose level of less than 1.26g/l or a haemoglobin-glyca level of less than 6.5% was considered as non-diabetic.

The independent variables were selected from the literature review on factors associated with diabetes. The independent variables are: Obesity, abdominal obesity, high blood pressure, high triglycerides, low HDL-cholesterol, high LDL-cholesterol, high total cholesterol, place of residence (urban or rural), socioeconomic level (income, housing and education level), lifestyle (diet, physical activity, smoking and alcohol consumption), age, gender and family history (history of diabetes and high blood pressure).

2.4. Data processing and analysis

The data were analysed using Stata Version 14 software. Then a Peer Review of these analyses was carried out using R Studio Version 1.0.143.

The descriptive analysis of all the selected variables was the first step of our analysis. The numbers and percentages were calculated for each qualitative variable. The bivariate analysis consisted of measuring the association between the dependent variable and each of the selected independent variables by performing a simple logistic regression. A variable is retained for the construction of the model when its *P*-value is less than 0.2. For the multivariate analysis, binary logistic regression was performed using the stepwise ascending method. The successive models were compared using the likelihood ratio test. The Hosmer-Lemeshow test was used to judge the goodness of fit of the final models. The discriminative power of the model was assessed using the value of the area under the ROC curve (Receiver Operating Characteristic). The adjusted Odds ratios were estimated with their P-value and confidence interval. Associations are considered significant when $P < 0.05$.

3. RESULTS

3.1 Socio-demographic characteristics of the survey population

55.38% of the surveyed population lived in urban areas and 55% were women. The vast majority of participants were under 50 years of age (more than 60%), living with a partner (61%) and not attending school (47.81%). Just over half of this population had a professional occupation (51%). However, 50% had no income and almost all (93%) had no health insurance (Table 1).

Table 1. Socio-demographic characteristics of the surveyed population (n=3,089)

Varaibles	Sample	
	n	%
Gender		
Male	1 386	43.34
Female	1 812	56.66
Age group		
[20-29]	543	16.98
[30-39]	730	22.83
[40-49]	621	19.42
[50-59]	620	19.38
[60-69]	461	14.42
[70-79]	223	6.97
Marital status		
Married	337	10.54
Common-law (cohabitation)	1 975	61.76
Single	624	19.51
Widowed	252	7.88
Divorced	10	0.31
Level of education		
None	1 529	47.81
Primary	722	22.58
Secondary	710	22.20
Higher	237	7.41
Profession		
With profession	1 633	51.06
No profession	1 558	48.72
Refused	7	0.22

Place of residence		
Urban	1 771	55.38
Rural	1 427	44.62
Do you have an income		
Yes	1 578	49.34
No	1 620	50.66

3.2. Prevalence of diabetes according to the socio-demographic characteristics of the population surveyed

The overall prevalence of diabetes in the survey population was 6.2% with a 95% confidence interval [5.34 - 7.2]. The prevalence of diabetes is almost the same among women (6.06%) with a 95% CI [5.00 - 7.33] as among men (6.40%), 95% CI [4.97 - 8.22]. However, this prevalence of diabetes increases with age from 30 years onwards. Married or widowed people had relatively higher prevalences, at 10.37% and 11.57% respectively, than those in common-law relationships or single people. Urban populations have a higher prevalence of diabetes (7.36%) and almost double that of rural populations. Similarly, the prevalence of diabetes among those with an income (6.59%) is higher than among those without (Table 2).

Table 2: Prevalence of diabetes according to the socio-demographic characteristics of the surveyed population (n=197)

	Total Diabetic (n=197)	
Variables	**%**	**[95% CI]**
Together	6.2	[5.34 – 7.20]
Gender		
Male	6.40	[4.97 – 8.22]
Female	6.06	[5.00 – 7.33]
Age group		
[20-29]	5.57	[3.92 – 7.84]
[30-39]	4.65	[3.34 – 6.44]
[40-49]	5.09	[3.66 – 7.04]

[50-59]	7.15	[5.32 – 9.55]
[60-69]	8.81	[6.23 – 12.32]
[70-79]	8.28	[5.13 – 13.09]
Marital status		
Married	10.37	[7.50 – 14.18]
Common-law (cohabitation)	4.84	[3.91 – 5.97]
Single	6.04	[4.58 – 7.94]
Widow(er)	11.57	[8.19 – 16.10]
Divorced	-	-
Place of residence		
Urban	7.36	[6.18 – 8.76]
Rural	4.56	[3.39 – 6.11]
Income		
Yes	6.59	[5.33 – 8.14]
No	5.82	[4.79 – 7.07]

3.3. Risk factors associated with diabetes in the surveyed population

Diabetes is associated with socio-demographic factors such as age and sex, certain behavioural factors such as alcohol consumption, family heredity, anthropometric measurements such as waist circumference and certain biological parameters such as triglycerides and LDL-cholesterol. There is an association between diabetes and age (*P=0.028*). Age 60 and above is 1.6 times (AOR 1.61) more likely to be associated with diabetes than the 20-39 age group. Similarly, there is an association between gender and the prevalence of diabetes (P=0.020). Being male in diabetes is also 1.5 times (AOR 1.56) more likely to be associated with diabetes than being female.

An association was observed between high blood pressure (HBP) and the prevalence of diabetes. While this association was relatively strong (P=0.000) in the bivariate analysis, it became weak in the multivariate analysis (P=0.048). Hypertensive status is 1.4 times more likely to be associated with diabetes than non-hypertensive status. On the other hand, alcohol consumption is strongly associated *(P=0.009*) with the low prevalence of diabetes. Subjects who consume alcohol have less diabetes than those who do not consume alcohol. Alcohol consumption is protective against diabetes (AOR 0.63).

Family heredity is strongly associated with diabetes *(P=0.000)*. Indeed, having people with diabetics in one's ancestry is 2.5 times (AOR 2.5) more likely to be associated with diabetes compared to not having diabetes. There is also an association with waist circumference (*P=0.042*). In fact, people with a waist circumference greater than 88 cm in women and greater than 102 cm in men, i.e. abdominal obesity is 1.5 times (AOR 1.56) more likely to be associated with diabetes than waist circumference < 94 cm in men or < 80 cm in women.

The prevalence of diabetes is also associated with the Triglyceride level. Indeed, having higher Triglyceride level (≥2 g/l) among diabetic are 3-times (AOR 3.30) more likely to be associated with prevalence of diabetes as compared to having <1.5 g/l Triglyceride level (P<0.001). With regard to cholesterol, the association that was identified was with LDL-cholesterol. It is a strong association (*P<0.001*) in people with LDL-cholesterol levels between 1.35 and 1.74 g/l. This level of LDL-cholesterol is 2 times (AOR 2.01) more likely to be associated with diabetes than an LDL-cholesterol level < 1.35 g/l (Table 3).

Table 3. Risk factors most significantly associated with diabetes among respondents

Risk factors	N	Prev. Diab. (%)	Odds Ratio brut	P-value	[95% Conf.	Interv]	Odds Ratio adjusted	P-value	[95% Conf	Interv]
Together	3089	6.2								
Age group										
[20-39]	1223	4.89	1				1			
[40-59]	1195	6.28	1.33	0.102	0.94	1.88	1.29	0.169	0.89	1.87
[60-79]	665	7.81	1.70	0.006	1.16	2.48	1.61	0.028*	1.05	2.48
Gender										
Male	1342	6.04	1				1.56	0.020*	1.07	2.28
Female	1741	6.06	0.99	0.958	0.73	1.33	1			

Table 3. (Continued) Risk factors most significantly associated with diabetes among respondents

Risk factors	N	Prev. Diab. (%)	Odds Ratio brut	p value	[95% Conf.	Interv]	Odds Ratio adjusted	p value	[95% Conf	Interv]
Marital_situation										
Married or common-law	2228	5,47	0.92	0.674	0.63	1.34	0.74	0.150	0.50	1.12
Never married	602	6.14	1				1			
Divorced or widowed	253	10.98	1.97	0.009	1.18	3.28	1.62	0.09	0.91	2.88
Level of education										
None	222	5.55	1							
Primary	1476	6.71	1.22	0.277	0.84	1.76				
Secondary	700	6.10	1.16	0.425	0.80	1.69				
Higher	685	7.17	1.24	0.437	0.71	2.16				
Living environment										
Urban	1692	7.37	1.75	0.000	1.28	2.39	1.37	0.070	0.97	1.94
Rural	1391	4.45	1				1			
Income generating activity										
Yes	1519	6.52	1.24	0.148	0.92	1.66	1.29	0.130	0.92	1.79
No	1564	5.61	1				1			
Physical activity level										
High	593	4.63	1				1			
Medium	1317	5.03	0.69	0.084	0.46	1.04	1.21	0.469	0.72	2.02
Borderline	1173	7.38	1.14	0.483	0.78	1.68	1.62	0.057	0.98	2.66
Alcohol consumption										
Yes	1215	4.45	0.59	0.002	0.43	0.82	0.63	0.009*	0.44	0.89
No	1868	7.09	1				1			
Nibbling										
Yes	1215	7.27	1.284	0.121	0.93	1.76	1.31	0.118	0.93	1.86
No	1868	5.64	1				1			
Hypertension status										
Yes	1321	7.95	1.75	0.000	1.30	2.35	1.39	0.048*	1.01	1.93
No	1762	4.79	1				1			

Table 3. (Continued) Risk factors most significantly associated with diabetes among respondents

Risk factors	N	Prev. Diab. (%)	Odds Ratio brut	P-value	[95% Conf.	Interv]	Odds Ratio adjusted	P-value	[95% Conf	Interv]
Family heredity										
Yes	423	11.79	2.87	0.000	2.01	4.10	2.50	0.000*	1.71	3.66
No	1849	4.70	1				1			
Don't know	811	6.15	1.33	0.115	0.93	1.89	1.41	0.063	0.98	2.04
Nutrional status & BMI (kg/m2)										
< 18.5	220	5.45	1.15	0.631	0.63	2.11	1.19	0.589	0.62	2.28
≥18.5 & < 25	164	4.94	1				1			
≥ 25 & < 30	759	7.09	1.45	0.038	1.02	2.06	1.11	0.599	0.74	1.67
≥ 30	464	8.55	1.78	0.003	1.21	2.63	1.18	0.480	0.73	1.91
Waist size (cm)										
M < 94 and F < 80	1641	4.70	1				1			
M ≥ 94 & < 102 and F ≥ 80 & < 88	552	6.29	1.33	0.158	0.89	2.00	1.419	0.152	0.88	2.27
M ≥ 102 and F ≥ 88	1641	8.39	1.85	0.000	1.33	2.55	1.56	0.042*	1.01	2.39
Triglyceride (g/l)										
< 1.5	2654	5.19	1				1			
≥ 1.5 & < 2	239	9.09	1.82	0.012	1.14	2.92	1.73	0.031*	1.05	2.86
≥ 2	190	14.87	3.19	0.000	2.07	4.90	3.30	0.000*	2.08	5.22
LDL cholesterol (g/l)										
< 1.35	2516	5.12	1				1			
≥ 1.35 & < 1.75	415	10.02	2.06	0.000	1.43	2.97	2.01	0.001*	1.30	3.09
≥ 1.75	152	10.46	2.16	0.006	1.25	3.73	1.76	0.061	0.97	3.21
HDL cholesterol (g/l)										
Male: < 0.4 or Female: < 0.5	958	5.92	1				1			
Male: ≥ 0.4 or Female: ≥ 0.5	2125	6.20	0.99	0.982	0.72	1.36	0.91	0.597	0.65	1.27
Total cholesterol (g/l)										
< 2	2023	5.00	1				1			
≥ 2	106	8.22	1.70	0.000	1.26	2.28	1.18	0.372	0.82	1.69

(*) P< 0.05 M : Male F : Female BMI : Body Mass Index

Logistic model for diabet, goodness-of-fit test

number of observations = 3089

number of covariate patterns = 2719

Pearson chi2(2694) = 2706.61

Prob > chi2 = 0.4283

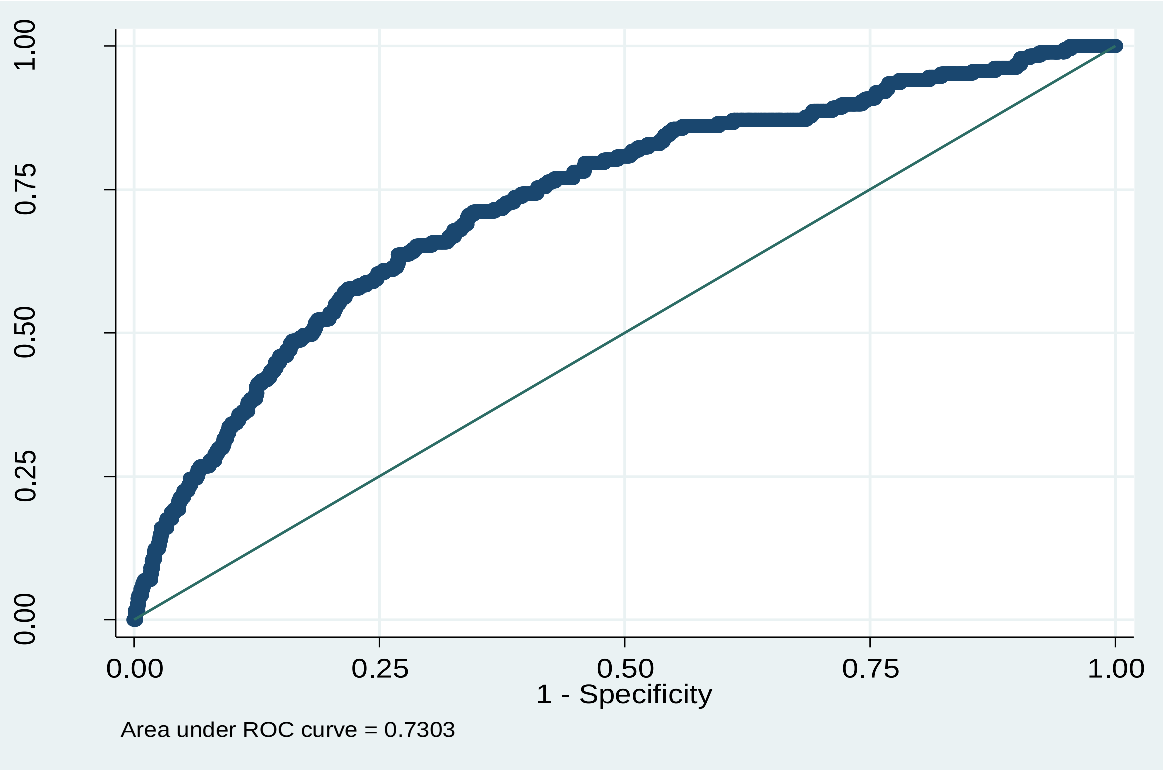

Figure 2 : Receiver Operating Characteristic Curve

4. DISCUSSION

Our study on diabetes reveals a national prevalence of 6.2% with a confidence interval of [5.34 - 7.20]. This prevalence has increased slightly from its level of 5.7% in the 1979 Zmirou study [9].

Considering this 1979 prevalence, one could even deduce that the increase in prevalence to 6.2% in our study is considerably low, or even that it has almost stagnated over a period of 4 decades. This is paradoxical, as the prevalence of diabetes is increasing rapidly in Africa south of the Sahara [8]. The WHO Director for the African Region rightly recalled that the prevalence of diabetes in the adult population increased from 3.1% in 1980 to 7% in 2014 [15]. This low increase in prevalence cannot be explained by the awareness of the population in Côte d'Ivoire, nor by an exceptional response from the health system in terms of prevention and management. Indeed, in 2007, the Government created a national programme to combat metabolic diseases. On the other hand, the challenges that this Programme tries to take up consist in developing and implementing a policy of awareness, prevention and management of diabetes [16]. It is therefore premature to attribute this low growth in the prevalence of diabetes to the results of this policy.

The explanation lies elsewhere. Indeed, according to McLarty et al. (1990), several studies were conducted from the early 1960s to the 1980s to determine the prevalence of diabetes in 14 African countries. The studies involved different populations, methodologies and criteria for the diagnosis of diabetes. However, most of these studies reported a prevalence of 0.0% to 1.0% in the indigenous population and only five reported a prevalence of more than 1.5% [17]. Zmirou's study in Côte d'Ivoire, which is one of these five, diagnosed diabetes if the 2-h postprandial blood glucose level was > 7.8 mmol/l [9]. McLarty et a.l (1990) noted that most of these five studies used criteria for the diagnosis of diabetes which were less strict than those currently recommanded by the WHO Study Group Report on Diabtete Mellitus [17].

Mbanya et al. (2010) also noted that the high levels found in some studies on diabetes prevalence are inconsistent with other reports among indigenous African peoples. Whether this inconsistency is an indication of a sudden upsurge in diabetes in sub-Saharan Africa or whether it is related to study methods (sampling strategy, true fasting blood samples) needs further evaluation [8]. The prevalence of 6.2% would be more in line with the reality of the epidemiological situation in Côte d'Ivoire. The small variation from the 5.7% prevalence in Zmirou's study would not account for a small increase in diabetes prevalence. Like McLarty (1990) and Mbanya (2010), we believe that this level of prevalence (5.7%) may be due to an overestimation of the prevalence of diabetes in relation to the methodology and criteria for the diagnosis of diabetes used in Zmirou's study in 1979.

The prevalence of 6.2% in our study is still below the WHO estimate of 6.9% in 2020 [11]. The prevalence of diabetes is indeed on the rise, as is generally observed for non-communicable diseases in Côte d'Ivoire [18]. Although the prevalence of diabetes in Côte d'Ivoire is significantly lower than the global prevalence (10.5%) and the prevalence in middle-income countries (10.8%), it is still higher than in low-income countries (5.5%) and the African region (4.5%) [4]. Compared to other West African countries, diabetes in Côte d'Ivoire is in the middle between Niger at 5.6% and Liberia at 7.7% [11].

The prevalence of diabetes is associated with age 60-79 (*P=0.028*). Indeed, this prevalence increases with the ageing of the population, rising from 4.89% in the 20-39 age group to (7.81%) in the 60-79 age group. Age 60 and over is 1.6 times (AOR 1.61) more likely to be associated with diabetes than the 20-39 age group. This association of diabetes prevalence with population ageing is consistent with the findings of many studies worldwide, including those of Amoussou-Guenou et al. (2015) in Benin, Thibault et al. (2016) in New Brunswick in Canada, Tripathy et al. (2017) in India, Millogo et al. (2018) in Burkina Faso and Mphekgwana et al. (2021) in South Africa [19]–[23].

Although there was almost no difference in the prevalence of diabetes between men and women in our study, there is however an association of the prevalence of diabetes with male sex, in our study (*P=0.020*). Other things being equal, being male was 1.5 times (AOR 1.56) more associated with diabetes than female. This association of diabetes with male sex is similar to that of the work of Matshipi (2017) and Mphekgwana (2021) in South Africa and Githinji (2017) in Kenya [20], [24], [25]. On the other hand, this result in Côte d'Ivoire is contrary to those of Millogo (2018) in Burkina Faso [21], Amoussou-Génou (2015) in Benin [23] and Tripathy (2017) in India [22] who observed no association between sex and diabetes.

Our work did not find an association between residence and diabetes prevalence (p=0.070) although

the prevalence varied from urban to rural areas. The higher prevalence of diabetes in urban areas is similar to the results of many studies. Millogo et al. (2018) found a significant difference in diabetes prevalence between urban and rural areas in Burkina Faso [21]. The same finding was made by Mohamed (2018) in Kenya [26] and Tripathy (2017) in India [22]. This difference in prevalence between residential settings can be explained by a more rapid epidemiological transition in urban areas [26]. This transition may suggest that a greater proportion of the population may be exposed to obesogenic environments and lower levels of physical activity [19].

An association was observed between high blood pressure (HBP) and the prevalence of diabetes. While this association is relatively strong (P=0.000) in the bivariate analysis, it becomes weak in the multivariate analysis (P=0.048). Hypertensive status is therefore 1.4 times more likely to be associated with diabetes than non-hypertensive status (AOR 1.39). This is consistent with the findings of Sitorus (2020) in Indonesia, Mphekgwana (2021) in South Africa and Mohamed (2018) in Kenya who found in a cross-sectional study that people with hypertension have a greater risk of developing diabetes than those without hypertension [20], [26], [27]. This is also the conclusion of the work of Zeru et al. (2021) in Ethiopia who report that hypertension can precede diabetes, i.e. a history of hypertension was significantly associated with diabetes [28]. In contrast, Krzesinski et al. (2005) in Belgium argue that hypertension frequently accompanies diabetes mellitus, as it is present in 50% of diabetic patients. In type 2 diabetes, insulin resistance plays a major role in hypertensive risk [29].

Our study also showed a strong association between alcohol consumption and the low prevalence of diabetes (p=0.009). Alcohol consumption would be protective against diabetes (AOR 0.63). This low level of diabetes prevalence in subjects who drink alcohol could be explained by their preference for alcohol and their rejection of sweetened drinks. Conversely, people who refuse to consume alcohol would more often switch to sweetened drinks. Our results thus contrast with those of Mutyambizi (2019) [30] and Mphekgwana (2021) [20] in South Africa who did not report an association between alcohol consumption and diabetes prevalence. However, our results converge with those of other studies elsewhere that report a protective effect of alcohol at moderate levels of consumption [31], [32]. Better still, frequent drinking offers the greatest protection against type 2 diabetes, even at low levels of consumption per day of drinking [33], [34].

One of the factors identified as being strongly associated (AOR 2.5; *P<0.001)* with the prevalence of diabetes in our study was the familial inheritance of diabetes. Indeed, having diabetics in one's ancestry is 2.5 times (AOR 2.5) more likely to be associated with diabetes compared to not having diabetes. This result is in line with those of Amoussou-Guenou (2018) in Benin and Tripathy et al. in India who found that a family history of diabetes was a strong predictor of the disease[22], [23]. However, our results differ from those of Millogo (2018) in Burkina Faso who found that a family history of diabetes was protective against diabetes. According to this author, the knowledge that a subject was at greater risk of diabetes could lead him or her to adopt a healthier lifestyle [21]. We also observed an association of diabetes with waist circumference, i.e. abdominal obesity. Indeed, in women with a waist circumference of more than 88 cm and in men with a waist circumference of more than 102 cm, abdominal obesity was found to be 1.5 times (AOR 1.56) more likely to be associated with diabetes than normal waist circumference. Our results are similar to those obtained in the USA by Osei et al. (2019), Amoussou-Guenou (2015) in Benin, Tripathy (2017) in India and Thibault (2016) in New Brunswick in Canada, who reported an association between diabetes and abdominal obsessiveness [19], [22], [23], [35]. However, our results are contrary to the findings of Mphekgwana (2021) in South Africa who did not find a statistically significant association between high waist circumference and diabetes [20].

Other factors with which the prevalence of diabetes was correlated in our study were high Triglycerides and high LDL-Cholesterol. Having higher Triglyceride level (≥2 g/l) among diabetic are 3-times (AOR 3.30) more likely to be associated with prevalence of diabetes as compared to having <1.5 g/l Triglyceride level (P<0.001). Our result partially coincides for high Triglycerides with the results of the work of Mphekgwana (2021) in South Africa who reported a significant association of diabetes with high Triglycerides and HDL-cholesterol. However, our results diverge from those of Mphekgwana (2021) for cholesterol because it is LDL-cholesterol that is associated with diabetes in our study [20]. Indeed, it is a strong association (P<0.001) in people with an LDL-cholesterol level between 1.35 and 1.74 g/l that is 2 times (AOR 2.01) more likely to be associated with diabetes than an LDL-cholesterol level < 1.35 g/l.

Strength and Limitations of the Study

This work represents the first population-wide study of diabetes prevalence and associated risk factors in Côte d'Ivoire. It is, however, a cross-sectional study that only collected information at one point in time. No causal relationship can be determined between diabetes and its associated factors. Glucose measurements were only taken on one occasion and were not tracked. Finally, some well-known risk factors for diabetes were not included because data for these variables were not collected.

5. CONCLUSION

This article aimed to estimate the current prevalence of diabetes and its associated factors. This study reports that the prevalence of diabetes is relatively high and continues to increase in Côte d'Ivoire. The factors associated with this prevalence are age at 60 years and above, alcohol consumption, hypertension, family history of diabetes, abdominal obesity through waist circumference, high Triglycerides and LDL-cholesterol.

Most of these risk factors are modifiable and can therefore be corrected. Therefore, information, education, awareness and early detection actions towards the populations most at risk, supported by immediate and massive care are essential to reduce the burden of this disease which is constantly increasing in Côte d'Ivoire.

ETHICAL APPROVAL

The PREVADIA study has received approval from the Ministry of Health and Public Hygiene and the National Ethics Committee for Life Sciences in Côte d'Ivoire.

Consent

As per international standard or university standard, Participants' written consent has been collected and preserved by the author(s).

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COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

REFERENCES

1. WHO. Global status report on noncommunicable diseases 2014. 2014. Accessed 31 March 2022. Available: https://www.who.int/publications-detail-redirect/9789241564854

2. WHO. Non communicable diseases. 2021 Accessed 13 sept 2021. Available: https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases

3. WHO. Diabetes. 2021. Accessed 30 March 2022. Available: https://www.who.int/news-room/fact-sheets/detail/diabetes

4. Sun H, Saeedi P, Karuranga S, Pinkepank M, Ogurtsova K, Duncan BB, et al. IDF Diabetes Atlas: Global, regional and country-level diabetes prevalence estimates for 2021 and projections for 2045. Diabetes Res Clin Pract. 5 déc 2021. Accessed 30 Jan 2022;0(0). Available: https://www.diabetesresearchclinicalpractice.com/article/S0168-8227(21)00478-2/fulltext#secst100

5. WHO. The top 10 causes of death. 2020. Accessed 12 Sept 2021. Available: https://www.who.int/news-room/fact-sheets/detail/the-top-10-causes-of-death

6. Making Diabetes Easier. 2020 : les chiffres du diabète en Europe et dans le monde. 2020. Accessed 26 Aug 2021. Available: https://www.makingdiabeteseasier.com/be-fr/le-diabete-explique/diabete/2020-les-chiffres-du-diabete-en-europe-et-dans-le-monde. French

7. International Diabetes Federation. IDF Diabetes Atlas Ninth edition 2019. 2019 Accessed 30 March 2022. Available: https://www.idf.org/e-library/epidemiology-research/diabetes-atlas/159-idf-diabetes-atlas-ninth-edition-2019.html

8. Mbanya JCN, Motala AA, Sobngwi E, Assah FK, Enoru ST. Diabetes in sub-Saharan Africa. Lancet Lond Engl. 26 juin 2010;375(9733):2254-66.

9. Zmirou-Navier D. Epidémiologie du diabète en Côte d'Ivoire [Thèse Médecine]. [France]: Université Joseph Fourier (Grenoble); 1979.

10. Oga ASS, Tebi A, Aka J, Adouéni KV, Malan KA, Kouadio LP, et al. Le diabète sucré diagnostiqué en Côte d'Ivoire: des particularités épidémiologiques. Médecine Trop. 2006;66(3):241_245.

11. WHO. WHO reveals leading causes of death and disability worldwide: 2000-2019. 2020 Accessed 30 March 2022. Available: https://www.who.int/news/item/09-12-2020-who-reveals-leading-causes-of-death-and-disability-worldwide-2000-2019

12. National program for the prevention of NCDs. Survey on the prevalence and characteristics of Diabetes in Côte d'Ivoire_Prévadia-CI 2017_Preliminary report. Abidjan Côte d'ivoire; 2018 sept p. 46.

13. Lavrakas P. Kish Selection Method. In: Encyclopedia of Survey Research Methods. 2455 Teller Road, Thousand Oaks California 91320 United States of America: Sage Publications, Inc.; 2008 Accessed 28 March 2022. Available: http://methods.sagepub.com/reference/encyclopedia-of-survey-research-methods/n262.xml

14. ADA. Standards of Medical Care in Diabetes—2016: Summary of Revisions. Diabetes Care. 16 déc 2015;39(Supplement_1):S4-5.

15. WHO AFRO. Message of the WHO Regional Director for Africa Dr Matshidiso Moeti on World Diabetes Day, 14 November 2017. WHO | Regional Office for Africa. 2017. Accessed 12 apr 2022. Available: https://www.afro.who.int/regional-director/speeches-messages/message-who-regional-director-africa-dr-matshidiso-moeti-19

16. Ministry of Health and Public Hygiene. Order No. 173 MSHP/CAB of 21 June 2007 on the organisation, attributions and functioning of the National Programme for the Fight against Metabolic Diseases. No. 173 MSHP/CAB of 21 June 2007 2007.

17. McLarty DG, Pollitt C, Swai ABM. Diabetes in Africa. Diabet Med. 10 sept 1990;7(8):670-84.

18. Institute for Health Metrics and Evaluation. Global burden of 87 risk factors in 204 countries and territories, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. Institute for Health Metrics and Evaluation. 2020. Accessed 29 Jun 2021. Available: http://www.healthdata.org/research-article/global-burden-87-risk-factors-204-countries-and-territories-1990%E2%80%932019-systematic

19. Thibault V, Bélanger M, LeBlanc E, Babin L, Halpine S, Greene B, et al. Factors that could explain the increasing prevalence of type 2 diabetes among adults in a Canadian province: a critical review and analysis. Diabetol Metab Syndr. 9 nov 2016;8:71.

20. Mphekgwana PM, Mabila LN, Maimela E. Indirect and direct effects of factors associated with diabetes amongst the rural black population in the Dikgale Health and Demographic Surveillance System, South Africa. Afr J Prim Health Care Fam Med. 15 juill 2021;13(1):2819.

21. Millogo T, Bicaba BW, Soubeiga JK, Dabiré E, Médah I, Kouanda S. Diabetes and abnormal glucose regulation in the adult population of Burkina Faso: prevalence and predictors. BMC Public Health. 13 mars 2018;18(1):350.

22. Tripathy JP, Thakur JS, Jeet G, Chawla S, Jain S, Pal A, et al. Prevalence and risk factors of diabetes in a large community-based study in North India: results from a STEPS survey in Punjab, India. Diabetol Metab Syndr. 23 janv 2017;9:8.

23. Amoussou-Guenou D, Wanvoegbe A, Hermans M, Agbodande A, Boko M, Amoussou-Guenou Fandi A. Prévalence et facteurs de risque du diabète sucré en milieu noir urbain : cas de Porto-Novo (Bénin). Ann Endocrinol. 1 sept 2015;76(4):523. French

24. Githinji GG, Hussein AA, Kimani T, Mutuku B, Githuku J, Gura Z, et al. Prevalence of diabetes and co-morbidities in five rural and semi-urban Kenyan counties, 2010–2015. Int J Diabetes Dev Ctries. 1 avr 2018;38(2):243-8.

25. Matshipi M, Monyeki KD, Kemper H. The Relationship between Physical Activity and Plasma Glucose Level amongst Ellisras Rural Young Adult Males and Females: Ellisras Longitudinal Study. Int J Environ Res Public Health. févr 2017;14(2):198.

26. Mohamed SF, Mwangi M, Mutua MK, Kibachio J, Hussein A, Ndegwa Z, et al. Prevalence and factors associated with pre-diabetes and diabetes mellitus in Kenya: results from a national survey. BMC Public Health. 7 nov 2018;18(Suppl 3):1215.

27. Sitorus N, Hanafi AS, Simbolon D, Martina null. Joint effect of high blood pressure and physical inactive on diabetes mellitus: a population-based cross-sectional survey. J Prev Med Hyg. déc 2020;61(4):E614-20.

28. Zeru MA, Tesfa E, Mitiku AA, Seyoum A, Bokoro TA. Prevalence and risk factors of type-2 diabetes mellitus in Ethiopia: systematic review and meta-analysis. Sci Rep. 5 nov 2021;11:21733.

29. Krzesinski JM, Weekers L. Hypertension and diabetes. Rev Med Liege. juin 2005;60(5-6):572-7.

30. Mutyambizi C, Booysen F, Stokes A, Pavlova M, Groot W. Lifestyle and socio-economic inequalities in diabetes prevalence in South Africa: A decomposition analysis. PLoS ONE. 30 janv 2019;14(1):e0211208.

31. Carlsson S, Hammar N, Grill V, Kaprio J. Alcohol consumption and the incidence of type 2 diabetes: a 20-year follow-up of the Finnish twin cohort study. Diabetes Care. oct 2003;26(10):2785-90.

32. Koppes LLJ, Dekker JM, Hendriks HFJ, Bouter LM, Heine RJ. Moderate alcohol consumption lowers the risk of type 2 diabetes: a meta-analysis of prospective observational studies. Diabetes Care. mars 2005;28(3):719-25.

33. Conigrave KM, Hu BF, Camargo CA, Stampfer MJ, Willett WC, Rimm EB. A prospective study of drinking patterns in relation to risk of type 2 diabetes among men. Diabetes. oct 2001;50(10):2390-5.

34. Holst C, Becker U, Jørgensen ME, Grønbæk M, Tolstrup JS. Alcohol drinking patterns and risk of diabetes: a cohort study of 70,551 men and women from the general Danish population. Diabetologia. oct 2017;60(10):1941-50.

35. Osei K, Gaillard T. Pathogenic Mechanisms of Prediabetes in Obese vs. Very Obese African American Women: Implications for Diabetes Prevention. J Natl Med Assoc. févr 2019;111(1):76-82.

ACRONYMS, ABBREVIATIONS

CI : Confidence Interval

NCD : Non Communicables diseases

WHO : World Health Organization

LMICs : Low and Middle income Countries

IDF : International Diabetes Federation

ROC : Receiver Operating Characteristic