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]. Factors associated with this prevalence were age 60-79 years, male gender, family heredity of diabetes, abdominal obesity (waist circumference), high triglycerides and high LDL cholesterol. However, moderate and frequent alcohol consumption is protective against diabetes.
Conclusion: The prevalence of diabetes in Côte d'Ivoire has increased relatively since the last survey in 1979 with a greater burden in older populations. 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 unremitted 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 KISCH table [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).

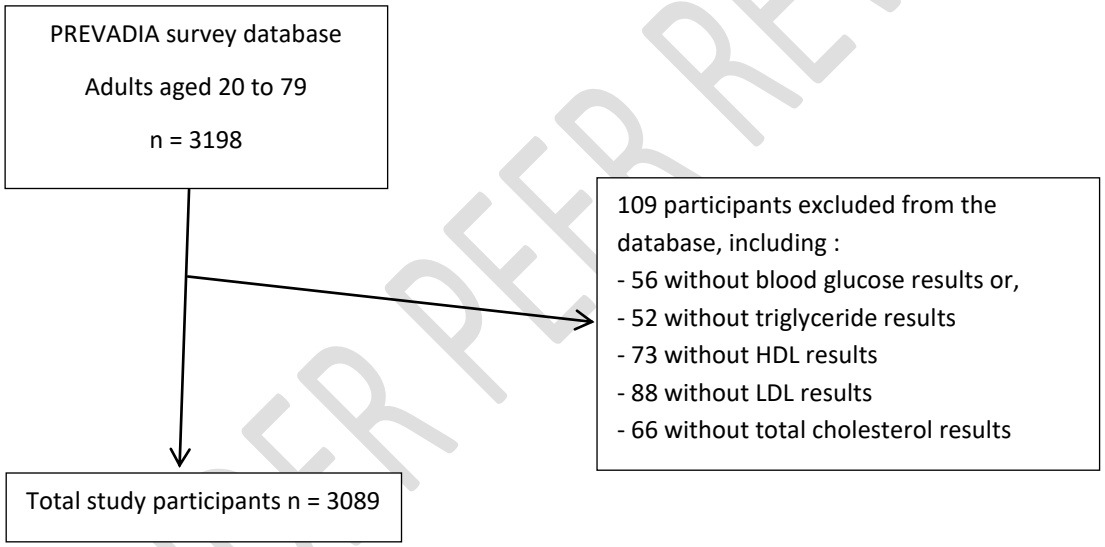

Figure 1: Flow chart of participants

2.3. Variables

The dependent variable was diabetes. It was constructed from the interview and blood glucose measurement. Diabetes and fasting hyperglycaemia were determined from fasting blood glucose levels 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 univariate 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 $P < 0.05$.

2.5. Ethical considerations

The PREVADIA study was authorised by the Ministry of Health and Public Hygiene and then by the National Ethics Committee for Life Sciences in Côte d'Ivoire.

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).

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

	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)	
	%	**[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 a positive correlation between diabetes and age. Indeed, the prevalence of diabetes increases with age, from 4.89% in the 20-39 age group to 6.28% (40-59 years) and 7.81% in the

60-79 age group. Subjects have a higher risk of developing diabetes as age increases. Similarly, there is an association between gender and the prevalence of diabetes, whereas the difference is not significant between men (6.04%) and women (6.06%). On the other hand, alcohol consumption is associated 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.

Family heredity is strongly associated with diabetes. Indeed, people with diabetics in their ancestry have twice the prevalence of diabetes. There is also an association with waist circumference. In fact, people with a waist circumference greater than 88 cm in women and greater than 102 cm in men, i.e. respondents with abdominal obesity, have a prevalence of diabetes that is almost doubled.

The prevalence of diabetes is also correlated with the triglyceride level. Indeed, this prevalence increases with the increase of the glyceride level, as it goes from 5.19% for low levels (<1.5 g/l) to 9.09% for medium levels [1.5 to 2 g/l], to reach 14.87% for high glyceride levels (> 2 g/l).

With regard to cholesterol, the association that was identified was with LDL-cholesterol. It is a strong association in people with LDL-cholesterol levels between 1.35 and 1.74 g/l, with a twofold increased risk of developing diabetes (Table 3).

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

	Diabetes (%) n=3089	P>|z|	Odds Ratio adjusted	P>|z|	[95% Conf.	Interval]
Age group						
[20-39]	4,89	0,036	1			
[40-59]	6,28		1,29	0,169	0,89	1,87
[60-79]	7,81		1,61	0,028*	1,05	2,48
Gender						
Male	6,04	0,978	1,56	0,020*	1,07	2,28
Female	6,06		1			
Marital_situation						
Married or common-law	5,47	0,002	0,74	0,150	0,50	1,12

Never married	6,14		1			
Divorced or widowed	10,98		1,62	0,09	0,91	2,88
Level of education						
None	5,55	0,640				
Primary	6,71					
Secondary	6,10					
Higher	7,17					
Living environment						
Urban	7,37	0,001	1,37	0,070	0,97	1,94
Rural	4,45		1			
Professional Activity						
Yes	6,52	0,288	1,29	0,130	0,92	1,79
No	5,61		1			
Physical activity level						
High	4,63	0,016	1			
Medium	5,03		1,21	0,469	0,72	2,02
Borderline	7,38		1,62	0,057	0,98	2,66
Alcohol consumption						
Yes	4,45	0,003	0,63	0,009*	0,44	0,89
No	7,09		1			
Nibbling						
Yes	7,27	0,098	1,31	0,118	0,93	1,86
No	5,64		1			
Hypertension status						
Yes	7,95		1.31	0.102	0,94	1,83
No	4,79		1			
Family heredity						
Yes	11,79	0,000	2,50	0.000*	1,71	3,66
No	4,70		1			
Don't know	6,15		1.41	0,063	0,98	2,04

Nutritional status						
< 18.5	5,45	0,017	1,19	0,589	0,62	2,28
[18.5 - 25[	4,94		1			
[25 - 30[	7,09		1,11	0,599	0,74	1,67
≥ 30	8,55		1,18	0,480	0,73	1,91
Waist size						
Male<94 and	4,70	0,001	1			
Male [94-102[and Female [80-88[	6,29		1,419	0,152	0,88	2,27
Male≥94 and	8,39		1,56	0,042*	1,01	2,39
Triglyceride						
< 1,5	5,19	0,000	1			
[1,5-2[	9,09		1,73	0,031*	1,05	2,86
≥ 2	14,87		3,30	0,000*	2,08	5,22
LDL cholesterol						
< 1,35	5,12	0,000	1			
[1,35-1,75[	10,02		2,01	0,001*	1,30	3,09
≥ 1,75	10,46		1,76	0,061	0,97	3,21
HDL cholesterol						
Yes (M<0,4 et F<0,5)	5,92	0.960				
No (M≥0,4 et F≥0,5)	6,20		0,9151927	0,597	0.658801	1.271366
Total cholesterol						
< 2	5,00	0,000	1			
≥ 2	8,22		1,18	0,372	0,82	1,69

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]. However, it 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 [15].

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. Indeed, this prevalence increases with the ageing of the population, rising from 4.89% in the 20-39 age group to almost double (7.81%) in the 60-79 age group. Older subjects are significantly more likely to have diabetes (p=0.028). This association of diabetes prevalence with population ageing is consistent with the findings of many studies worldwide, including those of Thibault et al. in New Brunswick, Canada, Mphekgwana et al. in South Africa, Millogo et al. in Burkina Faso, Amoussou-Guenou et al. in Benin and Tripathy et al. in India [16-20]. Although there is an association of the prevalence of diabetes with male sex, in our study there was no significant difference in prevalence between men and women as in the work of Matshipi and Mphekgwana in South Africa and Githinji in Kenya [17,21,22]. On the other hand, this result in Côte d'Ivoire is contrary to those of Millogo in Burkina Faso [18], Amoussou-Génou in Benin [20] and Tripathy in India [19] 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. found a significant difference in diabetes prevalence between urban and rural areas in Burkina Faso [18]. The same finding was made by Mohamed in Kenya [23] and Tripathy in India [19]. This difference in prevalence between residential settings can be explained by a more rapid epidemiological transition in urban areas [23]. This transition may suggest that a greater proportion of the population may be exposed to obesogenic environments and lower levels of physical activity [16].

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. 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

[24] and Mphekgwana [17] 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 [25,26]. Better still, frequent drinking offers the greatest protection against type 2 diabetes, even at low levels of consumption per day of drinking [27,28].

One of the factors identified as being strongly associated with the prevalence of diabetes in our study was the familial inheritance of diabetes. Indeed, people with diabetics in their ancestry have a prevalence of diabetes that is twice as high. This result is in line with those of Amoussou-Guenou in Benin and Tripathy et al. in India who found that a family history of diabetes was a strong predictor of the disease [19,20]. However, our results differ from those of Millogo 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 [18]. 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, we observed a prevalence of diabetes that is almost double that of normal people. Our results are similar to those obtained in the USA by Osei, Amoussou-Guenou in Benin, Tripathy in India and Thibault in New Brunswick, Canada, who reported an association between diabetes and abdominal obsessiveness [16,19,20,29]. However, our results are contrary to the findings of Mphekgwana in South Africa who did not find a statistically significant association between high waist circumference and diabetes [17].

Other factors with which the prevalence of diabetes was correlated in our study were high Triglycerides and high LDL-Cholesterol. The prevalence of diabetes increases strongly to three times as much in subjects with high Triglycerides. Our result partially coincides for high Triglycerides with the results of the work of Mphekgwana in South Africa who reported a significant association of diabetes with high Triglycerides and HDL-cholesterol. However, our results diverge from those of Mphekgwana for cholesterol because it is LDL-cholesterol that is associated with diabetes in our study [17].

Strength and Limitations of the Study

This work represents the second study on the prevalence of diabetes and the first to investigate the risk factors associated with this prevalence at a population level across the country. 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 determine the prevalence of diabetes and its associated factors. This study reports that the prevalence of diabetes has increased in Côte d'Ivoire since the last survey in 1979 and the factors associated with it are age at 65 years and above, alcohol consumption, 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.

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.

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ACRONYMS, ABBREVIATIONS

CI : Confidence Interval

NCD : Non Communicables diseases

WHO : World Health Organization

LMICs : Low and Middle income Countries

FID/IDF : Fédération Internationale du Diabète (International Diabetes Federation)

OMS : Organisation mondiale de la santé (World Health Organization)