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Jacobs Journal of Epidemiology and Preventive Medicine

Research Article

Risk Factors of Type 2 Diabetes Mellitus in Benin Adults: A Hospital-Based Case-Control Study

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Received: 03-31-2017

Accepted: 11-17-2017

Published: 11-21-2017

Abstract

Background: Prevalence of diabetes is rising worldwide. According to projections, by 2030, diabetes will be the seventh leading cause of death worldwide.

Objective: To identify dietary, lifestyle and biological risk factors of type 2 diabetes in adults in south western Benin setting.

Methods: This was a case-control study which included patients with type 2 and controls (matching for age, gender, ethnicity and level of education) selected departmental hospital center (DHC) in Lokossa in Benin. Data were collected from medical records and individual interviews. Odds ratio for risk factors of diabetes were determined using conditional multiple logistic regression.

Results: 140 cases (diabetes) and 140 controls (free from diabetes) selected in DHC Lokossa participated in the study. Age mean was 51.42 ± 11.88 years and 51.79 % of participants were men. Risk factors of diabetes identified were: lack of knowledge about diabetes [OR=2.93 CI95% (1,71–4.16)], physical inactivity [OR=1,42 CI95% (0,31–2,54)], frequent consumption of sugar-sweetened foods [OR=1.27 CI95% (0.12-2.42)], abdominal obesity [OR=1,89 CI95% (0.05-3.84)] and family history of diabetes [OR=1.23 CI95% (0.15 -2.45)].

Conclusion: Risk factors of diabetes were low knowledge, dietary and lifestyle. Communication for awareness of diabetes and adoption of healthy dietary patterns and lifestyles are timely to prevent diabetes in southwestern Benin populations.

Keywords: Type 2 diabetes; Risk factors; Adults; Benin

Introduction

Diabetes mellitus (DM) is defined as a "metabolic disorder caused by different factors characterized by a chronic high level of blood sugar with disturbances to carbohydrate, fat, and protein metabolism resulting from defects in insulin secretion, insulin action, or both. Several type of diabetes are known including mainly: type 1 DM or insulin dependent DM, type 2 DM or noninsulin dependent diabetes mellitus and gestational DM is defined as any degree of glucose intolerance with onset or first recognition during pregnancy [1, 2]. Type 2 DM accounts for 90% of all diabetes. Globally, an estimated 422 million adults lived with diabetes in 2014, and by 2030, diabetes will be the seventh leading cause of death worldwide [3].

As new lifestyles, imported dietary practices, and globalization take roots sub-Saharan Africa favoring diabetes and its complications in the region, compelling African governments to start paying more attention to its impact as thousands of Africans run the risk of dying young. The potential severity of diabetes is such that some epidemiologists predict that its economic impact and death toll will surpass the ravages of HIV and AIDS in the near future [4]. Diabetes is a particular challenge for African countries that face the double epidemiological burden of persisting infectious diseases and the emergence of chronic diseases. In a review [5] reported that populations of African origin have the highest prevalence of micro-vascular complications related to diabetes [5]. In sub-Saharan Africa, about 15% of people who suffered from a stroke are diabetic and 5% of people with diabetes have stroke at the time of diagnosis. The mortality attributable to diabetes in sub-Saharan Africa was estimated at 6% in 2010 and was 2.5% higher than in 2000 [6]. Eighty per cent (80%) of diabetics aged 40-59 years are in low- and middle-income countries. The direct health care costs of diabetes-related diseases account for between 2.5% and 15% of annual budgets for health [7]. Identification of people at high risk for developing diabetes is timely to prevent the onset of the disease.

In Benin, the prevalence of diabetes in the department of Mono was 1.2% versus a national average of 2.6% according to the national survey conducted in 2008 [8]. Benin is a resource-constrained country that cannot afford the costs of diabetes care. The fight against diabetes must therefore rely on its prevention. The objective of the study was to identify dietary, lifestyle and biological risk factors of type 2 diabetes in the south-western region of Benin.

Methods

Setting

The study was conducted at the Diabetes Unit care of Departmental Hospital Center (DHC) in Lokossa, Benin, managed by a doctor assisted by a nurses. The diabetes unit care ensures the prevention, detection and treatment of diabetes with the support of diabetologists and dieticians of a non-governmental organization. The DHC covers the departments of South-West Benin whose population was estimated at 1237202 inhabitants in 2013.

Type and study population

This is a case-control study conducted from March to July 2014. The study population consisted of users of the DHC. Cases were type 2 diabetics followed in 2013 in the diabetes unit of the Lokossa DHC. Control group was selected in outpatients in the same hospital matching with cases by age, sex, ethnicity and educational criteria. The sources of the matching data were the medical records of diabetic patients and the diabetes-free out patient records in the Lokossa DHC.

Sample size

Considering abdominal obesity as a risk factor of interest with prevalence of 61.3% and 35.8% respectively in diabetics and non-diabetics [9] and setting the case-to-control ratio to 1, a minima sample size of 131 diabetic patients and 131 controls is sufficient to detect an Odds ratio (OR) of 2.0 with a statistical power of 80%. Finally, 140 diabetics (cases) and 140 controls participated in the study as shown in figure 1.

Selection of participants

Selection of cases

All type 2 diabetics registered at 30 June 2015 at the diabetes management unit of the Lokossa DHC were eligible. Subjects excluded were those lost to follow-up, diabetic with hypertension in order to skip this confounding factor, who refuse to participate in the investigation and who, were unable to answer the questions because of their state of health.

Selection of controls

Non-diabetic subjects received for medical consultation in internal medicine service of the hospital and met the matching criteria of age, gender, ethnicity, and education were selected [7]. Patients who refused to participate in the survey and those with high blood pressure were excluding.

Variables of the study

The independent variables included socio-economic factors (age, sex, educational attainment, occupation and the level of economic well-being), diet and lifestyle recorded prior to the diagnosis of type 2 diabetes for diabetics (frequencies of food consumption, physical activity, sedentary lifestyle, alcohol consumption, and tobacco use), biological and anthropometric factors (family history of diabetes, personal history of dyslipidemia and gestational diabetes, body mass index and waist circumference) and Knowledge of type 2 diabetes (risk factors

Type of variable	Name of variable or group of variable	Components of group of variable
Dependent variable	Presence of type 2 diabetes (fasting blood glucose ≥ 7 mmol / L)	fasting blood glucose
Independent variables	Socio-economic factors	age sex, educational occupation level of economic well-being
	Diet and lifestyle factors	frequencies of food consumption, physical activity, sedentary lifestyle, alcohol consumption, tobacco use
	Biological and anthropometric factors	family history of diabetes personal history of dyslipidemia and gestational diabetes body mass index waist circumference
	Knowledge of type 2 diabetes	risk factors of type 2 diabetes symptoms and complications of type 2 diabetes

Table 1. Variables of the study
The dependent variable was the presence of type 2 diabetes. Diabetes was diagnosed when fasting blood glucose ≥ 7 mmol / L.

of type 2 diabetes, symptoms and complications of type 2 diabetes).

The level of economic well-being was determined using the method in the Demographic Health Survey of Benin 2006 [10]. Five (5) criteria with predefined score were used: home membership, source of lighting, energy source for cooking, sources of information and means of travel. Scores were assigned to each criterion. The subjects were classified into economic well-being terciles.

Frequencies of food consumption of at most twice a week were considered rare/sometimes and consumption rates of at least three times a week to several times a day were considered frequent. Cumulatively less than thirty minutes of moderate to vigorous physical activity per day was considered a low level of physical activity. The sedentary lifestyle was defined as keeping a fixed sitting position for more than three hours without getting up [11]. Alcohol consumption of more than two standard drinks per day for women and four drinks for men was considered excessive. The experience of using tobacco regardless of the duration is considered as tobacco consumption.

Weight recorded prior to the diagnosis of type 2 diabetes for cases were used to calculate body mass index (BMI).

The weight status of the patients was classified as: overweight BMI ≥ 25, and absence of overweight (BMI < 25). Waist circumference recorded at the time of data collection was rated high if greater than or equal to 102 cm for men and 88 cm for women. Knowledge of type 2 diabetes refers to basic knowledge about risk factors, signs and complications of diabetes in participants was considered prior diabetes diagnosis in diabetics.

Data collection

Data collection techniques consisted of medical records exploitation and individual interview. Data on lifestyle and basic knowledge about diabetes were collected by individual interview.

Questionnaires were used for data collection in study participants. The questionnaires were pre-tested in other health district by checking the answerability and the appropriateness of questions. The result of the pre-test informed the investigator on the required adjustments in the final questionnaire used.

Ethical Considerations

Departmental health officials were informed on the objectives of the study. The respondents were informed on the nature,

purpose and objectives of the study. Informed consent was obtained from respondents prior to data collection. That consent claims that participants are not at risk by refusing to participate in the survey or stopping their collaboration during the study. The anonymity and confidentiality of the information gathered were ensured.

Data analysis

The data were entered with the epi-info software and analyzed by the Stata11.0 software. The characteristics of the sample were described the estimated proportions and the odds ratio (OR) were calculated with their 95% confidence intervals. Independent variables significantly associated with the dependent variable at p <0.20 in the univariate analysis were introduced into the multiple logistic regression model. The significance level for the multivariate analysis was set to p <0.05. The goodness of the final model was verified by the Hosmer and Lemeshow test.

Results

Of the 181 patients invited for interview, 41 (22.65%) declined. There were no significant differences in sex, age and anthropometric parameters between the cases who participated in the study and refusals. Since we set case-to-control ratio to 1 for minimal sample size calculation, the controls included in the study were 140, the total number of participants was 280 (Figure 1).

General characteristics of participants

Of the 280 participants, men accounted for 50%. The age of participants varied between 16 and 80 years with an average age of 51.42 ± 11.88 years. Subjects with formal secondary education accounted for 35% of respondents. The most represented occupations in diabetics were officials (37% in men and 42% in women) while the most frequent occupations in control group were traders (51% in women) and artisans (27% in men). The economic level was medium in 87% of diabetics and 85% of controls. In diabetics, 29.3% used metformin and 48.57% received metformin and sulfonamides. The mean waist circumference was 95.36 ± 16.0 cm for diabetics and 89.80 ± 10.1 cm for the controls (p <0.001). The mean number of daily meals was 3.74 ± 0.61 in diabetics and 2.84 ± 0.52 (p <0.001) in controls.

Table 2 shows that familial diabetes (diabetes in relatives) was present in 5% of controls and in 28.57% of diabetics (p <0.001). Among participants, excessive alcohol drinking and tobacco use was observed in 63.57% and 19.3% in the diabetics respectively and 51.43% and 11.43% (p <0.001) in the control group. Proportions of physically inactive participants were 52.14% in diabetics and 26.43% in control group (table 2).

Risk factors for type 2 diabetes

Table 2 shows that the biological factors associated with type 2 diabetes in univariate analysis were history of family diabetes, overall and abdominal obesity.

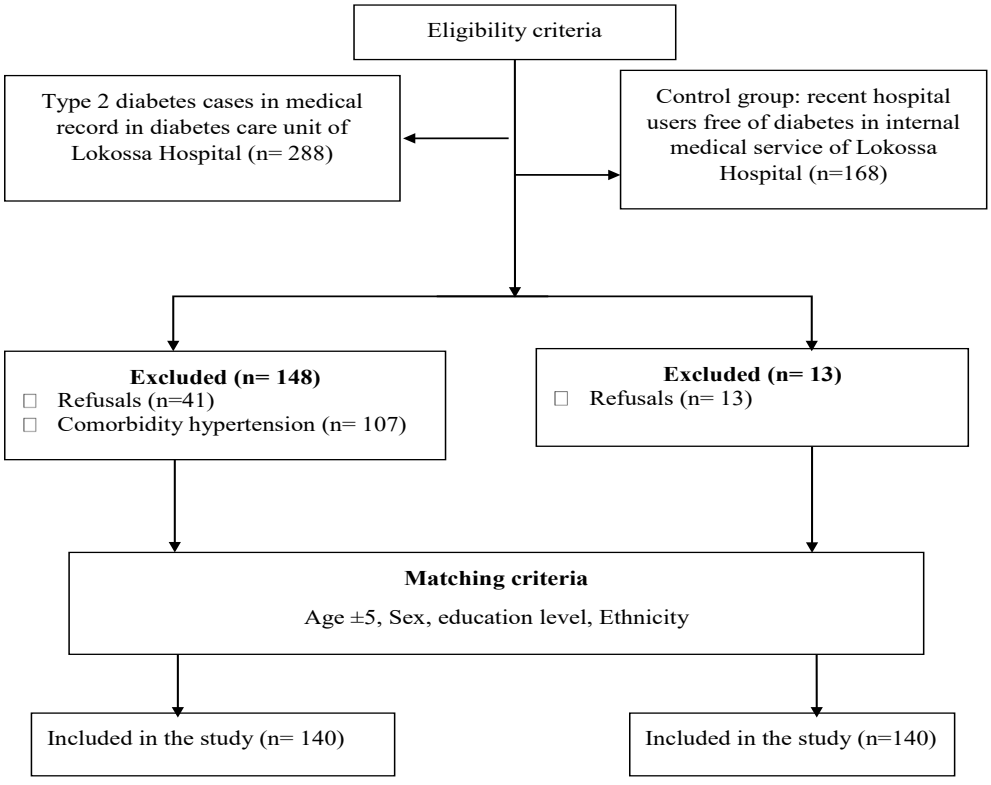

Figure 1. Prisma flow diagram for participants included and excluded from the study.

Table indicates also that dietary and lifestyle factors and knowledge status associated with type 2 diabetes in univariate analysis were alcohol consumption, tobacco use, level of physical activity, daily number of meals consumed, frequency of sugars sweetened food consumption and knowledge on diabetes.

Table 3 summarizes in multivariate logistic regression analysis, the risk factors for diabetes: low level of knowledge on diabetes [OR = 2.93 CI95% (1.71 - 4.16)], physical inactivity [OR = 1.42 CI95% (0.31 - 2.54)], consumption of sugar sweetened foods [OR = 1.27 CI95% (0.12 -2.42)], abdominal obesity [OR = 1.89 CI95% (0.05 - 3.84)], and a family history of diabetes [OR = 1.23 CI95% (0.15 -2.45)]. The goodness of the model was verified by the Hosmer and Lemeshow test (p = 0.5801) that confirms the model adequation.

Dietary and lifestyle risk factors	All	Groups		p
		Cases n (%)	Controls n (%)	
Alcohol consumption				
No	119 (42.5)	51 (36.4)	68 (48.6)	
Yes	161 (57.5)	89 (63.6)	72 (51.4)	**0.039**
Tobacco use				
No	237 (84.6)	113 (80.7)	124 (88.6)	
Yes	43 (15.4)	27 (19.3)	16 (11.4)	**<0.067**
Physical activity status				
Active	169 (60.4)	67 (47.9)	102 (72.9)	
Inactive	111 (39.6)	73 (52.1)	38 (27.1)	**<0.001**
Knowledge on diabetes				
Adequate	206 (73.6)	79 (56.4)	127 (90.7)	
Poor	74 (26.4)	61 (43.6)	13 (9.3)	**<0.001**
Frequency of meal intake				
<=3 times /day	229 (81.8)	99 (70.7)	130 (92.9)	
>3 times /day	51 (18.2)	41 (29.3)	10 (7.1)	**<0.001**
Consumption of sugar sweetened foods				
<3 times /week	239 (85.4)	114 (81.4)	125 (89.3)	
≥3 times /week	41 (14.6)	26 (18.6)	15 (10.7)	**<0.062**
Consumption of cereals				
<3 times /week	15 (5.4)	7 (5.0)	8 (5.7)	
≥3 times /week	265 (94.6)	133 (95.0)	132 (94.3)	0.795
Consumption of fruits				
<3 times /week	177 (63.2)	93 (66.4)	84 (60.0)	
≥3 times /week	103 (36.8)	47 (33.6)	56 (40.0)	0.267
Consumption of vegetables				
<3 times /week	185 (66.1)	89 (63.6)	96 (68.6)	
≥3 times /week	95 (33.9)	51 (36.6)	44 (31.4)	0.359
Overweight/obesity				
No	130 (46.4)	49 (35.0)	81 (57.9)	
Yes	150 (53.6)	91 (65.0)	59 (42.1)	**<0.001**
Abdominal obesity				
Non	180 (64.3)	77 (55.0)	103 (73.6)	
Oui	100 (35.7)	63 (45.0)	37 (26.4)	**0.001**
Diabetes in relatives				
No	133 (47.5)	100 (71.4)	133 (95.0)	
Yes	147 (52.5)	40 (28.6)	7 (5.0)	**<0.001**

Table 2. Dietary, lifestyle an biological risk factors of type 2 diabetes in adults, univariate analysis, Lokossa Hospital, Benin, 2015 (n=280).

Risk factors	OR	95%IC	p value
Diabetes in relatives (familial diabetes)			
No	**1**		
Yes	**1.23**	**[0.15 -2.45]**	**0.047**
Knowledge on diabetes (prior diabetes diagnosis)			
Adequate	**1**		
Poor	**2.93**	**[1.71 – 4.16]**	**<0.001**
Alcohol consumption			
No	1		
Yes	1.18	[-0.09 – 2.90]	0.121
Tobacco use			
No	1		
Yes	0.18	[-1.03 – 1.40]	0.771
Overweight/obesity			
No	**1**		
Yes	**1.01**	**[0.05 - 1.96]**	**0.040**
Abdominal obesity			
No	**1**		
Yes	**1.89**	**[0.05 - 3.84]**	**0.011**
Physical activity status			
Active	**1**		
Inactive	**1.42**	**[0.31 – 2.54]**	**0.012**
Daily frequency of meal			
≤ 3 /day	1		
> 3 /day	0.20	[- 0.17 - 0.56]	0.165
Consumption of sugar sweetened foods			
<3 times /week	**1**		
≥3 times /week	**1.27**	**[0.12 - 2.42]**	**0.030**
Consumption of fruits			
<3 times /week	1		
≥3 times /week	0.52	[-1.02 – 0.49]	0.490

Table 3. Risk factors of type 2 diabetes in adults, multivariate logistic regression analysis, Lokossa Hospital, Benin, 2015 (n=280).

Discussion

The study examined the risk factors for type 2 diabetes in south-west Benin using case-control study design. The risk factors identified were related to knowledge about the disease, diet, and lifestyle.

Knowledge on type 2 diabetes

The poor knowledge about diabetes increased the risk of being diabetic. Indeed [12]. reported that, there is a positive correlation between knowledge, attitudes and behavior. According to the theory of reasoned action, humans are generally rational and logical, and they systematically use available information in changing behaviors. Humans consider the consequences of their actions before deciding whether or not they will adopt behavior [13]. According to the literature, knowledge, attitudes and beliefs are individual factors that influence the behavior of individuals [14]. The basic understanding of type 2 diabetes risk factors and the knowledge of its complications will allow patients to make efforts to adopt the lifestyle that contribute to the prevention of diabetes. The level of knowledge of diabetes was satisfactory in less than half of the respondents (26.43%) while [12]. reported a proportion of (59%) in Tunisia. A communication action to improve basic knowledge on diabetes in the population is needed for adopting preventives measures.

Lifestyles and Type 2 Diabetes

Low physical activity increased the risk of being diabetic. This result is consistent with the literature that identifies physical activity as a factor that prevents the onset of diabetes and its complications. In a study on assessment of risk factors carried out in South Africa, authors reported a significant association of type 2 diabetes with physical activity [15]. According to [16], physical activity helps to improve many metabolic aspects of the body's carbohydrates and lipids with beneficial effects on diabetes. Physically inactive persons accounted for 39.6% in the present study. This proportion is higher than those found by [17]. who observed 31% of the active population in their sample. The National surveillance of non-communicable diseases conducted in Benin in 2008 reported that 79.45% of participants with high level of physical activity. This high proportion of low physical activity my linked to lifestyle in relation to the ongoing nutritional transition in developing countries.
The present study did not establish a statistically significant relationship between alcohol use and diabetes. Unlike many authors [18, 19] who have shown an association between alcohol consumption and chronic diseases including diabetes. Indeed, the effect of alcohol on diabetes-related morbidity depends not only on the nature, but also on quantities and habits of consumption. Other studies have reported that low or moderate alcohol use reduces the risk of type 2 diabetes [20].

Diet and type 2 diabetes

Dietary pattern was associated with diabetes. In a hospital-based case-control study on risk factors for type 2 diabetes in Kumasi, a FFQ was administered to 675 controls and 542 cases. Two dietary patterns were identified by using factor analysis including thirty-three food items: a 'purchase' dietary pattern which positively correlated with the consumption of sweets, rice, meat, fruits and vegetables and (2) and a 'traditional' dietary pattern that correlated with the intake of fruits, plantain, green leafy vegetables, fish, fermented maize products and palm oil. Using logistic regression, authors found that the 'purchase' dietary pattern was inversely associated with type 2 diabetes while the 'traditional' dietary pattern increased the odds of diabetes [21].

Frequent consumption of sugar-sweetened foods increased the risk of being diabetic. The results are consistent with findings of [22]. There is widespread evidence that excessive sugar intake is associated with various health problems, including obesity and diabetes by increasing energy intake [23-25].

The Beninese food guide recommends the daily consumption of five (5) portions of fruits and vegetables (2 fruits and 3 vegetables are recommended). In the present study, few proportions in diabetics and in control group consumed fruit at least three times a week. Regarding vegetables intake, 36% of diabetics and 69% of participants in control group consumed them at least three times a week.

The link between fruit and vegetable consumption and diabetes is not significant in the study, while other studies have shown that consumption of fruits and vegetables decreases the risk of diabetes [26, 27]. This difference is certainly due to the fact that we have not quantified the consumption of fruits and vegetables. Crude frequency consumption of fruit and vegetable may not exactly reflect the quantities of this food consumed. Furthermore, this result may also be linked to desirability bias since diabetics are exposed to nutritional education, they response one fruit and vegetables consumption could be modified accordingly.

Weight status and type 2 diabetes

Abdominal obesity increased the risk of being diabetic. This finding is in agreement with cohort studies that reported the high risk of developing diabetes in subjects with abdominal obesity [28, 29]. In a study on assessment of risk factors carried out in the Cape Coast metropolis of Ghana, authors reported that body weight was found to be independently associated with diabetes [30]. Other authors have also reported that abdominal obesity is a component of the metabolic syndrome that showed an independent association with diabetes [31, 32]. Prospective cohort studies have also reported abdominal obesity association with the onset of diabetes [29, 33]. The association between abdominal obesity and diabetes has been mainly explained by the lower insulin sensitivity, beta-cell dysfunction, favoring abnormalities of glucose homeostasis in subjects with excess visceral fat [34]. Further, several molecules released in greater or lower amount by visceral adipocytes exert also a detrimental role on beta-cell function. Among these molecules free fatty acids and adipokines should be mentioned. The latter include inflammatory cytokines, such as tumor necrosis factor-alpha and interleukin-6 and hormones synthesized by adipocytes, such as adiponectin, leptin and resistin. Visceral obesity is also associated with an excessive depot of triglycerides and other lipid products within the key organ of glucose metabolism namely the liver [34]. Additional evidence also suggests that the cardiometabolic risk related to the hyperglycemic state observed in subjects with the metabolic syndrome or type 2 diabetes is largely explained by the high prevalence of the metabolic complications of abdominal obesity [35]. Metabolic syndrome refers to events that occur in the human body defined as any three of the following five CMR risk factors had to be present: abdominal obesity, elevated serum triglycerides, low serum high density cholesterol, high blood pressure (or treatment for hypertension) and high fasting glucose or diabetes [36].

Family history of diabetes

Family history of diabetes was found in more than one diabetic out of four. Proportion or family history of diabetes observed

in the present study is higher than those observed by [37]. It is recognized that type 2 diabetes has a strong genetic component. Family studies have shown that offspring with first-degree relatives with type 2 diabetes are about 3 times more likely to develop the disease than people without a family history of the disease [38,39] reported in rural Thai villagers that having a first-degree relative with DM is considered an important risk factor to develop T2DM, due to inheritance of genetic risk factors and/or a similar life style pattern among family members [39].

This study has limitation related to memory that is required by answers on dietary and lifestyles factors. Previous data are not available for abdominal obesity so we use current data for this. Furthermore, desirability bias is possible since diabetics are exposed to nutritional education, they response one fruit and vegetables consumption for example could be modified accordingly.

Conclusion

This study identified factors that increase the risk of diabetes among patients of Lokossa DHC in Benin. These factors were: family history of diabetes, low level of knowledge about diabetes, excessive consumption of sugar-sweetened foods, lack of physical activity and abdominal obesity. Communication for improving community knowledge of diabetes and adopting healthy lifestyle will prevent diabetes onset in the study population.

Conflicts of interest

The authors declare no conflict of interest.

Author contributions

Adégnandjou I.P and Ouendo E-M and Sossa Jérome C drafted the research protocol. Adégnanjou I.P collected the data under supervision of Sossa Jérome C. Kpozehouen A and Sossa Jérome C analyzed the data. Adégnandjou wrote the first version of the manuscript. Sossa Jérome C. revised it in collaboration with the authors.

Acknowledgments

The authors would like to thank the managers of the Lokosssa DHC and all patients who agreed to participate in this study.

References

1. Baynest HW. Classification, Pathophysiology, Diagnosis and Management of Diabetes Mellitus. J Diabetes Metab. 2015, 6(5): 1-9.

2. American diabetes association. Diagnosis and classification of diabetes mellitus. Diabetes Care. 2004, 27: 5–10.

3. Mathers CD, Loncar D. Projections of global mortality and burden of disease from 2002 to 2030. PLoS Med. 2006, 3: e442.

4. Azevedo M, Alla S. Diabetes in Sub-Saharan Africa: Kenya, Mali, Mozambique, Nigeria, South Africa and Zambia. Int J Diabetes Dev Ctries. 2008, 28(4): 101-108.

5. Mbanya JC, Sobngwi E. Diabetes in Africa. Diabetes microvascular and macrovascular disease in Africa. J Cardiovasc Risk. 2003, 10(2): 97-102.

6. Kengne AP, Amoah AG, Mbanya JC. Cardiovascular complications of diabetes mellitus in sub-Saharan Africa. Circulation. 2005, 112(23): 3592-3601.

7.International Diabetes Federation. Diabetes Atlas. Third edition, Brussels (Belgium) 2006.

8. Houinato D, Segnon-Agueh J, Djrolo F, Djigbenoude O. [Final report of the STEPS survey in Benin. National Program for the Fight against Non Communicable; 2007] [cited 04.07.2016]. Available on sur: http://www.who.int/chp/steps/2008_STEPS_Report_Benin.pdf

9. Azandjeme CS, Bouchard M, Djrolo F, Dismand Stephan Houinato, Hélène Delisle. Serum concentrations of organochlorine pesticides associated with diabetes and obesity in Northern Benin (West Africa). J Environ Occup Sci. 2014, 3(3): 121-129.

10. Ndiaye FK. [Type 2 diabetes at the Marie-Louise Brevié Clinic of the Dakar Main Hospital (descriptive study of 111 cases)]. Thesis Med, Dakar, 2005, n°5.

11. Bankoski A, Harris TB, McClain JJ, Brychta RJ, Caserotti P et al. Sedentary activity associated with metabolic syndrome independent of physical activity. Diabetes Care. 2011, 34(2): 497-503.

12. Ben Abdelaziz A, Thabet H, Solthane I, Gana R, Tlili H, Ghannem H. [Knowledge of type 2 diabetic patients on their disease in Sousse, Tunisia]. East Mediterr Health J. 2007, 13(3): 505-514.

13. Ajzen I. The theory of planned behavior: reactions and reflections. Psychol Health. 2011, 26(9): 1113-1127.

14. Boucher D, Gagne C, Cote F. [Determinants of the intention of post-secondary students to eat at least five servings of vegetables and fruit daily]. Rev Epidemiol Sante Publique. 2012, 60(2): 109-119.

15. Motala AA, Omar MA, Pirie FJ. Diabetes in Africa. Epidemiology of type 1 and type 2 diabetes in Africa. J Cardiovasc Risk. 2003, 10(2): 77-83.

16. Kriska AM, Pereira MA, Hanson RL, de Courten MP, Zimmet PZ et al. Association of Physical Activity and Serum Insulin Concentrations in Two Populations at High Risk for Type 2 Diabetes but Differing by BMI. Diabetes Care. 2001, 24(7): 1175-1180.

17. Damoune, I. Yassine, H. El Ouahabi, F. Ajdi L'activité physique chez le diabétique. Diabetes & Metabolism, 2014; 40 (1) : 72307-9.[http://www.sciencedirect.com/science/article/pii/S1262363614723079]

18. Rehm J, Room R, Graham K, Monteiro M, Gmel G, et al. The relationship of average volume of alcohol consumption and patterns of drinking to burden of disease: an overview. Addiction. 2003, 98(9): 1209-1228.

19. Carlsson S, Hammar N, Efendic S, Persson PG, Ostenson CG et al. Alcohol consumption, Type 2 diabetes mellitus and impaired glucose tolerance in middle-aged Swedish men. Diabet Med. 2000, 17(11): 776-781.

20. Sinkiewicz W, Weglarz M. [Alcohol and wine and cardiovascular diseases in epidemiologic studies]. Przeglad Lekarski. 2009, 66(5): 233-238.

21. Frank LK, Kröger J, Schulze MB, Bedu-Addo G, Mockenhaupt FP et al. Dietary patterns in urban Ghana and risk of type 2 diabetes. Br J Nutr. 2014, 112(1): 89-98.

22. Laurenco S, Oliveira A, Lopes C. Effects of current and lifetime alcohol consumption on overall and central obesity. Eur J Clin Nutr. 2012, 66(7): 813-818.

23. Perrick H. [Carbohydrates]. 2014. [consulted on 15 February 2015]. Available on http://sante medecine.commentcamarche.net/forum/affich-1651121-glucides.

24. Rippe JM, Angelopoulos TJ. Sucrose, High-Fructose Corn Syrup, and Fructose, Their Metabolism and Potential Health Effects: What Do We Really Know? Adv Nutr. 2013, 4(2): 236-245.

25. Bray GA, Nielsen SJ, Popkin BM. Consumption of high-fructose corn syrup in beverages may play a role in the epidemic of obesity. Am J Clin Nutr. 2004, 79(4): 537-543.

26. Hodge AM, English DR, O'Dea K, Giles GG. Glycemic Index and Dietary Fiber and the Risk of Type 2 Diabetes. Diabetes Care. 2004, 27(11): 2701-2706.

27. Davis MS, Miller CK, Mitchell DC. More favorable dietary patterns areassociated with lower glycemic load in older adults. J Am Diet Assoc. 2004, 104(12): 1828-1835.

28. Tuomilehto J, Knowler WC, Zimmet P. Primary prevention of non-insulin dependent diabetes mellitus. Diabetes Metab Rev. 1992, 8(4): 339-353.

29. Tuomilehto J, Lindström J, Eriksson JG, Valle TT, Hämäläinen H et al. Prevention of type 2 diabetes mellitus by changes in lifestyle among subjects with impaired glucose tolerance. N Engl J Med. 2001, 344(18): 1343-1350.

30. Gato WE, Acquah S, Apenteng BA, Opoku ST, Boakye BK. Diabetes in the Cape Coast metropolis of Ghana: an assessment of risk factors, nutritional practices and lifestyle changes. Int Health. 2017, 9(5): 310-316.

31. Balde NM, Diallo I, Balde MD, Barry IS, Kaba L et al. Diabetes and impaired fasting glucose in a rural and urban populations in Futa Jallon (Guinea): prevalence and associated risk factors. Diabetes Metab. 2007, 33(2): 114-120.

32. Rheeder P, Stolk RP, Veenhouwer JF, Grobbee DE. The metabolic syndrome in black hypertensive women-waist circumference more strongly related than body mass index. S Afr Med J. 2002, 92(8): 637-641.

33. Tuomilehto J, Knowler WC, Zimmet P. Primary prevention of non-insulin-dependent diabetes mellitus. Diabetes Metab Rev. 1992, 8(4): 339-353.

34. Bonora E, Brangani C, Pichiri I. [Abdominal obesity and diabetes]. G Ital Cardiol. 2008, 9(4 Suppl 1): 40S-53S.

35. Després J-P, Arsenault BJ, Côté M, Cartier A, Lemieux I. Abdominal obesity:The cholesterol of the 21st century? Can J Cardiol. 2008, 24 Suppl D: 7D-12D.

36. Alberti KG, Eckel RH, Grundy SM, Zimmet PZ, Cleeman JI et al. Harmonizing the metabolic syndrome: a joint interim statement of the international diabetes federation task force on epidemiology and prevention; National heart, lung, and blood institute; American heart association; World heart federation; International atherosclerosis society; And international association for the study of obesity. Circulation. 2009, 120(16): 1640–1645.

37. Videau C. Prévalence du diabète et ses facteurs associés, et état des lieux de la prise en charge des patients diabétiques, au

sein de l'observatoire de la population de Moramanga, à Madagascar, 2014. Mémoire.

38. Flores JC, Hirschhorn J, Altshuler D. The inherited basis of diabetes mellitus: implications for the genetic analysis of complex traits. Annu Rev Genomics Hum Genet. 2003, 4: 257-291.

39. Muktabhant B, Sanchaisuriya P, Trakulwong M, Mingchai R, Schelp FP. A first-degree relative with diabetes mellitus is an important risk factor for rural Thai villagers to develop type 2 diabetes mellitus. Asia Pac J Public Health. 2015, 27(4): 385-393.