Nùùùùùùùù

JOURNAL OF SCIENCE & DISEASES

Assessment of Type 2 Diabetes Risk in the Population of Douala, Cameroon: An Analysis of 2,080 Cases

Evaluation du risque du diabète de type 2 dans la population de Douala, Cameroun : Une analyse de 2 080 cas

Mbango Ekouta ND[1,2 *], Ongnessek S[1], Ngo Bikai V[1,3], Ndeme Mboussi WS[5], Adiogo D[4]

Article original

[1] Faculty of Medicine and Pharmaceutical Sciences, The University of Douala
[2] Douala Gynaeco-Obstetric and Pediatric Hospital
[3] Douala Laquintinie Hospital,
[4] Faculty of Medicine and Pharmaceutical Sciences, The University of Dschang
[5] Faculty of Science, Departement of Biochemistry, The University of Douala

Corresponding author:
Mbango-Ekouta Noël Désirée, endocrinologist, Faculty of medicine and pharmaceutical sciences, The University of Douala,
Email : mbangoedisari@yahoo.fr,
Tel : +237 650 76 47 24

Keywords: Diabetes risk, Type 2 diabetes, FINDRISC score, Douala population..

Mots-clés : Risque de diabète, Diabète de type 2, Score de FINDRISC, Population de Douala.

Date de soumission : 21/01/2025
Date d' acceptation : 28/02/2025

ABSTRACT

Background: The prevalence of type 2 diabetes is steadily increasing within the Cameroonian population due to the emergence of new risk factors. However, the lack of data on the risk of developing type 2 diabetes in this population may undermine the effectiveness of prevention and control strategies for this disease. This study aimed to assess the risk of developing type 2 diabetes in the population of Douala.
Methods: We conducted a cross-sectional study during diabetes awareness and screening activities for World Diabetes Day at the Douala General Hospital, Laquintinie Hospital, the Douala Gyneco-Obstetrics and Pediatric Hospital, and the Parcours-Vita in Douala. Sociodemographic data, diabetes diagnosis, and the risk of developing type 2 diabetes (FINDRISC score) were collected using a survey form and analyzed with R software.
Results: A total of 2,080 participants were included. Their mean age was 47 ± 12 years, with a female predominance (61% vs. 39%). The 10-year risk of developing type 2 diabetes was 4.9%, while 27.3% had an increased risk, and 53.2% were at low risk. The prevalence of type 2 diabetes was 14.7%. Lack of physical activity, family history of diabetes, previous hyperglycemia, or therapy for hypertension were strongly associated with an increased risk of type 2 diabetes or an established diabetic status ($p < 0.001$) in this population.
Conclusion: There is an urgent need to strengthen prevention strategies, particularly through education on healthy lifestyles and early screening of at-risk populations.

RESUME

Contexte : La prévalence du diabète de type 2 augmente au Cameroun. Le but de cette étude était d'évaluer le risque de faire le diabète de type 2 dans la population de la ville de Douala.
Méthodologie : Nous avons mené une étude transversale lors des activités de sensibilisation et dépistage du diabète de la journée mondiale du diabète organisée à l'Hôpital Général de Douala, l'Hôpital Laquintinie de Douala, l'Hôpital Gynéco-obstétrique et pédiatrique de Douala et au Parcours-vita de Douala. Les données sociodémographiques, diagnostiques et l'évaluation du score de FINDRISC ont été récoltées et analysées avec le logiciel R.
Résultats : Nous avons inclus 2080 participants. L'âge moyen était de 47 ± 12 ans avec une prédominance féminine (61%). Le risque de développer le diabète de type 2 dans 10 ans était de 4,9%, 27,3 % présentaient un risque accru, et 53,2 % étaient à faible risque. La prévalence de diabète de type 2 était de 14,7 %. L'absence d'activité physique, et les antécédents familiaux de diabète, Les antécédents d'hyperglycémie ou d'une thérapie pour hypertension étaient fortement associés à un risque accru de diabète de type 2 ou à un statut diabétique établi ($p < 0,001$) dans cette population.
Conclusion : Le renforcement des stratégies de prévention est une urgence. L'éducation à un mode de vie sain et le dépistage précoce des populations à risque reste des défis à relever.

Introduction

Diabetes is defined as a chronic metabolic disease characterized by persistent hyperglycemia, which has become a significant global public health challenge. This condition results from insufficient production or utilization of insulin, a hormone essential for regulating blood sugar levels (1–3). Type 2 diabetes (T2D), which accounts for nearly 90% of cases, is strongly influenced by behavioral and environmental factors. Key risk factors include advanced age, obesity, physical inactivity, a family history of diabetes, and unhealthy dietary habits, such as excessive consumption of sugars and saturated fats (4–6).

Diabetes currently affects 537 million adults worldwide, and this figure is expected to rise to 783 million by 2045 (7–9). In Africa, the prevalence is estimated at 5.1%, but it is rapidly increasing due to urbanization and lifestyle changes (10). In Cameroon, the diabetes prevalence is estimated at 6.5% and could be much higher (11). Major cities like Douala, characterized by rapid urbanization, are particularly affected. Emerging risk factors such as sedentary lifestyles, obesity, and unhealthy eating habits play a crucial role in increasing diabetes prevalence in urban populations. In Douala, these trends are exacerbated by the growing availability of processed foods, reduced opportunities for physical activity, and the stress of urban living (12).

Despite the alarming rise in diabetes prevalence in Cameroon, recent data on diabetic and prediabetic profiles remain limited. A better understanding of these profiles is essential to guide prevention and management strategies, particularly in urban areas like Douala. Therefore, our study aimed to fill this gap by evaluating the diabetic and prediabetic status of Douala residents to better inform public health decisions.

Methods

We conducted a cross-sectional study in Douala, Cameroon, during the 2024 edition of World Diabetes Day, from November 11 to 12, 2024. Data were collected during free diabetes screening and awareness activities organized in major hospitals, including the Douala General Hospital, Laquintinie Hospital, Douala Gyneco-Obstetrics and Pediatric Hospital, as well as popular gathering places such as the Parcours-Vita in Douala during a dedicated fitness walk (**Figure 1**).

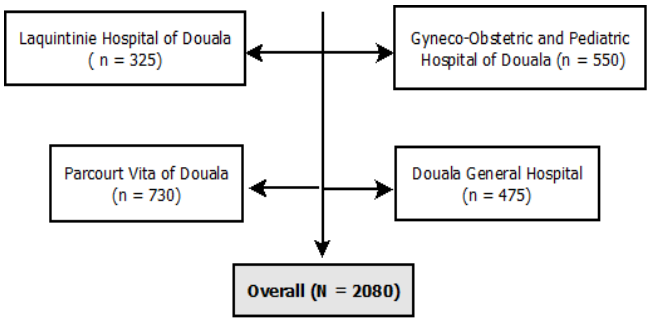

Figure 1: *data collection procedure*

The study was approved by the medical boards of these hospitals. We included all Douala residents who attended the screening or awareness sessions, provided informed consent, and excluded those who refused to participate.

We recruited 2,080 participants, from whom we collected sociodemographic data (age, gender, marital status, and residence) and information necessary to assess diabetes risk using the FINDRISC score (age, body mass index, physical activity level, fruit and vegetable consumption, family or personal history of diabetes, hypertension, or previously detected elevated blood sugar). Data collection was performed using a validated survey form.

Diabetes risk was assessed by summing the scores of each variable's categories according to the FINDRISC scale. Participants with a FINDRISC score below 7 points were classified as low risk, between 7 and 11 points as increased risk, and between 12 and 15 points as likely to develop type 2 diabetes within 10 years. Diabetes was suspected in participants with a FINDRISC score above 15 and confirmed if fasting blood glucose and glycated hemoglobin (HbA1c) levels exceeded 1.26 g/L (7.0 mmol/L) and 6.5%, respectively, on two tests.

Data were recorded in an Excel spreadsheet and imported into R software version 4.4.2 for Windows. Qualitative variables were presented as frequencies (N, n) and percentages in tables and graphs, while quantitative variables were expressed as mean ± standard deviation (SD). Pearson's Chi-squared test and the Kruskal-Wallis rank sum test were performed to identify associations between risk groups and compare age across groups, respectively. The null hypothesis confidence interval was set at 95%, with a 5% margin of error (p-value < 0.05 was considered significant).

Citation as **J Sci Dis 2025, Vol 3 (2): 20-25**

Results

Among the 2,080 participants, 53.1% (n = 1,101) had a low risk of developing diabetes, while 27.3% (n = 568) were at an increased risk. Approximately 4.9% (n = 101) of the participants were at risk of developing type 2 diabetes within the next 10 years, and 14.7% (n = 305) were diagnosed with diabetes during the study (**Figure 2**).

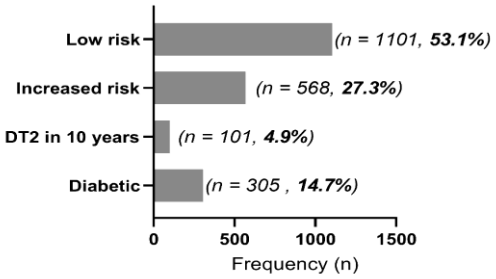

Figure 2: *profile of Diabetic and Prediabetic Status According to the FINDRISC Score*

The mean age of our study population was 47 ± 12 years. The data showed that 305 individuals (14.7%) were diabetic, 101 (4.9%) were at risk of developing type 2 diabetes (T2D) within 10 years, 568 (27.3%) had an increased risk, and 1,106 (53.2%) were at low risk. Factors such as advanced age (>50 years), female gender, and marital status (married or widowed) were associated with a higher prevalence of diabetes and increased risk. Areas of residence, such as Yassa and the village, also showed a notable concentration of cases. Statistical tests revealed significant differences ($p < 0.001$) between groups for age, gender, and marital status, but not for residence (**Table 1**).

Table 1: *sociodemographic factors by diabetic status*

Sociodemographic factors	Overall (N = 2,080)	Diabetic (N = 305)	DT2 in 10 Years (N = 101)	Increased Risk (N = 568)	Low Risk (N = 1,106)	p-value
Age (years)	47±12	54±11	49±7	52±11	42±11	<0.001
Age_groups						<0.001
17-50	1,315 (63%)	136 (6.5%)	53 (2.5%)	226 (11%)	900 (43%)	
>50	765 (37%)	169 (8.1%)	48 (2.3%)	342 (16%)	206 (9.9%)	
Gender						<0.001
Female	1,262 (61%)	228 (11%)	86 (4.1%)	301 (14%)	647 (31%)	
Male	818 (39%)	77 (3.7%)	15 (0.7%)	267 (13%)	459 (22%)	
Matrimonial status						<0.001
Married	1,220 (59%)	166 (8.0%)	48 (2.3%)	414 (20%)	592 (28%)	
Single	710 (34%)	82 (3.9%)	53 (2.5%)	121 (5.8%)	454 (22%)	
Widowed	150 (7.2%)	57 (2.7%)	0 (0%)	33 (1.6%)	60 (2.9%)	
Residence						na
Yassa	585 (28%)	123 (5.9%)	15 (0.7%)	180 (8.7%)	267 (13%)	
village	224 (11%)	57 (2.7%)	38 (1.8%)	74 (3.6%)	55 (2.6%)	
nyalla	142 (6.8%)	0 (0%)	0 (0%)	62 (3.0%)	80 (3.8%)	
Yatchika	117 (5.6%)	0 (0%)	0 (0%)	0 (0%)	117 (5.6%)	
Makepe	99 (4.8%)	51 (2.5%)	48 (2.3%)	0 (0%)	0 (0%)	
Lendi	78 (3.8%)	0 (0%)	0 (0%)	0 (0%)	78 (3.8%)	
Ndogbong	75 (3.6%)	0 (0%)	0 (0%)	50 (2.4%)	25 (1.2%)	
Logpom	70 (3.4%)	0 (0%)	0 (0%)	0 (0%)	70 (3.4%)	
Ndog-passi	64 (3.1%)	0 (0%)	0 (0%)	0 (0%)	64 (3.1%)	
Japoma	63 (3.0%)	0 (0%)	0 (0%)	43 (2.1%)	20 (1.0%)	
Youpoue	51 (2.5%)	0 (0%)	0 (0%)	51 (2.5%)	0 (0%)	
Cité berge	44 (2.1%)	0 (0%)	0 (0%)	0 (0%)	44 (2.1%)	
Logbaba	41 (2.0%)	0 (0%)	0 (0%)	41 (2.0%)	0 (0%)	
Ari	38 (1.8%)	0 (0%)	0 (0%)	0 (0%)	38 (1.8%)	
Ngodi bakoko	38 (1.8%)	38 (1.8%)	0 (0%)	0 (0%)	0 (0%)	
Banga bakoko	37 (1.8%)	0 (0%)	0 (0%)	37 (1.8%)	0 (0%)	
Bonaberi	37 (1.8%)	0 (0%)	0 (0%)	0 (0%)	37 (1.8%)	
Cité des palmiers	37 (1.8%)	0 (0%)	0 (0%)	0 (0%)	37 (1.8%)	

Citation as **J Sci Dis 2025, Vol 3 (2): 20-25**

Dakar	36 (1.7%)	36 (1.7%)	0 (0%)	0 (0%)	0 (0%)
PK11	33 (1.6%)	0 (0%)	0 (0%)	0 (0%)	33 (1.6%)
Brazaville	32 (1.5%)	0 (0%)	0 (0%)	0 (0%)	32 (1.5%)
PK14	31 (1.5%)	0 (0%)	0 (0%)	0 (0%)	31 (1.5%)
Kotto	30 (1.4%)	0 (0%)	0 (0%)	30 (1.4%)	0 (0%)
new bell	27 (1.3%)	0 (0%)	0 (0%)	0 (0%)	27 (1.3%)
Omnisport	26 (1.3%)	0 (0%)	0 (0%)	0 (0%)	26 (1.3%)
Souboum	25 (1.2%)	0 (0%)	0 (0%)	0 (0%)	25 (1.2%)

DT2: *Type 2 Diabetic, Data are presented as mean ± standard deviation (sd), number of cases (N) and percentage (%). P-value: Pearson's test of independence and the Kruskal-Wallis rank sum test were used to compare mean ages and to test for dependence between diabetic status groups. For these tests, the confidence interval for the null hypothesis was set at 95% and the margin of error at 5% (p significant if p <0.05).*

Table 2: *components of the FINDRISK score*

Components of the FINDRISK score	Overall (N = 2,080)	Diabetic Status				p-value
		Diabetic (N = 305)	DT2 in 10 Years (N = 101)	Increased Risk (N = 568)	Low Risk (N = 1,106)	
Age_groups (years)						<0.001
17-50	1,315 (63%)	136 (6.5%)	53 (2.5%)	226 (11%)	900 (43%)	
>50	765 (37%)	169 (8.1%)	48 (2.3%)	342 (16%)	206 (9.9%)	
Daily physical activity						<0.001
No	1,201 (58%)	177 (8.5%)	101 (4.9%)	300 (14%)	623 (30%)	
Yes	879 (42%)	128 (6.2%)	0 (0%)	268 (13%)	483 (23%)	
Family history of diabetes						<0.001
No	1,349 (65%)	136 (6.5%)	48 (2.3%)	151 (7.3%)	1,014 (49%)	
Yes	731 (35%)	169 (8.1%)	53 (2.5%)	417 (20%)	92 (4.4%)	
FFVCF						<0.001
Not Every Day	1,857 (89%)	305 (15%)	53 (2.5%)	541 (26%)	958 (46%)	
Every Day	223 (11%)	0 (0%)	48 (2 .3%)	27 (1.3%)	148 (7.1%)	
HUTH						<0.001
No	1,827 (88%)	156 (7.5%)	38 (1.8%)	527 (25%)	1,106 (53%)	
Yes	253 (12%)	149 (7.2%)	63 (3.0%)	41 (2.0%)	0 (0%)	
History of elevated blood glucose						<0.001
No	1,788 (86%)	163 (7.8%)	38 (1.8%)	525 (25%)	1,062 (51%)	
Yes	292 (14%)	142 (6.8%)	63 (3.0%)	43 (2.1%)	44 (2.1%)	
Body Mass Index (BMI) (kg/m²)						<0.001
Above 30	927 (45%)	152 (7.3%)	101 (4.9%)	257 (12%)	417 (20%)	
Between 25 and 30	694 (33%)	153 (7.4%)	0 (0%)	186 (8.9%)	355 (17%)	
Less than 25	459 (22%)	0 (0%)	0 (0%)	125 (6.0%)	334 (16%)	

DT2*: Type 2 Diabetic, FFVC : Frequency of fruit and vegetable consumption, HUTH: Having undergone therapy for hypertension; Data are presented number of cases (N) and percentage (%). P-value: Pearson's test of independence is used to test for dependence between diabetic status groups. For these tests, the confidence interval for the null hypothesis was set at 95% and the margin of error at 5% (p significant if p <0.05).*

Age (>50 years), lack of physical activity, and a family history of diabetes were strongly associated with an increased risk of diabetes or an established diabetic status (p < 0.001) in our study population. Approximately 63% of individuals were aged 17 to 50 years, while 37% were over 50 years old, with the latter group exhibiting a higher risk. Among those with regular physical activity, only 6.2% were diabetic, compared to 8.5% among those without physical activity.

A family history of diabetes was reported by 35% of participants, significantly impacting the risk. Daily fruit and vegetable consumption remained low (11%), while participants with a BMI above 30 were common (45%), further reinforcing the link to diabetes. Lastly, a history of elevated blood sugar or therapy for hypertension were also notable contributing factors (p < 0.001) **(Table 2).**

Discussion

Our study revealed a diabetes prevalence of 14.7% among the residents of Douala, with 4.9% at risk of developing type 2 diabetes within 10

Citation as **J Sci Dis 2025, Vol 3 (2): 20-25**

years (by 2035) and 27.3% at increased risk. These percentages align with similar studies conducted in sub-Saharan Africa, where rapid urbanization and lifestyle changes are driving a significant rise in diabetes prevalence. For instance, Guariguata et al. (2014) and Zimmermann et al. (2018) estimated a regional average prevalence of 7.1%, with higher rates in urban areas (13,14). This highlights the role of urbanization in the epidemiological transition of diabetes in Africa.

In a study in Ghana, Bosu et al. (2015) demonstrated that diabetes prevalence in urban areas was three times higher than in rural areas (15). This disparity can be attributed to increased access to processed foods high in sugars and fats and reduced physical activity, possibly explained by the rise of sedentary leisure activities such as social media usage. Visceral fat, commonly associated with obesity, secretes inflammatory cytokines like TNF-α, which disrupt insulin signaling and promote insulin resistance, as demonstrated by Kahn et al. in 2006 (16).

In a more recent study by Liu et al. (2024), rapid urbanization and sedentary lifestyles were strongly correlated with the global increase in diabetes prevalence. This aligns with our findings, where lack of physical activity was significantly associated with an increased risk of diabetes ($p < 0.001$).

Family history of diabetes, reported by 35% of participants, is consistent with observations by the IDF (2021), which emphasizes the importance of genetic factors in the development of type 2 diabetes. Genomic studies have identified mutations in genes such as TCF7L2, associated with impaired insulin secretion and elevated blood glucose levels (17).

The low consumption of fruits and vegetables, observed in 11% of participants, reflects a trend documented in several African studies. For instance, Parit Hiri-O-tappa (2024) showed that diets high in processed foods increased metabolic risks, whereas diets rich in fiber and antioxidants could reduce oxidative stress, thereby protecting pancreatic β-cells (4).

Obesity, present in 45% of participants, is a critical factor. A recent meta-analysis by Zheng et al. (2018) confirmed that high BMI is directly linked to an increased risk of type 2 diabetes, primarily through insulin resistance induced by abdominal fat (18).

The findings of this study underscore the need to strengthen prevention programs focusing on health education, promotion of physical activity, and improved dietary habits. Targeted public health policies, such as those suggested by Hu et al. (2003), could significantly reduce the burden of diabetes in urban populations in Cameroon, including Douala (19).

Conclusion

Our study highlighted a significant prevalence of diabetes and prediabetic states in the Douala population, with key risk factors including lack of physical activity, family history of diabetes, low consumption of fruits and vegetables, and high BMI. These findings emphasize the urgency of implementing targeted prevention strategies, including education on healthy lifestyles, promotion of regular physical activity, and improved access to healthcare, to mitigate the growing diabetes burden in this population.

Conflicts of interest: The authors declare that the research was conducted in the absence of any commercial or financial relationship that could be construed as a potential conflict of interest.

Authors' contributions:
MEND and AD designed the experimental approach and the writing plan. MEND, OS and NMWS recruited the participants and carried out the laboratory analyses. MEND and NMWS carried out the statistical analysis. NMWS drew all the figures. MEND wrote the draft. OS, NBV,and AD reviewed the manuscript. All the authors mentioned made a substantial, direct and intellectual contribution to the work and approved it for publication.

Acknowledgements: We extend our gratitude to all the patients who participated in this study and contributed to the advancement of science in Cameroon.

References

1. Lea Stogdale, L S. Definition of diabetes mellitus. The Cornell veterinarian. 1 avr 1986;76(2):156-74.
2. Martin Buysschaert, Buysschaert M, Michael Bergman, Bergman M. Definition of Prediabetes. Medical Clinics of North America. 1 mars 2011;95(2):289-97.
3. Samar A. Antar, Nada A. Ashour, Marwa Sharaky, Muhammad Khattab, Nadia Ashour, R. Zeirideen Zaid, et al. Diabetes mellitus: Classification, mediators, and complications; A gate to identify potential targets for the development of new effective treatments. Biomedicine & pharmacotherapy = Biomedecine & pharmacotherapie. 1 déc 2023;168: 115734-115734.
4. Parit Hiri-O-tappa, Kasidid Lawongsa. Factors Associated with Malnutrition in Older Patients with Type 2 Diabetes in Bangkok, Thailand. Vajira Medical Journal: Journal of Urban Medicine. 2024;

5. Emmanuel Ekpor, Samuel Akyirem, Precious Adade Duodu. Prevalence and associated factors of overweight and obesity among persons with type 2 diabetes in Africa: a systematic review and meta-analysis. Annals medicus. 23 févr 2023 ;55(1):696-713.
6. S. Dusabeyezu, Jean Nepomuscene Renzaho, Nasiru Sani. Prevalence and factors associated with uncontrolled type 2 diabetes among patients in Kirehe District, Rwanda: a cross-sectional study. The Pan African Medical Journal. 2024;
7. Rebuma Belete, Belete R, Zerihun Ataro, Ataro Z, Ahmedmenewer Abdu, Abdu A, et al. Global prevalence of metabolic syndrome among patients with type I diabetes mellitus: a systematic review and meta-analysis. Diabetology & Metabolic Syndrome. 2021;13(1):1-13.
8. Hafiz Muhammad Usman Abid, Muhammad Hanif, Muhammad Naveed Bin Afzal, Muhammad Azeem, Dur E Shahwar, Khalid Mahmood. Global Prevalence and Mortality of Type-2 Diabetes from 1990 to 2019, with Future Projections to 2023 and 2050: a Systematic Review. Global Drug Design & Development Review. 2024;
9. Alina Ioana Forray, Mădălina Adina Coman, Ruxandra Simonescu-Colan, Andreea Isabela Mazga, Răzvan Mircea Cherecheș, Cristina Borzan. The Global Burden of Type 2 Diabetes Attributable to Dietary Risks: Insights from the Global Burden of Disease Study 2019. Nutrients. 30 oct 2023;15(21):4613-4613.
10. Atun R, Davies JI, Gale EAM, Bärnighausen T, Beran D, Kengne AP, et al. Diabetes in sub-Saharan Africa: from clinical care to health policy. The Lancet Diabetes & Endocrinology [Internet]. 1 août 2017 [cité 6 janv 2025];5(8):622-67. Disponible sur: https://www.thelancet.com/journals/landia/article/ PIIS2213-8587(17)30181-X/abstract
11. Sobngwi E, Mbanya JCN, Unwin NC, Kengne AP, Fezeu L, Minkoulou EM, et al. Physical activity and its relationship with obesity, hypertension and diabetes in urban and rural Cameroon. Int J Obes [Internet]. juill 2002 [cité 6 janv 2025];26(7):1009-16. Disponible sur: https://www.nature.com/articles/0802008
12. Mbanya JCN, Motala AA, Sobngwi E, Assah FK, Enoru ST. Diabetes in sub-Saharan Africa. The Lancet [Internet]. 26 juin 2010 [cité 6 janv 2025];375(9733):2254-66. Disponible sur: https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(10)60550-8/abstract
13. Zimmermann M, Bunn C, Namadingo H, Gray CM, Lwanda J. Experiences of type 2 diabetes in sub-Saharan Africa: a scoping review. Glob Health Res Policy. 2018;3:25.
14. Guariguata L, Whiting DR, Hambleton I, Beagley J, Linnenkamp U, Shaw JE. Global estimates of diabetes prevalence for 2013 and projections for 2035. Diabetes Research and Clinical Practice [Internet]. 1 févr 2014 [cité 6 janv 2025];103(2):137-49. Disponible sur: https://www.sciencedirect.com/ science/ article/pii/S0168822713003859
15. Bosu WK. The prevalence, awareness, and control of hypertension among workers in West Africa: a systematic review. Global Health Action [Internet]. 1 déc 2015 [cité 6 janv 2025];8(1):26227. Disponible sur: https://doi.org/10.3402/gha.v8.26227
16. Kahn SE, Hull RL, Utzschneider KM. Mechanisms linking obesity to insulin resistance and type 2 diabetes. Nature [Internet]. déc 2006 [cité 6 janv 2025];444(7121):840-6. Disponible sur: https://www.nature.com/articles/nature05482
17. Mahajan A, Taliun D, Thurner M, Robertson NR, Torres JM, Rayner NW, et al. Fine-mapping type 2 diabetes loci to single-variant resolution using high-density imputation and islet-specific epigenome maps. Nat Genet. nov 2018;50(11):1505-13.
18. Zheng Y, Ley SH, Hu FB. Global aetiology and epidemiology of type 2 diabetes mellitus and its complications. Nat Rev Endocrinol. févr 2018;14(2):88-98.
19. Hu FB, Li TY, Colditz GA, Willett WC, Manson JE. Television watching and other sedentary behaviors in relation to risk of obesity and type 2 diabetes mellitus in women. JAMA. 9 avr 2003;289(14):1785-91.

Citation as **J Sci Dis 2025, Vol 3 (2): 20-25**