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Type 2 *Diabetes Mellitus* in South Africa: socioeconomic disadvantage and associated complications

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ABSTRACT

Background: The prevalence of type 2 Diabetes Mellitus (T2DM) has been rapidly increasing worldwide. The situation in South Africa is worsening, as the population moves into a more urbanized way of life.

Objectives: To analyze the prevalence of T2DM in South Africa: causes and side effects on health and economy.

Methods: Review of recent research, consulting Pubmed, Google Shcolar, oficial sources from governments, the World Health Organization, American Diabetes Association and the International Diabetes Federation.

Results: Despite in South Africa the reported numbers may still be undervalued due to the failure of health care and diagnosis, there has been a rapid increase in T2DM, resulting in associated health complications and economic costs. Diabetes is contributing to increase physical disability (lower-extremity amputations), mortality and poverty.

Conclusions: Lack of healthcare access results in poor diabetes control among low income populations of South Africa, particularly in rural areas. A strategy that prioritizes health education crossing general population seems to be the best approach for a better understanding of the signs and symptoms of diabetes in order to contribute to an early diagnosis and treatment, minimizing health risks.

Keywords: *Diabetes Mellitus,* health complications, economic issues.

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INTRODUCTION

Diabetes Mellitus (DM) is a multifactorial metabolic disorder characterized by high blood glucose levels (termed hyperglycemia) and impaired carbohydrate, lipid, and protein metabolism caused by complete, or partial, insufficiency of insulin secretion and/or its action. The classic categorization of diabetes proposed by the American Diabetes Association (ADA) in 1997 is still the widely used standard in treatment strategies. Type 1 DM (T1DM) is a genetic disorder where the immune system attacks and destroys the insulin-producing cells, frequently manifesting itself early in life. Type 2 DM (T2DM) is characterized by a decrease in insulin production or a resistance to its action, usually appearing in middle age and is closely related to lifestyle. Gestational DM (GDM) adds to the mentioned risk conditions the increase in progesterone, an anti-insulin hormone. There are several other types of diabetes, including monogenic diabetes, maturity onset diabetes of the young, cystic fibrosis-related diabetes, among others[1-3].

The objectives of this paper were to evaluate the evolution of the global prevalence of diabetes, comparing South Africa and European countries, as well as evaluating the rate of diabetic-related complications in South Africa and the resulting economic consequences[4]. The research is based on a review of recent research literature on Pubmed, Google Scholar the last reports of the World Health Organization (WHO), the International Diabetes Federation (IFD), the American Diabetes Association (ADA) and consultation of official South African government reports on health expenditures and gains when compared to the two other continents.

T2DM

The rapid outbreak of T2DM is, as of today, one of the largest public health crises around the globe. T2DM may result from loss of number and/or function of β-cells of the pancreatic islets of Langerhans, resulting in insufficient insulin production and subsequent hyperglycemia, but may also be related to the development of insulin resistance (IR), where body cells do not respond efficiently to insulin action. Although genetic inheritance may predispose to T2D2 development, the increase in health expectancy, changes into a sugar and fat-rich diet and to more sedentary lifestyles (these latter related to increased urbanization) have led to increased obesity thus contributing to escalate T2DM incidence during the past few decades. Insulin resistance is the main cause of T2DM, through inhibition of action of insulin receptors, thus preventing the regulation of glucose homeostasis[3-6].

Although T2DM is a chronic disorder, studies have shown that, in some individuals, it can be reversed by dietary and lifestyle changes[5-8].

The pathophysiology of DM is complex, involving various organs and tissues (such as pancreas, liver, kidneys, adipose and muscle tissues). In spite of some overlapping clinical features among most types of DM, there are other features which allow differentiation between T1DM and T2DM, as shown in table 1. Associated risk factors are also important to distinguish between the two major groups of DM[9-11].

Table 1. Clinical features of type 1 and type 2 diabetes with differentiating factors.

	TYPE 1 DIABETES	TYPE 2 DIABETES
Onset of age	Any age mostly young <40	Mostly adults >40
Onset of symptoms	Acute symptomatic Weight loss Polyuria Polydipsia Polyphagia Polyasthenia	Slow often asymptomatic Obese Polydipsia Polyuria
Therapy	Insulin	Oral Farmacs/Insulin
Associated autoimmune diseases	Yes	No
Family history of diabetes	Uncommon	Yes
Complications at diagnosis	Uncommon	Yes

Adapted from McMillin JM, 1990[12].

DIAGNOSIS

As of today, there are several laboratory ways to help diagnose DM, including different diagnostic techniques: fasting glycosuria, fasting plasma glycaemia (FPG), oral glucose tolerance testing (OGTT), random plasma glucose (RPG), glycosylated hemoglobin (HbA1c) and others, like insulin and/or C peptide concentration or antibodies against pancreatic B cells. OGTT gauges the body's ability to metabolize glucose and clear it from the bloodstream, while HbA1c measures the percentage of hemoglobin bound to glucose, thus providing an integrative measure of long-term glycemic levels by reflecting the average level of glycemia for the past 120 days, the normal life time of a red cell, therefore not subject to daily fluctuations[12].

The diagnostic criteria of diabetes has been constantly evolving. The following table (Table 2) sumarizes the recent concensus by WHO, IFD and ADA.

Table 2. Diabetes Diagnosis Criteria.

Criteria	Comments
Hba1c ≥6.5%	The test should be performed in a laboratory using a method that is national glycohemoglobin standardization program (NGSP) certified and standardized to the assay.
Fasting blood glucose ≥126mg/dl	Fasting is defined as no caloric intake for at least 8 h.
2hrs blood glucose after 75g of glucose ≥200mg/dl	During an OGTT. The test should be performed as described by the WHO, using a glucose load containing the equivalent of 75 g anhydrous glucose dissolved in water.
Random blood glucose ≥200mg/dl	In a patient with classic symptoms of hyperglycemia or hyperglycemic crisis.
In the absence of unequivocal hyperglycemia, result should be confirmed by repeated testing.	

Adapted From American Diabetes Association, 2014[13].

PREVALENCE

The IDF 2013 update from Africa, reports undiagnosed DM at an unacceptably high rate of 50.7% which increases in low income African countries (75.1%), when compared to lower-and upper-middle income countries (46.0%). This undiagnosed DM cases were higher among the poorest-to-poorer than among the richer-to-richest group. In South Africa, it is estimated that 1 out of 11 adults are living with DM (32 million) and, of those, a third remain undiagnosed. In 2016, the WHO reported a rapid rise in global diabetes statistics from 108 million in 1980 to 422 million. This trend is observed in middle-income and low-income countries. DM affects one in 11 adults worldwide (61 million) and it is estimated that 36% of adults living with DM are, as of yet, undiagnosed. According the IDF Diabetes Atlas Tenth edition, 24 million adults (20-79 years of age) are living with DM in the IDF Africa Region in 2021[4,10-12,14].

Figure 1 shows an exponential increase of diabetes prevalence in South Africa between 2000 and 2021, which is estimated to increase further by 2045[13]. DM prevalence among 20-79-years-olds is currently at 4.9%, with most people falling under the <60 years old bracket; the highest prevalence (43.2%) was found in those aged 40–59 years. The expected increase in numbers from 19.8 million in 2013 to 41.5 million in 2035 includes those with impaired glucose tolerance, the prevalence of which is 7.3% among 20–79-year-olds in 2013[10,14].

DM in Africa is becoming more prevalent as urbanization increases, diet is changed, a more sedentary lifestyle is established, increasing obesity prevalence. Figure 1 and figure 2 represent statistics of diabetes by IDF from 2000 until 2045 comparing South Africa and Portugal[10,14,15].

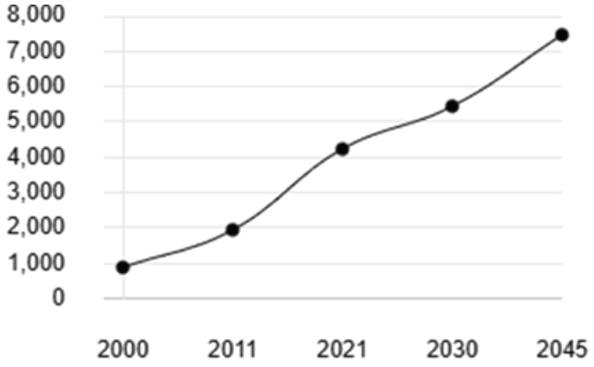

Figure 1. People with diabetes in 1,000s, in South Africa. IDF Diabetes Atlas Tenth edition 2021[10]

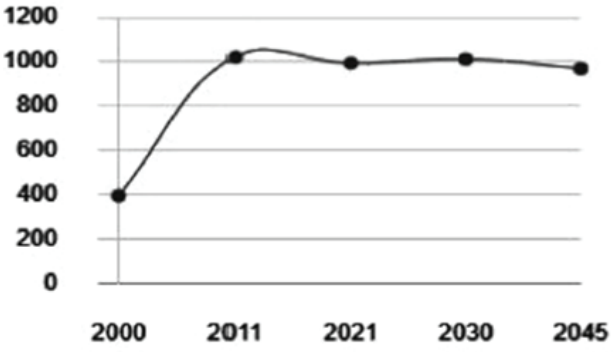

Figure 2. People with diabetes in 1,000s, in Portugal. IDF Diabetes Atlas Tenth edition 2021[10]

The trend shows an increasing prevalence of diabetes in South Africa over the years compared to a steady constant slope in Portugal, thus indicating control of the disease. Table 3 summarizes the evolution of diabetes in South Africa according to WHO and IFD.

Table 3. Prevalence of diabetes in South Africa from 1980 from two different sources.

Years	IDF data (%)	WHO, Global health observatory data (%)
1980-1990	N/A	6.3
1990-2000	7.0	7.0
2000-2010	10.8	8.5
2010-2020	12.2	10.2
2030-2045	13.0	N/A

WHO (2014)[9] and IDF (2021)[10].

DIABETES COMPLICATIONS

Macro and microvascular complications of diabetes include coronary heart disease, stroke, renal disease retinopathy and neuropathy and diabetic foot wounds involving lower-extremity amputations (LEA)[16-19]. These are particularly frequent when diagnosis and treatment are late or absent. Vascular disease in DM is multifactorial, involving inhibition of nitric oxide with impairment of the vasodilator response, dysfunction of smooth muscle cells, with overproduction of growth factors, decreased fibrinolytic capacity, thrombocytosis and platelet aggregation, hemodynamic changes and the accumulation of harmful products derivatives of advanced glycosylation which, in addition to hyperglycemia, are also stimulated by generated oxidative stress[18].The WHO Global report (issued 21 April 2016) on diabetes demonstrates that in 2012 alone diabetes caused 1.5 million deaths[9]. A review on the prevalence of diabetes-related micro and macrovascular disease in Africa reported that the prevalence of diabetic retinopathy varies from 16 to 77%, depending on the years of disease and diabetes control[17,20,21]. In addition, diabetes-related nephropathy varied between 32-57% and cardiomyopathy was present in about 50% of all patients with DM[22,23].

Retinopathy

WHO reported that 90% of visually impaired people are living in low-income settings[23]. Diabetic retinopathy, a result of damage to the retinal vessels and neuroglia by hyperglycemia, is the third most common cause of blindness in diabetics after cataracts and glaucoma, as stated by The South African National Prevention of Blindness Program[17]. The disease progresses from mild nonproliferative abnormalities to moderate and severe nonproliferative diabetic retinopathy (NPDR) and, finally, to proliferative diabetic retinopathy (PDR)19. In the study in Africa, referred to above, about a quarter of patients with DM already had retinopathy at the time of diagnosis[20]. Although there has been an increase in the screening of diabetic retinopathy in Africa, the number of people treated remains low, so an increase in retinopathy prevalence over the next years is expected[17,25].

Cardiovascular and Renal diseases

Cardiovascular and renal diseases (CVRD) are major causes of mortality in individuals with T2DM. Diabetic patients, compared with no diabetics, are at greater risk of CVRD. Two out of three diabetic patients will die due to cardiovascular complications. A review of cardiovascular complications of T2DM in Sub-Saharan Africa of published data over the past 2 decades shows that diabetes is present in more than one-third of patients presenting with coronary events[29,30].

ECONOMIC BURDEN

In South Africa, T2DM imposes a significant financial burden on the public healthcare system. Diabetes is one of the world's most important causes of expenditure, mortality, disability, and economic loss. The direct costs of managing T2DM and caring for diabetic sequels such as renal failure, blindness, and amputations include hospital and medication costs. In 2018, public sector costs of diagnosed T2DM patients were approximately 2.7 billion South African Rand (ZAR) and 21.8 billion (ZAR), if both diagnosed and undiagnosed patients are considered. In real terms, the 2030 cost of all T2 DM cases is estimated to be ZAR 35.1 billion[15, 24, 27, 31, 32].

*(1 ZAR= 0,059 Euro).

DISCUSSION

South Africa is a diverse country in terms of race, socioeconomic status, and other social and structural determinants of health. An increase in socioeconomic and demographic changes in the country, as well as ageing population, are some of the factors influencing the prevalence of DM and associated medical conditions. More disadvantaged areas suffer more, historically a poverty generated inequalities at working, housing and health conditions. The unemployment favors school dropout and crime. DM usually affects working-age individuals between the ages of 40 and 60, potentially reducing the country's efficiency and having a negative impact on the South African economy. More than one peer-reviewed paper describes three factors that contribute to South Africa's diabetes problem: socioeconomic inequalities, excess weight or obesity, and illiteracy[32-35].

Nearly half of South Africans do not know they have T2DM since the disease takes time to manifest and its symptoms are easily confused with those of other illnesses. Many patients in South Africa's remote rural locations do not receive a diagnosis until their illnesses are advanced. The high cost of diagnostic testing and the lack of medical personnel constitute significant obstacles to patient diagnosis and monitoring. Researchers from these studies call attention to the essential point of sensitizing populations to signs of the disease and the search for a diagnosis and treatment before serious health issues occur[18,23]. Furthermore, the guidelines for health established by governments must leave the paper being fulfilled[31,36-38].

Despite de the fact that South African national guidelines recommend annual kidney, eye, and foot screenings among individuals with T2DM, a cross-sectional survey published by South African Family Practice (SAFP) has demonstrated that the selected Primary Health Clinics (PHC) fell short of this target. It is

consensual that it will be essential that all relevant parties in public and private health sectors contribute to spreading knowledge and awareness about diabetes[16,32].

There is a significant problem with access to health care in South Africa and there are significant delays in patient transfers to tertiary units for specialist assessment. PHC is the primary point of contact with the public health care system. The failure of primary health care countries to bear a responsibility for the high mortality rates in these countries. Poor neighborhoods in South Africa lack quality health care. According to recent estimates, approximately 80.6% of the population in South Africa with DM (diagnosed and undiagnosed cases) has an unmet need for care. When one considers the case of South Africa, the gravity of health and socioeconomic inequalities becomes clear[32,39].

South Africa has limited financial and human capital resources, which may affect the distribution of resources in the public health system. DM statistics have been significantly influenced by emigration of people from rural to cities, urbanization inactive lifestyles. According to Joubert et al.,(2000)[40] and Weickert et al.,(2018)[41] excess body weight or obesity also contributes to the country's diabetes prevalence. The government should implement diabetes awareness campaigns promoting overall health, and thus, helping to decrease the incidence of diabetes, control diabetes-related complications and reduce the disease's growing economic burden as well as prioritize health clinics and medical staff training for diagnosis, proper management, and prevention of related complications[39-41].

CONCLUSION

T2DM is a global health concern, but it has reached critical proportions in Africa. South Africa has one of the highest rates of T2DM in Africa, and is predicted to rise exponentially (from 19.8 to 55 million by 2045). More effective approaches to prevent, control and manage diabetes are required. Priority should be given to direct strategies, the improvement of primary health care, and access to early diagnosis and treatment. Screening at-risk populations as primary prevention, as well as implementing educational programs to raise awareness.

BIBLIOGRAPHY

1. Care ADAJD. 2. Classification and diagnosis of diabetes: standards of medical care in diabetes-2019. 2019;42(Supplement_1):S13-S28.

2. James WPT. The epidemiology of obesity: the size of the problem. Journal of internal medicine. 2008;263(4):336-52.

3. DeFronzo RA, Ferrannini E, Groop L, Henry RR, Herman WH, Holst JJ, et al. Type 2 diabetes mellitus. Nature reviews Disease primers. 2015;1(1):1-22.

4. Peer N, Kengne A-P, Motala AA, Mbanya JC. Diabetes in the Africa Region: an update. Diabetes research and clinical practice. 2014;103(2):197-205.

5. Pandey A, Chawla S, Guchhait P. Type-2 diabetes: Current understanding and future perspectives. IUBMB life. 2015;67(7):506-13. Epub 2015/07/17. doi: 10.1002/iub.1396. PubMed PMID: 26177573.

6. Zhu Y, Zhang C. Prevalence of Gestational Diabetes and Risk of Progression

to Type 2 Diabetes: a Global Perspective. Current diabetes reports. 2016;16(1):7. Epub 2016/01/09. doi: 10.1007/s11892-015-0699-x. PubMed PMID: 26742932; PubMed Central PMCID: PMCPMC6675405.

7. Chen L, Magliano DJ, Zimmet PZ. The worldwide epidemiology of type 2 diabetes mellitus—present and future perspectives. Nature Reviews Endocrinology. 2012;8(4):228-36. doi: 10.1038/nrendo.2011.183.

8. Chawla R, Madhu S, Makkar B, Ghosh S, Saboo B, Kalra S. RSSDI-ESI clinical practice recommendations for the management of type 2 diabetes mellitus 2020. Indian journal of endocrinology and metabolism. 2020;24(1):1.

9. Roglic G. WHO Global report on diabetes: A summary. International Journal of Noncommunicable Diseases. 2016;1(1):3.

10. Wang H, Li N, Chivese T, Werfalli M, Sun H, Yuen L, et al. IDF diabetes atlas: estimation of global and regional gestational diabetes mellitus prevalence for 2021 by International Association of Diabetes in Pregnancy Study Group's Criteria. Diabetes Research and Clinical Practice. 2022;183:109050.

11. Alberti G, Zimmet P, Shaw J, Bloomgarden Z, Kaufman F, Silink M, et al. Type 2 diabetes in the young: the evolving epidemic: the international diabetes federation consensus workshop. Diabetes care. 2004;27(7):1798-811.

12. McMILLIN JM. Blood glucose. Clinical Methods: The History, Physical, and Laboratory Examinations 3rd edition. 1990.

13. Association AD. Standards of Medical Care in Diabetes—2014. Diabetes Care. 2013;37(Supplement_1):S14-S80. doi: 10.2337/dc14-S014.

14. Pheiffer C, Pillay-van Wyk V, Turawa E, Levitt N, Kengne AP, Bradshaw D. Prevalence of type 2 diabetes in South Africa: a systematic review and meta-analysis. International journal of environmental research and public health. 2021;18(11):5868.

15. Ogurtsova K, Guariguata L, Barengo NC, Ruiz PL-D, Sacre JW, Karuranga S, et al. IDF diabetes Atlas: Global estimates of undiagnosed diabetes in adults for 2021. Diabetes Research and Clinical Practice. 2022;183:109118.

16. Dunbar GL, Hellenberg DA, Levitt NS. Diabetes mellitus and non-traumatic lower extremity amputations in four public sector hospitals in Cape Town, South Africa, during 2009 and 2010. South African medical journal. 2015;105(12):1053-6.

17. Bascaran C, Zondervan M, Walker C, Astbury NJ, Foster A. Diabetic retinopathy in Africa. Nature Publishing Group; 2022. p. 1-3.

18. Lee S, Washburn DJ, Colwell B, Gwarzo IH, Kellstedt D, Ahenda P, et al. Examining social determinants of undiagnosed diabetes in Namibia and South Africa using a behavioral model of health services use. Diabetes Research and Clinical Practice. 2021;175:108814. doi:https://doi.org/10.1016/j.diabres.2021.108814.

19. Cade WT. Diabetes-related microvascular and macrovascular diseases in the physical therapy setting. Physical therapy. 2008;88(11):1322-35.

20. Sobngwi E, Mbanya J. Diabetes in Africa. Diabetes microvascular and macrovascular disease in Africa. Journal of

Cardiovascular Risk. 2003.

21. Ali MK, Echouffo-Tcheugui JB, Williamson DF. How effective were lifestyle interventions in real-world settings that were modeled on the Diabetes Prevention Program? Health affairs. 2012;31(1):67-75.

22. Diabetes South Africa 2016 country profile [Internet]. 2016.

23. Okaiyeto K, Oguntibeju OO. Trends in diabetes research outputs in South Africa over 30 years from 2010 to 2019: A bibliometric analysis. Saudi Journal of Biological Sciences. 2021;28(5):2914 24. doi: https://doi.org/10.1016/j.sjbs.2021.02.025.

24. Pillay S, Lutge E, Aldous C. The burden of diabetes mellitus in KwaZulu-Natal's public sector: A 5-year perspective. South African medical journal. 2016;106(4):384-8.

25. Resnikoff S, Pararajasegaram R. Blindness prevention programmes: past, present, and future. Bulletin of the World Health Organization. 2001;79:222-6.

26. Mbanya JC, Mba CM. Centenary of the discovery of insulin: People with diabetes in Africa still have poor access to insulin. EClinicalMedicine. 2021;34.

27. Zhang Y, Lazzarini PA, McPhail SM, van Netten JJ, Armstrong DG, Pacella RE. Global disability burdens of diabetes-related lower-extremity complications in 1990 and 2016. Diabetes Care. 2020;43(5):964-74.

28. Khan MZ, Smith MT, Bruce JL, Kong VY, Clarke DL. Evolving indications for lower limb amputations in South Africa offer opportunities for health system improvement. World journal of surgery. 2020;44(5):1436-43.

29. Wu Y, Ding Y, Tanaka Y, Zhang W. Risk factors contributing to type 2 diabetes and recent advances in the treatment and prevention. International journal of medical sciences. 2014;11(11):1185.

30. Pálsson R, Patel UD. Cardiovascular complications of diabetic kidney disease. Advances in chronic kidney disease. 2014;21(3):273-80.

31. Erzse A, Stacey N, Chola L, Tugendhaft A, Freeman M, Hofman K. The direct medical cost of type 2 diabetes mellitus in South Africa: a cost of illness study. Global health action. 2019;12(1):1636611.

32. Goetjes E, Pavlova M, Hongoro C, Groot W. Socioeconomic inequalities and obesity in South Africa—a decomposition analysis. International Journal of Environmental Research and Public Health. 2021;18(17):9181.

33. Malik VS, Popkin BM, Bray GA, Després J-P, Hu FB. Sugar-sweetened beverages, obesity, type 2 diabetes mellitus, and cardiovascular disease risk. Circulation. 2010;121(11):1356-64.

34. Majeed A, El-Sayed AA, Khoja T, Alshamsan R, Millett C, Rawaf S. Diabetes in the Middle-East and North Africa: an update. Diabetes research and clinical practice. 2014;103(2):218-22.

35. Misra A, Gopalan H, Jayawardena R, Hills AP, Soares M, Reza-Albarrán AA, et al. Diabetes in developing countries. Journal of diabetes. 2019;11(7):522-39.

36. Pastakia SD, Pekny CR, Manyara SM, Fischer L. Diabetes in sub-Saharan Africa–from policy to practice to progress: targeting the existing gaps for future care for diabetes. Diabetes, metabolic

syndrome and obesity: targets and therapy. 2017;10:247.

37. Devey R, Møller V. Closing the gap between rich and poor in South Africa. Rich and poor: Springer; 2002. p. 105-22.

38. Mayosi BM, Lawn JE, Van Niekerk A, Bradshaw D, Karim SSA, Coovadia HM, et al. Health in South Africa: changes and challenges since 2009. The lancet. 2012;380(9858):2029-43.

39. Stokes A, Berry KM, Mchiza Z, Parker W-a, Labadarios D, Chola L, et al. Prevalence and unmet need for diabetes care across the care continuum in a national sample of South African adults: Evidence from the SANHANES-1, 2011-2012. PloS one. 2017;12(10):e0184264.

40. Joubert J, Norman R, Bradshaw D, Goedecke JH, Steyn NP, Puoane T. Estimating the burden of disease attributable to excess body weight in South Africa in 2000. South African Medical Journal. 2007;97(8):683-90.

41. Weickert MO, Pfeiffer AF. Impact of dietary fiber consumption on insulin resistance and the prevention of type 2 diabetes. The Journal of nutrition. 2018;148(1):7-12.