

Prediabetes in Sub-Saharan Africa: Pathophysiology, Predictors, and Prevalence

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Abstract

Prediabetes – comprising impaired fasting glycaemia (IFG) and/or impaired glucose tolerance (IGT) – is a transitory median interphase between normal blood glucose levels and diagnostic levels of diabetes. The raised blood glucose levels surreptitiously damage the body's organ systems and are often an augury of type 2 diabetes mellitus (T2DM), the two having been found to share similar pathogenesis. Current concepts in the pathogenesis of prediabetes support a pentad of mechanisms responsible for its development. Majority of the countries in Sub-Saharan Africa belong to the low and middle income category, whose population accounts for more than 70% of the 352 million adults (20–79 years) worldwide with IGT (one component of prediabetes), as at 2017. The presence of prediabetes increases health care related expenditure in individuals and takes a toll on the workforce. Nigeria (West Africa) is currently among the top ten countries with the highest number of individuals with IGT as at 2017, and Ethiopia (East Africa) has been projected to join Nigeria in this category by 2045. A PubMed and MEDLINE search was conducted using the keywords prediabetes, Sub-Saharan Africa, prevalence, and pathophysiology. Major studies were identified and reviewed. Numerous large scale studies have revealed that progression from prediabetes to T2DM is not relentless. Structured and intensive lifestyle modifications aimed at modest weight loss, increased physical activity, and healthy dietary habits have shown to halt or slow the progression to T2DM, and in some cases, even reverse prediabetes, with such individuals regaining normal blood glucose levels.

Keywords: Pathogenesis, prediabetes, prevalence, prevention, Sub-Saharan Africa

INTRODUCTION

A post glucose challenge state of glucose tolerance, intermediate between that defined as normal and that classified as diabetes, was described in 1979 and in 1980, respectively, by both the American National Diabetes Working Group and the World Health Organization (WHO) to replace the terms – borderline, chemical, and asymptomatic diabetes mellitus.^[1] This apparently new state, which was termed impaired glucose tolerance (IGT) or prediabetes, represented a raised 2 hours plasma glucose level of between 140 and 199 mg/dL (7.8–11.0 mmol/L) in an individual who had normal fasting plasma glucose levels.^[1] In addition, individuals in this new category were discovered to have an increased tendency towards developing type 2 diabetes mellitus (T2DM) in future and cardiovascular disease.

Close to two decades after the term IGT was adopted, a different but related category of elevated, nondiabetic range of fasting plasma glucose levels which also predicted future diabetes

was likewise-reported in some individuals. This was termed impaired fasting glucose (IFG) by the American Diabetes Association (ADA) in 1997 and was subsequently adopted by the WHO in 1999, as impaired fasting glycemia (IFG).^[1] Thus, IFG was defined as a fasting plasma glucose value of 110–125 mg/dL (6.1–6.9 mmol/L).^[2]

However, over time, several research-based data evidence showed that the lower limit of 110 mg/dL for IFG was unconvincing, as it was found to be the exact threshold predictive of future diabetes, in an individual. The sore point

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over the years, had been the resetting of the fasting cutoff point for making a diagnosis of diabetes from 140 mg/dL to 126 mg/dL (i.e from 7.8 mmol/L to 7.0 mmol/L) which was done at the exact time that IFG was officially adopted. This resetting thereby effectively removed the group with the highest risk for the progression to diabetes from the IFG population and subsequently rendered it less predictive of future diabetes when compared to IGT.^[1]

In view of the above apparent shortcomings, the ADA in 2002, through its expert committee on the diagnosis and classification of diabetes,^[3] lowered the cutoff point for IFG, citing data from several longitudinal studies to support their action. Hence, 100 mg/dL (5.6 mmol/L) was chosen by the ADA as the lower cutoff point for predicting future diabetes using the IFG,^[3] while the WHO retained the initial lower cutoff point for fasting plasma glucose value at 110 mg/dL (6.1 mmol/L).^[2]

Glycosylated hemoglobin (HbA1c) values between 5.6 and 6.4% have also been defined as prediabetes.^[4] However, the HbA1c is only recommended as an additional diagnostic criterion, not a primary one, as results may be misleading in several ethnic populations due to some innate ethno-specific, metabolic, and environmental factors including hemoglobinopathies – with resultant high red blood cell turnover and chronic iron deficiency anemia.^[5,6]

Currently, 352 million people worldwide (7.3% of adults 20–79 years) are estimated to have IGT alone (one component of prediabetes) and 72.3% of them reside in low and middle income countries. This number is projected to increase to 587 million (8.3% of adults 20–79 years) by 2045.^[7] Equally of note is that nearly one-third of adults with IGT belong to the age category 20–39 years and hence are likely to spend many years at high risk of developing T2DM and other associated health-care challenges.^[7] Nigeria, a country in Sub-Saharan Africa, is currently among the top ten countries with the highest number of individuals with IGT worldwide. It is projected that another Sub-Saharan African country; Ethiopia, located in East Africa will also join these top ten countries by the year 2045.^[7]

The IGT and IFG are clearly two separate metabolic states with marked differences in their prevalence and population of people affected.^[8] Most population studies record a higher prevalence for IGT than for IFG, with the former being more prevalent among females, while the IFG seems to have a bias for the male gender.^[9] In addition, IGT has also been noted to increase with increasing age across both groups, while the prevalence of IFG tends to level off in middle age.^[8]

About a quarter of individuals with prediabetes (IFG and or IGT) will progress to diabetes and roughly half will remain in their abnormal glycemic state, with possible progression in the distant future, and an annual progression rate estimated to be between 10 and 12%.^[10,11] The remaining quarter will revert to normal glucose tolerance (NGT) over a period of 3–5 years.^[10,11]

Some races, including the Afro-Caribbean, Asian, and Hispanics, for some unclear reasons, tend to have a high risk

for developing prediabetes.^[12] Interestingly, these races are clustered in the low and middle income countries which also have the highest prevalence of T2DM.^[7] In addition, recent studies have observed a shift from the traditional lower prevalence rates of diabetes in rural African communities towards higher urban values, possibly due to the increasing adoption of “westernized” cultures.^[13]

MORBIDITY AND MORTALITY OF PREDIABETES

Individuals with prediabetes tend to have similar vascular risk factors (dyslipidemia, hypertension, insulin resistance (IR), physical inactivity, obesity, endothelial dysfunction, pro-coagulant state, and inflammation) that put patients with T2DM at heightened risk of macrovascular complications.^[14]

A significant number of people with IGT and IFG will advance to diabetes within a few years if left untreated,^[15] though there appears to be a stronger evidence for advancement in patients with IGT than IFG.^[16]

Evidence shows that prediabetes increases the tendency in individuals of developing heart diseases, eye diseases, kidney diseases and stroke,^[14,17] with IGT emerging as a stronger predictor of macrovascular complications than IFG.^[14]

With the exponential increase in the prevalence of prediabetes and in effect diabetes, a great surge in diabetes-related morbidity and mortality is envisaged, with adverse socioeconomic consequences.

PATHOGENESIS OF PREDIABETES – THE “PORTENTOUS PENTAD”

Normal plasma glucose levels in the body are largely maintained through a complex, dynamic, and efficient interplay between plasma glucose and insulin. Prediabetes has been described as a transitional, median phase over a sequence, extending from NGT to frank T2DM.^[15,18]

However, of the eight pathogenetic pathways (“*ominous octet*”)^[19] for the development of T2DM (1. IR, 2. impaired insulin secretion, 3. increased lipolysis, 4. increased glucagon secretion, 5. incretin deficiency/resistance, 6. increased hepatic glucose production, 7. increased glucose reabsorption in the kidneys, and 8. decreased dopamine secretion in the brain. Only the first five of these, which collectively, may be described as the “*portentous pentad*” (1. IR, 2. impaired insulin secretion, 3. increased lipolysis, 4. increased glucagon secretion, and 5. incretin deficiency/resistance) actually play a role in the pathogenesis of prediabetes [Figure 1].^[20]

IR and suboptimal glucose sensing at the beta cell, which results in impaired insulin secretion, are the two predominant pathophysiological determinants that together cause hyperglycemia.^[14,15,21] Current evidence favors a two-step development, whereby individuals with NGT progress to prediabetes with IR as the primary determinant. Subsequently, there is a worsening of prediabetes to T2DM, driven by a

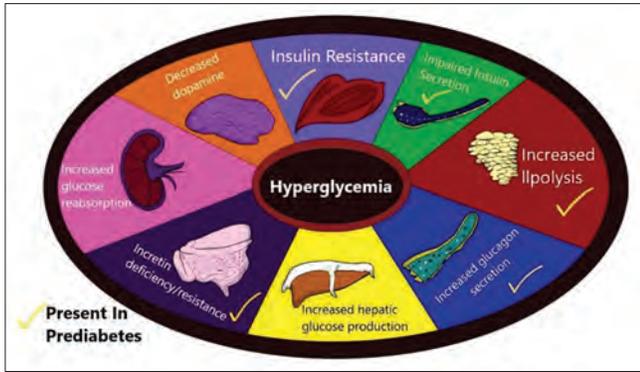


Figure 1: Pathophysiological defects in type 2 diabetes mellitus and prediabetes

progressive deterioration in beta-cell function and insulin sensitivity.^[16,21]

Insulin resistance

IR appears to be the outcome of a multiplex interplay between strong genetic predisposition and environmental factors including weight gain, physical inactivity, and aging.^[16,18] In general, IR points to the presence of a reduced peripheral tissue response to endogenously secreted insulin. Characteristically, it presents as both reduced insulin-mediated glucose uptake, at the level of adipose and skeletal muscle tissue, and as impaired suppression of hepatic glucose output.^[15] Insulin sensitivity, which is somewhat the opposite of IR, is a measure of how efficiently a given unit of plasma insulin is able to lower the plasma glucose over a given period of time and can be assessed directly, using the hyperinsulinemic-euglycemic clamp.^[22-24] Therefore, an individual who has a low insulin sensitivity, invariably, is said to have high IR. Since the exacting nature of the euglycemic clamp procedure, IR can be extrapolated clinically, using a surrogate measure, known as the homeostatic model assessment of IR (HOMA-IR), such that the higher the HOMA-IR value, the higher the IR in the subject. This in effect translates to a higher propensity toward developing prediabetes and eventually T2DM.^[25] It is to be noted, however, that the hyperinsulinemic euglycemic clamp better reflects the whole body (predominantly skeletal muscle) insulin sensitivity, while the HOMA-IR value reflects more of hepatic insulin sensitivity.^[25]

Impaired insulin secretion/beta-cell dysfunction

Although IR is a major pathogenic factor inducing progression from NGT to IGT to T2DM, deterioration in glycemic control does not occur unless the beta-cells fail to compensate for the IR. Ultimately, beta-cell failure is responsible for the progression of IGT to T2DM.^[16]

Among IGT patients, a low 2-h plasma insulin concentration during an oral glucose tolerance test (OGTT) predicts IGT progression to T2DM in all ethnic groups.^[16] At fasting plasma glucose levels of 100–110 mg/dl, loss of first-phase insulin secretion is common in IGT subjects, and studies have shown that impaired first-phase secretion also predicts progression to T2DM.^[16]

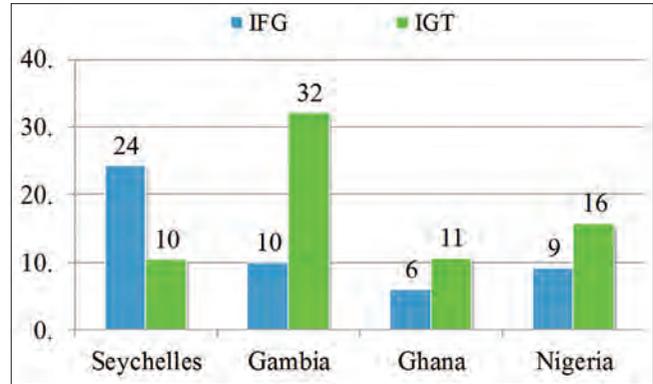


Figure 2: Prevalence of prediabetes in selected Sub-Saharan African countries

An important characteristic of the beta-cell is its ability to upregulate insulin secretion in response to IR, and the extent to which the cells are able to perform this role is referred to as the disposition index (DI)^[22-24] and is represented by the equation:

$$DI = \text{Insulin sensitivity} \times \text{Insulin secretion.}$$

In effect, the DI mirrors the ability of the beta-cells of the pancreatic islets to compensate for IR, by increasing beta-cell responsiveness through increased insulin secretion. This increased responsiveness of the beta cells has been touted as possibly the most important factor in the maintenance of NGT and normal fasting glucose and in the early stages of IR in individuals. However, as the DI decreases, the individual then tends toward prediabetes and eventually T2DM.^[22-24] In a study on beta-cell responsiveness in Nigerian patients with Type 2 DM, the authors reported low fasting and postprandial beta-cell responsiveness in the patients, which was also strongly correlated with their HbA1c levels. Their findings suggest that beta-cell dysfunction occurs early in the natural history of the disease in these patients.^[25]

Increased lipolysis

Adipocytes have been shown to play a part in the pathogenesis of T2DM through the action of some fat cells that develop abnormal metabolism and structure. The resultant alterations in the structure and internal cell functioning then cause these cells to become resistant to insulin's antilipolytic effect, resulting in chronically elevated plasma free fatty acid concentration. This leads to the stimulation of gluconeogenesis and induction of liver and muscle cell IR with impairment of insulin secretion.^[19] In addition, the high levels of disruptive "bad" adipocytokines produced by these aberrant fat cells, at the expense of the "good," insulin-sensitizing adipocytokines like adiponectin, induce inflammation, atherosclerosis, and IR. Indeed, current research has shown that a low adiponectin level is a strong predictor of prediabetes progression from NGT.^[26]

Incretin deficiency/resistance

The two main incretin hormones of the gut: GLP-1 and GIP have been demonstrated to also play a part in glucose homeostasis and both have been shown to stimulate insulin secretion by the

pancreatic beta cells in normal individuals.^[19] Their secretion in the gut, however, only follows glucose ingestion (as against intravenous glucose administration) such that the higher the glucose level in the gut, the higher the incretin hormone secreted and vice versa. Individuals with prediabetes have reduced GLP-1 levels plus a resistance to the stimulatory effects of GIP on insulin secretion.^[19] In addition to the above-mentioned glucose-dependent insulin secretion, the GLP-1 also strongly inhibits glucagon secretion, thereby suppressing hepatic glucose output and hence maintaining plasma glucose levels within the normal range. Conversely, incretin deficiency/resistance naturally results in elevated plasma glucose levels.

Increased glucagon secretion

Abnormally high levels of glucagon, produced by the pancreatic alpha cells, have been observed in subjects with prediabetes, and this has been shown to be responsible for the increased rates of hepatic glucose output, with resultant hyperglycemia.^[19]

Molecular/genomics aspects of the pathogenesis of prediabetes

The place of epigenetic mechanisms in the pathogenesis of prediabetes has been brought to the fore with recent data-based evidence of abnormal deoxyribonucleic acid (DNA) methylation in individuals with prediabetes and diabetes. In their preliminary genome-wide DNA methylation analysis in South Africa, Matsha *et al.*^[27] reported hypomethylation of differentially methylated gene regions (DMRs) associated with the linoleic acid metabolism as well as the arachidonic acid metabolism pathways in subjects with prediabetes but not in normal controls. In these same individuals with prediabetes, hypermethylation of DMRs were observed in genes involved in the immune system, signal transduction, glucose transport and insulin signaling pathway as well as muscle and pancreas development. They have also been associated with inflammatory pathways. Therefore, epigenetic changes were thought to be an early process that precedes the development of prediabetes and diabetes;^[27] hence, further research may throw more light on the utility of these DMRs as possible biomarkers of disease onset or progression.

Recently, the role of secreted frizzled-related protein 4 (SFRP4) in the pathogenesis of prediabetes and T2DM has been highlighted.^[28] The SFRP4, a member of the SFRP family that contains a cysteine-rich domain, homologous to the harmful “wingless/integrated” (Wnt) binding site of frizzled proteins, acts as soluble modulators of Wnt signaling. The Wnt signaling pathways are a group of signal transduction pathways that begin with proteins that pass signals into a cell through cell surface receptors. The SFRP4 gene is highly expressed in human islet cells, in addition to various other cells and levels which are found to be increased, several years before the onset of diabetes. Studies have shown that high levels of SFRP4 are associated with IR, β -cell dysfunction, IGT, and T2DM.^[28]

Another relatively new molecule, which has been implicated in the pathogenesis of prediabetes and T2DM, is known as

fractalkine (FKN). This pro-inflammatory cytokine, produced by nonhemopoietic cells, is the only known member of the CX3C chemokine family and has a G-protein-coupled receptor known as CX3CR1.^[29] FKN has been shown to promote chemotaxis and adhesion in the presence of inflammation and is thought to drive the migration of leukocytes to tissues during inflammatory processes. Through this mechanism, FKN is believed to mediate the adipose tissue inflammation associated with T2DM. The ensuing monocyte accumulation in the adipocytes then leads to abnormal structure and function of the fat cells which then starts to produce high levels of disruptive adipocytokines, resulting in systemic inflammation and IR.^[20,30]

Lee *et al.*, in their animal study, described the FKN/FKN receptor axis – CX3CL1/CX3CR1 – and demonstrated that the axis functioned to promote increased insulin secretion, both *in vitro* and *in vivo*. In addition, while CX3CR1 deficiency mimicked some of the β -cell abnormalities seen in diabetic islet cells, FKN treatment was shown to restore β -cell function.^[29]

Chronic FKN administration was recently shown to improve glucose tolerance and pancreatic endocrine function. Specifically, it enhanced glucose-stimulated insulin secretion with an associated reduction in β -cell apoptosis; enhanced hepatic insulin sensitivity, and reduced α -cell glucagon secretion.^[31]

Among newly diagnosed T2DM patients versus those with NGT, Baldane *et al.* found significantly higher basal OGTT (0-min) and 120-min-FKN levels in the newly diagnosed T2DM group, compared to the NGT group. However, intra-group FKN values showed no significant change following a 75 g glucose load.^[30]

RISK FACTORS FOR PREDIABETES

The development of prediabetes is usually promoted by some major risk factors, most of which are modifiable. Landmark clinical research shows that intensive lifestyle changes mainly, in addition to early intervention with some pharmacological agents, have the potential to reverse prediabetes and even prevent or delay the development of T2DM.^[32-38]

These risk factors include overweight/obesity, IR, physical inactivity, high blood pressure, dyslipidemia, age (45 years and above), family history of diabetes in first-degree relatives, polycystic ovary syndrome, gestational diabetes, inadequate night sleep, and race.^[8,12] However, in a recent study among a bi-racial cohort, Dagogo-Jack *et al.* revealed that people of African descent and Caucasians had an equal risk for the development of prediabetes.^[39]

PREDICTORS OF PREDIABETES

Although independent risk factors for prediabetes have been defined, it does not follow automatically that every individual with either one or a combination of these risk factors must eventually develop prediabetes. However, some specific pointers have been shown to predict, with a relatively

high level of certainty, the development of prediabetes in at-risk individuals.^[18] These predictors of prediabetes include age >40 years, body mass index >30 kg/m², waist circumference >92 cm, total fat mass >30 kg, trunk fat mass >14.2 kg, 2-h plasma glucose (2-HrPG) >120 mg/dl, serum high density lipoprotein levels <48 mg/dl, and serum triglycerides >110 mg/dl. Other predictors of prediabetes also include decreased insulin sensitivity <1.2 μmol/kg FFM-min/pM, a DI value <700, a low diet-adjusted physical activity level, a serum adiponectin level <9.5 μg/ml in women, and ≤7.0 μg/ml in men, or specifically ≤9.5 μg/ml in Caucasians and ≤7.3 μg/ml in blacks.^[18,39] Of these predictors, the combination of increased trunk fat and 2-HrPG ≥90th percentile was found to confer a particularly high risk for the development of prediabetes^[18] and hence can be deployed as an easy and affordable screening tool for prediabetes.

PREVALENCE OF PREDIABETES – DATA FROM SUB-SAHARAN AFRICA

Sub-Saharan Africa, most of whose countries belong to the low and middle income group of countries, is part of the region projected to record the fastest growth rate for prediabetes prevalence in the near future.^[7] This unfortunate trend is superimposed on the already heavy burden of infectious diseases ravaging its people, thereby taking a heavy toll on the scant human and financial resources available to the region. The state of affairs regarding prediabetes prevalence in the different regions of Sub-Saharan Africa is outlined below and in Figure 2.

Prediabetes in east Africa

Studies on the prevalence of prediabetes in parts of East Africa have shown wide variations in prevalence with differing values among urban and rural areas as well as between males and females.

In Seychelles, a rapidly developing country in the East African region, bordered by Kenya and Mauritius, the prevalence of IGT and IFG was 10.4% and 24.2%, respectively.^[40] In rural Eastern Uganda, among persons aged 35–60 years, the prevalence of IFG alone was 8.6% (WHO criteria) and 20.2% (ADA criteria).^[41] Here, obesity emerged as the most significant factor associated with prediabetes. However, a more recent study revealed the prevalence of IFG among adults in rural Uganda as 26.5% and 13.7% in peri-urban Uganda. In a cohort of teachers in urban Tanzania, the prevalence of IFG was as low as 2.4%.^[42] Among urban and rural adults in Zimbabwe, prediabetes was prevalent at 5.3% and 5.2% in males and females, respectively, using the WHO criteria.^[43] In urban Mozambique, IFG was prevalent at 2.3% and 2.6% (WHO criteria) among adult males and females, respectively.^[42] Among a cross-section of all the inhabitants of urban Lusaka.^[44] Among a cross-section of all the inhabitants of urban Lusaka Zambia, IFG was prevalent at 1.3% in both sexes.^[45] The IGT was prevalent at 6.1% and 13.1% among males and females, respectively, when a cross-section of all the inhabitants of both urban and rural areas of Kenya was

screened.^[46] However, when a section of rural dwellers alone was screened for IGT, males had a prevalence of 3.7%, while females had 11.9%.^[47] Among a cross-section of both urban and rural Malawi adults, IFG was prevalent at 5.7% in males and 2.7% in the females.^[48] In a rural Ethiopian community, IFG was found to be prevalent in 12.0% of the adult population with no significant gender bias.^[49]

Prediabetes in central Africa

In rural Angola, the prevalence of IGT among adult males was 5.6%, while it was 9.1% in females.^[50] Screening of a section of the inhabitants in the Democratic Republic of the Congo revealed an IFG prevalence of 9.5% in males and 9.2% in females, respectively, while the prevalence of IGT was 6.4% in males and 8.2% in females.^[51] Among the Fulbe ethnic group of Cameroon, IFG was prevalent in 7.7% of males and 6.5% of the females, while in the Mbororo ethnic group also in Cameroon, IFG was prevalent in 7.0% of the males and 8.0% of the females.^[52] However, assessment of a cross-section of the general population in Cameroon revealed an IFG prevalence of 8.2% among the males, while the females had a prevalence value of 8.7%.^[52] A recent study among newly diagnosed hypertensive patients in Cameroon revealed that IFG was prevalent at 23.7%.^[53] Among a cross-section of adult rural dwellers in Chad, IFG was prevalent in 9% of the females and 2.77% of the males, giving an overall prevalence of 5.44% when both genders were clustered together.^[54]

Prediabetes in West Africa

A cross-section of adults aged ≥18 years residing in the Borgou area of Benin Republic had an IFG prevalence of 12.4% (WHO criteria).^[55] Among adults aged ≥20 years in urban Ouagadougou, Burkina Faso, IFG was prevalent at 5.9%.^[56] In Abidjan, urban Cote d' Ivoire, IFG was prevalent at 14.5% among a cross-section of children and adolescents aged between 2 and 19 years with no significant gender differences.^[57] The prevalence of IFG and IGT among adult patients attending outpatient clinics in Banjul urban, the Gambia, was 10% and 32%, respectively,^[58] and hypertension emerged as the major risk factor for IGT. In a community-based prevalence study among adults aged ≥25 years in urban Accra Ghana, IFG and IGT were prevalent at 6.0% and 10.7%, respectively, with hypertension found to be significantly associated with worsening glycemic states.^[59] In rural Ghana, a community-based study revealed IGT to be prevalent at 28.7% among adults aged ≥18 years.^[60] In Guinea Conakry, the combined prevalence of IFG in both urban and rural areas was 13.4% among adults aged ≥35 years.^[61] Among a cross-section of Liberian adults from five randomly selected counties aged between 25 and 64 years, IFG was prevalent at 14.9% overall, though the males and females had prevalence values of 14% and 15.7%, respectively.^[62]

A pioneer study of the prevalence of IGT, in a Nigerian city done in 1998, revealed a prevalence rate of 2.2%, while that of diabetes, it was 0.8%, and the study showed no sex differences in the prevalence rates.^[63]

Bakari and Onyemelukwe in their study among apparently healthy Hausa–Fulani Nigerians in 2004 recorded a prevalence of 7.7% for IGT and none for IFG, and remarkably, all the patients with IGT were females.^[64]

Among the hypertensive patients attending a tertiary health-care facility in Southeast Nigeria, the prevalence of prediabetes was 25%. Of these, 14% had IFG, 5% had IGT, while 6% had both IFG and IGT.^[65]

In a recent study in rural Southeast Nigeria, IFG and IGT were prevalent at 9.2% and 15.8%, respectively, in adults aged ≥ 18 years using the WHO criteria,^[66] with no significant gender bias, and hypertension emerged as the strongest predictor of prediabetes. In this same community, when the ADA criteria applied, the prevalence figures for IFG rose to 27.2%.^[67] Among a cross-section of rural Fulani individuals in Northern Nigeria, IFG and IGT were prevalent at 6.9% and 8.0%, respectively.^[68] Among urban-dwelling secondary school students in Port Harcourt, Southern Nigeria, whose mean age was 15 ± 2 years, the IFG was prevalent at 4% using the WHO criteria.^[69] In a rural Senegalese community, the IFG was prevalent at 6.6% among a cross-section of adults with no significant gender disparity.^[70]

Prediabetes in Southern Africa

In Buffalo City Metropolitan Municipality in South Africa, IFG was prevalent at 14% among the adult residents.^[71] Among a cross-section of a rural Zulu community, IFG was prevalent at 4.0% in the males and 0.8% in the females, while IGT was almost equally prevalent in both genders at 4.6% in the males and 4.7% in the females.^[72]

In an earlier study among a cross-section of urban adult Durban residents, IGT was prevalent at 7.1% and 4.8% of the males and females, respectively.^[73] However, a recent study among adult Durban South African Indians revealed that IFG alone was prevalent at 14.4%, while the combined prevalence of IFG and IGT was 29.1%.^[74] In Cape Town, South Africa, 6.0% and 5.9% of males and females, respectively, had IGT.^[75] Among newly presenting hypertensive patients in South Africa, IGT was found to be highly prevalent at 30.0%.^[76] In urban Botswana, among adults attending outpatient clinics, IFG was prevalent at 54.3% using the HBA1c method.^[77] In Swaziland, the STEPS survey of 2014 revealed a combined prevalence of IFG in both sexes as 9.8%.^[78]

PREVENTION OF DIABETES

Within the past few decades, several landmark studies were initiated to determine the benefit or otherwise of various strategies – use of some classes of drugs or intensive lifestyle intervention – and aimed at preventing or delaying the onset of T2DM in people with prediabetes, with remarkable results.^[31-37] Findings from these studies have revealed that progression from prediabetes to T2DM is not ineluctable. Indeed, prediabetes can be halted and even reversed, as some individuals with IGT were observed to revert to NGT with intensive lifestyle

changes targeting modest weight loss, increased physical activity, and dietary pattern changes. However, a more cursory look revealed that although drugs contributed significantly to decrease progression to T2DM, their effect was disappointingly short lived, and in most cases, not lasting up to 3 months after cessation of the drugs.^[18] On the other hand, intensive lifestyle intervention, a cost-effective and eminently harmless process, was shown to have a profound and (perhaps more importantly) sustained beneficial effect, even up to a decade or more, post intervention^[18,79] – a phenomenon now widely referred to as the “legacy effect.”^[80] Studies on the progression from prediabetes to diabetes in Sub-Saharan Africa as well as advocacy and campaigns for the adoption of healthy lifestyles by the population are needed to halt the increase in diabetes prevalence in this region.

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Conflicts of interest

There are no conflicts of interest.

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