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SOCIODEMOGRAPHIC PROFILE AND CLINICAL DETERMINANTS OF PREDIABETES AMONG ADULTS AT THE AMINU KANO TEACHING HOSPITAL, KANO, NIGERIA

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ABSTRACT

Background: Prediabetes is an intermediate phase in the natural history of type 2 diabetes mellitus in which individuals have blood glucose levels higher than normal but not enough to be classified as diabetes mellitus. Early detection and timely intervention would prevent or slow its progression to diabetes. The aim of this study is to determine the sociodemographic profile and clinical determinants of prediabetes among adults at the General Out-patient Clinic of Aminu Kano Teaching Hospital, Kano Nigeria.
Methods: A cross sectional study was carried out among 385 adult patients who met the inclusion criteria. Demographic and clinical characteristics were obtained using an interviewer administered questionnaire. Prediabetes was defined as Fasting blood glucose of 6.1-6.9mmol/L and plasma glucose of 7.8-11.1mmol/L two hours after a 75g glucose load. The data was analyzed using Statistical Package for Social Science (SPSS) version 16.0.
Results: A total of 385 participants were recruited for the study, 14 were excluded due to incomplete data and complete data for 371 participants was analyzed. The participants comprised 155 (41.8%) males and 216 (58.2%) females giving a male female ratio of 1:1.4. Their ages ranged from 18 to 85 years with a mean age of 44 (SD±13.6) years. Majority of the participants were married and were Hausas. The predominant occupation and religion were trading and Islam respectively. Seventy-one (19.1%) out of 371participants had prediabetes. Of the 71 with prediabetes 16 (22.5 %) had impaired fasting glucose, 43 (60.5%) had impaired glucose tolerance while 12 (17%) had both impaired glucose tolerance and impaired fasting glucose. Increasing age ($p< 0.0001$), obesity ($p <0.0001$) and hypertension ($p<0.0001$) were significant determinants of prediabetes.
Conclusion: The prevalence of prediabetes of 19.1% is relatively high in this study population. The identified risk factors were increasing age, obesity and hypertension. Individuals with prediabetes should be educated on lifestyle modification to prevent or delay progression to diabetes.

INTRODUCTION

Prediabetes is defined by the World Health Organisation as impaired fasting blood glucose (6.1-6.9mmol/L), impaired glucose tolerance (7.8-11.1mmol/L) or a combination of both.[1] It is an intermediate phase in the natural history of type 2 diabetes. Prediabetic patients are at increased risk of progressing to type 2 diabetes and developing cardiovascular complications.[2]

The prevalence of prediabetes is increasing worldwide and Tabak *et al* have projected that greater than 470 million people will have prediabetes by the year 2030.[3] In Sokoto, Northwest, Nigeria, the prevalence rate of 31.5% was reported among an urban ethnic Fulani population.[4] Prediabetes has similar risk factors as diabetes including increasing age, physical inactivity, obesity, hypertension, family history of diabetes, high serum triglycerides, low high density lipoprotein and high low density lipoprotein.[5]

Management of prediabetes involves intensive lifestyle modification because it is safe and effective in delaying progression to diabetes and reducing cardiovascular risk factors.[2,6] It is essential to identify persons with prediabetes and institute appropriate lifestyle management as this would reduce the burden of diabetes and its complications. There is paucity of data on the sociodemographic profile and clinical determinants of prediabetes in the study environment.

Research Question. Are sociodemographic profile and clinical characteristics determinants of prediabetes?

Null Hypothesis- There is no association between sociodemographic profile and clinical determinants and prediabetes.

Alternative Hypothesis- There is an association between sociodemographic profile and clinical determinants and prediabetes.

Aim: The aim of the study is to evaluate the sociodemographic profile and clinical determinants of prediabetes among adults at the General outpatient Clinic of Aminu Kano Teaching Hospital, Kano.

Objectives

1. To determine the prevalence of prediabetes among adults at the General Outpatient Clinic of Aminu Kano Teaching Hospital.
2. To determine the sociodemographic profile and clinical determinants among adults at the General Outpatient Clinic of Aminu Kano Teaching Hospital.
3. To determine the association between sociodemographic profile and prediabetes among adults at the General Outpatient Clinic of Aminu Kano Teaching Hospital.
4. To determine the association between clinical determinants and prediabetes among adults at the General outpatient Clinic of Aminu Kano Teaching Hospital.

MATERIALS AND METHODS

The study was carried out at the General Outpatient Clinic of the Aminu Kano Teaching Hospital, Kano, Nigeria. Kano state is located in the North West zone of Nigeria and has a population of approximately 9.3 million people (2006 National census).[7] Aminu Kano Teaching Hospital, Kano is located within Kano Metropolis. The main ethnic groups are the Hausa and Fulani. Islam is the main religion.

The study is a descriptive cross-sectional study. Consenting adult patients aged 18 years and above were eligible to participate in the study. Patients already diagnosed with diabetes mellitus were excluded as well as pregnant women because they may have gestational diabetes and measurements of waist circumference will not be reliable.

The minimum sample size for the study was determined using this formula.[8]

$n = Z\alpha^2 p\, q / d^2$ where

n – Minimum sample size

$Z\ \alpha^2$ - standard normal deviate corresponding to the 95% confidence interval (1.96)

p – Prevalence rate of prediabetes, 35.1% was obtained from a previous study in Sokoto, Nigeria.[4]

q = 1 – p

d – level of precision, set at 5%

Thus $n = \frac{1.96^2 \times 0.351 \times (1 - 0.351)}{(0.05)^2} = 350$

A minimum sample size of 350 was obtained. An additional 10% (35 participants) were added to this to allow for missing or incomplete data, therefore 385 participants were recruited for the study using a systematic sampling method. About 280 patients attend the General Outpatient Clinic daily and approximately 1400 patients are seen every week, giving a sampling frame of 11,200 over 8 weeks. Three hundred and eighty–five participants were recruited over 8 weeks from May to June 2014. Forty-eight persons were recruited each week from a sampling interval of 1:29 (385/11200). The first person was chosen randomly by ballot. Subsequently every consenting 29th person was selected from the daily OPD attendance register.

Participation was voluntary and a written informed consent in English and Hausa languages were obtained before enrolment into the study. Questionnaire containing information on the biodata, relevant family history and cardiovascular risk factors was administered to the participants in English or Hausa languages.

The weight was measured in Kilograms, to the nearest gram using a Seca (Germany) scale. It was daily adjusted to zero at the beginning of each day. The participants were asked to remove heavy accessories such as handbags, keys and shoes before weighing. The height was measured in meters, to the nearest centimeters using a Seca® (Germany) stadiometer. The participants were asked to remove their shoes, stand with their back to the wall and look directly forward. The participants were positioned directly underneath the drop down measuring device which was lowered to rest gently on top of the participants head. Body mass index was calculated using weight in Kg divided by height in metres square. BMI was classified according to WHO classification of obesity. Waist and hip circumference was measured with a non-elastic measuring tape in centimeters. Waist:Hip ratio greater than 0.9 in men 0.85 in women were classified as abnormal. The blood pressure was recorded using an Accoson® mercury sphygmomanometer.

Following recruitment of the participants, they came the next day for laboratory investigation after an overnight fast of 8 hours. After routine antiseptic technique, 2.5mls of venous blood was collected in a fluoride oxalate bottle for fasting plasma glucose and 4mls of venous blood was collected in a lithium heparin bottle for lipid profile. The participants were given 75g of anhydrous glucose D in 250 mls of water to drink over five minutes. Two hours after glucose ingestion, 2.5mls of venous blood was collected for the estimation of two hours plasma glucose. The blood analysis was performed by a laboratory scientist at the chemical pathology laboratory of Aminu Kano Teaching Hospital.

Normal Fasting Blood Glucose (FBG) was defined as 3.9- 5.5mmol/L.
Normal 2 hours post prandrial plasma glucose (2HRPP) was defined as 3.9-7.8mmol/L.
Prediabetes was defined as FBG of 6.1-6.9 mmol/L and/ or 2HRPP plasma glucose of>7.8-11.1mmol/L .
Diabetes was defined as FBG of ⩾ 7mmol/L or 2HRPP plasma glucose of >11mmol/l.[2]
Dyslipidaemia was classified as:
Elevated Total cholesterol > 200mg/dl (5.2mmol/l)
Elevated Triglycerides ⩾ 150mg/dl (1.7mmol/l)
Reduced High density lipoprotein Men< 40mg/dl(1.0mmol/l)
Women < 50mg/dl (1.3mmol/l)
Elevated Low density lipoprotein >130mg/dl (3.38 mmol/l.)

All participants had health education on prediabetes and lifestyle modification. Those identified with prediabetes, diabetes or any cardiovascular risk factors were commenced on appropraite treatment according to management guidelines.

Data was analyzed using Statistical Package for Social Sciences (SPSS) version 16. Absolute numbers and simple percentages were used to describe categorical variables, such as sex and marital status. Quantitative variables such as age and blood pressure were described using measures of central tendency and measures of dispersion as appropriate. Frequencies and proportions were used to describe the characteristics of the study population. The chi-square test was used in accessing the significance of association between categorical variables. The relationship of prediabetes with the risk factors were assessed using bivariate analysis and multivariate logistic regression analysis. A p-value of < 0.05 was considered statistically significant.

Ethical approval to conduct the study was obtained from the Health Research Ethics Committee of Aminu Kano Teaching Hospital, Kano (Approval no. AKTH.(MAC/SUB/12A/P-3V1/1166).

RESULTS

The ages of the participants ranged from 18 - 85 years. The mean age was 44 (SD ±13.6) years. The mean ages for females and males was 56.1 and 43.9 years respectively. There were 216 (58.2%) females and 155 males (41.8%), giving a male to female ratio of 1:1.4.Majority of the participants were married and were Hausas. The predominant occupation and religion were trading and Islam respectively (Table1)

The mean Body Mass Index (BMI) of the participants was 28.7kg/m.[2] Thirteen participants (3.5%) were underweight, 92 (24.8%) had normal BMI, 127 (34.2%) were overweight and 139 (37.5%) participants were obese. Two hundred and forty-eight (66.8%) participants had abnormal waist: hip ratio while 123(33.2%) had normal waist: hip ratio. One hundred and fifty-nine (73.6%) of the 216 female participants had abnormal waist: hip ratio. Eighty-nine (57.4%) of the 155 male participants had abnormal waist: hip ratio. A total of 208 participants were hypertensive. (Table 2).

Table 1: Socio-demographic characteristics of the study participants: N=371.

Characteristics	Frequency	Percentage
Age group(in years)		
18-30	66	17.7
31-40	108	29.1
41-50	78	21.2
51-60	60	16.2
61-70	52	14.0
>70	7	1.8
Sex		
Male	155	41.8
Female	216	58.2
Marital status		
Single	51	13.7
Divorced	30	8.0
Married	235	63.4
Widowed	55	14.9
Religion		
Islam	281	75.7
Christianity	90	24.3
Tribe		
Hausa	245	66.0
Fulani	20	5.4
Yoruba	18	4.9
Igbo	62	16.7
Others	26	7.0
Educational level		
None	33	8.9
Quranic	98	26.4
Primary	54	14.5
Secondary	64	17.4
Tertiary	122	32.8
Occupation		
Civil servant	60	16.1
Trader	132	35.6
Self-employed/artisans	73	19.7
Housewife	70	18.9
Unemployed	30	8.1
Student	6	1.6
Monthly income(Naira₦)		
<5,000	63	16.9
5000-20,000	119	32.0
20,001-50,000	79	21.4
50,001-100,000	62	16.8
>100,000	48	12.9

Table 2: Clinical characteristics of the study participants N: 371

Variable		Freq	%
BMI			
Underweight		13	3.5
Normal		92	24.8
Overweight		127	34.2
Obesity		139	37.5
WHR			
Males			
Normal		66	42.5
Abnormal		89	57.5
Females			
Normal		57	26.4
Abnormal		159	73.6
Blood pressure			
Normal		163	43.9
Elevated		208	56.1
Lipid profile			
Total cholesterol			
Normal		245	66.1
Elevated		126	33.9
Low density lipoprotein			
Normal		278	74.9
Elevated		93	25.1
High density lipoprotein			
Normal		246	66.3
Low		125	33.7
Triglycerides			
Normal		283	76.3
Elevated		88	23.7
Blood glucose			
Normal	282	282	76
Prediabetes	71	71	19.1
Diabetes	18	18	4.9

Seventy-one of the 371 participants had prediabetes giving a prevalence of 19.1% (Figure 1).The 41-50 year age range recorded the highest frequency of prediabetes with a male:female ratio of (1:1.4). Out of the 71 participants with prediabetes, sixteen (22.5 %) had impaired fasting glucose (IFG);43 (60.5%) had impaired glucose tolerance (IGT) while 12(17%) had both impaired glucose tolerance and impaired fasting glucose. Majority (60.5%) of the participants had impaired glucose tolerance. (Figure 2)

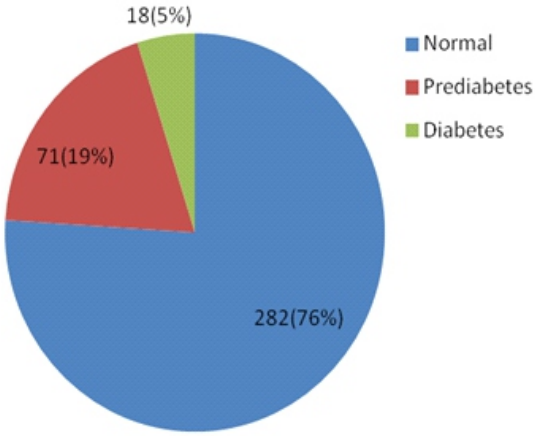

Figure 1: The prevalence of prediabetes among the study participants

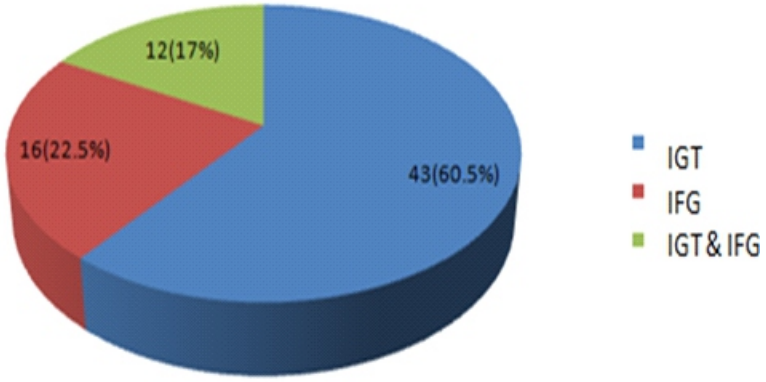

Figure 2: The pattern of prediabetes among the study participants.

On bivariate analysis, older age, being married, Hausa ethnicity, high triglycerides level, high body mass index, abnormal waist:hip ratio and hypertension were independently associated with prediabetes. Association between the socio-demographic and clinical characteristics of the study participants and prediabetes are shown in Table 3 and Table 4. Multiple logistic regression showed that increasing age, hypertension and high body mass index were independently associated with prediabetes (Table 5).

Table 3: Association between prediabetes and socio-demographic characteristics of the study participants. N=71

Variable	Prediabetes		χ^2	p value
	Freq.	%		
Age group (years)			39.507	0.0001*
18-30	2	2.8		
31-40	12	16.9		
41-50	27	38.0		
51-60	17	24.0		
61-70	11	15.5		
>70	2	2.8		
Sex			0.079	0.962
Female	42	59. 2		
Male	29	40. 8		
Marital status			31.342	0.0001*
Single	2	2.8		
Divorced	0	0		
Married	48	67.6		
Widowed	21	29.6		
Educational level			10.850	0.203
None	4	5.6		
Quranic	24	33.8		
Primary	9	12.7		
Secondary	8	11.3		
Tertiary	26	36.6		
Religion			1.294	0.835
Islam	52	73.2		
Christianity	19	26.8		
Ethnicity			21.450	0.010*
Hausa	48	67.6		
Fulani	0	0		
Yoruba	5	7.0		
Igbo	9	12.7		
Others	9	12.7		
Occupation			15.834	0.192
Civil servant	3	4.2		
Self-employed/artisans	16	22.5		
Trader	30	42.3		
Housewife	14	19.7		
Unemployed	8	11.3		
Student	0	0		
Monthly Income (Naira)			7.829	0.455
<5000	12	16.9		
5000-20,000	16	22.5		
20,001-50,000	19	26.8		
50,001-100,000	16	22.5		
>₦100,000	8	11.3		

*Statistically significant

Table 4: Association between prediabetes and clinical characteristics of the study participants. N=71

Variable	Prediabetes		χ^2	p value
	Freq.	%		
BMI			18.725	0.006*
<18.5kg/m^2	3	4.3		
18-24.9kg/m^2	14	19.7		
25-29.9kg/m^2	14	19.7		
⩾30Kg/m^2	40	56.3		
WHR			19.940	0.0001*
Abnormal	63	88.7		
Normal	8	11.3		
Blood Pressure			9.460	0.007*
Elevated blood pressure	51	72.8		
Normal blood pressure	20	27.2		
Total cholesterol			2.358	0.308
Normal	43	60.6		
Elevated	28	39.4		
Low density lipoprotein			6.141	0.050
Normal	48	67.7		
Elevated	23	32.3		
High density lipoprotein			0.298	0.874
Normal	47	66.2		
Low	24	33.8		
Triglycerides			8.245	0.015*
Normal	45	63.4		
Elevated	26	36.6		

*Statistically significant

Table 5: Multiple logistic regression analysis of the determinants of prediabetes

Variable	Odds ratio	95%Confidence Interval	p-value
Age	3.47	3.153-8.437	0.0001 *
Marital Status	0.07	0.523-1.202	0.992
Tribe	0.087	0.189-9.542	0.767
Hypertension	4.163	1.551- 4.776	0.041*
Body Mass Index	1.839	0.237-0.717	0.017*
Waist: hip ratio	0.415	0.101-3.186	0.520
Triglycerides	0.361	0.820-1.322	0.503

*Statistically significant

DISCUSSION

The prevalence of prediabetes (IFG or IGT alone, or both IGT and IFG) varies based on the age, socio-demographic characteristics, lifestyle and diagnostic criteria used. The prevalence of prediabetes in this study population is 19.1% using the WHO criteria.[1] The prevalence obtained in this study is slightly higher than the prevalence of 16.1% reported by Chaoyang *et al* in 2009 in the US among adolescents.[9] The disparity could be explained by the different age groups of the two study populations. Chaoyang *et al* studied subjects within the age range of 12-19 years, while this study included both adolescents and adults between the ages of 18 and 85 years. Mohammed *et al* in India using the American Diabetic Association (ADA) criteria for prediabetes (FBG - 5.6 - 6.9 mmol/l) reported a higher prevalence of 35% compared to the prevalence in this study.[10] The higher prevalence was because the American Diabetic Association criteria have a lower value of fasting blood glucose level (5.6 - 6.9 mmol/l) compared to the WHO criteria (6.1 - 6.9 mmol/l) used in this study. Hence, more people would be diagnosed as prediabetic using the American Diabetic Association criteria. James *et al* in 2011 in the USA reported a higher prevalence (26.2%) of prediabetes using the ADA criteria and 7% using the WHO criteria in their study population.[11] The prevalence of prediabetes in Tanzania and Uganda was 13.8% which is lower than the prevalence of

prediabetes in this study.[12] This could be because this study is a hospital-based study in an urban centre which usually has a higher prevalence compared to the studies done in Tanzania and Uganda which are community based studies. Martins et al in Ibadan SouthWest Nigeria, reported a higher prevalence of 22.3% using the ADA criteria.[13] The higher prevalence was because the American Diabetic Association criteria have a lower value of fasting blood glucose level (5.6 - 6.9 mmol/l) compared to the WHO criteria (6.1 - 6.9 mmol/l) used in this study. Hence, more people would be diagnosed as prediabetic using the American Diabetic Association criteria. The disparity of these two studies could also be explained by the different occupation of the two study groups. In Martin et al study, all the participants were administrative staff, predisposing them to a similar risk factor of sedentary lifestyle unlike this study which included participants who had various occupation.

Prediabetes could present as isolated IFG, isolated IGT or both IFG and IGT. In this study there were more participants with IGT (60.5%) compared to IFG (22.5%). Only a few (17%) had both IFG and IGT. Essien *et al* in Calabar South-South Nigeria, also reported that more participants had IGT (20%) compared to IFG (9%).[14]In Sokoto, Northwest Nigeria, a similar pattern of IGT(8.9%) being more prevalent than IFG (6%) was reported by Isuezo *et al* among rural ethnic Fulanis.[15]The reason postulated for a higher prevalence of isolated IGT compared to isolated IFG in the study and that of Essien and Isuezo, is that OGTT (2hrPP) which is used in making a diagnosis of IGT is more sensitive in detecting glucose dysregulation than fasting blood glucose. It also reflects hepatic gluconeogenesis and slower uptake of glucose from blood into skeletal muscle and adipose tissue following a meal.[16,17] FBG and 2HRPP plasma glucose represent different entities in impaired glucose regulation. IGT is substantially associated with insulin resistance whereas IFG is related to impaired insulin secretion. Though OGTT is more sensitive for detection of dysglycaemia, it is less practical and more expensive for screening. Ogbu *et al* in Enugu South East Nigeria reported a higher prevalence of IFG (15%) compared to IGT (5%).[16]David *et al* in the Republic of Seychelles also reported a higher prevalence of IFG (24.6%) compared to IGT (10.2%).[18] In the study by David et al, fasting blood glucose was carried out in all the participants and only those who were found with IFG were subjected to OGTT, thereby, omitting those with IGT who had a normal fasting blood glucose.[17]On the contrary, OGTT and fasting blood glucose were done for all the participants in this study. This could explain the higher prevalence of IGT compared to IFG in this study.

The higher prevalence of IFG and IGT in this study could be because the study is a hospital-based study in an urban centre which usually has a higher prevalence compared to the studies of Essien and Isuezo which are community based studies. Moreso, the higher prevalence of IFG and IGT demonstrated in this study population, may be attributable to modernization and the adoption of a western lifestyle among urban residents.

In this study, age, obesity and hypertension are the independent determinants of prediabetes on logistic regression analysis. The prevalence of prediabetes peaked from the age of 40 to 50 years. There is a higher prevalence of prediabetes with increasing age because insulin resistance and impaired glucose tolerance are commonly observed phenomena in elderly people.[19]

Majority of the participants in this study with prediabetes had hypertension and there was significant association between prediabetes and hypertension (OR 4.163, P- 0.041). Ogbu *et al* in Enugu Stateand Obiegu *et al* in Imo State both in South East Nigeria reported prevalences of prediabetes of 25% and 33% respectively among those with hypertension.[16,20] Hypertension and diabetes frequently coexist because vascular hypertrophy, rarefaction and vasoconstriction resulting from hypertension would lead to altered insulin sensitivity of skeletal muscle tissue and reduced blood flow to skeletal muscle.[21]

A statistically significant relationship was established between a high BMI and prediabetes in this study (OR-1.839, CI-0.237-0.717, p -0.017). Obiegu *et al* in Imo State, Nigeria and Akintunde *et al* in Osun State, South West Nigeria, also reported a statistically significant association between prediabetes and a high BMI.[20,21] Obesity promotes insulin resistance and a cluster of risk factors for cardiovascular disease. In obesity, adipose cells release non-esterified free fatty acids, hormones such as leptin, resistin, adiponectin and adipocytokines. These are all involved in the development of insulin resistance.[20] A high level of free fatty acids may impair beta cell function through lipotoxicity and contribute to an increase in hepatic glucose output and worsening hyperglycemia.[23,24]

Malin *et al* in the USA reported a significant association between sustained moderate to vigorous physical exercise and prediabetes.[25] Contrary to their report, this study found no significant association between prediabetes and exercise (χ^2 = 5.737, p =

0.058). Majority of the participants (56.1%) in this study did not partake in exercises. The exercises were not structured or sustained in those that partook in the exercises. This could explain the reason for the lack of association between prediabetes and exercise in this study.

CONCLUSION

The prevalence of prediabetes is relatively high in this study. Sociodemographic profile such as increasing age and clinical determinants such as obesity and hypertension are associated with prediabetes. Those at high risk of prediabetes such as persons above 40 years of age, obese persons and hypertensives should be encouraged to screen regularly for prediabetes using both fasting blood glucose and 2hrPP on OGTT, to improve detection of those with IGT.

Limitation of the study

The cross-sectional design of the study did not allow any inference to be drawn with respect to the causal relationship between prediabetes and variables such as age, sex, obesity and hypertension.

Implication for policy makers.

Policy maker should strengthen the primary, secondary and tertiary levels of health care system by making the screening test for prediabetes affordable.

They should set policies that will favour lifestyle modification such as modification in the environment that will encourage greater physical activity thereby reducing obesity.

Implication for clinical practice.

High risk persons such as those above 40 years, obese persons, hypertensives and those with family history of diabetes should be encouraged to screen regularly for prediabetes.

Those identified with prediabetes should be commenced on intensive structured lifestyle modification to delay its progression to diabetes or even revert prediabetes to normoglycemia.

There is need to increase awareness of prediabetes in primary care as this is key to diabetes prevention.

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