Type 2 diabetes mellitus; screening for type 2 diabetes mellitus with fasting plasma glucose in adults older than 45 years

[SCREENING CAPSTONE PROJECT]

MPH 510 – APPLIED EPIDEMIOLOGY

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Background of type 2 diabetes mellitus

Diabetes is a metabolic disease in which blood sugar is high because the pancreas fails to produce sufficient insulin or the body cells fails to respond to insulin produced by the pancreas (Shoback, David, Gardner & Dolores, 2011). It is a leading cause of non traumatic blindness, end stage renal disease, heart disease and limb loss from amputation (United State Preventive Services Task Force, 2008). Approximately 285 million people had diabetes in the world in 2010, with 90% of them having type 2 diabetes (Williams textbook of endocrinology, n.d.). It is predicted that this will double by 2030 because of its rapid increase in incidence (Wild, Roglic, Green, Sicree, & King, 2004). Though it is commoner in developed countries, the greatest increase in prevalence is expected to occur in Asia and Africa because of rapid urbanization, lifestyle changes and western diets adopted in these continents (Williams textbook of endocrinology, n.d.). This will make it commoner in developing countries by 2030 (Wild et al, 2004).

Risk factors for diabetes are family history/ genetics, lifestyle (Risérus & Willet, 2009).

Causes of diabetes include;

- Genetic defects of β-cell function
- Genetic defects in insulin processing or action
- Exocrine pancreatic defects (chronic pancreatitis, pancreatectomy, pancreatic neoplasia, cystic fibrosis)
- Endocrinopathies (growth hormone excess, cushing syndrome, hyperthyroidism, pheochromocytoma, glucagonoma)
- Infections (Cytomegalovirus infection, Coxsackie virus B, Statins) (Hu, Pan, Malik & Sun, 2012).
• Drugs (glucocorticoids, thyroid hormone, beta – adrenergic agonists) (Lee, Shiroma, Lobelo, Puska, Blair & Katzmarzyk, 2012).

There are three main types of diabetes mellitus;

Type 1 diabetes mellitus, it was previously called insulin dependent diabetes mellitus or juvenile diabetes mellitus. It is due to the body’s inability to produce insulin. It is common in children. Its onset is sudden with a genetic predisposition and a thin body frame and its prevalence is approximately 10% (Shoback, et al 2011).

Type 2 diabetes mellitus, it was previously called noninsulin-dependent diabetes mellitus or adult-onset diabetes. This is the commonest type of diabetes with a prevalence of approximately 90%.. A metabolic disorder characterized by recurrent or persistently high blood glucose, insulin resistance (cells fail to use insulin properly) and a relative insulin deficiency. It is common in adults. Its onset is gradual, affected individuals are usually obese (Shoback, et al 2011).

Gestational diabetes mellitus, a pregnant woman with a pre pregnancy normal blood sugar develops diabetes. It is seen in 2 – 5 % of pregnancies, it may disappear post partum but 20 – 50 % of women may develop type 2 diabetes later in life (Shoback, et al 2011).

Diabetes can be asymptomatic but its symptoms are excessive thirst (polydypsia), frequent urination (polyuria), excessive hunger (polyphagia), weight loss despite adequate caloric intake and excessive urination at night (nocturia). Other symptoms include blurred vision, itchiness, peripheral neuropathy, fatigue and recurrent vaginal infections (Shoback, et al 2011).

Diabetes mellitus is diagnosed by either of these values (World Health Organization (WHO), 1999):

• Fasting plasma glucose level $\geq 7.0$ mmol/l (126 mg/dl)
- Plasma glucose ≥ 11.1 mmol/l (200 mg/dL) two hours after a meal or after a 75 g oral glucose load as in a glucose tolerance test
- Symptoms of hyperglycemia and casual plasma glucose ≥ 11.1 mmol/l (200 mg/dl)
- Glycated hemoglobin (Hb A1C) ≥ 6.5% (American Diabetes Association (ADA), 2010).

There is a lot of awareness on diabetes because it is a chronic disease with severe complications if untreated. Complication of diabetes mellitus include; acute diabetic emergencies (diabetic ketoacidosis, hyperosmolar non ketotic coma), chronic renal failure, diabetic retinopathy (reduced vision and blindness), stroke, peripheral vascular disease, diabetic nephropathy, diabetic neuropathy, diabetic foot ulcers, amputations. Diabetes doubles the risk of ischaemic heart disease like angina, myocardial infarction e.t.c (Boussageon, Bejan-Angoulvant, Saadatian-Elahi, Lafont, Bergeonneau, Kassa & Cornu, 2011) and damages capillaries (Emerging Risk Factors Collaboration, 2010).

Management of type 2 diabetes mellitus depends on patient’s individual needs and health status (National Institute for Health and Clinical Excellence, 2008). It is aimed at maintaining blood sugar levels to normal levels or close to normal, achieving HbA1C of 6.5% (The diabetes control and complications trial research group, 1995) with the use of education, lifestyle adjustment (diet, exercise, weight loss for obese patients), counseling sessions (to discontinue smoking, foot care (National Institute of Health and Clinical Excellence, 2008) and use of medications (insulin and insulin analogues, oral hypoglycemic drugs, antihypertensive in patients with hypertension coexisting with diabetes and lipid lowering agents in patients with abnormal lipid levels) (Cavanagh, 2004). Lifestyle adjustment measures like, weight reduction and increased physical activity are effective in delaying the onset of transition of diabetes (WHO, 2013).
“Screening is the process of identifying those individuals who are at sufficiently high risk of a specific disorder to warrant further investigation or direct action” (WHO, 2001). Approaches to screening for diabetes include screening the entire population, haphazard screening which has no screening policy, selective or targeted screening done in high risk patients and opportunistic screening done when patients are seen by healthcare professionals. Screening tests are used to identify asymptomatic individuals who may have the diabetes (WHO, 2013). Plasma values are higher than whole blood values because water content is higher in plasma (Diabetes UK, 2006). Screening test for diabetes is recommended in high risk group which includes; age above 45 years, family history of diabetes mellitus in first degree relatives, polycystic ovarian syndrome with BMI > 30, ischaemic heart disease, cerebrovascular diseases, obesity, sedentary lifestyle, metabolic syndrome, waist circumference > 80cm in females and 94cm in males, Asian/African descent (Diabetes UK, 2006), hypertension, previous history of gestational diabetes, dyslipidemia, impaired glucose tolerance, impaired fasting glycemia, a history of peripheral vascular disease, hypertriglyceridemia which is not as a result of excess alcohol or renal disease (American diabetes association, 2007). Screening tests for diabetes can be combined to improve performance (WHO, 2003).

Common screening tests for type 2 diabetes are; urine glucose test, fasting blood glucose, random blood glucose, oral glucose tolerance test and glycated hemoglobin (HbA1c). There is limited data on the performance of screening tests used in screening for diabetes mellitus and there is evidence base that no screen test is ideal for diabetes screening. None has a high sensitivity, high specificity and a positive predictive value close to 100% (Diabetes UK, 2006). Screening method and choice of cut off used is usually based on circumstances where the
screening is being conducted like ease of follow up, staff availability, facilities present, purpose of screening program e.t.c.

Urine glucose test

It is less sensitive but most sensitive following ingestion of either a specific glucose load or a normal meal. Its limitations are due to the varying renal threshold for glucose which has the tendency to increase with age. It has the lowest PV+ but it is the simplest (Diabetes UK, 2006). It has a low sensitivity (21% to 64%) with specificity > 98%. Studies done by Davies et al tested for postprandial glycosuria, reported a positive urine test sensitivity of 43% and specificity of 98%. Hanson et al tested reported a sensitivity of 64% and specificity of 99%. Friderichen and Maunsbach reported a sensitivity of 21% and specificity of 99%. Despite its limitations it can be used in poor settings where no other screening test is available and the prevalence of undiagnosed diabetes is high (WHO, 2013).

Fasting blood glucose test

It is easier, faster to perform, more convenient, less expensive and acceptable to patients (US preventive services task force, 2008). A value ≥ 6.6 mmol/l (120 mg/dl) is indicative of diabetes. Sensitivity can be improved but specificity and PV+ will reduce if the threshold for a “positive” fasting blood sugar test is reduced (Diabetes UK, 2006; Sainaghi, Castello, Limoncini, Bergamasco, Bartoli & Schianca, 2007). There is evidence that screening laboratory–measured capillary plasma glucose >8.6 mmol/l has a sensitivity of 90%, specificity of 93% and PV+ of 18% (Diabetes UK, 2006). A fasting blood glucose (FBG) > 5.5mmol/ l is recommended by the World Health Organization and a value > 6.1mmol/ l for American Diabetic Association as diagnostic criteria for diabetes. Fasting blood glucose value of 6.1 to 7.8mmol/ l has a sensitivity between 40% and 65% with a specificity > 90%. Optimal sensitivity and specificity was reported
at the lower cut-points in studies conducted by Costa et al (FBG ≥ 5.4 mmol l), Larsson et al at FBG of 5.3 mmol l and Cockram et al at a FBG of 5.6 mmol l. after comparing FPG levels in individuals in the USA and Isreal, Modan and Harris reported that a FPG ≥ 5.55 mmol l was preferably than other values because it had a sensitivity of 83% in the US, 95% in Isreal; specificity of 76% in the US and 47% in Isreal and PPVs of 17.2% in the US and 11.8% in Isreal. No FPG level provided a satisfactory cutoff point to use in screening for diabetes. Studies have reported sensitivities ranging from 58% - 87% (median – 81%) and specificities ranging from 75% - 98% (median 92%) for a FPG of 6.1 mmol l.

Oral glucose tolerance test (OGTT)

A fasting blood glucose reading is taken before consumption of a 75g oral glucose. A blood glucose reading is taken 2 hours after consumption. It is the most sensitive but the most complex to perform of the screening tests (Diabetes UK, 2006; Sainaghi, Castello, Limoncini, Bergamasco, Bartoli & Schianca, 2007). A value between 7.8 to 11 mmol/l is indicative of an impaired glucose tolerance while, a value > 11 mmol/L is diagnostic of diabetes (Diabetes UK, 2006).

Random blood sugar (RBS) test

This is not as sensitive or specific as a fasting blood glucose test or an oral glucose tolerance test. RBS is sensitive and specific for high readings. It is difficult to diagnose unless its value is diagnostic of diabetes. High values are good indicators of impaired glucose tolerance or impaired fasting glucose. There might be need to rescreen lower values with a fasting blood sugar.

Glycated hemoglobin (HbA1c)
In 1996, HbA1C cutoff value of 6.4% was found to have 66% sensitivity and 98% specificity with positive predictive value of 63% in a population with a diabetes prevalence of 6% (Peters, Davidson, Schriger & Hasselbald, 1996). When the cutoff value was increased to 7.0%, the positive predictive value increased to 90%. An HbA1c cutoff point of 6.1% corresponds with a 2-hour plasma glucose concentration of 11.1 mmol. Peters et al found this value to have a sensitivity of 36% and specificity of 100% (WHO, 2013).

The number of individuals with diabetes in the world is predicted to double by year 2030. It is asymptomatic and detectable in the preclinical stage. Type 2 diabetes is the commonest; its mean prevalence above age 40 is 2 – 5%. In the developing world, there is an increasing epidemic of type 2 diabetes, the younger age groups are affected (WHO, 2013). Definitive studies of the effectiveness of screening for type 2 diabetes are not available. The presence of a risk factor for diabetes improves the performance of all screening tests. Though it is not supported because there is no evidence that early detection and treatment reduce long term complications and no uniform screening process is used (Centers for Disease Control and Prevention (CDC), 2011). Screening conducted in community settings identifies small number of patients and follow up is poor making such screening expensive. There is a need for regular periodic screening of high-risk individuals. The optimal screening method is not known but it will vary from place to place depending on local situations like facilities, ease of follow up (CDC, 2011).

Fasting blood glucose is commonly used in all parts of the world as a screening test. As a public health professional and epidemiologist, one would not screen individuals for diabetes without counseling them and obtaining an informed consent. One would not conduct a haphazard screening as there will be no opportunity to follow up these individuals.
Recommendations for screening for type 2 diabetes with fasting blood sugar

One would recommend fasting blood glucose with a cutoff point of > 6.6mol/ l as a screening test for Lagos state for adults older than 45 years and people at risk of diabetes in the health care facilities, in the community and at organized community screening programs. These are people with a family history of diabetes mellitus in first degree relatives, gestational diabetes, polycystic ovarian syndrome, obesity and metabolic syndrome. It is because fasting blood glucose is easier, faster to perform, more convenient, less expensive, has less intra individual variation and acceptable to patients (ADA, 2010; United States Preventive Services Task Force, 2008).

One will be involved in educating the community on diabetes mellitus, its risk factors, the need for an early detection and diagnosis, complications and methods of preventing diabetes. One will take diabetes screening into the community on weekends or evenings after the day’s work, it will be stationed at the community hall to ensure limitations to access are removed. One will source for funding for this program from the government, philanthropists, religious bodies and non-governmental organizations. All of these measures will help me increase participation levels in the screening. Other than education, funding and access public health can increase participation of diabetes screening by increasing awareness of diabetes mellitus, emphasizing on diabetes mellitus prevention which includes healthy diet and physical activity and tying diabetes mellitus screening to individuals’ employment medical check above the age of 45 years. At the first African conference, the International Diabetic Federation and the World Health Organization called on African leaders to make provision for free treatment of diabetes in all
health facilities in Africa because the cost of treatment is enormous. If individuals are assured of free therapy after diagnosis they will submit themselves to screening for diabetes mellitus. This is the case with HIV/AIDS in my part of the world. Also, encouraging community participation is an essential way of increasing participation. This can be achieved by encouraging the village head and his chiefs to be screened in the presence of the village dwellers, employing community dwellers into the public health work force carrying out the screening as health educators after they have been educated and evaluated. They will in turn encourage their friends, relatives, family and neighbors to be screened. Also, methods of invitation like the use of letters mailed educational materials, letter of invitation with the use of phone call as a reminder, phone calls only and training activities with use of direct reminders are reported to have increased participation for screening unlike the use of home visits.

The Nigerian public health team should encourage screening for diabetes above the age of 45 years in all our communities as diabetes is a health threat to our generation and generations after us.
References


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