Prevalence, Distribution, and Knowledge-Attitude-Practices, of Type 2 Diabetes Mellitus Patients amongst Urban School-Going Adolescents - A Review

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ABSTRACT

BACKGROUND

Non communicable diseases such as diabetes mellitus (mainly Type 2) continue to form a significant proportion of disease burden worldwide, be it in terms of morbidity, mortality or socio-economic impact. The problem of Type 2 DM is more severe in developing nations such as India, with a predominantly younger and middle age population structure. Urbanization and globalization have made a telling impact, mainly on the lifestyle practices of urban school going adolescents, thereby rendering them a crucial subset in the epidemiology of Type 2 DM.

Selected studies on T2DM amongst adolescent school students in urban settings were compared and summarized through open access internet search. The Medical Subject Heading (MeSH) Search terms thus used were 'diabetes mellitus, Type 2, adolescent, urban, school going'. These terms were used in different permutations and combinations using AND / OR methodology by Boolean search. Existing hypotheses, theories and models for DM type 2 epidemiology in this setting as per scientific body of evidence were used as baseline templates for this purpose. The results arrived at through this methodology were collated both on qualitative and quantitative levels-terms.

This review found that prevalence of T2DM amongst urban school-going adolescents in India is on the rise and knowledge-attitude-practices with respect to the condition per se, its features and preventive modalities, are just adequate. Recommendations: Large scale awareness creation for lifestyle modification on a community level (by harnessing latest technology), coupled with widespread availability of facilities for timely screening, early diagnosis and comprehensive management, will enable stemming the tide.

KEYWORDS

Diabetes mellitus (Type 2), Urban, School-Going, Adolescents, Lifestyle Factors

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Developing countries across the world are in the midst of an epidemiological transition, wherein non-communicable, lifestyle-related diseases are replacing communicable, infectious diseases as the major causes of mortality and morbidity. As per latest estimates by the World Health Organization (WHO), Coronary Heart Disease (CHD) was the most common amongst all the causes of death in developing countries. In 2015, CHD was responsible for approximately 7.4 million deaths; with estimated three-quarters of these deaths taking place in low and middle-income countries.[1,2]

Globally, an estimated 422 million adults were living with diabetes in 2014, compared to 108 million in 1980. The global prevalence (age-standardized) of diabetes has nearly doubled since 1980, rising from 4.7 % to 8.5 % in the adult population.[3] This also reflects an increase in associated risk factors such as being overweight or obese[4]. Over the past decade, diabetes prevalence has risen faster in low- and middle-income countries than in high-income countries.[5]

Diabetes caused 1.5 million deaths in 2012. Higher than optimal blood glucose caused an additional 2.2 million deaths, by increasing the risks of cardiovascular and other diseases. Forty-three percent of these 3.7 million deaths occur before the age of 70 years. The percentage of deaths attributable to high blood glucose or diabetes that occurs prior to age 70 is higher in low- and middle-income countries than in high-income countries. The majority of people with diabetes are affected by type 2 diabetes. This used to occur nearly entirely among adults, but now occurs in children and adolescents / young adults too.[5]

India is home to more than one-sixth of the world's population, and this proportion is expected to increase with time. It is also expected to become the diabetes capital of the world, by the year 2025[6]. Type 2 Diabetes Mellitus (T2DM) is an ice-berg disease, with more than 50 % of diabetics in India being unaware of their diabetic status. In keeping with the worldwide trends, the age structure of T2DM in Indians is also shifting from an adult preponderance, to increased prevalence amongst adolescents and even children. This paradigm downward age shift and rising prevalence are more pronounced in urban areas.[7,8]

It is thus imperative to critically study the available body of scientific evidence on prevalence, distribution and determinants of Type 2 DM amongst urban school going adolescents, so as to derive intelligible inferences on the epidemiology of Type 2 DM in this vital subset. This is envisaged to enable identification of knowledge gains obtained hitherto fore on these aspects; as also in spotting the knowledge gaps with potential for focused future research, which in turn will contribute to devising optimally productive prevention and control strategies. This review article is a step in such a direction.

Diabetes Mellitus - Definition and Types

Diabetes is a chronic disease with life-threatening complications, that occurs either when the pancreas does not produce enough insulin (a hormone that regulates blood sugar, or glucose), or when the body cannot effectively use the insulin it produces. There are two types: type 1 diabetes (which requires insulin injections for survival) and type 2 diabetes (where the body cannot properly use the insulin it produces), separate global estimates of diabetes prevalence for type 1 and type 2 are few and far between. The majority of people with diabetes are affected by type 2 diabetes. This used to occur nearly entirely among adults, but now occurs in adolescents and children too.[9]

Type 2 diabetes mellitus is a metabolic disorder (Alberti et al., 2005) that is characterized by hyperglycaemia (high blood sugar) in the context of insulin resistance and relative lack of insulin (Kumar et al., 2005). It constitutes about 90 % of diabetic cases, with the other 10 % accounting primarily for Type 1 diabetes and gestational diabetes related cases.[10] An algorithmic representation for classification of diabetes mellitus is depicted in Figure 1.[11,7]

Diagnostic Criteria

The World Health Organisation defines diabetes (both Type 1 and Type 2) as a single, raised glucose reading with symptoms. The American Diabetes Association (ADA) includes the following criteria to be the investigative benchmarks (Davidson, 2010):

- A Fasting Plasma Glucose (FPG) level of 126 mg / dL (7.0 mmol / L) or more, or
- A 2-hour plasma glucose level of 200 mg / dL (11.1 mmol / L) or more during a 75 - g Oral Glucose Tolerance Test (OGTT), or
- A random plasma glucose of 200 mg / dL (11.1 mmol / L) or more in a patient with typical signs of hyperglycaemia or hyperglycaemic emergency‖.

A random blood sugar count greater than 200 mg / dL (11.1 mmol / l) in association with typical symptoms (David and Gardner, 2011) or a glycated haemoglobin (HbA1c) greater than 6.5 % is another method of diagnosing diabetes (WHO report). According to International Expert Committee Report in 2009, an international expert committee that included representatives of the American Diabetes Association, the International Diabetes Federation (IDF) and the European Association for the Study of Diabetes (EASD) recommended that a threshold of ≥ 6.5 % HbA1c should be used to diagnose diabetes‖ (Vijan, 2010). This recommendation was also adopted by the American Diabetes Association in 2010.[12,13,14,15]

Symptoms

The classic symptoms of diabetes are polyuria (frequent urination), polydipsia (increased thirst), polyphagia (increased hunger) and weight loss. Other symptoms commonly present at the diagnosis include a history of blurred vision, itchiness, peripheral neuropathy, recurrent vaginal infections and fatigue. Many people, however, have no symptoms during the first few years and are diagnosed on routine testing. As per Expert Committee (2012) people with T2DM may rarely present with hyperosmolar hyperglycaemic state, a condition of very high blood sugar associated with a decreased level of consciousness and low blood pressure.[9]

Complications

Diabetes of all types can lead to complications in many parts of the body and can increase the overall risk of dying prematurely. Possible complications include heart attack, stroke, kidney failure, leg amputation, vision loss and nerve damage. In pregnancy, poorly controlled diabetes increases the risk of fetal death and other complications.

In 2018, Ravi P Saha, Ajay Aggarwal, Ghazala Zaidi, et al conducted an observational cohort study to delineate the clinical features in young patients with T2DM and determined role of mutations in the hepatocyte nuclear factor 1α (HNF1α) gene (MODY Type 3), mitochondrial A3243G mutation and islet autoimmunity. The study was conducted in outpatient diabetes clinic in a teaching hospital. 96 consecutive young patients with T2DM were included in the study. Findings were patients were clinically heterogenous with 42 % having normal body index. Glutamic acid decarboxylase antibody was found in 3 % and mitochondrial A3243G mutation in 1 %. MODY #3 mutation was detected in 3 %. Study concluded that approximately 60 % were overweight or obese with a high prevalence of bi-parental diabetes and acanthosis nigricans.[16]

Problem Statement - Global

Diabetes is an important public health problem, one of four priority Non-Communicable Diseases (NCDs) targeted for action by world leaders. Both the number of cases and the prevalence of diabetes has been steadily increasing over the past few decades. As per the Global Report on Diabetes, released by the World Health Organisation, an estimated 422 million. Adults were living with diabetes worldwide in 2014, compared to 108 million in 1980. The global prevalence (age-standardized) of diabetes has nearly doubled since 1980, rising from 4.7 % to 8.5 % in the adult population. This reflects an increase in associated risk factors such as being overweight or obese. Over the past decade, diabetes prevalence has risen faster in low and middle-income countries than in high-income countries. Diabetes caused 1.5 million deaths in 2012. Higher than optimal blood glucose caused an additional 2.2 million deaths, by increasing the risks of cardiovascular and other diseases. Forty-three percent of these 3.7 million deaths occur before the age of 70 years. The percentage of deaths attributable to high blood glucose or diabetes that occurs prior to age 70 is higher in low- and middle-income countries than in high-income countries. The greater rise of diabetes in Low- and Middle-Income Countries (LMIC) as compared to High Income countries is depicted in Figure 2[17]

Socio-Economic Impact

Diabetes and its complications bring about substantial economic loss to people with diabetes and their families, and to health systems and national economies through direct medical costs and loss of work and wages. While the major cost drivers are hospital and outpatient care, a contributing factor is the rise in cost for analogue insulins which are increasingly prescribed despite little evidence that they provide significant advantages over cheaper human insulins.

Problem Statement - India

Diabetes is fast gaining the status of a potential epidemic in India with more than 62 million diabetic individuals currently diagnosed with the disease (Kumar et al., 2013). In 2000, India (31.7 million) topped the world with the highest number of people with diabetes mellitus followed by China (20.8 million) with the United States (17.7 million) in second and third place respectively (Wild et al., 2004). Recent studies on the geographical and ethnic influences on health have shown that people of Indian origin are highly prone to diabetes (King et al., 1998). Asian Indian constitutions manifests insulin resistance and the metabolic syndrome at younger ages and at higher magnitudes than any other ethnic group (Whincup et al., 2002).

With rapid economic development and increased westernization of lifestyles over the past few decades, the prevalence of the lifestyle diseases has reached alarming proportions among Indians in recent years (Sarkar et al., 2006). In this context, special attention has been devoted to Cardiovascular Disease (CVD) and T2DM. It has been predicted that, by 2025, NCD – diabetes, hypertension and metabolic syndrome, which already pose grim challenges will cause seven out of every ten deaths in developing countries (Boutayeb, 2006). It is critical here to note the contribution of dietary practices and lifestyle factors is significantly increasing the incidence and prevalence of these lifestyle diseases among the urban population[18,19]. Hence, it becomes imperative to monitor the disease in India, (Boutayeb, 2006) particularly among the urban population (Sarkar et al., 2006).[20]

Region-Wise Distribution - Urban-Rural Differences

During the period 1971–2000, studies from different parts of India reported a 10-fold increase in the incidence of diabetes in urban India (from 1.2 % in 1971 to 12.1 % in 2000). 5 - 7 in 2003 – 2005, a national survey was conducted in persons of age greater than or equal to 15 years, in which self-reported prevalence of diabetes was 7.3 % in the urban areas and 3.2 % in peri urban slum areas. The prevalence in rural areas was significantly lower (3.1 %). 8 Urban areas have witnessed a three- to fourfold increase in diabetes prevalence in many regions of India. The prevalence of diabetes is reaching a pandemic proportion which is mostly attributed to rapid lifestyle transitions and by a narrowing in the urban-rural divide in living conditions. Although there are disparities in the sample selection and screening criteria, the prevalence estimates are escalating both in the urban and rural regions of India. A recent study in Kerala showed that the rural population has a higher prevalence of diabetes than the urban population. In fact, the urbanization rate in Kerala is so rapid that the whole of Kerala is almost urbanized. 2004 – V Mohan, in his review article "Why Indians are more prone to diabetes?" gives a detailed review of the growing epidemic, T2DM in India and the magnitude of problem. The author states the reason for this due to strong genetic factors coupled with urbanization and lifestyle changes leading to insulin resistance. Obesity and physical inactivity as the other major threats to the insulin resistance. The

author gives an alarming escalating prevalence of T2 DM with years and emphasizes the fact that the prevalence of diabetes is highest in urban India.[21,22,14,20]

Prevalence of Pre-Diabetes

Prevalence of prediabetes constituting Impaired Fasting Glucose (IFG) and Impaired Glucose Tolerance (IGT) is also high in all parts of India[23]. As per the current estimates by the IDF, India has nearly 3.0 % of adults with prediabetes. The Indian Diabetes Prevention Programme-1 (IDPP - 1) a 3 year prospective study in IGT subjects in India showed a very high conversion rate to diabetes (18 % per year). Recent epidemiological studies in Chennai have indicated a rapid conversion of IGT to diabetes, resulting in increased prevalence of diabetes with a concomitant reduction in the number of IGT [24,25,13]

Age-Wise Distribution

It has been noted that the age at diagnosis has decreased considerably among the Indian patients. Type 2 diabetes mellitus among adolescents and youth has become increasingly common [26,27]. The development of the disease at a young age predisposes the patients to develop the chronic long-term complications at a relatively young age and severe morbidity and early mortality occur in the most productive years of life. [28,29]

In Chennai, it was noted that the prevalence of diabetes in persons below 44 years of age had increased from 25 % of the total prevalence in 2000 to 34.7 % in 2006. Indians and many other Asian populations have the "metabolically obese" phenotype characterized by higher abdominal obesity despite normal Body Mass Index (BMI), low muscle mass, higher percentage of body fat and increased levels of insulin resistance, which makes them highly susceptible to diabetes. A study in Chennai had shown high prevalence of insulin resistance and cardiometabolic abnormalities among healthy adolescents, the rate of which significantly increased in overweight and obese children (up to 85 %). Moreover, the cardiovascular factors tended to cluster. Similar data have been reported by Misra and co-workers in northern India.[11,30,31]

Gender-Wise Distribution

A survey done on prevalence and risk factors of diabetes and impaired fasting glucose in Nauru by Amina Khambilia in 2011 found that the sex standardized prevalence of diabetes was 13.0 % in men, 14.4 % in women and 13.7 % combined. The sex standardized prevalence of diabetes was 6.4 % for men, 5.5 % for women and 6 % combined. The prevalence for diabetes for individuals 15 - 24, 25 - 34, 35 - 44, 45 - 54 and 55 - 64 year was 4.5 %, 7.6 %, 24.1 %, 32.9 % and 42.7 % respectively.[32]

A research conducted by D. Narayanappa and HS Rajni on prevalence of prediabetes in school going children in 2010 concluded that the prevalence of prediabetes was 3.9 % in boys and 3.4 % in girls. The average fasting blood sugar was 76.6 mg / dl with standard deviation of 15.9 mg / dl. Prevalence of overweight and obesity was 11 % and 5 % respectively.[30]

A research conducted by Jinping Zhang, Zhaozun Yang in Chinese population in 2014 revealed that the age and gender adjusted prevalence rate of diabetes were 32.7 % in at least two generations and 20.1 % in one generation of first-degree relatives, and 8.4 % in no first-degree relatives.[33]

Risk Factors - Family History

A research was conducted by Benja Muktaband, Pattara Sanchaisuriya et al on whether first degree relative with diabetes mellitus was an important risk factor for rural Thai villagers to develop type II diabetes mellitus in 2014. The study included 609 villagers in rural areas of North Eastern resulted in detection of 110 new cases of diabetes mellitus Type II. Among all those screened 243 reported having a father or mother with diabetes mellitus Type II. Among the new cases 66 reported a first degree relative, predominantly their mothers who had the disease. A mother or father with diabetes mellitus was strong risk factor for development of diabetes mellitus Type II.[34]

Risk Factors - Childhood Predilection

There is a global increase in the prevalence of obesity in children and adolescents [35]. This is closely linked to lifestyle factors such as unhealthy eating habits and decreased physical activity, both of which are widely occurring in developing countries with urbanization [36,37]. Insulin resistance occurs in early ages and it is an independent risk factor for CVD and also a root cause for diabetes [38,39].

Type 2 diabetes mellitus in children is becoming common in many countries, especially among the Asian-Indian population[40]. In India, the age at onset of T2DM is generally low and this form of diabetes in children is being detected more frequently now. In 2003, Ambady et al conducted a study on Diabetes in Asian-Indian Urban Children to assess the type 2 diabetes with age in children. A total of 18 children aged 9 - 15 years were assessed. The children were diagnosed as a case of insidious onset of DM and they were on oral antidiabetic from 2 - 12 months. The factors like clinical details, anthropometry, details of family history of diabetes were elicited. Children were tested for presence of anti-GAD65 antibodies and for pancreatic-cell reserve by measuring serum C-peptide response. All children showed response to ODAs. They had good cell reserve and negligible GAD65 antibodies indicating presence of type 2 diabetes. One child had polycystic ovary syndrome. Family history was positive for all cases. The clinical profile was similar to children from other countries. However, T2DM in children in Asian-Indians is a condition that needs to be assessed and analysed in greater detail.[41,42]

Risk Factors amongst Adolescents - Lifestyle Related Determinants

Paul Zimmet and Jonathan Shaw FF in their review article on Incidence trends of T1DM and T2DM among youths (in

2017) brought out the appalling facts of T2DM in the young / adolescents. The study was conducted among 2846 youth aged 10 - 19 years. The study showed a steady increase in T2DM - 4.8 % annually ($p < 0.001$). The trends showed major ethnic differences in which Native American and Non-Hispanic black where T2DM aged 10 - 19 years approximately doubled over ten years. An increased contribution of environmental and behavioural factors such as dietary, infection, and psychosocial risk factors like addictions and delinquency were seen. Obesity was found to be singularly important cause for T2DM.[43,44]

Knowledge-Awareness on T2DM

K S Achuth, S Mangala, C Pradeep et al conducted a study in 2015, on the risk of Type 2 diabetes mellitus in adolescents in a medical college in Bangalore, India as there is an emerging of growing prevalence of type 2 DM among urban children. Sample was medical students. Tool was Indian Diabetes Risk Score that includes age, exercise status, waist circumference, and family history of DM. In this study out of 238 students, 114 (47.9 %) were found to be in medium and high-risk category. According to the obesity classification, for Asians 43 (18.1 %) were overweight, and 68 (28.6 %) were obese. The study concluded with the information, education, and communication need to be highlighted on healthy lifestyle incorporating a balanced diet and physical activity to reduce obesity in view of reducing the risk of T2DM in the future.

In 2017, Shilpa Gaidhane et al conducted a cross sectional study in rural India to find the awareness regarding T2DM and distribution of risk factor in adolescents of rural India. Samples were 412 adolescent boys and girls selected by systematic random sampling technique. 65 % were aware of Type II diabetes mellitus. The awareness was more in girls, older adolescents and those with higher education. Totally 204 had some risk factors for diabetes mellitus type II was found in 204. Out of these 191 had sedentary lifestyle, 153 adolescents had nutritional risk factors, 69 boys had WHR (Waist Hip Ratio) more than 0.90 and 113 girls had WHR more than 0.85 and 77 % reported family history of diabetes mellitus Type II. Hence there is a need to create awareness among adolescents so as to curb the incidences.[14]

Vital Role of Prevention - Lifestyle Modification, Early Detection, and Complete Treatment

In 2011, AN Prasad in his article titled 'Type 2 Diabetes mellitus in young: Need for early screening', has given his perspective of the same. From the literature review, the author has derived that there is 10-fold increase in T2DM in young between 1982 - 1994. The comparison of studies also concluded those with visceral fat manifested by truncal obesity are at high risk for insulin resistance. Other contributory factors are genetic predisposition and changes in lifestyle. Those children with impaired fasting plasma glucose between 100 - 126 mg / dl and impaired glucose tolerance with post prandial plasma glucose between 140 - 200 mg / dl are to be targeted. The author also discusses the prevention under primary and secondary. The primary prevention to be focused on life style modification by promotion of breast feeding, preventing obesity in child bearing age as it can lead to diabetic pregnancy, micronutrient food rich, reducing salty and junk foods, promoting traditional food like thali (50 % - Vegetables / fruit / salads, 25 % - Cereals - rice / wheat, 25 % - dal, milk, egg / animal protein). The author recommends a minimum of 30 min cumulative moderate exercise (Brisk walking) and additional 20 minutes vigorous exercise (running) three times a week. The article stresses on restricting TV watching, computers, and tuition class to 1 - 2 hrs. per day. Children also need to be advised to refrain from quick-fix weight reduction program which are harmful. Secondary prevention includes measures to control BP, timely screening and diabetes education. Community, school prevention activities, role of government and media is also discussed in the article. An easy-to-adopt algorithm devised by WHO for diabetes control is depicted in Figure 3.[45]

Felt Need for More Research

Elizabeth R Pulgaron, Alan M Delamater in 2014, reviewed journal articles on obesity and T2 DM in children and epidemiology & treatment. In the article, the authors give evidences of overweight in childhood that increases risk for Type 2 DM. Lower income and ethnic minority status are associated with both obesity and T2D in the youth. As obesity and T2DM are major public health issues with potential long-term impact on future generations, it leads to a disproportionate increase in personal and societal cost. The authors also recommend for the urgent need of research addressing the prevention of obesity and T2D among youth.

CONCLUSIONS

It is evident from the above review that the threat posed by type 2 diabetes mellitus amongst Indians in general, and urban school-going adolescents in particular, is real and emerging. However, most, if not all, the risk factors of the condition are amenable to amelioration by simple changes in lifestyle. This can be brought about by increasing awareness of adolescent school goers on a mass / community level, by leveraging latest information technology tools like social media. The message (on disease features, risk factors and elements of prevention-control) needs to be tailor-made to fill in the gaps in knowledge-attitude-practices, and to blend with the outlook of the new-generation target population. Inclusion of salient aspects of T2DM early in school curriculum can be one of such measures. The primordial prevention steps thus envisaged, need to be complemented by corresponding buttressing of secondary prevention components, like upscaling of diagnostic modalities and good treatment facilities for T2DM. Such a holistic strategy, when conceptualised and implemented, will be a significant step forward in our campaign to ease the burden posed by T2DM to this sub-set of urban school going adolescents. It will also be serving as

a template for future such health promotive missions for control of lifestyle-related diseases.

Further, there is evidently a need for wider and deeper research on all epidemiological aspects of T2DM, in variegated settings, to enrich our understanding of the condition. WHO recommendations for comprehensive diabetes prevention-control are encapsulated in a nutshell, as depicted.

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