DISSERTATION ON

SCREENING CHILDREN OF TYPE 2 DIABETES MELLITUS PARENTS

Dissertation submitted to

THE TAMIL NADU DR. M.G.R. MEDICAL UNIVERSITY
CHENNAI

In partial fulfillment of regulations

for award of the degree of

M.D.PAEDIATICS BRANCH- VII

DEPARTMENT OF PAEDIATRICS,
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CHENNAI - 10

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MAY 2018

BONAFIDE CERTIFICATE

This is to certify that this dissertation entitled **"SCREENING CHILDREN OF TYPE 2 DIABETES MELLITUS PARENTS"** is the original and bonafide work done by **Dr.A.C.RAJARAJAN** under the guidance of **Prof.Dr.K.SUGUNA, M.D., DCH.,** Professor and Head, Department of Pediatrics , Govt Kilpauk Medical College & Hospital & Govt Royapettah Hospital, Chennai – 600 014, during the tenure of his course in M.D. Pediatrics from May-2015 to May-2018 held under the regulation of the Tamilnadu Dr. M.G.R Medical University, Guindy, Chennai – 600 032.

Prof.Dr.P.VASANTHAMANI,
M. D., D.G.O., MNAMS., DCPSY., MBA
DEAN,
Govt. Kilpauk Medical College& Hospital,
Chennai-600 010

Prof.Dr.K.SUGUNA,
M.D,DCH.,
Professor and Head,
Department of Pediatrics,
Govt.Kilpauk Medical College,
Govt.Royapettah Hospital,
Chennai- 600 014.

Place : Chennai
Date :

CERTIFICATE BY THE GUIDE

This is to certify that this dissertation titled **"SCREENING CHILDREN OF TYPE 2 DIABETES MELLITUS PARENTS"** is the original and bonafide work done by **Dr.A.C.RAJARAJAN** under my guidance and supervision at the Govt Royapettah Hospital & Govt Kilpauk Medical College & Hospital, Chennai – 600 010, during the tenure of his course in M.D. Pediatrics from May-2015 to May-2018 held under the regulation of the Tamilnadu Dr.M.G.R. Medical University, Guindy , Chennai – 600 032.

Prof.Dr.K.SUGUNA, M.D,DCH.,
Professor and Head,
Department of Pediatrics,
Govt. Kilpauk Medical College,
Govt. Royapettah Hospital,
Chennai- 600 010.

Place : Chennai
Date :

DECLARATION BY THE CANDIDATE

I solemnly declare that this dissertation titled **"SCREENING CHILDREN OF TYPE 2 DIABETES MELLITUS PARENTS"** is the original and bonafide work done by me at the Govt Royapettah Hospital & Govt Kilpauk Medical College & Hospital, Chennai – 600 014.

This is submitted to the **Tamilnadu Dr.M.G.R.Medical University**, Chennai in partial fulfilment of the rules and regulations for the award of M.D.Degree in PAEDIATRICS, BRANCH 7.

Signature by the candidate

(Dr.A.C.RAJARAJAN)

Place : Chennai

Date :

CERTIFICATE - II

This is to certify that this dissertation work titled **"SCREENING CHILDREN OF TYPE 2 DIABETES MELLITUS PARENTS"** of the candidate **Dr.A.C.RAJARAJAN,** Post graduate in **PAEDIATRICS** with registration Number **201517153** for the award of **M.D.PAEDIATRICS** in the **Branch VII**. I personally verified the urkund.com website for the purpose of plagiarism check. I found that the uploaded thesis file contains from introduction to conclusion pages and result shows **2%** percentage of plagiarism in the dissertation.

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INSTITUTIONAL ETHICS COMMITTEE
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Protocol ID. No.20/2017 Meeting held on 20/01/2017
CERTIFICATE OF APPROVAL

The Institutional Ethical Committee of Govt. Kilpauk Medical College, Chennai reviewed and discussed the application for approval "**Screening in Children of Type 2 Diabetes Mellitus Parents. "** submitted by Dr.A.C.Rajarajan, Postgraduate in Paediatrics, Govt. Kilpauk Medical College, Chennai.

The Proposal is APPROVED.

The Institutional Ethical Committee expects to be informed about the progress of the study any Adverse Drug Reaction Occurring in the Course of the study any change in the protocol and patient information /informed consent and asks to be provided a copy of the final report.

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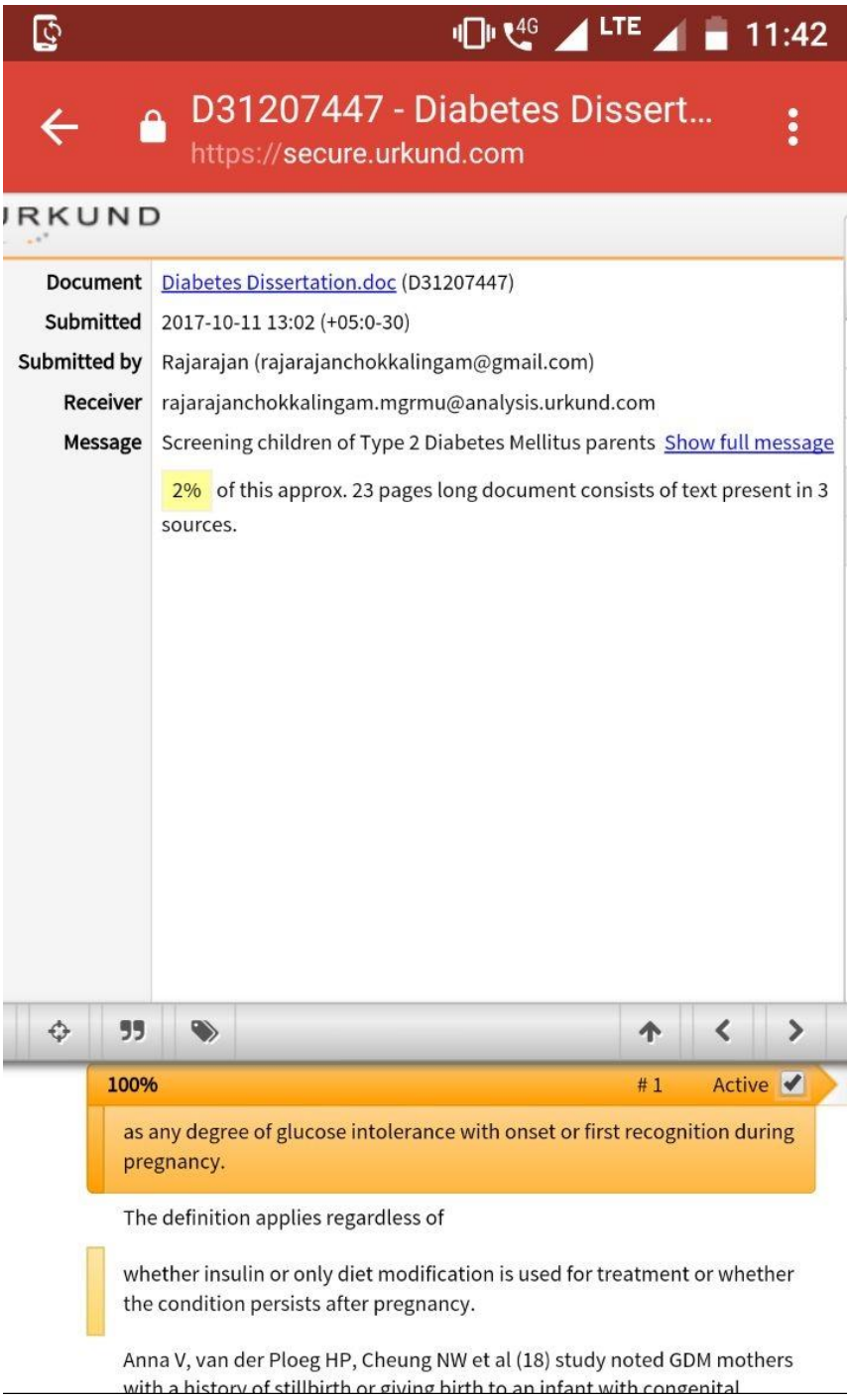
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Screening children of Type 2 Diabetes Mellitus parents Show full message
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Active
as any degree of glucose intolerance with onset or first recognition during pregnancy.
The definition applies regardless of
whether insulin or only diet modification is used for treatment or whether the condition persists after pregnancy.
Anna V, van der Ploeg HP, Cheung NW et al (18) study noted GDM mothers

CONTENTS

INTRODUCTION

Diabetes mellitus is a common chronic metabolic syndrome characterised by hyperglycemia as a cardinal biochemical feature. It is group of disorders having varying etiology and pathogenesis leading to the impairment of glucose tolerance characterised by hyperglycemia, glycosuria and polyuria.

Diabetes mellitus is the most common non communicable disease which shortens lifespan by 15 years and it is a leading cause of blindness and end stage renal disease. The factors that contribute to hyperglycemia include decreased insulin secretion, decreased insulin action and gluconeogenesis.

Diabetes mellitus can be treated and complications can be avoided or delayed by dietary management, lifestyle management, medication and regular screening and treatment for complications.

INCIDENCE OF DIABETES MELLITUS :[1]

Incidence is increasing alarmingly affecting 3% of world population. 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. This reflects an increase in associated risk factors such as being overweight or obese.

In 2014, 8.5% of adults aged 18 years and older had diabetes. In 2015, diabetes was the direct cause of 1.6 million deaths and in 2012 high blood glucose was the cause of another 2.2 million deaths. WHO projects that diabetes will be the seventh leading cause of death in 2030. Healthy diet, regular physical activity, maintaining a normal body weight and avoiding tobacco use are ways to prevent or delay the onset of type 2diabetes.

INCIDENCE OF DIABETES MELLITUS IN CHILDREN [(2)]

The most common cause of diabetes in children is due to an absolute deficiency of insulin secretion because of destruction of the beta cells of the pancreatic islets. Diabetes in children and adolescence affects growth and puberty.

In 2001, 4958 of 3.3 million youth were diagnosed with type 1 diabetes for a prevalence of 1.48 per 1000. In 2009, 6666 of 3.4 million youth were diagnosed with type 1 diabetes for a prevalence of 1.93 per 1000.

In 2001, 588 of 1.7 million youth were diagnosed with type 2 diabetes for a prevalence of 0.34 per 1000. In 2009, 819 of 1.8 million were diagnosed with type 2 diabetes for a prevalence of 0.46 per 1000.

CLASSIFICATION OF DIABETES MELLITUS

DM classification based on **American Diabetes association**[3]

1. Type 1 diabetes (β-cell destruction causing insulin deficiency)

2. Type 2 diabetes (defect in insulin secretion on the background of insulin resistance)

3. Gestational diabetes mellitus (diabetes diagnosed in pregnancy)

4. Specific types of diabetes due to other causes

- Monogenic diabetes syndromes(maturity-onset diabetes of the young [MODY])
- Diseases of the exocrine pancreas : Chronic pancreatitis, Pancreatectomy, Neoplasia, Cystic fibrosis, Hemochromatosis, Fibrocalculous pancreatopathy.

- Drug induced diabetes (Glucocorticoids, Thyroid hormone,β-Adrenergic agonists)
- Infections (Cytomegalovirus, Coxsackievirus B, Congenital rubella)
- Genetic Syndromes Associated with Diabetes (Down syndrome, Klinefelter syndrome, Turner syndrome).

TYPE 2 DIABETES IN CHILDREN AND ADOLESCENTS

Type 2 diabetes mellitus is emerging as a new clinical problem within pediatric practice. Recent reports indicate an increasing prevalence of type 2 diabetes mellitus in children and adolescents around the world in all ethnicities.

Reinehr T et al study [4] described, type 2 diabetes mellitus has been thought to be a rare occurrence in children and adolescents 30 years ago. However, in the mid-1990s, investigators began to observe an increasing incidence of type 2 diabetes mellitus worldwide. This observation followed a striking increase in both the prevalence and the degree of obesity in children and adolescents.

Type 2 Diabetes Mellitus was considered a rarity in adolescence until recently. However, in recent decades, many authors have been reporting an increase in the incidence of diabetes in adolescents with similar characteristics to those of DM 2 in adults. The increase in the incidence of T2DM in young people was observed among those between 15 and 24 years old. The increase in the prevalence of obesity in adolescence explains the increase of DM2 in young populations.

T2DM IN INDIAN CHILDREN AND ADOLESCENTS

The prevalence of T2DM in children in India is increasing and during the last ten years it was shown by the following studies.

Study conducted by **Ramachandran, et al** [5] reported T2DM in 18 children (13 girls and 5 boys) out of 257 aged less than 15 years. Nine of them were obese and without any symptoms and was detected on screening which was done due to strong family history of DM and/or due to obesity.

Bhatia, et al [6] conducted study in which of 160 children, 12% of children less than 18years of age had T2DM was diagnosed.

Hence in India we need Screening for T2DM in children seems meaningful especially in high risk groups such as children and adolescents with obesity, parents with type 2 diabetes mellitus, and clinical features of insulin resistance (Hypertension, Dyslipidemia, PCOS and Acanthosis nigricans).

PATHOPHYSIOLOGY OF TYPE 2 DIABETES MELLITUS IN CHILDREN AND ADOLESCENTS [4]

Type 2 diabetes mellitus is a disorder with heterogeneous etiology such as social, behavioral, and environmental risk factors. These factors unmask the effects of genetic susceptibility which plays a major role in Type 2 DM.

Glucose homeostasis

It depends on the balance between insulin secretion and insulin action. The insulin resistance to glucose uptake is a characteristic finding in patients with type 2 diabetes mellitus. The evolution from normal to impaired glucose tolerance (IGT) is associated with a worsening of insulin resistance.

Impaired glucose tolerance is an intermediate stage in the natural history of type 2 diabetes mellitus. IGT is a predictor of the

risk of developing diabetes mellitus. Insulin resistance alone is not sufficient for development of diabetes but also inadequate insulin secretion. It has been proposed that hyperglycaemia may worsen both insulin resistance and insulin secretory function and thus enhancing the transition from impaired glucose tolerance to diabetes mellitus.

INSULIN RESISTANCE

Resistance to the action of insulin in the liver leads to an increase of hepatic glucose production. During the initial phase, the increase in glycemia levels is compensated by an increase in insulin secretion, but as the process persists for prolonged periods a glucotoxic effect will come. A glucotoxic effect is defined as an increased resistance to the effects of insulin and a decrease in beta cell function due to chronic hyperglycemia.

Disorders associated with insulin resistance and obesity: [7]

1. **Acanthosis nigricans**
2. **Polycystic Ovarian Syndrome**

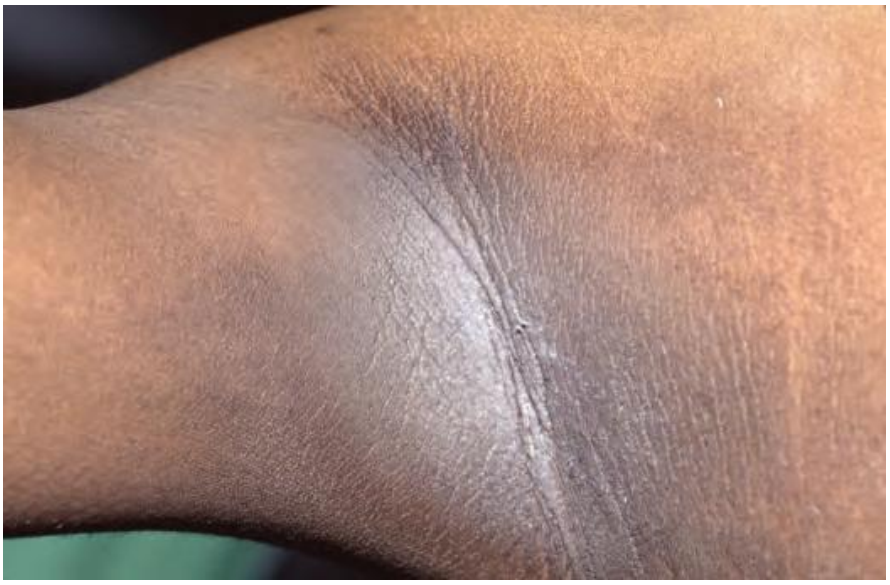
1. Acanthosis nigricans:

Acanthosis nigricans is a cutaneous finding characterized by velvety hyperpigmented patches most prominent in the

intertrigenous area and is present in up to 90% of children with T2DM. It is recognized more frequently in darker-skinned obese individuals.

Histology of Acanthosis nigricans

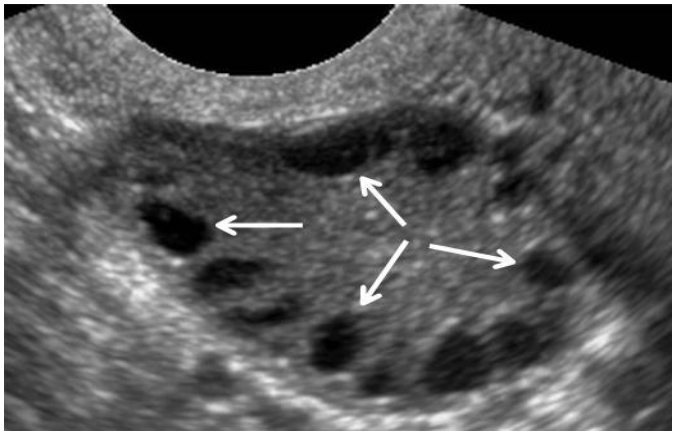
It is characterized by papillomatosis and hyperkeratosis which is a darkening due to the thickening of the superficial epithelium which contains keratin. There is hyperplasia of all elements of the dermis and epidermis which suggests stimulation by a local growth factor. Increased IGF-1 and epidermal growth factor (EGF) are implicated in this process.[8]



Picture of Acanthosis nigricans in axilla

Polycystic Ovarian Syndrome (PCOS) [9]

PCOS is a reproductive disorder characterized by hyperandrogenism and chronic anovulation. PCOS is a disorder of hormone function affecting 5-8% of women of reproductive age . It is characterized by the triad of oligoovulation or anovulation, clinical or biochemical hyperandrogenism, and ovaries with a polycystic morphology on ultrasound examination (≥12 follicles in 1 ovary and/or ovarian volume >10 ml/mm3). Abnormalities commonly associated with PCOS include obesity, insulin resistance, and the metabolic syndrome. Insulin resistance is greater and more prevalent among women with PCOS. PCOS is associated with an increased prevalence of insulin resistance and type 2 diabetes in adolescent girls.



Picture of PCOS in Ultrasonogram

RISK FACTORS FOR T2DM

1.Ethinicity
2.Family History
3.Puberty
4.Obesity
5.Low birth weight
6.History of GDM in mother

1. Ethnicity

According to survey conducted by **Health Survey for England** (HSE) [10], the risk group for T2DM are Indo-Asians. Indo-Asians who have migrated to western societies as well as those living in urban areas of the Indian subcontinent have higher prevalence of T2DM.

Yajnik CS, Lubree HG, Rege SS et al study [11] described, Indian babies are usually lighter at birth but their fat mass is preserved and have tendency to truncal or central adiposity even during intrauterine development. They also have Higher umbilical cord insulin concentrations have been demonstrated, suggesting that an insulin-resistant phenotype is present at birth in Indian babies. By 8 years of age, these lower birth weight Indian babies have

abnormalities in systolic blood pressure, fasting plasma insulin, subscapular/triceps skinfold ratios and total LDL cholesterol concentrations and are at risk for diabetes.

2. Family history

Haines L, Wan KC, Lynn R, Barrett TG, Shield JPH et al study [12] shows the great majority of children with T2DM have a strong family history of T2DM. 74–100% had a first- or second degree relative with T2DM.

Diabetes in the parent or other relative may not be recognized until the child is diagnosed. The high frequency of relatives with T2DM demonstrate the strong hereditary (likely multigenic) component to the disease.

Families will also share the same dietary habits as well as approaches to physical activity. UK data suggest that 84% of children diagnosed with T2DM have a family history. Family history is also important among children with obesity. 85%, of children with T2DM are obese or overweight at presentation.

3. Puberty

Arslanian SA et al study [13] described a major role of puberty in the development of type 2 diabetes mellitus in children. During puberty, there is increased resistance to the action of insulin, resulting in hyperinsulinemia. After puberty, basal and stimulated insulin responses decline and there is normalization from IGT to normal glucose tolerance in children and adolescents with impaired glucose tolerance. This normalization has been attributed to changes of insulin resistance at end of puberty.

Increased growth hormone secretion in puberty is also responsible for the insulin resistance. Growth hormone acts as a lipase stimulant, provoking an increase in free fatty acid oxidization, which results in a reduced sensitivity to the action of insulin.

Hence, it is not surprising that the peak and average age at presentation of type 2 diabetes mellitus in children coincides with the usual age of mid-puberty approximately 13 years.

4. Obesity

Obesity is defined as excess adipose tissue in the body. It is the hallmark of type 2 diabetes mellitus. Most of the children with T2DM up to 85% are obese or overweight at diagnosis. Adipose tissue expanding in the obese state synthesizes and secretes metabolites & signalling proteins like leptin, adiponectin, and tumor necrosis factor-alpha which alters the insulin secretion and sensitivity and cause insulin resistance.

In a study conducted by **Weiss R, Dziura J et al** [14] the effect of obesity on glucose metabolism is evident early in childhood and obese children are hyperinsulinemic and have approximately 40% lower insulin stimulated glucose metabolism compared with non obese children.

In a study conducted by **Taksali SE, Caprio S et al** [15] there is a inverse relationship between insulin sensitivity and abdominal fat is stronger for visceral than for subcutaneous fat.

Haines L, Wan KC, Lynn R et al [12] did study in Argentina. They studied 400 obese children who showed a prevalence rate of 1.6% for T2DM and 7% for IGT.

Definition of overweight and obesity:

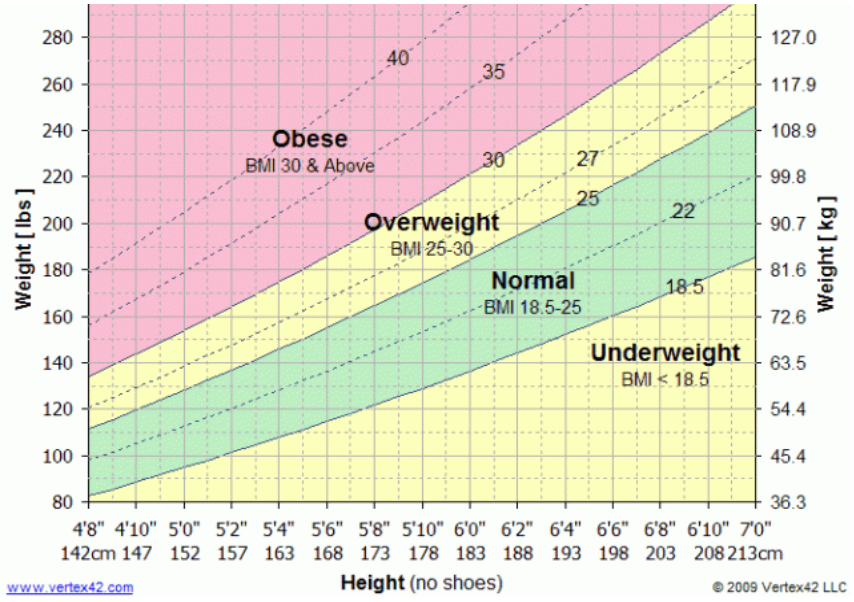
According to **WHO**, [16]

Overweight is defined as > +1 Standard deviation (equivalent to BMI 25 kg/square meters at 19 years). Obesity is defined as >+2 Standard deviation (equivalent to BMI 30kg/square meters).

The most commonly used and preferred indicator for obesity is the body mass index (BMI). BMI has become the standard practical measure of adiposity.

BMI =WEIGHT (Kg) / HEIGHT (m2)

Picture of BMI chart



5. Low Birth weight

Low birth weight is one of the risk factor for T2DM. The following studies has clearly demonstrated the fact that low birth weight babies born for mothers with high maternal BMI has higher risk in future for developing T2DM.

Monica Gabbay, Paulo R. Cesarini et al[8] study noted that adults who were born with low birth weights with inadequate intrauterine nutrition had a sevenfold risk of developing insulin resistance, glucose intolerance and T2DM.

Erikkson et al [17] did a study on Effects of size at birth and childhood growth on the insulin resistance syndrome in elderly individuals.They studied 7086 men and women born in Helsinki, Finland and they found that the development of Type II diabetes mellitus is associated with low birth weight followed by accelerated gain in height and weight during childhood and with high maternal BMI. They concluded that the Insulin resistance and Type II diabetes share common associations with retarded fetal growth and accelerated growth during childhood

6. History of gestational diabetes in mother

ADA [3] defines Gestational diabetes as any degree of glucose intolerance with onset or first recognition during pregnancy. The definition applies regardless of whether insulin or only diet modification is used for treatment or whether the condition persists after pregnancy.

Anna V, van der Ploeg HP, Cheung NW et al [18] study noted GDM mothers with a history of stillbirth or giving birth to an infant with congenital abnormality and excess glucose in urine during pregnancy has increased risk of obesity and type 2 diabetes in offspring.

Monica Gabbay, Paulo R. Cesarini et al[8] study described the increased risk of T2DM among the children of GDM women. An abnormal intrauterine environment is the key factor which is responsible for the development of diabetes. Factors which increases the insulin secretion is associated with the intrauterine environment. Those factors have a direct effect on the fetus, increasing insulin secretion leading to the development of insulin resistance in the children.

CRITERIA FOR SCREENING FOR T2DM IN CHILDREN AND ADOLESCENTS

Screening for diabetes is needed for at-risk asymptomatic children to prevent Type 2 diabetes related morbidity and mortality. Screening should commence at the age of 10 years at onset of puberty and should be repeated every 2 years.

ADA [3] suggests that children who are overweight (BMI, 85th percentile for age and sex) and who have any two of the following risk factors should be tested for T2DM:

1. Family history of T2DM in first- or second-degree relative
2. Race/ethnicity (American Indian, African American, Hispanic, Asian/Pacific Islander)
3. Signs of insulin resistance or conditions associated with insulin resistance (acanthosis nigricans, hypertension, dyslipidaemia, polycystic ovarian syndrome)

Recommended test by ADA is fasting plasma glucose. Hba1c can be used as alternative test.

HbA1c - SCREENING TEST FOR TYPE 2 DM:

HbA1c can be used as alternative test for screening T2DM. The following studies described the use of HbA1c test in screening diabetes.

Chirag Kapadia, Philip Zeitler et al [19] conducted study in diabetic patients and found HbA1c and FPG tests as equally effective screening tools for the detection of Type 2 diabetes.

C. M. Bennett, M. Guo et al [20] study clearly described the glycated haemoglobin (HbA1c) test as a screening tool for early detection of Type 2 diabetes. They also noted HbA1c and FPG are equally effective screening tools for the detection of Type 2 diabetes.HbA1c has higher specificity than fasting plasma glucose (FPG) in detecting Diabetes. Hence HbA1c can be suggested as an alternative screening test for Type 2 diabetes.

Pavithra Vijayakumar, Robert G. Nelson et al [21] study described HbA1c as a useful predictor of diabetes risk in children and can be used to identify prediabetes in children with type 2 diabetes risk factors with the same predictive value as FPG and 2hPG.

CUT OFF POINT FOR HbA1c:

In most of the diabetic studies[19,20,21] so far reviewed recommends the HbA1c cut-off point of > 5.7 to 6.1% for detection of Prediabetes and > 6.1% for the detection of Diabetes.

ADVANTAGES OF HbA1c TEST:

1. Compared with the OGTT, HbA1c measurement is quicker and more convenient.
2. HbA1c can be measured at any time of the day regardless of the duration of fasting or the content of the previous meal.
3. HbA1c levels represent a 2–3-month average of blood glucose concentrations.
4. HbA1c, OGTT and FPG are equivalent as predictors of the development of retinopathy and nephropathy

LIMITATIONS OF HbA1c TEST:

The accuracy of HbA1c is influenced by the presence of haemoglobinopathy or renal failure, as well as laboratory error and/or use of certain medications.

CRITERIA FOR DIAGNOSIS OF PRE DIABETES IN CHILDREN AND ADOLESCENTS

According to ADA [3], Prediabetes is defined as

Impaired fasting glucose (IFG)

(Glucose level ≥ 100 mg/dl but <125 mg/dl)

or

Impaired glucose tolerance (IGT)

(2-hour postprandial ≥ 140-199 mg/dl)

or

Glycated Hemoglobin level HbA1c >5.7 but < 6.1%

Prediabetes represents the earliest stages of impaired glucose metabolism. Many studies have reported a high prevalence of prediabetes in obese children and adolescents. Screening for prediabetes should be considered for these high-risk children to understand the early pathophysiologic changes underlying this metabolic dysfunction and to halt the progression of prediabetes to diabetes thereby preventing the diabetes related complications.

CRITERIA FOR DIAGNOSIS OF DIABETES IN CHILDREN AND ADOLESCENT

American Diabetes Association (ADA) Criteria for DM [3]:

1) Symptoms of diabetes (polyuria, polydipsia, and unexplained weight loss) plus random glucose level >200 mg/dl (11.1 mmol/l) in venous plasma or capillary whole-blood samples

or

2) Fasting glucose level >126 mg/dl (7.0 mmol/l) in venous plasma or capillary whole-blood samples

or

3) 2 hour glucose level during oral glucose tolerance test (OGTT) >200 mg/dl (11.1 mmol/l) in venous plasma or capillary whole-blood sample.

or

4) HbA1c > 6.1%. The test should be performed in a laboratory using a method that is NGSP certified and standardized to the DCCT assay.

CLINICAL PRESENTATION OF T2DM IN CHILDREN AND ADOLESCENTS [22]

Clinicians should be aware of the clinical presentation of T2DM in children and adolescents. It includes the following

Age: 11yrs–17yrs

Gender: Female > male

Family history of T2DM

Overweight / Obesity

Acanthosis nigricans

Polycystic ovarian syndrome (PCOS)

Symptoms:

1. Mild form T2DM – Asymptomatic (or) mild polyuria and polydipsia.

2. Severe form T2DM - Polyuria, polydipsia, and weight loss.

COMPLICATIONS OF DIABETES [23]

If diabetes is not treated properly at appropriate time, complications will develop which endanger life and health. The complications of diabetes are as follows,

1. **Acute complications**
2. **Hypoglycemia**
3. **Multiorgan damage**

Acute complications

Acute complications are due to the abnormally high blood glucose level and can have a life-threatening impact. Acute complications are diabetic ketoacidosis (DKA) in type 1 and 2 and hyperosmolar coma in type 2.

Hypoglycemia

Hypoglycemia is one of the complication of diabetes due to abnormally low blood glucose that can also lead to seizures or loss of consciousness. It is mainly due to skipping the meal or excessive exercising more than usual, or due to the intake of anti-diabetic drugs with high dosage.

Multiorgan damage

Over time diabetes can damage multiple organs which include the heart, blood vessels, eyes, kidneys and nerves. It is the leading cause of blindness and kidney disease. Diabetes patients are at increased risk of developing the following diseases,

- Cardiovascular disease
- Stroke
- Diabetic Neuropathy in the feet which increases the chance of foot ulcers, infection and the eventual need for limb amputation.
- Diabetic retinopathy is an important cause of blindness and occurs due to the long-term accumulated damage to the small blood vessels in the retina.
- Diabetic Nephropathy - Renal failure.

Management of T2DM in Children and Adolescents [4]

Goal of Management of T2DM in Children And Adolescents

The ideal goal of treatment is normalization of blood glucose values and HbA1c. Successful control of the associated co morbidities is also important. The ultimate goal of treatment is to decrease the risk of acute and chronic complications associated

with diabetes mellitus. There are three main steps in the management of T2DM.

1. Weight management
2. Pharmacological Management of T2DM
3. Management of complications of T2DM

1. **Weight Management in Children and Adolescents**

Weight control is the initial management of obese children and adolescents with T2DM consists of lifestyle and behaviour modifications like decreasing high-caloric high-fat food choice while increasing the physical activity. Referral to a dietician for nutritional management of children with diabetes mellitus is necessary. Encouraging healthy eating habits by the entire family is important.

2. Pharmacological management of T2DM in Children and Adolescents

Indication for Pharmacological treatment:

Pharmacological therapy is indicated if treatment goal (HbA1c < 7%) with diet and exercise is not met.

Drug of choice:

Many drugs are available for treatment of type 2 diabetes but only metformin and insulin are drug of choice for use for under 18-year-old.

Oral anti diabetic drug:

Most of the doctors use oral agents for children with type 2 diabetes mellitus. Advantages of oral agents include potentially greater compliance and convenience for the patient. The oral anti diabetic drug of choice is Metformin.

Insulin treatment:

If monotherapy with metformin for a period of 3-6 months is not successful Insulin treatment should be started.

Metformin treatment in T2DM in children and adolescents:

Metformin, a biguanide, is the most appropriate drug for pharmacological treatment in children with type 2 diabetes mellitus.

Action of Metformin:

Metformin decreases hepatic glucose output and enhances primarily hepatic and also muscle insulin sensitivity without a direct effect on β-cell function.

Dose of metformin: up to 2 g in split doses

Advantages of metformin:

Metformin has the advantage of weight reduction, decrease in lipids without the risk of hypoglycaemia.

Side effect of metformin:

The most common side effects of metformin are gastrointestinal disturbances. The other side effect is lactic acidosis. Hence metformin is contraindicated in patients with impaired renal function

Insulin treatment:

If monotherapy with metformin for a period of 3-6 months is not successful insulin treatment should be started. There is no specific contraindication to insulin in children. Insulin regimes can

be adjusted according to the level of blood glucose (bedtime insulin alone, twice-a-day insulin or multidose insulin regimes).

3. Management of complications T2DM in children and adolescents

1. Dilated eye examinations should be performed to detect retinopathy.
2. Screening for microalbuminuria should be performed yearly to detect nephropathy. Angiotensin converting enzyme (ACE) inhibitors are the agents of choice in children with microalbuminuria.
3. Control of hypertension in diabetes mellitus is necessary. If normotension is not achieved by ACE inhibitors, combination therapy with a-blockers, calcium antagonists or low-dose diuretics may be needed.
4. Testing for and treating lipid abnormalities are necessary to avoid macro vascular diseases.

PREVENTION OF T2DM IN CHILDREN AND ADOLESCENTS [24]

Prevention of type 2 diabetes mellitus means prevention of obesity in childhood. Prevention should start very early in life, perhaps even before birth.

To prevent the development of type 2 diabetes mellitus and its life-shortening complications early detection of impaired glucose regulation may represent an appropriate strategy to prevent type 2 diabetes mellitus, as subjects with impaired glucose tolerance are at increased risk of developing this disease.

Adoption of a healthy lifestyle characterized by healthy eating, regular physical activity and subsequent modest weight loss can prevent the progression of impaired glucose tolerance to clinical diabetes mellitus.

Prevention of diabetes can be done at two levels.

1. Primary Prevention
2. Secondary Prevention

Prevention of Childhood obesity and T2DM:

Population and community approach for prevention of obesity in childhood and hence type 2 diabetes mellitus in childhood and

adolescence seems to be the most promising and reasonable treatment strategy available at present. Family based, behavioural treatment for obesity is also effective in preventing type 2 diabetes mellitus and is also extremely cost-effective. Good nutrition and modest exercise for pregnant women as well as monitoring of intrauterine growth of the foetus are mandatory. After birth, rapid weight gain should be avoided and the principles of good nutrition and physical activity be taught at all ages. Breast-feeding should be strongly recommended. Children's food choice can be influenced by early intervention and guidance. In fact, teacher training, modification of school meals and physical education are effective in reducing risk factors for obesity.

Primary prevention:

The main modes in primary prevention is lifestyle modification which includes

A) Measures to prevent obesity by encouraging Physical activity, exercise and healthy food habits.

B) Promotion of breast feeding.

Secondary prevention:

The main step in secondary prevention is to delay or prevent the development of complications of diabetes. Following measures can be taken

1. Early screening and diagnosis of DM
2. Good control of blood sugar.
3. Good Control of blood pressure.
4. Early screening for long term morbidities and mortalities.
5. Medical education for diabetes.
6. Emotional and social support.

REVIEW OF LITERATURE

The purpose of our study is to screen the Obese children with positive family history of diabetes and those children with signs of insulin resistance or conditions associated with insulin resistance (acanthosis nigricans, hypertension, dyslipidemia, polycystic ovarian syndrome) should be screened for T2DM using HbA1c test as screening tool. **ADA** [3] recommends using HbA1c test as one of the screening test. General screening for type 2 diabetes mellitus in youth is unlikely to be cost effective. Therefore a targeted screening seems to be necessary.

Mazza CS, Ozuna B, Krochik AG et al [25] did a study in Germany. They included 500 obese children and adolescents who showed a prevalence rate of 1.5% for T2DM and 2.1% for IGT. Excess body fat is the strongest risk factor for type 2 diabetes. Overweight and obesity, together with physical inactivity, are estimated to cause a large proportion of the global diabetes burden. From the above study it is clear that obesity is the main factor in developing T2DM in children and adolescents. Hence in ours study we did a targeted screening for T2DM in obese children

NEED OF SCREENIG FOR T2DM IN CHILDREN:

The following studies highlighted the importance of early screening for T2DM,

Hillier TA , **Pedula KL et al**[23] study clearly described type 2 diabetes mellitus developing at a younger age is associated with a much higher risk of long-term cardiovascular disease than those who develop type 2 diabetes mellitus in middle age group. Hence early targeted screening for T2DM is needed in high risk children.

Eppens MC, Craig ME et al [26] study mentioned the important fact that Screening of young people with type 2 diabetes mellitus is necessary since they are at a much higher risk of developing early diabetes mellitus associated complications than those with type 1 diabetes mellitus. They also noted this higher level of risk is related to occurrence of hypertension and dyslipidemia associated with childhood obesity. Hence early screening of obese children for T2DM is needed and also measures to take modification of life style to prevent childhood obesity must be emphasized.

Copeland KC, Zeitler P et al [27]study described cardiovascular risk factors are more frequent in adolescents suffering from type 2 diabetes mellitus compared to type 1 diabetes mellitus. Hence to reduce the T2DM related complication we need early screening for at risk children and adolescents.

The DECODE study group [28] described the Development of type 2 diabetes mellitus and its life-shortening sequelae can be prevented by early detection of impaired glucose regulation. Children with impaired glucose tolerance are at increased risk of developing diabetes in future. Hence early screening represents an appropriate strategy to prevent type 2 diabetes mellitus.

Helena W. Rodbard et al study[29] discussed the dramatic rise in the incidence and prevalence of type 2 diabetes mellitus in the paediatric and adolescent populations and its association with the ongoing epidemic of overweight, obesity, insulin resistance, and metabolic syndrome seen in these age groups. 50% of patients with diabetes in the paediatric age < 18 years have type 2diabetes. Hence screening of high-risk children for diabetes and prediabetes is important for early intervention in terms of lifestyle changes, hopefully leading to avoidance or delay of the development of diabetes.

HbA1c TEST AS SCREENING TEST FOR DIAGNOSIS OF DIABETES

The following studies support the use of HbA1c test as screening test for diagnosis of diabetes.

In a study conducted by ***Tapp RJ, Tikellis G, et al*** [30] found a stronger correlation between HbA1c and retinopathy than between fasting glucose levels and retinopathy.

Stratton IM, Adler AI, Neil HA et al[31] conducted a controlled clinical trial study in type 2 diabetes and found the strong correlation between HbA1c levels and macro vascular and micro vascular complications of type 2 diabetes.

Weykamp C, John WG, Mosca A et al [32] did a 6year study on The IFCC reference measurement system for HbA1c and reported that preanalytic errors owing to sample handling is more in FPG measurement than HbA1c assay. HbA1c values are relatively stable after collection, and the recent introduction of a new reference method to calibrate all HBA1c assay instruments has further improved A1c assay standardization.

Miller WG, Myers GL, Ashwood ER et al study [33] analysed the performance of a variety of clinical laboratory instruments and methods that measure glucose and they found 41% of instruments have a significant bias from the reference method leading to misclassification of 12% of patients. Hence the measurement of glucose alone is less accurate and precise. Storage of blood samples at room temperature for as little as 1 to 4 h before analysis decreases the glucose levels by 3–10 mg/dl. Hence Hba1c can be used along with FPG to detect diabetes.

Ollerton RL, Playle R, et al study [34] showed the variability of HbA1c values is considerably less than that of FPG levels, with day-to-day and within-person variance of 2% for A1C but 12–15% for FPG

International expert committee [35] was convened in 2008 to consider the current and future means of diagnosing diabetes and the Committee made its report on the role of the HbA1c assay in the diagnosis of diabetes.

In 1997 expert committee report was against the use of HbA1c values for diagnosis of diabetes because of the lack of assay standardization.

After the National Glycohemoglobin Standardization Program had succeeded in standardizing HbA1c assays, the current Expert Committee examined the laboratory measurements of glucose and A1C assay and they reported that with advances in instrumentation and standardization, the accuracy and precision of A1C assays match those of glucose assays. Committee has concluded HbA1c as a laboratory measure of chronic glycemia and a more stable biological marker than FPG which is known to fluctuate within and between days.

All of these studies [30, 31, 32, 33, 34, 35] suggest that HbA1c as a reliable measure of chronic glycemic levels and also related more intimately to the risk of complications. HbA1c may serve as a better biochemical marker of diabetes and should be considered a diagnostic tool. The convenience for the patient and ease of sample collection for A1c testing (which can be obtained at any time, requires no patient preparation, and is relatively stable at room temperature) compared with that of FPG testing (which requires a timed sample after at least an 8-h fast and which is unstable at room temperature) support using the A1c assay to diagnose diabetes.

The following studies are reviewed for our study references :

Thomas reinter, et al [4] did *"A Study of Type 2 Diabetes Mellitus in Children and Adolescents"*. They did screening in high risk children and adolescents with family history of with T2DM, obese children and those with clinical features of insulin resistance such as hypertension, dyslipidemia, polycystic ovarian syndrome or acanthosis nigricans. For diagnosis of DM they used the following criteria,

a) Symptoms like polydipsia, polyuria and unexplained weight loss
b) Casual glucose concentration ≥200mg/dl in venous plasma, fating glucose ≥126mg/dl in venous plasma or two hour glucose during OGTT≥200mg/dl in venous plasma and HbA1c ≥ 6.5%.

In this study they demonstrated type 2 diabetes mellitus in 1% of screened obese children in Germany and 4% of screened obese adolescents with high risk ethnic groups in the United States. They used HbA1c as one of the screening tool in diagnosis of DM since HbA1c test has been included in the ADA [3] recommendation for the diagnosis of diabetes. They also suggested HbA1c can be

used as screening tool for the diagnosis of T2DM in children and adolescents after the standardisation of HbA1c test.

***Jinan B.saddiine*, et al** [(36)] did "*A Study of Distribution of HbA1c Levels for Children and Young Adults*" in the U.S. Concentration of HbA1c is an indicator of average blood glucose concentration over the preceding 2-3 months. A total of 7,974 children, adolescents and young adults aged 5-24 years who were not treated for diabetes had their HbA1c levels measured. The mean age was 15 years, 49% were men and 11% were overweight. The overall sex-related differences in HbA1c means levels were significant but very small. In this study, statistically higher mean HbA1C level were noted in the 10-14 year old age group, overweight participants, those with lower levels of education i.e. those with low Socioeconomic status ,those with a positive parental history of diabetes and those with serum glucose≥126mg/dl. They described these differences in HbA1c may reflect higher average glycemia over the preceding 2–3 months or it may reflect some level of relative insulin resistance. Indeed, an elevated HbA1c level has been associated with excess mortality risk in the general population. They also described the higher HbA1c level in the age group of 10-14 years may be due transient increase in insulin resistance at the onset of puberty and the return to near pre pubertal insulin sensitivity level by the end of puberty.

K .A. MATYKA, et al [37] did an *"A STUDY OF TYPE 2 DIABTES IN CHILDHOOD: EPIDEMIOLOGICAL AND CLINICAL ASPECTS"*, and they discussed about the obesity epidemic and risk of type 2 diabetes in childhood. In this study they discussed the risk factors for T2DM. Regarding ethnicity the Indo-Asians are at high risk for developing diabetes. In this study majority of children with T2DM had family history of diabetes. According to their study the recent increase in the prevalence of childhood T2DM was linked to the increase in childhood obesity.

C. M. Bennett, M. Guo and S. C. Dharmage et al [19] did a study to assess the validity of glycated haemoglobin A1C in early detection of Type 2 diabetes. They had done a Systematic review of primary cross-sectional studies (about 63 studies) for the accuracy of HbA1c for the detection of Type 2 diabetes using the oral glucose tolerance test as the reference standard and fasting plasma glucose as a comparison. They have demonstrated that HbA1c has slightly lower sensitivity than fasting plasma glucose (FPG) in detecting diabetes, but has slightly higher specificity HbA1c and better predict both micro- and macro vascular complications. They concluded HbA1c and FPG as equally effective screening tools for the detection of Type 2 diabetes.

Pavithra Vijayakumar, Robert G. Nelson et al [20] did a study about HbA1c and the Prediction of Type 2 Diabetes in Children and Adults. They included 2,095 American Indian children, adolescents, and adults children without diabetes aged 10–19 years and followed them every 2years.Children and adults underwent comprehensive clinical examinations, which included detailed medical histories, anthropometric measurements, and biochemical tests. They measured FPG, 2hPG and HbA1c in all these subjects. HbA1c was measured by high performance liquid chromatography. Participants were classified into prediabetes (5.7–6.4%), intermediate (5.4–5.6%), or lower (<5.3%) baseline HbA1c categories. During long-term follow-up of children and adolescents who did not initially have diabetes, the incidence rate of subsequent diabetes was fourfold (in boys) as high and more than sevenfold (in girls) as high in those with HbA1c 5.7% as in those with HbA1c 5.3% category. Their analysis revealed no significant differences between HbA1c, FPG, and 2hPG in sensitivity and specificity for identifying children and adolescents who later developed diabetes. Hence they suggested HbA1c as a useful predictor of diabetes risk in children and can be used to identify prediabetes in children with

other type 2 diabetes risk factors with the same predictive value as FPG and 2hPG.

Stefan Ehehalt, Antje Körner et al [38] did a study "Diabetes screening in overweight and obese children and adolescents: choosing the right test". Type 2diabetes can occur without any symptoms. They performed an observational analysis of 4848 (2668 female) overweight and obese children aged 7 to 17 years without previously known diabetes. They used HbA1c (≥6.5%) and OGTT 2-h glucose levels ≥200 mg/dl as diagnostic criteria for diagnosis of diabetes. About 2.4% (*n* = 115, 55 female) were classified as having diabetes. Out of the 115 cases fulfilling the OGTT and/or HbA1c criteria for diabetes, diabetes was confirmed in 43.5%. Within this group, 68.7% had HbA1c levels ≥48 mmol/mol (≥6.5%) and 46.1%. had FPG ≥126 mg/dl (≥7.0 mmol/l) and/or 2-h glucose levels ≥200 mg/dl (≥11.1 mmol/l). In their study analysis they found, an optimal threshold to diagnose diabetes for FPG as 98 mg/dl (5.4 mmol/l) (sensitivity 70%, specificity 88%) and for HbA1c, the best cut-off value was 42 mmol/mol (6.0%) (Sensitivity 94%, Specificity 93%). Hence they concluded HbA1c as more reliable test than OGTT for diabetes screening in overweight and obese children and adolescents. They also suggested optimal HbA1c threshold for identifying patients with diabetes as 6.0%.

STUDY JUSTIFICATION

1. India has the largest number diabetes mellitus patient in the world. Many clinical oriented diabetic studies shows that the prevalence and incidence of type 2 DM in children and adolescent is increasing among indoasians Indian children belongs to a high risk ethnic group, so all overweight/obese children >10 years with any risk factors for T2DM should be screened for Type 2DM.
2. At risk children for T2DM but asymptomatic for long period may remain undiagnosed. Screening is needed in such situation.
3. Type 2 diabetes related morbidity and mortality can be decreased by early screening and intense treatment in the early stage. Hence screening for T2DM is needed to avoid complications like retinopathy, nephropathy.
4. T2DM can be prevented, if children are treated in the pre-diabetes stage itself.

Hence screening and early identification of children in the age group of 10-18 years with risk factors for Type 2DM is essential for preventing long term organ dysfunction.

AIM OF THE STUDY

The main aim of our study is to screen the children of Type 2 Diabetic mellitus Parents for early detection of diabetes by HBA1C test to prevent long term consequences of diabetes mellitus.

SUBJECTS AND METHODS

METHODOLOGY

STUDY DESIGN:

Cross sectional study

STUDY POPULATION:

Adolescent children aged 10-18 Years of Parents having Type2 Diabetes Mellitus

PLACE OF STUDY:

Govt. Royapettah Hospital, Chennai.

SOURCE OF DATA:

Diabetic OP and Paediatric OP at Govt. Royapettah Hospital Chennai.

STUDY PERIOD:

March 2017 to August 2017- 6 months

INCLUSION CRITERIA:

All adolescent children aged between 10-18 years with one or both parents having Type 2 Diabetes Mellitus.

EXCLUSION CRITERIA:

1. All children and adolescents with known Type 1 Diabetes Mellitus (Insulin Dependent Diabetes Mellitus).

2. All children and adolescents suffering from Chronic Pancreatic Disorders.

3. All children and adolescents suffering from other Endocrine Disorders

ETHICS:

Ethical committee clearance was obtained from our Institutional Review Board.

SAMPLE SIZE: 140

SAMPLE SIZE DETERMINATION: Sample size Determination is based on the following study

Study: Long term consequences for offspring of Paternal Diabetes and Metabolic Syndrome

Authored by: Benigno Linares Segovia et al.

Published in: Experimental Diabetes Research Volume 2012 Journal.

Calculation: In the above study following calculations were followed.

The confidence level is estimated at 95% with a z value of 1.96.

The confidence interval or margin of error is estimated at +/-8

Assuming p% = 37.00 and q% = 63.00

n = p% x q% x [z/e%] ^2

n = 37.00 x 67.00 x [1.96/8] ^2

n = 139.92 (rounded to 140)

Therefore 140 is the minimum sample size required for the study assuming 80% as the power of study.

METHOD OF COLLECTION OF THE CLINICAL DATA

Type 2 Diabetes mellitus patients who came to Diabetic OP at Govt Royapettah Hospital have been advised to bring their adolescent children aged between 10-18 years for the diabetic screening.

All children aged between 10-18 years who were brought by the parents were enrolled in my study. Detailed history regarding the onset, duration and mode of treatment of type 2 diabetes mellitus in the parents were noted.

Complete examination including anthropometry & signs of insulin resistance like acanthosis nigricans, PCOS in female child [by USG], and Blood pressure measurement has been recorded for all those children.

Blood has been collected under aseptic sterile technique in fasting state and sent to the laboratory for measurement of HbA1c level.

Children with HbA1c level more than >5.7 % were further evaluated by FPG and OGTT for further management.

CLINICAL QUESTIONNAIRE

PARENT'S DETAILS:

The questions were asked about parent's education level and employment status, consanguinity between the parents as well as information regarding the child's health condition.

CHILDREN DETAILS:

Information was collected regarding the children's clinical history.

Family history: Documented evidence of diabetes mellitus in parents, sibling, paternal and maternal grandparents, maternal and paternal aunty (or) uncle.

Physical activity: Physical activity score were recorded based on different levels of physical leisure activity. Physical activity score was based on the validated questionnaire for physical exercise taken from the National Diabetes Register (NDR), Sweden's national quality registers operated by the Swedish Society for Diabetology.

PHYSICAL ACTIVITY SCORE:

No activity, activity (1 time/ week)

Regular activity (1–2 times/week),

Regular activity (3–5times/week)

Regular daily activity

SYMPTOMS OF HYPERGLYCAEMIA:

The following symptoms of hyperglycaemia were enquired in all children included in the study,

- Excessive Thirst And Drinking
- Frequent Urination
- Recent Weight Loss
- Fatigue
- Recurrent Thrush Or Skin Infections

TOOLS USED IN THE STUDY:

1. Digital Weighing Scale for Weight

2. Stadiometer for Height

3. Sterile Tube for collection of Blood for HBA1C

MEASUREMENTS DONE IN THE STUDY:

1. Anthropometric Measurements

   Measurement of Weight

   Measurement of Height

   Calculation of BMI

2. Acanthosis nigricans

3. Blood pressure measurement

4. USG study for Female children

5. Blood collection for HBA1C Measurement

1. ANTHROPOMETRIC MEASUREMENTS

These measurements were carried out in all my study subjects for calculating BMI to detect overweight and obesity in children which is one of the risk factor for T2DM.

WEIGHT MEASUREMENT PROCEDURE:

Weight was taken using a Digital Weighing Scale to the nearest 0.1kg, which was calibrated every day with a standard weight. The weight was taken after removing the footwear but no

adjustments were made for the weight of the dress worn during the examination.

HEIGHT MEASUREMENT PROCEDURE:

Height was recorded to the nearest 0.1cm using an in-built stadiometer. The height was taken after removing the footwear. The height was measured with child standing in erect posture with heels, buttocks and back in close contact with the stadiometer. The head was positioned with child looking forward so that the Frankfurt plane (the line joining floor of external auditory meatus to the lower margin of orbit) and the biauricular plane were horizontal.

CALCULATION OF BMI:

Quetlet Index was used to calculate BMI. The children were classified into overweight (or) obesity using WHO Z-scores reference.

BMI = WEIGHT IN kg / HEIGHT IN m^2

1. Overweight (BMI 25 to 30)

BMI > +1SD to < +2SD for age and sex.

2. Obesity (BMI >30)

BMI > +2SD to +3SD for age and sex.

2. ACANTHOSIS NIGRICANS

It is characterized by dark, thick, velvety, pigmented skin in the neck and axilla. The most commonly used site to find acanthosis nigricans in our study was neck area since it is found that this site was commonly involved in acanthosis nigricans in 93 to 99% of the cases as evident from the previous studies. It is also easy to expose the neck area in practical settings and it is more comfortable for the subjects to expose the neck area than other areas.

3. BLOOD PRESSURE MEASUREMENT (BP)

BP was measured using Mercurial type Sphygmomanometer with appropriate cuff size. Prior to taking BP readings all children were instructed to rest for at least 10 minutes in an air-conditioned environment. Measurements were taken two times on the right arm with short intervals between readings, and the average of BP readings was calculated and used for analysis.

4. USG STUDY FOR FEMALE CHILDREN

Ultra sonogram of abdomen and pelvis was done for all female children and we used ROTTERDAM CRITERIA for detecting PCOS in female children. When 2/3 of the following criteria are met, female children were categorised as having PCOS.

1. Oligo or anovulation
2. Polycystic ovaries on ultrasonography (12 or more follicles in a single ovary or ovarian volume of >10ml in 1 ovary)
3. Clinical and/or biochemical hyperandrogenism.

5. HbA1c MEASUREMENT

Fasting venous blood sample(after a eight hours fasting) was drawn for all children included in the study and taken to laboratory immediately under full aseptic and cold chain precautions for HbA1c measurement.HbA1C test was done using the standardised High performance liquid chromatography method.

HbA1c measurement was used as the screening test for the diagnosis of pre-diabetes and diabetes in my study as it was convenient, easier and faster to perform. The oral glucose tolerance test although considered the ‘gold standard,’ was time consuming

than the HbA1c test and also HbA1c has higher specificity compared to fasting blood sugar.

Cut off criteria used in my study is as follows

HbA1c < 5.7 classified as normal.

HbA1c > 5.7 to 5.9 classified as prediabetes.

HbA1c > 6.1 classified as diabetic

OBSERVATION AND ANALYSIS

140 children and adolescents were enrolled in the study on the basis of inclusion and exclusion criteria. The data entry was done in Microsoft Excel sheet.

STATISTICAL METHODS: Diabetic status and HbA1c are primary outcome variable. Age, Gender, Family history of Diabetic, Anthropometric parameters and if presence Acanthosis Nigricans was considered as explanatory variable.

DESCRIPTIVE ANALYSIS: Descriptive analysis was carried out by mean and standard deviation for quantitative variables, frequency and proportion for categorical variables. Data was also represented using appropriate diagrams like bar diagram, pie diagram and box plots.

INFERENTIAL STATISTICS:

The association between explanatory variables and categorical outcomes was assessed by cross tabulation and comparison of percentages. Chi square test was used to test statistical significance.

P value < 0.05 was considered statistically significant. IBM SPSS version 22 was used for statistical analysis.

Table 1: Descriptive analysis for Age in study population (N=140)

Parameter	Mean± STD	Median	Min	Max	95% C.I. for EXP(B)	
					Lower	Upper
Age	14.5± 2.87	15.00	10.00	9.00	14.03	14.99

The mean of age was 14.51 years with a standard deviation of 2.87. The youngest person was 10years old and the oldest person was 19-years-old. (Table1)

Table 2: Descriptive analysis of Age group in study population (N=140)

Age group	Frequency	Percentages
10-12 years	45	32.14%
13-15years	31	22.14%
16-19years	64	45.71%

Among the study population, the age group 10-12 years was 32.14%, 13-15 and 16 -19 years was 22.14% and 45.71% respectively. (Table 2 & figure 1, 2)

Figure 1: Pie chart of Age group distribution in study population (N=140)

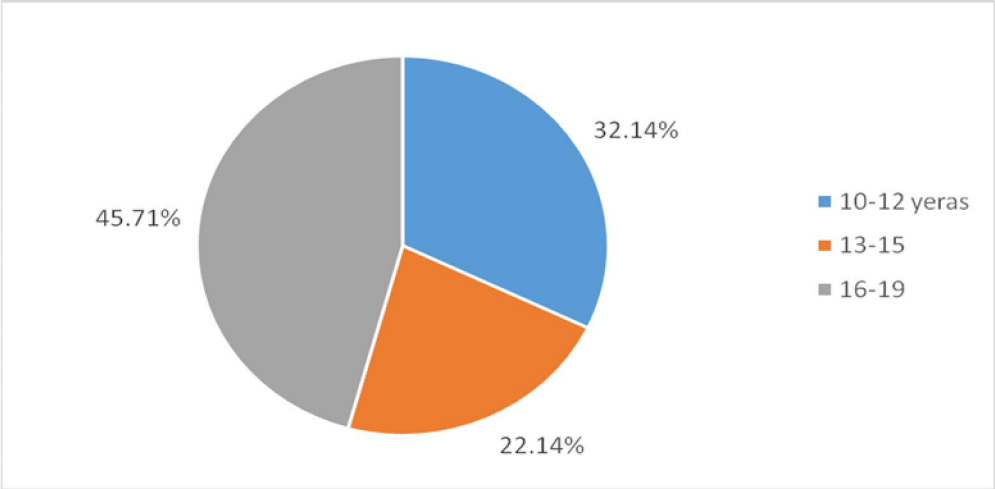


Figure 2: Bar chart of Age groups in study population (N=140)

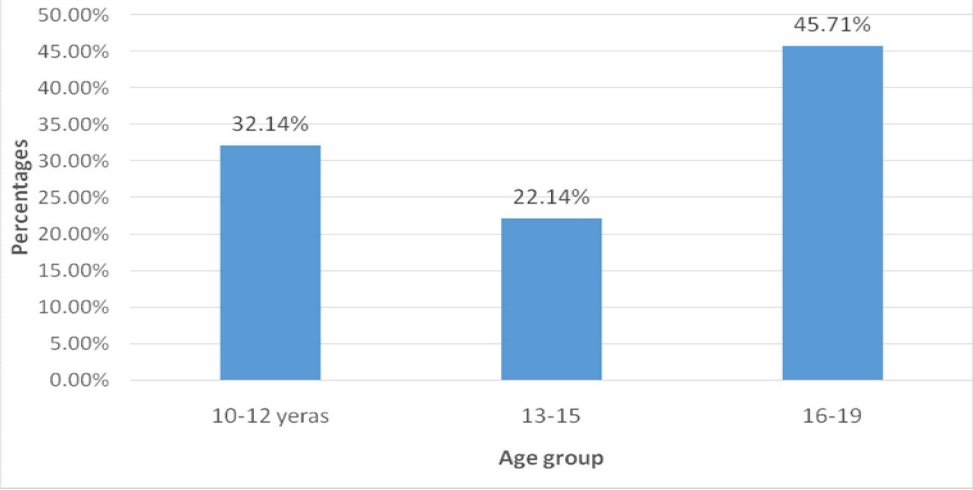


Table 3: Descriptive analysis of Gender in study population (N=140)

Gender	Frequency	Percentage
Male	86	61.43%
Female	54	38.57%

Among the study population, the proportion of boys were 61.43% and 38.57% were girls. (Table 3 & figure 3)

Figure 3: Bar chart of Gender distribution in study population (N=140)

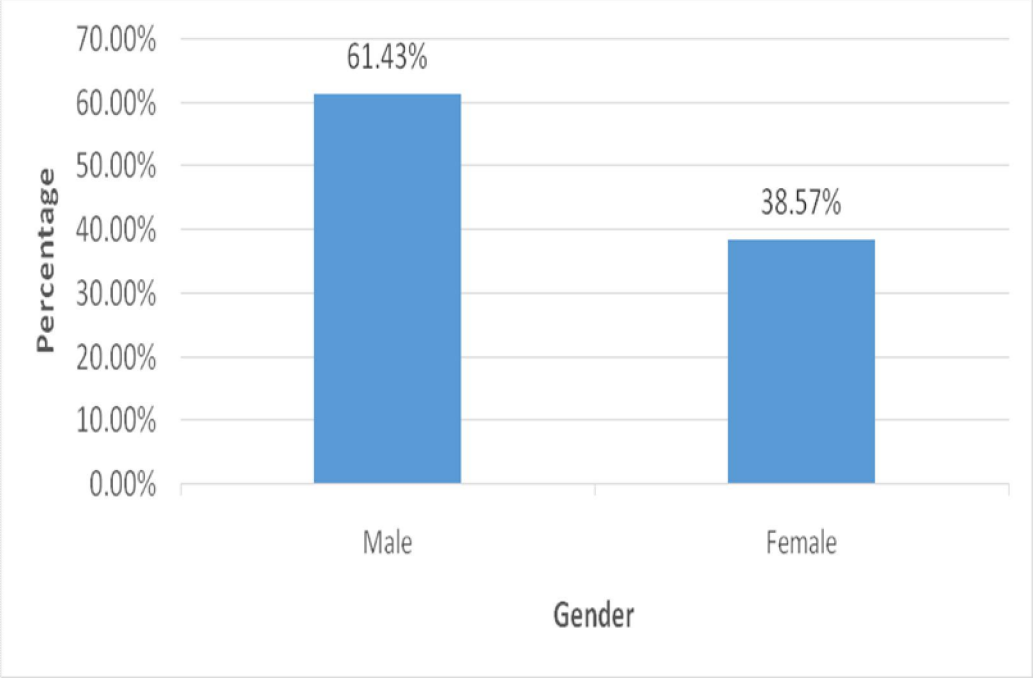


Table 4: Descriptive analysis of Diabetic H/o Mother in study population (N=140)

Diabetic H/o Mother	Frequency	Percentage
Yes	71	50.71%
No	69	49.29%

Among the study population, the Family history of diabetes in Mother was present in 50.71% of subjects. (Table 4 & figure 4)

Figure 4: Bar chart of Diabetic H/o Mother in study population (N=140)

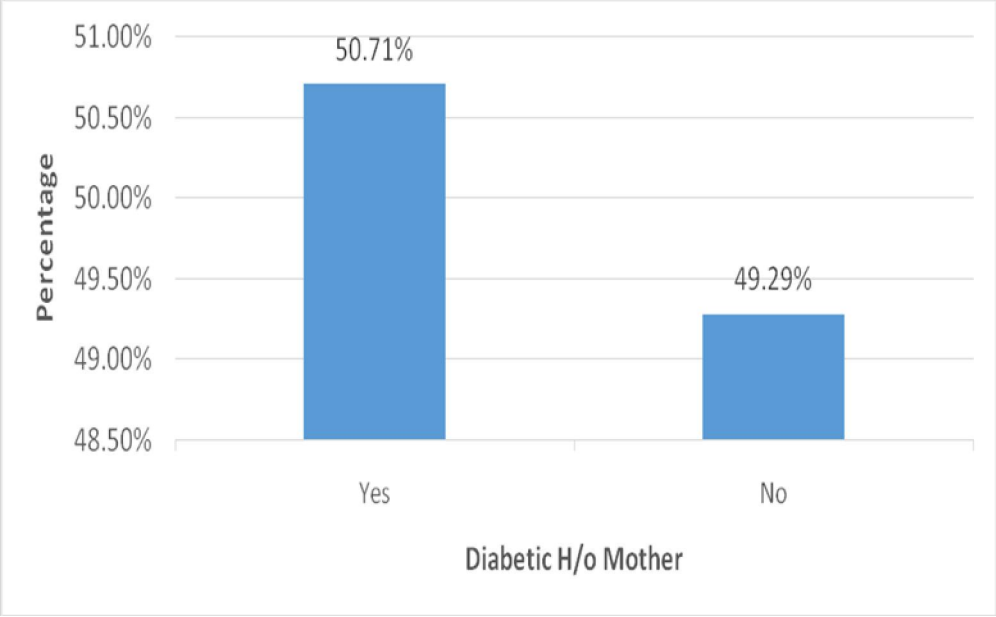


Table 5: Descriptive analysis of Diabetic H/o Father in study population (N=140)

Diabetic H/o Father	Frequency	Percentage
Yes	83	59.29%
No	57	40.71%

Among the study population, the Family history of diabetes in Father was present in 59.29% of people. (Table 5 & figure 5)

Figure 5: Bar chart of Diabetic H/o Father in study population (N=140)

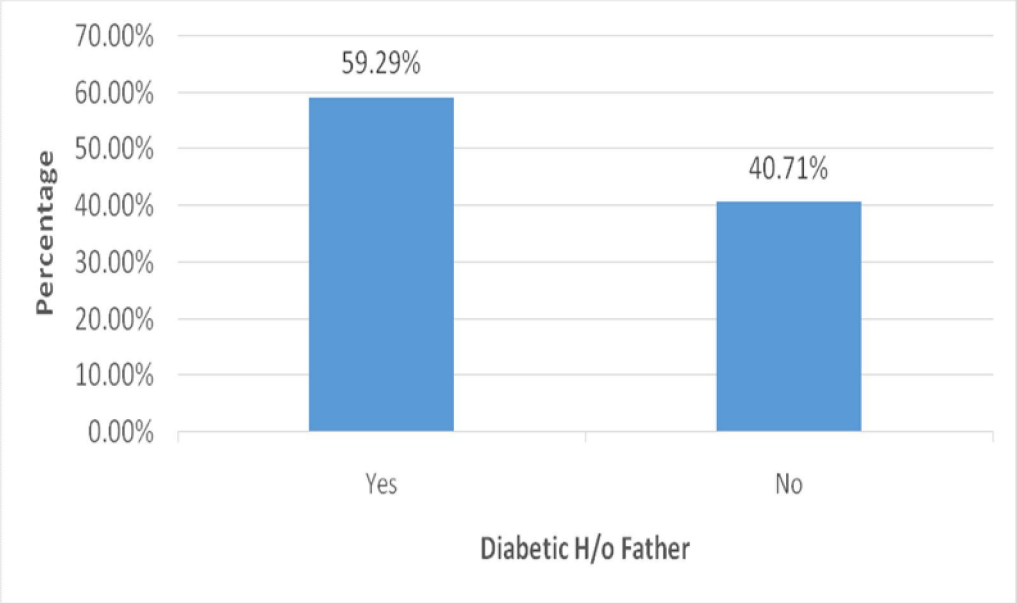


Table 6: Descriptive analysis for Height in study population (N= 140)

Parameter	Mean± STD	Median	Min	Max	95% C.I .for EXP(B)	
					Lower	Upper
Height	153.53± 9.94	156.00	123.00	172.00	151.87	155.19

The Mean height of study population was 153.53± 9.94 with minimum 123 cm and Maximum 172 cm (95 C.I 151.87 to 155.19).(Table 6).

Table 7: Descriptive analysis for Weight in study population (N= 140)

Parameter	Mean± STD	Median	Min	Max	95% C.I. for EXP(B)	
					Lower	Upper
Weight	47.91± 9.75	49.00	22.00	70.00	46.28	49.54

The Mean weight of study population was 47.91± 9.75 with minimum 22 kg and Maximum 70 kg (95 C.I 46.28 to 49.54). (Table 7)

Table 8: Descriptive analysis for BMI in study population (N=140)

Parameter	Mean± STD	Median	Min	Max	95% C.I. for EXP(B)	
					Lower	Upper
BMI	20.32± 3.26	19.67	14.60	28.80	19.77	20.86

The Mean BMI of study population was 20.32± 3.26 with minimum 14.60 and Maximum 28.80 (95 C.I 19.77 to 20.86). (Table 8)

Table 9: Descriptive analysis of BMI category in study population (N=140)

BMI category	Frequency	Percentages
Under weight	40	28.57%
Normal	82	58.57%
Over weight	18	12.86%

Among the study population, the BMI category of Underweight was 40(28.57%), normal and overweight was 82(58.57%) and 18(12.86%) respectively. (table9 & figure 6, 7)

Figure 6: Bar chart of BMI category distribution in study population (N=140)

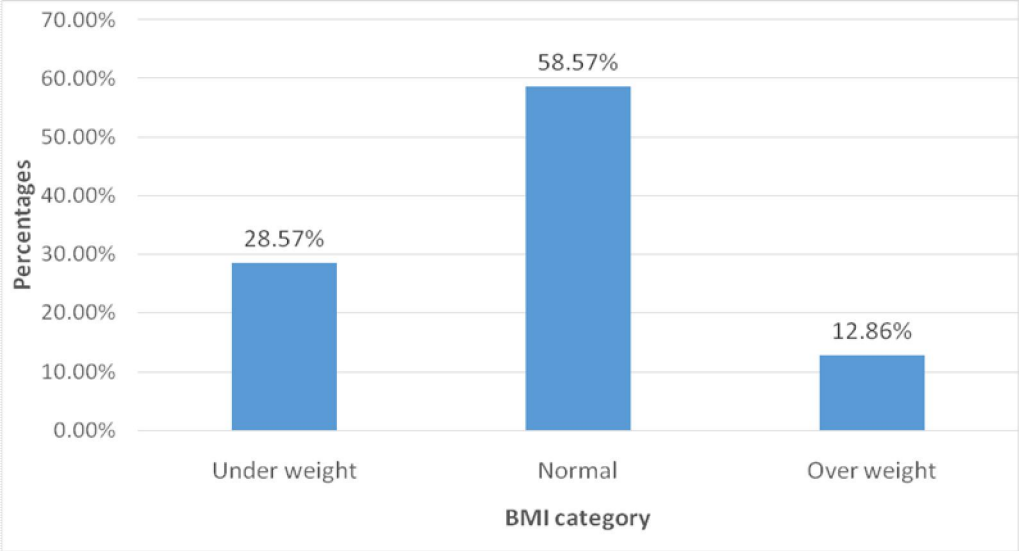


Figure 7: Pie chart of BMI category distribution in study population (N=140)

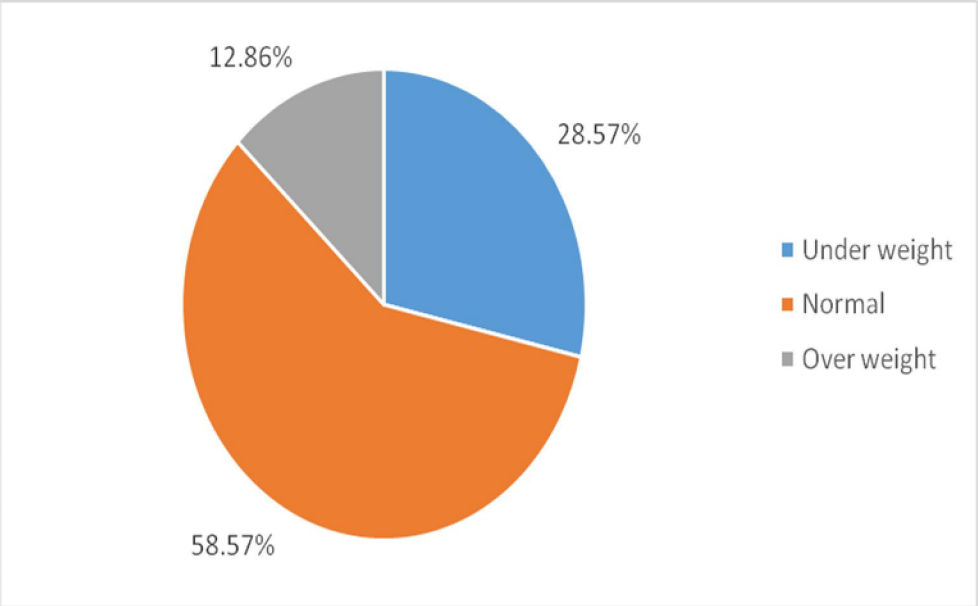


Table 10: Descriptive analysis for BP Systolic in study population (N=140)

Parameter	Mean± STD	Median	Min	Max	95% C.I. for EXP(B)	
					Lower	Upper
Systolic BP	101.64 ± 7.38	100.00	90.00	120.00	100.41	102.88

The Mean Systolic BP of study population was 101.64± 7.38 with minimum 90 and Maximum 120 (95 C.I 100.41 to 101.88). (Table 10)

Table 11: Descriptive analysis for BP Diastolic in study population (N= 140)

Parameter	Mean± STD	Median	Min	Max	95% C.I. for EXP(B)	
					Lower	Upper
Diastolic BP	70.21 ± 2.54	70.00	60.00	80.00	69.79	70.64

The Mean Diastolic BP of study population was 70.21± 2.54 with minimum 60 and Maximum80 (95 C.I 69.79 to 70.64). (Table 11)

Table 12: Descriptive analysis of Acanthosis Nigricans in study population (N=140)

Acanthosis Nigricans	Frequency	Percentage
Yes	27	19.29%
No	113	80.71%

Among the study population 19.29% people had Acanthosis Nigricans. (Table 12 & figure 8)

Figure 8: Bar chart of Acanthosis Nigerians distribution in study population (N=140)

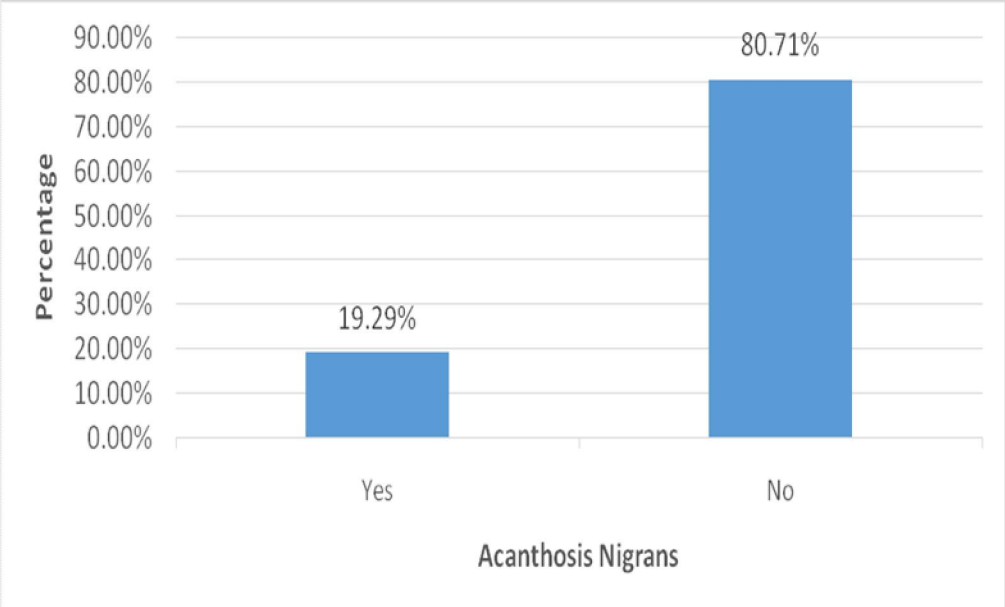


Table 13: Descriptive analysis of USG (female) in study population (N=54)

USG (female)	Frequency	Percentages
Normal study	52	96.30%
Prominent ovaries/PCOD	2	3.70%

Among the study population, Ultra sound study (female) was normal in 52(96.30%) of the female subjects. PCOD was present in 2 (3.70%) of female subjects (table 13 & figure 9)

Figure 9: Pie chart of USG (female) distribution in study population (N=54)

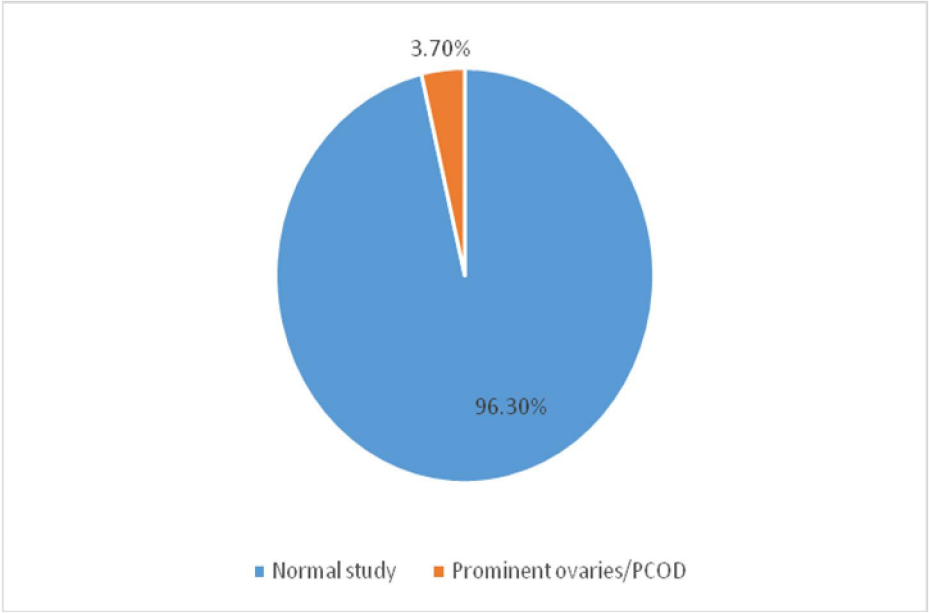


Table 14: Descriptive analysis for HbA1c in study population (N=140)

Parameter	Mean± STD	Median	Min	Max	95% C.I. for EXP(B)	
					Lower	Upper
HbA1c	4.9 ± 0.31	4.90	4.10	5.80	4.85	4.96

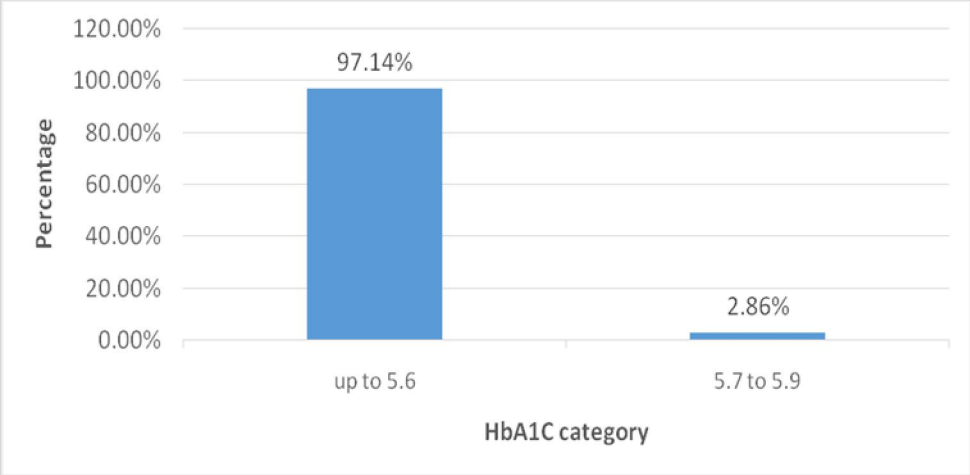
The Mean HbA1c of study population was 4.9± 0.31 with minimum 4.10 and Maximum 5.80 (95 C.I 4.85 to 4.96). (table14)

Table 15: Descriptive analysis of HbA1c category in study population (N=140)

HbA1c category	Frequency	Percentage
up to 5.6 (Normal)	136	97.14%
5.7to 5.9 (Prediabetes)	4	2.86%

Among the study population, the HbA1c category of up to 5.6 and was present in 97.14% and the HbA1c category of 5.7 to 5.9 was 2.86% respectively. (Table 15& figure 10)

Figure 10: Bar chart of HbA1c category in study population (N=140)



Part-II: Factors associated with High HbA1c (Prediabetes and diabetes) level

Table 16: Association of HbA1c category with Age group of study population (N=140)

Age group	HbA1c category		Chi square	P value
	upto5.6(N=136) (Normal)	5.7to 5.9(N=4) (Prediabetes)		
10-12 years	43 (31.62%)	2 (50%)	.810a	0.667
13-15years	30 (22.06%)	1 (25%)		
16-19years	63 (46.32%)	1 (25%)		

Among the HbA1c up to 5.6 normal category (normal HBA1C level) 43 (31.62%) were aged between 10-12 years, 30 (22.06%) were aged between 13-15 years and 63 (46.32%) were aged between 16-19 years was respectively. Among subjects with HbA1c 5.7 to 5.9 category (Pre diabetic), the number of subjects in Age group 10-12, 13-15 and 16-19 years were 2 (50%), 1 (25%) and 1 (25%) respectively. The differences in HBA1C level and specific age group were statistically not significant (P value 0.667). (table16 & figure 11)

Figure 11: Bar chart of comparing Age group of the two study groups (N=140)

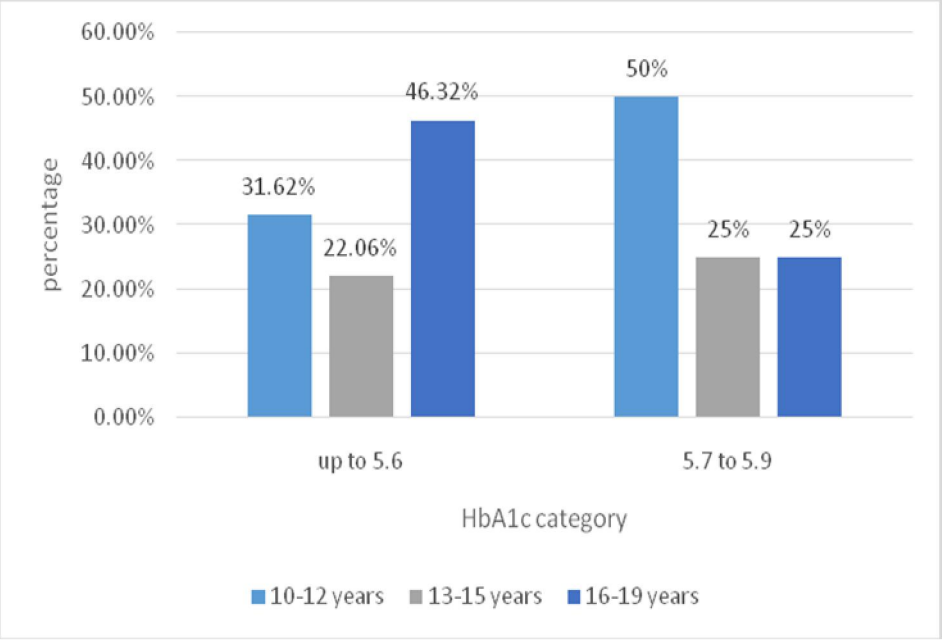


Table 17: Association of HbA1c category with Gender of study population (N=140)

Gender	HbA1c category		Chi square	P-value
	Up to 5.6 (N=136) (Normal)	5.7to5.9 (N=4) (Prediabetes)		
Male	85 (98.84%)	1 (1.16%)	2.306a	0.129
Female	51 (94.44%)	3 (5.56%)		

Among the HbA1c up to 5.6 category 85(98.84%) were Male and51 (94.44%) were Female. The number of Male and Female was 1 (1.16%) and3 (5.56%) in HbA1c 5.7 to 5.9 category. The differences in gender proportion between the two groups was statistically not significant (P value 0.129) (table 17 & figure 12)

Figure 12: Bar chart of comparing gender composition of the two study groups (N=140)

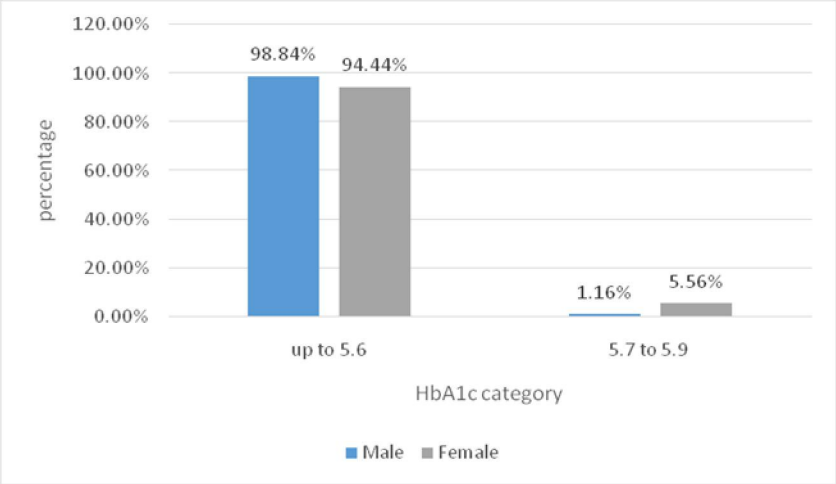


Table 18: Association of HbA1c category with BMI category of study population (N=140)

BMI category	HbA1c category	
	up to 5.6(N=136) (Normal)	5.7to 5.9(N=4) (Prediabetes)
Under weight	40 (29.41%)	0 (0%)
Normal	79 (58.09%)	3 (75%)
Over weight	17 (12.5%)	1 (25%)

No statistical test was applied considering “0” subjects in one of the BMI category.

Among the HbA1c up to 5.6 normal category 40 (29.41%) were under weight, 79 (58.09%) were Normal Weight and 17 (12.5%) were Overweight children. The number of Normal and Overweight children in HbA1c 5.7 to 5.9 prediabetes category were 3 (75%) and 1 (25%). (Table 18& figure 13)

Figure 13: Bar chart of comparing BMI category of the two study groups (N=140)

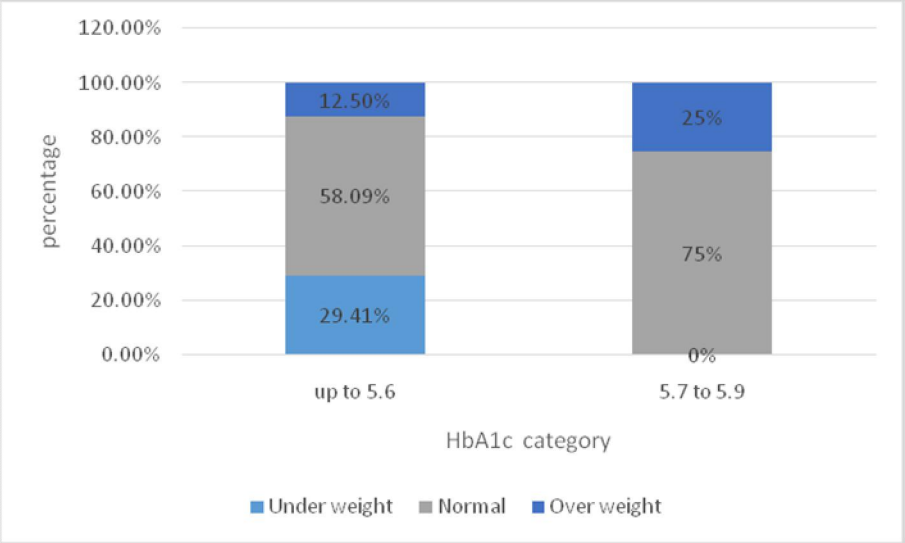
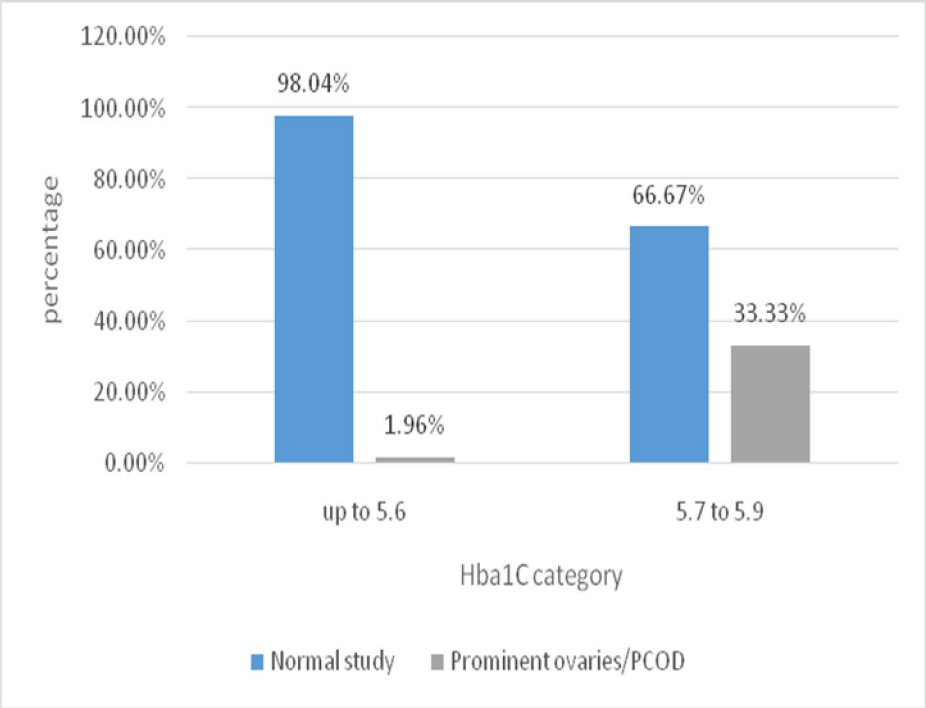


Table 19: Association of HbA1c category with USG (female) of study population (N=54)

USG (female)	HbA1c category		Chi square	P-value
	up to 5.6	5.7 to 5.9		
Normal study	50 (98.04%)	2 (66.67%)	7.819a	0.005
Prominent ovaries/PCOD	1 (1.96%)	1 (33.33%)		

Among the HbA1c up to 5.6 category 50 females (98.04%) were Normal and 1female child (1.96%) had PCOD. Among the HbA1c 5.7 to 5.9 category 2 females (66.67%) had Normal USG and 1 female (33.33%) had PCOD. The differences in USG between the two groups were statistically significant (P value 0.005).

Bar chart of comparing USG (female) of the two study groups (N=54)



DISCUSSION

Children of T2DM parents were chosen for conducting the study because it is proven in many clinical trial studies that type 2 diabetes run in families. Hence we instructed the diabetic patients (father/mother) who all came to the Diabetic op to bring their adolescent children aged 10-19 years for diabetic screening using various clinical and biochemical parameters.

140 children were brought by the parents and were included in our study. We divided the children into three groups to know any age specific variation in HbA1c level. Age groups were 10-12 years, 13-15years and 16-19years. Among the study population, children in the age group of 10-12 years were 45 in number (32.14%), children in the age group of 13-15years were 31 in number (22.14%) and 16 -19 years age group were 64 in number (45.71%). Majority of the subjects in our study belonged to 16-19 years (45.71%) i.e. adolescent age.

Among the study population, boys were 86 in number (61.43%) and girls were 54 in number (38.57%). Majority of the children in our study were male children (61.43%).

All the children have family history of diabetes either in father or mother or both. Among the study population, the family history of diabetes in Mother was present in 59 children, family history of diabetes in father was present in 71children and family history of diabetes in both mother and father was present in 12 children.

Height and weight of all the children included in the study were measured and Body mass index was calculated. Based on the BMI children were divided into underweight, overweight or obese. Among the study population, 40 children (28.57%) belonged to the BMI category of Underweight and 82 children (58.57%) belonged to the BMI category of Normal weight and 18 children belonged to the BMI category of overweight (12.86%).

Systolic and Diastolic BP was measured in all children. All the 140 children have normal BP.

All the children included in the study were examined for Acanthosis Nigricans. Among the study population 27 children (19.29%) were noted to have Acanthosis Nigricans.

All the 54 female children underwent detailed ultrasound abdomen and pelvis study for the presence of PCOS. Among the 54 female children, Ultra sound study was normal in 52 girls (96.30%) and 2 girls (3.70%) had PCOS.

HbA1c test was performed for all the 140children included in the study. The study population was categorised into 3 groups based on the HbA1c level. HbA1c level < 5.6 as normal category, HbA1c level 5.7 to 5.9 as prediabetes category and HbA1c level > 6 as diabetic category.

Among the 140 children screened for T2DM 136 children (97.14%) were normal, 4 children (2.86%) were diagnosed to have prediabetes.

Among the 136 children categorised as normal (HbA1c ≤ 5.6 category) 43 children (31.62%) were aged between 10-12 years, 30 children (22.06%) were aged between 13-15 years and 16 children (46.32%) were aged between 16-19 years.

Among the 4 children categorised as Pre diabetic (HbA1c 5.7 to 5.9), 2 children (50%), belonged to Age group 10-12, 1 children

(25%) belonged to Age group 13-15 and 1 children (25%) belonged to Age group 16-19 years.

Among the 136 children with normal HbA1c level 85 (98.84%) were Male and 51 (94.44%) were Female. Among the 4 children with HbA1c 5.7 to 5.9 (Prediabetes children) the number of Male and Female was 1 (1.16%) and 3 (5.56%) respectively.

Among the 136 children with normal HbA1c ≤ 5.6 level 40 (29.41%) children were under weight, 79 (58.09%) children were Normal weight and 17 (12.5%) children were Overweight.The number of Normal and Overweight children diagnosed in prediabetes category i.e. HbA1c 5.7 to 5.9 was 3 (75%) and 1 (25%) respectively. Among the 4 children diagnosed in prediabetes category underweight children was nil (0).

Among the 52 female children with normal ultrasound scan study 50 children had normal HbA1c level ≤ 5.6 and 2 female children with normal USG scan study was found to have HbA1c > 5.6 and diagnosed as prediabetes child. Among the 2 female children who were found to have PCOS on USG, one child have normal HbA1c level <5.6 and 1child have HbA1c >5.6 and diagnosed as prediabetes child.

COMPARISON OF OUR STUDY WITH OTHER PREVIOUS STUDIES:

In **Bhatia, *et al.* study** [6] T2DM accounted for 12% of cases (total 160 cases) in children below 18 years of age. In our study Prediabetes accounted for 2.86% of cases (total 140 cases) in children below 16 years of age.

Ranjani et al study [39] did a study in children aged 12 to 19 years for prediabetes screening. In their study the overall prevalence of pre-diabetes was 3.7% and pre-diabetics in girls was 4.2% and 3.2% of boys were prediabetic. In our study the overall prevalence of pre-diabetes in children and adolescents aged 10-16years was 2.86% and the prevalence of pre-diabetes among the girls with high risk factors was 5.56% and in boys was 1.16%.

In our study prediabetes is more common in girls than boys and this difference may be due to the hormonal changes which are more rapid in females than males.

In a study conducted by **Chaoyang et al** [40] in U.S. adolescents the prevalence of pre-diabetes among those with positive family history of diabetes was 25%, while in our study the

prevalence of pre-diabetes among those with positive family history of diabetes was 100 %. The prevalence was 100% in our study since we conducted the study in children of T2DM parents.

In a study conducted by **Kaur et al study** [41]18.2% of obese children had pre-diabetes (impaired glucose tolerance). In our study 25% of overweight children had pre-diabetes.

Ramachandran, *et al* [5] reported 18 children below the age of 15 years (5 boys and 13 girls) with T2DM diagnosed. 9 were obese and were asymptomatic and picked up on screening which was performed due to strong family history of DM. In our study we reported 4 children below the age of 15 years (1 boy and 3 girls) with prediabetes diagnosed. All these prediabetic children were asymptomatic and picked up on screening which was performed due to strong family history of DM. Among these 4 prediabetes children 1 child was overweight.

In a screening study conducted by **Reinher et al** [22] the prevalence of T2DM in obese children was 0.4 % to 1%. In our study the prevalence of prediabetes in overweight children of T2DM parents was 25%

Elham Al Amiri et al study [42] estimated the prevalence of prediabetes and type 2diabetes among 1034 overweight/obese children and adolescents aged 11–17 years. Capillary fasting blood glucose (FBG) and glycated hemoglobin (HbA1c) were measured by finger prick test, followed by confirmatory oral glucose tolerance tests (OGTT). The median age of the study population was 14.7 years. They reported prevalence of prediabetes in 21.9 % of the children using the HbA1c criteria 5.7 – 6.4 % for prediabetes. In our study 140 children aged 10 -19 years were screened for diabetes and prediabetes by using HbA1c criteria as recommended by ADA. We collected venous sample for HbA1c test. Prevalence of prediabetes in adolescents aged 10-16years with high risk factors for T2DM was 2.86% and the prevalence of prediabetes in overweight children was 25%.

In a epidemiological study conducted by **Fagot-Campagna A et al** [43] Acanthosis nigricans was present in 90% of children and adolescents with T2DM in North America. In our study Acanthosis nigricans was present in 11.1% of children and adolescents with pre-diabetes.

In **Jinan B saddine et al** [36] study mean age of the study population was 15years.The majority of the study population were males (49%). 11% of the participants were overweight. The mean HbA1c level was 4.99. The statistically highest mean HbA1c level was found in the participants aged 10-14years, male and overweight participants.

In our study mean age of the study population was 14.5 years years. The majority of the study populations were males (61.43%). 12.86% of the participants were overweight. The mean HbA1c level was 4.9± 0.31 which correlated with Jinan B saddine et al study. Variations of HbA1c level with specific age and sex group was analysed statistically but the differences in HbA1c level and specific age and sex group was not statistically significant which is not correlated with **Jinan B saddine et al**[36] study. This may be due to the less number of study population in our study(7974 children, adolescents, adults in **Jinan B saddine et al** [36] and only 140 children and adolescents in our study).

In our study we found a statistically significant higher HbA1c in female children with PCOS than their counterparts (P value < 0.005). This significant difference may be due to the

presence of insulin resistance in PCOS children associated with High HbA1c level.

To conclude the discussion all the 4 children (2.86%) who were diagnosed to have prediabetes based on the high HbA1c level >5.6 to 5.9 category had one or more risk factors for T2DM such as family history of diabetes or with signs of insulin resistance like overweight or PCOS or Acanthosis nigricans.

HbA1c test can be used as screening test to detect prediabetes and diabetes in high risk children having family history of diabetes with one or more risk factors for T2DM like overweight /obesity /Acanthosis nigricans /PCOS. By early screening at young age group we can prevent diabetes related complications. HbA1c test can also be used to diagnose diabetes in the prediabetic stage itself so that we can implement preventive strategies to halt the progression of pre-diabetes to diabetes.

CONCLUSIONS

1. Targeted screening of children and adolescents with risk factors for Type 2 diabetes by HbA1c test is justified in many studies and in our study.
2. By early screening for diabetes in children of T2DM parents, we can prevent Type 2 diabetes related morbidity and mortality.
3. Identification of type 2 diabetes in the asymptomatic children in the pre-diabetic stage itself by HbA1c analysis must be encouraged in the paediatric practice.
4. Early screening and diagnosis of type 2 diabetes mellitus should be one of the main targets of public health intervention programs.
5. Pediatricians should make the public aware of both the childhood obesity epidemic and its serious consequences of type 2 diabetes mellitus.

LIMITATIONS OF THE STUDY

Our study analyzed only the prevalence of pre diabetes in children and adolescents of T2DM parents using HbA1c test as a screening test.

In our study we included 140 subjects as sample size which was small to make comparisons and to draw conclusions for the general population.

Hence large scale studies are needed to know the accurate prevalence of diabetes in children and adolescents among general population.

RECOMMENDATIONS

- Targeted screening in apparently asymptomatic children and adolescents presenting with risk factors for T2DM like positive family history of diabetes or obesity or PCOS or acanthosis nigricans or hypertension is needed.
- HbA1c can be used as the choice of the method for screening due to high the levels of sensitivity and specificity compared to Fasting Plasma Glucose.
- Health authorities and professional organisations should formulate policies concerning screening for type 2 diabetes.
- Awareness program for prevention of T2DM in the young population should be initiated.
- Lifestyle modification & Daily physical activity to prevent overweight/obesity should be stressed for all children particularly those with risk factors for T2DM.
- Regular follow up with appropriate screening test is important for at risk children and adolescents for T2DM to prevent the diabetes development and its complications.

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PATIENT CONSENT FORM

Study Detail : **Screening Children of Type 2 Diabetes Mellitus Parents**

Study centre : GRH AND KILPAUK MEDICAL COLLEGE, CHENNAI

Patients Name :

Patients Age :

Identification Number :

Patient may check ( ) these boxes

I confirm that I have understood the purpose of procedure for the above study. I have the opportunity to ask question and all my questions and doubts have been answered to my complete satisfaction. ☐

I understand that my participation in the study is voluntary and that I am free to withdraw at any time without giving reason, without my legal rights being affected. ☐

I understand that sponsor of the clinical study, others working on the sponsor's behalf, the ethical committee and the regulatory authorities will not need my permission to look at my health records, both in respect of current study and any further research that may be conducted in relation to it, even if I withdraw from the study I agree to this access. However, I understand that my identity will not be revealed in any information released to third parties or published, unless as required under the law. I agree not to restrict the use of any data or results that arise from this study. ☐

I agree to take part in the above study and to comply with the instructions given during the study and faithfully cooperate with the study team and to immediately inform the study staff if I suffer from any deterioration in my health or well-being or any unexpected or unusual symptoms. ☐

I hereby consent to participate in this study. ☐

I hereby give permission to undergo complete clinical examination and diagnostic tests including haematological, biochemical, radiological tests. ☐

Signature/thumb impression:

Patients Name and Address:

place date

Signature of investigator :

Study investigator's Name :

place date

சுயஒப்புதல் படிவம்

ஆய்வு செய்யப்படும் தலைப்பு: : நீரிழிவு நோயுற்ற மருந்து உட்கொள்ளும் பெற்றோர்களின் குழந்தைகளுக்கு நீரிழிவு நோய் கண்டறிதல்

இடம்:

இராயப்பேட்டை மருத்துவமனை
அரசு கீழ்பாக்கம் மருத்துவ கல்லூரி மருத்துவமனை.
சென்னை

பங்குபெறுபவரின் பெயர் :

பங்குபெறுபவரின் வயது : பங்குபெறுபவரின் எண் :

மேலே குறிப்பிட்டுள்ள மருத்துவ ஆய்வின் விவரங்கள் எனக்கு விளக்கப்பட்டது. நான் இவ்வாய்வில் தன்னிச்சையாக பங்கேற்கிறேன். எந்த காரணத்தினாலோ எந்த சட்டசிக்கலுக்கும் உட்படாமல் நான் இவ்வாய்வில் இருந்து விலகிக்கொள்ளல்லாம் என்றும் அறிந்து கொண்டேன்.

இந்த ஆய்வு சம்பந்தமாகவோ, இதை சார்ந்து மேலும் ஆய்வு மேற்கொள்ளும்போதும் இந்த ஆய்வில்பங்கு பெறும் மருத்துவர் என்னுடைய மருத்துவ அறிக்கைகளை பார்ப்பதற்கு என் அனுமதி தேவையில்லை என அறிந்து கொள்கிறேன். இந்த ஆய்வின் மூலம் கிடைக்கும் தகவலையோ, முடிவையோ பயன்படுத்திக்கொள்ள மறுக்க மாட்டேன்.

இந்த ஆய்வில் பங்கு கொள்ள ஒப்புக்கொள்கிறேன். இந்த ஆய்வை மேற்கொள்ளும் மருத்துவ அணிக்கு உண்மையுடன் இருப்பேன் என்றும் உறுதியளிக்கிறேன்.

பங்கேற்பவரின் கையொப்பம் ஆய்வாளரின் கையொப்பம்

இடம் :

தேதி :

PROFORMA

Screening Children of Type 2 Diabetes Mellitus Parents

Sl.No:

Name: Age: Sex:

Address: OP.No:

Phone No:

Parent's Details:

Details	Age	Diabetic or Non Diabetic	Age Onset	Duration	Oral Drugs/ Insulin
Father					
Mother					
Children					

Children's details:

1. Height: 2.Weight:
3. BMI : Underweight / Normal /Overweight / Obese

Physical Examination:

1. Acanthosis Nigricans: present / not
2. Blood pressure : normal/ increased
3. PCOD by USG :
4. HBA1C level :

ABBREVATION

ADA	-	American Diabetes association
T2DM	-	Type 2 Diabetes Mellitus
T1DM	-	Type 1 Diabetes Mellitus
BMI	-	Body Mass Index
FPG	-	Fasting Plasma Glucose
IFG	-	Impaired Fasting Glucose
IGT	-	Impaired Glucose Tolerance
NIDDM	-	Non-Insulin Dependent Diabetes Mellitus
IAP	-	Indian Academy of Pediatrics
NCD	-	Non Communicable Disease
OGTT	-	Oral Glucose Tolerance Test
WHO	-	World Health Organization

S No	Name	Age	Sex	Parents Diabetic Status		BP(Mm Hg)	Height (Cm)	Weight (Kg)	BMI	Acanthosis Nigricans	USG(Female)	HBA1C
				Mother	Father							
1	Monica	10	F	Yes	No	90/70	131	35	20.4	No	Normal study	4.6
2	Monish	10	M	Yes	No	100/70	130	25	14.79	No	-	4.2
3	Jagadeshwaran	11	M	Yes	No	90/70	141	43	21.71	No	-	4.8
4	Paramesh	11	M	No	Yes	100/70	140	40	20.4	Yes	-	5.1
5	Renuga devi	12	F	No	Yes	100/70	158	57	22.89	No	Normal study	4.7
6	Sanjay	15	M	No	Yes	100/70	165	42	15.44	No	-	5.1
7	Nasrren	12	F	No	Yes	100/70	160	68	26.56	Yes	Prominent ovaries/PCOD	5.2
8	Kalaiselvi	10	F	Yes	No	90/70	140	33	16.8	Yes	Normal study	4.5
9	Meena	14	F	Yes	No	100/70	150	35	15.55	No	Normal study	4.8
10	Saradha	18	F	No	Yes	110/70	164	52	19.4	No	Normal study	5.2
11	Aishwarya	10	F	No	Yes	100/70	142	40	19.9	Yes	Prominent ovaries/PCOD	5.4
12	Guruprasad	17	M	No	Yes	110/70	165	52	19.11	No	-	5.1
13	Mubin	17	M	No	Yes	100/70	162	54	20.61	No	-	4.4
14	Afridi	16	M	No	Yes	100/70	158	49	19.67	No	-	4.7
15	Vignesh	17	M	No	Yes	110/70	165	58	21.32	No	-	4.7
16	Lokesh	16	M	No	Yes	100/70	162	53	20.22	No	-	4.6
17	Vignesh	18	M	Yes	No	110/70	165	68	26.32	No	-	4.7
18	Priya	16	F	No	Yes	90/70	158	49	19.67	No	Normal study	5.1
19	Keerthana	14	F	No	Yes	90/70	154	46	19.4	No	Normal study	5.8
20	Tamil mani	17	M	No	Yes	100/70	162	54	20.61	No	-	5.1
21	Lavanya	14	F	No	Yes	100/70	154	46	19.4	No	Normal study	4.5
22	Santhosh	10	M	Yes	No	100/70	140	48	24.4	No	-	4.6

S No	Name	Age	Sex	Parents Diabetic Status		BP(Mm Hg)	Height(Cm)	Weight (Kg)	BMI	Acanthosis Nigricans	USG(Female)	HBA1C
				Mother	Father							
23	Santhiya	11	F	Yes	No	100/70	133	36	20.45	No	Normal study	4.5
24	Dharanidharan	10	M	No	Yes	90/70	136	30	16.3	No	-	4.1
25	Anand	17	M	No	Yes	110/70	161	50	19.3	No	-	4.9
26	Gautam	15	M	No	Yes	90/70	157	39	15.85	No	-	5.2
27	Santhosh	13	M	No	Yes	90/70	150	34	15.11	No	-	5.1
28	Magendra kumar	11	M	No	Yes	90/70	138	35	18.42	No	-	4.4
29	Sanjay	18	M	No	Yes	110/70	165	56	20.58	No	-	4.8
30	Vishal	18	M	Yes	No	100/70	160	49	19.14	No	-	4.9
31	Naveen	16	M	Yes	No	90/70	152	42	18.18	No	-	5.1
32	Irfan	15	M	Yes	No	100/70	152	40	17.31	No	-	4.9
33	Reshma	12	F	Yes	No	90/70	144	36	17.39	No	Normal study	4.6
34	Fathima	10	F	Yes	No	90/70	135	29	15.9	No	Normal study	4.5
35	Dhanush	11	M	Yes	No	90/70	138	34	17.89	No	-	4.2
36	Gokul	18	M	No	Yes	100/70	159	46	18.25	No	-	5.2
37	Rahul	13	M	No	Yes	100/70	146	36	16.9	No	-	4.4
38	Velan	18	M	Yes	No	100/70	160	49	19.14	No	-	4.7
39	Kowsalya	16	F	Yes	No	100/70	152	44	19.04	No	Normal study	4.2
40	Manivannan	18	M	No	Yes	100/70	159	42	16.66	No	-	5.1
41	Malarvizhi	17	F	No	Yes	100/70	160	45	17.57	No	Normal study	4.9
42	Madhu	16	F	No	Yes	100/70	158	43	17.26	No	Normal study	4.6
43	John roshan	18	M	No	Yes	100/70	172	56	18.98	Yes	-	5.2
44	Janani	10	F	No	Yes	90/70	123	22	14.6	No	Normal study	4.9
45	Priyadharshini	12	F	No	Yes	100/70	144	46	22.3	Yes	Normal study	5.4

S No	Name	Age	Sex	Parents Diabetic Status		BP(Mm Hg)	Height(Cm)	Weight (Kg)	BMI	Acanthosis Nigricans	USG(Female)	HBA1C
				Mother	Father							
46	Sai kishore	10	M	No	Yes	110/80	144	50	25.5	Yes	-	4.7
47	Sahara fathima	10	F	No	Yes	100/70	145	39	18.5	Yes	Prominent ovaries/PCOD	5.8
48	Elakiya	12	F	Yes	No	110/80	143	56	27.39	Yes	Prominent ovaries/PCOD	5.7
49	Lokesh	12	M	No	Yes	110/70	145	60	28.5	Yes	-	5.6
50	Madhan	10	M	No	Yes	110/70	142	52	25.8	Yes	-	4.7
51	Deepak	18	M	No	Yes	110/70	161	58	22.4	No	-	5.1
52	Irfan	12	M	No	Yes	110/70	147	42	19.4	Yes	-	4.9
53	Mohanraj	18	M	Yes	No	110/70	167	43	16.4	No	-	5.2
54	Ramya	18	F	Yes	No	110/70	165	49	18.4	No	Normal study	5.1
55	Dhanush	13	M	Yes	No	95/60	146	28	14.8	No	-	5
56	Harish	12	M	Yes	No	90/60	142	29	15.4	No	-	5.1
57	Divya	19	F	Yes	No	100/70	169	43	15.6	No	Normal study	4.9
58	Rohith	11	M	Yes	No	110/70	157	69	28	Yes	-	4.9
59	Saranraj	13	M	No	Yes	90/70	154	42	17.8	No	-	4.8
60	Madhan	17	M	No	Yes	120/80	164	49	18.2	No	-	5.1
61	Malathi	18	F	No	Yes	105/70	154	44	18.6	No	Normal study	5.2
62	Venkatesh	19	M	Yes	No	110/70	165	55	20.2	No	-	5.2
63	Manikandan	17	M	Yes	No	110/70	163	54	20.3	No	-	5.1
64	Tamilarasan	18	M	Yes	No	110/70	163	52	19.6	No	-	4.9
65	Tamil selvi	19	F	Yes	No	110/70	157	49	20	No	Normal study	4.8
66	Yokesh	10	M	No	Yes	110/70	130	30	17.7	No	-	5.1
67	Dharani	12	F	No	Yes	110/70	148	63	28.8	No	Simple right Ovarian cyst	4.7

S No	Name	Age	Sex	Parents Diabetic Status		BP(Mm Hg)	Height(Cm)	Weight (Kg)	BMI	Acanthosis Nigricans	USG(Female)	HBA1C
				Mother	Father							
68	Asina afreen	12	F	Yes	No	110/70	163	61	23	No	Normal study	4.9
69	Divya bharathi	12	F	No	Yes	90/70	152	50	21.6	No	Normal study	4.8
70	Nandhini	10	F	No	Yes	100/80	142	50	24.8	Yes	Normal study	5
71	Vaishali	11	F	Yes	No	110/80	146	55	25.8	Yes	Normal study	4.8
72	Nandhini	17	F	Yes	No	110/70	151	37	16.2	No	Normal study	5.1
73	Jesima	16	F	Yes	No	110/70	159	45	17.8	No	Normal study	5
73	Santhiya	13	F	Yes	No	110/70	152	64	27.7	Yes	Normal study	5.3
75	Safna fathima	10	F	No	Yes	110/70	150	50	22.2	Yes	Normal study	4.9
76	Deepalakshmi	10	F	Yes	No	110/70	169	47	24.3	No	Normal study	4.6
77	Nithish kumar	12	M	Yes	Yes	120/70	163	70	26.3	Yes	-	4.6
78	Ajay calvin	10	M	No	Yes	100/60	130	37	21	Yes	-	4.9
79	Shireen	18	F	Yes	No	110/70	163	60	22.6	No	Normal study	5
80	Saran raj	13	M	No	Yes	100/70	147	38	17.6	No	-	4.7
81	Sanjay	10	M	No	Yes	90/70	139	36	18.6	No	-	4.9
82	Rasheeka	12	F	Yes	No	90/70	146	40	18.8	No	Normal study	4.8
83	Nandhini	18	F	Yes	Yes	100/70	158	49	19.6	No	Normal study	5.1
84	Naveen kumar	12	M	Yes	Yes	90/70	144	36	17.4	No	-	4.7
85	Ramya	18	F	Yes	No	90/70	163	50	18.8	No	Normal study	5.1
86	Mohanraj	17	M	Yes	No	110/70	165	52	19.1	No	-	4.8
87	Prasanna	18	M	No	Yes	100/70	164	54	20.1	No	-	5
88	Sridharan	15	M	No	Yes	100/70	156	42	17.3	No	-	4.9
89	Ashwin	18	M	Yes	No	100/70	165	49	18	No	-	4.6
90	Dhanush	17	M	Yes	No	100/70	162	52	19.8	No	-	4.6
91	Madhan	17	M	No	Yes	100/70	161	49	18.9	No	-	5.1
92	Malathi	18	F	No	Yes	100/70	164	50	18.6	No	Normal study	5.2

S No	Name	Age	Sex	Parents Diabetic Status		BP(Mm Hg)	Height(Cm)	Weight (Kg)	BMI	Acanthosis Nigricans	USG(Female)	HBA1C
				Mother	Father							
93	Venugopal	16	M	No	Yes	100/70	162	51	19.4	No	-	4.5
94	Kishore	11	M	No	Yes	90/70	142	36	17.9	No	-	4.3
95	Nandhini	18	F	Yes	No	110/70	158	46	18.4	No	Normal study	5.1
96	Divya	16	F	Yes	No	110/70	155	46.5	19.1	No	Normal study	4.9
97	Sham kumar	15	M	Yes	No	100/70	157	44	17.9	No	-	4.8
98	Divyashree	17	F	Yes	No	100/70	155	48	20	No	Normal study	4.9
99	Prashanth	18	M	Yes	Yes	110/70	160	49	19.1	No	-	5.1
100	Sai ananth	15	M	Yes	Yes	110/70	158	52	20.8	No	-	5
101	Vaithiyalingam	17	M	Yes	No	110/70	165	53	19.5	No	-	4.7
102	Vinayagam	15	M	Yes	No	110/70	159	50	19.8	No	-	4.8
103	Rahul	17	M	Yes	Yes	110/70	162	54	20.6	Yes	-	5.2
104	Dhanapal	18	M	No	Yes	100/70	164	52	19.3	No	-	5
105	Raji	14	F	No	Yes	100/70	149	39	17.6	No	Normal study	4.9
106	Kirubakaran	13	M	No	Yes	120/80	148	52	23.7	Yes	-	4.9
107	Jeeva	14	M	Yes	No	100/70	159	50	19.8	No	-	4.8
108	Jeevanantham	15	M	Yes	No	100/70	162	52	19.8	No	-	4.9
109	Saranraj	13	M	No	Yes	100/70	156	48	19.7	No	-	5
110	Sanjay	10	M	No	Yes	90/70	136	33	17.2	No	-	4.7
111	Rashika	12	F	Yes	No	100/70	147	44	20.4	No	Normal study	4.9
112	Gandhi	14	M	No	Yes	100/70	156	52	21.4	No	-	4.9
113	Suganya	12	F	No	Yes	100/70	146	52	24.5	No	Normal study	4.8
114	Mayilvahanan	16	M	Yes	No	110/70	162	56	21.3	No	-	5.1
115	Raju	13	M	Yes	No	100/70	146	38	17.8	No	-	4.8
116	Janiya sultana	17	F	Yes	No	100/70	159	49	19.4	No	Normal study	5.1

117	Faizal	15	M	Yes	No	100/70	155	47	19.6	No	-	4.9
S No	**Name**	**Age**	**Sex**	**Parents Diabetic Status**		**BP(Mm Hg)**	**Height(Cm)**	**Weight (Kg)**	**BMI**	**Acanthosis Nigricans**	**USG(Female)**	**HBA1C**
				Mother	**Father**							
118	Ali ahamed	14	M	No	Yes	100/70	153	46	19.8	No	-	4.8
119	Fathima	12	F	No	Yes	100/70	150	39	17.3	No	Normal study	4.7
120	Kughan	17	M	No	Yes	100/70	163	54	20.3	No	Normal study	5
121	Vishal	11	M	Yes	No	90/70	141	43	21.71	No	-	5
122	Surya	15	M	Yes	No	100/70	151	48	19.7	No	-	5.1
123	Manikandan	16	M	Yes	Yes	100/70	154	46	19.4	No	-	5.1
124	Saravanan	13	M	Yes	Yes	100/70	146	42	19.7	No	-	4.9
125	Venkatesh	18	M	Yes	No	110/70	165	55	20.02	No	-	5.2
126	Mani	16	M	Yes	No	100/70	153	46	19.7	No	-	4.9
127	Nilofar sharma	18	F	Yes	No	100/70	154	47	19.3	No	Normal study	4.8
128	Prema	16	F	Yes	Yes	100/70	158	58	23.2	Yes	Normal study	4.5
129	Dinesh	16	M	No	Yes	110/70	162	58	22.1	No	-	4.6
130	Suresh	14	M	No	Yes	100/70	152	56	24.2	No	-	5.4
131	Mohammed ibrahim	17	M	Yes	Yes	110/70	162	60	22.9	No	-	5.5
132	Noorjahan	15	F	Yes	Yes	100/70	156	70	28.8	Yes	Normal study	4.8
133	Prema	17	F	No	Yes	110/70	160	66	25.8	Yes	Normal study	4.5
134	Sathish	16	M	No	Yes	100/70	160	64	25	Yes	-	4.9
135	Jeevan	15	M	Yes	Yes	100/70	156	62	25.5	No	-	4.7
136	Nazir	16	M	Yes	Yes	100/70	162	64	24.4	Yes	-	5.8
137	Muhil	10	F	No	Yes	90/70	134	40	22.3	No	Normal study	4.9
138	Ramesh	15	M	Yes	Yes	100/70	152	59	25.5	No	-	4.9
139	Abirami	17	F	No	Yes	100/70	158	70	28	No	Normal study	5.3
140	Kavitha	16	F	No	Yes	100/70	149	56	25.2	Yes	Normal study	4.6