

**“THE IMMEDIATE EFFECT OF ARDHA MATSYENDRASANA ON
BLOOD GLUCOSE LEVEL IN TYPE II DIABETICS”**

By

**DR. G. TAMIL SELVI
Reg.461712003**



Dissertation Submitted to the
Tamil Nadu Dr. M. G. R. Medical University, Chennai, Tamil Nadu
In partial fulfillment of the requirements for the degree of

DOCTOR OF MEDICINE

IN

YOGA

Under the Guidance of

Dr. S. T. VENKATESWARAN
Prof. & Head
Department of Yoga,
Government Yoga & Naturopathy Medical College & Hospital,
Arumbakkam,
Chennai- 600106

2017 - 2020

TAMILNADU Dr. M. G. R. MEDICAL UNIVERSITY,

CHENNAI, TAMIL NADU

CERTIFICATE BY THE GUIDE

This is to certify that the dissertation entitled “**THE IMMEDIATE EFFECT OF
ARDHA MATSYENDRASANA ON BLOOD GLUCOSE LEVEL IN TYPE II
DIABETICS**” is a bonafide research work done by **Dr. Dr. G. TAMIL SELVI** in
partial fulfillment of the requirement for the degree of **M.D. Yoga**.

Date:
Place: Chennai

Dr. S. T. VENKATESWARAN
Prof. & Head,
Dept. of Yoga,
GYNMC & H, Arumbakkam, Chennai

**TAMILNADU Dr. M. G. R. MEDICAL UNIVERSITY,
CHENNAI, TAMIL NADU**

ENDORSEMENT BY THE HEAD OF THE DEPARTMENT

This is to certify that the dissertation “**THE IMMEDIATE EFFECT OF ARDHA MATSYENDRASANA ON BLOOD GLUCOSE LEVEL IN TYPE II DIABETICS**” is a bonafide research work done by **Dr. G. TAMIL SELVI** under the guidance of **Dr. S. T. VENKATESWARAN**, Professor & Head, Department of Yoga, Govt. Yoga & Naturopathy Medical College & Hospital, Arumbakkam, Chennai.

Date:
Place: Chennai

Dr. S. T. VENKATESWARAN
Prof. & Head,
Dept. of Yoga,
GYNMC & H, Arumbakkam, Chennai

TAMILNADU Dr. M. G. R. MEDICAL UNIVERSITY,

CHENNAI, TAMIL NADU

ENDORSEMENT BY THE PRINCIPAL / HEAD OF THE INSTITUTION

This is to certify that the dissertation entitled “**THE IMMEDIATE EFFECT OF ARDHA MATSYENDRASANA ON BLOOD GLUCOSE LEVEL IN TYPE II DIABETICS**” is a bonafide research work done by **Dr. G. TAMIL SELVI** under the guidance of **Dr. S. T. VENKATESWARAN**, Professor & Head, Department of Yoga, Govt. Yoga & Naturopathy Medical College & Hospital, Arumbakkam, Chennai.

Date:

Place: Chennai

Dr. N. MANAVALAN

Principal

GYNMC & H, Arumbakkam, Chennai

**TAMILNADU Dr. M. G. R. MEDICAL UNIVERSITY,
CHENNAI, TAMIL NADU**

DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation / thesis entitled “**THE IMMEDIATE EFFECT OF ARDHA MATSYENDRASANA ON BLOOD GLUCOSE LEVEL IN TYPE II DIABETICS**” is a bonafide and genuine research work carried out by me under the guidance of **Dr. S. T. VENKATESWARAN**, Prof. & Head, Department of Yoga, Govt. Yoga & Naturopathy Medical College & Hospital, Arumbakkam, Chennai.

Date:

Place: Chennai

Dr. G.TAMIL SELVI

Post Graduate in Yoga

GYNMC & H, Arumbakkam, Chennai

INSTITUTIONAL ETHICAL COMMITTEE

**GOVERNMENT YOGA AND NATUROPATHY MEDICAL COLLEGE AND
HOSPITAL, CHENNAI – 600 106.**

CERTIFICATE OF APPROVAL

The Institutional Ethical Committee of Government Yoga & Naturopathy Medical College and Hospital, Chennai reviewed and discussed the application for approval of “**THE IMMEDIATE EFFECT OF ARDHA MATSYENDRASANA ON BLOOD GLUCOSE LEVEL IN TYPE 11 DIABETICS**” project work submitted by Dr. G. TAMIL SELVI, 1st year M. D. Yoga, Postgraduate, Government Yoga and Naturopathy Medical College and Hospital, Chennai.

The proposal is **Approved**.

The Institutional Ethical Committee expects to be informed about the progress of the study and adverse drug reactions during the course of the study and any change in the protocol and patient information sheet / informed consent and asks to be provided a copy of the final report.

COPYRIGHT

DECLARATION BY THE CANDIDATE

I hereby declare that the Tamilnadu Dr. M. G. R. Medical University, Chennai, Tamilnadu shall have the rights to preserve, use and disseminate this Dissertation / Thesis in print or electronic format for academic / research purpose.

Date:

Dr. G. TAMIL SELVI

Place:

Post Graduate in Yoga
GYNMC & H, Arumbakkam, Chennai

© Tamilnadu Dr. M. G. R. Medical University, Chennai

ACKNOWLEDGEMENT

Foremost, I express my sincere gratitude to **Dr. N. Manavalan**, Prinicipal, Govt. Yoga & Naturopathy Medical College and Hospital, Chennai, for giving me this opportunity to pursue my Post Graduation degree M.D. Yoga from this prestigious institute.

I extend my gratitude towards **Dr. S. T. Venkateswaran**, Prof. & Head, Department of Yoga, Govt. Yoga and Naturopathy Medical College and Hospital, Chennai for his constant support and encouragement. I once again thank Dr. S. T. Venkateswaran sir for his continuous support and provision of all necessary requirements needed for the completion of this dissertation.

I express my thanks to my parents and my family members for always being there and helping me with their moral support.

I specially thank **Dr. A. Moovendhan & Dr. M. H Vinoth Kumar** for helping me throughout the completion of the study and the dissertation.

My sincere thanks go out to all my Post-Graduate and Undergraduate friends who have been there at all phases of this study including the preparation of this dissertation. I also acknowledge the support of all the subjects who participated in the study.

Above all I thank God for all that I am blessed with.

Date:
Place: Chennai

Dr. G. TAMIL SELVI

LIST OF ABBREVIATIONS USED

DM	Diabetes Mellitus
T2 DM	Type 2 Diabetes Mellitus
T1DM	Type 1 Diabetes Mellitus
NCCIH	National Center for Complementary and Integrative Health
IDF	International Diabetes Federation
IDDM	Insulin Dependent Diabetes Mellitus
NIDDM	Non-Insulin Dependent Diabetes Mellitus
MRDM	Malnutrition-Related Diabetes Mellitus
GDM	Gestational Diabetes Mellitus
LADA	Latent Autoimmune Diabetes In Adults
IGT	Impaired Glucose Tolerance
LDL	Low Density Lipoprotein
HDL	High Density Lipoprotein
BCE	Before The Common Era
HYP	Hatha Yoga Pradipika

ABSTRACT

Background: Diabetes mellitus is a group of metabolic disorders characterized by hyperglycemia resulting from defects in insulin secretions, insulin action, or both. There are reports as regards to the influence of group of asana on blood glucose levels. However, to the best of our knowledge there are no studies evaluated the effects of single asana i.e. Ardha Matsyendrasana on blood glucose levels in type 2 diabetes mellitus (T2DM). Thus, the present study was conducted to evaluate the effect of Ardha Matsyendrasana on random blood glucose (RBG) levels in patients with T2DM.

Methods: A total of 100 subject with T2DM were included in the study. All the subjects were asked to undergo a single session (15 minutes) of control session (CS) (rest in sitting pose) and yoga session (YS) on day-1 and day-2 respectively. Baseline and post-test assessments of RBG levels were measured just before and immediately after each intervention. Statistical analysis was performed using statistical package for the social sciences, version 16. P value <0.05 was considered as significant.

Results: There is a significant reduction in RBG levels in the YS compared with the CS.

Conclusion: The Results of the present study demonstrated that the practice of Ardha Matsyendrasana is effective in reducing the blood glucose levels in patients with T2DM.

Keywords: Ardha Matsyendrasana; Blood Glucose Level; Diabetes; Yoga.

TABLE OF CONTENTS

S. NO.	INDEX	PAGE NO.
1.	INTRODUCTION	1
2.	AIMS & OBJECTIVES	6
3.	REVIEW OF LITERATURE	6
4.	MATERIALS & METHODS	65
5.	RESULTS	70
6.	DISCUSSION	74
7.	CONCLUSION	77
8.	BIBLIOGRAPHIC REFERENCES	78
9. .	ANNEXURES	86

LIST OF TABLES

TABLE NO.	TOPIC	PAGE NO.
1.	Most common mouth problems from diabetes	41
2.	Pre test and Post test assessments of Yoga session and Control Session	72
3.	Mean Random blood sugar difference in yoga and control session	73

LIST OF FIGURES

FIGURE NO.	CONTENTS	PAGE NO.
1.	World Wide troll of diabetes	2
2.	Demographic & Geographic Outline	3
3.	Anatomy Of Pancreas	7
4.	Glucose Homeostasis	8
5.	Diabetes & Types	9
6.	Ratio Of Type 1 & Type 2 Diabetes mellitus	11
7.	Diabetes Prevalence	12
8.	Types & Stages Of Diabetes	14
9.	Classification Of Diabetes	16
10.	Glucose & Insulin Overview	17
11.	Type 1 Diabetes	18
12.	Causes Of Type 1 Diabetes	18
13.	Latent Autoimmune Diabetes in Adults	19

14.	Etiology Of Type 2Diabetes Mellitus	20
15.	Disease Process Of Type 2 Diabetes mellitus	25
16.	Food Vs Insulin	26
17.	Comparison Between Active & Destroyed Insulin Producing Cells	27
18.	Factors Affecting Insulin Secretion & Action	27
19.	Charcot's Foot	35
20.	Normal Vision Of Two Boys Playing	36
21.	Image Viewed By A Person With Diabetic Retinopathy	37
22.	Image vied By People With Glaucoma Slowly Lose Side Vision	38
23.	Cloudy Vision & Faded Colors - Viewed By Cataracts	39
24.	Healthy Gums & Periodontitis	41
25.	History Of Yoga	45
26.	Sage Patanjali	48
27.	Eight Limbs Of Yoga	51
28.	Various Asana For Diabetes Mellitus	57

29.	Ardha Matsyendrasana (half spinal twist)	61
30.	Trial profile	65
31.	Study Session	71
32.	Control Session	71
33.	Difference Between Yoga And Control Sessions	72

1.0 INTRODUCTION

Increased blood glucose level Diabetes Mellitus (DM) is one of the world's major diseases & reaching potentially epidemic proportions in India. India currently faces an uncertain future in relation to the potential burden that diabetes may impose upon the country.(1)

In 2000, the global estimate of adults living with diabetes was 151 million. By 2009 it had grown by 88% to 285 million. Today, we calculate that 9.3% of adults aged 20-79 years a staggering 463 million people are living with diabetes. A further 1.1 million children and adolescents under the age of 20, live with type 1 diabetes. A decade ago, in 2010, the global projection for diabetes in 2025 was 438 million. With over five years still to go, that prediction has already been surpassed by 25 million.

IDF (International Diabetes Federation) estimates that there will be 578 million adults with diabetes by 2030, and 700 million by 2045.

The increasing prevalence of diabetes worldwide is driven by a complex interplay of socioeconomic, demographic, environmental and genetic factors. The continued rise is largely due to an upsurge in type 2 diabetes (T2DM) and related risk factors, which include rising levels of obesity, unhealthy diets and widespread physical inactivity. However, levels of childhood-onset type 1 diabetes are also on the rise.

Growing urbanization and changing lifestyle habits (e.g. higher calorie intake, increasing consumption of processed foods, sedentary lifestyles) are contributory factors for the increasing prevalence of T2DM at a societal level. While global prevalence of

diabetes in urban areas is 10.8%, in rural areas it is lower, at 7.2%. However, this gap is closing, with rural prevalence on the rise.(2)

In 2000, the global estimate of diabetes prevalence in the 20–79 year age group was 151 million, which was close to the WHO estimate at the time (150 million).¹ Estimates have since shown alarming increases (see Figure 1), tripling to the 2019 estimate of 463 million. Projections for the future have clearly indicated that the global impact of the diabetes is likely to continue increasing considerably.

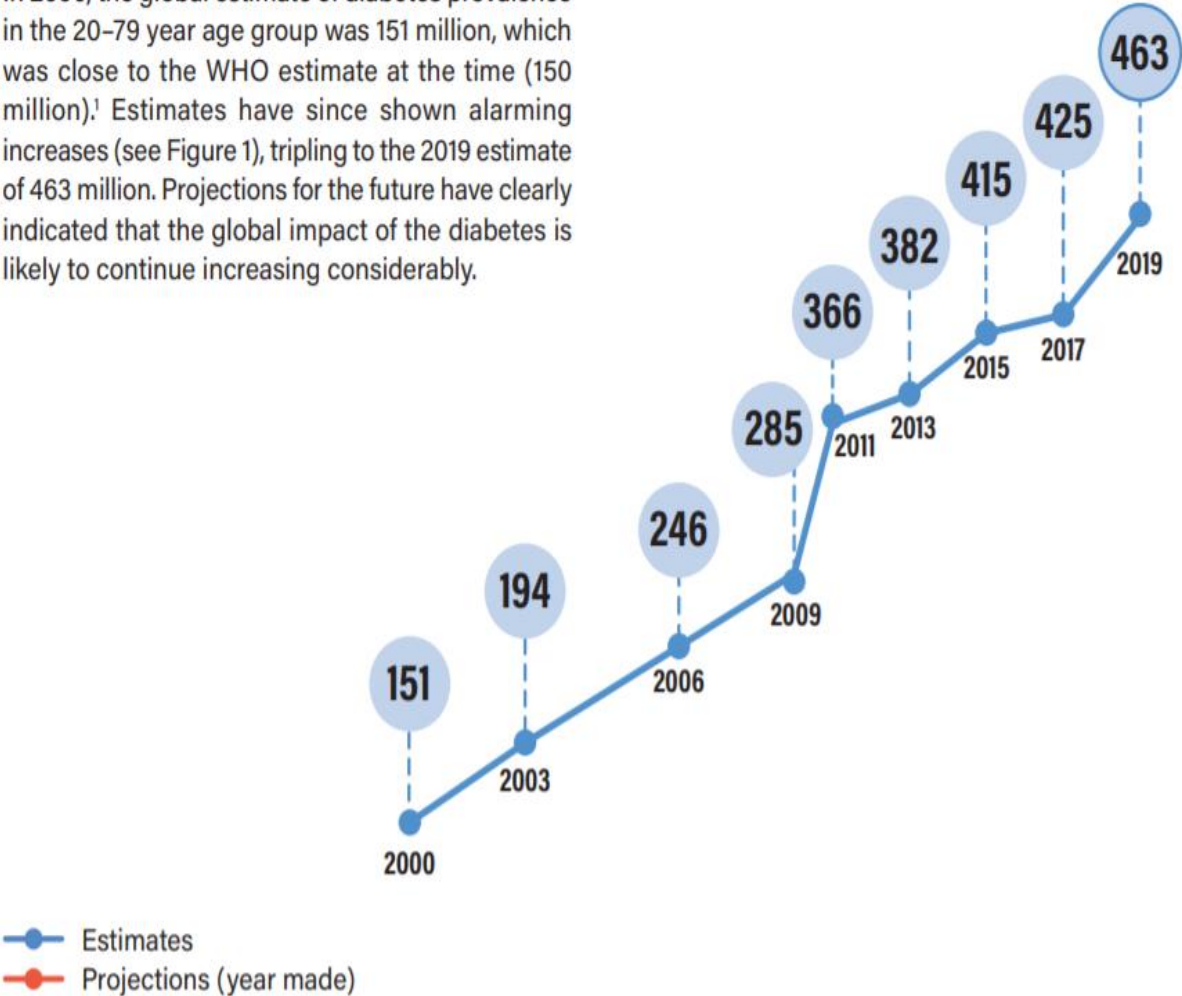


Figure 1: World Wide troll of diabetes

Source: IDF Diabetes Atlas, 9th edition 2019.

Map Prevalence of diabetes in adults (20–79 years) in IDF Regions, by age-adjusted comparative diabetes prevalence

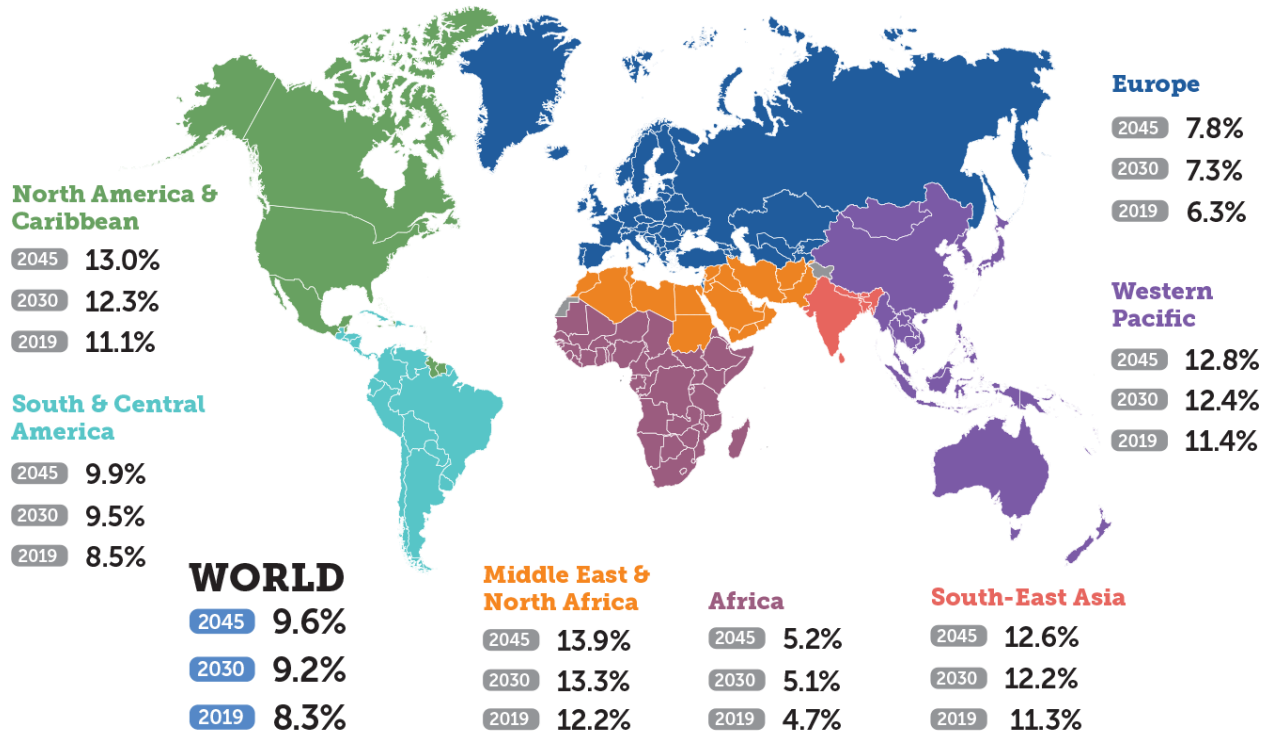


Figure 2: Demographic & Geographic Outline

Source: IDF Diabetes Atlas, 9th edition 2019.

In worldwide T2DM is the most frequently encountered metabolic syndrome.(3)
 DM is one of the oldest diseases. About 3000years ago It was first reported in Egyptian manuscript. The distinction between type 1 and T2DM was clearly made in 1936. In 1988 T2DM was first described as a component of metabolic syndrome.(4)

T2DM is a metabolic disorder characterized by chronic hyperglycemia due to relative insulin deficiency or resistance or the both. Patients with DM can have a reasonably normal living style. Their late complications result in reduced life expectancy and

considerable utilization of health resources.(5) T2DM results from the interaction between genetic, environmental and behavioral risk factors. T2DM are more vulnerable to short and long term complications, which lead to the premature death because of its insidious onset and late recognition.(6)

The ratio of men-to-women afflicted with diabetes is roughly equal, women are uniquely and often more severely, affected by complications of diabetes. The prevalence of overweight, abdominal obesity is also high among women and they also suffer from related complications like elevated lipids and blood sugar levels. T2DM is a complex and demanding chronic disease requiring considerable dexterity on the part of the patient to manage drugs, diet and exercise. Therefore, it is necessary to look at low cost interventions that can empower the patient and build on available resources. Yoga and peer support can be considered to be two such interventions which can empower the patient to institute behavior change and adhere to the complex and demanding nature of this chronic disease. (7)

Yoga is the traditional form of mind-body training originated in India over 4000 years ago that seeks to unite the individual self with the transcendental self.(3) Yoga philosophy and practice were 1st described by Patanjali in the classical text- YOGA SUTRA. Patanjali outlines an eight-fold path in the yoga sutras which comprised of ethical principles for living and purposeful life and also direct attention towards one's health while acknowledge the spiritual aspects of one's nature.(8)While its origins root from religious

principles, modern day culture is primarily drawn to it for its relaxation benefits (meditation and breathing exercises) and stretching and strengthening movements (physical poses). According to the National Center for Complementary and Integrative Health (NCCIH), yoga is the most popular form of complementary therapy practiced by more than 13 million adults, with 58% of adults refer to maintenance of health & well-being as their reason for practice. One of the reasons for yoga's increase in popularity is its versatility, in that it can be taught at a range of different intensities. Indeed, the practice of engaging the mind and body through meditation, breathing and physical poses has attracted significant attention from the medical community, and yoga has been frequently studied for its possible beneficial effects on physical and mental health outcomes. Depression and stress are known to detrimentally impact both cognitive functioning and brain structure. Many studies have demonstrated the potential of yoga to improve anxiety, depression, stress and overall mental health.(9)

There are many studies in chronic diseases with yoga, such as asthma, hypertension, diabetes, and chronic obstructive pulmonary disease, where the effective role of yoga in chronic disease is explained. Many trials have shown that yoga can reduce the fasting blood glucose, glycosylated hemoglobin A1c and quality of life in T2DM.(3)since there is a significant decrease in the fasting blood sugar and post prandial blood sugar levels after the practice of yoga it indicates the potential role of yoga in prevention and management strategies of T2DM. (5) Studies have also confirmed an increase in insulin secretion by practicing a group of asanas such as Ardha Matsyendrasana (half-twist pose), Dhanurasana

(bow pose), Vakrasana (twisted pose), Matsyendrasana (half-spinal twist) and Halasana (plough pose) (10). However, to the best of our knowledge there are no studies to evaluate the effects of single asana i.e. Ardha Matsyendrasana on blood glucose levels in T2DM.

2.0 AIM & OBJECTIVE

2.1 AIM:

- To evaluate the immediate effect of Ardha Matsyendrasana on blood glucose levels in patients with T2DM

2.2 OBJECTIVE OF THE STUDY:

- To study the changes in random blood glucose (RBG) levels after the practice of Ardha Matsyendrasana in patients with T2DM

3.0 REVIEW OF LITERATURE

The pancreas is a glandular organ that functions as a both an endocrine and exocrine gland. In other words, the pancreas has the dual function of secreting hormones into blood (endocrine) and secreting enzymes through ducts (exocrine).(11)

- ❖ The pancreas belongs to the endocrine and digestive systems—with most of its cells (more than 90%) working on the digestive side.
- ❖ However, the pancreas performs the vital duty of producing hormones—most notably insulin—to maintain the balance of blood glucose (sugar) and salt in the body.

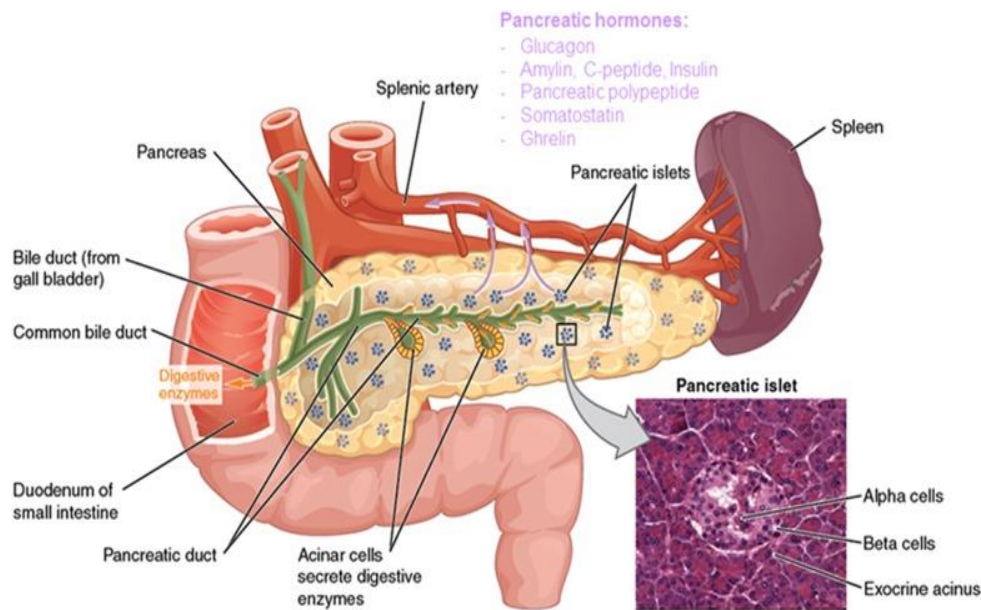


Figure 3: Anatomy Of Pancreas

Source: IDF Diabetes Atlas, 9th edition 2019.

The opposing and balanced actions of glucagon and insulin, referred to as glucose homeostasis. During sleep or in between meals, when the blood glucose levels reduces, glucagon is released from α -cells to promote hepatic glycogenolysis. In addition, glucagon drives hepatic and renal gluconeogenesis to increase endogenous blood glucose levels during prolonged fasting. In contrast, insulin secretion from β -cells is stimulated by elevated exogenous glucose levels, such as those occurring after a meal.(12) After docking to its receptor on muscle and adipose tissue, insulin enables the insulin-dependent uptake

of glucose into these tissues and hence lowers blood glucose levels by removing the exogenous glucose from the blood (Figure 2).

Furthermore, insulin promotes glycogenesis, lipogenesis and the incorporation of amino acids into proteins; thus, it is an anabolic hormone, in contrast to the catabolic activity of glucagon.(13) Without this balance, your body is susceptible to serious complications, such as diabetes.(11)

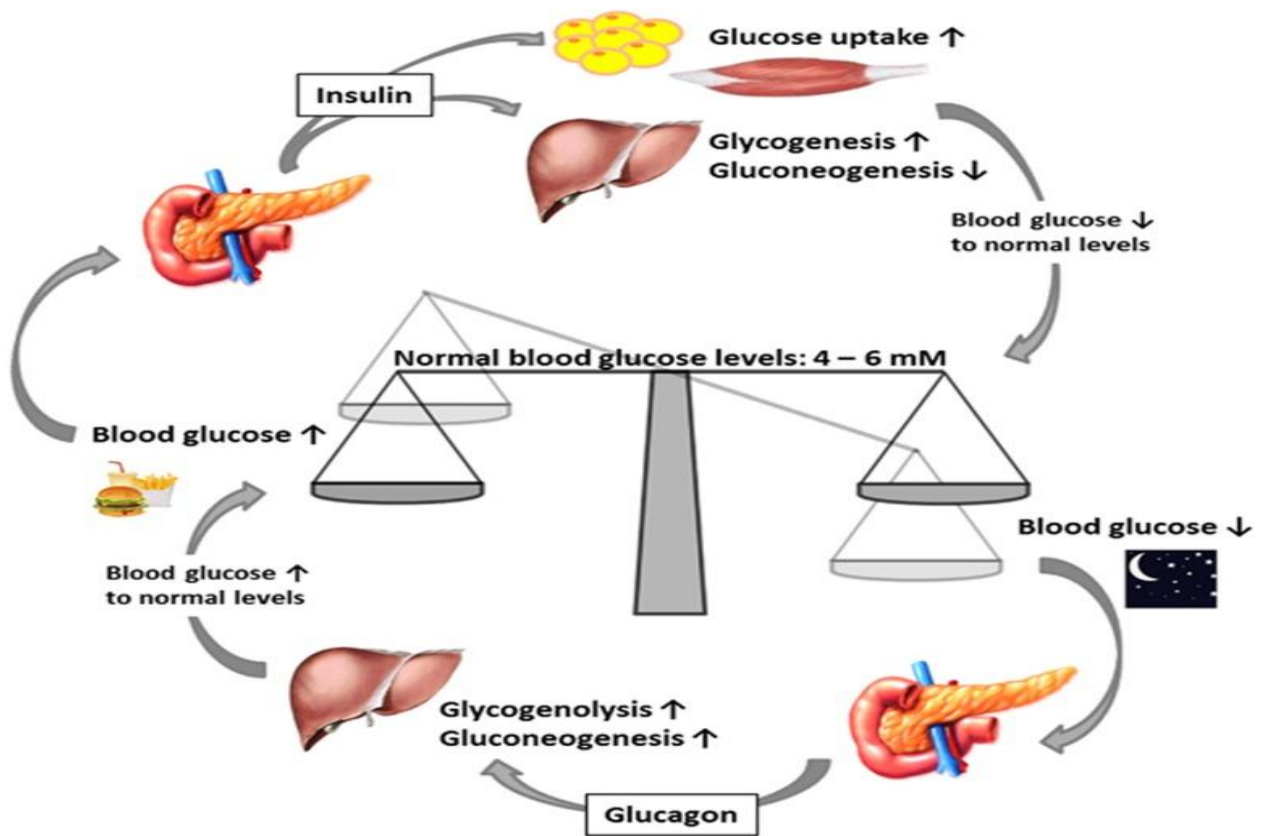


Figure 4: Glucose Homeostasis

Source: IDF Diabetes Atlas, 9th edition 2019.

3.1 DEFINITION:

Diabetes is a disease that occurs when the blood glucose, also called blood sugar, is too high. Blood glucose is the main source of energy and comes from the food consumed. Insulin, a hormone made by the pancreas, helps glucose from food get into your cells to be used for energy.(14)

DIABETES MELLITUS

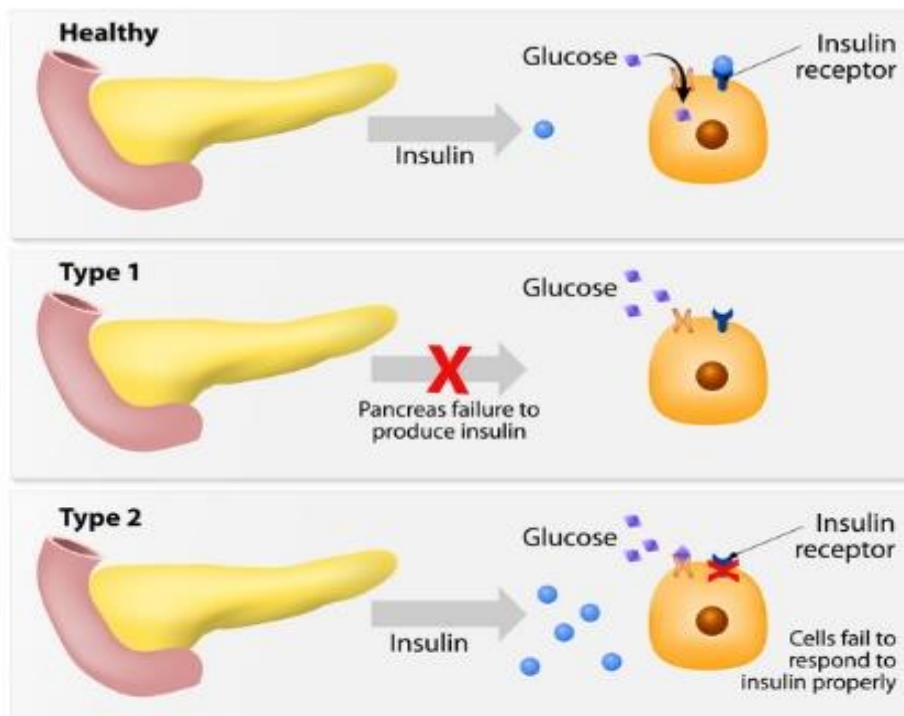


Figure 5: Diabetes & Types

Diabetes mellitus is a group of metabolic diseases characterized by chronic hyperglycemia resulting from defects in insulin secretion, insulin action, or both.(15)

"Diabetes mellitus is a sign of overstate metabolism evoked through the sympathetic and the linked endocrines which first asserts itself in relation to the most abundant food material - the carbohydrates, but as the disease advances it expresses itself in relation to all the diet, fats especially, blood contains normally a certain proportion of sugar which varies from .15 per cent to .2 per cent, but this is increased after meals. The liver and muscles act as a reservoir and store up the oversupply or excess of the carbohydrates in the form of glycogen. If it were not for this store-house, we should have far more than .2 per cent glucose in the blood; then hyperglycemia would occur and glycosuria would follow. In health the glycogen that is stored in the liver is reconverted into glucose which is distributed to the muscles by the circulation of the blood and there burnt up, producing heat and energy.(16)

Metabolic abnormalities in carbohydrates, lipids, and proteins result from the importance of insulin as an anabolic hormone.

The severity of symptoms is due to the type and duration of diabetes. Uncontrolled diabetes may lead to stupor, coma and if not treated death, due to ketoacidosis or rare from nonketotic hyperosmolar syndrome.(17)

3.2 PREVALENCE:

Diabetes is found in every population in the world and in all regions, including rural parts of low- and middle-income countries. The number of people with diabetes is steadily

rising, with WHO estimating there were 422 million adults with diabetes worldwide in 2014. The age-adjusted prevalence in adults rose from 4.7% in 1980 to 8.5% in 2014, with the greatest rise in low- and middle-income countries compared to high-income countries.(18) .

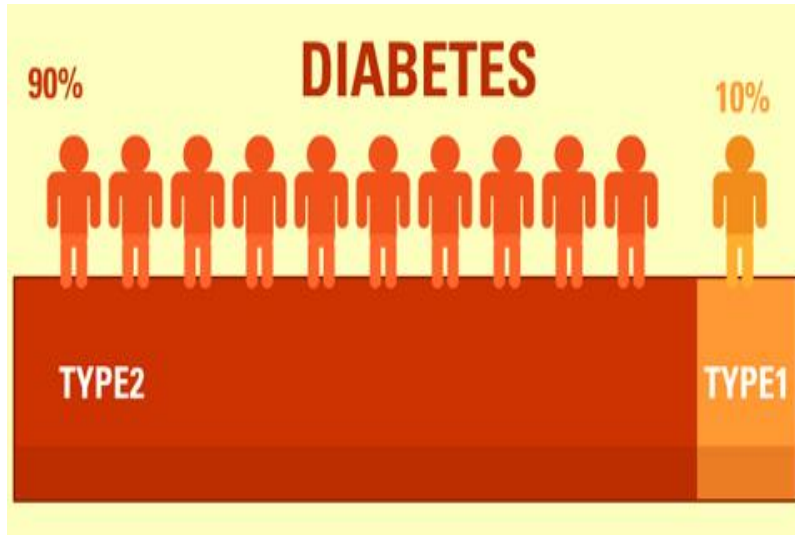


Figure 6: Ratio Of Type 1 & Type 2 Diabetes mellitus

Source: IDF Diabetes Atlas, 9th edition 2019.

In addition, the IDF estimates that 1.1 million children and adolescents aged 14–19 years have T1DM. Without any measures to prevent the increase in diabetes, there will be at least 629 million people living with diabetes by 2045. High blood glucose causes almost 4 million deaths each year and the IDF estimates that the annual global health care spending on diabetes among adults was US\$ 850 billion in 2017.(19)(18).

1. Type 1 Diabetes.
2. Type 2 Diabetes.
3. Gestational diabetes mellitus (GDM).

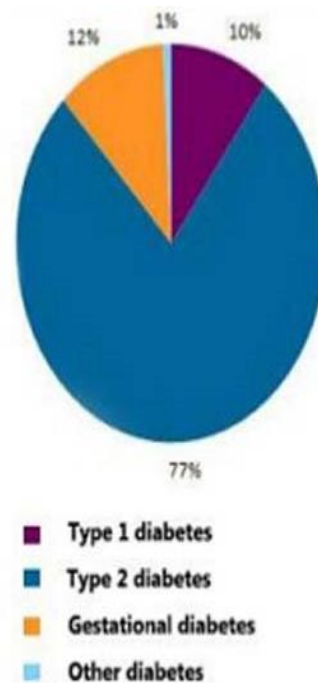


Figure 7: Diabetes Prevalence

3.3 CLASSIFICATION:

WHO (World Health Organization) published its first widely accepted and globally adopted classification of diabetes in 1980 (20) and an updated version of this in 1985 (21). These classifications included two major classes of diabetes: insulin dependent diabetes mellitus (IDDM), or type 1; and non-insulin dependent diabetes mellitus (NIDDM), or type 2 (20). The 1985 report omitted the terms “type 1” and “type 2”, but retained the classes IDDM and NIDDM, and introduced a class of malnutrition-related diabetes mellitus (MRDM) (21). Both the 1980 and 1985 reports included two other classes of diabetes: “other types” and “gestational diabetes mellitus” (GDM). These were reflected in the International nomenclature of diseases (IND) in 1991, and the tenth revision of the

International Classification of Diseases (ICD–10) in 1992. These reports represented a compromise between clinical and etiological classification and allowed clinicians to classify individual subjects even when the specific cause or etiology was unknown.

In 1999 WHO recommended that the classification should encompass not only the different etiological types of diabetes, but also the clinical stages of the disease (see Figure 3). The clinical staging reflects that people with diabetes, regardless of type, can progress through several stages, from normoglycaemia to severe hyperglycaemia with ketosis. However, not everyone will go through all stages. Moreover, individuals with T2DM may move from stage to stage in either direction. People who have, or who are developing, diabetes can be categorized by stage according to clinical characteristics, in the absence of information concerning the underlying etiology. In 1999, WHO reintroduced the terms type 1 and type 2 diabetes and dropped MRDM because of lack of evidence to support its existence as a distinct type.(22)

Types	Stages	Normoglycaemia	Hyperglycaemia			
		Normal glucose tolerance	Impaired glucose regulation IGT and/or IFG	Diabetes Mellitus		
				Not insulin requiring	Insulin requiring for control	Insulin requiring for survival
Type 1 • Autoimmune • Idiopathic		←				→
Type 2* • Predominantly insulin resistance • Predominantly insulin secretory defects		←			→	→
Other specific types*		←			→	→
Gestational diabetes*		←			→	→

Figure 8: Types & Stages Of Diabetes

TYPE 1 DIABETES MELLITUS (T1DM)

DESCRIPTION

- Known as Insulin-Dependent Diabetes Mellitus (IDDM).
- Characterized by hyperglycemia due to an absolute deficiency of the insulin hormone produced by the pancreas.
- Patients require lifelong insulin injections for survival.

- Usually develops in children and adolescents.
- With / without severe symptoms such as coma or ketoacidosis.
- Patients are usually not obese in T1DM.
- Increased risk factors are development of microvascular and macro vascular complications.

TYPE 2 DIABETES MELLITUS (T2DM)

DESCRIPTION

- Named as non-insulin-dependent diabetes mellitus (NIDDM).
- Characterized by hyperglycemia due to a defect in insulin secretion along with insulin resistance.
- Patients do not require lifelong medication which can be controlled blood diet and exercise, or in combination with oral medications, or with the addition of insulin.
- Is related to obesity, decreased physical activity and unhealthy diets.
- As in T1DM patients are prone for micro vascular and macro vascular complications.

GESTATIONAL DIABETES (GDM)

DESCRIPTION

- Characterized by hyperglycemia of varying severity diagnosed during pregnancy (without previously known diabetes) and usually (but not always) resolving within 6 weeks of delivery.
- Risks to the pregnancy itself include congenital malformations, increased birth weight and an elevated risk of perinatal mortality.
- increased risk to woman of developing diabetes (T2D) later in life.(23)

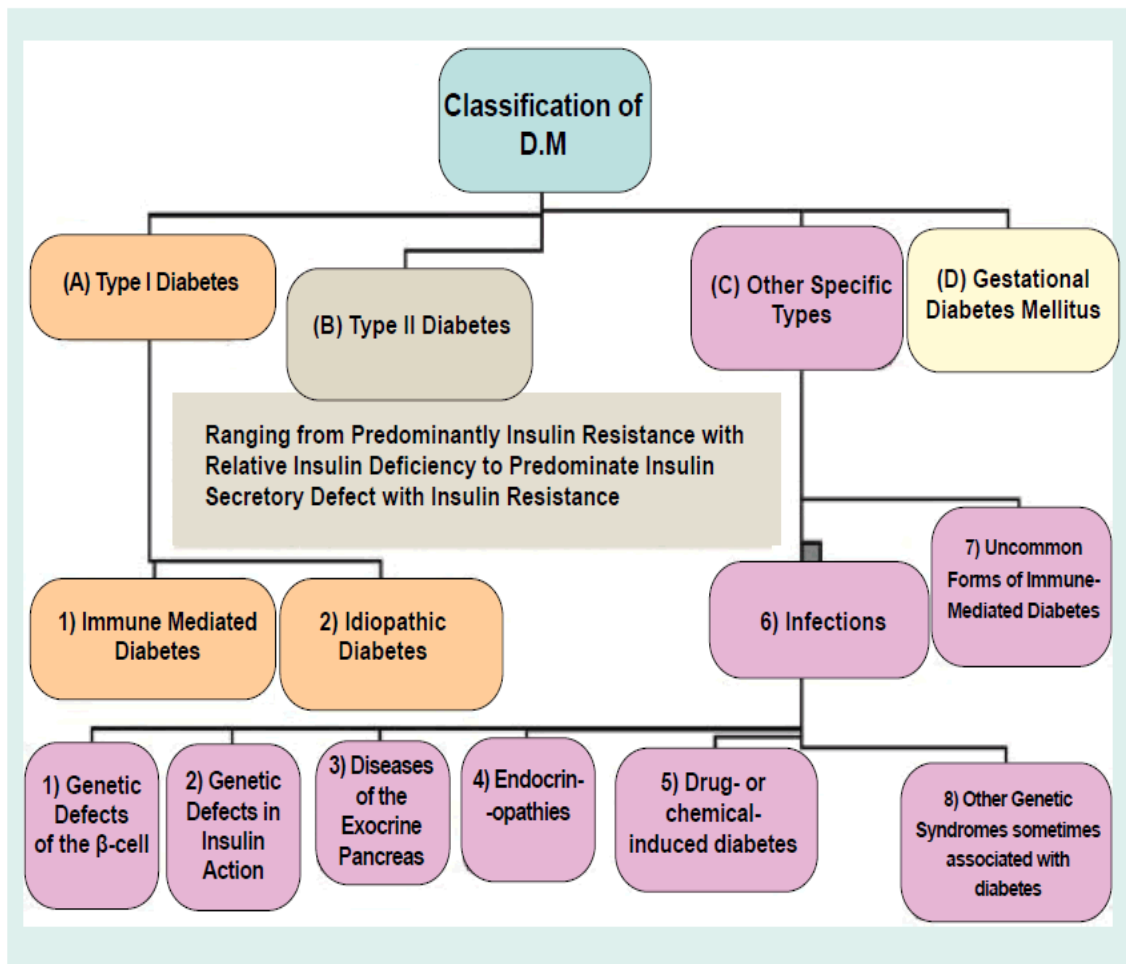


Figure 9:Classification Of Diabetes

3.4 CAUSES:

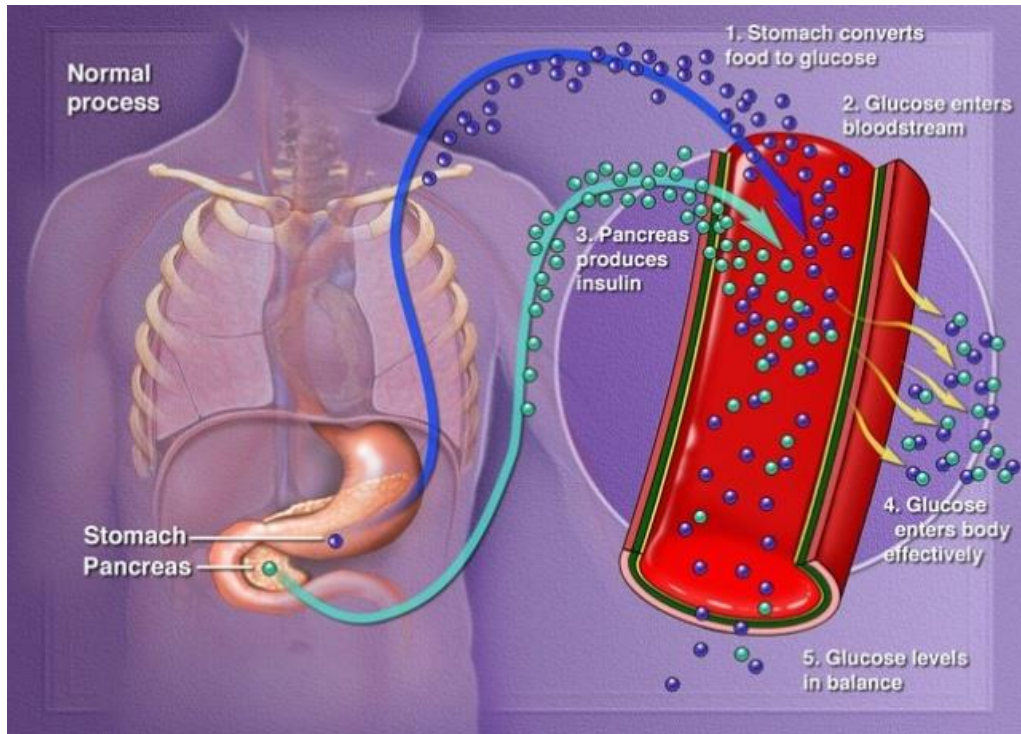


Figure 10: Glucose & Insulin Overview

Source: IDF Diabetes Atlas, 9th edition 2019.

Diabetes Mellitus is a disease characterized by the build-up of sugar in the blood. This is made possible by a hormone called insulin which allowing glucose into the cells to be used as energy.

TYPE 1 DIABETES MELLITUS:

In patient with [type 1 DM](#) the insulin is deficient. This deficiency is the result of autoimmune process in which white blood cells specifically target and destroy the beta-cells of the pancreas (which produce and release insulin).

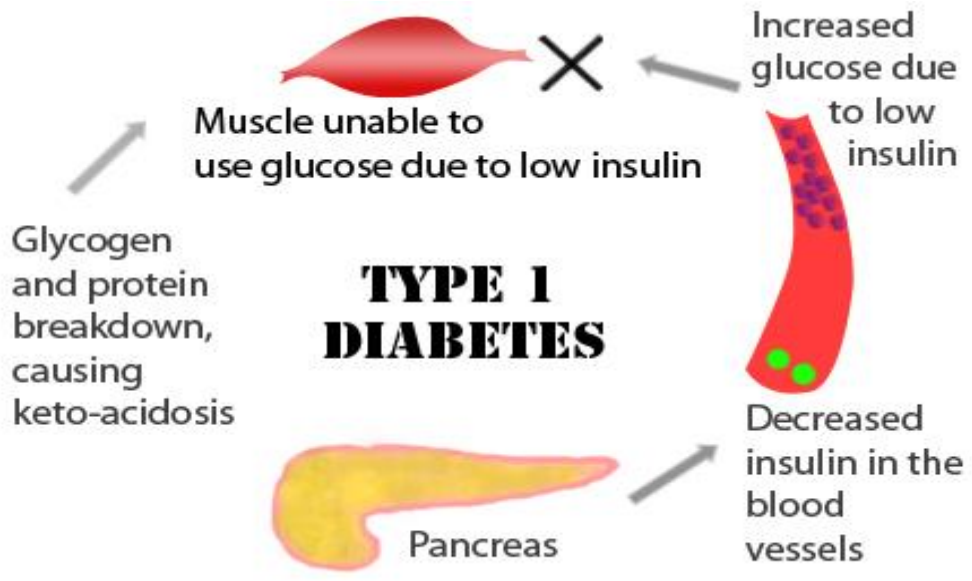


Figure 11: Type 1 Diabetes

Source: IDF Diabetes Atlas, 9th edition 2019.

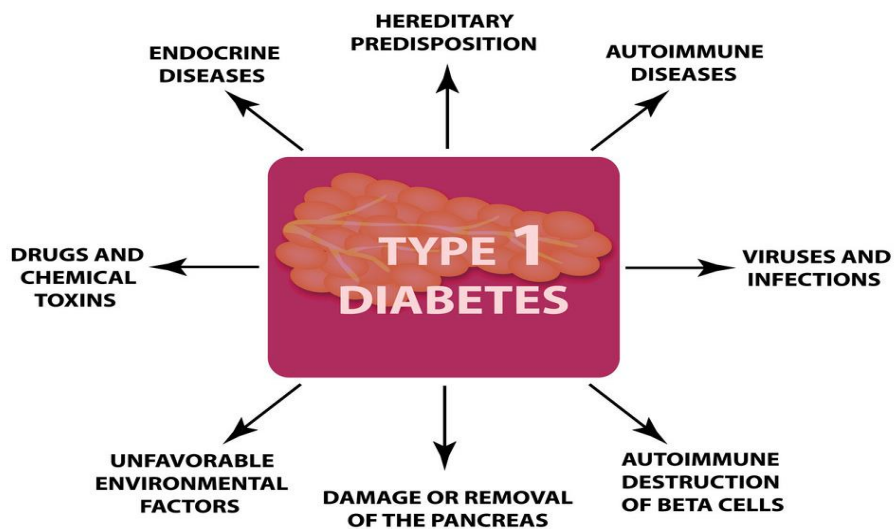


Figure 12: Causes Of Type 1 Diabetes

LADA (Latent Autoimmune Diabetes in Adults) is an adult-onset variant of type 1 DM. In this Beta cells are damaged and stop producing both insulin and glucagon. The diagram shows that there is lots of glucose building up in the blood stream because it cannot enter the muscle due to a lack of insulin which would normally allow sugar to flow from the blood into the muscle to be used as energy.

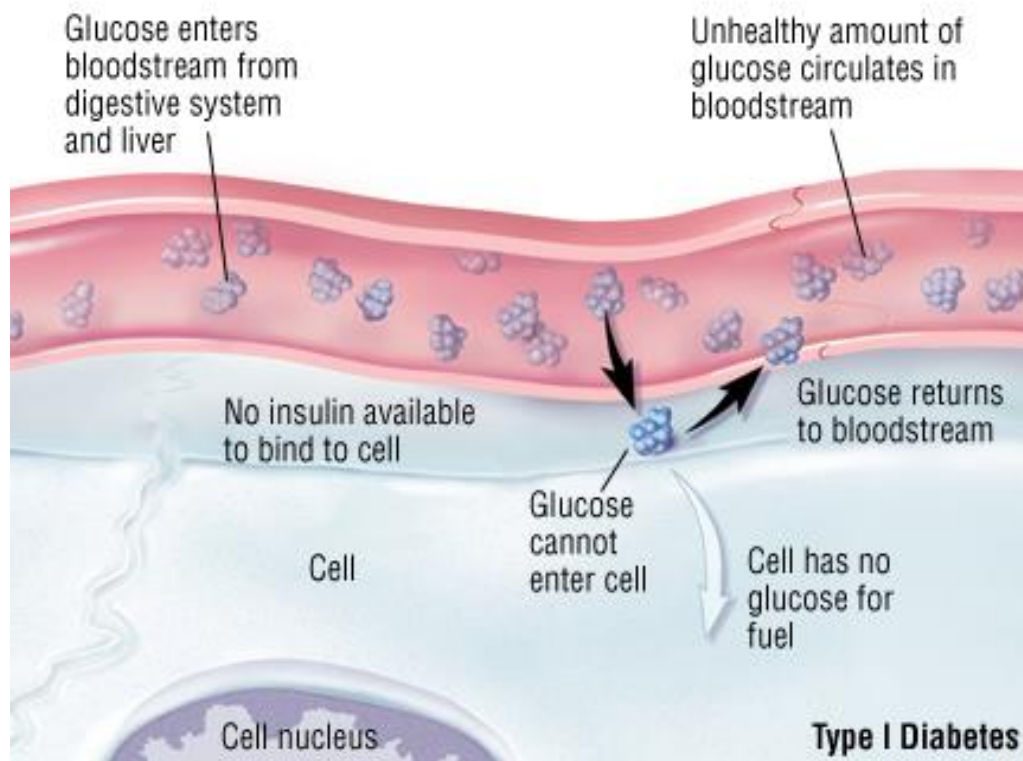


Figure 13: Latent Autoimmune Diabetes in Adults

TYPE 2 DIABETES MELLITUS:

In patients with type 2 diabetes insulin is still produced but the [root problem is instead "insulin-resistance"](#), that is in that plenty of insulin available they are not working

properly. In fact, the pancreas might actually release more insulin than usual in an attempt to help more glucose leave the blood. Although not fully understood, insulin resistance appears to be the result of genetic risk factors often in combination with poor diet and a sedentary lifestyle. For this reason, [diet](#) and exercise in combination with oral medications may be sufficient to regulate blood sugar in some patients. However, the progression of the disease often mandates insulin by injections at long-term because beta-cells may begin to die out. In other words, type 2 can progress to an insulin-deficiency over time.(24)

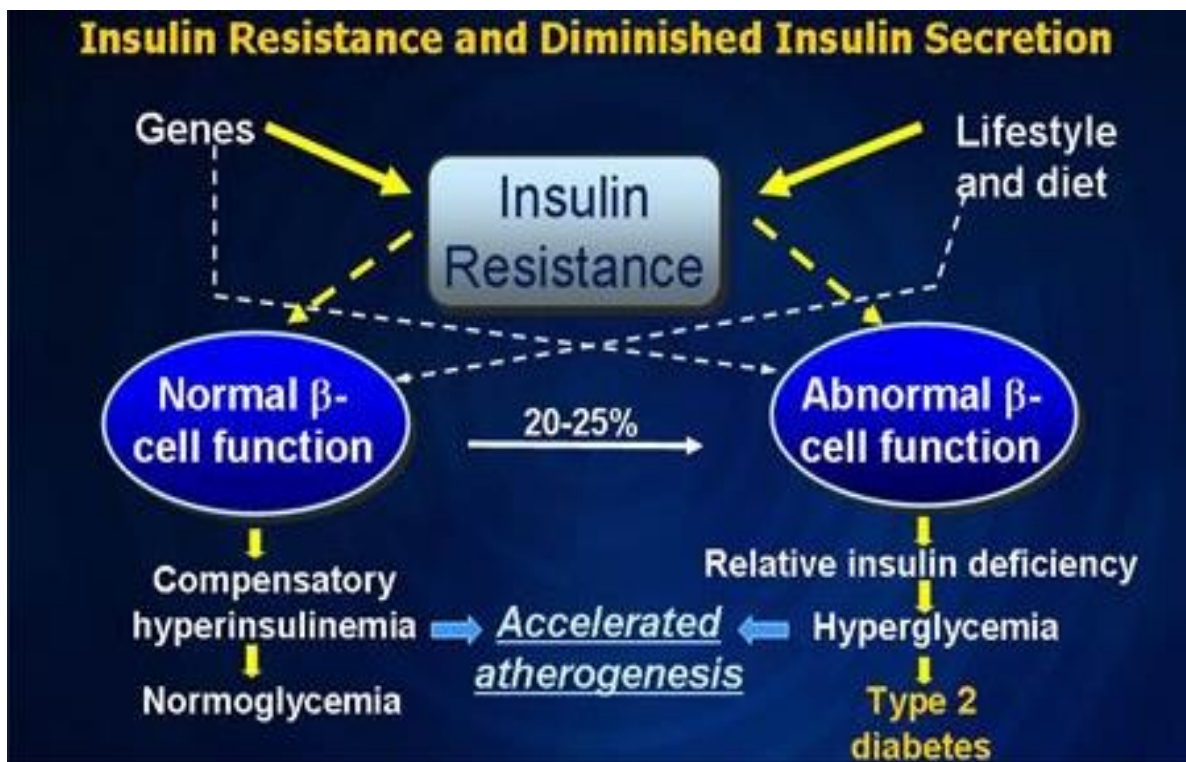


Figure 14: Etiology Of Type 2 Diabetes Mellitus

3.5 SYMPTOMS:

Frequent urination or great thirst - approach the doctor.

The symptoms are:

1. Thirst or polydipsia.
2. Passing large quantities of saccharine urine-- polyuria.
3. Excessively large appetite or polyphagia.
4. Loss of weight.
5. Blurred vision
6. Sores that do not heal
7. Numbness or tingling in the feet or hands. (25)

Complain of itching over the body; pulse is usually rapid, with no temperature. As the disease progresses, there is a train of complications that arise that make the patient more anxious. Boils, carbuncles, itching, gangrene, impotence, may complicate diabetes. The sexual function is greatly impaired. If conception occurs, abortion is likely to follow. (16)

SYMPTOMS OF T1DM:

- Increased urinary frequency (polyuria), thirst (polydipsia), hunger (polyphagia), and unexplained weight loss.
- Numbness in extremities, pain in feet (disesthesias), fatigue, and blurred vision.
- Recurrent or severe infections.

- Loss of consciousness or severe nausea/vomiting (ketoacidosis) or coma.
Ketoacidosis more common in T1D than in T2D.

SYMPTOMS OF T2DM:

- Patients may have no symptoms at all or minimal symptoms for years before being diagnosed.
- May have increased urinary frequency (polyuria), thirst (polydipsia), hunger (polyphagia), and unexplained weight loss.
- May also experience numbness in extremities, pain in feet (disesthesias), and blurred vision.
- May have recurrent or severe infections.
- Patients may present with loss of consciousness or coma but this is less common than in T1D.

SYMPTOMS OF GDM

- Increased thirst (polydipsia) and increased urination (polyuria) are more commonly noted (although other symptoms can be present).
- Because pregnancy itself causes increased urination, these symptoms are difficult to recognize as abnormal.

- a larger than normal baby during pregnancy (noted on routine prenatal exam) may prompt diabetic screening.(23)

3.6 TREATMENT:

TREATMENT – T1DM

- Delay of complications by targeting normal blood glucose levels
- Lifelong insulin injections in different combinations
- Glucometers to self-monitor blood glucose
- Early detection and treatment of complications
- Educating patient about self-monitoring for sign/symptoms of hypoglycemia and hyperglycemia
- Educating patient about diet, exercise, and foot care

Treatment – T2DM

- Aim of treatment is to give symptomatic relief and targeting normal blood glucose levels.
- With diet and exercise, or with addition of oral medications, with or without insulin alone.
- Glucometers to self-monitor blood glucose.
- Early detection and treatment of complications.

- Self-monitoring for signs/symptoms of hypoglycemia and hyperglycemia.
- Educating patient about diet, exercise, and foot care.

Treatment - GDM

- Strict metabolic control of blood glucose to prevent the obstetrical complications.
- Treated with diet & exercise, with addition of oral medications, or with the addition of insulin therapy.
- Glucometers to self-monitor blood glucose.
- Patient education about diet and exercise.
- Educating patients after delivery regarding weight loss/exercise to prevent future diabetes.
- Lifelong screening for t2d as patient will be in high risk category.(23)

3.9 PATHOPHYSIOLOGY:

MECHANISM:

In type 2 diabetes, the body does not respond properly to insulin - known as insulin resistance. The disease process of type 2 diabetes involves:

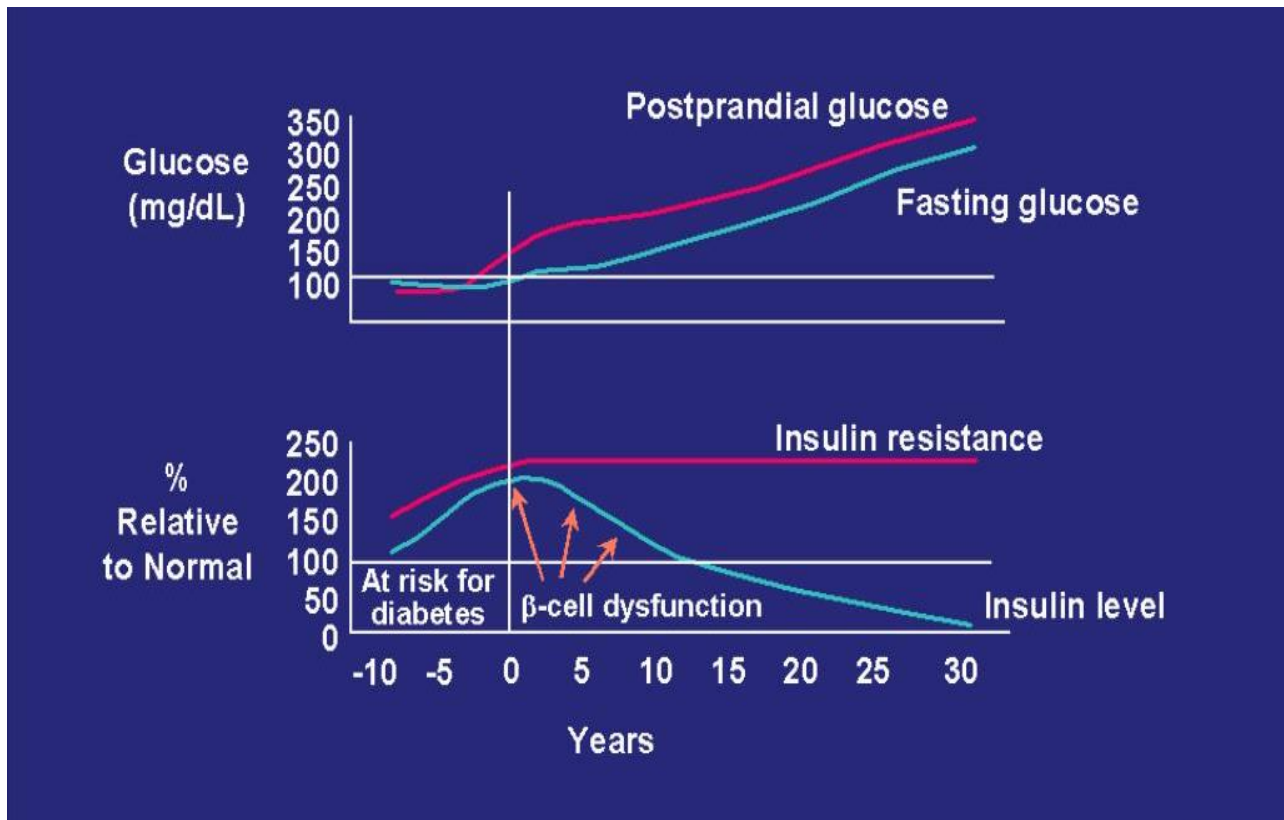


Figure 15: Disease Process Of Type 2 Diabetes mellitus

- The first stage in T2DM is insulin resistance. Although insulin can attach normally to the receptors on liver and muscle cells, the hormone becomes less effective at triggering the mechanisms inside the cell that allow glucose to enter and be burned for fuel or stored. Most people with type 2 diabetes mellitus initially produce normal, or even high, amounts of insulin, and the insulin is enough to normally regulate blood sugar and usually enough to overcome resistance.

- Over time, the pancreas becomes unable to produce enough insulin to overcome the resistance. In type 2 diabetes, the initial effect of this stage is usually an abnormal rise in blood sugar level after a meal (called postprandial hyperglycemia or impaired glucose tolerance [IGT]).
- Eventually, the cycle of elevated glucose further damages the beta cells, thereby drastically reducing insulin production and causing full-blown diabetes. This is made evident by fasting hyperglycemia, in which glucose levels are high, even in the early morning before eating breakfast.
- Finally, as beta cell insulin production reduces even more patient develop full type 2 diabetes.(26)

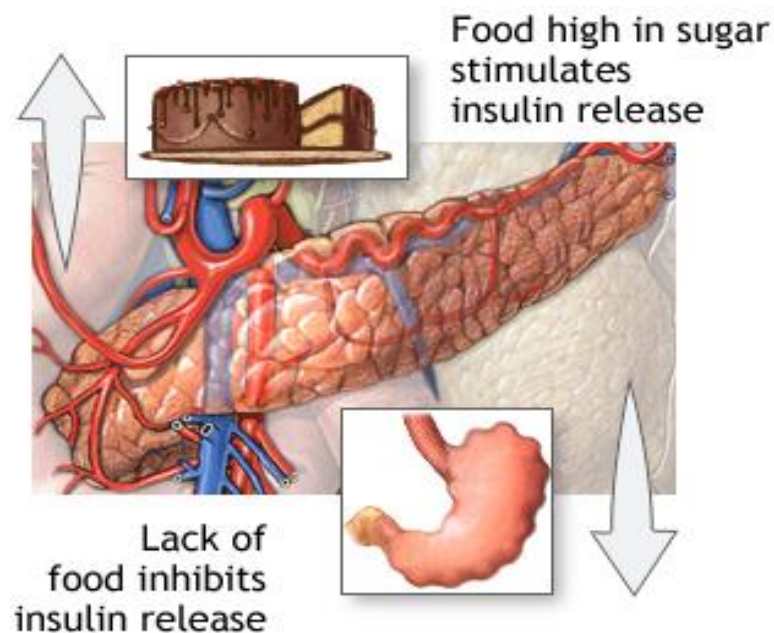


Figure 16: Food Vs Insulin

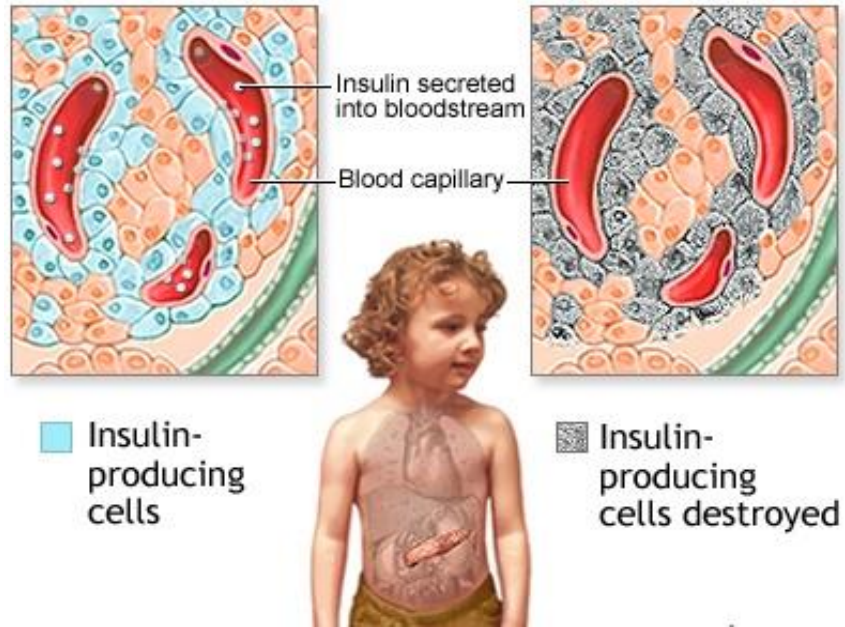


Figure 17: Comparison Between Active & Destroyed Insulin Producing Cells

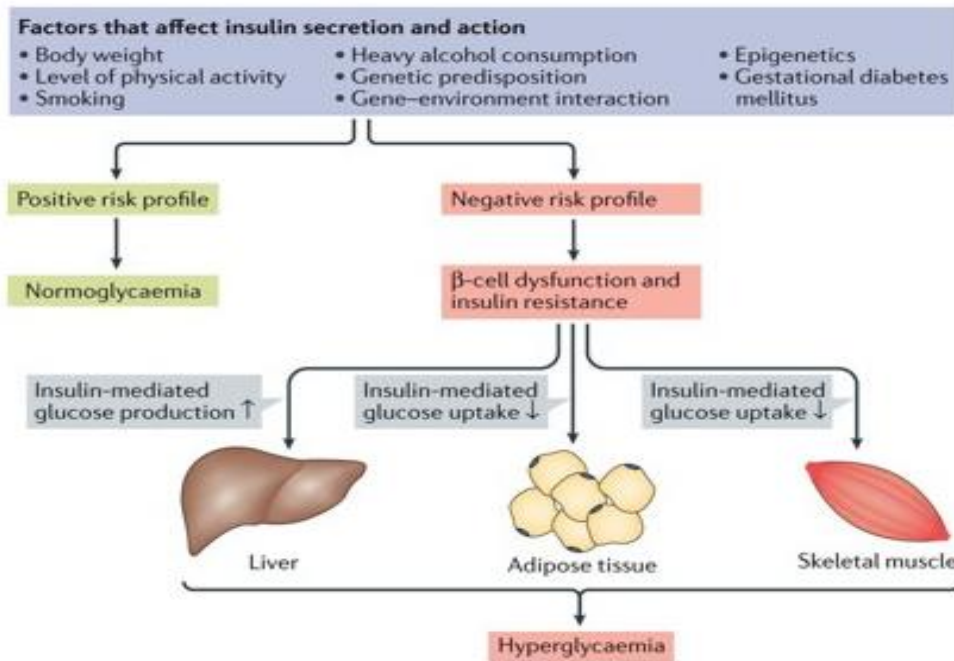


Figure 18: Factors Affecting Insulin Secretion & Action

Insulin secretion from the β -cells in the pancreas normally reduces glucose output by the liver and increases glucose uptake by skeletal muscle and adipose tissue. Once β -cell dysfunction in the pancreas and/or insulin resistance in the liver, skeletal muscle or adipose tissue occur, hyperglycemia develops, leading to an excessive amount of glucose circulating in the blood. The various factors affecting insulin secretion and insulin action are:

- ❖ Body weight
- ❖ Heavy alcohol consumption
- ❖ Epigenetics
- ❖ Level of physical activity
- ❖ Smoking
- ❖ Genetic predisposition
- ❖ Gestational diabetes mellitus
- ❖ Gene – environment interaction

3.10 COMPLICATION:

High blood glucose level leads to problems such as

- Heart disease
- Stroke

- Kidney disease
- Eye problems
- Dental disease
- Nerve damage
- Foot problems

HEART DISEASE & STROKE

Diabetes can damage blood vessels and lead to heart disease and stroke.

Over time, high blood glucose levels - diabetes can damage the blood vessels and the nerves that control the heart and blood vessels. The longer you have diabetes, the higher the chances that you will develop heart disease. (27)

People with DM tend to develop heart complaints at a younger age than people without diabetes. In adults with DM, the most common causes of death are the heart disease and stroke. Adults with diabetes are nearly twice as likely to die from heart disease or stroke as people without diabetes.(28)

can be prevented by managing your blood glucose, blood pressure, and cholesterol levels; and by not smoking.

❖ Smoking

It is important to stop smoking because both smoking and DM can narrow blood vessels. Smoking also increases the chances of developing other long-term problems such as lung disease. Smoking also can damage the blood vessels in your legs and increase the risk of lower leg infections, ulcers, and amputation.

❖ **High blood pressure**

Heart will work harder to pump blood. High blood pressure can strain the heart, damage blood vessels, and increase the risk of heart attack, eye problems, stroke, and kidney problems.

❖ **Abnormal cholesterol levels**

Cholesterol is a type of fat produced by the liver and found in the blood.

There are two kinds of cholesterol: Low Density Lipoprotein (LDL) and High Density Lipoprotein(HDL).

LDL can build up and clog the blood vessels. High levels of LDL cholesterol raise the risk of developing heart disease.

Another type of blood fat, triglycerides, also can raise the risk of heart disease.(29)

LOW BLOOD GLUCOSE (Hypoglycemia)

Hypoglycemia occurs when the blood glucose drops too low. Certain diabetes medicines can lower blood glucose more likely. Testing the blood glucose regularly will help to prevent hypoglycemia.

FACTORS CAUSING HYPOGLYCEMIA:

Not eating enough carbohydrates (carbs)

When foods containing carbohydrates is consumed, digestive system breaks down the sugars and starches into glucose. Glucose then enters bloodstream and raises blood glucose level. If the consumption of carbohydrates is not enough to match the medication, blood glucose could drop too low.

Skipping or delaying a meal

Skip or delaying of meal blood glucose could drop too low.

Increasing physical activity

Increasing the physical activity level beyond normal routine can lower your blood glucose level for up to 24 hours after the activity.

Drinking too much alcohol without enough food

Alcohol makes it harder for body to keep blood glucose level steady, especially if the food is not taken in a while. The effects of alcohol can also keep people from feeling the symptoms of hypoglycemia, which may lead to severe hypoglycemia.

Being sick

When sick people may not be able to eat as much or keep food down, which can cause low blood glucose.(30)

Diabetic Neuropathy

Diabetic neuropathy is the nerve damage that can result from DM. Different types of nerve damage affect different parts of the body.

❖ **Peripheral Neuropathy**

It is a type of nerve damage that typically damage the feet and legs and sometimes affects the hands and arms. This type of neuropathy is very common. About one-third to one-half of the people with diabetes will have peripheral neuropathy.

❖ **Autonomic Neuropathy**

Autonomic neuropathy is damage to nerves that control your internal organs, leading to problems with heart rate and blood pressure, digestive system, bladder, sex organs, sweat glands, and eyes. The damage can also lead to hypoglycemia unawareness

❖ **Focal Neuropathies**

Focal neuropathies are conditions in which it typically have damage to single nerves, most often in hand, head, torso, or leg. The most common types of focal neuropathy

are entrapment syndromes, such as carpal tunnel syndrome. Other types of focal neuropathy are much less common.

❖ **Proximal Neuropathy**

Proximal neuropathy is a rare and disabling type of nerve damage in hip, buttock, or thigh. The damage typically affects one side of your body and may rarely spread to the other side. Symptoms gradually improve over a period of months or years.(31)

KIDNEY DISEASE

Diabetic kidney disease, also called diabetic nephropathy. kidney disease caused by diabetes.

Diabetes is the leading cause of kidney disease. About 1 out of 4 adults with diabetes has kidney disease.(32)

Having diabetes for a longer time increases the chances that will have kidney damage.

- blood glucose is too high
- blood pressure is too high

American Indians, African Americans, and Hispanics/Latinos develop diabetes, kidney disease, and kidney failure at a higher rate than Caucasians.

People are more likely to develop kidney disease if they have diabetes and

- smoke

- don't follow diabetes eating plan
- eat foods high in salt
- are not active
- are overweight
- have heart disease
- have a family history of kidney failure.(33)

Foot Problems

Diabetes can lead to nerve damage and poor blood flow, which can lead to serious foot problems. Common foot problems such as a callus lead to pain or an infection that makes it hard to walk. Get a foot checkup at each visit with your health care team

Over time, diabetes may cause nerve damage, also called diabetic neuropathy, that can cause tingling and pain, and can make people lose feeling in their feet. Diabetes also can reduce the amount of blood flow in the feet. Not having enough blood flowing to legs and feet can make it hard for a sore or an infection to heal. Sometimes, a bad infection never heals. The infection might lead to gangrene.

Gangrene and foot ulcers that do not get better with treatment can lead to an amputation of toe, foot, or part of the leg. Although rare, nerve damage due to diabetes can lead to changes in the shape of your feet, such as Charcot's foot. Charcot's foot may

start with redness, warmth, and swelling. Later, bones in the feet and toes can shift or break, which can cause the feet to have an odd shape, such as a “rocker bottom.”(34)



Figure 19: Charcot’s Foot

EYE DISEASE:

Diabetes can damage the eyes and lead to low vision and blindness. Diabetes affects the eyes when the blood glucose, also called blood sugar, is too high. **If your blood glucose stays high over time**, it can damage the tiny blood vessels in the back of your eyes. This damage can begin during prediabetes. Damaged blood vessels may leak fluid and cause swelling. New, weaker blood vessels may also begin to grow. These blood vessels can bleed into the middle part of the eye, lead to scarring, or cause dangerously high pressure inside the eye.

Most serious diabetic eye diseases begin with blood vessel problems. The four eye diseases that can threaten vision are

Diabetic retinopathy

The retina is the inner lining at the back of each eye. The retina senses light and turns it into signals that the brain decodes, so we can see the world around. Damaged blood vessels can harm the retina, leading to a disease called diabetic retinopathy.

In early diabetic retinopathy, blood vessels get weaken, bulge, or leak into the retina. This stage is called as non proliferative diabetic retinopathy.

If the disease gets worse, some blood vessels close off, which causes new blood vessels to grow, or proliferate, on the surface of the retina. This stage is called proliferative diabetic retinopathy. These abnormal new blood vessels can lead to serious vision problems.



Figure 20: Normal Vision Of Two Boys Playing.



Figure 21: Image Viewed By A Person With Diabetic Retinopathy

Diabetic macular edema

The part of your retina that needed for reading, driving, and seeing faces is called the macula. Diabetes lead to swelling in the macula, which is called diabetic macular edema. Over time, this disease can destroy the sharp vision in part of the eye, leading to partial vision loss or blindness. Macular edema usually develops with people who already have other signs of diabetic retinopathy.

Glaucoma

Glaucoma is a group of eye diseases that can damage the optic nerve—the bundle of nerves that connects the eye to the brain. If not treated early, Diabetes doubles the chances of having glaucoma, which can lead to vision loss and blindness.



Figure 22:Image vied By People With Glaucoma Slowly Lose Side Vision

Cataracts

The lenses within our eyes are clear structures that help provide sharp vision—but they tend to become cloudy as age goes. People with diabetes are more likely to develop cloudy lenses, called cataracts. People with diabetes can develop cataracts at an earlier age than people without diabetes. Researchers think that high blood glucose levels cause

deposits to build up in the lenses of the eyes. Cloudy vision & faded colors are symptoms of cataracts.(35)(36)



Figure 23: Cloudy Vision & Faded Colors - Vied By Cataracts

Gum Disease & Other Dental Problems

Diabetes can lead to problems in the mouth, such as infection, gum disease, or dry mouth. To prevent keep the mouth healthy, manage the blood glucose, brush the teeth twice a day, check with the dentist at least once a year, and no smoke.

Too much glucose, also called sugar, in the blood from diabetes can cause pain, infection, and other problems in the mouth. the mouth includes

- teeth

- gums
- jaw
- tissues such as tongue, the roof and bottom of the mouth, and the inside of cheeks

Glucose is present in the saliva—the fluid in the mouth that makes it wet. When diabetes is not controlled, high glucose levels in the saliva help harmful bacteria grow. These bacteria combine with food to form a soft, sticky film called plaque. Plaque also comes from foods that contain sugars or starches. Some types of plaque cause tooth decay or cavities. Other types of plaque cause gum disease and bad breath.

High Glucose Levels = ↑ Plaque

Gum disease can be more severe and take longer to heal if diabetes present. In turn, having gum disease can make the blood glucose hard to control.

What happens if plaque present?

Plaque that is not removed hardens over time into tartar and collects above the gum line. Tartar makes it more difficult to brush and clean between the teeth. The gums become red and swollen, and bleed easily—signs of unhealthy or inflamed gums, called gingivitis.

When gingivitis is not treated, it can advance to gum disease called periodontitis. In periodontitis, the gums pull away from the teeth and form spaces, called pockets, which slowly become infected. This infection can last a long. The body fights the bacteria as the plaque spreads and grows below the gum line. Both the bacteria and the body's response

to this infection start to break down the bone and the tissue that hold the teeth in place. If periodontitis is not treated, the gums, bones, and tissue that support the teeth are destroyed. Teeth may become loose and might need to be removed.

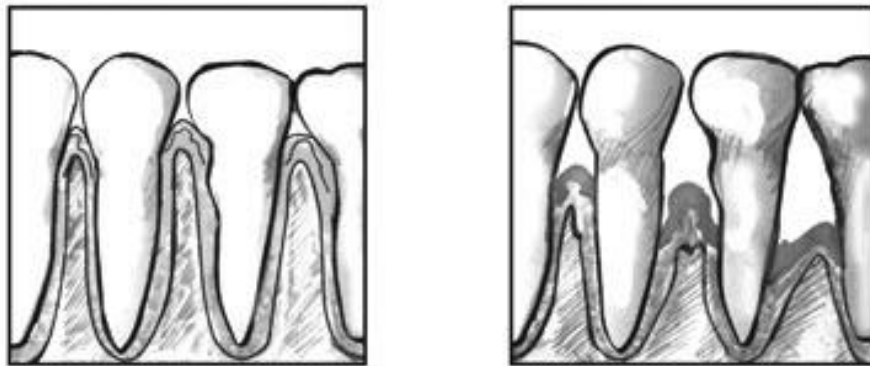


Figure 24: Healthy Gums & Periodontitis

Table 1: Most common Mouth Problems From Diabetes

Problem	What It Is	Symptoms
Gingivitis	<ul style="list-style-type: none"> • unhealthy or inflamed gums 	<ul style="list-style-type: none"> • red, swollen, and bleeding gums
periodontitis	<ul style="list-style-type: none"> • gum disease, which can change from mild to severe 	<ul style="list-style-type: none"> • red, swollen, and bleeding gums • gums that have pulled away from the teeth • long-lasting infection between the teeth and gums • bad breath that won't go away

Problem	What It Is	Symptoms
		<ul style="list-style-type: none"> • permanent teeth that are loose or moving away from one another • changes in the way your teeth fit together when you bite • sometimes pus between the teeth and gums • changes in the fit of dentures, which are teeth you can remove
thrush, called candidiasis	<ul style="list-style-type: none"> • the growth of a naturally occurring fungus that the body is unable to control 	<ul style="list-style-type: none"> • sore, white—or sometimes red—patches on your gums, tongue, cheeks, or the roof of your mouth • patches that have turned into open sores
dry mouth, called xerostomia	<ul style="list-style-type: none"> • a lack of saliva in your mouth, which raises your risk for tooth decay and gum disease 	<ul style="list-style-type: none"> • dry feeling in your mouth, often or all of the time • dry, rough tongue • pain in the mouth • cracked lips • mouth sores or infection

Problem	What It Is	Symptoms
		<ul style="list-style-type: none"> • problems chewing, eating, swallowing, or talking
oral burning	<ul style="list-style-type: none"> • a burning sensation inside the mouth caused by uncontrolled blood glucose levels 	<ul style="list-style-type: none"> • burning feeling in the mouth • dry mouth • bitter taste • symptoms may worsen throughout the day

More symptoms of a problem in the mouth are

- a sore, or an ulcer, that does not heal
- dark spots or holes in the teeth
- pain in the mouth, face, or jaw that doesn't go away
- loose teeth
- pain when chewing
- a changed sense of taste or a bad taste in the mouth
- bad breath that doesn't go away in spite of brushing. (37)

Sexual & Bladder Problems

Sexual and bladder problems are more common in people with diabetes. Problems like erectile dysfunction, loss of interest in sex, bladder leaks, and retained urine can happen if diabetes damages the blood vessels and nerves. (38)

Changes in sexual function or bladder habits may be a sign that they have diabetes. Nerve damage caused by diabetes, also called diabetic neuropathy, can damage parts of the body—like your genitals or urinary tract. For example, men with diabetes may develop erectile dysfunction (ED) 10 to 15 years earlier than men without diabetes.(39)

People are more likely to develop sexual or bladder problems if they have diabetes and

- have high blood glucose that is not well controlled, also called high blood sugar
- have nerve damage, also called neuropathy
- have high blood pressure that is not treated
- have high cholesterol that is not treated
- are overweight or have obesity
- are not physically active
- are taking certain medicines
- drinking too many alcoholic drinks
- smoke(40)(41)

3.11 HISTORY OF YOGA:

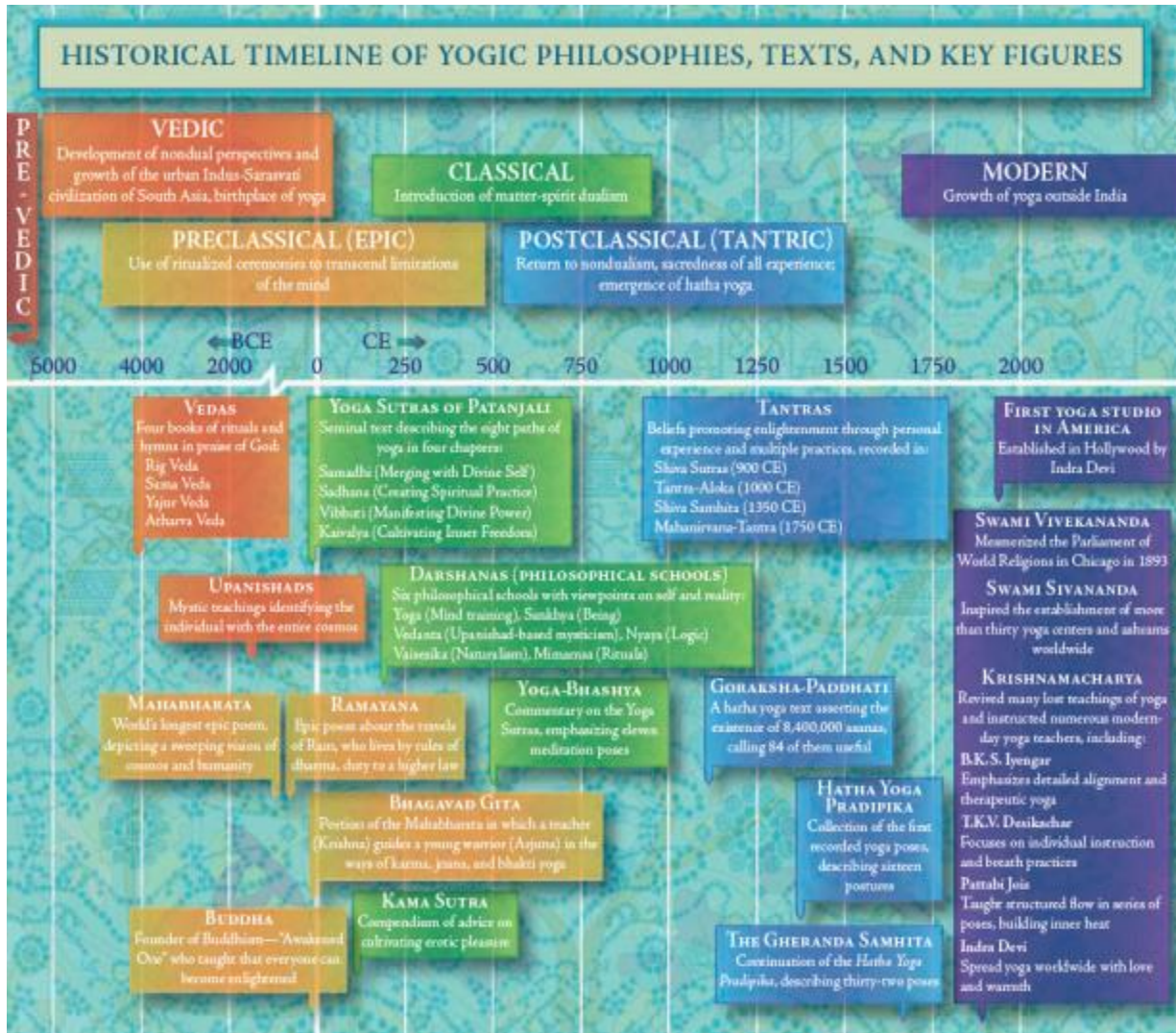


Figure 25: History Of Yoga

Yoga is a group of [physical](#), [mental](#), and [spiritual](#) practices or disciplines which got originated in [ancient India](#).(42) it is designed to bring balance and health to the physical, mental, emotional, and spiritual dimensions of the individual.(43) The word ‘Yoga’ is derived from the Sanskrit root ‘Yuj’, meaning ‘to join’ or ‘to yoke’ or ‘to unite’. As per Yogic scriptures the practice of Yoga leads to the union of individual consciousness with

that of the Universal Consciousness, indicating a perfect harmony between the mind and body, Man & Nature. One who experiences this oneness of existence is said to be in yoga, and is termed as a yogi who have attained to a state of freedom referred to as mukti, nirvana or moksha. Thus the aim of Yoga is Self-realization, to overcome all kinds of sufferings leading to 'the state of liberation' (Moksha) or 'freedom' (Kaivalya). The development of yoga can be traced back to over 5,000 years ago, but some researchers think that yoga may be up to 10,000 years old. Yoga's long rich history can be divided into four main periods of innovation, practice and development.

Pre-Classical Yoga

The beginnings of Yoga were developed by the Indus-Sarasvati civilization in Northern India over 5,000 years ago. The word yoga was first mentioned in the oldest sacred texts, the Rig Veda.

Classical Yoga

In the pre-classical stage, yoga was a mishmash of various ideas, beliefs and techniques that often conflicted and contradicted each other. The Classical period is defined by Patanjali's Yoga-Sûtras, the first systematic presentation of yoga. Written sometime in the second century, this text describes the path of Raja Yoga, often called "classical yoga". Patanjali organized the practice of yoga into an "eight limbed path" containing the steps and stages towards obtaining Samadhi or enlightenment. Patanjali is often considered the father of yoga and his Yoga-Sûtras still strongly influence most styles of modern yoga.

Post-Classical Yoga

A few centuries after Patanjali, yoga masters created a system of practices designed to rejuvenate the body and prolong life. They rejected the teachings of the ancient Vedas and embraced the physical body as the means to achieve enlightenment. They developed [Tantra Yoga](#), with radical techniques to cleanse the body and mind to break the knots that bind us to our physical existence. This exploration of these physical-spiritual connections and body centered practices led to the creation of what we primarily think of yoga in the West: Hatha Yoga.

The importation of yoga to the West still continued at a trickle until Indra Devi opened her yoga studio in Hollywood in 1947. [Hatha Yoga](#) now has many different schools or styles, all emphasizing the many different aspects of the practice.(44)



Figure 26: Sage Patanjali

Sage patanjali is the Father of yoga and compiler of the Yoga sutras, a text on Yoga theory and practice and a notable scholar of Samkhya school of Hindu philosophy. Pantanjali is also said to be an incarnation of Adi Sesha who is the first ego-expansion of Vishnu, Sankarshana. Pantanjali is worshiped by the dancers of India as their patron saint. However, Pantanjali's reputation as a great dancer is doubted by scholars who know him

as the author of the famous Sutras. It is said that once while watching a dance by Lord Shiva, Adi Shesha found it unbearable to support the weight of Lord Vishnu

Patanjali was born to Atri and Anusuya; both masters of Ashtanga yoga. The details surrounding his birth have assumed mythical dimensions. It is said that in order to teach yoga, Patanjali fell from the heavens in the form of a little snake, and fell into his virginal mother's open palms.(45)

Patanjali's ashtanga yoga includes eight components of practice ("ashtanga" means "eight-limbed" in Sanskrit), and dharana, or concentration is the sixth of these eight limbs. The seventh limb is dhyana, or meditation, and the eighth and final limb is samadhi, or enlightenment.

Patanjali divided his Yoga Sutras into four chapters, containing in all 196 aphorisms, divided as follows:

Samadhi Pada(51 sutras).

Samadhi refers to a state of direct and reliable perception (pramāṇa) where the yogi's self-identity is absorbed into the object meditated upon, collapsing the categories of witness, witnessing, and witnessed.

This chapter contains the famous definitional verse: "Yogaścitta-vritti-nirodhaḥ" ("Yoga is the restraint of mental modifications").

Sadhana Pada(55 sutras).

Sadhana is the Sanskrit word for "practice" or "discipline". it consists of two forms of Yoga: Kriyā Yoga and Ashtanga Yoga (Eightfold or Eight limbed Yoga).

Kriyā Yoga in the Yoga Sūtras is the practice of three of the Niyamas of Aṣṭāṅga Yoga: tapas, svādhyaya, and iśvarapraṇidhana – austerity, self-study, and devotion to god.

Aṣṭāṅga Yoga is the yoga of eight limbs: Yama, Niyama, Āsana, Prāṇāyāma, Pratyahara, Dhāraṇa, Dhyāna, and Samādhi.

VibhutiPada(56 sutras).

Vibhuti is the Sanskrit word for "power" or "manifestation". 'Supra-normal powers' (Sanskrit: siddhi) are acquired by the practice of yoga. Combined simultaneous practice of Dhāraṇā, Dhyana and Samādhi is referred to as Samyama, and is considered a tool of achieving various perfections, or Siddhis.

KaivalyaPada(34 sutras).

Kaivalya literally translates to "isolation", but as used in the Sutras stands for emancipation or liberation and is used where other texts often employ the term moksha (liberation). The KaivalyaPada describes the process of liberation and the reality of the transcendental ego.

Ashtanga, the eight components of yoga

Patanjali defines yoga as having eight components² (astanga, "eight limbs") The eight limbs of yoga are

- ★ **Yama** (abstinences),
- ★ **Niyama** (observances),

- ★ **Asana** (yoga postures),
- ★ **Pranayama** (breath control),
- ★ **Pratyahara** (withdrawal of the senses),
- ★ **Dharana** (concentration),
- ★ **Dhyana** (meditation) and
- ★ **Samadhi** (absorption).



Figure 27: Eight Limbs Of Yoga

1. Yama

Yama are ethical rules in Hinduism and can be thought of as moral imperatives. The five yamas listed by Patañjali in Yogasūtra are:

1. **Ahiṃsā**: Nonviolence, non-harming other living beings²
2. **Satya**: truthfulness, non-falsehood
3. **Asteya**: non-stealing
4. **Brahmacarya**: sexual restraint
5. **Aparigraha**: non-possessiveness

2. Niyama

The second component of Patanjali's Yoga path is called niyama, which includes virtuous habits, behaviours and observances (the "dos").

1. **Śauca**: purity, clearness of mind, speech and body
2. **Santoṣa**: contentment
3. **Tapas**: austerity
4. **Svādhyāya**: introspection of self's thoughts,
5. **Īśvarapraṇidhāna**: contemplation of the Ishvara (God/Supreme Being, Brahman, True Self.

3. Āsana

An asana is what is steady and pleasant. Motionless and Agreeable form (of staying)
is Asana — Yoga Sutras II.46

Asana is thus a posture that one can hold for a period of time, staying relaxed, steady, comfortable and motionless. "Posture one can hold with comfort and motionlessness". Asanas are perfected over time by relaxation of effort with meditation on the infinite";this combination and practice stops the quivering of body.The posture that causes pain or restlessness is not a yogic posture. Other 29 secondary texts studying Patanjali's sutra state that one requirement of correct posture is to keep chest, neck and head erect (proper spinal posture).

4. Prāṇāyāma

Prāṇāyāma is made out of two Sanskrit words prāṇa(, breath) and āyāma (, restraining or stretching). prāṇāyāma, which is the practice of consciously regulating breath (inhalation and exhalation). This is done in several ways, inhaling and then suspending exhalation for a period, exhaling and then suspending inhalation for a period, slowing the inhalation and exhalation, consciously changing the time/length of breath (deep, short breathing).

5. Pratyāhāra

Pratyāhāra is a combination of two Sanskrit words prati- (the prefix -, "against" or "contra") and āhāra ("bring near, fetch").

Pratyahara is drawing within one's awareness. It is a process of retracting the sensory experience from external objects. It is a step of self extraction and

abstraction. Pratyahara is not consciously closing one's eyes to the sensory world, it is consciously closing one's mind processes to the sensory world.

Pratyahara empowers one to stop being controlled by the external world, fetch one's attention to seek self-knowledge and experience the freedom innate in one's inner world.

6. Dhāraṇā

Dharana :sanskrit - means concentration, introspective focus and one-pointedness of mind. "hold, maintain, keep". Dharana as the sixth limb of yoga, is holding one's mind onto a particular inner state, subject or topic of one's mind. The mind is fixed on a mantra, or one's breath/navel/tip of tongue/any place, or an object one wants to observe, or a concept/idea in one's mind. Fixing the mind means one-pointed focus, without drifting of mind, and without jumping from one topic to another.

7. Dhyāna

Dhyana (Sanskrit) literally means "contemplation, reflection" and "profound, abstract meditation". Dhyana is contemplating, reflecting on whatever Dharana has focused on. If in the sixth limb of yoga one focused on a personal deity, Dhyana is its contemplation.

If the concentration was on one object, Dhyana is non-judgmental, non-presumptuous observation of that object. If the focus was on a concept/idea, Dhyana is contemplating that concept/idea in all its aspects, forms and consequences. Dhyana is uninterrupted train of thought, current of cognition, flow of awareness.

Dhyana is integrally related to Dharana, one leads to other. Dharana is a state of mind, Dhyana the process of mind. Dhyana is distinct from Dharana in that the meditator becomes actively engaged with its focus. Patanjali defines contemplation (Dhyana) as the mind process, where the mind is fixed on something, and then there is "a course of uniform modification of knowledge".

AdiShankara, in his commentary on Yoga Sutras, distinguishes Dhyana from Dharana, by explaining Dhyana as the yoga state when there is only the 31. "stream of continuous thought about the object, uninterrupted by other thoughts of different kind for the same object"; Dharana, states Shankara, is focussed on one object, but aware of its many aspects and ideas about the same object.

8. Samādhi

Samadhi (Sanskrit) literally means "putting together, joining, combining with, union, harmonious whole, trance". Samadhi is oneness with the subject of meditation. There is no distinction, during the eighth limb of yoga, between the actor of meditation, the act of meditation and the subject of meditation. Samadhi is that spiritual state when one's mind is so absorbed in whatever it is contemplating on, that the mind loses the sense of its own identity. The thinker, the thought process and the thought fuse with the subject of thought. There is only oneness, samadhi.

Asana:

Asana in the Vedic Texts

In the yogic context, the term ‘asana’ first time used in the fourth Veda, i.e. **Atharva Veda** around 1500 BCE. The literal meaning of ‘asana’ derived from the root word ‘Aas’ means ‘existence’. Here asanas as postures are meant to develop a ‘state of existence’ in the seeker.

Further, In **Bhagavad-Gita**, a part of Mahabharata, ‘asana’ could be seen to ‘sit straight’ in a comfortable seat. There are two asanas mentioned in Mahabharata, namely – ‘Mandukasana (Frog Pose)’ and ‘Virasana (Hero Pose)’.

Other Indian texts like VisnudharmottraPurana and **Brahma Purana** in 300 CE also mentioned the name to some meditative postures like Swastikasana, Padmasana, and ArdhaPadmasana.



Figure 28: Various Asana For Diabetes Mellitus

Asana in Patanjali's Yoga Sutra

Yoga's most ancient and comprehensive text found till date is the Yoga Sutras of Patanjali in 2nd century BCE.

Yoga Sutra 'Chapter 2 Verse 47' "**SthiraSukhamAsanam**"

- **Sthira** – Steady, stable or grounded

- **Sukham** – Comfort, ease or peaceful
- **Asanam** – Posture
- **Narration** – When you try to come into a pose, it takes time to stabilize the body, i.e., in the beginning, it seems hard to hold the body into a pose. It's the steadiness of a pose.

Asana in Hatha Yoga Pradipika

“Asana is the first accessory of hatha yoga which is practised to gain steadiness in pose and lightness in the body” – HYP 1.19

Origin of Yoga Poses

Some of the yoga postures came into existence when Indian exercise tradition (called *vyayama*) and west's gymnastics approach exercises get mixed. These are called **modern yoga asanas**, barely has 200 years of history. However, traditional asanas have a history even before when Patanjali existed 2000 years back in India.

Some examples of asanas originated from natural observation are:

1. **Cobra pose** – By observing how cobra releases their aggression and emotions by stretching through the head, Bhujangasana (Cobra pose) is derived.
2. **Tree Pose** – By observing how a tree firmly stands on its base, Virksasana (tree pose) is derived where we try to balance our upper body on unshakable feet.

3. **Sun Salutation** – For being a source of light to the world, Sun Salutation is derived to worship the sun at the time of sunrise. It comprises 12 asanas which said to have ties to ancient times.

- According to GorakshaSamhitha/GorakshaPaddhathi- Number of Asana - 2
- According to Shiva Samhitha - Number of Asana – 4
- According to HYP - Number of Asana – 15
- According to Gheranda Samhita - Number of Asana – 32
- According to Hatha Ratnavali - Number of Asana – 84
- According to JogaPradipika - Number of Asana – 84
- According to Light on Yoga - Number of Asana – 200 etc..(46)

From the various asana we selected a particular asana – Ardha Matsyendrasana for the diabetes patients, with the reference from many studies.

MATSYENDRASANA (spinal twist pose)

Technique :

Ardha Matsyendrasana (half spinal twist) Keep the right foot by the side of the left buttock, the left leg on top, with the foot in front of the right knee and the left knee raised upward. (Or the left foot can be placed by the outside of the right knee or right thigh.) Inhale while raising the arms shoulder high, keeping the elbows straight.

Place the right foot at the base of the left thigh, the left foot at the side of the right knee. Take hold of the left foot with the right hand, pass the left arm behind the waist and remain with the body turned. This asana is described by Sri Matsyendranath.

Matsyendranath supposedly practiced this asana and thus it is named after him. In English it is called the spinal twist. There are variations in the placement of the arms and hands and the degree of twisting in the spine.



Figure 29: Ardha Matsyendrasana (half spinal twist)

Technique 1: Ardha Matsyendrasana (half spinal twist)

- Sit straight with the legs stretched out
- Keep the right foot by the side of the left buttock, the left leg on top, with the foot in front of the right knee and the left knee raised upward. (Or the left foot can be placed by the outside of the right knee or right thigh.)
- Inhale while raising the arms shoulder high, keeping the elbows straight.

- Exhaling, twist to the left, place the right arm by the outer side of the left knee and hold the left ankle with the right hand.
- Take the left arm behind the back and rest the back of the left hand against the right side of the waist.
- Hold the position.
- Slowly release the hands and the legs simultaneously
- Practice on the other side by changing the leg and arm position.

Practice of this asana (matsyendrasana) increases the digestive fire to such an incredible capacity that it is the means of removing diseases and thus awakening the serpent power and bringing equilibrium in the bindu.

Matsyendrasana helps to channelize the prana in a particular direction so that awakening takes place in the dormant energy centers. It specifically stimulates the navel center or manipura chakra. Under normal circumstances the rate of pranic vibration is slow. Performing those asanas which direct the prana to the navel center is very important for the awakening of kundalini. The navel center is responsible for maintaining the body. When it is underactive or overactive, body functions are not harmonious and if it is sluggish, diseases develop in other areas. If the capacity of manipura is increased systematically, it not only eliminates imbalances and disease, but the dormant potential of sushumnanadi can be awakened.

Manipura is directly connected to the digestive system. Proper digestion and assimilation is the key to good health. Many texts talk about the ‘fire’ of manipura, i.e. the

digestive fire. It is said that a certain fluid produced in the higher brain centers is consumed by this fire, and the result is old age, disease and death. This fluid refers to the neuro hormones of the pituitary and pineal glands which activate the other endocrine glands.

In yoga it is said that this fluid is stored in bindu visarga and it is often associated with semen or ova. If one can prevent that fluid from falling into the fire of manipura, vitality can be increased and longevity can be cultivated. The navel region is powered by samanavayu. Samana is responsible for the assimilation of nutrients and prana from the air and food. Above the region of the body where samana operates, pranavayu pervades, and one of its functions is to absorb prana. In the region of the body below the navel, apanavayu is located and its chief function is elimination.

Prana and apana are the two major forces and normally move in opposite directions. One of the aims of yoga is to make prana and apana move towards each other so they meet in the navel and connect with samana. Pranavayu is positive energy, apana is negative and samana is neutral. When the two opposite energies are brought together in manipura chakra, there is an explosion of energy and the energy forces its way through sushumna nadi. That is why manipura is such an important center in the process of awakening kundalini. It is even said that kundalini awakening starts from manipura and not in either of the lower centers.

The chakras below manipura are concerned with the animal instincts and those above are connected with the higher qualities of the mind. Manipura is midway between

the two and is said to be the midpoint between heaven and earth. Matsyendrasana increases the vital capacity of manipura so it can sustain the effects of kundalini awakening.

The other important physiological aspects of this asana are that it stimulates the pancreas, liver, spleen, kidneys, stomach and ascending and descending colons. It is useful in the treatment of diabetes, constipation, dyspepsia and urinary problems. It tones the nerve roots, and adjusts and realigns the vertebral column. The back muscles are pulled and stretched in a different direction than usual and this relieves them of tension. Matsyendrasana is, therefore, recommended in cases of lumbago, rheumatism and slipped disc. In fact, it is a powerful asana and its vitalizing effects can be felt quickly.(47)

4.0 METHODOLOGY

4.1 THE STUDY DESIGN:

Self as control study design was adopted for this study. All the subjects were asked to undergo a single session (15 minutes) of control session (CS) (rest in sitting pose) and yoga session (YS) on day-1 and day-2 respectively. Baseline and post-test assessments of RBG levels were measured just before and immediately after each intervention.

4.1.1 TRIAL PROFILE:

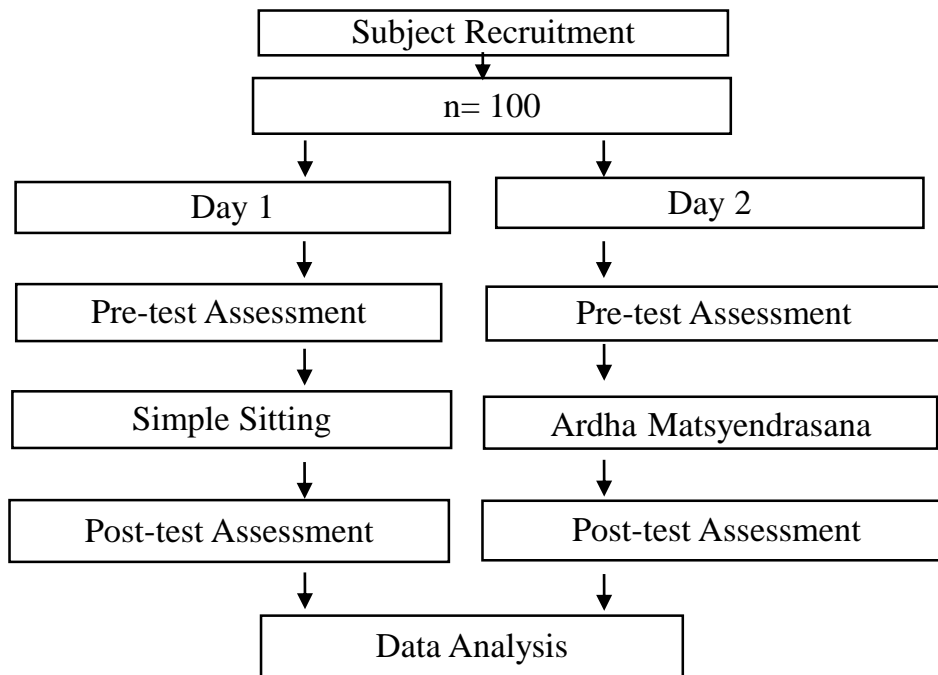


Figure 30: Trial profile

4.2 ETHICAL CONSIDERATION

4.2.1 ETHICAL CLEARANCE

Ethical clearance was sought from the Institutional Ethics Committee prior to the start of the study and the approval for the same was granted.

4.2.2 WRITTEN AND INFORMED CONSENT

Subjects who fulfilled inclusion criteria were apprised about the purpose of the study and their rights as research subjects. Informed consent form was administered in English.

As few subjects did not understand English, translating the signed informed consent form into native language i.e., Tamil was done. Adequate time was given to each patient to go through the information sheet and their queries were answered.

Their right to withdraw anytime from the study and the need for willingness to participate voluntarily in the study was explained. All the subjects expressed their willingness to participate in the study by giving a signed informed consent. A sample information sheet and consent form is enclosed as Annexure.

4.3 SUBJECTS:

The study subject comprised of 100 T2DM patients between the age group of 35-70 years. The subjects were recruited from Govt. Yoga and Naturopathy Medical College and Hospital, Arumbakkam, Chennai-106, based on the following selection inclusion and exclusion criteria.

4.3.1 INCLUSION CRITERIA

- Age group: 35 to 70 years
- Both gender
- People who are willing to participate in the study
- Body mass index (BMI) less than or equal to 29.9 kg/m²
- People with T2DM

4.3.2 EXCLUSION CRITERIA

- Subjects on insulin therapy
- Gestational diabetes
- Spinal problems
- Subjects diagnosed with any mental illness
- Subjects diagnosed with clinical illness other than mentioned above
- Subjects undergone hospitalization or surgery in the past 6 months
- Females during menstruation, pregnancy, lactation
- Who cannot perform Ardha Matsyendrasana

4.4 WITHDRAWAL CRITERIA

All subjects are free to withdraw from participation in the study at any time, for any reason, specified or unspecified, and without prejudice to further treatment.

4.5 OUTCOME VARIABLES:

Random blood glucose (RBG) is the outcome variable of the study. It was assessed through capillary blood using a glucometer (Dr. Morepen) on day-1 and day-2 as follows:

Day-1: RBG was assessed before and after 15 minutes of CS.

Day-2: RBG were assessed before and after 15 minutes of YS.

4.6 INTERVENTION:

1) Control session: All the subjects were asked to sit in a comfortable posture for 15 minutes on day-1.

2) Yoga session: All the subjects were asked to perform Ardha Matsyendrasana for 15 minutes as follows:

- Sit on the floor with legs straight.
- Keep the right foot by the side of the left buttock, the left leg on top, with the foot in front of the right knee and the left knee raised upward. (Or the left foot can be placed by the outside of the right knee or right thigh.)
- Inhale while raising the arms shoulder high, keeping the elbows straight.
- Place the right foot at the base of the left thigh, the left foot at the side of the right knee.
- Exhaling, twist to the left, place the right arm by the outer side of the left knee and hold the left ankle with the right hand.

- Take the left arm behind the back and rest the back of the left hand against the right side of the waist & place the palm down.
- Hold the position and then slowly release the hands and legs one by one.
- Practice on the other side by changing the leg and arm position.

DATA ANALYSIS:

Data were checked for normality using Shapiro-Wilk test. Within session analysis (Pre-test vs. Post-test of respective session) and between sessions analysis (mean difference of YS vs. mean difference of CS) was performed using Wilcoxon Signed Ranks Test. P value <0.05 was considered as significant.

5.0 RESULT

Out of 120 patients 100 patients fit into the criteria and were selected for the study. All the participants underwent the CS and YS as self as control trial. Pre and post RBG were collected and data analysis was done.

Results of this study showed a significant reduction in RBG levels in the YS compared to CS. Within group analysis showed a significant reduction in RBG levels in the YS, while a significant increase in RBG levels in CS. Moreover, none of the subjects reported any adverse events during or after the yoga practice.

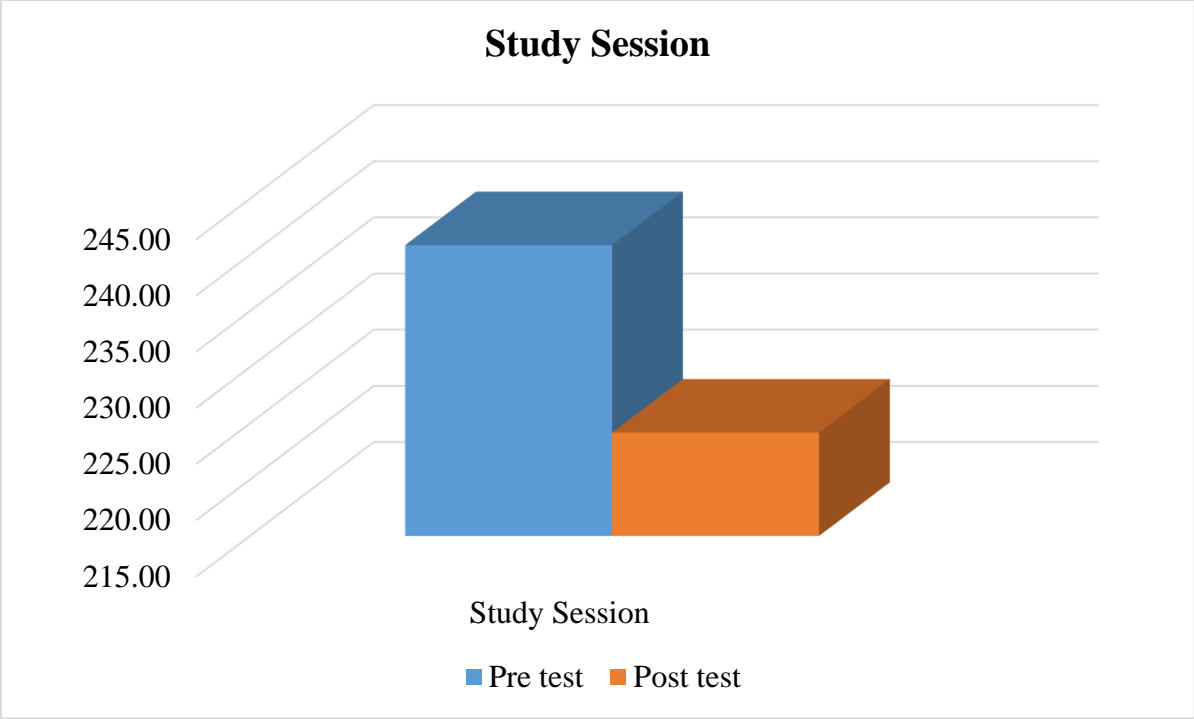


Figure 31: Study Session

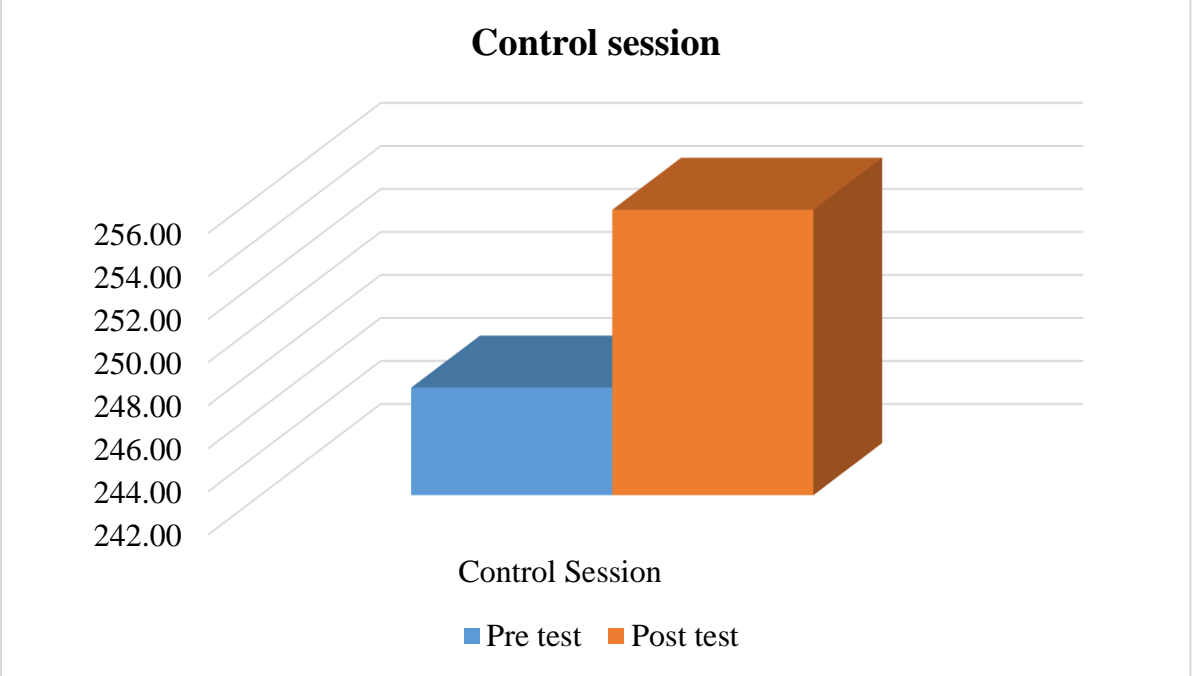


Figure 32: Control Session

Table 2: Pre Test And Post Test Assessments Of Yoga Session And Control Session

S.NO	Session	RBS (mg/dl) Mean \pm SD	
		Pre RBS	Post RBS
1	Yoga Session	240.87 \pm 84.17	224.18 \pm 88.39
2	Control session	246.99 \pm 86.18	255.26 \pm 89.56

Note: RBS- Random Blood Sugar

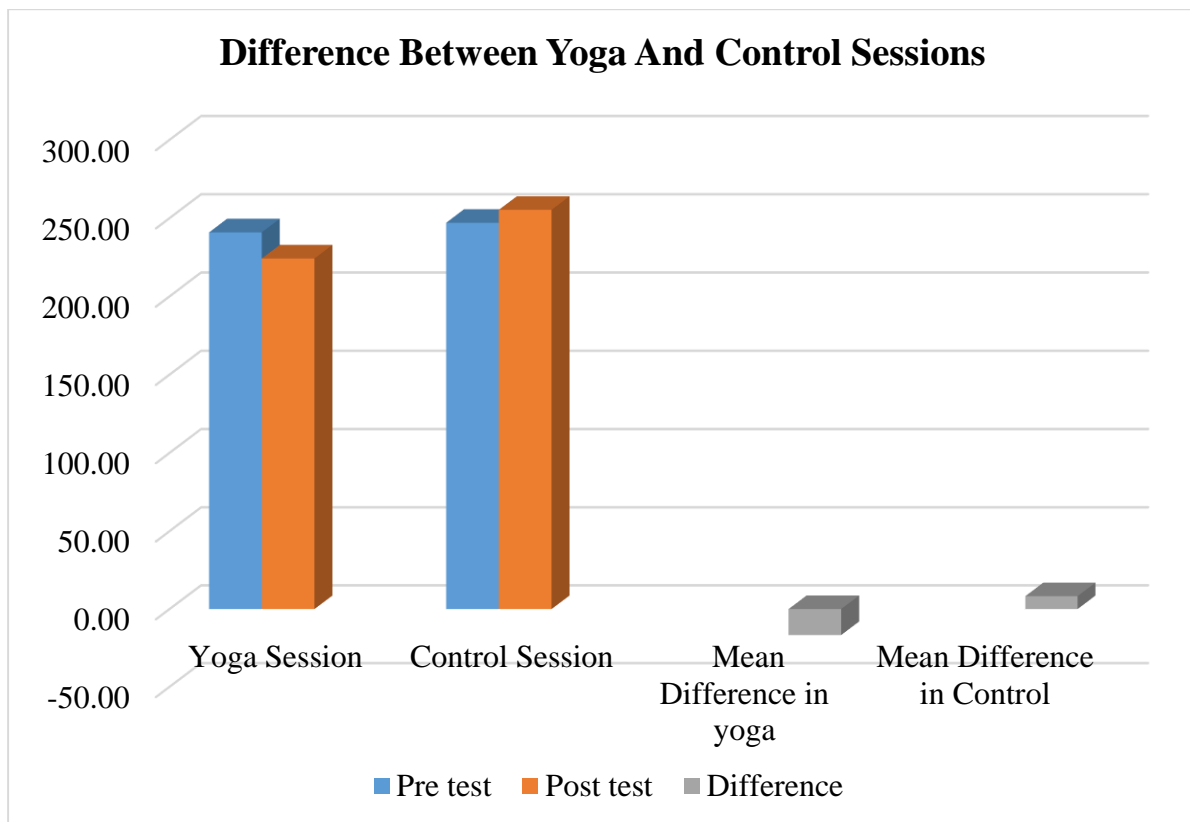


Figure 33: Difference Between Yoga And Control Sessions

Table 3: Mean Random blood sugar difference in yoga and control session

S.NO	Session	RBS (mg/dl) Mean \pm SD		Difference
		Pre RBS	Post RBS	
1	Yoga Session	240.87 \pm 84.17	224.18 \pm 88.39	-16.69
2	Control session	246.99 \pm 86.18	255.26 \pm 89.56	8.27

Note: RBS- Random Blood Sugar

6. DISCUSSION

The present study showed the significant changes in the random blood glucose level of the type 2 diabetes patients in yoga session in compare to the control session. The diabetes is the leading prevailing diseases of many countries including India. Diabetes leading to stress, kidney failure, neurological problems, heart disease & Stroke, eye problems, dental disease etc. which increase the death rate. There by the prevention of diabetes can reduce the death rate associated with diabetes.

There are many studies in which reducing FBS and PPBS were noted by the yoga practices. To find the effect of single asana on blood glucose level, with the reference of many studies we selected the Ardha Matsyendrasana.(10, 48-50)

In the practice of Ardha Matsyendrasana it increases the digestive fire to such an incredible capacity that it is the means of removing diseases and thus awakening the serpent power and bringing equilibrium in the bindu. It specifically stimulates the navel center or manipura chakra.

The navel center is responsible for maintaining the body. When it is underactive or overactive, body functions are not harmonious and if it is sluggish, diseases develop in other areas. If the capacity of manipura is increased systematically, it not only eliminates imbalances and disease, but the dormant potential of sushumnanadi can be awakened. Manipura is directly connected to the digestive system.

Proper digestion and assimilation is the key to good health. The chakras below manipura are concerned with the animal instincts and those above are connected with the

higher qualities of the mind. Manipura is midway between the two and is said to be the midpoint between heaven and earth.

Matsyendrasana increases the vital capacity of manipura. The other important physiological aspects of this asana are that it stimulates the pancreas, liver, spleen, kidneys, stomach and ascending and descending colons. It is useful in the treatment of diabetes, constipation, dyspepsia and urinary problems. It tones the nerve roots, and adjusts and realigns the vertebral column. The back muscles are pulled and stretched in a different direction than usual and this relieves them of tension. Matsyendrasana is, therefore, recommended in cases of lumbago, rheumatism and slipped disc. In fact, it is a powerful asana and its vitalizing effects can be felt quickly.(47)

The beneficial effect of yoga in T2DM has led to increased insulin sensitivity at target tissues which decreases insulin resistance and consequently increases peripheral utilization of glucose.(51)

Hence in the view of immediate effect of single asana on blood glucose level of T2DM, there is a significant change in the RBS of T2DM by the practice of Ardha Matsyendrasana.

6.1 LIMITATION:

- The current study measures only the immediate effects.
- The study has only limited dependent variables.
- Only capillary blood glucose was tested.

6.2 RECOMMENDATION

- The same study can be conducted for a longer period with various dependent variables to validate the current results.
- In future laboratory test has to be done instead of glucometer.

7.0 CONCLUSION

The results of the present study demonstrated that the practice of Ardha Matsyendrasana is effective in reducing the blood glucose levels in patients with T2DM.

8.0 REFERENCES:

1. Kaveeshwar SA, Cornwall J. The current state of diabetes mellitus in India. *Australas Med J.* 2014 Jan 31;7(1):45-8.
2. IDF Atlas 9th edition and other resources [Internet]. [cited 2020 Aug 18]. Available from: <https://www.diabetesatlas.org/en/resources/>
3. Cui J, Yan JH, Yan LM, Pan L, Le JJ, Guo YZ. Effects of yoga in adults with type 2 diabetes mellitus: A meta-analysis. *Journal of Diabetes Investigation.* 2017;8(2):201–9.
4. Olokoba AB, Obateru OA, Olokoba LB. Type 2 diabetes mellitus: a review of current trends. *Oman Med J.* 2012 Jul;27(4):269-73.
5. Chimkode SM, Kumaran SD, Kanhere V V., Shivanna R. Effect of yoga on blood glucose levels in patients with Type 2 diabetes mellitus. *Journal of Clinical and Diagnostic Research.* 2015;9(4):CC01–3.
6. Olokoba AB, Obateru OA, Olokoba LB. Type 2 diabetes mellitus: a review of current trends. *Oman Med J.* 2012 Jul;27(4):269-73.
7. Sreedevi A, Gopalakrishnan UA, Karimassery Ramaiyer S, Kamalamma L. A Randomized controlled trial of the effect of yoga and peer support on glycaemic outcomes in women with type 2 diabetes mellitus: A feasibility study. *BMC Complement Altern Med.* 2017;17(1):100.
8. Woodyard C. Exploring the therapeutic effects of yoga and its ability to increase

- quality of life. *International Journal of Yoga*. 2011;4(2):49.
9. Gothe NP, Khan I, Hayes J, Erlenbach E, Damoiseaux JS. Yoga Effects on Brain Health: A Systematic Review of the Current Literature. *Brain Plasticity*. 2019 Dec 26;5(1):105-122.
 10. ARUNA RATHOD PANVEL. 4 Yoga Poses to Cure Diabetes at Home. *Toi*. Sep 4, 2017;16:52
 11. An Overview of the Pancreas - Understanding Insulin and Diabetes [Internet]. [cited 2020 Apr 10]. Available from:
<https://www.endocrineweb.com/endocrinology/overview-pancreas>
 12. Komatsu M, Takei M, Ishii H, Sato Y. Glucose-stimulated insulin secretion: A newer perspective [Internet]. Vol. 4, *Journal of Diabetes Investigation*. 2013 [cited 2020 Apr 10]. p. 511–6. Available from:
<http://www.ncbi.nlm.nih.gov/pubmed/24843702>
 13. Röder PV, Wu B, Liu Y, Han W. Pancreatic regulation of glucose homeostasis. *Exp Mol Med*. 2016 Mar 11;48(3):e219.
 14. What is Diabetes? | NIDDK [Internet]. [cited 2020 Apr 10]. Available from:
<https://www.niddk.nih.gov/health-information/diabetes/overview/what-is-diabetes#types>.
 15. Galtier F. Definition, epidemiology, risk factors. *Diabetes Metab*. 2010 Dec;36(6 Pt 2):628-51.

16. Garg A, Bantle JP, Henry RR, Coulston AM, Griver KA, Raatz SK, et al. Effects of varying carbohydrate content of diet in patients with non—insulin-dependent diabetes mellitus. *Jama*. 1994 May 11;271(18):1421-8.
17. Kharroubi AT, Darwish HM. Diabetes mellitus: The epidemic of the century. *World J Diabetes*. 2015 Jun 25;6(6):850-67.
18. World Health Organization. WHO expert committee on diabetes mellitus. Geneva: WHO; 1980. *World Health Organization technical report series*.;646:7-12.
19. Federation ID. *IDF diabetes atlas 8th edition*. International Diabetes Federation. 2017:905-11.
20. World Health Organization. WHO expert committee on diabetes mellitus. Geneva: WHO; 1980. *World Health Organization technical report series*.;646:7-12.
21. World Health Organization. *Diabetes Mellitus: Report of a WHO Study Group [meeting held in Geneva from 11 to 16 February 1985]*. World Health Organization; 1985.
22. *Classification of Diabetes Mellitus*. World Health Organization;2019:11–12.
23. WHO | About diabetes. WHO [Internet]. 2014 [cited 2020 Apr 12]; Available from: http://www.who.int/diabetes/action_online/basics/en/index3.html
24. *Causes of Diabetes Mellitus - Houston Thyroid and Endocrine Specialists* [Internet]. [cited 2020 Jun 15]. Available from: <http://www.houstonendocrine.com/what-is-endocrinology/diabetes->

mellitus/causes-of-diabetes-mellitus

25. Symptoms & Causes of Diabetes | NIDDK. [cited 2020 Apr 12]; Available from: <https://www.niddk.nih.gov/health-information/diabetes/overview/symptoms-causes>
26. Alavi A, Sibbald RG, Mayer D, Goodman L, Botros M, Armstrong DG, et al. Diabetic foot ulcers: Part I. Pathophysiology and prevention. *Journal of the American Academy of Dermatology* [Internet]. 2014 Aug 28 [cited 2020 Jun 16];70(1):1.e1-18; quiz 19–20. Available from: <https://www.limamemorial.org/health-library/In-Depth-Reports/10/000060>
27. Huo X, Gao L, Guo L, Xu W, Wang W, Zhi X, et al. Risk of non-fatal cardiovascular diseases in early-onset versus late-onset type 2 diabetes in China: A cross-sectional study. *The Lancet Diabetes and Endocrinology*. 2016 Feb 1;4(2):115–24.
28. CDC. National Diabetes Statistics Report | Data & Statistics | Diabetes | CDC [Internet]. 2018 [cited 2020 Apr 12]. Available from: <https://www.cdc.gov/diabetes/data/statistics/statistics-report.html>
29. Disease H. Diabetes, Heart Disease, and Stroke | NIDDK. 2018 [cited 2020 Apr 12];1–9. Available from: <https://www.niddk.nih.gov/health-information/diabetes/overview/preventing-problems/heart-disease-stroke>
30. Funnell M. Low Blood Glucose (Hypoglycemia) | NIDDK [Internet]. NIDDK. 2016 [cited 2020 Apr 12]. Available from: <https://www.niddk.nih.gov/health->

information/diabetes/overview/preventing-problems/low-blood-glucose-hypoglycemia

31. NIDDK. Diabetic Neuropathy | NIDDK [Internet]. National Institute of Diabetes and Digestive and Kidney Diseases. 2016 [cited 2020 Apr 12]. Available from: <https://www.niddk.nih.gov/health-information/diabetes/overview/preventing-problems/nerve-damage-diabetic-neuropathies>
32. Afkarian M, Zelnick LR, Hall YN, Heagerty PJ, Tuttle K, Weiss NS, et al. Clinical manifestations of kidney disease among US adults with diabetes, 1988-2014. JAMA - Journal of the American Medical Association [Internet]. 2016 Aug 9 [cited 2020 Apr 12];316(6):602–10. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/27532915>
33. Ian de Boer. Diabetic Kidney Disease | NIDDK. Diabetic Kidney Disease [Internet]. 2017 [cited 2020 Apr 12]; Available from: <https://www.niddk.nih.gov/health-information/diabetes/overview/preventing-problems/diabetic-kidney-disease>
34. Diabetes and Foot Problems | NIDDK [Internet]. [cited 2020 Apr 12]. Available from: <https://www.niddk.nih.gov/health-information/diabetes/overview/preventing-problems/foot-problems>
35. Fraser C, D'Amico D. Diabetic retinopathy: Prevention and treatment - UpToDate. Wolters Klumer [Internet]. 2018 [cited 2020 Apr 12];(table 1):1–38. Available

from: <https://www.uptodate.com/contents/diabetic-retinopathy-prevention-and-treatment>

36. National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK). Diabetic Eye Disease | NIDDK [Internet]. 2018 [cited 2020 Apr 12]. Available from: <https://www.niddk.nih.gov/health-information/diabetes/overview/preventing-problems/diabetic-eye-disease>
37. Diabetes, Gum Disease, & Other Dental Problems | NIDDK [Internet]. [cited 2020 Apr 12]. Available from: <https://www.niddk.nih.gov/health-information/diabetes/overview/preventing-problems/gum-disease-dental-problems>
38. Diabetes, Sexual, & Bladder Problems | NIDDK [Internet]. [cited 2020 Apr 12]. Available from: <https://www.niddk.nih.gov/health-information/diabetes/overview/preventing-problems/sexual-bladder-problems>
39. Kouidrat Y, Pizzol D, Cosco T, Thompson T, et al. High prevalence of erectile dysfunction in diabetes: a systematic review and meta-analysis of 145 studies. *Diabetic Medicine*. 2017 Sep;34(9):1185-92.
40. Witzel II, Jelinek HF, Khalaf K, Lee S, Khandoker AH, Alsafar H. Identifying common genetic risk factors of diabetic neuropathies. *Frontiers in endocrinology*. 2015 May 28;6:88.
41. Putta S, Peluso I, Yarla NS, Kilari EK, Bishayee A, Lu D-Y, et al. Diabetes Mellitus and Male Aging: Pharmacotherapeutics and Clinical Implications. *Current*

- Pharmaceutical Design. 2017 Aug 23;23(30).
42. Feuerstein G. The Yoga tradition: its history, literature, philosophy and practice. Prescott, AZ. Hohm Press. 2001:513.
 43. Ross A, Thomas S. The health benefits of yoga and exercise: a review of comparison studies. J Altern Complement Med. 2010 Jan;16(1):3-12.
 44. Burgin T. History of Yoga • Yoga Basics [Internet]. 2016 [cited 2020 Apr 24]. Available from: <https://www.yogabasics.com/learn/history-of-yoga/>
 45. Story of Maharishi Patanjali - Art of Living Blog [Internet]. [cited 2020 Apr 24]. Available from: <http://artoflivingsblog.com/Maharishi-Patanjali/>
 46. What is Asana? Yoga Poses Classification, History, Origin & Benefits - Fitsri [Internet]. [cited 2020 Jun 16]. Available from: <https://fitsri.com/poses/what-is-asana>
 47. Muktibodhananda S. Hatha Yoga Pradipika. 3 [sup] rd ed. Munger, Bihar: Yoga Publication Trust. 2009:160:85–89.
 48. Malhotra V, Singh S, Tandon OP, Sharma SB. The beneficial effect of yoga in diabetes. Nepal Medical College journal : NMCJ. 2005;7(2):145–7.
 49. Raveendran AV, Deshpandae A, Joshi SR. Therapeutic Role of Yoga in Type 2 Diabetes. Endocrinol Metab (Seoul). 2018 Sep;33(3):307-317.
 50. S Mullur R, Ames D. Impact of a 10 minute Seated Yoga Practice in the

Management of Diabetes. J Yoga Phys Ther. 2016;6(1):1000224.

51. Sahay BK. Role of yoga in diabetes. J Assoc Physicians India. 2007 Feb;55:121-6.

9.0 ANNEXURE:

10.1 INFORMED CONSENT FORM

Title of the study : “The Immediate effect of Ardha Matsyendrasana on blood glucose level in type II diabetics.”

Name of the Participant:

Name of the Principal Investigator: Dr. G. TAMIL SELVI

Name of the Institution: Government Yoga & Naturopathy Medical

College & Hospital, Chennai – 600 106

Documentation of the informed consent

I _____ have read the information in this form (or it has been read to me). I was free to ask any questions and they have been answered. I am over 18 years of age and, exercising my free power of choice, hereby give my consent to be included as a participant in

1. I have read and understood this consent form and the information provided to me.

2. I have had the consent document explained to me.
3. I have been explained about the nature of the study.
4. I have been explained about my rights and responsibilities by the investigator.
5. I have been informed the investigator of all the treatments I am taking or have taken in the past _____ months including any native (alternative) treatment.
6. I have been advised about the risks associated with my participation in this study.
7. I agree to cooperate with the investigator and I will inform him/her immediately if I suffer unusual symptoms.
8. I have not participated in any research study within the past _____ month(s).
9. I am aware of the fact that I can opt out of the study at any time without having to give any reason and this will not affect my future treatment in this hospital.
10. I am also aware that the investigator may terminate my participation in the study at any time, for any reason, without my consent.
12. I hereby give permission to the investigators to release the information obtained from me as result of participation in this study to the sponsors, regulatory authorities, Govt. agencies, and IEC. I understand that they are publicly presented.
13. I have understood that my identity will be kept confidential if my data are publicly presented.
14. I have had my questions answered to my satisfaction.

15. I have decided to be in the research study.

I am aware that if I have any question during this study, I should contact the investigator. By signing this consent form I attest that the information given in this document has been clearly explained to me and understood by me, I will be given a copy of this consent document.

For adult participants:

Name and signature / thumb impression of the participant (or legal representative if participant incompetent)

Name _____ Signature _____

Date _____

Name and Signature of impartial witness (required for illiterate patients):

Name _____ Signature _____

Date _____

Address and contact number of the impartial witness:

Name and Signature of the investigator or his representative obtaining consent:

Name _____ Signature _____

Date _____

