EXPLORATORY STUDY ON CHRONONUTRITION PROFILE and TYPE 2 DIABETES MELLITUS

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Faculty of Family and Community Science

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B.Sc.

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(Hons.)

EXPLORATORY STUDY ON CHRONONUTRITION PROFILE and TYPE 2 DIABETES MELLITUS

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CERTIFICATE

This is to certify that the research work presented in this thesis has been carried out independently by Ms. Nupur Mehta under the guidance of Dr. Suneeta Chandorkar in pursuit of Degree of Master of Science (Family and Community Sciences) with major in Foods and Nutrition (Dietetics) and represents her original work.

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With Warm Regards,

Nupur Mehta

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ABBREVIATIONS

ACTH	Adrenocorticotropic Hormone
ADA	American Diabetic Association
BMI	Body Mass Index
BP	Blood Pressure
CAD	Coronary Artery Disease
CI	Castelli Index
CRH	Corticotropin releasing hormone
CSRWD	Circadian Sleep- wake Disorder
DKA	Diabetic Ketoacidosis
DN	Diabetic Nephropathy
EEE	Exercise Energy Expenditure
ESRD	End Stage Renal Disease
FPG	Fasting Plasma Glucose
GPAQ	Global Physical Activity Questionnaire
HDL	High Density Lipoprotein
HPA	Hypothalamic-pituitary-adrenal axis
ICMR	Indian Council of Medical Research
IDF	International Diabetic Federation
Kcal	Kilo Calorie
LDL	Low Density Lipoprotein
MET	Metabolic Equivalent
MT	Melatonin Receptor
NCDs	Non-communicable Diseases
NES	Night Eating Syndrome
NHFS	National Health and Family Welfare
NHLBI	National Heart, Lung and Blood Institute
NIDDM	Non-Insulin Dependent Diabetes Mellitus

PAD	Peripheral Artery Disease
PPBS	Post Prandial Blood Sugar
PSS	Perceived Stress Scale
PSQI	Pittsburgh Sleep Quality Index
RPG	Random Plasma Glucose
SCN	Suprachiasmatic Nucleus
SDG	Sustainable Development Goals
T2DM	Type 2 Diabetes Mellitus
TRE	Time Restricted Feeding
WHR	Waist- Hip Ratio
WHtR	Waist-Height Ratio

ABSTRACT

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INTRODUCTION: Chrononutrition involves the intimate interaction between circadian rhythms, nutrition, and metabolism. Circadian rhythms are 24-h cycles endogenously regulated by molecular oscillators called the circadian clock. Circadian clocks play a vital role in our daily physiological processes, biological processes and also in metabolism and in turn controls the appetite, timing of digestion, nutrient uptake and metabolism, hormonal and metabolite regulation and physical activity. Disruption of circadian rhythm may lead to hypertension, dyslipidaemia, hyperglycaemia, abdominal obesity and increases the risk of metabolic syndrome. All the aspects of glucose homeostasis including production and uptake of glucose, release of insulin and insulin sensitivity exhibits the circadian rhythmicity and discordance of meal timing with metabolic pacemaker exaggerates the glycaemic responses to meals. Chrononutrition profile assesses an individual's specific behavioural factors and eating patterns which provides an insight on individual's current health status.

OBJECTIVES: To study the association of Chrono nutrition Profile and Type 2 Diabetes Mellitus.

METHODS: A cross-sectional study was carried out at three diabetes clinics of Vadodara. Adults of age 35-60 years suffering from Type 2 Diabetes Mellitus from no more than five years were included. Data was collected using telephonic interview method through structured questionnaire for collecting information on personal information, diet information, physical activity, screen time, stress, sleep, knowledge attitude practice and chronotype. Anthropometric measurements and body composition (bioelectrical impedance) was done and biochemical parameters were collected from the case file. The data was analysed using the SPSS version 27.

RESULTS: This study included 227 participants suffering from Type 2 Diabetes Mellitus. Nearly four-fifth of the participants had uncontrolled fasting blood glucose levels (77%), uncontrolled PP2BS (79%) and nearly two-fifth participants (40%) had poor HbA1C levels. Participants with circadian preference towards eveningness skipped breakfast and had irregular meal timings ($p < 0.000$). Higher consumption of sweets, fried foods and caffeine ($p < 0.000$) and lower consumption of fibre, fruits and

vegetables ($p < 0.000$) was seen among evening chrono typed individuals. Participants with eating window of 12 hours or less, evening latency, night eating and heavy dinner consumption had higher BMI, higher visceral and total body fat % and lower skeletal muscle %. Poor lipid profiles and higher atherogenic indices along with poor glycaemic control was seen among participants having poor chrononutrition profile.

CONCLUSION: The findings of this study suggest that in patients with Type 2 Diabetes Mellitus, Circadian misalignment and Poor Chrononutrition profile was positively linked with poor glycaemic control. Chrononutrition profile may serve as an important counselling tool which can help in examining the feeding behavior and lifestyle patterns of the people with Type 2 Diabetes Mellitus and help in treatment of T2DM along with metabolically strengthening the health of general population.

INTRODUCTION

INTRODUCTION

Chrononutrition is a developing field which encompasses the interaction between circadian rhythms, nutrition, and metabolism. (Kessler & Pivovarova-Ramich, 2019) Chrononutrition involves not just the concept of how the food intake time and biological rhythms affect health, metabolism, and nutrition but also how nutrient composition affects our internal circadian system. (Arola-Arnal et al., 2019) Biological rhythms can impact the action of biologically active compounds, and simultaneously, the consumption of these compounds can regulate the biological rhythms. In recent years, there has been an increase in realisation of the effect of the biological clock on nutrition, energy balance and metabolism that has a direct impact on health status. (Arola-Arnal et al., 2019; Johnston et al., 2016)

The Sustainable Development Goals (SDGs) involves a target for reducing the proportion of premature deaths caused due to Non-Communicable Diseases, including diabetes, by one third by 2030. The Indian National Health Policy 2017, aims on increasing the treatment of 80% of people suffering from diabetes and also reduce 25% of the premature deaths from diabetes by 2025.(Tandon et al., 2018) Diabetes mellitus is a chronic, life-threatening metabolic disorder having complex pathogenesis. It is characterized by elevated blood glucose levels scientifically known as hyperglycaemia, resulting from alterations in insulin secretion due to β-cell dysfunction or action (insulin resistance) or both along with excess production of glucose by the liver. Prolonged hyperglycaemia can be the cause several microvascular and macrovascular diabetic complications, that generally are the cause of diabetes related morbidity and mortality.(Ahmed et al., 2017; Banday et al., 2020a) Type 2 Diabetes mellitus leads to be one of the chronic diseases in the world with four times increase in the number of people suffering from type 2 diabetes in the past thirty years. (Henry et al., 2020) It is the most important and challenging health issues in current times for the human population around the globe due to rapid urbanization and adoption to modern lifestyle habits.(Banday et al., 2020a) Diabetes management includes lifestyle modifications like regular exercise, weight loss, and also suitable drug therapy. Apart from all these factors consumption of healthy diet which concentrates on the quantity, quality and timing of nutrients present in food continues to be the key factor for preventing and managing Type 2 Diabetes Mellitus. (Henry et al., 2020; Mirghani et al., 2020)

This notion brought about the advancement of a discipline known as chrononutrition, which was first introduced in 2005 in a Japanese book about nutrition and health that relates the body's internal circadian rhythm and metabolism. (Arola-Arnal et al., 2019; Johnston et al., 2016)

The word circadian in Latin means, approximately "one day".(Serin & Acar Tek, 2019) The circadian rhythm is an endogenous timing system that has a 24-hour cycle that coordinates individual's behavioural and physiological processes, including activity, metabolism, energy balance, sleeping and eating patterns throughout the day.(Garcez et al., 2021) The Circadian rhythm is regulated by constantly interacting network of circadian clocks.(Johnston et al., 2016) The circadian clock is highly specific and has a hierarchical system consisting of the master pacemaker that is located in the suprachiasmatic nucleus of the hypothalamus and synchronizes the peripheral oscillators present in nearly all body cells that controls the bodily rhythms.(Suzana Almoosawi et al., 2019a; Asher & Sassone-Corsi, 2015) Circadian clock prepares the body for daily events like hormone secretion, heartbeat, sleep-wake cycle and body temperature fluctuations.(Henry et al., 2020) Apart from daily activities, circadian clocks acts as a sensor for synchronising the body with the environmental factors such as day-night alterations, hot and cold environment and food availability.(Drăgoi et al., 2019) Light, hormones and food timings act as synchronising factors to reset circadian clocks.(Berendsen et al., 2020) The circadian clock system takes care of many metabolic rhythms. Central clock that is entrained by the dark–light cycle regulates the intake of food, energy expenditure and insulin sensitivity, while peripheral clocks that are present in every organ controls the tissue specific functions like, peripheral clock of the intestine manages glucose absorption, adipose tissue and liver clocks regulate the insulin sensitivity and the peripheral clock of the pancreas regulates insulin secretion. (Paoli et al., 2019)

Chrononutrition is determined by an individual's "chronotype". Chronotype is the interpretation of an individual's circadian rhythmicity that is categorised according to the individual's preference for the morning or evening. (Henry et al., 2020; Toktaş, Erman, et al., 2018) Chronotype affects an individual's behavioural patterns.(Suzana Almoosawi et al., 2019b) The time of day during which an individual would choose to sleep or to carry out daily activities signifies as morningness or eveningness of an individual. Individuals having eveningness are more prone to circadian misalignment

among their sole behavioural rhythms and their internal circadian clock which may predispose an individual to have an unfavourable dietary pattern, increasing the individual's risk to become obese.(Anothaisintawee et al., 2018; B. Y. M. Yu et al., 2020) Chronotype is directly linked to dietary intake. Evening chrono typed individuals are less likely to consume healthy diet.(Mazri et al., 2020a) Evening chronotyped individuals tend to eat less in the morning, and consume foods that are high in calories and contain more amount of sucrose, fat, and saturated fatty acids during evening as compared to morning chronotypes. Lower consumption of fruit and vegetables and unhealthy habits such as smoking and more alcohol consumption is commonly seen among evening chronotypes. Less physical activity and more sedentary behaviour is also associated with eveningness which leads to obesity, increased visceral fat, and higher BMI which is directly associated with development of metabolic syndrome and diabetes.(De Amicis et al., 2020; Mazri et al., 2020a) Evening types tend to skip breakfast because of lack of signalling of hunger by biological clocks during the morning time. (Aparecida Crispim & Carliana Mota, 2019) Skipping breakfast was commonly seen among evening types which affects the postprandial insulin concentration, and increases the risk of impairment of glucose homeostasis. Also, higher levels of HbA1c were seen among evening chronotype individuals who regularly skipped breakfast.(Borel, 2019) These habits lead the later chrono-typed individuals to suffer from type 2 diabetes mellitus.(Mason et al., 2020)

Exposure of artificial light during the biological night due to work and social life leads to misalignment in the endogenous circadian rhythms, known as circadian misalignment. (Mason et al., 2020) Circadian misalignment causes the desynchronisation of the central circadian clock present in the suprachiasmatic nucleus from the peripheral clocks present throughout the body. "Circadian misalignment" occurs due to inappropriate feeding and sleeping time.(Mirghani et al., 2020) Delayed feeding time, especially the dinner leads to circadian misalignment as the feeding time move towards the resting time. (Mazri et al., 2020a) Insufficient sleep and circadian misalignment negatively impact the endocrine, metabolic, and immune function of the body and contributes to metabolic disorders, like obesity as it affects the levels of ghrelin and leptin, by decreasing leptin (satiety hormone) and also reduces the basal metabolic rate and also type 2 diabetes mellitus.(Aparecida Crispim & Carliana Mota, 2019; Basnet, 2019; K. P. Wright et al., 2015)

Circadian misalignment adversely impacts the glucose metabolism. There is reduction in beta cell responsivity, which causes negative effects on insulin action, insulin release (Basnet, 2019) and increases the insulin production. (Noble & Smith, 2015) Impaired glucose tolerance and decrease in the insulin sensitivity (Mason et al., 2020) along with increased inflammation (Suzana Almoosawi et al., 2019b) leads to development of type 2 diabetes mellitus. Therefore, misalignment of circadian rhythm directly impacts the glucose control. (Henry et al., 2020)

Glucose metabolism is regulated by the circadian rhythm (S. Almoosawi et al., 2016) under the regulation of Suprachiasmatic nucleus. (Serin & Acar Tek, 2019) Chronotype affects the individual's dietary intake and eating patterns.(Suzana Almoosawi et al., 2019a) Misalignment of circadian clock impacts the food intake which has direct relation to glucose metabolism and could lead to type 2 diabetes mellitus in future.(Suzana Almoosawi et al., 2019a; Henry et al., 2020) Melatonin is a sleep hormone and plays a vital role in circadian synchronization. Secretion of melatonin hormone follows a diurnal pattern. The receptors of melatonin are present throughout the body and regulates energy metabolism and body weight. Due to inadequate sleep or circadian misalignment, the melatonin receptors are misaligned which causes disruption in sleep due to reduction in serum melatonin secretion which increases the insulin secretion and insulin resistance resulting in type 2 diabetes mellitus.(S. Sharma et al., 2015a) Sleep plays an important role in energy metabolism, glucose regulation and appetite(Pot, 2018) Reduced sleep quality and delayed sleeping time negatively impacts the glucose metabolism (Kim et al., 2015) as multiple hormones that are involved in glucose metabolism like insulin and cortisol follows a circadian rhythm so disruption in their circadian cycle causes changes in insulin sensitivity and insulin secretion patterns which affect the individual's blood sugar level.(Henry et al., 2020) Secretion of leptin which suppresses hunger and ghrelin which promotes intake of food are regulated under the circadian rhythmicity. When there is a disruption of circadian system there is an imbalance between these two hormones that increases the consumption of food which negatively impacts the energy intake and leads to overweight, obesity and higher BMI among individuals and predisposes them to the develop Type 2 Diabetes Mellitus.(Kim et al., 2015)

Cortisol is released into the blood in response to stress. Sleep deprivation is positively associated with increase in stress which notably increases the cortisol levels. (K. P. J.

Wright et al., 2015) Higher morning serum cortisol levels were directly related to higher Fasting Blood Glucose levels and HbA1c levels with lower functioning of the β-cell of islets of pancreas in individuals suffering from type 2 diabetes mellitus.(Ortiz et al., 2019)

Apart from sleep, meal timing and meal composition along with physical activity plays a significant role in regulating the blood glucose levels. Meal timing influences either the central master clock (SCN) or peripheral cellular clocks. (Paoli et al., 2019) Meal timing has been known to entrain the body clock.(Oda, 2015) Breakfast skipping, consuming high energy meals during dinner, and higher snack frequency that includes foods that have higher sugar, saturated fat and trans-fat content are linked with a higher risk of being overweight or obese and with adverse metabolic effects in humans.(Arola-Arnal et al., 2019) Consuming high calories during breakfast showed greater weight loss and lower daily glucose, insulin, and ghrelin concentrations and hunger scores than consuming the same amount of calories in dinner. Late consumption of dinner was associated with increased weight gain, less energy expenditure and negative impact on the circadian rhythms of hormones controlling appetite, managing stress, and sleep regulating hormones. (Kessler & Pivovarova-Ramich, 2019) Carbohydrate consumption at night results in a higher postprandial glucose while consumption of protein reduces the post prandial glucose and gives the feeling of satiety. High fat diet does not increase the blood glucose level when consumed at night but they type of fat that is consumed needs to be taken care as high amount of trans fatty acids and saturated fats increase the risk of developing cardiovascular diseases. (Henry et al., 2020) These shows that meal timings and nutrient composition has a direct relationship with glucose metabolism and so incorrect timing of intake of food throughout the day, increases the risk to develop obesity and type 2 diabetes mellitus.(Kessler & Pivovarova-Ramich, 2019)

Along with the timing of consumption of meals, the timing of exercise can modify the central circadian clock and also the peripheral clocks as exercise training balances the appetite by increasing the satiety hormone after the meal which prevents over consumption of food. There is reduction in fat mass that positively affects the body composition and improves overall health of an individual. Exercise training also improves glucose tolerance. (Parr et al., 2020)

Proper timing of exercise may improve circadian rhythm and reduce the negative outcomes due to disruption of circadian rhythms like metabolic disorders, cardiovascular disease, and diabetes. Therefore involving in timed exercise can shifts the internal circadian rhythm and reduce the occurrence of circadian disruption and thereby reducing the negative health impacts.(Thomas et al., 2020) This demands the need to understand the interrelationship of chrononutrition, chronotype, meal timing, meal composition, hormones, stress, sleep and physical activity with an individual's circadian clock for ones well-being.

RATIONALE:

- There has been an exponential increase in the prevalence of type 2 diabetes mellitus in India. According to The International Diabetes Federation (IDF) 463 million adults had diabetes in 2019, and by 2045, it is projected to reach 700 million. India had 77 million people with Diabetes in 2019 and its expected to reach 134.2 million by 2045. (International Diabetes Federation, 2019)
- In modern times the lifestyle of people has become sedentary. Consumption of high sugar and fats containing foods are increased due to underlying stress and sleep disturbances which has been directly associated with the cause of obesity and type 2 diabetes mellitus.
- Also, there is an association of meal timing, nutrient composition, physical activity, sleep and stress with chrononutrition profile. So, this study is planned to assess the relationship of Chrononutrition profile with Type 2 diabetes mellitus.

OBJECTIVES:

The objectives of the present study are:

Broad Objective:

• To study the association of Chrono nutrition Profile and Type 2 Diabetes Mellitus.

Specific Objectives:

1. To derive Chrono nutrition profile of subjects with Type 2 Diabetes Mellitus.
2. To associate the chrononutrition profile with dietary pattern and nutrient composition of meal of subjects with Type 2 Diabetes Mellitus.
3. To associate chrononutrition profile with anthropometric parameters, biochemical parameters, Exercise Energy Expenditure (EEE), Screen time, sitting time, sleeping time and Stress.
4. To identify Chronotype of subjects with Type 2 Diabetes Mellitus.
5. To associate the chronotype with dietary pattern and nutrient composition of meal of subjects with Type 2 Diabetes Mellitus.
6. To associate chronotype with anthropometric parameters, biochemical parameters, Exercise Energy Expenditure (EEE), Screen time, sitting time, sleeping time and Stress of subjects with Type 2 Diabetes Mellitus.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

The present chapter includes literature review under the following heads:

1) Circadian Rhythm and Circadian clocks

2) Chrononutrition

3) Chrononutrition Profile

4) Chronotype

5) Circadian misalignment

6) Non-communicable diseases

7) Type 2 Diabetes Mellitus

8) Association of Diabetes with chrononutrition

A) Sleep

B) Hormones

i)Melatonin

ii)Insulin

iii)Leptin

iv)Ghrelin

v)Cortisol

C)Meal timing and Meal composition

D)Physical Activity

CIRCADIAN RHYTHMS AND CIRCADIAN CLOCK:

Circadian rhythms are endogenous processes regulated by molecular oscillators with a cycle length of approximately 24 hours.(S. Almoosawi et al., 2016; Johnston et al., 2016; Serin & Acar Tek, 2019) French scientist de Mairan in the 1720s was the first one to scientifically describe a circadian rhythm. In the 1970s Ron Konopka and Seymour Benzer were the first to isolate the first mutant in the fruit fly (Drosophila melanogaster) for mapping the period (per) gene, which is the first discovered genetic component of a circadian clock. (Basnet, 2019) Circadian systems are nearly ubiquitous in the living system and are composed of oscillators that follows a hierarchy at the cellular, tissue, and system level.(Mohawk et al., 2012)The circadian system encompasses the network of molecular clocks known as circadian clocks, present throughout the body tissues.(Mainous et al., 2017) CLOCK genes have been investigated since past two decades and it is proven that they are present in all body tissues and they authorise the daily events in living organisms.(Bravo et al., 2017) Transcriptional negative feedback controls the circadian clock. Transcription factors, Clock/ bmal1binds to E-box hexanucleotides and activates the transcription of Per and Cry clock genes.(Oda, 2015) Circadian clocks play a vital role in our daily physiological processes, biological processes and also in metabolism. The circadian system represents all the physiological processes like the sleep/wake cycle, blood pressure, heart rate, hormone secretion, cognitive performance and mood regulation and biological processes such as, neuronal, endocrine, metabolic, and behavioural functions. (Johnston et al., 2016; Réda et al., 2020)

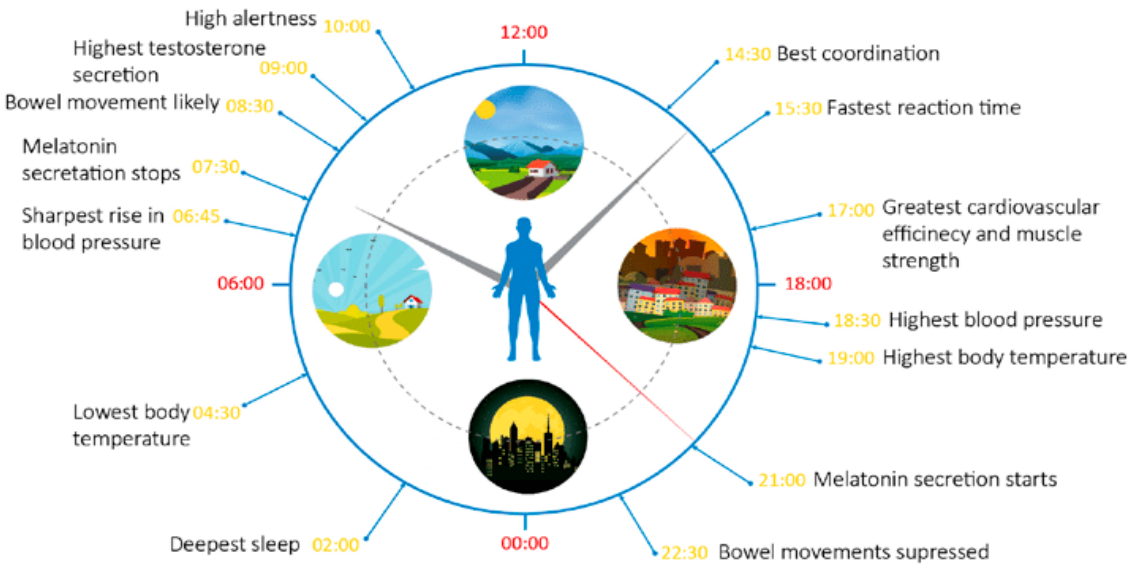


Figure 2.1: Human Circadian Rhythm

(Source adapted from Smolensky and lamberg 2001)

The Circadian clock can be broadly divided into 2 parts: i) The Master clock which is a network of up to 20,000 neurons residing in the suprachiasmatic nucleus (SCN) of the hypothalamus, and ii) the Peripheral clocks residing in tissues which are present throughout the human body. Light is the main and the only stimulus for the SCN. Suprachiasmatic nuclei are made up of oscillators that are multiple and single-celled located in the anterior hypothalamus region of the brain above the optic chiasma. SCN is activated via a nerve bundle called the "retino-hypothalamic tract." (Serin & Acar Tek, 2019) The SCN, also known as the primary pacemaker of the mammalian circadian system, predominantly serves as a relay transmitter that conveys light and darkness data to other oscillators present in the body tissues.(Drăgoi et al., 2019) Mammals have innumerable clocks in all major tissues and most individual cells of the body, called as peripheral tissue clocks. The SCN coordinates with the peripheral clocks using varied pathways. The peripheral clocks play an intrinsic and unique role in the local tissue specific processes like, the hepatic tissue clock regulates fasting blood sugar and clearance of glucose, the clock of pancreatic tissue regulates insulin secretion, the adipose clock regulates storage of lipid and also its mobilization, and the peripheral clock of the skeletal muscle regulates uptake of glucose and its

metabolism. Feeding and fasting behaviour is believed to be a key synchronizer in regulating the clock gene rhythms in most peripheral tissues. The master clock and the peripheral clocks ought to be in synchrony with each other and the external environment to serve an organism. This synchronization can occur by external factors called zeitgebers. Light is the key zeitgeber for most terrestrial organisms. (Johnston et al., 2016) The interlinkage of the central and peripheral clocks is firmly regulated by the eating patterns, nutritional metabolites and secretion of hormone which is also dependent on food availability. Abstained feeding has no effect on the central pacemaker in the SCN but it does modify the secondary oscillators from peripheral tissues such as liver, kidney, heart, and pancreas. The function of the central clock remains unaffected and it resets the peripheral oscillators as soon as the supply of food returns to normal. (Drăgoi et al., 2019)

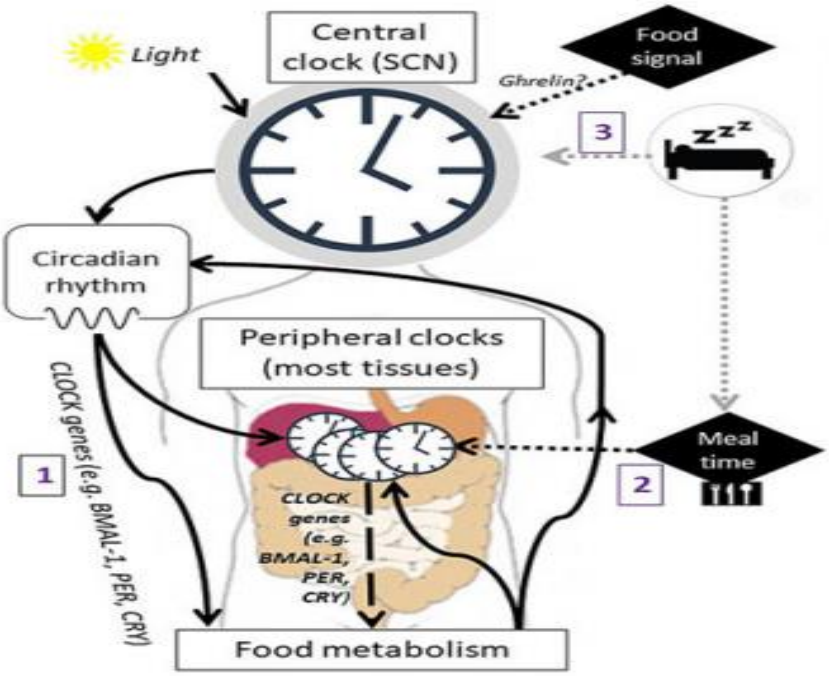


Figure 2.2: Human Circadian Clock

(Source:(Oike et al., 2014))

CHRONONUTRITION:

Nutritional science since ages have been prioritizing on what we eat. The well-known verse "You are what you eat" is used to describe the relationship between an individual's health and diets that are consumed.(Bravo et al., 2017) Systematic eating habits are crucial for maintaining good health. The importance of the circadian rhythm in synchronizing food consumption and metabolism in humans has been recognised since long. (S. Almoosawi et al., 2016) Several proverbs such as "have breakfast like a king, lunch like a prince, and dinner like a pauper" shows that the effects of different foodstuffs eaten throughout the day might have different effects on circadian rhythms depending on the time of the consumption is not only a recent scientific declaration, but also popular knowledge fact which has been known since past many years. (Bravo et al., 2017)This concept gave rise to the development of a new area known as chrononutrition.(Arola-Arnal et al., 2019) Chrononutrition was defined by French nutritionist Alain Delabos along with professor Jean-Robert Rapin in 1986 in France. Actually, Oike et al., referred to the concept of chrononutrition when he said: "food components regulate circadian clocks, and meal times affect metabolic homeostasis". (Bravo et al., 2017) The term 'Chrononutrition' was first published in a Japanese Nutrition textbook in 2005. The first book on Chrononutrition was published in 2009.(Oda, 2015)

Chrononutrition is an emerging discipline which encircles the complex interaction between circadian rhythms, nutrition, and metabolism to ensure the energy equilibrium in the organism.(Kessler & Pivovarova-Ramich, 2019) It highlights the interaction between dietary intake and time of eating.(Azmi et al., 2020)Chrononutrition also highlights the concept of how timing of food intake is as critical as the quantity and quality of food.(Kessler & Pivovarova-Ramich, 2019) Chrono-nutrition encompasses three elements of time: (1) regularity, (2) frequency, and (3) clock timing.(Berendsen et al., 2020)

Nutrition and Chrononutrition are always in tune with each other yet are different which influences the health of an organism. Biological, psychological, and social factors also effect the behavioural components of chrononutrition.(Prior, 2020)

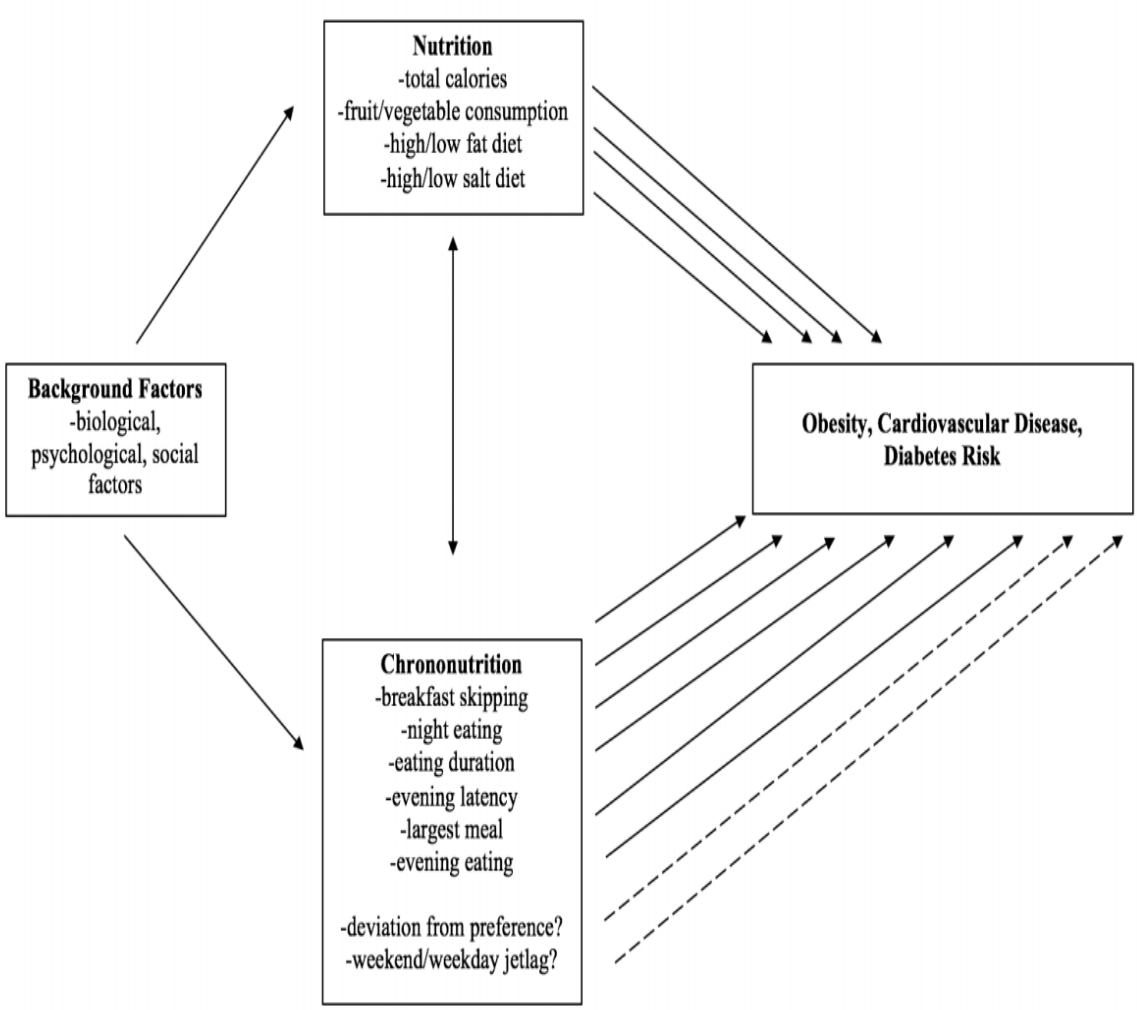


Figure 2.3: Theoretical model of the relationship between chrononutrition, nutrition, and health outcomes. (Source:(Prior, 2020))

Behavioural Components of Chrononutrition:

There are 6 specific behavioural patterns that are accepted to affect an individual's chrononutrition profile.

These are: 1) Eating at night,

2) Time-restricted Eating,

3) Consumption of Breakfast,

4) Timing of consumption of largest meal,

5) Timing of eating at evening, and

6) Time gap between eating and bedtime.

1) Night eating: The vital evidence regarding night time eating in humans is emanated from the study of night eating syndrome (NES) which was first reported by Stunkard et al. in 1955. NES involves a decision that is consciously taken to consume food, and is typically identified by eating huge amounts of food during the evening, waking up late in the night to eat, insomnia, and lack of hunger in the morning. NES causes Circadian desynchronization of the feeding-fasting cycles and the sleep-wake cycles in humans which may negatively affect health and may lead to anorexia nervosa, bulimia nervosa, stress, anxiety, depression, poor sleep, and obesity in individuals.(Prior, 2020)

2) Time restricted eating: Time-restricted feeding (TRE), refers to consumption of food within an assigned time frame. (8 hours / 10 hours of eating window) during the 24-hour day to reduce the time in which energy is consumed.is also applicable in the field of chrononutrition. Gill and Panda were the first to show 16 weeks of 10 to 11 hours of TRE in overweight humans. Due to TRE the participants lost considerable amount of weight and reported higher satisfaction during sleep. The weight loss was maintained for a year, which suggested that TRE may be a practical strategy for maintaining weight over the long term. TRE also improved insulin sensitivity and B-cell responsiveness, blood pressure, and oxidative stress among the participants.(Parr et al., 2020; Prior, 2020)

3) Consumption of Breakfast: Breakfast is considered as the major meal of the day. Breakfast consumption is thought to have favourable effects on diet consumption throughout the day. Skipping breakfast reduces insulin sensitivity. Skipping breakfast increases the risk of developing obesity by 4.5 times. Consumption of breakfast should be considered in chrononutrition as it adjusts the liver clock timing in human body.(Pot, 2018; Prior, 2020)

4) Timing of consumption of largest meal: The timing of consuming the largest meal is efficiently associated with the chronotype of an individual and health status. For example, higher BMI was found in individuals who consumed the largest meal in the evening, rather than those who consumed the largest meal during breakfast or lunch.(Prior, 2020)

5) Timing of eating at evening: Nocturnal Eating or consuming food or drinks after 11:00 P.M. has directly been linked to consumption of more calories leading to weight gain, higher BMI and breakfast skipping.(Pot, 2018; Prior, 2020)

6) Time gap between eating and bedtime: Evening latency, or the duration of time gap between the last eating event and bed time has been related with the health of an individual. Gap or two hours or less between last eating event and bedtime has been directly corelated with increased acid reflux symptoms.

So, these are several key elements of chrononutrition and their involvement in an individual's health. (Prior, 2020)

CHRONONUTRITION PROFILE:

Chrononutrition profile includes 6 chrononutrition behaviours which helps to evaluate the six components of chrononutrition that are expected to impact the health of an individual. These 6 components are eating window, breakfast skipping, evening latency, evening eating, night eating and largest meal which helps to evaluate the general chrononutrition behaviour and the favourable timing of food intake. The Chrononutrition profile can be used individually to provide a thorough assessment of one's eating behaviours. This can also help the health care professionals and researchers to evaluate chrononutrition profile and spot the intended population to prevent and treat the numerous health repercussions which are corelated with improper feeding timing and also for general improvement of health. (Prior, 2020)

Table 2.1: Assessment of Chrononutrition profile

CHRONONUTRITION CUT-OFF	**DESCRIPTION**	**FORMAT**	**SCORING CUT-OFF (POOR, FAIR, GOOD)**
Eating Window	Duration between first eating event and last eating event	HH:MM	14:00 12:01 to 14:00 ≤12:00
Breakfast Skipping	Frequency of breakfast skipping	Days/Week	≥ 4 days/week 2-3 days/week 1 day/week or less
Evening Latency	Duration between last eating event and sleep onset	HH:MM	≤2:00 2:01 to 6:00 >6:00
Evening Eating	Risk of eating late in the waking day	HH:MM	≥23:00 20:00 to 22:59 < 20:00
Night Eating	Frequency of night eating	Days/Week	≥ 4 days/week 2-3 days/week 1 day/week or less
Largest Meal	Meal in which largest amount of food is eaten	Meal Name	Dinner/Supper Lunch Breakfast

Source: (Prior, 2020)

Scoring of the chrononutrition behaviour involves scoring all six components as poor, fair and good and marked as 0,1 and 2 respectively. The scores of six component are totalled to calculate a total Chrononutrition profile score which ranges from 0 to 12 where 0 indicates good chrononutrition status and 12 indicates poor chrononutrition status which helps to portray an individual's chrononutrition profile. (Prior, 2020)

CHRONOTYPE:

Chrononutrition is governed by an individual's "chronotype".(Henry et al., 2020) Chronotype helps to express an individual's circadian phenotype which could be an individual's behavioural inclination for morningness or eveningness. Chronotype is believed to be regulated by an individual's central clock and classifies individual as a morning chronotype or an evening chronotype person. Genetic differences and environmental factors influence the variation of chronotypes among individuals. There are nonmodifiable and modifiable factors which have an impact on the chronotype. Ethnicity is one of the nonmodifiable factor which influences the Black British individuals to be 1.4 times more likely to have morning chronotype than the white British people, according to the UK Biobank Study. Sex is another example of a nonmodifiable determinant of chronotype. Some studies stated that higher prevalence of morningness was seen in women and considerable prevalence of eveningness in men. Age also plays an important role determining the chronotype. Morning chronotype was more prevalent in children, while a transition of shift towards eveningness was seen during the puberty and a shift at the age of 50 years was seen towards morningness which indicates that ageing impacts the chronotype. Social factors like urban living, environmental factors, family, and social schedules act as key modifiable factor of an individual's chronotype. Increased exposure to artificial light at night compared with natural daylight may modify the circadian clock system. Also, noise and crowding in an urban environment may cause disruption in sleeping patterns. working schedules are also important in anticipating the chronotype, as it is seen that night workers are expected to be more of "definitely evening-type" and the unemployed individuals are less probable to be "moderately morning-type" compared with other workmen. (Suzana Almoosawi et al., 2019a)

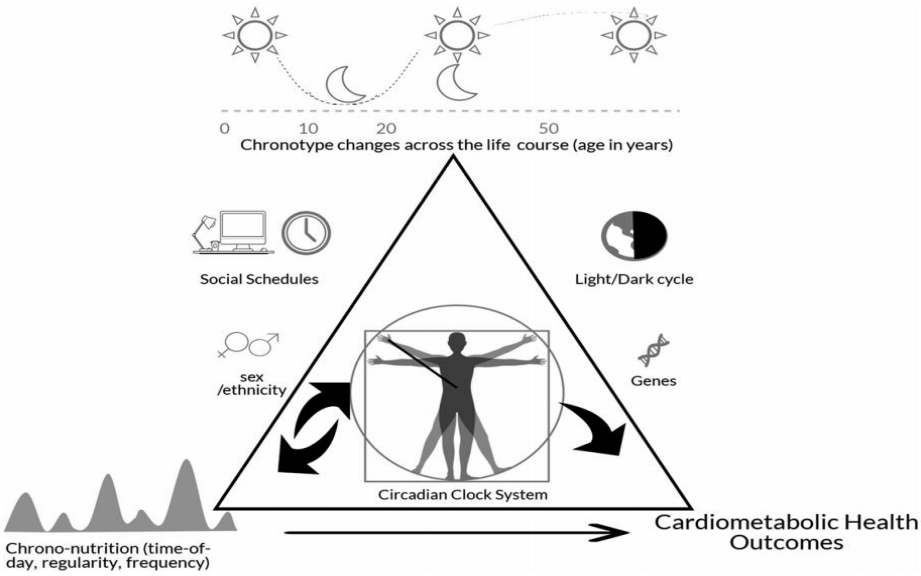


Figure 2.4: Determinants of chronotype

Source: (Suzana Almoosawi et al., 2019a)

Chronotype is also affected by the entraining effect of food components or consumption patterns on the peripheral circadian clocks. An observational study which was conducted in Japan found that consumption of foods like meat, bread or rice, fish, natto, and milk which have higher amount of tryptophan is related with greater morningness in 0–8-year-old children but not in children who are >8 years old. Morning Chronotype boys used to consume good amount of fruits and vegetables as compared boys with later chronotypes, whereas consumption of fruits and vegetables in girls were similar in both chronotype. (B. Y. M. Yu et al., 2020) Higher consumption of stimulants such as caffeine, energy drinks, sugar-sweetened beverages, and alcohol and less dairy consumption was found with evening chrono typed adolescents. (Suzana Almoosawi et al., 2019b)Also, adolescents who are evening chrono typed tend to have greater time variations in consumption of breakfast and lunch during weekdays and weekends.(Silva et al., 2016a) In a cross-sectional study named Midlands Adolescent Schools Sleep Education Study (MASSES) 511 young adolescents (11–13 years) from 8 schools participated to study the where evening chronotype was positively related with BMI z-score compared to definitely morning chronotypes. Higher frequency of consuming unhealthy snacks, night-time caffeine consumption and inadequate daily intake of fruit/vegetables were also

associated with later chronotype and was concluded that adolescents who had later chronotype are at risk of increased BMI and poorer dietary behaviours. Although short sleep duration, but not sleep efficiency, was also an independent risk factor for increased BMI.(Arora & Taheri, 2015)

Considering that this dietary pattern continues from adolescence to adulthood, the risk of development of chronic diseases increases which underlines the correlation of how irregular meal patterns can be a risk factor for cardiometabolic disorders. Morning chrono typed adults exhibit regularity in eating patterns whereas adults who are of evening chronotype, reports lower percentage of energy from protein and carbohydrates, increased percent of energy intake from sucrose, fats and oils especially saturated fatty acids and alcohol and less consumption of vegetables, eggs and milk products which results in insufficient intake of varied vitamins and minerals like calcium, magnesium, zinc, B complex vitamins and Vitamin D.(Suzana Almoosawi et al., 2019b) In the National FINRISK study conducted in Finland in 2007, 1,854 participants aged from 25 to 74 years, evening chronotype individuals in the morning had less energy and macronutrient consumption (except for sucrose of which they had a higher intake) than morning types, while in the evening, they showed increased energy intakes for energy, sucrose, fat, and saturated fatty acids than morning types.(Maukonen et al., 2017a) Older adults who are of evening chronotype ingest high amount of caffeinated beverages at night, eats heavy meals before sleep time, and tends to have irregular sleep-wake schedules.(Suh et al., 2017a) Due to this tend to skip breakfast more frequently than did morning chronotypes. They are also predisposed to be physically inactive as skipping of breakfast has been correlated to lower physical activity and have higher BMI than the morning chronotype people.(Suzana Almoosawi et al., 2019b) In the National Weight Control Registry, people having morning chronotype were associated with better weight loss maintenance after losing considerable of weight in comparison to evening chronotype.(Anothaisintawee et al., 2018) Evening chronotype, is linked with a higher tendency to engage in practices that increases the risk of cardiovascular disorders, including smoking, accumulating sleep debt during the time transition, low intake of fruit and vegetables, and sedentary behaviour. (Anothaisintawee et al., 2018)

The mechanisms underlying the association between chronotype and disturbances in glucose metabolism are multifactorial. Due to circadian misalignment and social jet lag, insulin sensitivity is reduced which gives rise to inflammation. Having heavy dinner is associated with poor blood glucose control. In FINRISK 2007 study, individuals having an evening chronotype were at 2.5 times more risk than individuals with a morning chronotype. Chronotype not only impacts the angle of food, energy, and macronutrient intake but also correlates it to different aspects of eating patterns including the timing, frequency, and regularity of food consumption. (Suzana Almoosawi et al., 2019b) 1620 participants aged 47-59 years were enrolled from the Ansan cohort of the Korean Genome Epidemiology Study (KoGES), that was started in 2001. Evening chronotype was independently associated with diabetes, metabolic syndrome, and sarcopenia when compared with morning type, (Curtis KM et al., 2015) Knowledge of how chronotype impacts or is impacted by diet and eating patterns is crucial in the development of suitable dietary recommendations to prevent the development of chronic diseases.(Suzana Almoosawi et al., 2019b)

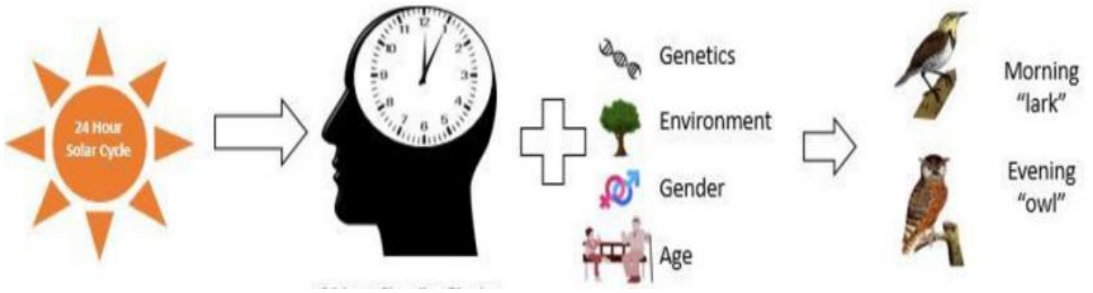


Figure 2.5: Chronotype and its types: morning chronotype (morning lark) and evening chronotype (evening lark)

Source:(B. Y. M. Yu et al., 2020)

CIRCADIAN MISALIGNMENT:

Circadian stability is of prime importance for the normal functioning of our body. (Basnet, 2019) In spite of having genetically well-regulated master circadian clock, we frequently take part in activities that skew the circadian clock and the standard pattern of the light-dark cycle. (Suzana Almoosawi et al., 2019b) Circadian misalignment can occur within the master clock and environmental factors (e.g., light–dark cycle) which is known as 'environmental misalignment' or between central clock and behavioural factors (e.g., feeding–fasting, wake– sleep, activity–rest) known as 'behavioural misalignment'. Also, when there is an imbalance between the central clock and the peripheral clocks present throughout the body, it is known as 'internal misalignment'. Circadian misalignment can badly affect the regular metabolism of the body as humans follow a diurnal pattern. (Aparecida Crispim & Carliana Mota, 2019) Circadian misalignment is very common in modern industrialised societies where there is ample of artificial light exposure coupled with work and social demands.(Mason et al., 2020) Feeding patterns appear to be the strongest zeitgeber for peripheral circadian clocks and organs related to metabolism such as liver. (Kim et al., 2015; Mason et al., 2020) Consuming food at varied time points throughout the day due to social or personal schedules, is believed to be physiologically improper from an evolutionary perspective and hastens the process of circadian misalignment. Recent studies indicate that even mild form of circadian misalignment caused due to disturbed sleep-wake cycle in both shift and non-shift workers can cause deleterious effect on health (Suzana Almoosawi et al., 2019b) The misalignment among the sleep-awake cycle, fasting-feeding cycles, and the light-dark cycle eventually disorganises the natural pattern of physiological activities.(Suzana Almoosawi et al., 2019b) When the circadian misalignment becomes chronic, these effects can favour the development of metabolic diseases. (Aparecida Crispim & Carliana Mota, 2019)

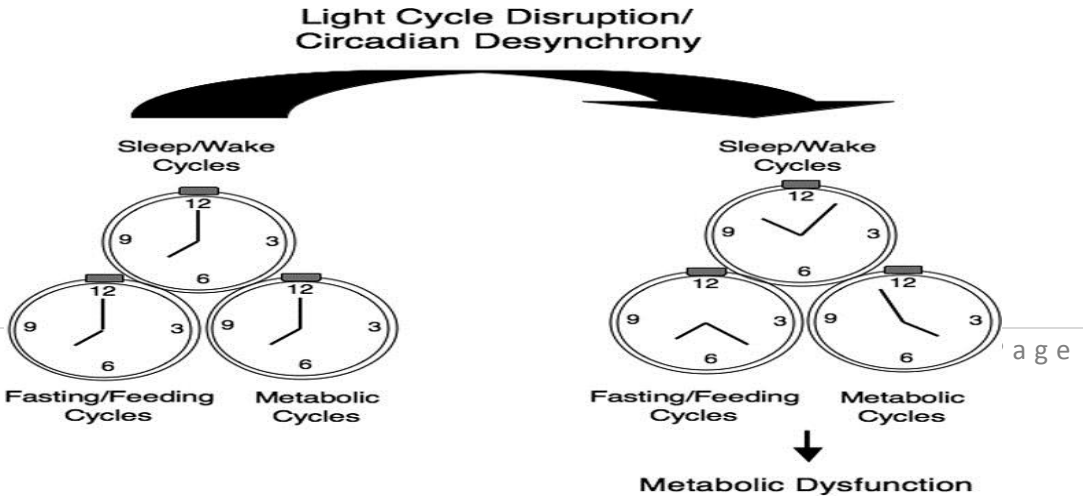


Figure 2.6: Circadian Desynchronization and metabolic dysfunction

Source:(B. Y. M. Yu et al., 2020)

Misalignment of the circadian rhythm has directly been correlated with increasing incidences of several NCDs such as metabolic syndrome, cancer, cardiovascular diseases, chronic respiratory disease, as well as depression.(Basnet, 2019) Distruption of circadian rhythm can distrupt the body's metabolism such as glucose metabolism, lipid metabolism, maintenance of blood pressure, which at last intensifies the risk of developing cardiovascular diseases and Type 2 diabetes. Circadian misalignment has negative impact on energy metabolism by reducing the resting metabolic rate which can lead to obesity.(Anothaisintawee et al., 2018)Circadian misalignment, causes negative impact on glucose metabolism which reduces insulin sensitivity, raises postprandial glucose nearly by 20%,(Drăgoi et al., 2019) and causes surge in inflammation which increases the risk of impaired glucose tolerance in shift workers. A randomized, crossover study with 9 healthy shift workers, who were non-smoking, and did not consume drugs and medicines were studied with two 3-day laboratory visits. It was established that postprandial glucose was 6.5% higher at 8:00PM than 8:00AM (circadian phase effect). Circadian misalignment increased the postprandial glucose by 5.6%, independent of behavioural and circadian effects which showed that internal circadian time affects glucose tolerance in shift workers and reduces glucose tolerance.(Curtis KM et al., 2015) These studies suggests that circadian misalignment inclines an individual towards type 2 diabetes. (Suzana Almoosawi et al., 2019b)

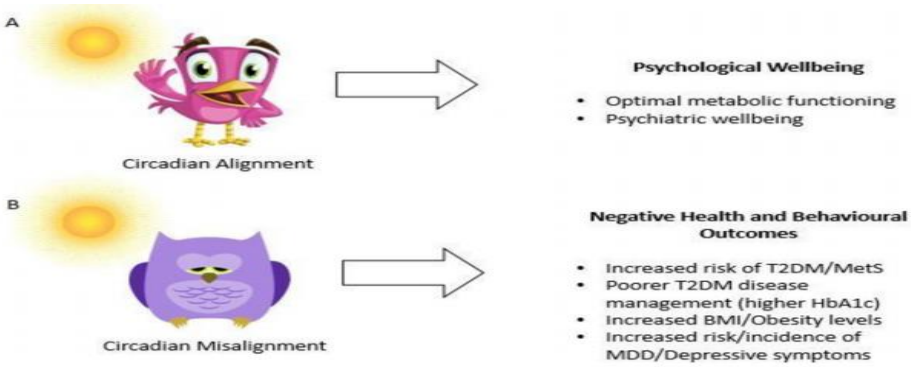


Figure 2.7: Difference between circadian alignment and misalignment

Source: (Kelly et al., 2018)

NON-COMMUNICABLE DISEASES:

According to WHO, Non-Communicable diseases (NCDs), also known as chronic diseases, tend to be of long duration and are the result of a combination of genetic, physiological, environmental and behaviours factors. The main types of NCDs are cardiovascular diseases (like heart attacks and stroke), cancers, chronic respiratory diseases (such as chronic obstructive pulmonary disease and asthma) and diabetes. 41 million people each year are killed by Noncommunicable diseases (NCDs), that comes up to 71% deaths globally. Out of which 15 million people ageing between 30 and 69 years die from a NCD with more than 85% deaths occur in low-income and middle-income group countries. Non-communicable diseases (NCDs) contribute to around 5.87 million (60%) of all deaths in India with 1.6 million of death occurring due to diabetes. (World Health Organization, 2015)

TYPE 2 DIABETES MELLITUS:

According to The International Diabetes Federation (IDF) 9.3% (463 million) adults had diabetes in 2019, and by 2045, it is projected to reach 10.9% (700 million). India had 77 million people with Diabetes in 2019 and is expected to reach 134.2 million by 2045. (International Diabetes Federation, 2019). India is home to the second largest

number of adults with diabetes worldwide. About 1 in 11 adults have now been diagnosed with diabetes mellitus, out of which 90% of the them suffer from type 2 diabetes mellitus (T2DM). (Zheng et al., 2018)

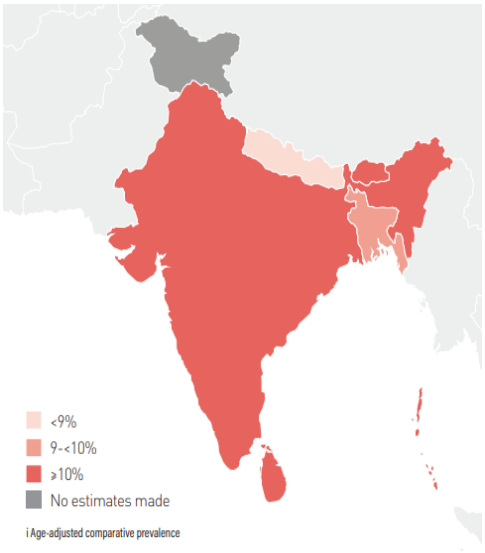


Figure 2.8: Age-adjusted comparative prevalence (%) of diabetes (20–79 years) in IDF South-East Asia Region, 2019

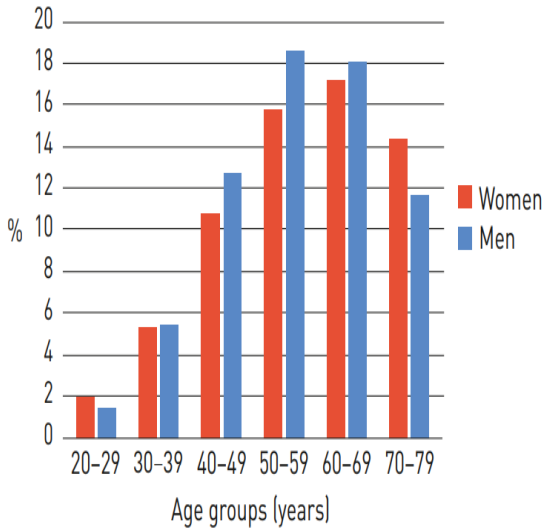


Figure 2.9: Prevalence (%) estimates of diabetes by age and sex, IDF South-East Asia Region, 2019

According to NFHS-5 (2019-20), individuals above age of 15 years among the 22 States/UTs, around 16.8% of the male adult population and 14.6% of the female adult population on average are estimated to be diabetic.15.8% women and 16.9% men suffers from diabetes and takes medications to control the raised blood sugar in Gujarat.

While in Vadodara the prevalence of diabetes is more amongst women with 16.6% and 15.1% men suffer from diabetes and takes the medications. (NFHS-5,2019-20)

The term diabetes mellitus describes a metabolic disorder of multiple aetiology characterized by chronic hyperglycaemia with disturbances of carbohydrate, fat and protein metabolism resulting from defects in insulin secretion, insulin action, or both.

(*Definition,Diagnosis and Classification of Diabetes Mellitus and Its Complications,WHO*, 1999) Type 2 Diabetes Mellitus, is also known as non-insulin-dependent diabetes mellitus (NIDDM) constitutes about 90–95% of the total cases of diabetes and is identified by two chief insulin-related abnormalities: insulin resistance and disfunction of β-cells of islets of pancreas. Insulin resistance leads to a decreased sensitivity for insulin in the muscle, liver, adipose tissue and other peripheral tissues. Decrease in insulin sensitivity causes increase in the functioning of β-cells to bring about a satisfactorily increase in insulin secretion to sustain the state of normoglycemia. Slowly the functioning of β-cells begins to falloff which in due course leads to insulin deficiency resulting in hyperglycaemia. Advancement of Type 2 Diabetes Mellitus occurs at a very slow pace and also asymptomatically such as it generally remains undiagnosed till the definitive symptoms linked with severe hyperglycaemia such as weight loss, growth impairment, blurred vision, polyuria, and polydipsia starts to take shape in the advanced stages of the disease. Uncontrolled or under detected hyperglycaemia disrupts the normal functioning of multiple organs of the body which can lead to acute or chronic complications. (Banday et al., 2020b)

Acute complications include **Diabetic ketoacidosis (DKA)**, which leads to decrease in blood pH because of elevated ketone bodies that are formed when liver coverts fatty acid to ketone for fuel during low insulin levels. Ketoacidosis if not treated immediately can lead to hypotension, shock, and also death. **Diabetic Coma** occurs in a person suffering from Diabetes Mellitus when there is severe diabetic hypoglycaemia, or when there is unconsciousness resulting from extreme hyperglycaemia, dehydration, shock, and exhaustion due to diabetic ketoacidosis or when there is severe hyperglycaemia along with dehydration due to hyperosmolar non-ketotic coma which makes a diabetic person unconscious is known as diabetic coma. **Respiratory Infections** are quite common in diabetic individuals. High blood sugar diminishes the function of immune cells and escalates inflammation which leads to increased vulnerability to respiratory infections such as pneumonia, influenza and can also change the lung function due to vascular effects caused due to hyperglycaemia. Chronic complications lead to damage in the blood vessels resulting from long and uncontrolled hyperglycaemia leading to microvascular (damage to small blood vessels) and macrovascular complications (damage to the arteries).

Microvascular disease involves 3 major complications, Diabetic retinopathy, Diabetic nephropathy and Diabetic neuropathy. (Balaji et al., 2019)

According to national eye institute Diabetic retinopathy is an eye condition that causes loss of vision and can also cause blindness in diabetic people. It affects blood vessels in the retina which starts bleeding into gel-like fluid in the center of the eye. Diabetic nephropathy (DN) or diabetic kidney disease leads to the decline in the function of kidney as High levels of blood sugar makes the kidneys to filter too much blood which puts an extra load to the filters. After long years of extra work to kidney the protein starts to leak and is excreted in the urine known as microalbuminuria. When large amount of protein is excreted in the urine is called macroalbuminuria. If this condition is not treated it may lead to end-stage renal disease (ESRD) and also can cause kidney failure according to American Diabetes Association. According to National Institute of diabetes and digestive and kidney disease, Diabetic neuropathy is damage caused to nerves as a result of prolonged uncontrolled hyperglycaemia. Nerves carry signals from the brain to the other parts of the body. There are 4 types of neuropathies. i) Peripheral Neuropathy affects the feet, legs, hands and arms of the body. ii)Autonomic Neuropathy damages the nerves that control your internal organs and can affect heart rate and blood pressure, digestive system, bladder, sex organs, sweat glands, eyes, and also the ability to sense hypoglycaemia. iii)In Focal neuropathies there is damage to single nerve which commonly involves your hand, head, torso, and leg. iv)Proximal Neuropathy is a rare kind of nerve damage that happens in hip, buttock, or thighs. It affects one side of your body and rarely spreads to the other side.

The etiology of type 2 diabetes mellitus is composite and includes multi-fold known and unknown factors, which can be expressed as the joined effect of genetic dispositions with strongly potent environmental impacts. (Banday et al., 2020b)

The factors that may lead to development of diabetes can be both modifiable and non-modifiable.

Non modifiable factors include:

i) AGE: Type 2 diabetes usually occurs in the middle years of life and rises steeply thereafter.

ii) SEX: The prevalence of diabetes in men is more in South East Asia.

iii) IMMUNE MECHANISMS: Cell mediated immunity and humoral immunity may act against islet cells of the pancreas due to certain environmental trigger and attacks the body's own insulin producing cells.

Modifiable factors include:

i) SEDENTARY LIFESTYLE: Sedentary lifestyle is an important risk factor in the development of type 2 diabetes mellitus as inadequate exercise alters the interaction among insulin and its receptors and substantially leads to the development of type 2 diabetes mellitus.

ii) DIET: Consumption of foods that are high in saturated fats increase the risk of developing impaired glucose tolerance. Consuming polyunsaturated fatty acids is associated with reduced risk of developing type 2 diabetes. Replacing the consumption of saturated fatty acids with unsaturated fatty acids leads to improvement in glucose tolerance and increases insulin sensitivity.

iii) DIETARY FIBRE: High fibre intake results in reduction of blood glucose and impaired glucose tolerance.

iv) ALCOHOL: Excessive alcohol intake accelerates the risk of developing type 2 diabetes mellitus by damaging the liver and the pancreas and also by promoting obesity.

v) OBESITY: With increasing BMI, waist circumference and waist hip ratio, the risk of diabetes increases. Central adiposity is a risk factor for type 2 diabetes and is also an important contributing factor of insulin resistance. Losing weight improves sensitivity of insulin and reduces the risk of advancement of impaired glucose tolerance to type 2 diabetes mellitus. (Park, 2015)

Hormones affect the energy metabolism and are involved in regulating blood glucose levels.

Table 2.2: The metabolic effect and actions of hormones in regulation of blood glucose

Hormone	**Action**	**Tissue of Origin**	**Metabolic effect**	**Effect on blood Glucose**
Insulin	To regulate the metabolism of carbohydrates and fats by allowing the absorption of glucose from the blood. Fat is stored and is not used for providing energy.	Pancreatic β cells	Helps entering glucose into cells; Stores glucose as glycogen, or converts to Fatty Acids; synthesizes Fatty Acids and proteins; Suppresses breakdown of proteins into Amino Acids, and adipose tissue into Free Fatty Acids.	Lowers
Glucagon	Increases the glucose concentration in blood by breaking down the stored liver glycogen into glucose.	Pancreatic α cells	Releases glucose from glycogen; Synthesizes glucose from amino acids or fatty acids.	Raises
Somatostatin	Inhibits the release of numerous secondary hormones. It inhibits insulin and glucagon secretion.	Pancreatic δ cells	Suppresses release of glucagon from α cells; suppresses release of Insulin, PTH, gastrin & secretin.	Lowers
Epinephrine	Increases blood flow to muscles, output of the heart, pupil dilation, and blood sugar level during fight-or- flight situation.	Adrenal medulla & neurons	Releases glucose from glycogen; Releases Fatty Acids from adipose tissue.	Raises
Cortisol	Released in response to stress and low blood-glucose	Adrenal cortex	Enhances gluconeogenesis; Acts as Insulin antagonist.	Raises

	concentration			
ACTH	Promotes secretion of glucocorticoid (cortisol in human).	Anterior pituitary	Releases cortisol; Releases Fatty Acids from adipose tissue.	Raises
Growth hormone	Reduces blood glucose level.	Anterior pituitary	Antagonizes insulin and somatostatin	Raises
Thyroxin	Acts on growth, development and metabolism.	Thyroid	Release glucose from glycogen; absorbs sugars from intestine	Raises

(Source:(Qaid & Abdelrahman, 2016))

Diagnosis of Diabetes:

Health care professionals generally use the fasting plasma glucose (FPG) test or the HbA1C test to diagnose diabetes. Fasting plasma glucose (FPG) test measures your blood glucose level at a single point in time after you fast for at least 8 hours.
The HbA1C is a blood test that provides your average levels of blood glucose over the past 3 months. Health care professionals at times use the Random Plasma glucose (RPG) is a test that can diagnose diabetes without fasting.

Table 2.3: Diagnostic Criteria for Diabetes by American Diabetic Association

Diagnosis	Fasting blood Glucose (FBG)	Random Plasma Glucose (RPG)	HbA1c (%)
Normal	<100 mg/dl		<5.7%
Prediabetes	100-125 mg/dl		5.7 to 6.4%
Diabetes	>=126 mg/dl	>200mg/dl	>6.4%

Prevention of Type 2 Diabetes Mellitus:

1) Primary prevention: Two strategies for primary prevention have been suggested: (a) population strategy, and (b) high-risk strategy.

(a) Population Strategy: The development of type 2 diabetes prevention programs are based on eliminating the environmental risk factors. There is a serious need for primordial prevention which includes maintaining normal body weight by adopting nutritional eating habits like consumption of adequate protein, high fibre intake and being physically active.

(b) High risk Strategy: Non-Insulin Dependent Diabetes Mellitus is linked with sedentary life style and obesity, measures to increase physical activity and reducing obesity needs to be taken to reduce the risk of development of diabetes. Consumption of alcohol and smoking should be strictly avoided. These plans of action can be most effectively administered to the target population groups.

2) Secondary Prevention: The aims of treatment are (a) to maintain blood glucose levels within normal levels and (b) to maintain ideal body weight. These can be achieved through consumption of healthy and balanced diet, timely administration of oral antidiabetic drugs, with help of insulin. Good control of blood glucose protects against the development of complications.

3) Tertiary prevention: The main objective at the tertiary level is to establish specialized clinics in cities and towns which are efficient in diagnosing and treatment of diabetes.(Park, 2015)

Effect of diet on type 2 diabetes mellitus:

The role of diet in the etiology of Type 2 Diabetes Mellitus was proposed by Indians years ago by observing its relationship with rich people who consumed oil, flour, and sugar in excessive amounts. (Sami et al., 2017) Individuals suffering from diabetes should consume 50-55 % calories from carbohydrate, 20-25% energy from protein and the rest 20-30% should be consumed from fats. (Mohan et al., 2018) Intake of carbohydrate has a direct effect on postprandial glucose levels in people with diabetes and is the principal macronutrient in management of Type 2 Diabetes Mellitus. (Sami et al., 2017) The quantity and quality of carbohydrate plays an important role in preventing and managing Type 2 Diabetes Mellitus. Diets that were low in carbohydrates showed effectiveness in improving the glycaemic control, losing weight, and reduced cardiovascular risk, but could not be sustained over a long period of time among people with type 2 diabetes mellitus. (Dyson, 2015) Foods that are high in glycaemic index increases the level of glucose and insulin in the blood post meal and promotes insulin resistance which leads to type 2 diabetes mellitus by exhausting the functioning of beta-cell of pancreas. Foods like polished rice, refined wheat, sugar, glucose, highly processed foods such as cookies and pastries, fruit juice and sweetened beverages, fried potatoes or French fries are high in GI and raises the blood sugar value.(Mohan et al., 2018) Certain studies reveal that High Carbohydrate diets may increase the serum triglyceride levels and reduce high density lipoprotein-cholesterol (HDL-C) levels, which could increase the risk of cardiovascular disease while certain studies shows that there is no deterioration in the glycaemic control and lipid profiles, especially the triglyceride and HDL-C levels. According to studies a High Carbohydrate diet that is composed of high fibre and low GI foods has same effects on when compared with and a low carbohydrate diet.(Jung & Choi, 2017) A prospective cohort study that involved US women for 24 years showed that diets that have higher starch-to-cereal fibre ratio and lower fibre intake was associated with increase in risk of Type 2 Diabetes Mellitus.(AlEssa et al., 2015) Dietary proteins are important in modulating the metabolism of glucose. Higher intake of protein was directly associated with lower risk of type 2 diabetes mellitus. (Sluik et al., 2019) There was improvement in weight, fasting glucose, and insulin requirements among participants who consumed 30% energy from protein.(Evert et al., 2019)

Consumption of vegetable protein sources are associated with lower risk of type 2 diabetes mellitus whereas high intake of animal protein was associated with a higher

risk of Type 2 Diabetes Mellitus. (Malik et al., 2016) Greater weight loss along with improvement in HbA1c by 0.5% was seen in individuals consuming 25-32% energy from plant based protein.(Evert et al., 2019) There is evident research based on the interventional studies that shows that consumption of dairy proteins has significant effect on insulin secretion compared to other commonly consumed animal proteins. Along with the protein components like insulinogenic amino acids and bioactive peptides, dairy products also contains a food matrix that is rich in calcium, magnesium, potassium, trans-palmitoleic fatty acids, and also have low-glycaemic index sugars having beneficial effects on controlling blood glucose levels, secretion of insulin and increasing the insulin sensitivity which reduces the risk of Type 2 Diabetes Mellitus.(Comerford & Pasin, 2016) Dietary fat intake leads to development of obesity and affects the metabolism of glucose. Increased total fat intake increased the LDL cholesterol, triglycerides, HbA1c and C-reactive protein in an observational study conducted on 1785 European adults aged 50–75 years with type 2 diabetes. (McMacken & Shah, 2017) The type of fat that is consumed is of utmost importance. Higher consumption of Saturated Fatty Acids is related to insulin resistance. Replacing Saturated fats with unsaturated fats might have a favourable effect. (Ericson et al., 2015) PUFA consumption is associated with lower risk of Type 2 Diabetes Mellitus in the Nurses' Health Study (NHS) (Guasch-Ferre et al., 2017) Consuming soluble dietary fibre regularly leads to improved blood glucose levels, insulin resistance and metabolic profiles (Chen et al., 2016). High intake of dietary fibre reduces the risk of developing Type 2 Diabetes Mellitus by 20-30%. (Weickert & Pfeiffer, 2018)Dietary fibre intake was associated with a lower risk of diabetes in European Prospective Investigation in Cancer and Nutrition (EPIC) conducted on 11,559 participants with type 2 Diabetes Mellitus. (McMacken & Shah, 2017)

ASSOCIATION OF DIABETES AND CHRONONUTRITION:

Glucose metabolism is a diurnal physiological process that follows a circadian rhythm. Glucose tolerance in humans' spikes during day time and gradually declines throughout the day reaching the lowest during the night time. The circadian rhythmicity that is recognised in the metabolism of glucose, emerges as a result of shifts in utilization of glucose, insulin sensitivity, and secretion of insulin on the specific time each day.(Suzana Almoosawi et al., 2019a; Henry et al., 2020) There are certain lifestyle behaviours and external factors which disrupts the circadian pattern of glucose metabolism and therefore alters the well-established interaction between an individual's chrononutrition (circadian rhythm) and its effect on diabetes.

These factors are:

A) **Sleep:** Sleep is the metabolic controller, and the sleep-wake cycle is the most potential mode for aligning the organism to its circadian rhythm.(Drăgoi et al., 2019) The urban environment encompasses several dietary and lifestyle factors that can affect health. Rise in activities that includes excessive use of television, internet, and mobile phones almost throughout the day leads to a gradual decrease in the adequate sleeping time as exposure to light during the 'biological night' affects the sleep activity by affecting the sleep quality and the duration of sleep. Insufficient sleep has directly been associated with deleterious health effects. (Pot, 2018; Serin & Acar Tek, 2019)Decrease in duration of sleep (>5.6 h) was associated with decrease in RMR. (Gupta, 2019) Individuals with lack of sleep are prone to consume higher number of meals and inclined towards choosing unhealthy foods high in fat and energy.(Garcez et al., 2021) Higher consumption of fat, meat, alcohol, noodles and candies and low consumption of carbohydrate, protein, dairy products, rice, vegetables, eggs, minerals like potassium, calcium, magnesium, iron and zinc and vitamins like vitamin A and D, thiamine, riboflavin, vitamin B6, folate was found in sleep deprived individuals. (Toktaş, Erman, et al., 2018) Disruption in satiety and hunger hormones have been observed as leptin levels were found to be low and high ghrelin levels were seen in individuals who had lesser sleep duration, and was directly related to increase appetite which could lead to high BMI.(Berendsen et al., 2020) Spiegel et al., conducted a randomized, crossover clinical study where plasma leptin and ghrelin levels were measured.

Subjects exhibited an 18% decrease in leptin, 24% increase in ghrelin, 24% increase in hunger, and 23% increase in appetite when there was sleep restriction to 4 hours/day. (Kim et al., 2015)Sleep deprivation can cause abdominal obesity and metabolic syndrome.(De Amicis et al., 2020) The degradation of the sleep-wake cycle, especially in healthy individuals, can cause obesity, impaired glucose tolerance, increased postprandial plasma glucose and diabetes.(Serin & Acar Tek, 2019) A strong correlation between short sleep duration and eating dinner late at night and consumption of more calories in the late evening have been found out to significantly increase the risk for developing obesity and diabetes. (Berendsen et al., 2020) In a study conducted at Oman, total of 172 diabetics and 188 healthy controls were enrolled in the study. The study showed a positive association between sleep duration of <6 hours at night with Type 2 Diabetes Mellitus. (Al-Abri et al., 2016) A crossover study conducted on 21 participants with mean age of 33 years who were sleeping for less than 6 hours showed that extending sleep in chronically sleep deprived individuals help to improve glucose metabolism. (So-Ngern et al., 2019) Cross-sectional observational study of 124 patients with circadian sleep-wake disorder (CRSWD) was conducted at Hyogo Children's Sleep and Development Medical Research Center in Hyogo, Japan where decrease in sleep duration was associated with hyperglycaemia in patients with CRSWD. (Toyoura et al., 2020)

B) Hormones: Hormones play an important role in regulation of metabolism and are crucial in evaluating the metabolic orders and disorders. Several hormones affect the energy balance regulation like leptin and ghrelin while some are involved in regulating the blood glucose levels like insulin and glucagon, and some hormones increase the blood glucose levels like growth hormone, thyroxine and cortisol. Sleep is regulated in the body by melatonin hormone.(Qaid & Abdelrahman, 2016) The functioning of certain hormones varies according to the light and dark cycle and are also afflicted by sleep, feeding, and general lifestyle patterns. Circadian disruption negatively influences the hormonal rhythms and metabolism of an organism which can lead to obesity, insulin insensitivity, diabetes, impaired glucose and lipid homeostasis and reversed melatonin and cortisol rhythms.(Kim et al., 2015)

i) Melatonin: Melatonin is known as the darkness hormone which is an indoleamine whose chemical name is N-acetyl-5-me-thoxytryptamine. (S. Sharma et al., 2015b)The pineal gland produces and releases the melatonin hormone and is activated or deactivated by light exposure to the eyes. Secretion of melatonin starts around 3 months of age and establishes the circadian rhythm in life.(Kodali, 2017) Melatonin shows strong circadian rhythmicity. The level of melatonin hormone is elevated during the night and lowers at the sunrise. Melatonin secretion peaks between 11:00 p.m. and 5:00 a.m., with 3 to 10 times increase in the blood concentration. (Serin & Acar Tek, 2019) Melatonin plays an important role in regulating sleep in humans. (Kim et al., 2015) The prime role of the melatonin hormone is to support the biological clock and adjustment of the body rhythm.(Serin & Acar Tek, 2019) Melatonin maintains the circadian rhythm through the presence of melatonin receptors on different peripheral tissues. (S. Sharma et al., 2015b) Melatonin influences insulin and glucagon release. These actions are mediated by two specific Gi-protein-coupled melatonin receptors, MT1 and MT2 that are present in the alpha, beta and gamma cells of the islets of Langerhans in the pancreas which can harmonise the insulin secretion. Desynchronisation or mutations in the signalling of the receptors may lead to distortion of insulin secretion and the development of type 2 diabetes.(Peschke et al., 2015) Melatonin regulates sleep in diurnal species including humans. After 2 hours of endogenous melatonin production, there is a sharp incline in sleep in humans at night. Presence of Light inhibits the synthesis of melatonin and in turn causes disruption of sleep. (Zisapel, 2018) Deprived Sleep reduces insulin sensitivity and insulin secretion. (Kodali, 2017) A Case-control study was conducted within the Nurses' Cohort Health Study cohort where 370 with type 2 diabetes mellitus from the year 2000-2012 was selected as cases and other 370 women were selected as controls by using risk-set sampling. The study showed that lower melatonin secretion was independently correlated with increased risk of developing type 2 diabetes mellitus by associating the melatonin secretion with lifestyle habits, sleep quality, biomarkers of inflammation and endothelial dysfunction.(McMullan et al., 2013) Administrating of melatonin causes increase in tolerance of glucose and insulin sensitivity in the morning and decreases in insulin sensitivity in the evening. Decreased glucose tolerance was seen during sleep deprivation which advocates that the melatonin is crucial for regulating glucose concentration in blood and maintaining homeostasis and

thus reducing the chances of developing type 2 diabetes mellitus. (S. Sharma et al., 2015b)

ii) Insulin: Insulin is a hypoglycaemic anabolic hormone, secreted from the β cells of the Islets of Langerhans of pancreas when blood glucose levels rise and promotes the energy storage in peripheral stores.(Qaid & Abdelrahman, 2016) Level of Insulin in the body fluctuates according to the meal time. (Oda, 2015) During normal body metabolism, insulin sensitivity and insulin secretion decrease steeply between 3:00 and 5:00 a.m. at night. (Serin & Acar Tek, 2019) Insulin acts as a strong factor to synchronise the liver and the adipose tissue clock which highlights its entrainment in organs that contribute to metabolic syndrome. (Oda, 2015)

Insulin and glucagon have an antagonist effect which acts together as a an energy regulator between fast and fed states. (Drăgoi et al., 2019) Circadian clock in pancreas regulate the secretion of insulin and its response to the presence or absence of glucose in the blood.(Johnston et al., 2016) When the circadian clocks are regulated, there is increased beta cell responsiveness, insulin sensitivity, insulin clearance and glucose tolerance. Glucose tolerance shows circadian rhythmicity, which is higher in the morning resulting in poor glycaemic control during the evening and at night in healthy adults. (Paoli et al., 2019) This also highlights the difference that is seen in postprandial glucose concentrations and altered secretions of insulin when the same food is consumed in the morning and in the evening. (Kessler & Pivovarova-Ramich, 2019) Circadian rhythm alterations damage the beta cell functioning leading to increased glucose and insulin levels as well as impaired glucose tolerance and sleep deficiency.(Arola-Arnal et al., 2019) There is a strong evidence from various epidemiological studies that sleep deprivation is strongly associated with the development of glucose intolerance, insulin resistance, reduced insulin sensitivity, increased inflammation and ultimately Type 2 Diabetes Mellitus. (Suzana Almoosawi et al., 2019a; Mirghani et al., 2020) Postprandial glucose was 6% higher and postprandial late-phase insulin was 10% higher during circadian misalignment as compared to the aligned circadian conditions.(Mason et al., 2020) Circadian misalignment with sleep restriction resulted in a worse reduction in insulin sensitivity and higher insulin resistance when compared to circadian misalignment without sleep restriction. A study showed that circadian misalignment since past 3 weeks along with sleep restriction shows decrease in glucose tolerance and insulin release, which could

be recovered with one week of sleep extension. (Johnston et al., 2016) Acute or chronic sleep deprivation in humans following nocturnal lifestyle may result in insulin resistance at a cell signalling level which causes insulin resistance, glucose intolerance, and increases the risk of developing type 2 diabetes mellitus. (Kim et al., 2015)

iii) Leptin: Leptin is an anorexigenic hormone mainly secreted by adipocytes that is involved in the control of intake of food by its action on the hypothalamus which leads to the suppression of appetite.(Noble & Smith, 2015) The Suprachiasmatic nucleus has receptors for leptin and ghrelin, which regulates appetite and hunger signals.(Drăgoi et al., 2019) It is a chief regulator of energy balance, and body adiposity is characterized by hyperleptinemia which is caused due to leptin resistance. Leptin has an influence on glucose homeostasis and thermogenesis. When the leptin signalling is compromised, it leads to metabolic disorders like obesity and diabetes mellitus. (Ramos-Lobo & Donato, 2017) The release of leptin hormone follows a circadian cycle with its serum levels peaking at night. After just a few days of circadian misalignment, secretion of leptin suppress (Serin & Acar Tek, 2019) which leads to elevation in glucose levels and risk of obesity and diabetes increases.(Johnston et al., 2016) Leptin levels were decreased by 17% with 10 days of forced desynchronisation in healthy participants (Anothaisintawee et al., 2018) Irregular timing in food intake is linked to alteration in satiety signals and reduction in serum leptin levels which causes increase in appetite and unusual timing in food consumption, specifically at night and reduction in energy expenditure.(Arola-Arnal et al., 2019; Azmi et al., 2020) Timing in the intake of carbohydrates and fat affects the average blood concentrations of the leptin. (Kessler & Pivovarova-Ramich, 2019) Leptin levels were found to be lowest during sleep deprivation and circadian disruption(Kim et al., 2015)which leads to increase in appetite resulting in a higher BMI (Berendsen et al., 2020) and can also lead to severe insulin resistance which is directly associated with hyperglycaemia. (Ramos-Lobo & Donato, 2017)

iv) Ghrelin: Ghrelin is a 28-amino acid peptide, isolated from the stomach of rats. (Lindqvist et al., 2020) Ghrelin is secreted from stomach A-like cells in humans and has orexigenic and adipogenic effect which increases the intake of food and body weight and thus plays an important role in energy balance. (Ahmed et al., 2017) Apart

from stomach which is the prime source of circulating ghrelin, pancreas and intestine also secrets ghrelin in small amount. It was also recognised that ghrelin cells were the fifth type of cells in the islets of Langerhans which contributes to nearly 1% of all cells in islets of Langerhans. (Lindqvist et al., 2020)

Ghrelin follows circadian oscillation and has lowest levels in the morning.(Arola-Arnal et al., 2019) The Suprachiasmatic nucleus has receptors for leptin and ghrelin in heart and adipose tissue and controls the hunger and satiety signals through the hypothalamus.(Drăgoi et al., 2019) Ghrelin levels rise ahead of the regular meal timing and subsequently decreases. (Kim et al., 2015) Apart from its ability to increase the food intake, it also activates gastric emptying as well as gastric acid secretion. Ghrelin also enhances olfactory sensitivity, taste sensation and also increases locomotor activity towards food reward. (Poher et al., 2018) When there was restricted sleep and circadian misalignment for 3 weeks, ghrelin levels were slightly increased. (Anothaisintawee et al., 2018) Sleep deprivation increases ghrelin concentrations which leads to increased feeling of hunger and suppression in satiety, which increases the appetite throughout the day as well as during night, resulting in a higher BMI. (Azmi et al., 2020; Berendsen et al., 2020; Garcez et al., 2021) 24% increase in ghrelin, 24% increase in hunger, and 23% increase in appetite was seen in individuals whose sleep was restricted to 4 hours in a day. Appetite for high carbohydrate food was increased by 32% during sleep deprivation. (Kim et al., 2015) It is established that ghrelin has insulin-suppressing effects. (Lindqvist et al., 2020) Ghrelin stimulates glucagon secretion which affects the glucose metabolism. (Poher et al., 2018) Total plasma ghrelin levels has been found to be low in obese individuals and higher among individuals who are lean. (Ahmed et al., 2017) So, diabetogenic actions of ghrelin is seen among individuals with obesity. (Mani et al., 2019)

iv) Cortisol: Cortisol is the main glucocorticoid synthesized from cholesterol in the zona fasciculate of the adrenal cortex. It is secreted in response to biochemical stress. Cortisol exhibits circadian rhythmicity with its levels increasing during the early morning (highest at about 8 a.m.) and decreasing slightly in the evening and also during the early phase of sleep. (D. Y. Lee et al., 2015) Hypothalamic–pituitary–adrenal (HPA) axis is activated, which results in secretion of corticotropin-releasing hormone (CRH) from the hypothalamus, and stimulates the anterior pituitary gland to release adrenocorticotropic hormone (ACTH). ACTH then stimulates the release of

cortisol from the adrenal gland in response to stress.(Joseph & Golden, 2017) Sleep deprivation has been correlated with the elevation of cortisol, due disablement of regulation of Hypothalamic–pituitary–adrenal axis, which results in overload of glucocorticoid, which can cause large deleterious effects on the body.(Hirotsu et al., 2015)

Sleep disruption increased the activity of sympathetic nervous system and also the evening cortisol levels. (Kim et al., 2015) Decrease in glucose effectiveness and the acute insulin response was seen by 30% was seen in a study with only 4 hours of sleep for six consecutive days.(Hirotsu et al., 2015) Disruption caused to the cortisol rhythm by circadian rhythm disruption or sleep deprivation causes dysfunction in the β-cell of islets of Langerhans of pancreas leading to the development of insulin resistance, glucose intolerance, and ultimately leading to development of Type 2 Diabetes Mellitus.(Briançon-Marjollet et al., 2015)

C) Effect of Meal timings and Meal Composition on Glucose Metabolism:

Meal timing has a major influence on circadian rhythm of the peripheral organs (Azmi et al., 2020) that regulates the metabolic functions which affects metabolism and are critical for maintaining metabolic health. (Kessler & Pivovarova-Ramich, 2019; Réda et al., 2020) Unusual meal timings can affect the relationship between the master circadian clock and peripheral clocks which can lead to glucose intolerance. (Henry et al., 2020) The first meal of the day adjusts the circadian rhythm of the peripheral clocks, while, the last meal of the day leads to lipogenesis and accumulation of adipose tissues. Breakfast consumption has a beneficial effect on the quality of diet throughout the day.(Azmi et al., 2020) Consuming carbohydrate-rich diet during breakfast indicates protective effect against the development of diabetes and metabolic syndrome.(Kessler & Pivovarova-Ramich, 2019) Consuming protein during breakfast gives feeling of fullness, increases satiety, and lowers the concentration of ghrelin. (Azmi et al., 2020)

Individuals who skipped breakfast consumed higher energy during lunch, and snacks and higher energy and carbohydrate intake at dinner which can lead to overweight/obesity. (S. Almoosawi et al., 2016) Meal timing is a key factor that affects the thermal effect of foods. Consuming food during the morning time has higher Diet-induced thermogenesis compared to food consumption during evening

and night time. (Serin & Acar Tek, 2019) Breakfast skipping leads to rise in postprandial insulin concentrations, increases fat oxidation and inflammation which might cause impairment in glucose homeostasis. (Paoli et al., 2019)

The individuals who do receive appetite signals due to disrupted biological clock tend to skip breakfast and consume food at inappropriate time has higher risk of developing type 2 diabetes mellitus. A 16-year follow-up cohort study in USA showed that men who skipped breakfast increased the risk of developing Type 2 Diabetes Mellitus by 21% times in comparison to the men who consumed breakfast. Skipping of breakfast leads to insulin resistance among individuals who are diagnosed with type 2 diabetes mellitus. Later chrono-typed individuals having Type 2 diabetes mellitus who skipped breakfast, had poor glycaemic control and higher HbA1c values. (Henry et al., 2020) Late eating was associated with decrease in resting energy expenditure, glucose tolerance, and reduction in thermal effect of food.(Azmi et al., 2020) Postprandial hyperglycaemia was seen during the sleep hours after the consumption of meal at late evening which decreases the glucose tolerance. A cohort study reported 2 times higher incidence of type 2 diabetes mellitus in older men and women who consumed high calories at dinner. Cohort study highlighted the relationship between late-night dinner consumption with increase in HbA1c in diabetic individuals. These studies illustrate how glucose metabolism is not just affected by what and how much you eat, but also when you eat the meal is of prime importance. (Henry et al., 2020) The quantity, quality and the digestive rate of dietary carbohydrates act as a determining factor for postprandial glucose levels and insulin response. (Henry et al., 2020) Glucose helps in harmonising of circadian rhythm.(Oda, 2015) A four-way, randomized crossover study was conducted to compare the glycaemic Index, glycaemic Load and the timing of meal consumption on healthy individuals by Morgan et al. When foods with higher glycaemic Load were consumed in the evening, it led to higher glucose and insulin response compared with consuming the same meal in the morning. Foods with high glycaemic index when consumed during evening, had a notable effect on glucose and insulin. These results confirmed that the quality and quantity of carbohydrates, influences glycaemic control and insulin secretion. (Henry et al., 2020) Liver clocks are synchronised in the presence of carbohydrate and protein. (Oda, 2015) Protein-rich meals boosts satiety and alertness due to its higher thermogenic effect (Azmi et al., 2020) A crossover

study conducted on healthy participants indicated that increasing the amount of proteins in a meal can reduce postprandial glucose at night. effect (Azmi et al., 2020)

Epidemiological studies described that consuming more carbohydrates than fats in the morning helps to prevent the development of type 2 diabetes mellitus. Randomised crossover trial which compared two isocaloric meals, that differed just in total sugar and saturated fat content, concluded that by reducing saturated fat and sugar content food in dinner was directly linked with improvement in glucose response. Ingestion of green tea that contains catechins reduces postprandial plasma glucose concentrations when consumed in the evening while protective effect on diabetes has been seen in individuals who consume coffee during lunch time in a prospective cohort study. These major declarations propose that the peripheral circadian clocks are affiliated with the food components, determined by the time of consumption. (Henry et al., 2020)

D) Physical Activity: Physical activity has a major role in the management of Type 2 Diabetes Mellitus. Individuals are motivated to exercise daily or on alternate days to meet the present guidelines on physical activity i.e., Moderate physical activity for at least 150 minutes/ week or vigorous intensity exercise for 75/ week. (Henson et al., 2020) Exercise is a part of physical activity which has planned, structured, and repetitive bodily movements that are performed for improving or maintaining general bodily fitness. Exercise improves sleep quality and thus prevent chronic illness that are caused due to sleep deprivation.(Cai et al., 2017) Exercise training delays the onset of at least 40 chronic metabolic conditions/diseases. Exercise also has a notable impact on body composition, as it reduces subcutaneous and visceral fat by increasing fat oxidation and at the same time preserves the lean body mass. Aerobic exercise when performed for adequate duration and proper intensity can cause improvement in glycaemic control when performed in the afternoon or in the evening time as insulin resistance follows a circadian pattern. Exercise also causes reduction in appetite and consumption of carbohydrate, sugar, sweets, and desserts among older adults with prediabetes.(Parr et al., 2020) Individuals who suffer from diabetes when exercise regularly, improvement in glycaemic control, reduction in insulin resistance and blood pressure is seen.(Cai et al., 2017) There is a correlation between the timing of exercise and consumption timing of meals on glycaemic control. Heden et al. indicated that performing exercise after consuming the meal remarkably reduced the glucose

concentration in individuals with Type 2 Diabetes Mellitus when compared with performing exercise before meal. Exercise performed for even a short period of time is directly linked with increase in glucose uptake among individuals having impaired glucose tolerance and Type 2 Diabetes Mellitus. The speed of uptake of glucose increases by 24% when exercise was performed just 30 minutes prior to the oral glucose tolerance test. Studies indicate that exercising for >150 minutes per week exercise reduces HbA1c by 0.89%. (Teo et al., 2018)

These studies indicate how important it is to correlate the meal timing with the exercise timing to regulate the glycaemic control for managing type 2 diabetes mellitus among individuals. (Teo et al., 2018)

The above review of various literature shows a clear association between chrononutrition, chronotype, meal timing, meal composition, hormones, stress, sleep and physical activity. Therefore, the present study aims to identify the correlation between chrononutrition profile and type 2 diabetes mellitus.

METHODS AND MATERIALS

METHODS AND MATERIALS

The present study was undertaken to study the "Association of Chrono nutrition Profile and Type 2 Diabetes Mellitus." This chapter states the study design and discusses the methods and materials that are used to accomplish the stated objectives.

Sample Size: 227 subjects

- Required sample size was obtained using formula $n = (3.84)\ pq / L^2$, (Sample size for estimation of proportion) at 5% level of significance.
- p = 15.9% (average of high blood sugar in men and women as 15.1% and 16.6% respectively, as per NFHS-5, Vadodara district factsheet), and q = 1 – p.
- Absolute precision (L) was taken as 5%.
- Design effect was taken as 1.
- Thus, the required sample size was 206
- Considering 10% attrition, the total sample was calculated as 227.

Sampling Technique: The sample size was selected through Random Sampling.

Study design: This study was a Cross-section Study, based in Urban Vadodara.

Permission from the doctors of 3 diabetes clinics were taken to enrol the subjects suffering from Type 2 diabetes mellitus from their respective clinics. Subjects from 3 diabetes clinics were identified who met the study criteria.

Inclusion Criteria:

- Both Men and Women
- 35-60 years
- Those who have been diagnosed with Type 2 Diabetes Mellitus from past 0-5 years.
- Having controlled diabetes.
- Subjects without secondary complications.
- Willingness to participate.

Exclusion Criteria:

- Subjects with poor compliance for follow up at the clinic.

A total of 227 participants were enrolled in the study.

Written informed consent (Annexure I) was taken from the subjects who agreed to participate in the study.

The following information was collected through the structured questionnaire (Annexure II):

- Personal information,
- Diet information,
- Consumption of ultra-processed foods,
- Chronotype,
- Physical activity,
- Screen time,
- Stress,
- Sleep,
- Knowledge Attitude Practice information,
- Anthropometric data and
- Biochemical parameters

The following data was collected through the telephonic interview technique.

- **Personal Information**: The personal information including name, age, gender, education qualification, occupation and type of family was collected from the participants.

  Education qualification was classified into 7 categorized according to kuppuswamy scale.

Table 3.1: Educational Qualification Categorization:

Category
Illiterate
Primary School
Secondary School
Higher Secondary
Diploma
Graduate
Post-Graduate

Source: (MODIFIED KUPPUSWAMY SCALE | PSM Made Easy)

The occupation was categorised according to National Occupation Classification into the following categories:

Table 3.2: Occupation categories according to National Classification:

Occupational Categories:
Business owner/ self employed
Professionals
Government / Civil service
Manager/ Supervisor
Clerks
Sales / Service workers
Agriculture and fishery worker
Home-maker
Retired

Source: National classification of occupation (Ii, 2015)

- **Diet Information** was collected using a 24-hour dietary recall for 3 days. According to National Cancer Institute, The A 24-hour dietary recall is a structured interview that captures the detailed information about all foods and beverages consumed by the respondent in the past 24 hours, most commonly, from midnight to midnight the previous day. The 3 days 24-hour diet recall was converted into raw ingredients and then quantified using the Dietcal software developed by Ms. Gurdeep Kaur, Chief Dietitian at AIIMS, New Delhi.

- **Consumption of Ultra-processed foods** were collected using the food frequency questionnaire. According to National Cancer Institute, a food frequency questionnaire (FFQ) is an advanced form of checklist of finite list of foods and beverages which collects the information about how often the specific food is consumed over a specific period by the respondent.

- **Chronotype** was assessed using the Horne and *Ostberg Morningness-Eveningness* Questionnaire. There are 19 questions in the questionnaire to determine *morningness-eveningness* in human circadian rhythms. Scoring ranges from 16-86. Scores from 16 to 30 indicates "Definitely Evening", 31 to 41 indicates "Moderate Evening", 42 to 58 indicate "Intermediate types", 59 to 69 indicates "Moderate Morning" and 70 to 86 indicates "Definite Morning".

- **Physical Activity:** The Physical activity was assessed using the Global Physical activity Questionnaire (GPAQ). The Global Physical Activity Questionnaire was developed by WHO for physical activity surveillance in countries. It collects information on physical activity as well as sedentary behaviour and comprises of 16 questions. The domains are: 1) Activity at work 2) Travel to and from places and 3) Recreational activities. Information on type of activity and duration of activity was obtained from the GPAQ questionnaire and the Exercise Energy Expenditure (EEE) was calculated using the following formula EEE=Time (hour) × RMR/24 × MET.

- **Sitting Time:** Sitting time was assessed using the thresholds defined in the study "Sitting time and all-cause mortality risk in 2012. The categories are as follows:

Table 3.3: Sitting hours and associated risk:

Category of Risk	Hours of Sitting
Low risk	< 4 hours/ day
Medium Risk	4-8 hours/ day
High Risk	8-11 hours/ day
Very High Risk	>11 hours / day

Source:(van der Ploeg et al.)

- **Stress:** Stress among the participants was assessed using the perceived stress scale by Sheldon Cohen. The Perceived Stress Scale (PSS) is the most widely used psychological instrument for measuring the perception of stress. It is a measure of the degree to which situations in one's life are appraised as stressful. Scoring of the PSS ranges from 0 to 40. Higher the scores, higher the perceived stress. Scores ranging from 0-13 are considered low stress, scores ranging from 14-26, moderate stress and scores ranging from 27-40 are considered as high perceived stress.

- **Sleep:** The Pittsburgh Sleep Quality index (PSQI) was used to assess the sleep quality among participants. The PSQI contains 19 self-rated questions and 5 questions rated by the bed partner or roommate. The scoring is divided into 7 components which has a range of 0-3 points with "0" scoring indicating no difficulty, while scoring of "3" indicating severe difficulty. The score of the 7 components are then added and one "global" score is obtained that ranges from 0-21 where "0" indicates no difficulty and "21 " indicates severe difficulties in all areas. A global score of 5 or more indicates poor sleep quality.

- **Knowledge Attitude Practice**: Basic medical, dietary and exercise related 11 knowledge questions, 2 questions for attitude and 10 questions regarding practice that were directly related to diabetes which are generally considered to be known by patients suffering from diabetes were asked using a self-made questionnaire. Each response was scored as "1" for correct response and "0" for incorrect responses. Knowledge scores of individuals were calculated and summed up to give the total knowledge attitude and practice score. Participants who correctly responded to ≥ 50%

of the questions were considered as having adequate knowledge, proper attitude and correct practices whereas those who scored <50% were considered as having inadequate knowledge, improper attitude and incorrect practices related to type 2 diabetes mellitus.

- **Anthropometric data** was collected at the hospital and includes:

Weight: The weight was measured using Omron Full Body Sensor Body Composition Monitor and Scale Model HBF-224

Height: The Height was measured using the heightometer.

BMI: According to the NHLBI, BMI is calculated as weight in kilograms divided by the square of the height in meters (kg/m^2) and has been categorised into four groups according to the Asian-Pacific classification.

BMI = Weight (in kg) / Height (m^2)

Table 3.4 BMI Asia-pacific classification:

Category	**Asia Pacific BMI Cut-offs**
Under weight	<18.5
Normal	18.5-22.9
Over-weight	23-24.9
Obese	>25

Waist Circumference: Waist circumference is measured at the midpoint between the lower margin of the least palpable rib and the top of the iliac crest, using a stretch-resistant. According to American Diabetes Association, the normal cut-off of waist circumference for Asian men was 85cm and 80 cm for Asian women.

Hip Circumference: Hip circumference Is measured around the widest portion of the buttocks, with the non-stretching tape parallel to the floor.

Waist-Hip Ratio: The Waist Hip Ratio is calculated by dividing the waist measurement by hip measurement. The formula is: *WHR= waist circumference / hip circumference. According to American Diabetes Association the* normal Waist-Hip Ratio for Indian men is 0.88 and for women it is 0.81.

Waist-Height Ratio: The Waist-Height ratio is calculated by dividing the waist measurement by height. 0.5 is the cut-off for Waist-Height Ratio that is accepted universally to measure central obesity in children above 6 years and adults.

The Body fat, Visceral fat and Skeletal muscle were measured using the Omron Full Body Sensor Body Composition Monitor and Scale (Model HBF-224) that estimates the body fat percentage by the Bioelectrical Impedance Method having weak electrical current of 50 kHz and less than 500 µA. Body tissues having high water content include muscles, blood, bones conduct electricity easily. While body fat does not store much water, therefore has little electric conductivity and higher resistance which slows the rate of travel of current and therefore helps to estimate the fat, visceral fat and muscle content of the body.

Body Fat: Body fat serves a vital role in storing energy and protecting internal organs. We carry two types of fat in our bodies: 1) essential fat which is stored in small amounts to protect the body and 2) stored fat which is stocked for energy during physical activity. While too much body fat may be unhealthy, having too little fat can be just as unhealthy. Body fat was classified according the cutoffs provided by the omron heath care.

Table 3.5 Body Fat Percentage Classification:

Classification	**Male**	**Female**
Low (-)	5.0-9.9 %	5.0 – 19.9 %
Normal (0)	10.0 – 19.9 %	20.0 – 29.9 %
High (+)	20.0 – 24.9 %	30.0 – 34.9 %
Very High (++)	≥ 25.0 %	≥ 35.0 %

Source: (Omron health care)

Visceral Fat: Visceral fat is found in the abdomen and surrounding vital organs. It is different from the subcutaneous fat. Visceral fat can be seen through Magnetic Resonance Imaging (MRI). Too much visceral fat is thought to be closely linked to increased levels of fat in the bloodstream, which may lead to conditions such as high cholesterol, heart disease and type 2 diabetes.

Table 3.6 Classification of Visceral Fat:

Category	**Cut-off**
Normal	<=9
High	10-14
Very High	>=15

Source: (Omron health care)

Skeletal Muscle: Skeletal muscles is attached to the skeleton and come in pairs -- one muscle to move the bone in one direction and another to move it back the other way. Increasing skeletal muscle will increase your body's energy requirements. Building skeletal muscle can help prevent "rebound" weight gain. The maintenance and increase of skeletal muscle is closely linked to resting metabolism rate.

Table 3.7: Classification of Skeletal Muscle:

Gender	**Age**	**Low (-) (%)**	**Normal (0) (%)**	**High (+) (%)**	**Very High (++) (%)**
Female	**18-39**	**< 24.3**	**24.3 – 30.3**	**30.4 – 35.3**	**≥ 35.4**
	40-59	**< 24.1**	**24.1 – 30.1**	**30.2 – 35.1**	**≥ 35.2**
	60-80	**< 23.9**	**23.9 – 29.9**	**30.0 – 34.9**	**≥ 35.0**
Male	**18-39**	**< 33.3**	**33.3 – 39.3**	**39.4 – 44.0**	**≥ 44.1**
	40-59	**< 33.1**	**33.1 - 39.1**	**39.2 – 43.8**	**≥ 43.9**
	60-80	**< 32.9**	**32.9 – 38.9**	**39.0 – 43.6**	**≥ 43.7**

Source: (Omron health care)

- The **Biological parameters** were collected from the patient's case file which included the following:

Fasting Blood Glucose: According to ADA, FPG is a test that measures the blood glucose level at one point after fasting for at least 8 hours.

Table 3.8: Classification of Fasting Blood Glucose:

Category	**Cut-off**
Normal	<100 mg/dl
Pre-diabetes	100-125 mg/dl
Diabetes	>=126 mg/dl

Source: (*Diagnosis | ADA*)

Random Blood Glucose: According to ADA, it is a blood test that can be done at any time of the day. Diabetes is diagnosed at blood sugar of **greater than or equal to 200 mg/dl.**

Post-prandial Blood Glucose: It is a blood test that is done after 2 hours of consuming any meal.

HbA1c: According to ADA, the HbA1C is a test that measures the average blood glucose of past 2-3 months.

Table 3.9: Classification of HbA1c:

Category	**Cut-off**
Normal	less than 5.7%
Pre-diabetes	5.7% to 6.4%
Diabetes	6.5% or higher

Blood pressure: According to American Heart Association, blood pressure is a pressure that pushes blood through arteries, veins and capillaries. The blood pressure is the result of two forces: 1) Systolic pressure occurs as blood pumps out of the heart and into the arteries that are part of the circulatory system. 2)Diastolic pressure is created as the heart rests between heart beats.

Table 3.10: Classification of Blood Pressure:

Category	Systolic pressure (mm hg)	Diastolic pressure (mm hg)
Normal	<120	<80
Elevated	120-129	<80
High BP (Stage 1)	130-139	80-89
High BP (Stage 2)	>=140	>=90

Source: (*Hypertension Guideline Resources | American Heart Association*)

Cholesterol: According to National Heart, Lung and Blood Institute (NHLBI) cholesterol is a waxy, fat-like substance made in the liver, and found in the blood and in all cells of the body.

LDL and HDL are two types of lipoproteins. They are a combination of fat (lipid) and protein. The lipids need to be attached to the proteins so they can move through the blood. LDL and HDL have different purposes:

Low Density Lipoprotein: LDL stands for low-density lipoproteins. It is sometimes called the "bad" cholesterol because a high LDL level leads to a build-up of cholesterol in your arteries and increases the risk for heart attack, stroke and peripheral artery disease. (PAD)

High Density Lipoprotein: HDL stands for high-density lipoproteins. It is sometimes called the "good" cholesterol because it carries cholesterol from other parts of your body back to your liver. Your liver then removes the cholesterol from your body.

Triglycerides: Triglycerides are a type of fat. They are the most common type of fat in your body.

Table 3.11: ATP III Classification of LDL, Total, and HDL Cholesterol (mg/dL)

TOTAL CHOLESTROL	
Desirable	<200 mg/dl
Border High	200-239 mg/dL
High	>=240 mg/dL
LDL CHOLESTROL	
Optimal	<100 mg/dL
Near Optimal	100-129 mg/dL
Borderline high	130-159 mg/dL
High	160-189 mg/dL
Very high	>=190 mg/dL
HDL CHOLESTROL	
Low	<40 mg/dL
High	>=60 mg/dL
TRIGLYCERIDES	
Normal	<150 mg/dL
Borderline High	150-199 mg/dL
High	200-499 mg/dL
Very high	>500 mg/dL

Source: (*High Blood Cholesterol ATP III Guidelines At-A-Glance Quick Desk)*

TG/HDL Ratio: The TG/HDL Ratio is also known as Castelli Index (CI) is suggested to be an excellent predictor of coronary artery disease (CAD) as proposed by Dr. William Castelli. A **TG/HDL ratio** of < 2 is considered as normal and the suggested target for TC/**HDL** is < 4.5.

After collecting the above information, the Chrononutrition profile of the individuals were assessed.

- **Chrononutrition Profile:** Chrononutrition profile was assessed using the chrononutrition profile scoring method developed by Allison Christine Engwall. Six chrononutrition behaviour cut-off scores are categorized into one of three 'chrononutrition behaviour cutoffs' for each chrononutrition behaviour (0=good, 1=fair, and 2=poor). These scores are then totalled to obtain Chrononutrition Profile score which represents one's chrononutrition profile. Scoring ranges from 0 to 12 with 0 indicating good chrononutrition status and 12 indicating poor chrononutrition status. (Prior, 2020)

Table 3.12: Chrononutrition behaviour descriptions and scoring cut-offs for the Chrononutrition Profile:

CHRONONUTRITION CUT-OFF	DESCRIPTION	FORMAT	SCORING CUT-OFF (POOR, FAIR, GOOD)
Eating Window	Duration between first eating event and last eating event	HH:MM	> 14:00 12:01 to 14:00 ≤ 12:00
Breakfast Skipping	Frequency of breakfast skipping	Days/Week	≥ 4 days/week 2-3 days/week 1 day/week or less
Evening Latency	Duration between last eating event and sleep onset	HH:MM	≤2:00 2:01 to 6:00 >6:00
Evening Eating	Risk of eating late in the waking day	HH:MM	≥23:00 20:00 to 22:59 < 20:00
Night Eating	Frequency of night eating	Days/Week	≥ 4 days/week 2-3 days/week 1 day/week or less
Largest Meal	Meal in which largest amount of food is eaten	Meal Name	Dinner/Supper Lunch Breakfast

Source: (Prior, 2020)

The data was analysed in SPSS 27. Association of chronotype with anthropometric parameters, biochemical parameters, Exercise Energy Expenditure (EEE), Screen time, sitting time, sleeping time, Stress and dietary intake was done using student's independent T-Test. Association of chrono nutrition profile with anthropometric parameters, biochemical parameters, Exercise Energy Expenditure (EEE), Screen time, sitting time, sleeping time and Stress was obtained by using one-way ANOVA test while the Correlation of chrono nutrition profile with body fat composition and biochemical parameters is calculated using spearman's rank-order correlation and Association between Chrononutrition profile and Chronotype is based on Chi-square test.

The present study was approved by institutional review board of the department of Foods and Nutrition, Faculty of Family and Community Sciences, The Maharaja Sayajirao University of Baroda. The Ethical approval number of the study is **IECHR/FCSC/2020/46**.

RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

The present investigation was undertaken to study the "Association of Chrononutrition Profile and Type 2 Diabetes Mellitus." This chapter presents the results and their discussions in eleven sections as mentioned in the "Chapter 3: Methods and Materials". The sections included are:

1. Personal information,
2. Anthropometric data,
3. Biochemical parameters,
4. Diet information,
5. Physical activity,
6. Screen time,
7. Sleep,
8. Stress,
9. Knowledge Attitude Practice information,
10. Chronotype and
11. Chrononutrition Profile

The first section of the present study was “Personal Information”

Table 4.1.1: Personal details of participants suffering from diabetes

Variables	**Male**	**Female**
	N (%)	N (%)
Age group		
35-39 years	26 (21.9)	23 (21.3)
40-44 years	19 (15.9)	16 (14.8)
45-49 years	14 (11.8)	15 (13.8)
50-54 years	15 (12.6)	26(24.2)
55-60 years	45 (37.8)	28 (25.9)
Educational Qualification		
Illiterate	-	-
Primary School	04 (3.4)	30 (27.7)
Secondary School	18 (15.1)	20(18.5)
Higher Secondary	26 (21.9)	19 (17.6)
Diploma	01(0.8)	01(0.9)
Graduate	63 (52.9)	33 (30.5)
Post-Graduate	07 (5.9)	05 (4.8)
Occupation		
Business owner/ self employed	27 (22.7)	04 (3.7)
Professionals	17 (14.3)	05(4.7)
Government / Civil service	11 (9.2)	01(0.9)
Manager/ Supervisor	04 (3.4)	-
Clerks	02 (1.7)	-
Sales / Service workers	11 (9.2)	01(0.9)
Agriculture and fishery worker	12 (10.1)	02(1.9)
Home-maker	-	95(87.9)
Retired	35 (29.5)	-

Table 4.1.1 shows the personal details among the 227 participants. It can be seen that maximum male (37.8%) and female participants (25.9%) are from age group of 55-60 years followed by 24.2% women from age group of 50-54 years and 21.9% male from age group of 35-39 years of age.

The percentage of graduates in both male (52.9%) and female (30.5%) is the highest among all education qualifications followed by 21.9% male participants who studied till higher secondary category and 27.7% female participants from primary school category, while no one is illiterate.

Maximum number (87.9%) of females are home-makers while only (4.7%) are professionals. Maximum number of male (29.5%) are retired followed by business owners (22.7%) and government/civil services (14.3%).

Table 4.1.2: Type of family of study population

Sr.no	**Type of family**	**N (%)**
1	Nuclear Family	165 (72.7)
2	Extended Family	051 (22.5)
3	Joint Family	011 (4.8)

Table 4.1.2 details the type of family of study population. It can be seen that maximum number of participants (72.7%) live in a nuclear family while only a few (22.5%) lives in extended family and least (4.8%) living in joint family.

The second section of the study included the "Anthropometric measurements"

Table 4.2.1: Anthropometric Profile of participants suffering from diabetes

Variables	**Cut-off**	**Mean** ± SD	**N (%)**	**Cut-off**	**Mean** ± SD	**N (%)**
	Male			**Female**		
Number of Participants	**119**			**108**		
Waist Circumference						
Normal	≤ 85	83.3 ± 2.1	4 (3.4)	≤ 80	79	1 (0.9)
High	>85	102.8 ± 8.5	115 (96.6)	> 80	96.1 ± 8.7	107 (99.1)
Waist-Hip Ratio						
Normal	≤ 0.88	0.8 ± 0.0	7 (5.8)	≤ 0.81	0.7 ± 0.0	8 (7.4)
High	> 0.88	0.9 ± 0.1	112 (94.1)	> 0.88	0.9 ± 0.1	100 (92.6)

Waist-Height Ratio						
Normal	≤ 0.5		-	≤ 0.5		-
High	> 0.5	0.6 ± 0.1	119 (100)	> 0.5	0.6 ± 0.1	108 (100)

Table 4.2.1 shows that the Mean Waist circumference for 4 male participants under the normal category was 83.3 ± 2.1 while for 115 male participants under high category was 102.8 ± 8.5. 107 and 107 female participants had mean of 96.1 ± 8.7 under high waist circumference category. Mean Waist hip ratio among 112 male participants was 0.9 ± 0.1 and in 100 females it was 0.9 ± 0.1 under the high-risk category. Mean Waist-Height ratio was higher in both male and female category.

Table 4.2.2: BMI of participants suffering from diabetes

BMI	**Cut-off**	**Mean** ± SD	**N (%)**	**Cut-off**	**Mean** ± SD	**N (%)**
	Male			**Female**		
Number of Participants	**119**			**108**		
Under weight	<18.5	-	-	<18.5	-	-
Normal	18.5-22.9	21.6 ± 1.1	6 (5.0)	18.5-22.9	21.1 ± 1.4	7 (6.5)
Over-weight	23-24.9	24.3 ± 0.5	9 (7.6)	23-24.9	24.2 ± 0.6	14 (12.9)
Obese	>25	29.0 ± 2.9	104 (87.4)	>25	29.1 ± 3.7	87 (80.6)

Table 4.2.2 shows that none of the participants were underweight. The mean BMI in normal category for 6 male participants was 21.6 ± 1.1 and among 7 female participants was 21.1 ± 1.4. Overweight category had 9 male and 14 female participants with mean BMI of 24.3 ± 0.5 and 24.2 ± 0.6 respectively. 87.4% male participants and 80.6% female participants in obese category had mean BMI of 29.0 ± 2.9 and 29.1 ± 3.7 respectively.

Table 4.2.3: Body composition of participants suffering from diabetes

Variables	**Cut-off**	**Mean** ± SD	**N (%)**	**Cut-off**	**Mean** ± SD	**N (%)**
	Male			**Female**		
Number of Participants	**119**			**108**		
Body Fat (%)						
Low (-)	5.0-9.9 %	-	-	5.0 – 19.9 %	-	-
Normal (0)	10.0 – 19.9 %	-	-	20.0 – 29.9 %	28.1 ± 1.4	5 (4.6)
High (+)	20.0 – 24.9 %	23.0 ± 1.4	17 (14.3)	30.0 – 34.9 %	33.4 ± 1.4	29 (26.9)
Very High (++)	≥ 25.0 %	30.1 ± 3.4	102 (85.7)	≥ 35.0 %	39.3 ± 2.5	74 (68.5)
Visceral Fat						
Normal	<=9	6.3 ± 1.9	6 (5.1)	<=9	6.2 ± 2.3	18 (16.8)
High	10-14	12.1 ± 1.3	58 (48.7)	10-14	12.0 ± 1.4	57 (52.7)
Very High	>=15	18.7 ± 3.3	55 (46.3)	>=15	19.5 ± 4.4	33 (30.5)
Skeletal Muscle (%)						
Low (-)	< 24.1	29.2 ± 2.6	109 (91.6)	< 33.1	22.6 ± 1.2	87 (80.5)
Normal (0)	24.1 – 30.1	35.1 ± 1.4	10 (8.4)	33.1 - 39.1	26.6 ± 1.5	21 (19.5)
High (+)	30.2 – 35.1	-	-	39.2 – 43.8	-	-
Very High (++)	≥ 35.2	-	-	≥ 43.9	-	-

Body fat % was categorised into low, normal, high and very high category according to the classification given by the Omron healthcare with 20.0 – 24.9 % classified as high body fat % and ≥ 25.0 % classified as very high body fat % in male. No participants had lower or normal body fat %. Eighty-five-point seven percent male participants under the very high fat % category had a mean fat % of 23 ± 1.4 followed by 14.3% male participants under the high fat % category with mean fat% of 30.1 ± 3.4. Sixty-eight-point five percent female participants were classified under the very high fat % category having mean body fat % of 39.3 ± 2.5 while 26.9% female were

classified into high fat % category and only 4.6% women were classified into normal fat % category having 33.4 ± 1.4 and 28.1 ± 1.4 as the mean body fat % respectively.

Visceral fat was categorised into normal, high and very high category according to the classification given by the Omron healthcare with <=9, 10-14 and >=15 respectively in both male and female. Forty-eight-point seven percent male had mean value of 12.1 ± 1.3 and 52.7 % female had mean value of 12 ± 1.4 under the high category followed by 46.3 % male and 30.5 % female had mean visceral value of 18.7 ± 3.3 and 19.5 ± 4.4 under very high category and only 5.1% male and 16.8% female participants had visceral fat under normal category.

Skeletal Muscle was categorised into low, normal, high and very high category according to the classification given by the Omron healthcare. 109 male participants and 87 female participants had low skeletal muscle % with a mean of 29.2 ± 2.6 and 22.6 ± 1.2 respectively. While only 10 male and 21 female participants had skeletal muscle % under normal category with mean of 35 ± 1.4 and 26.6 ± 1.5 respectively.

The third section of the study included the "Biological parameters"

Table 4.3.1 Duration of detection of diabetes among participants

Sr.no	**Duration of detection of diabetes**	**N (%)**
1	Less than 1 year	53 (23.3)
2	1 year	45 (19.8)
3	02 years	55 (24.4)
4	03 years	40 (17.6)
5	04 years	32 (14.1)
6	05 years	02 (0.8)

Table 4.3.1 shows the duration of detection of diabetes among 227 participants. Maximum patients were detected with diabetes in past 2 years (24.4%) followed by less than year (23.3%) and only 0.8% of participants had diabetes since last 5 years.

Table 4.3.2: Blood glucose levels of study population suffering from diabetes

Variables	**Cut off values**	**Mean** ± SD	**N (%)**	**Mean** ± SD	**N (%)**
		Male		**Female**	
Number of participants		119		108	
BLOOD GLUCOSE LEVELS:					
Fasting Blood Glucose (mg)					
Controlled	< 126	105 ± 15	23 (19.3)	106 ± 14	30 (27.7)
Uncontrolled	≥ 126	175 ± 48	96 (80.7)	156 ± 31	78 (72.2)
Post Prandial Blood Sugar (PP2BS) (mg)					
Controlled	< 160	126 ± 27	21 (17.6)	126 ± 15	26 (24.1)
Uncontrolled	≥ 160	227 ± 65	98 (82.4)	207 ± 42	82 (75.9)
HbA1C (%)					
Good Control	< 7	7 ± 5	31 (26.1)	7 ± 5	36 (33.3)
Fair Control	7-8	8 ± 4	38 (31.9)	8 ± 3	32 (29.7)
Poor Control	> 8	10 ± 4	50 (42)	10 ± 3	40 (37)

Table 4.3.2 categorises the participants in having controlled or uncontrolled blood sugar levels. Participants having fasting blood sugar level of <126 mg are classified under controlled category while participants having ≥ 126mg have uncontrolled fasting blood glucose levels. Controlled fasting blood glucose was seen among 23 male participants with a mean of 105 ± 15 and 30 female participants with mean of 106 ± 14. Ninety-six male participants and 78 female participants had uncontrolled fasting blood sugar levels with mean values of 175 ± 48 and 156 ± 31 respectively.

The 2 hour post prandial blood sugar level < 160mg is considered as controlled PPBS while level ≥ 160 is classified as uncontrolled PP2BS levels. Uncontrolled PPBS levels were seen among 98 male participants and 82 female participants with a mean of 227 ± 65 and 207 ± 42 respectively.

The HbA1c is classified into 3 categories. The HbA1c level of <7% is considered as good control while 7-8% is considered as fair control and >8% is considered as poor control. Majority of participants both male (42%) and female (37%) had poor controlled HbA1c levels with a mean of 10 ± 4 and 10 ± 3 respectively followed by 38 male and 32 female participants with a mean of 8 ± 4 and 8 ± 3 respectively for fair controlled HbA1C levels. Only 31 male participants (7 ± 5) and 36 female participants (7 ± 5) had good controlled HbA1C levels.

Table 4.3.3: Blood pressure levels of participants suffering from diabetes (mmHg)

Variables	Male	Female
Blood Pressure (Average of 3 readings)	**N (%)**	**N (%)**
Normal Blood pressure (<120 mm Hg / <80 mm Hg)	14 (11.8)	08 (7.4)
Elevated Blood pressure (120-129 mm Hg / <80 mm Hg)	51 (42.9)	34 (31.5)
High BP (Stage 1) (130-139 mm Hg / 80-89 mm Hg)	37 (31.1)	39 (36.1)
High BP (Stage 2) (>=140 mm Hg />=90 mm Hg)	17 (14.2)	27 (25)

Table 4.3.3 shows that 42.9 % male and 31.5% female had Elevated blood pressure. 36.1% female and 31.1% male had high Blood pressure (stage 1) followed by 25 % female and 14.2% male have High Blood pressure (stage 2). Only 11.8 % male and 7.4 % female had normal blood pressure.

Table 4.3.4: Lipid profile of participants suffering from diabetes

Variables	**Cut off Values**	**Mean ± SD**	**N (%)**	**Mean ± SD**	**N (%)**
		Male		**Female**	
Number of participants		119		108	
LIPID PROFILE:					
TOTAL CHOLESTEROL(mg)					
Desirable	<200 mg/dl	163 ± 26	56 (47.1)	152 ± 27	59 (54.6)
Border High	200-239 mg/dL	217 ± 10	36 (30.3)	216 ± 12	27 (25)
High	>=240 mg/dL	253 ± 10	27 (22.6)	259 ± 17	22 (20.4)
LDL (mg)					
Optimal	<100 mg/dL	76 ± 21	12 (10.1)	72 ± 23	20 (18.5)
Near Optimal	100-129 mg/dL	116 ± 9	16 (14.3)	114 ± 9	14 (12.9)
Borderline high	130-159 mg/dL	140 ± 7	86 (72.3)	140 ± 6	65 (60.3)
High	160-189 mg/dL	165 ± 4	3 (2.6)	173 ± 9	6 (5.5)
Very high	>=190 mg/dL	196 ± 4	2 (1.7)	199 ± 7	3 (2.8)
HDL (mg)					
Low	<40 mg/dL	34 ± 4	97 (81.6)	34 ± 5	43 (39.8)
Normal	40-59 mg/dL	46 ± 5	19 (15.9)	45 ± 4	61 (56.5)
High	>=60 mg/dL	64 ± 3	3 (2.5)	68 ± 5	4 (3.7)
TRIGLYCERIDES (mg)					
Normal	<150 mg/dL	121 ± 24	20 (16.8)	122 ± 26	32 (29.6)
Borderline High	150-199 mg/dL	174 ± 15	69 (57.9)	168 ± 15	51 (47.2)
High	200-499 mg/dL	285 ± 62	29 (24.5)	264 ± 56	25 (23.2)
Very High	>500 mg/dL	547	1 (0.8)	-	
TG/HDL					
Normal	≤ 2	2 ± 1	6 (5.0)	2 ± 1	9 (8.3)
High	> 2	6 ± 3	113 (95.0)	5 ± 2	99 (91.7)

Table 4.3.4 presents the Lipid profile of 119 male participants and 108 female participants. It can be seen those 56 male participants and 59 female participants have desirable cholesterol levels with mean of 163 ± 26 and 152 ± 27 respectively. Thirty-six male participants and 27 female participants with mean of 217 ± 10 and 216 ± 12 had borderline high LDL levels. Twenty- seven male and twenty-two female participants have low HDL levels with 253 ±10 and 259 ±17 respectively.

Twelve male participants and 20 female participants with a mean of 76 ± 21 and 72 ± 23 have optimal LDL levels. Near optimal level of LDL was seen in 16 males with a mean of 116 ± 9 and 14 females with 114 ± 9. Eighty-six males and sixty-five females had borderline high LDL levels. Mean of 165 ± 4 and 173 ± 9 was seen in 3 males and 6 females under high LDL level category. Two males and three females had very high LDL levels with a mean of 196 ± 4 and 199 ± 7 respectively.

Majority of male participants (81.6%) had lower HDL levels with a mean of 34 ± 4 while 56.5% females had normal HDL levels with a mean of 168 ± 15. Majority of male (n=69) and female participants (n=51) have borderline high triglyceride levels with a mean of 174 ± 15 and 168 ± 15 respectively. TG/HDL level was high among both male (n=113) and female (n=99) participants with a mean of 6 ± 3 and 5 ± 2 respectively.

The fourth section of the study was “Diet Information”

Table 4.4.1: Type of food choice among study subjects

Sr.no	**Type of food choice**	**N (%)**
1	Vegan	001 (0.4)
2	Lacto-Vegetarian	131 (57.8)
3	Non-vegetarian	037 (16.3)
4	Lacto-ovo-Vegetarian	058 (25.5)

Table 4.4.1 details the food choice among the study subjects. It can be seen that 57.8% of the total participants were lacto-vegetarian while 25.5% were lacto-ovo vegetarian and 16.3% were non-vegetarian with only 0.4% participants were vegan. Similar findings were reported in a study conducted by Muley (2015) at Vadodara where maximum participants were lacto- vegetarian followed by lacto-ovo vegetarian and non-vegetarian.

Table 4.4.2: Meal generally skipped among study population

Sr.no	Generally skipped meal	N (%)
1	Breakfast	112 (49.3)
2	Lunch	-
3	Dinner	-
4	No meal ever skipped	115 (50.7)

Table 4.4.2 shows that 50.7 % of study population generally do not skip any meal while the rest 49.3% skips the meal, is generally the breakfast. In a study conducted by Sharma et al., (2018) the habit of skipping the breakfast was found to be 54.2% in cases when compared with controls. Skipping of breakfast increases the risk of Type 2 Diabetes Mellitus independent of lifestyle in both male and female as reported by Uemura et al.,(2015)

Table 4.4.3: Most important meal of the day among study subjects

Sr.no	Important Meal	N (%)
1	Breakfast	014 (6.2)
2	Lunch	084 (37)
3	Dinner	129 (56.8)

Table 4.4.3 shows the preference for most important meal of the day on the basis of quantity. It can be seen that only 6.2 % of the total participants preferred breakfast as their main meal while 36.9 % had lunch as their main meal and 56.8 % had dinner as their main meal. A study by Bo et al., (2014) showed that one third of their sample consumes the largest amount of calories at dinner and after 6-years of follow-up, those individuals were 2 times more likely to be obese. Serum glucose levels were significantly higher in high-calorie dinner meal when compared to high-calorie breakfast meal according to a study conducted by Jakubowicz et al., (2015).

Table 4.4.4: Nutrient Intake of Patients with diabetes (Mean ± SD)

Nutrient	**Male**	**Female**
N	119	108
Macronutrients		
Total Calorie Intake (kcal)	1787 ± 170	1771 ± 202
Total Carbohydrate (g)	296 ±30	301.3 ± 36
Protein (g)	48 ± 9	42.2 ± 8
Fibre (g)	18 ± 4	16.3 ± 3
Fat (g)	46 ± 4	44 ± 5
Saturated fat (g)	21 ± 3	20.1 ± 4
Monounsaturated fatty acids (g)	17 ± 1	16 ± 1
Polyunsaturated fatty acids (g)	8 ± 0	8 ± 0
Micronutrients		
Calcium (mg)	403 ± 96	382.6 ± 112
Iron (mg)	15 ± 3	15.1 ± 3
Sodium (mg)	4232 ± 585	4250.4 ± 692
Potassium (mg)	2057 ± 88	2042.4 ± 110

Table 4.4.4 shows the nutrient intake of 227 participants based on 24-hr. dietary recall. The mean fat intake was very high among both male (46 ± 4) and female participants (44 ± 5) which clearly exceeded the recommended daily allowance. The mean fibre intake is less in both male (18 ± 4) and female (16.3 ± 3). The mean protein intake was also very less among the participants with only (11 ± 2) and (42.2 ± 8) percent of calories in male and female respectively. The calcium intake was very less among participants with (403 ± 96) in males and (382.6 ± 11) in female. The consumption of Iron was also very less in both male and female participants. The

sodium consumption was more than double among all participants when compared to the recommended daily intake guidelines.

Figure 4.4.1: Daily sugar and salt intake of participants

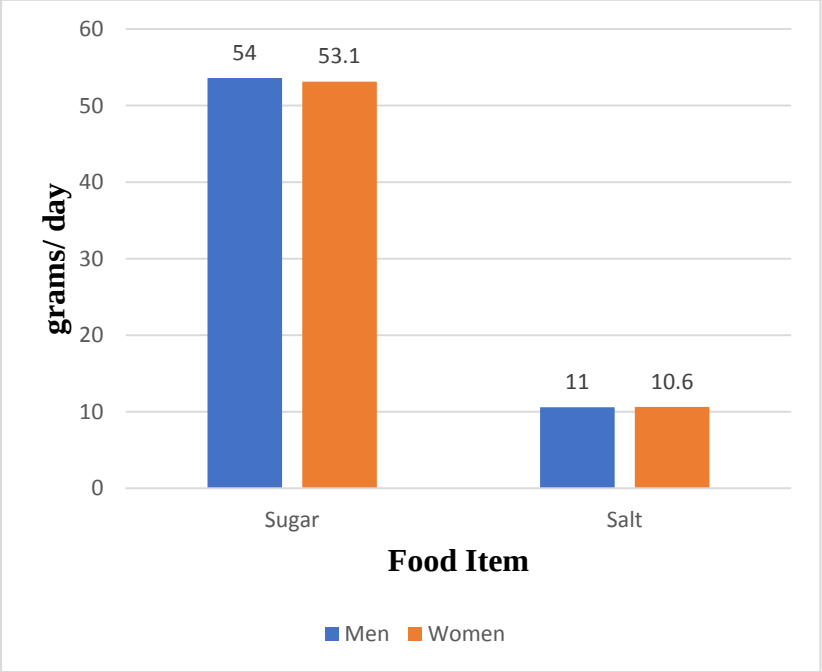


Figure 4.4.1 shows the sugar and salt intake of 227 participants based on 24-hour dietary recall. It can be seen that the sugar intake is very high among both male (54g/day) and female (53.1g/day) participants as compared to the recommendations given by the ICMR which says no more that 5-7% of energy intake. Salt intake as recommended by ICMR is no more than 5g/ day but the average daily intake of male is 11g/day and female is 10.6 g/day among the study population.

Table 4.4.5: Participants Consulting Dietitian

Sr.no	**Dietitian consultation**	**N (%)**	**Place of consultation**		
			Online consultation (N)	**Dietitian's Clinic (N)**	**Diabetes Clinic (N)**
1	Yes	5 (2.2)	1	2	2
2	No	222	-	-	-

		(97.7)			

Table 4.4.5, shows the number of participants that have consulted a dietitian among the 227 participants. It can be seen that only 2.2 of the total participants have consulted a dietitian while 97.7 have never consulted a dietitian for diet advice.

Figure 4.4.2: Consumption of Ultra-processed foods among study population

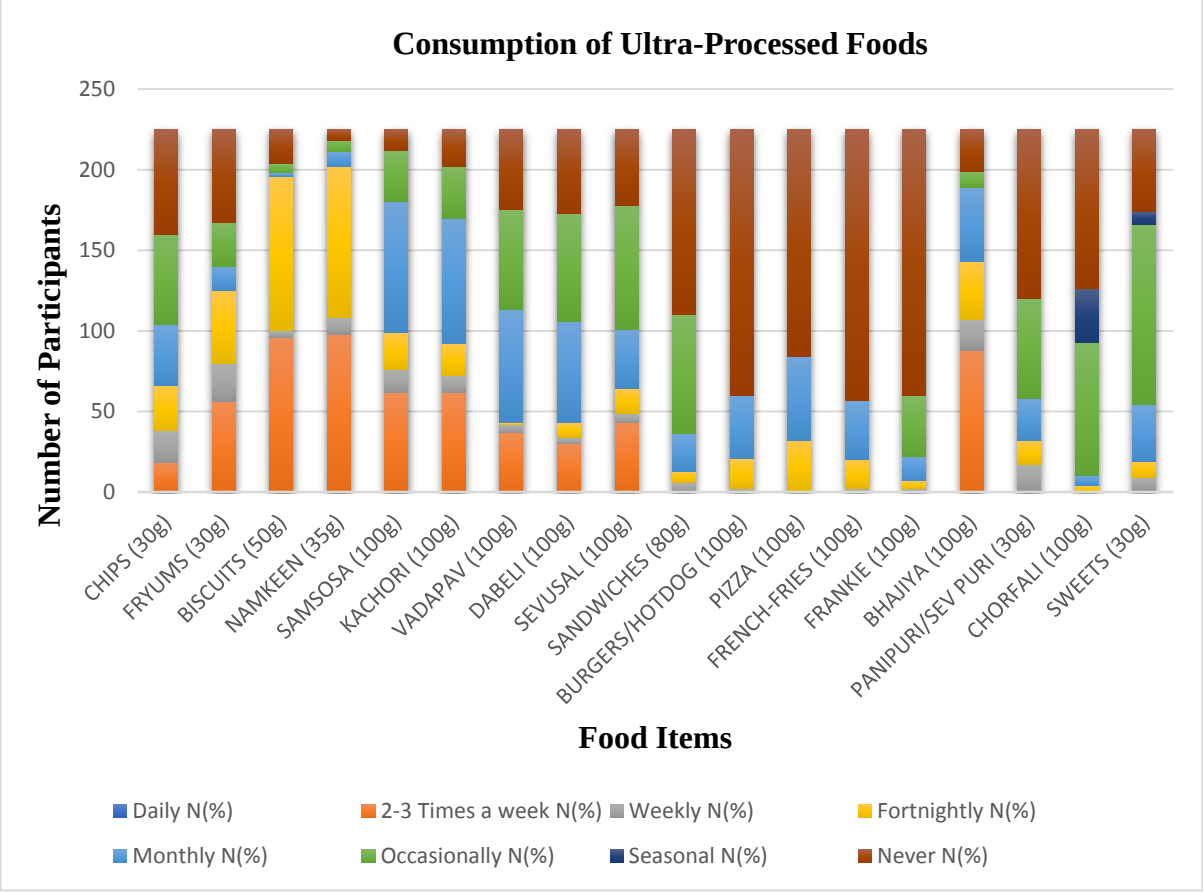


Figure 4.4.2, details the Consumption of ready-to-eat foods among study population. It can be seen that consumption of fried foods like samosa and kachori were consumed by 27.6 % participants 2-3 times/week followed by 36 % and 35 % on monthly basis respectively 31.1% and 28 % participants consumed vadapav and

dabeli once in a month followed by 27 % and 30 % of occasional consumption of vadapav and dabeli. Biscuits, fryums, namkeen, and bhajiya were commonly consumed 2-3 times/week by maximum participants. Sev-usal and sweets were occasionally consumed by 34.2 % and 49.8 % participants respectively.

Sandwich, burgers, pizza, frankie, french-fries were not commonly consumed by the participants. Strong evident risk of developing chronic disease was seen among participants when fried foods were consumed more frequently according to Gadiraju et al., (2015). Fried-food consumption is associated with increased risk of overweight/obesity according Qin et al., (2021) Frequent consumption of fried food was significantly associated with increase in Type 2 diabetes mellitus incidence and was intervened with body weight, hypertension and hypercholesterolemia. Cahill et al., (2015) In a study conducted by Sista & Railla (2020) only a small group of participants (20%) preferred to have junk foods such as pizza, sandwich, samosa, burger, fries, etc., for dinner occasionally. Participants who practised mindful eating consumed less sweets and had lower fasting glucose levels.(Sista & Railla, 2020)

The fifth section of the study was "Exercise"

Table 4.5.1: Habit of performing exercise, time preference and time duration among participants suffering from type 2 diabetes mellitus

Habit of performing Exercise	Participants that perform any form of moderate intensity exercise ≥ 5times/week				Participants that do not perform any form of moderate intensity exercise ≥ 5times/week
N (%)	091 (40.1)				136 (59.9)
Time of exercise	Morning time	Afternoon time	Evening time	Night time	-
N (%)	41 (45.1)		50 (54.9)		
Duration of exercise	**N (%)**	**N (%)**	**N (%)**	**N (%)**	-
< 30 minutes	1		6		
30 minutes	28		42		
> 30 minutes	14		-		

The Physical activity was assessed using the Global Physical activity Questionnaire. Information on type of activity and duration of activity was obtained from the GPAQ questionnaire and the Exercise Energy Expenditure (EEE) was calculated using the following formula EEE=Time (hour) × RMR/24 × MET.

It can be clearly seen in Table 4.5.1 that only 91 patients (40.1%) participants have a habit of performing exercise while 59.9 % fail to perform any form of exercise throughout the day. It can be seen that 54.9 % participants perform exercise during evening time while 45.1% participants perform exercise during morning time with maximum participants performing exercise for 30 minutes. The range of Energy Exercise Expenditure (EEE) of the study population was 100-300kcal. Moderate intensity walking was commonly performed by the participants. In a study conducted by (Ghimire, 2017) 46% of the participants who had type 2 diabetes did not perform any exercise. Exercise improves the metabolic markers and has anti-inflammatory properties. Regular exercise improved the body composition, physical fitness, lipid and glucose metabolism in individuals with type 2 diabetes.(Karstoft & Pedersen, 2016) Walking for at least 30 min per day was shown to reduce the risk of T2D by approximately 50%.(Hamasaki, 2016)

Table 4.5.2: Sitting hours among study population

Category of Risk	**Male**	**Female**
	N (%)	**N (%)**
Low risk	-	-
Medium Risk	62 (52.1)	22 (20.4)
High Risk	37 (31.1)	70 (64.8)
Very High Risk	20 (16.8)	16 (14.8)

Sitting for long period of time has a negative impact on overall health which includes excess body fat around waist, abnormal cholesterol levels, increased blood pressure and blood glucose levels. The sitting time (hours) has been categorised into the different risk levels. The categories are <4 hour of sitting time has lower health risk, 4-8 hours of sitting time has medium health risk, 8-11 hours has high risk and > 11 hours has very high risk on health. Table 4.5.2 shows the sitting hours throughout the day among study population. It can be seen that 52.1% of male participants are at

medium risk followed by 31.1% at high risk and 16.8 % at very high risk. 64.8% of female participants are at high risk followed by 20.4 % having low risk and 14.8% having very high risk. According to Dempsey et al., (2016) when 8 hours of prolonged sitting time was interrupted every 30 min with 3 min of brief bouts of Light intensity walking or Simple Resistance Activities, reduction in acute postprandial glucose, insulin, C-peptide, and triglyceride responses in adults with Type 2 Diabetes Mellitus was seen. A study conducted in young healthy men and women of Stephens and colleagues observed that just 1 day of prolonged sitting led to reductions in action of insulin throughout the body as compared to a day when sitting was replaced with standing and light activities.(Dempsey, Owen, et al., 2016)

The sixth section of the study was "screen time"

Table 4.6.1: Screen time duration and screen timing among study population

Duration of screen time post dinner	**N (%)**	**Screen time post dinner**						
		07:30 pm	08:00 pm	08:30 Pm	09:00 pm	09:30 Pm	10:00 Pm	10:30 Pm
< ½ hour/day	0	-	-	-	-	-	-	-
½ -1 hour/day	0	-	-	-	-	-	-	-
1-2 hours/day	110 (48.4)	001 (0.9)	021 (19.4)	006 (5.6)	049 (43.5)	008 (7.4)	006 (5.6)	019 (17.6)
>2 hours/day	117 (52)	002 (1.7)	010 (8.5)	012 (10.3)	032 (27.4)	026 (22.2)	017 (14.5)	018 (15.4)

Table 4.6.1 shows the screen timing and duration of Screen time among study population. It can be seen that 52% of the participants have screen time of more than 2 hours post dinner and 48 % have 1-2 hours of screen time post dinner. Maximum participants have screen time post 9:00 pm in both categories. According to a study conducted by Christensen et al., (2016) exposure to smartphone screens or tv screens particularly around bedtime has a negative impact on sleep. Longer screen-times

during bedtime and shorter sleeping period were associated with poor sleep quality, decreased sleep efficiency, and longer sleep onset latency among individuals.

The seventh section of the study was “Sleep Quality”

Table 4.7.1: Sleep quality among study subjects

Sleep Quality	**N (%)**
Good Sleep	046 (20.3)
Poor Sleep	181 (79.7)

The Pittsburgh Sleep Quality index (PSQI) was used to assess the sleep quality among subjects. A global score of 5 or more indicates poor sleep quality. Table 4.7.1, shows that only 20.3 % subjects have good sleep and 79.7 % subjects have poor sleep. 82.6% subjects had short sleeping duration of less than 6 hours a day with sleeping time starting generally from 11:30pm /12:30pm and waking time between 5:00am to 6:00am. Higher risk for diabetes, cardiovascular disease and hypertension is associated with sleep durations less than 6 hours when compared to sleep durations of 7–8 hours. Experimental sleep restriction reduces cellular insulin sensitivity and also lowers glucose tolerance. If these effects are prolonged, it compromises the functioning of β-cell of pancreas which leads to type 2 diabetes.(Watson et al., 2015)

The eighth section of the study was “stress”

Table 4.8.1: Stress among study population

Sr.no	**Category**	**N (%)**
1	Low stress	036 (15.8)
2	Moderate Stress	160 (70.5)
3	Perceived Stress (High Stress)	031 (13.7)

Stress among the participants was assessed using the perceived stress scale by Sheldon Cohen. Scores ranging from 0-13 are considered low stress, scores ranging from 14-26, moderate stress and scores ranging from 27-40 are considered as high perceived stress. It can be seen in Table 4.8.1 that only 15.8 % participants have low stress levels while 70.5 % participants suffer from moderate stress and 13.7% suffer from perceived stress (high stress). In a study conducted by Sendhilkumar et al., (2017) the prevalence of high/very high stress was 35% among Type 2 Diabetes Mellitus patients. Stress was directly associated with jobs, financial issues and lack of physical activity among individuals. Moderate/ high stress levels were associated with a 2.3-fold increase in the odds of diabetes in a 12-year longitudinal study conducted on women by Harris et al., (2017)

The ninth section of the study was "Knowledge Attitude Practice"

Figure 4.9.1: Knowledge Attitude and Practice among Participants:

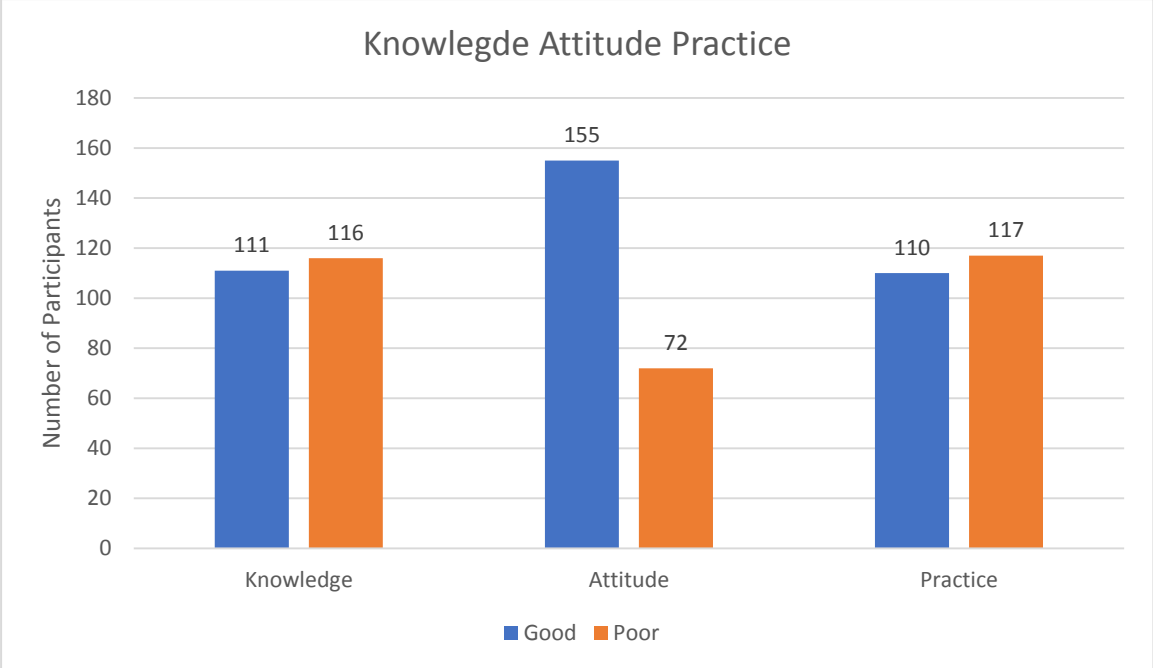


Figure 4.9.1 illustrates the knowledge attitude and practice among the participants. It can be clearly seen that 51.1% of participants have poor knowledge regarding the medical, dietary and exercise related questions of diabetes which includes poor knowledge regarding HbA1c (32%), Unsweetened fruit juice consumption (51.1%)

and effect of exercise on diabetes (42.2%). 68% participants show good attitude regarding the diabetic lifestyle while 51.1% participants have poor disease related practices like not checking glucose regularly (41.7%) and overeating during the eating window (38.6%).

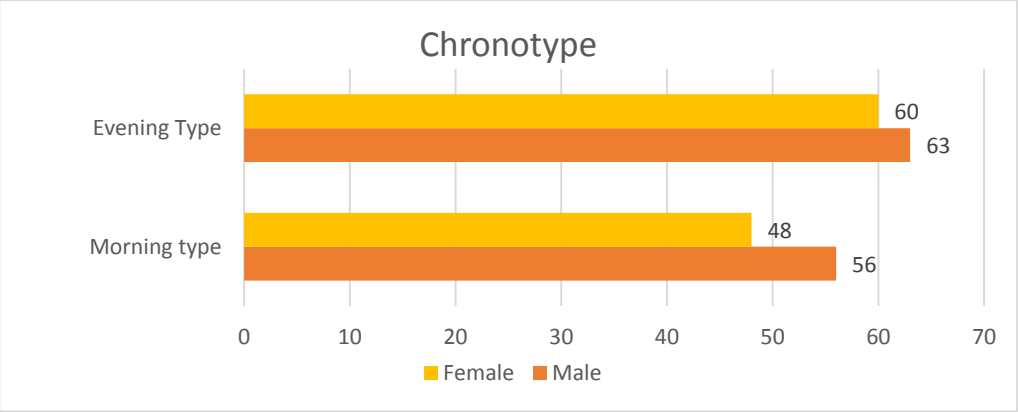
The tenth section of the present study was "Assessing Chronotype"

Table 4.10.1: Chronotype of study population

Chronotype	**N (%)**
Definitely Morning	053 (23.3)
Moderate Morning	051 (22.5)
Moderate Evening	116 (51.1)
Definitely Evening	007 (3.1)

Chronotype was assessed using the Horne and *Ostberg Morningness-Eveningness* Questionnaire. Scores <= 41 indicate "evening types", scores >=59indicate "morning types" and scores between 42 and 58 indicate "intermediate types". Table 4.10.1 summarises the chronotype among 227 participants. It can be seen that maximum of participants (51.1%) of the participants have moderate evening chronotype and 3.1% having definite evening chronotype 23.3 % population having definite morning chronotype and 22.5 % participants having moderate morning chronotype. Similar findings have been reported in a study by Wennman et al., (2015) where maximum participants (32%) were moderate evening type, followed by morning type 31%, moderate morning type 21%, and evening type 16%. Evening type has been associated with unhealthier food and nutrient intake that could predict a higher risk of obesity among them as compared to morning type. (Maukonen et al., 2016) Evening chronotype was significantly associated with diabetes and metabolic syndrome when compared with the morning chronotype according to Hee Yu et al.,(2015)

Figure 4.10.1: Chronotype distribution according to gender



The Figure 4.10.1 shows the chronotype among 119 male participants and 108 female participants. 47.1% male participants and 44.4% female participants are morning chrono typed while 52.9% male and 55.6% female have evening chronotype.

Table 4.10.2: Consumption and composition of meal throughout the day according to chronotype of participants

Morningness	**Meals**	**Carbohydrate**	**Protein**	**Fat**
	Breakfast	102 ± 12.2	19 ± 4.0	14 ±1.9
	Lunch	118 ± 13.8	14 ± 2.9	19 ± 2.3
	Dinner	74 ± 8.8	14 ± 3.1	9 ± 1.8
Eveningness	**Meals**	**Carbohydrate**	**Protein**	**Fat**
	Breakfast	61 ± 9.7	11 ± 1.9	7 ± 0.7
	Lunch	91 ± 10.9	25 ± 5.2	15 ± 1.4
	Dinner	148 ± 20.9	7 ± 1.9	21 ± 2.7

Table 4.10.2, shows the Composition of meal throughout the day among the 227 participants. It can be clearly seen that among the individuals who are morning type have higher amount of protein in their breakfast as compared to evening type. While the fat content was highest in the dinner in evening type and lowest for the morning

type. Highest amount of carbohydrates was consumed by evening types during the dinner while morning type consumed the highest carbohydrates at lunch. Morningness group ingested most of their energy and nutrients at breakfast and lunch, whereas the eveningness group showed a higher intake at dinner according to Muñoz et al., (2017) In a study conducted by Toktaş et al., (2018) evening chronotype was associated with improper dietary habits and status such as high daily energy (kcal), fat (g) and carbohydrates (g) intakes and low protein intake in dinner.

Table 4.10.3: Association of chronotype with anthropometric parameters, biochemical parameters, Exercise Energy Expenditure (EEE), Screen time, sitting time, sleeping time and Stress

Parameter	Morningness (n=104) Mean values	Eveningness (n=123) Mean values	*p* value *
BMI (kg/m^2)	26.7	28.3	0.008
Body Fat %	32.3	34.5	0.034
Visceral Fat	13.1	14.4	0.011
Skeletal muscle (cm)	27.2	25.6	0.002
Waist circumference (cm)	97.4	99.9	0.015
Waist hip ratio	0.91	0.96	0.035
Waist height ratio	0.55	0.62	0.026
SBP (mmHg)	125.9	127.6	0.231
DBP (mmHg)	78.5	80.4	0.078
Total Cholesterol (mg/dl)	184.3	204.3	0.001
LDL (mg/dl)	118.3	139.8	0.008
HDL (mg/dl)	40.1	37.5	0.019
TG (mg/dl)	169.2	200.8	0.000
TG/HDL ratio	4.6	5.6	0.000
FBS (mg/dl)	138.6	163.6	0.001
PP_2BS (mg/dl)	180.2	217.8	0.000
HBA1C (%)	7.7	8.3	0.006
EEE (Kcal)	97.4	57.4	0.000
Screen time (hours)	3.3	3.7	0.000
Sitting time (hours)	8.2	9.1	0.004
Sleep time (hours)	5.9	5.4	0.001
Poor Sleep Quality	70	110	0.002
High Stress	3	28	0.000
KAP	14.1	12.8	0.002
p value is based student's independent t-test * p value < 0.05 is considered to be significant level			

Morningness–eveningness shows the individual's preference for performing any activity and sleep throughout the day (Randler et al., 2016) Circadian rhythm influences the energy metabolism. Table 4.10.3 shows Individuals having eveningness showed significant association with higher BMI ($p< 0.008$) as compared to individuals having preference for morningness. According to study conducted by Nimitphong et al., 2018 showed that higher BMI was directly associated with eveningness in 210 patients with type 2 diabetes mellitus. Participants who had eveningness chronotype showed significant association with higher body fat % ($p < 0.034$), higher visceral fat($p <0.011$), higher waist circumference ($p < 0.015$), high waist hip ratio ($p<0.035$), higher waist height ratio ($p< 0.026$) and lower skeletal Muscle ($p < 0.002$). Evening chrono typed patients had a higher percentage of total body fat.(Ng et al., 2016). In a study conducted by Yu et al., 2015 anthropometrics showed that individuals with evening preference had more visceral fat and less muscle mass. In a study conducted by Melo et al., 2020 showed that eveningness has increased waist size and increased waist-hip ratio.

The study population having evening chronotype showed significant association with higher LDL levels ($p< 0.008$) and lower HDL level ($p < 0.019$) while highly significant association was seen in total cholesterol ($p< 0.001$), triglyceride level ($p < 0.000$) and TG/HDL ratio ($p < 0.000$) then the morning typed individuals. Yu et al., 2015 showed that eveningness was associated with higher triglycerides, lower HDL-cholesterol levels but surprisingly lower systolic blood pressure. Bhardwaj et al., 2021 showed that patients with evening chronotype have higher total cholesterol and atherogenic coefficient. Participants with the evening preference had significantly higher levels of total cholesterol, triglyceride, low-density lipoprotein cholesterol, and low high-density lipoprotein cholesterol when compared with those with morning type.(Kwon et al., 2019)

Significant association was found between eveningness and HbA1c ($p < 0.006$) and highly significant association between fasting blood glucose ($p < 0.001$) and post-prandial blood glucose ($p < 0.000$). Fasting blood glucose and HbA1c levels were significantly associated in the evening group in a cross-sectional study on 140 patients with type 2 diabetes by Hashemipour et al., 2020. Higher HbA1c and poorer glycaemic control was associated with evening chronotype in T2DM patients.(*Western Pacific Region Index Medicus*, 2016)

Significant association was seen in increased hours of sitting time ($p < 0.004$) with eveningness among participants as compared with participants having morning chronotype. Evening type had higher odds for more sitting time when compared to the morning type. (Wennman et al., 2015b) There was highly significant association between eveningness, screen time ($p < 0.000$) and sleep time ($p < 0.001$). Evening chronotype personality was directly related to longer daily screen time. (Randjelovic et al., 2021) Quality of sleep was worse among evening types than that of the morning type. (Bakhshandeh Bavarsad et al., 2015) Eveningness was correlated with poor sleep quality in a study conducted by on 591 undergraduate students. (Carciofo, 2020) Evening types had a later midpoint of sleep and shorter sleep duration. (Randler et al., 2016) Evening-type individuals when compared with individuals having morning-type are more susceptible to stress. (C. Y. Lee et al., 2015) Evening type individuals have higher perceived stress in 236 adult males in a study conducted by Tonon et al., 2020. Eveningness was significantly associated with lower KAP score ($p < 0.002$) as compared to the morning chrono type.

Table 4.10.4: Association of chronotype with dietary intake

Parameter	**Morningness (n=104)**	**Eveningness (n=123)**	***p* value ***
Protein intake in morning	97	1	0.000
Carbohydrate intake in evening	0	115	0.000
Fat intake in evening	1	117	0.000
Sweets in evening	0	116	0.000
Fried foods in evening	0	122	0.000
Baked foods in evening	0	118	0.000
Calcium (mean mg)	381	402	0.023
Iron (mean mg)	15	14	0.065
Sodium (mean mg)	4237	4237	0.99
Potassium (mean mg)	2043	2054	0.156
Consumption of fibre ≥ RDA	20	5	0.000
Consumption of sugar (mean gm)	41.9	53.8	0.000

Consumption of salt (mean gm)	9.7	10.6	0.006
No. of servings of fruits and vegetables (mean)	3.1	2.0	0.000
Cups of coffee/tea (mean)	1.7	3.3	0.000

Breakfast skipping	5	106	0.000
Irregular meal timings	1	109	0.000
Mean servings of cereals	8	11	0.001
Mean servings of milk	3	3	0.93
Mean servings of pulses	2	2	0.97
p value is based on chi-square test for categorical variables and student's independent test for continuous variables (mean) *** p value < 0.05 is considered to be significant level**			

Chronotype considers an individual's time preference to carry out any kind of activity or resting. Individuals can be classified as a morning, intermediate, or evening type according to their time preferences. There is a notable association between chronotype and dietary intake. A significant association was also found among chronotype with quality and quantity of diet. There was significant association of higher consumption of protein in the morning time ($p < 0.000$) among individuals who had morning chronotype as compared to evening chrono typed individuals. Dietary intake of protein was less in the evening types in a study conducted on 142 participants by Toktaş et al., in 2018. Evening chrono typed individuals consumed more of carbohydrates ($p < 0.000$) and fat ($p < 0.000$) in the evening. A study conducted by Maukonen et al., 2017a on 1,854 adult participants stated that evening types had higher intakes of energy, carbohydrates, sucrose, fat, and saturated fatty acids than morning types in the evening. Toktaş et al., in 2018 revealed that consumption of fat was significantly higher in evening types than morning types. Less consumption of fibre ($p < 0.000$) and fruits and vegetables ($p < 0.000$) was seen in evening chronotype individuals. Intake of fibre was lower among evening chronotype individuals.

(Muscogiuri et al., 2021) Evening chronotype had lower than adequate intake of mean dietary fibre. (Oseguera-Castro et al., 2019) In a study conducted by Muñoz et al., 2017b on 171 subjects evening chrono typed subjects reported fewer consumption of fruits than morning typed. Eveningness among individuals was associated with a lower total fruit intake. (Gontijo et al., 2019)

Evening chronotype had a lower consumption of fruit and vegetables in a cross-sectional study conducted by Patterson et al., 2016 on 4,39,933 adults in the UK Biobank Project. Evening typed individuals had a significantly lower intake of vegetable as compared to the morning types among 1095 day workers and 1464 rotating shift workers.(Yoshizaki et al., 2018) There was significant association of higher consumption of cereals ($p < 0.001$) while no significance was found in consumption of pulses ($p < 0.97$) and milk products ($p < 0.93$) among evening chrono typed. Individuals with eveningness preference had increased total grain intake. (Gontijo et al., 2019) No significant association was found in minerals with the chronotype. Sodium intake was similar and higher than recommended among both the chronotypes, while potassium and Calcium intake was consumed lesser than recommended but was higher in evening chronotype due to higher consumption of energy. Iron consumption was very low then the recommended values among both the chronotype but was even lower in evening chrono-typed individuals. People having circadian preference for evening type had higher calorie consumption and so has high micronutrient intake.

High consumption of simple sugar ($p < 0.000$), salt ($p < 0.006$), and caffeine ($p < 0.000$) was seen in participants with evening chronotype. Later chronotype was associated with greater consumption of sugar.(Yoshizaki & Togo, 2021) More amount of caffeine was consumed by evening chronotypes than morning types.(Suh et al., 2017b)

Evening chronotype are usually engaged in higher intake of caffeine for its stimulant properties that can boost wakefulness.(Mazri et al., 2020b)

Poor food choices are commonly made by individuals having evening chronotype. Higher consumption of sweets ($p < 0.000$), fried foods ($p < 0.000$) and baked foods ($p < 0.000$) was seen among evening chrono typed individuals. Intake of sweets was significantly associated with eveningness in 72 individuals in the study by (Mota et al., 2016) Higher fried food intake was seen among late chronotypes. (Lin et al., 2020)

Evening chrono-typed individuals are directly related with unhealthy dietary behaviour such as delayed meal timings and breakfast skipping. Participants having preference towards eveningness showed a highly significant association of skipping breakfast ($p < 0.000$) and having irregular meal timings ($p < 0.000$). Skipping of breakfast was significantly related to later chronotype.(Silva et al., 2016b) Teixeira et al., 2018 showed that evening-type individuals were 1.7 times more likely to skip breakfast than morning-types. Evening types have more irregular meal timings when

Chrononutrition Profile	**N (%)**
Good	062 (27.3)
Fair	047 (20.8)
Poor	118 (51.9)

compared to morning types. (Maukonen et al., 2017c). Irregular meal time were also associated with eveningness in a cross-sectional survey of 5,640 participants from 29 companies in 2017–2019 in a study conducted by Shimura et al., 2020.

The eleventh section of the study included the "assessment of chrononutrition profile"

Table 4.11.1: Chrononutrition profile among participants suffering from type 2 diabetes

Table 4.11.1 shows the Chrononutrition profile among participants. After taking in consideration the six behaviours for assessing the chrononutrition profile it can be seen that 51.9 % of participants have poor chrononutrition profile while

27.3% have good chrononutrition profile and 20.8% have fair chrononutrition profile.

Figure 4.11.1 Chrononutrition profile among participants suffering from type 2 diabetes

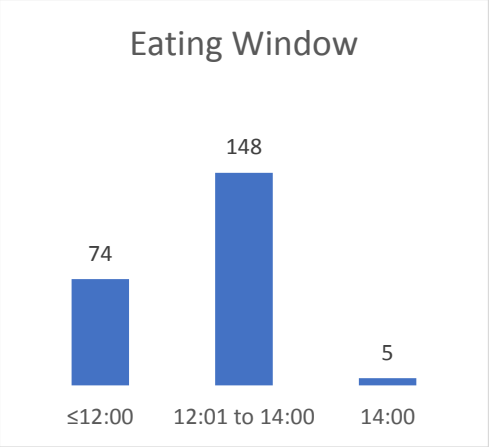


Figure 4.11.1(a): Eating window among participants

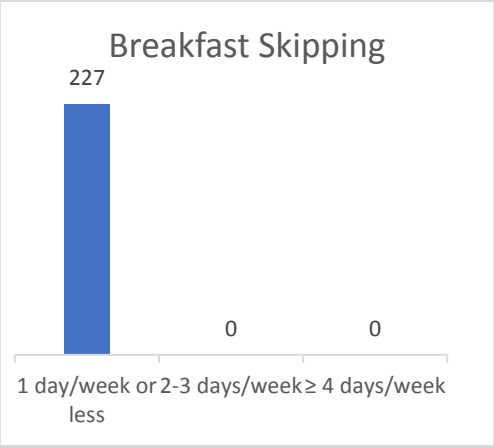


Figure 4.11.1(b): Breakfast Skipping among participants

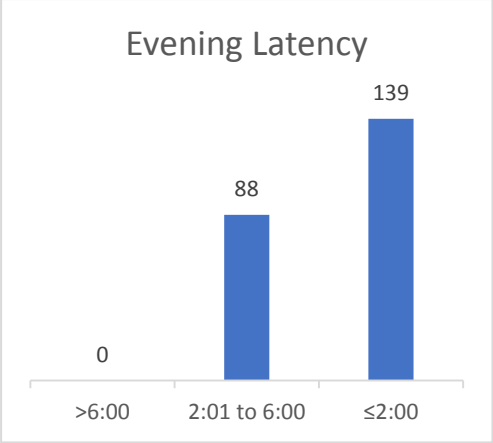


Figure 4.11.1(c): Evening Latency among participants

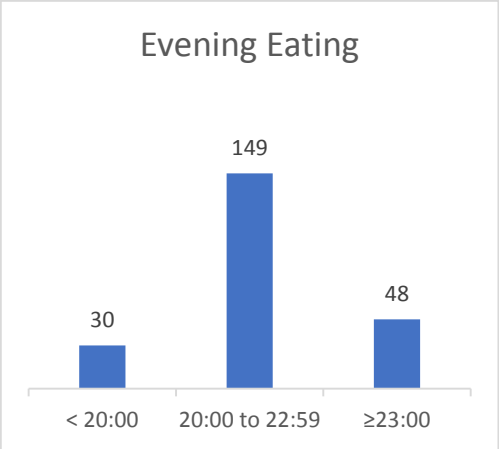


Figure 4.11.1(d): Evening Eating among

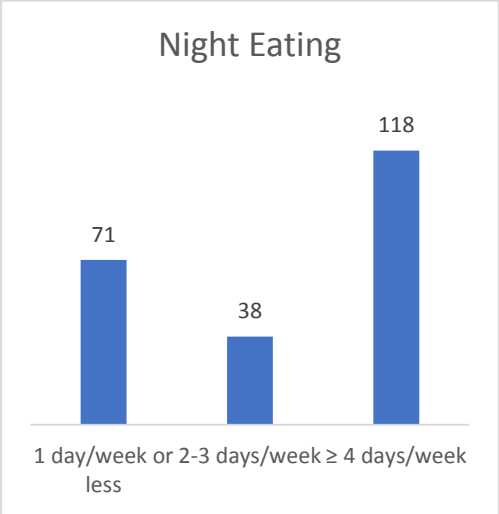


Figure 4.11.1(e): Night Eating among participants

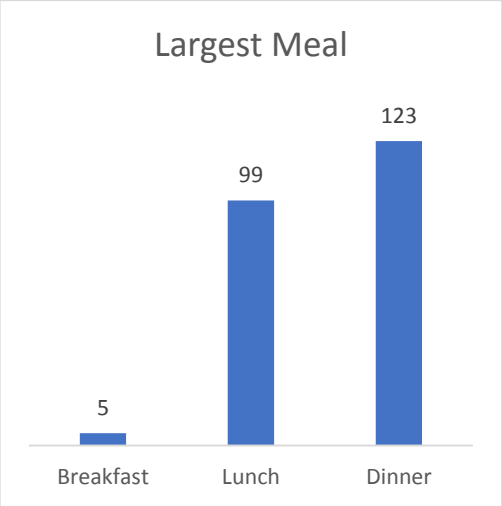


Figure 4.11.1(f): Largest meal among participants

Chrononutrition profile was assessed using the chrononutrition profile scoring method developed by Allison Christine Engwall. It has 6 indicators:

Eating Window includes duration between first eating event and last eating event. (HH:MM)

Breakfast Skipping includes frequency of breakfast skipping. (Days/Week)

Evening Latency includes duration between last eating event and sleep onset. (HH:MM)

Evening Eating includes risk of eating late in the waking day. (HH:MM)

Night Eating includes Frequency of night eating. (Days/Week)

Largest Meal includes meal in which largest amount of food is eaten. (Meal Name)

Scoring ranges from 0 to 12 with 0 indicating good chrononutrition status and 12 indicating poor chrononutrition status. Figure 4.11.1 shows the assessment of the Chrononutrition profile of participants. It can be seen in Figure 4.11.1(a) that maximum participants (65.2%) had fair duration between first eating event and last eating event, good frequency of skipping breakfast for one or less in a day in Figure 4.11.1(b), poor duration between last eating event and sleep onset among 61.2% participants in Figure 4.11.1(c), fair risk of eating late in the waking day among 66.2% participants in Figure 4.11.1(d), poor frequency of night eating among 51.8% participants in Figure 4.11.1(e) and 54.2% participants are in poor category where meal in which largest amount of food is eaten in Figure 4.11.1(f). In a cohort study by Jain Gupta et al.,(2017) more than 50% of people had their eating window for 15 hours or longer. The daily intake duration exceeded 14.75 hr for half of the participants in a cohort study by Gill & Panda (2015). The longer daily eating duration contributes to increased caloric intake and also reduces the sleep duration which directly contributes to increase in risk of developing metabolic diseases.

When overweight individuals with >14 hours of eating duration ate only for 10–11 hours/ day reduction in body weight, increase in energy and improvement in sleep was seen. In a study by Wilkinson et al., (2020) 10 hours of eating window in metabolic syndrome promotes weight loss, reduces waist circumference, reduces the percent body fat, and visceral fat, lowers blood pressure, atherogenic lipids, and also lowers glycated haemoglobin levels.

In a study conducted by (Burazeri et al., 2016) breakfast skipping was associated with a higher BMI. According to Karatzi et al., 2017 Late-night overeating was associated with skipping and/or consuming a smaller breakfast and increase in body mass index. Later circadian timing of consumption of food is associated with increase in body fat %. (McHill et al., 2017) Binge eating in the late evening increase susceptibility to obesity and other cardiometabolic diseases as night time eating resulted in small decrease in fat oxidation and increases the total cholesterol. Kinsey & Ormsbee, (2015) Late night eating was significantly associated with hyperglycaemia. Nakajima & Suwa,(2015) Sakai et al., (2018) demonstrated that late-night-dinner was independently associated with poor glycaemic control in people with type 2 diabetes. Triglyceride levels of people with late-night-dinner were worse and was directly associated with poor cardiometabolic profiles. Late-night-dinner is directly associated with poor glycaemic control as it prolongs the postprandial glucose spike, decreases the glucose tolerance and insulin sensitivity. In a study conducted by Fernanda Zerón-Rugerio et al., (2020) short time duration between dinner and midpoint of sleep were found to have significantly higher BMI and waist circumference. Time duration

Parameter	**Chrono nutrition profile**	***p* value**

between dinner and midpoint of sleep of 6 hours was associated with the lowest values of adiposity. Participants who had less than 3 or 4 hours dinner-to-bedtime duration are more likely to be overweight.(Gong et al., 2021) Verd et al., (2020) showed that day's largest caloric intake in dinner is a risk factor that predisposes an individual to develop obesity, metabolic syndrome and Type 2 diabetes mellitus.

	Good (n=62) Mean value	Fair (n=47) Mean value	Poor (n=118) Mean value	
FBS (mg/dl)	140.3	140.8	165.0	0.001
PP_2BS (mg/dl)	181.9	181.7	218.2	0.000
HB_1AC (%)	7.7	7.8	8.4	0.000
EEE (Kcal)	95.5	94.1	58.0	0.000
BMI (kg/m^2)	27.0	27.5	28.4	0.012
Screen time (hours)	3.4	3.4	3.7	0.006
Body Fat %	32.1	32.9	33.5	0.016
Sitting time (hours)	8.1	8.4	8.8	0.002
Visceral Fat	13.1	13.4	14.5	0.000
Sleep time (hours)	5.8	5.7	5.4	0.001
Skeletal muscle (%)	27.4	26.7	26.2	0.039
Poor Sleep	35	40	105	0.000
Waist circumference (cm)	96.1	97.6	100.0	0.038
High Perceived Stress	2	5	26	0.001
Waist hip ratio	0.90	0.91	0.95	0.000
KAP Score	14.3	13.7	12.5	0.014
Waist height ratio	0.60	0.62	0.65	0.000
SBP (mmHg)	126.0	126.8	128.0	0.495
DBP (mmHg)	76.2	76.8	80.4	0.030
Total Cholesterol (mg/dl)	186.4	187.3	202.9	0.000
LDL (mg/dl)	118.9	120.6	139.5	0.001
HDL (mg/dl)	35.3	36.0	38.4	0.023
TG (mg/dl)	163.4	169.9	199.9	0.000
TG/HDL ratio	4.4	4.5	5.6	0.000

p value is based one-way ANOVA test

* p value < 0.05 is considered to be significant level

Table 4.11.2: Association of chrono nutrition profile with anthropometric parameters, biochemical parameters, Exercise Energy Expenditure (EEE), Screen time, sitting time, sleeping time and Stress

Chrononutrition profile was assessed using the chrononutrition profile questionnaire developed by Allison Christine Engwall. The CP-Q assesses six components of chrononutrition that are likely to influence health like breakfast skipping, largest meal, evening eating, evening latency, night eating, and eating window which can evaluate an individual's chrononutrition profile. Poor Chrononutrition profile indicates poor habits that could negatively harm an individual's health. Table 4.11.2 shows how Poor Chrononutrition profile is significantly associated with higher BMI ($p < 0.012$), higher fat % ($p < 0.016$), high waist circumference ($p < 0.038$), higher Diastolic blood pressure ($p < 0.030$), lower HDL cholesterol ($p < 0.023$), high screen time ($p < 0.006$) and high sitting time ($p < 0.002$). Significant association with higher visceral fat ($p < 0.000$), high waist hip ratio ($p < 0.000$), high waist height ratio ($p < 0.000$), higher LDL Cholesterol ($p < 0.001$), high triglyceride level ($p < 0.000$), high TG/HDL ratio ($p < 0.000$), high Fasting Blood Sugar ($p < 0.001$), high Post prandial blood sugar ($p < 0.000$), high HbA1c ($p < 0.000$) and higher stress ($p < 0.001$) was also seen among participants with poor chrononutrition profile. Lower skeletal muscle

% ($p < 0.039$) and lesser sleeping hours ($p < 0.000$) was commonly seen in individuals with poor profile as compared to the individuals having fair or good chrononutrition profile. Mean KAP score ($p < 0.014$) was least among the individuals having bad chrononutrition profile as compared to the fair and good chrononutrition profile among individuals and has a significant association with an individual's chrononutrition profile.

Table 4.11.3: Association of chrono nutrition profile with dietary pattern

Parameter	**Chrono nutrition profile**			***p* value ***
	Good (n=62)	**Fair (n=47)**	**Poor (n=118)**	
Protein intake in morning	59	39	0	0.000
Carbohydrate intake in evening	0	0	115	0.000
Fat intake in evening	1	0	117	0.000
Sweets in evening	0	0	116	0.000
Fried foods in evening	1	4	117	0.000
Baked foods in evening	0	0	118	0.000
Calcium (mean mg)	373	390	402	0.000
Iron (mean mg)	15.1	15.2	14.9	0.147
Sodium (mean mg)	4129	4244	4361	0.010
Potassium (mean mg)	2048	2037	2054	0.492
Consumption of fiber ≥ RDA	15	11	9	0.003
Consumption of sugar (mean gm)	43.2	45.6	53.7	0.000
Consumption of salt (mean gm)	8.9	9.9	10.6	0.002
No. of servings of fruits and vegetables (mean)	3.1	2.9	2.0	0.000
Cups of coffee/tea (mean)	1.7	1.8	3.3	0.000

Breakfast skipping	1	9	101	0.000
Irregular meal timings	1	5	104	0.000
p value is based on chi-square test for categorical variables and one-way ANOVA for continuous variables (mean) *** p value < 0.05 is considered to be significant level**				

Table 4.11.3 shows the association between chrononutrition profile and dietary habits of the study population. Significant association was found between lesser consumption of fibre ($p < 0.003$) and higher salt consumption ($p < 0.002$).

The poor chrononutrition profile is highly significantly associated with less protein in morning ($p < 0.000$), more carbohydrate intake ($p < 0.000$), high fat intake ($p < 0.000$), more consumption of sweets ($p < 0.000$), fried foods ($p < 0.000$) and baked foods ($p < 0.000$) in evening. Higher consumption of calcium ($p < 0.000$), sodium ($p < 0.010$) and potassium ($p < 0.492$) and lower consumption of iron ($p < 0.147$), was seen in poor chrononutrition profile. More consumption of sugar ($p < 0.000$), lesser fruits and vegetables intake ($p < 0.000$), higher consumption of caffeine ($p < 0.000$), breakfast skipping ($p < 0.000$) and irregular meal timings ($p < 0.000$) were seen in poor chrononutrition profile as compared to the fair and good chrononutrition profile.

Table 4.11.4: Correlation between chrono nutrition profile and body fat composition

Chrono nutrition profile	**Body fat composition**			
	BMI	**Muscle %**	**Fat %**	**WHR**
Eating window	r=0.23, p=0.03	r=0.19, p=0.01	r=0.41, p=0.04	r=0.35, p=0.02
Breakfast skipping	r=0.44, p=0.00	r=0.27, p=0.02	r=0.11, p=0.04	r=0.23, p=0.02
Evening latency	r=0.38, p=0.01	r=0.22, p=0.00	r=0.34, p=0.03	r=0.29, p=0.01
Evening eating	r=0.39, p=0.02	r=0.14, p=0.04	r=0.19, p=0.02	r=0.30, p=0.01

Night eating	r=0.53, p=0.00	r=0.45, p=0.01	r=0.53, p=0.00	r=0.39, p=0.00
Largest meal	r=0.41, p=0.00	r=0.32, p=0.00	r=0.27, p=0.01	r=0.40, p=0.00
p value is based on spearman's rank-order correlation				

Table 4.11.4 shows the correlation between chrononutrition profile and body fat composition. There was a positive correlation and significant relationship between Eating window and BMI (r=0.23, p=0.03), fat % (r=0.41, p=0.04) and WHR (r=0.35, p=0.02) and a highly significant relationship with muscle % (r=0.19, p=0.01).

Highly significant association and positive correlation was found between breakfast skipping and BMI (r=0.44, p=0.00) while positive association was found on breakfast skipping with muscle % (r=0.27, p=0.02), fat % (r=0.11, p=0.04) and WHR (r=0.23, p=0.02) Evening latency was positively correlated with BMI (r=0.38, p=0.01), muscle % (r=0.22, p=0.00), fat % (r=0.34, p=0.03) and WHR (r=0.29, p=0.01) with highly significant association with BMI, Muscle % and WHR. Positive correlation was found

between evening eating and BMI (r=0.39, p=0.02) and highly significant association was seen between Evening eating and WHR (r=0.30, p=0.01). Highly significant association and moderate strong correlation was found between night eating and BMI (r=0.53, p=0.00), Muscle % (r=0.45, p=0.01), Fat % (r=0.53, p=0.00) and WHR (r=0.39, p=0.00). Largest meal also showed a highly significant association and positive correlation between BMI (r=0.41, p=0.00), muscle % (r=0.32, p=0.00), fat % (r=0.27, p=0.01) and WHR (r=0.40, p=0.00).

Table 4.11.5: Correlation between chrono nutrition profile and biochemical parameters

Chrono nutrition profile	**Biochemical parameters**			
	FBS	**PP_2BS**	**HbA1C**	**TG/HDL**
Eating window	r=0.13, p=0.02	r=0.29, p=0.01	r=0.35, p=0.01	r=0.14, p=0.04
Breakfast skipping	r=0.24, p=0.00	r=0.41, p=0.00	r=0.20, p=0.02	r=0.30, p=0.01
Evening latency	r=0.58, p=0.00	r=0.32, p=0.03	r=0.40 p=0.01	r=0.44, p=0.00
Evening eating	r=0.21, p=0.04	r=0.39, p=0.00	r=0.29, p=0.02	r=0.50, p=0.00
Night eating	r=0.55, p=0.00	r=0.32, p=0.00	r=0.49, p=0.00	r=0.53, p=0.00
Largest meal	r=0.51, p=0.00	r=0.62, p=0.00	r=0.39, p=0.01	r=0.39, p=0.01
p value is based on spearman's rank-order correlation				

Table 4.11.5 shows the correlation between chrononutrition profile and biochemical parameters. Positive correlation was found between eating window and FBS (r=0.13, p=0.02) and TG/HDL (r=0.14, p=0.04) while highly significant association with positive correlation was found between eating window and PPBS (r=0.29, p=0.01) and HbA1c (r=0.35, p=0.01). Breakfast skipping was positively correlated and highly significantly associated with FBS (r=0.24, p=0.00), PP2BS (r=0.41, p=0.00) and

TG/HDL (r=0.30, p=0.01). Evening latency had a positive correlation with FBS, PP2BS, HbA1c, and TG/HDL. Highly significant association with positive correlation was found between night eating and FBS (r=0.55, p=0.00), PP2BS (r=0.32, p=0.00), HbA1C (r=0.49, p=0.00) and TG/HDL (r=0.53, p=0.00) while FBS (r=0.51, p=0.00), PP2BS (r=0.62, p=0.00), HbA1c (r=0.39, p=0.01) and TG/HDL (r=0.39, p=0.01) also showed a positive correlation and significant association with the largest meal that was consumed.

Figure 4.11.2: Correlation between Chrononutrition profile score and EEE (kcal)

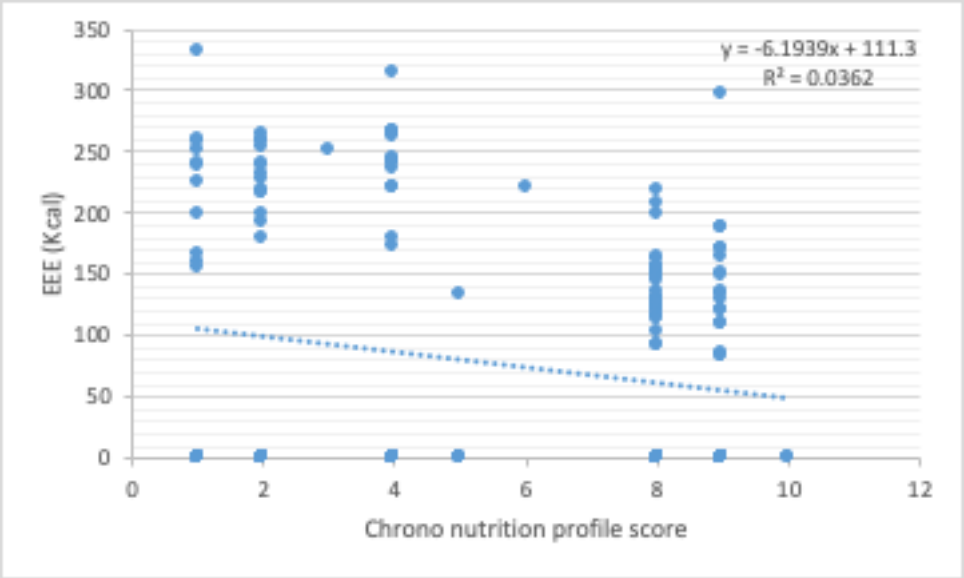


Figure 4.11.2 shows the positive correlation between EEE (Kcal) and Chrononutrition profile score. It can be seen that as the chrononutrition profile score increases the EEE decreases which clearly indicates how poor chrononutrition profile impacts the Energy Expenditure from exercise.

Figure 4.11.3: Correlation between Chrononutrition profile score and BMI

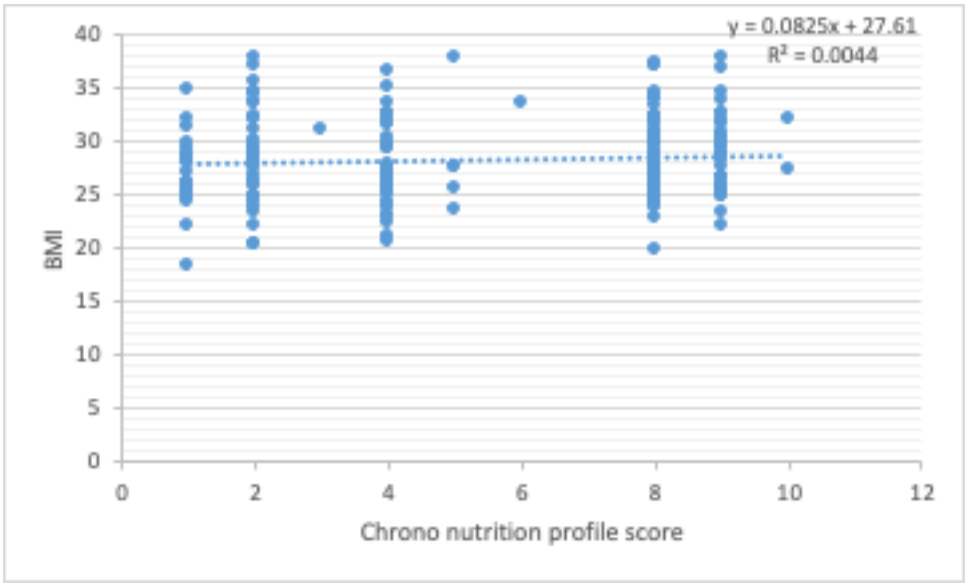


Figure 4.11.3 shows positive correlation between BMI and Chrononutrition profile score. These graph highlights the fact that higher the chrononutrition profile score higher is the BMI.

Figure 4.11.4: Correlation between Chrononutrition profile score and HbA1C

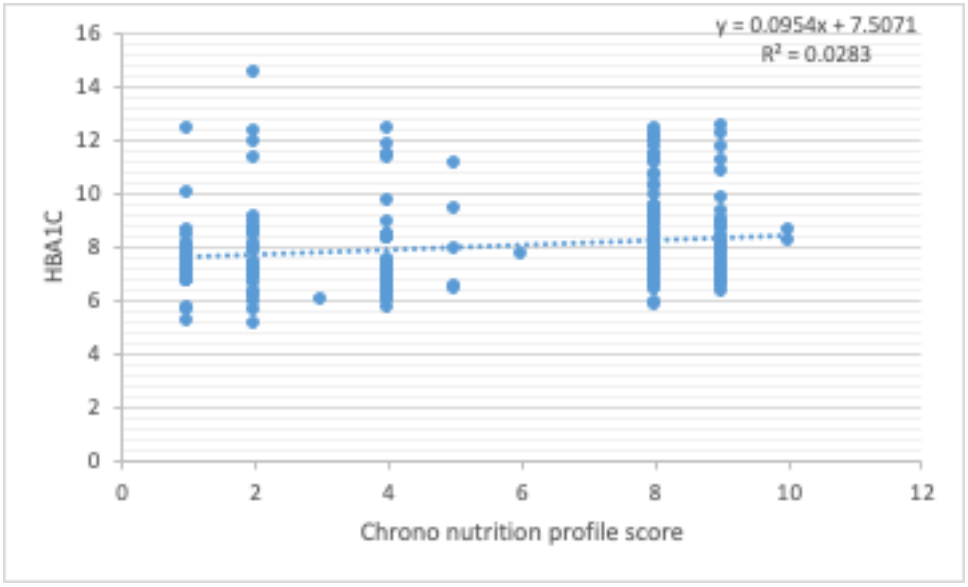


Figure 4.11.4 shows positive correlation between HbA1c and Chrononutrition profile score. These graph highlights the fact that higher the chrononutrition profile score higher is the HbA1c level.

Table 4.11.6: Association between Chrononutrition profile and Chronotype

Chrono nutrition profile	**Morningness**	**Eveningness**	**Total**	**p value**
Good	61	1	**62**	**P value = 0.000**
Fair	43	4	**47**	
Poor	0	118	**118**	
Total	**104**	**123**	**227**	
P value is based on chi-square test				

Table 4.11.6 shows that there is highly significant association between chrononutrition profile and an individual's chronotype ($p < 0.000$). It can be seen that 45.8 % of individuals have morning chronotype and 54.2 % individuals have evening chronotype. 58.6% individuals have good chrononutrition profile while 41.4 % have fair chrononutrition profile among morning chrono typed individuals. 95.9 % individuals having evening chronotype had poor chrononutrition profile score 3.3% had fair and only 0.8% had good chrononutrition profile score.

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

The present study was under taken to study the association of Chrononutrition Profile and Type 2 Diabetes Mellitus. The study was carried out on 227 participants which were selected from 3 diabetes clinics from urban Vadodara and data was collected in 11 sections like Personal information, diet information, physical activity, screen time, stress, sleep, knowledge attitude practice and chronotype was collected using a questionnaire by telephonic interview method, anthropometric measurements were collected at the clinic and biochemical parameters ware collected from their case file.

Major findings of the Study

- **Personal information**

Majority of the participants were from age group of 55-60 years (37.8% males and 25.9% females). Majority of participants had studied up to graduation. (male =52.9% and female =30.5%). Eighty eight percent of females were home-makers while maximum number of male (29.5%) were retired followed by business owners (22.7%). Seventy three percent participants lived in a nuclear family while 22.5% lived in extended family 4.8% were living in joint family.

- **Anthropometric data and Biochemical parameters**

Prevalence of central obesity by higher waist circumference and high waist-hip ratio was higher in males than females. Majority of participants were obese (male = 87.4%, female= 80.6%). Eighty six percent male and 68.5% female had very high body fat % while 48.7 % male and 52.7% female had high visceral fat with 91.6% males and 80.5% females having lower skeletal muscle %. Eighty-point seven percent male and 72.2% female had uncontrolled fasting blood sugar levels while 82.2% male participants and 75.9% female participants had uncontrolled PP2BS levels and forty two percent male and thirty seven percent female had poorly controlled HbA1c levels. Eleven-point eight percent male and 7.4 % female had normal blood pressure.

Fifty five percent male and 46.3% female participants had desirable cholesterol levels while 66.1 % male and 66.6% female had borderline high LDL levels. Sixty-one-point three percent male and female participants had low HDL levels. 57.9% male and 43.5% female participants had borderline high triglycerides values and 95.8% male and 98.2% female had high than recommended TG/HDL ratio which shows higher risk of suffering from cardiovascular diseases among participants.

- **Diet information**

Fifty eight percent of the total participants were lacto-vegetarian while 25.5% were lacto-ovo vegetarian and 16.3% were non-vegetarian with only 0.4% participants were vegan. Breakfast was generally skipped by 49.3%. Only 6.2 % of the total participants preferred breakfast as their main meal. Male participants consumed more sugar and salt as compared to the female participants.

- **Physical activity, sitting time, screen time, sleep and Stress**

Only 40.1% participants exercised daily. Female participants had higher sitting time compared to the male participants. Screen time of more than 2 hours post dinner was seen among fifty two percent of the participants. Shorter sleeping duration was seen in 82.6% subjects. Eighty percent subjects had poor sleep quality and only 20.3 % subjects had good sleep. Majority of the participants (70.5 %) suffered from moderate stress while 15.8 % participants had low stress levels and only 13.7% suffered from high stress.

- **Knowledge Attitude Practice**

Fifty-one-point one percent of participants had poor knowledge regarding the medical, dietary and exercise related questions of diabetes while 68% participants showed good attitude regarding the diabetic lifestyle while 51.1% participants had poor disease related practices.

- **Chronotype and Chrononutrition Profile**

  Majority of the participants (51.1%) had moderate evening chronotype followed by 23.3 % with definite morning chronotype while 22.5 % participants had moderate morning chronotype and only 3.1% participants had definite evening chronotype. Fifty two percent of participants had poor chrononutrition profile while 27.3% had good chrononutrition profile and 20.8 % had fair chrononutrition profile. Sixty five percent participants had acceptable chrononutrition profile for first and last eating event duration while hundred percent participants had a good chrononutrition profile of not skipping breakfast generally and unacceptable chrononutrition profile was seen among 61.2% participants for duration between last eating event and sleep onset. Acceptable profile was seen among 66.2% participants for eating late in the waking day, while unacceptable chrononutrition profile was seen in 51.8% participants for night eating and 54.2% participants had unacceptable chrononutrition profile for meal in which largest amount of food was eaten.

Conclusion:

The major conclusions that emerge from the present study are,

- Evening chronotype was more prevalent among female participants while majority of male participants showed morning chronotype.
- Higher BMI, body fat %, visceral fat, waist circumference, waist hip ratio, waist height ratio and lower skeletal Muscle was significantly associated with eveningness chronotype.
- Evening chrono type individuals had higher LDL levels, total cholesterol level, triglyceride level and lower HDL level and TG/HDL ratio then the morning typed individuals. Individuals having circadian preference for eveningness had higher HbA1c levels, fasting blood glucose and post-prandial blood glucose.
- Increased hours of sitting time, higher screen time and less sleep quality and quantity was seen among participants having evening type as compared with participants having morning chronotype.

- Poor dietary habits like breakfast skipping and irregular meal timings was seen in evening chrono typed individuals. Higher consumption of protein in the morning time was seen among individuals who had morning chronotype as compared to evening chrono typed individuals. While evening chrono typed individuals consumed more of carbohydrates and fat in the evening. Less consumption of fiber and fruits and vegetables was seen in evening chronotype individuals while consumption of cereals, simple sugar, salt, and caffeine was higher in participants with evening chronotype. Higher consumption of sweets, fried foods and baked foods was seen among evening chrono typed individuals.
- Poor chrononutrition profile was seen in majority of male and female participants followed by good and fair chrononutrition profile.
- Individuals having Poor Chrononutrition profile had higher BMI, body fat %, waist circumference, visceral fat, waist hip ratio and waist height ratio while had lower skeletal muscle %.
- Higher LDL Cholesterol, triglyceride level, TG/HDL ratio, and lower HDL cholesterol was seen among individuals with poor chrononutrition profile. Poor chrononutrition profiled individuals had high Fasting Blood Sugar, Post prandial blood sugar and HbA1c levels.
- High screen time, sitting time and stress was seen among participants with poor chrononutrition profile while and lesser sleeping hours was commonly seen in individuals with poor profile as compared to the individuals having fair or good chrononutrition profile.
- Breakfast skipping and irregular meal timings were seen in poor chrononutrition profile as compared to the fair and good chrononutrition profile. Individuals having poor chrononutrition profile had higher carbohydrate intake, fat intake, consumption of sweets, fried foods and baked foods in evening and less protein consumption in the morning. Higher consumption of calcium, sodium and potassium was seen due to higher intake of calories and lower consumption of iron was seen in poor chrononutrition profile. More consumption of sugar, salt and caffeine and lesser consumption of fiber, fruits and vegetables was seen among poor chrononutrition profiled individuals.

Thus, improving the chrononutrition profile can go a long way in better control of diabetes, control of dyslipidemia and thereby the complications arising out of the same.

Future Directions

Chrononutrition profiling should sincerely be considered by the dietitian/nutritionist when counselling for diet especially in high-risk groups like late night eaters, shift workers, students staying up late at night and individuals having chronic diseases along with the general population.

Chrononutrition should be included and emphasized in diabetes education course as timing and nutrient composition of meal affects the regular bodily functions which if not taken well care of may increase the risk of developing Type 2 diabetes mellitus or delays the process of management of Type 2 diabetes mellitus.

BIBLIOGRAPHY

Ahmed, A., Qarni, A., Joatar, F. E., Das, N., Awad, M., Eltayeb, M., Al-zubair, A. G., Ali, M. E., Masaud, A. Al, Shire, A. M., Gumaa, K., & Giha, H. A. (2017). *Original Article Association of Plasma Ghrelin Levels with Insulin Resistance in Type 2 Diabetes Mellitus among Saudi Subjects*. 230–240.

Al-Abri, M. A., Jaju, D., Al-Sinani, S., Al-Mamari, A., Albarwani, S., Al-Resadi, K., Bayoumi, R., Hassan, M., & Al-Hashmi, K. (2016). Habitual Sleep Deprivation is Associated with Type 2 Diabetes: A Case-Control Study. *Oman Medical Journal*, *31*(6), 399–403. https://doi.org/10.5001/omj.2016.81

AlEssa, H. B., Bhupathiraju, S. N., Malik, V. S., Wedick, N. M., Campos, H., Rosner, B., Willett, W. C., & Hu, F. B. (2015). Carbohydrate quality and quantity and risk of type 2 diabetes in US women. *American Journal of Clinical Nutrition*, *102*(6), 1543–1553. https://doi.org/10.3945/ajcn.115.116558

Almoosawi, S., Vingeliene, S., Karagounis, L. G., & Pot, G. K. (2016). Chrono-nutrition: A review of current evidence from observational studies on global trends in time-of-day of energy intake and its association with obesity. *Proceedings of the Nutrition Society*, *75*(4), 487–500. https://doi.org/10.1017/S0029665116000306

Almoosawi, Suzana, Vingeliene, S., Gachon, F., Voortman, T., Palla, L., Johnston, J. D., Van Dam, R. M., Darimont, C., & Karagounis, L. G. (2019a). Chronotype: Implications for Epidemiologic Studies on Chrono-Nutrition and Cardiometabolic Health. *Advances in Nutrition*, *10*(1), 30–42. https://doi.org/10.1093/advances/nmy070

Almoosawi, Suzana, Vingeliene, S., Gachon, F., Voortman, T., Palla, L., Johnston, J. D., Van Dam, R. M., Darimont, C., & Karagounis, L. G. (2019b). Chronotype: Implications for Epidemiologic Studies on Chrono-Nutrition and Cardiometabolic Health. In *Advances in Nutrition* (Vol. 10, Issue 1, pp. 30–42). Oxford University Press. https://doi.org/10.1093/advances/nmy070

Anothaisintawee, T., Lertrattananon, D., Thamakaison, S., Thakkinstian, A., & Reutrakul, S. (2018). The relationship among morningness-eveningness, sleep duration, social jetlag, and body mass index in Asian patients with prediabetes. *Frontiers in Endocrinology*, *9*(AUG), 1–12. https://doi.org/10.3389/fendo.2018.00435

Aparecida Crispim, C., & Carliana Mota, M. (2019). New perspectives on chrononutrition. *Biological Rhythm Research*, *50*(1), 63–77. https://doi.org/10.1080/09291016.2018.1491202

Arola-Arnal, A., Cruz-Carrión, Á., Torres-Fuentes, C., Ávila-Román, J., Aragonès, G., Mulero, M., Bravo, F. I., Muguerza, B., Arola, L., & Suárez, M. (2019). Chrononutrition and polyphenols: Roles and diseases. *Nutrients*, *11*(11), 1–18. https://doi.org/10.3390/nu11112602

Arora, T., & Taheri, S. (2015). Associations among late chronotype, body mass index and dietary behaviors in young adolescents. *International Journal of Obesity*, *39*(1), 39–44. https://doi.org/10.1038/ijo.2014.157

Asher, G., & Sassone-Corsi, P. (2015). Time for food: The intimate interplay between nutrition, metabolism, and the circadian clock. *Cell*, *161*(1), 84–92. https://doi.org/10.1016/j.cell.2015.03.015

Azmi, N. A. S. M., Juliana, N., Teng, N. I. M. F., Azmani, S., Das, S., & Effendy, N. (2020). Consequences of circadian disruption in shift workers on chrononutrition and their psychosocial well-being. *International Journal of Environmental Research and Public Health*, *17*(6). https://doi.org/10.3390/ijerph17062043

Bakhshandeh Bavarsad, M., Azimi, N., Moradbeigi, K., & Latifi, M. (2015). Associations Between Morningness-Eveningness and Sleep Quality Among Female Dormitory Residents. *Thrita*, *4*(1). https://doi.org/10.5812/thrita.25088

Balaji, R., Duraisamy, R., & Santhosh Kumar, M. P. (2019). Complications of diabetes mellitus: A review. *Drug Invention Today*, *12*(1), 98–103.

Banday, M., Sameer, A., & Nissar, S. (2020a). Pathophysiology of diabetes: An overview. *Avicenna Journal of Medicine*, *10*(4), 174. https://doi.org/10.4103/ajm.ajm_53_20

Banday, M., Sameer, A., & Nissar, S. (2020b). Pathophysiology of diabetes: An overview. *Avicenna Journal of Medicine*, *10*(4), 174. https://doi.org/10.4103/ajm.ajm_53_20

Basnet, S. (2019). *ASSOCIATIONS BETWEEN CIRCADIAN FACTORS AND NONCOMMUNICABLE DISEASES A POPULATION-BASED STUDY IN FINLAND* (Issue January).

Berendsen, M., Boss, M., Smits, M., & Pot, G. K. (2020). Chrono-nutrition and diet quality in adolescents with delayed sleep-wake phase disorder. *Nutrients*, *12*(2), 1–13. https://doi.org/10.3390/nu12020539

Bhardwaj, S., Bhattacharjee, J., Bhatnagar, M. K., Tyagi, S., & Delhi, N. (2021). S16-S38-Based Cohort. *European Neuropsychopharmacology*, *44*(2), 359–364. https://doi.org/10.1016/j.euroneuro.2021.01.030

Bo, S., Musso, G., Beccuti, G., Fadda, M., Fedele, D., Gambino, R., Gentile, L., Durazzo, M., Ghigo, E., & Cassader, M. (2014). *Consuming More of Daily Caloric Intake at Dinner Predisposes to Obesity. A 6-Year Population-Based Prospective Cohort Study*. https://doi.org/10.1371/journal.pone.0108467

Borel, A. L. (2019). Sleep apnea and sleep habits: Relationships with metabolic syndrome. *Nutrients*, *11*(11), 1–15. https://doi.org/10.3390/nu11112628

Bravo, R., Ugartemendia, L., & Cubero, J. (2017). Current Opinions in Chrononutrition and Health. *Journal of Clinical Nutrition & Dietetics*, *03*(01), 3–5. https://doi.org/10.4172/2472-1921.100040

Briançon-Marjollet, A., Weiszenstein, M., Henri, M., Thomas, A., Godin-Ribuot, D., & Polak, J. (2015). The impact of sleep disorders on glucose metabolism: Endocrine and molecular mechanisms. *Diabetology and Metabolic Syndrome*, *7*(1), 1–16. https://doi.org/10.1186/s13098-015-0018-3

Burazeri, G., Hyska, J., Mone, I., & Roshi, E. (2016). Breakfast skipping is an independent predictor of obesity but not overweight among children in a Southeastern European population. *International Journal for Vitamin and Nutrition Research*, *86*(5–6), 242–248. https://doi.org/10.1024/0300-9831/a000272

Cahill, L. E., Pan, A., Chiuve, S. E., Sun, Q., Willett, W. C., Hu, F. B., & Rimm, E. B. (2015). 1.35), 1.39 (1.30, 1.49), and 1.55 (1.32, 1.83), respectively, for T2D and 1.00 (reference). *Am J Clin Nutr*, *1*, 667–675. https://doi.org/10.3945/ajcn.114.084129

Cai, H., Li, G., Zhang, P., Xu, D., & Chen, L. (2017). Effect of exercise on the quality of life in type 2 diabetes mellitus: a systematic review. *Quality of Life Research*, *26*(3), 515–530. https://doi.org/10.1007/s11136-016-1481-5

Carciofo, R. (2020). Morningness–eveningness and affect: the mediating roles of sleep quality and metacognitive beliefs. *Sleep and Biological Rhythms*, *18*(1), 17–26. https://doi.org/10.1007/s41105-019-00238-9

Chen, C., Zeng, Y., Xu, J., Zheng, H., Liu, J., Fan, R., Zhu, W., Yuan, L., Qin, Y., Chen, S., Zhou, Y., Wu, Y., Wan, J., Mi, M., & Wang, J. (2016). Therapeutic effects of soluble dietary fiber consumption on type 2 diabetes mellitus. *Experimental and Therapeutic Medicine*, *12*(2), 1232–1242. https://doi.org/10.3892/etm.2016.3377

Christensen, M. A., Bettencourt, L., Kaye, L., Moturu, S. T., Nguyen, K. T., Olgin, J. E., Pletcher, M. J., & Marcus, G. M. (2016). Direct Measurements of Smartphone Screen-Time: Relationships with Demographics and Sleep. *PLOS ONE*, *11*(11), e0165331. https://doi.org/10.1371/journal.pone.0165331

Comerford, K. B., & Pasin, G. (2016). Emerging evidence for the importance of dietary protein source on glucoregulatory markers and type 2 diabetes: Different effects of dairy, meat, fish, egg, and plant protein foods. In *Nutrients* (Vol. 8, Issue 8, p. 446). MDPI AG. https://doi.org/10.3390/nu8080446

Curtis KM, NK, T., TC, J., E, B.-B., LG, H., LB, Z., & Simmons KB. (2015). Enhanced Reader.pdf. In *Nature* (Vol. 388, pp. 539–547).

De Amicis, R., Galasso, L., Leone, A., Vignati, L., De Carlo, G., Foppiani, A., Montaruli, A., Roveda, E., Cè, E., Esposito, F., Vanzulli, A., Battezzati, A., & Bertoli, S. (2020). Is abdominal fat distribution associated with chronotype in adults independently of lifestyle factors? *Nutrients*, *12*(3), 1–9. https://doi.org/10.3390/nu12030592

Definition,diagnosis and classification of diabetes mellitus and its complications,WHO. (1999).

Dempsey, P. C., Larsen, R. N., Sethi, P., Sacre, J. W., Straznicky, N. E., Cohen, N. D., Cerin, E., Lambert, G. W., Owen, N., Kingwell, B. A., & Dunstan, D. W. (2016). Benefits for Type 2 Diabetes of Interrupting Prolonged Sitting With Brief Bouts of Light Walking or Simple Resistance Activities. *Diabetes Care*, *39*. https://doi.org/10.2337/dc15-2336

Dempsey, P. C., Owen, N., Yates, T. E., Kingwell, B. A., & Dunstan, D. W. (2016). *Sitting Less and Moving More: Improved Glycaemic Control for Type 2 Diabetes Prevention and Management*. https://doi.org/10.1007/s11892-016-0797-4

Diagnosis | ADA. (n.d.). Retrieved April 22, 2021, from https://www.diabetes.org/a1c/diagnosis

Drăgoi, C. M., Moroşan, E., Dumitrescu, I. B., Nicolae, A. C., Arsene, A. L., Drăgănescu, D., Lupuliasa, D., Ioniţă, A. C., Stoian, A. P., Nicolae, C., Rizzo, M., & Mititelu, M. (2019). Insights into chrononutrition: The innermost interplay amongst nutrition, metabolism and the circadian clock, in the context of epigenetic reprogramming. *Farmacia*, *67*(4), 557–571. https://doi.org/10.31925/farmacia.2019.4.2

Dyson, P. (2015). Low Carbohydrate Diets and Type 2 Diabetes: What is the Latest Evidence? *Diabetes Therapy*, *6*. https://doi.org/10.1007/s13300-015-0136-9

Ericson, U., Hellstrand, S., Brunkwall, L., Schulz, C. A., Sonestedt, E., Wallström, P., Gullberg, B., Wirfält, E., & Orho-Melander, M. (2015). Food sources of fat may clarify the inconsistent role of dietary fat intake for incidence of type 2 diabetes. *American Journal of Clinical Nutrition*, *101*(5), 1065–1080. https://doi.org/10.3945/ajcn.114.103010

Evert, A. B., Dennison, M., Gardner, C. D., Timothy Garvey, W., Karen Lau, K. H., MacLeod, J., Mitri, J., Pereira, R. F., Rawlings, K., Robinson, S., Saslow, L., Uelmen, S., Urbanski, P. B., & Yancy, W. S. (2019). Nutrition therapy for adults with diabetes or prediabetes: A consensus report. In *Diabetes Care* (Vol. 42, Issue 5, pp. 731–754). American Diabetes Association Inc. https://doi.org/10.2337/dci19-0014

Fernanda Zerón-Rugerio, M., Longo-Silva, G., Hernáez, Á., Eugenia Ortega-Regules, A., Cambras, T., & Izquierdo-Pulido, M. (2020). *The Elapsed Time between Dinner and the Midpoint of Sleep Is Associated with Adiposity in Young Women*. https://doi.org/10.3390/nu12020410

Gadiraju, T. V, Patel, Y., Gaziano, J. M., & Djoussé, L. (2015). *Fried Food Consumption and Cardiovascular Health: A Review of Current Evidence*. https://doi.org/10.3390/nu7105404

Garcez, M. R., de Castro, M. A., César, C. L. G., Goldbaum, M., & Fisberg, R. M. (2021). A chrononutrition perspective of diet quality and eating behaviors of Brazilian adolescents in associated with sleep duration. *Chronobiology International*, *00*(00), 1–13. https://doi.org/10.1080/07420528.2020.1851704

Ghimire, S. (2017). *Barriers to Diet and Exercise among Nepalese Type 2 Diabetic Patients*. https://doi.org/10.1155/2017/1273084

Gill, S., & Panda, S. (2015). A Smartphone App Reveals Erratic Diurnal Eating Patterns in Humans that Can Be Modulated for Health Benefits. *Cell Metabolism*, *22*(5), 789–798. https://doi.org/10.1016/j.cmet.2015.09.005

Gong, Q.-H., Li, S.-X., Wang, S.-J., & Li, · Hui. (2021). Dinner-to-bed time is independently associated with overweight/ obesity in Chinese school-aged children. *Eating and Weight Disorders - Studies on Anorexia, Bulimia and Obesity*, *1*, 3. https://doi.org/10.1007/s40519-021-01129-0

Gontijo, C. A., Cabral, B. B. M., Balieiro, L. C. T., Teixeira, G. P., Fahmy, W. M., Maia, Y. C. de P., & Crispim, C. A. (2019). Time-related eating patterns and chronotype are associated with diet quality in pregnant women. *Chronobiology International*, *36*(1), 75–84. https://doi.org/10.1080/07420528.2018.1518328

Guasch-Ferre, M., Becerra-Tomas, N., Ruiz-Canela, M., Corella, D., Schroder, H., Estruch, R., Ros, E., Aros, F., Gomez-Gracia, E., Fiol, M., Serra-Majem, L., Lapetra, J., Basora, J., Martin-Calvo, N., Portoles, O., Fito, M., Hu, F. B., Forga, L., & Salas-Salvado, J. (2017). Total and subtypes of dietary fat intake and risk of type 2 diabetes mellitus in the Prevencí on con Dieta Mediterŕanea (PREDIMED) study. *American Journal of Clinical Nutrition*, *105*(3), 723–735. https://doi.org/10.3945/ajcn.116.142034

Gupta, N. J. (2019). Lifestyle and Circadian Health: Where the Challenges Lie? *Nutrition and Metabolic Insights*, *12*, 117863881986902. https://doi.org/10.1177/1178638819869024

Hamasaki, H. (2016). Daily physical activity and type 2 diabetes: A review. *World Journal of Diabetes*, *7*(12), 243. https://doi.org/10.4239/wjd.v7.i12.243

Harris, M. L., Oldmeadow, C., Hure, A., Luu, J., Loxton, D., & Attia, J. (2017). *Stress increases the risk of type 2 diabetes onset in women: A 12-year longitudinal study using causal modelling*. https://doi.org/10.1371/journal.pone.0172126

Hashemipour, S., Yazdi, Z., & Mahabad, N. (2020). Association of Evening Chronotype with Poor Control of Type 2 Diabetes: Roles of Sleep Duration and Insomnia Level. *International Journal of Endocrinology and Metabolism*, *18*(3), 99701. https://doi.org/10.5812/ijem.99701

Hee Yu, J., Yun, C.-H., Hee Ahn, J., Suh, S., Joo Cho, H., Ku Lee, S., Jin Yoo, H., Seo, J. A., Gon Kim, S., Mook Choi, K., Hyun Baik, S., Seop Choi, D., Shin, C., Hee Kim, N., & Jhy, A. (2015). Evening Chronotype Is Associated With Metabolic Disorders and Body Composition in Middle-Aged Adults Division of Endocrinology and Metabolism (. *2015) Jcem.Endojournals.Org J Clin Endocrinol Metab*, *100*(4), 1494–1502. https://doi.org/10.1210/jc.2014-3754

Henry, C. J., Kaur, B., & Quek, R. Y. C. (2020). Chrononutrition in the management of diabetes. *Nutrition and Diabetes*, *10*(1). https://doi.org/10.1038/s41387-020-0109-6

Henson, J., Rowlands, A. V., Baldry, E., Brady, E. M., Davies, M. J., Edwardson, C. L., Yates, T., & Hall, A. P. (2020). Physical behaviors and chronotype in people with type 2 diabetes. *BMJ Open Diabetes Research and Care*, *8*(1), 1–8. https://doi.org/10.1136/bmjdrc-2020-001375

High Blood Cholesterol ATP III Guidelines At-A-Glance Quick Desk Reference. (n.d.).

Hirotsu, C., Tufik, S., & Andersen, M. L. (2015). Interactions between sleep, stress, and metabolism: From physiological to pathological conditions. *Sleep Science*, *8*(3), 143–152. https://doi.org/10.1016/j.slsci.2015.09.002

Hypertension Guideline Resources | American Heart Association. (n.d.). Retrieved April 22, 2021, from https://www.heart.org/en/health-topics/high-blood-pressure/high-blood-pressure-toolkit-resources

Ii, V. (2015). *NCO 2015_Vol II*. *II*.

Jain Gupta, N., Kumar, V., & Panda, S. (2017). *A camera-phone based study reveals erratic eating pattern and disrupted daily eating-fasting cycle among adults in India*. https://doi.org/10.1371/journal.pone.0172852

Jakubowicz, D., Barnea, M., Wainstein, J., & Froy, O. (2015). High Caloric intake at breakfast vs. dinner differentially influences weight loss of overweight and obese women. *Obesity*, *21*(12), 2504–2512. https://doi.org/10.1002/oby.20460

Johnston, J. D., Ordovás, J. M., Scheer, F. A., & Turek, F. W. (2016). Circadian rhythms, metabolism, and chrononutrition in rodents and humans. *Advances in Nutrition*, *7*(2), 399–406. https://doi.org/10.3945/an.115.010777

Joseph, J. J., & Golden, S. H. (2017). Cortisol dysregulation: the bidirectional link between stress, depression, and type 2 diabetes mellitus. *Annals of the New York Academy of Sciences*, *1391*(1), 20–34. https://doi.org/10.1111/nyas.13217

Jung, C. H., & Choi, K. M. (2017). Impact of high-carbohydrate diet on metabolic parameters in patients with type 2 diabetes. In *Nutrients* (Vol. 9, Issue 4, p. 322). MDPI AG. https://doi.org/10.3390/nu9040322

Karatzi, K., Moschonis, G., Choupi, E., Manios, Y., Manios, Y., Skenderi, K. P., Grammatikaki, E., Androutsos, O., Tanagra, S., Koumpitski, A., Siatitsa, P. E., Vandorou, A., Kyriakou, A. E., Dede, V., Kantilafti, M., Farmaki, A. E., Siopi, A., Micheli, S., Damianidi, L., … Daskalou, E. (2017). Late-night overeating is associated with smaller breakfast, breakfast skipping, and obesity in children: The Healthy Growth Study. *Nutrition*, *33*, 141–144. https://doi.org/10.1016/j.nut.2016.05.010

Karstoft, K., & Pedersen, B. K. (2016). Exercise and type 2 diabetes: Focus on metabolism and inflammation. In *Immunology and Cell Biology* (Vol. 94, Issue 2, pp. 146–150). Nature Publishing Group. https://doi.org/10.1038/icb.2015.101

Kelly, R. M., Healy, U., Sreenan, S., McDermott, J. H., & Coogan, A. N. (2018). Clocks in the clinic: Circadian rhythms in health and disease. *Postgraduate Medical Journal*, *94*(1117), 653–658. https://doi.org/10.1136/postgradmedj-2018-135719

Kessler, K., & Pivovarova-Ramich, O. (2019). Meal timing, aging, and metabolic health. *International Journal of Molecular Sciences*, *20*(8), 1–16. https://doi.org/10.3390/ijms20081911

Kim, T. W., Jeong, J. H., & Hong, S. C. (2015). The impact of sleep and circadian disturbance on hormones and metabolism. *International Journal of Endocrinology*, *2015*. https://doi.org/10.1155/2015/591729

Kinsey, A. W., & Ormsbee, M. J. (2015). The health impact of nighttime eating: Old and new perspectives. In *Nutrients* (Vol. 7, Issue 4, pp. 2648–2662). MDPI AG. https://doi.org/10.3390/nu7042648

Kodali, V. R. R. (2017). Melatonin: the sleeping hormone. *International Journal of Diabetes in Developing Countries*, *37*(1), 1–3. https://doi.org/10.1007/s13410-016-0542-1

Kwon, Y. J., Chung, T. H., Lee, H. S., Park, J. Y., Chung, J. Y., Lee, B. K., & Lee, J. W. (2019). Association between circadian preference and blood lipid levels using a 1:1:1 propensity score matching analysis. *Journal of Clinical Lipidology*, *13*(4), 645-653.e2. https://doi.org/10.1016/j.jacl.2019.04.007

Lee, C. Y., Chen, H. C., Meg Tseng, M. C., Lee, H. C., & Huang, L. H. (2015). The relationships among sleep quality and chronotype, emotional disturbance, and insomnia vulnerability in shift nurses. *Journal of Nursing Research*, *23*(3), 225–235. https://doi.org/10.1097/jnr.0000000000000095

Lee, D. Y., Kim, E., & Choi, M. H. (2015). Technical and clinical aspects of cortisol as a biochemical marker of chronic stress. *BMB Reports*, *48*(4), 209–216. https://doi.org/10.5483/BMBRep.2015.48.4.275

Lin, T. T., Park, C., Kapella, M. C., Martyn-Nemeth, P., Tussing-Humphreys, L., Rospenda, K. M., & Zenk, S. N. (2020). Shift work relationships with same-and subsequent-day empty calorie food and beverage consumption. *Scandinavian Journal of Work, Environment and Health*, *46*(6), 579–588. https://doi.org/10.5271/sjweh.3903

Lindqvist, A., Shcherbina, L., Prasad, R. B., Miskelly, M. G., Abels, M., Martínez-lopéz, J. A., Fred, R. G., Nergård, B. J., Hedenbro, J., Groop, L., Hjerling-le, J., & Wierup, N. (2020). *Molecular and Cellular Endocrinology Ghrelin suppresses insulin secretion in human islets and type 2 diabetes patients have diminished islet ghrelin cell number and lower plasma ghrelin levels*. *511*(February), 0–4. https://doi.org/10.1016/j.mce.2020.110835

Mainous, A. G., Tanner, R. J., Anton, S. D., Jo, A., & Luetke, M. C. (2017). Physical Activity and Abnormal Blood Glucose Among Healthy Weight Adults. *American Journal of Preventive Medicine*, *53*(1), 42–47. https://doi.org/10.1016/j.amepre.2016.11.027

Malik, V. S., Li, Y., Tobias, D. K., Pan, A., & Hu, F. B. (2016). Dietary Protein Intake and Risk of Type 2 Diabetes in US Men and Women. *American Journal of Epidemiology*, *183*(8), 715–728. https://doi.org/10.1093/aje/kwv268

Mani, B. K., Shankar, K., & Zigman, J. M. (2019). Ghrelin's Relationship to Blood Glucose. *Endocrinology*, *160*(5), 1243–1261. https://doi.org/10.1210/en.2019-00074

Mason, I. C., Qian, J., Adler, G. K., & Scheer, F. A. J. L. (2020). Impact of circadian disruption on glucose metabolism: implications for type 2 diabetes. *Diabetologia*, *63*(3), 462–472. https://doi.org/10.1007/s00125-019-05059-6

Maukonen, M., Kanerva, N., Partonen, T., Kronholm, E., Konttinen, H., Wennman, H., & Männistö, S. (2016). The associations between chronotype, a healthy diet and obesity. *Chronobiology International*, *33*(8), 972–981. https://doi.org/10.1080/07420528.2016.1183022

Maukonen, M., Kanerva, N., Partonen, T., Kronholm, E., Tapanainen, H., Kontto, J., & Männistö, S. (2017a). Chronotype differences in timing of energy and macronutrient intakes: A population-based study in adults. In *Obesity* (Vol. 25, Issue 3, pp. 608–615). https://doi.org/10.1002/oby.21747

Maukonen, M., Kanerva, N., Partonen, T., Kronholm, E., Tapanainen, H., Kontto, J., & Männistö, S. (2017b). Chronotype differences in timing of energy and macronutrient intakes: A population-based study in adults. *Obesity*, *25*(3), 608–615. https://doi.org/10.1002/oby.21747

Maukonen, M., Kanerva, N., Partonen, T., Kronholm, E., Tapanainen, H., Kontto, J., & Männistö, S. (2017c). Chronotype differences in timing of energy and macronutrient intakes: A population-based study in adults. *Obesity*, *25*(3), 608–615. https://doi.org/10.1002/oby.21747

Mazri, F. H., Manaf, Z. A., Shahar, S., & Ludin, A. F. M. (2020a). The association between chronotype and dietary pattern among adults: A scoping review. In *International Journal of Environmental Research and Public Health* (Vol. 17, Issue 1). https://doi.org/10.3390/ijerph17010068

Mazri, F. H., Manaf, Z. A., Shahar, S., & Ludin, A. F. M. (2020b). The association between chronotype and dietary pattern among adults: A scoping review. In *International Journal of Environmental Research and Public Health* (Vol. 17, Issue 1, p. 68). MDPI AG. https://doi.org/10.3390/ijerph17010068

McHill, A. W., Phillips, A. J. K., Czeisler, C. A., Keating, L., Yee, K., Barger, L. K., Garaulet, M., Scheer, F. A. J. L., & Klerman, E. B. (2017). Later circadian timing of food intake is associated with increased body fat. *American Journal of Clinical Nutrition*, *106*(5), 1213–1219. https://doi.org/10.3945/ajcn.117.161588

McMacken, M., & Shah, S. (2017). A plant-based diet for the prevention and treatment of type 2 diabetes. In *Journal of Geriatric Cardiology* (Vol. 14, Issue 5, pp. 342–354). Science Press. https://doi.org/10.11909/j.issn.1671-5411.2017.05.009

McMullan, C. J., Schernhammer, E. S., Rimm, E. B., Hu, F. B., & Forman, J. P. (2013). Melatonin secretion and the incidence of type 2 diabetes. *JAMA - Journal of the American Medical Association*, *309*(13), 1388–1396. https://doi.org/10.1001/jama.2013.2710

Melo, M. C. A., Garcia, R. F., de Araújo, C. F., Luz, J. H., de Bruin, P. F., & de Bruin, V. M. (2020). Chronotype in bipolar disorder: An 18-month prospective study. *Brazilian Journal of Psychiatry*, *42*(1), 68–71. https://doi.org/10.1590/1516-4446-2019-0489

Mirghani, H., Albalawi, S., Awaji, H., Alharbi, A., Alamrani, A., Alzahrani, S., Alghamdi, S., Albalawi, N., & Alghabban, S. (2020). Circadian misalignment effect on HbA1c among patients with diabetes. *International Journal of Medicine in Developing Countries*, *4*(December 2019), 700–705. https://doi.org/10.24911/ijmdc.51-1577741348

MODIFIED KUPPUSWAMY SCALE | PSM Made Easy. (n.d.). Retrieved April 22, 2021, from http://www.ihatepsm.com/blog/modified-kuppuswamy-scale

Mohan, V., Unnikrishnan, R., Shobana, S., Malavika, M., Anjana, R. M., & Sudha, V. (2018). Are excess carbohydrates the main link to diabetes & its complications in asians? In *Indian Journal of Medical Research* (Vol. 148, Issue 5, pp. 531–538). Wolters Kluwer Medknow Publications. https://doi.org/10.4103/ijmr.IJMR_1698_18

Mohawk, J. A., Green, C. B., & Takahashi, J. S. (2012). Central and peripheral circadian clocks in mammals. *Annual Review of Neuroscience*, *35*, 445–462. https://doi.org/10.1146/annurev-neuro-060909-153128

Mota, M. C., Waterhouse, J., De-Souza, D. A., Rossato, L. T., Silva, C. M., Araújo, M. B. J., Tufik, S., de Mello, M. T., & Crispim, C. A. (2016). Association between chronotype, food intake and physical activity in medical residents. *Chronobiology International*, *33*(6), 730–739. https://doi.org/10.3109/07420528.2016.1167711

Muley, A. (2015). Determinants of Vitamin D Status Among Adult Population and Type-II Diabetics of Vadodara City and Impact of Vitamin D Supplementation on Cardio-metabolic Profile of Type-II Diabetic Subjects. *PQDT - Global*, *October*, 321. https://www.proquest.com/docview/2325379527?accountid=8359%0Ahttp://ne4ke2fg4p.search.serialssolutions.com?ctx_ver=Z39.88-2004&ctx_enc=info:ofi/enc:UTF-8&rfr_id=info:sid/ProQuest+Dissertations+%26+Theses+Global&rft_val_fmt=info:ofi/fmt:kev:mtx:dissertatio

Muñoz, J. S. G., Cañavate, R., Hernández, C. M., Cara-Salmerón, V., & Morante, J. J. H. (2017a). The association among chronotype, timing of food intake and food preferences depends on body mass status. *European Journal of Clinical Nutrition*, *71*(6), 736–742. https://doi.org/10.1038/ejcn.2016.182

Muñoz, J. S. G., Cañavate, R., Hernández, C. M., Cara-Salmerón, V., & Morante, J. J. H. (2017b). The association among chronotype, timing of food intake and food preferences depends on body mass status. *European Journal of Clinical Nutrition*, *71*(6), 736–742. https://doi.org/10.1038/ejcn.2016.182

Muscogiuri, G., Barrea, L., Aprano, S., Framondi, L., Di Matteo, R., Altieri, B., Laudisio, D., Pugliese, G., Savastano, S., & Colao, A. (2021). Chronotype and cardio metabolic health in obesity: does nutrition matter? *International Journal of Food Sciences and Nutrition*. https://doi.org/10.1080/09637486.2021.1885017

Nakajima, K., & Suwa, K. (2015). Association of hyperglycemia in a general Japanese population with late-night-dinner eating alone, but not breakfast skipping alone. In *Journal of Diabetes and Metabolic Disorders* (Vol. 14, Issue 1, pp. 1–5). BioMed Central Ltd. https://doi.org/10.1186/s40200-015-0147-0

Ng, T. H., Chung, K. F., Lee, C. T., Yeung, W. F., & Ho, F. Y. Y. (2016). Eveningness and Its Associated Impairments in Remitted Bipolar Disorder. *Behavioral Sleep Medicine*, *14*(6), 650–664. https://doi.org/10.1080/15402002.2015.1065407

Nimitphong, H., Siwasaranond, N., Saetung, S., Thakkinstian, A., Ongphiphadhanakul, B., & Reutrakul, S. (2018). The relationship among breakfast time, morningness–eveningness preference and body mass index in Type 2 diabetes. *Diabetic Medicine*, *35*(7), 964–971. https://doi.org/10.1111/dme.13642

Noble, H., & Smith, J. (2015). untitled _ Enhanced Reader.pdf. In *Clinical Infectious Diseases*.

Oda, H. (2015). Chrononutrition. *Journal of Nutritional Science and Vitaminology*, *61*, S92–S94. https://doi.org/10.3177/jnsv.61.S92

Oike, H., Oishi, K., & Kobori, M. (2014). Nutrients, Clock Genes, and Chrononutrition. *Current Nutrition Reports*, *3*(3), 204–212. https://doi.org/10.1007/s13668-014-0082-6

Omron. (n.d.). *Omron health care*. 5–6.

Ortiz, R., Kluwe, B., Odei, J. B., Echouffo Tcheugui, J. B., Sims, M., Kalyani, R. R., Bertoni, A. G., Golden, S. H., & Joseph, J. J. (2019). The association of morning serum cortisol with glucose metabolism and diabetes: The Jackson Heart Study. *Psychoneuroendocrinology*, *103*, 25–32. https://doi.org/10.1016/j.psyneuen.2018.12.237

Oseguera-Castro, K. Y., Madrid, J. A., Martínez Madrid, M. J., García, O. P., Del Castillo, M. D., & Campos-Vega, R. (2019). Antioxidant dietary fiber isolated from spent coffee (Coffea arabica L.) grounds improves chronotype and circadian locomotor activity in young adults. *Food and Function*, *10*(8), 4546–4556. https://doi.org/10.1039/c9fo01021a

Paoli, A., Tinsley, G., Bianco, A., & Moro, T. (2019). The influence of meal frequency and timing on health in humans: The role of fasting. *Nutrients*, *11*(4), 1–19. https://doi.org/10.3390/nu11040719

Park, k. (2015). *Textbook of Preventive and social medicine* (twenty thi).

Parr, E. B., Heilbronn, L. K., & Hawley, J. A. (2020). A Time to Eat and a Time to Exercise. *Exercise and Sport Sciences Reviews*, *48*(1), 4–10. https://doi.org/10.1249/JES.0000000000000207

Patterson, F., Malone, S. K., Lozano, A., Grandner, M. A., & Hanlon, A. L. (2016). Smoking, Screen-Based Sedentary Behavior, and Diet Associated with Habitual Sleep Duration and Chronotype: Data from the UK Biobank. *Annals of Behavioral Medicine*, *50*(5), 715–726. https://doi.org/10.1007/s12160-016-9797-5

Peschke, E., Bähr, I., & Mühlbauer, E. (2015). Experimental and clinical aspects of melatonin and clock genes in diabetes. *Journal of Pineal Research*, *59*(1), 1–23. https://doi.org/10.1111/jpi.12240

Poher, A., Tschöp, M. H., & Müller, T. D. (2018). Peptides Ghrelin regulation of glucose metabolism. *Peptides*, *100*(December 2017), 236–242. https://doi.org/10.1016/j.peptides.2017.12.015

Pot, G. K. (2018). Sleep and dietary habits in the urban environment: The role of chrono-nutrition. *Proceedings of the Nutrition Society*, *77*(3), 189–198. https://doi.org/10.1017/S0029665117003974

Prior, N. (2020). North Dakota State University. *Graduate Study in Criminology and Criminal Justice*, *December*, 212–213. https://doi.org/10.4324/9781315721606-101

Qaid, M. M., & Abdelrahman, M. M. (2016). Role of insulin and other related hormones in energy metabolism���A review. *Cogent Food & Agriculture*, *2*(1). https://doi.org/10.1080/23311932.2016.1267691

Qin, P., Liu, D., Wu, X., Zeng, Y., Sun, X., Zhang, Y., Li, Y., Wu, Y., Han, M., Qie, R., Huang, S., Zhao, Y., Feng, Y., Yang, X., Liu, Y., Li, H., Zhang, M., Hu, D., & Hu, F. (2021). *Fried-food consumption and risk of overweight/ obesity, type 2 diabetes mellitus, and hypertension in adults: a meta-analysis of observational studies Fried-food consumption and risk of overweight/obesity, type 2 diabetes mellitus, and hypertension in adu*. https://doi.org/10.1080/10408398.2021.1906626

Ramos-Lobo, A. M., & Donato, J. (2017). The role of leptin in health and disease. In *Temperature* (Vol. 4, Issue 3, pp. 258–291). https://doi.org/10.1080/23328940.2017.1327003

Randjelovic, P., Stojiljkovic, N., Radulovic, N., Stojanovic, N., & Ilic, I. (2021). Problematic Smartphone Use, Screen Time and Chronotype Correlations in University Students. *European Addiction Research*, *27*(1), 67–74. https://doi.org/10.1159/000506738

Randler, C., Jankowski, K. S., Rahafar, A., & Díaz-Morales, J. F. (2016). Sociosexuality, Morningness–Eveningness, and Sleep Duration: *Https://Doi.Org/10.1177/2158244015621958*. https://doi.org/10.1177/2158244015621958

Réda, A., Wassil, M., Mériem, M., Alexia, P., Abdelmalik, H., Sabine, B., & Nassir, M. (2020). Food timing, circadian rhythm and chrononutrition: A systematic review of time-restricted eating's effects on human health. *Nutrients*, *12*(12), 1–15. https://doi.org/10.3390/nu12123770

Sakai, R., Hashimoto, Y., Ushigome, E., Miki, A., Okamura, T., Matsugasumi, M., Fukuda, T., Majima, S., Matsumoto, S., Senmaru, T., Hamaguchi, M., Tanaka, M., Asano, M., Yamazaki, M., Oda, Y., & Fukui, M. (2018). Late-night-dinner is associated with poor glycemic control in people with type 2 diabetes: The KAMOGAWA-DM cohort study. *Endocrine Journal*, *65*(4), 395–402. https://doi.org/10.1507/endocrj.EJ17-0414

Sami, W., Ansari, T., Butt, N. S., & Hamid, M. R. A. (2017). Effect of diet on type 2 diabetes mellitus: A review. *International Journal of Health Sciences*, *11*(2), 65–71. http://www.ncbi.nlm.nih.gov/pubmed/28539866

Sendhilkumar, M., Tripathy, J., Harries, A., Dongre, A., Deepa, M., Vidyulatha, A., Poongothai, S., Venkatesan, U., Anjana, R., & Mohan, V. (2017). Factors associated with high stress levels in adults with diabetes mellitus attending a tertiary diabetes care center, Chennai, Tamil Nadu, India. *Indian Journal of Endocrinology and Metabolism*, *21*(1), 56–63. https://doi.org/10.4103/2230-8210.196006

Serin, Y., & Acar Tek, N. (2019). Effect of Circadian Rhythm on Metabolic Processes and the Regulation of Energy Balance. *Annals of Nutrition and Metabolism*, *74*(4), 322–330. https://doi.org/10.1159/000500071

Sharma, K., Shah, K., Brahmbhatt, P., & Kandre, Y. (2018). Skipping breakfast and the risk of coronary artery disease. *QJM*, *111*(10), 715–719. https://doi.org/10.1093/qjmed/hcy162

Sharma, S., Singh, H., Ahmad, N., Mishra, P., & Tiwari, A. (2015a). The role of melatonin in diabetes: Therapeutic implications. *Archives of Endocrinology and Metabolism*, *59*(5), 391–399. https://doi.org/10.1590/2359-3997000000098

Sharma, S., Singh, H., Ahmad, N., Mishra, P., & Tiwari, A. (2015b). The role of melatonin in diabetes: therapeutic implications. *Archives of Endocrinology and Metabolism*, *59*(5), 391–399. https://doi.org/10.1590/2359-3997000000098

Shimura, A., Sugiura, K., Inoue, M., Misaki, S., Tanimoto, Y., Oshima, A., Tanaka, T., Yokoi, K., & Inoue, T. (2020). Which sleep hygiene factors are important? comprehensive assessment of lifestyle habits and job environment on sleep among office workers. *Sleep Health*, *6*(3), 288–298. https://doi.org/10.1016/j.sleh.2020.02.001

Silva, C. M., Mota, M. C., Miranda, M. T., Paim, S. L., Waterhouse, J., & Crispim, C. A. (2016a). Chronotype, social jetlag and sleep debt are associated with dietary intake among Brazilian undergraduate students. *Chronobiology International*, *33*(6), 740–748. https://doi.org/10.3109/07420528.2016.1167712

Silva, C. M., Mota, M. C., Miranda, M. T., Paim, S. L., Waterhouse, J., & Crispim, C. A. (2016b). Chronotype, social jetlag and sleep debt are associated with dietary intake among Brazilian undergraduate students. *Chronobiology International*, *33*(6), 740–748. https://doi.org/10.3109/07420528.2016.1167712

Sista, R. V, & Railla, V. (2020). *Questionnaire Based Study : Changes in Dietary Habits and Sleep Pattern Before and During Covid-19 Lockdown Period (Indian Scenario)*. *9*(36), 1058–1062. https://doi.org/10.37273/chesci.CS2051101002v

Sluik, D., Brouwer-Brolsma, E. M., Berendsen, A. A. M., Mikkilä, V., Poppitt, S. D., Silvestre, M. P., Tremblay, A., Pérusse, L., Bouchard, C., Raben, A., & Feskens, E. J. M. (2019). Protein intake and the incidence of pre-diabetes and diabetes in 4 population-based studies: The PREVIEW project. In *American Journal of Clinical Nutrition* (Vol. 109, Issue 5, pp. 1310–1318). Oxford University Press. https://doi.org/10.1093/ajcn/nqy388

So-Ngern, A., Chirakalwasan, N., Saetung, S., Chanprasertyothin, S., Thakkinstian, A., & Reutrakul, S. (2019). Effects of two-week sleep extension on glucose metabolism in chronically sleep-deprived individuals. In *Journal of Clinical Sleep Medicine* (Vol. 15, Issue 5, pp. 711–718). https://doi.org/10.5664/jcsm.7758

Suh, S., Yang, H. C., Kim, N., Yu, J. H., Choi, S., Yun, C. H., & Shin, C. (2017a). Chronotype Differences in Health Behaviors and Health-Related Quality of Life: A Population-Based Study Among Aged and Older Adults. *Behavioral Sleep Medicine*, *15*(5), 361–376. https://doi.org/10.1080/15402002.2016.1141768

Suh, S., Yang, H. C., Kim, N., Yu, J. H., Choi, S., Yun, C. H., & Shin, C. (2017b). Chronotype Differences in Health Behaviors and Health-Related Quality of Life: A Population-Based Study Among Aged and Older Adults. *Behavioral Sleep Medicine*, *15*(5), 361–376. https://doi.org/10.1080/15402002.2016.1141768

Tandon, N., Anjana, R. M., Mohan, V., Kaur, T., Afshin, A., Ong, K., Mukhopadhyay, S., Thomas, N., Bhatia, E., Krishnan, A., Mathur, P., Dhaliwal, R. S., Shukla, D. K., Bhansali, A., Prabhakaran, D., Rao, P. V., Yajnik, C. S., Kumar, G. A., Varghese, C. M., … Dandona, L. (2018). The increasing burden of diabetes and variations among the states of India: the Global Burden of Disease Study 1990–2016. *The Lancet Global Health*, *6*(12), e1352–e1362. https://doi.org/10.1016/S2214-109X(18)30387-5

Teixeira, G. P., Mota, M. C., & Crispim, C. A. (2018). Eveningness is associated with skipping breakfast and poor nutritional intake in Brazilian undergraduate students. *Chronobiology International*, *35*(3), 358–367. https://doi.org/10.1080/07420528.2017.1407778

Teo, S. Y. M., Kanaley, J. A., Guelfi, K. J., Cook, S. B., Hebert, J. J., Forrest, M. R. L., & Fairchild, T. J. (2018). Exercise timing in type 2 diabetes mellitus: A systematic review. *Medicine and Science in Sports and Exercise*, *50*(12), 2387–2397. https://doi.org/10.1249/MSS.0000000000001732

Thomas, J. M., Kern, P. A., Bush, H. M., McQuerry, K. J., Black, W. S., Clasey, J. L., & Pendergast, J. S. (2020). Circadian rhythm phase shifts caused by timed exercise vary with chronotype. *JCI Insight*, *5*(3), 12–14. https://doi.org/10.1172/jci.insight.134270

Toktaş, N., Alparslan Erman, K., & Mert, Z. (2018). Nutritional Habits According to Human Chronotype and Nutritional Status of Morningness and Eveningness. *Journal of Education and Training Studies*, *6*(3a). https://doi.org/10.11114/jets.v6i3a.3159

Toktaş, N., Erman, K. A., & Mert, Z. (2018). Nutritional Habits According to Human Chronotype and Nutritional Status of Morningness and Eveningness. *Journal of Education and Training Studies*, *6*(3a), 61. https://doi.org/10.11114/jets.v6i3a.3159

Tonon, A. C., Carissimi, A., Schimitt, R. L., de Lima, L. S., Pereira, F. D. S., & Hidalgo, M. P. (2020). How do stress, sleep quality, and chronotype associate with clinically significant depressive symptoms? A study of young male military recruits in compulsory service. *Brazilian Journal of Psychiatry*, *42*(1), 54–62. https://doi.org/10.1590/1516-4446-2018-0286

Toyoura, M., Miike, T., Tajima, S., Matsuzawa, S., & Konishi, Y. (2020). Inadequate sleep as a contributor to impaired glucose tolerance: A cross-sectional study in children, adolescents, and young adults with circadian rhythm sleep-wake disorder. *Pediatric Diabetes*, *21*(4), 557–564. https://doi.org/10.1111/pedi.13003

Uemura, M., Yatsuya, H., Hilawe, E. H., Li, Y., Wang, C., Chiang, C., Otsuka, R., Toyoshima, H., Tamakoshi, K., & Aoyama, A. (2015). Breakfast skipping is positively associated with incidence of type 2 diabetes mellitus: Evidence from the Aichi Workers' Cohort Study. *Journal of Epidemiology*, *25*(5), 351–358. https://doi.org/10.2188/jea.JE20140109

van der Ploeg, H. P., Chey, T., Korda, R. J., Banks, E., & Bauman, A. (n.d.). *Sitting Time and All-Cause Mortality Risk in 222 497 Australian Adults*. Retrieved April 22, 2021, from https://jamanetwork.com/

Verd, S., Beiro, S., Fernandez-Bernabeu, M., & Ponce-Taylor, J. (2020). *Chronobiology International Early dinner or "dinner like a pauper": Evidence, the habitual time of the largest meal of the day-dinner-is predisposing to severe COVID-19 outcome-death Early dinner or "dinner like a pauper": Evidence, the habitual time of the largest meal of the day-dinner-is predisposing to severe COVID-19 outcome-death*. https://doi.org/10.1080/07420528.2020.1772810

Watson, N. F., Badr, M. S., Belenky, G., Bliwise, D. L., Buxton, O. M., Buysse, D., Dinges, D. F., Gangwisch, J., Grandner, M. A., Kushida, C., Malhotra, R. K., Martin, J. L., Patel, S. R., Quan, S. F., Tasali, E., Twery, M., Croft, J. B., Maher, E., Barrett, J. A., … Heald, J. L. (2015). Joint Consensus Statement of the American Academy of Sleep Medicine and Sleep Research Society on the Recommended Amount of Sleep for a Healthy Adult: Methodology and Discussion. *Journal of Clinical Sleep Medicine*, *11*(8), 931–952. https://doi.org/10.5664/jcsm.4950

Weickert, M. O., & Pfeiffer, A. F. H. (2018). Impact of dietary fiber consumption on insulin resistance and the prevention of type 2 diabetes. *Journal of Nutrition*, *148*(1), 7–12. https://doi.org/10.1093/jn/nxx008

Wennman, H., Kronholm, E., Partonen, T., Peltonen, M., Vasankari, T., & Borodulin, K. (2015a). Evening typology and morning tiredness associates with low leisure time physical activity and high sitting. *Chronobiology International*, *32*(8), 1090–1100. https://doi.org/10.3109/07420528.2015.1063061

Wennman, H., Kronholm, E., Partonen, T., Peltonen, M., Vasankari, T., & Borodulin, K. (2015b). Evening typology and morning tiredness associates with low leisure time physical activity and high sitting. *Chronobiology International*, *32*(8), 1090–1100. https://doi.org/10.3109/07420528.2015.1063061

Western Pacific Region Index Medicus. (2016). http://wprim.whocc.org.cn/admin/article/articleDetail?WPRIMID=662452&articleId=662452

Wilkinson, M. J., Manoogian, E. N. C., Zadourian, A., Lo, H., Fakhouri, S., Shoghi, A., Wang, X., Fleischer, J. G., Navlakha, S., Panda, S., & Taub, P. R. (2020). Ten-Hour Time-Restricted Eating Reduces Weight, Blood Pressure, and Atherogenic Lipids in Patients with Metabolic Syndrome. *Cell Metabolism*, *31*(1), 92-104.e5. https://doi.org/10.1016/j.cmet.2019.11.004

World Health Organization. (2015). Progress Monitor 2015. *Noncommunicable Diseases*, 2–236.

Wright, K. P., Drake, A. L., Frey, D. J., Fleshner, M., Desouza, C. A., Gronfier, C., & Czeisler, C. A. (2015). Influence of sleep deprivation and circadian misalignment on cortisol, inflammatory markers, and cytokine balance. *Brain, Behavior, and Immunity*, *47*(September 2018), 24–34. https://doi.org/10.1016/j.bbi.2015.01.004

Wright, K. P. J., Drake, A. L., Frey, D. J., Fleshner, M., Desouza, C. A., Gronfier, C., & Czeisler, C. A. (2015). Influence of sleep deprivation and circadian misalignment on cortisol, inflammatory markers, and cytokine balance. *Brain, Behavior, and Immunity*, *47*, 24–34. https://doi.org/10.1016/j.bbi.2015.01.004

Yoshizaki, T., Komatsu, T., Tada, Y., Hida, A., Kawano, Y., & Togo, F. (2018). Association of habitual dietary intake with morningness-eveningness and rotating shift work in Japanese female nurses. *Chronobiology International*, *35*(3), 392–404. https://doi.org/10.1080/07420528.2017.1410169

Yoshizaki, T., & Togo, F. (2021). Objectively measured chronotype and social jetlag are associated with habitual dietary intake in undergraduate students. *Nutrition Research*. https://doi.org/10.1016/j.nutres.2021.04.003

Yu, B. Y. M., Yeung, W. F., Ho, Y. S., Ho, F. Y. Y., Chung, K. F., Lee, R. L. T., Lam, M. Y., & Chen, S. (2020). Associations between the chronotypes and eating habits of Hong Kong school-aged children. *International Journal of Environmental Research and Public Health*, *17*(7). https://doi.org/10.3390/ijerph17072583

Yu, J. H., Yun, C. H., Ahn, J. H., Suh, S., Cho, H. J., Lee, S. K., Yoo, H. J., Seo, J. A., Kim, S. G., Choi, K. M., Baik, S. H., Choi, D. S., Shin, C., & Kim, N. H. (2015). Evening chronotype is associated with metabolic disorders and body composition in middle-aged adults. *Journal of Clinical Endocrinology and Metabolism*, *100*(4), 1494–1502. https://doi.org/10.1210/jc.2014-3754

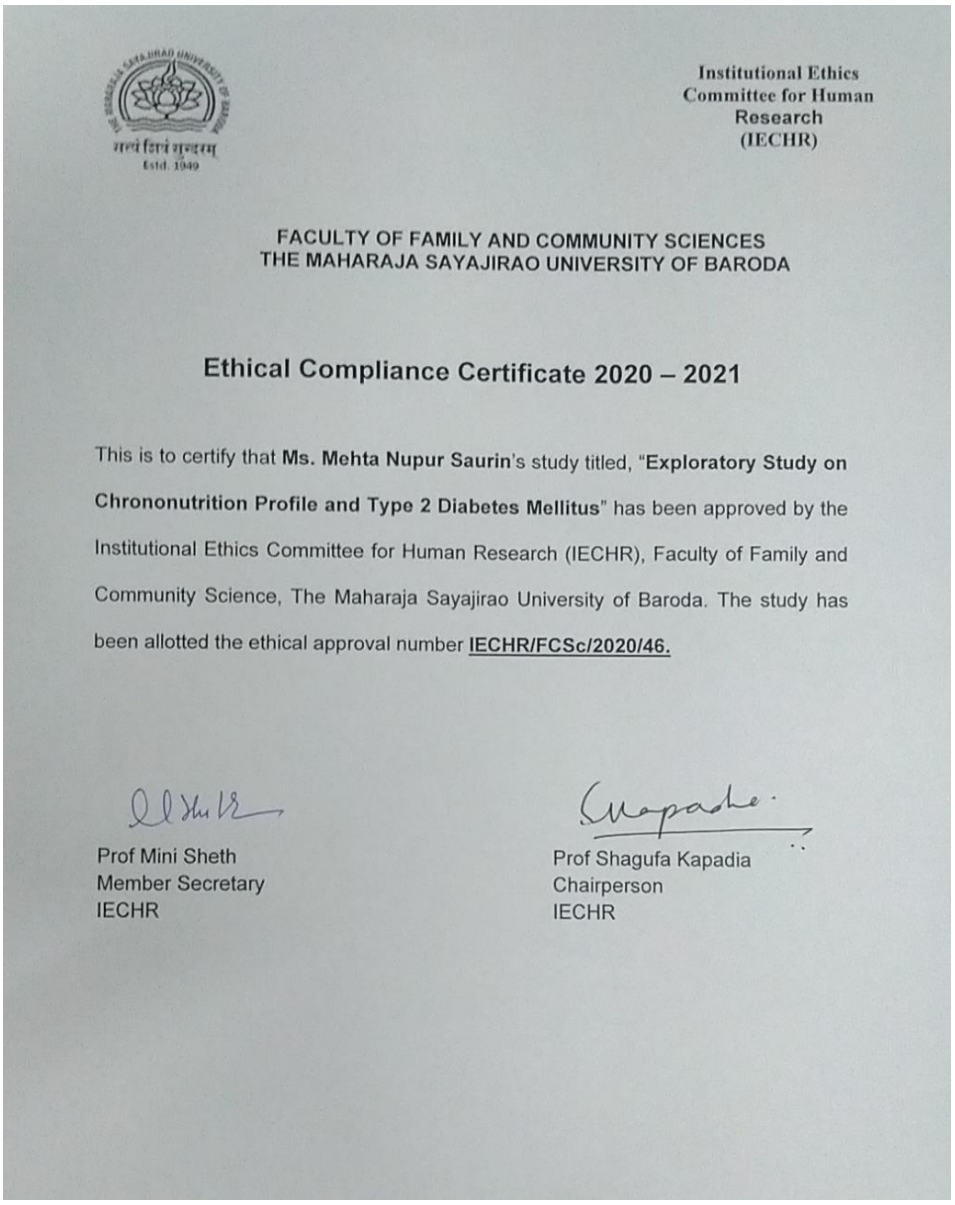
Zheng, Y., Ley, S. H., & Hu, F. B. (2018). Global aetiology and epidemiology of type 2 diabetes mellitus and its complications. *Nature Reviews. Endocrinology*, *14*(2), 88–98. https://doi.org/10.1038/nrendo.2017.151

Zisapel, N. (2018). New perspectives on the role of melatonin in human sleep, circadian rhythms and their regulation. In *British Journal of Pharmacology* (Vol. 175, Issue 16, pp. 3190–3199). https://doi.org/10.1111/bph.14116

ANNEXURES

Annexure I

Ethical Approval Certificate



Institutional Ethics Committee for Human Research (IECHR)

FACULTY OF FAMILY AND COMMUNITY SCIENCES
THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA

Ethical Compliance Certificate 2020 – 2021

This is to certify that **Ms. Mehta Nupur Saurin**'s study titled, "**Exploratory Study on Chrononutrition Profile and Type 2 Diabetes Mellitus**" has been approved by the Institutional Ethics Committee for Human Research (IECHR), Faculty of Family and Community Science, The Maharaja Sayajirao University of Baroda. The study has been allotted the ethical approval number **IECHR/FCSc/2020/46.**

Prof Mini Sheth
Member Secretary
IECHR

Prof Shagufa Kapadia
Chairperson
IECHR

Annexure II

Consent Form (English)

This informed consent form is for People with Diabetes from Vadodara who we are inviting to participate in research, titled 'EXPLORATORY STUDY ON CHRONONUTRITION STATUS and TYPE 2 DIABETES MELLITUS'.

Introduction:

I, Nupur Mehta, am pursuing M.Sc. from Department of Foods and Nutrition of The Maharaja Sayajirao University Baroda. My research Project is titled 'EXPLORATORY STUDY ON CHRONONUTRITION STATUS and TYPE 2 DIABETES MELLITUS'. Over 77 million have now been diagnosed with diabetes in India. There are 729 diabetic individuals among a lakh population in Gujarat. I am going to give you information and invite you to be part of this research. Before you decide, you can talk to anyone you feel comfortable with about the research.

This consent form may contain words that you may not understand. Please ask me to stop as we go through the information and I will take time to explain. If you have questions later, you can ask me again.

Purpose of the research:

Diabetes is highly prevalent in India. We want to find the correlation of Type 2 Diabetes Mellitus with Chrono nutrition of an individual. We believe that you can help us by telling us about your diet patterns, sleep pattern, activity pattern and about health practices in general.

Type of Research Intervention:

This research will involve questionnaire which you will have to fill and will take half an hour to One hour.

We will need the following information from you:

1. Diet Information

2. Physical Activity data

3. Screen Time data

4. Data regarding Stress

5. Data related to Sleep

{Using questionnaire and interview method}

6.Anthropometric data (Height, Weight, Waist Measurement, Hip measurement)

7.Biological Parameters

{From your case file}

Participant Selection:

You are being selected to take part in this research because we want to understand the association of Chronotype and Diabetes Mellitus.

Voluntary Participation:

Your participation in this research is entirely voluntary. It is your choice whether to participate or not.

Procedures:

You need to fill out a questionnaire which will be provided and collected by Nupur Mehta. You may answer the questionnaire yourself, or it can be read to you and you can say out loud the answer if you want me to write down.

If you do not wish to answer any of the questions included in the survey, you may skip them and move on to the next question. The information recorded will be confidential, your name will not be included on the forms, only a number will identify you, and no one else except research team will have access to your information.

Duration/Frequency:

We will need to meet twice during the entire course of research project for data collection.

Risks:

There is no perceived risk involved.

Benefits:

There will be no direct benefit to you, but your participation is likely to contribute toward better understanding.

Reimbursements:

You will not be provided any incentive to take part in the research.

Confidentiality:

We will not be sharing information about you to anyone outside of the research team. The information that we collect from this research project will be kept private. It will not be shared with or given to anyone except the Investigator, Research guide and Consultant Doctor.

Sharing the Results:

At the end of the study the relevant information will be shared with you.

Right to Refuse or Withdraw:

You do not have to take part in this research if you do not wish to do so. You may also stop participating in the research at any time even if you agreed earlier.

Whom to Contact:

If you have any questions, you can ask them now or later. If you wish to ask questions later, you may contact any of the following: Nupur Mehta (+91 9825763689; nupurm2598@gmail.com) and Dr. Suneeta Chandorkar (+91 9426366666; suneetachandorkar@gmail.com)

Certificate of Consent

I have been invited to participate in research about Chronotype and type 2 Diabetes.
I have read the foregoing information, or it has been read to me. I have had the opportunity to ask questions about it and any questions I have asked have been answered to my satisfaction. I consent voluntarily to be a participant in this study.

Name of Participant_____

Signature of Participant _____

Date _____

Statement by the researcher/person taking consent

I have accurately read out the information sheet to the potential participant, and to the best of my ability made sure that the participant understands that the following will be done:

1. Anthropometric data Collection

2. Biological Parameters

3. Diet Information

4. Physical Activity data

5. Screen Time data

6. Stress data collection

7. Sleep data collection

I confirm that the participant was given an opportunity to ask questions about the study, and all the questions asked by the participant have been answered correctly and to the best of my ability. I confirm that the individual has not been coerced into giving consent, and the consent has been given freely and voluntarily.

A copy of this ICF has been provided to the participant.

Name of Researcher/person taking the consent_____

Signature of Researcher /person taking the consent_____

Date _____

Annexure III

Consent Form (Gujarati)

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Annexure IV

QUESTIONNAIRE for "EXPLORATORY STUDY ON CHRONONUTRITION STATUS and TYPE 2 DIABETES MELLITUS"

PERSONAL INFORMATION:

1) Name:

2) Age:

3) Sex:

4) Educational Qualification:

5) Occupation:

Occupational Categories:	**Tick here**
Business owner/ self employed	
Professionals	
Government / Civil service	
Manager/ Supervisor	
Clerks	
Sales / Service workers	
Agriculture and fishery worker	
Home-maker	
Retired	

6)Type of family:1) Nuclear family ☐ 2) Extended family ☐ 3) Joint Family ☐

7) E-mail:

8) Contact no.

DIET INFORMATION:

9)You are:1) Vegan ☐ 2) Lacto-Vegetarian ☐ 3) Lacto-Ovo Vegetarian ☐
4) Non-vegetarian ☐

10)How many glasses of water do you drink daily? (200ml):

< 6 glasses 6-8 glasses ☐ >8 glasses ☐

11)Which meal do you generally skip? _____

12)Which is the most important meal of day? _____

13)How often do you consume a drink containing alcohol?

1)Daily ☐ 2) 3-5 times/week ☐ 3) Once a Week ☐

4) Monthly or less ☐ 5) Occasionally ☐ 6) Never ☐

14)What type of Alcoholic Beverage do you consume?

1) Beer ☐ 2) Whiskey ☐ 3) Vodka ☐ 4) Rum ☐ 5) Tequila ☐

6) Wine ☐ 7) Gin ☐

15)How many pegs/pints containing alcohol do you have on a typical day when you are drinking?

1) 1 or 2 ☐ 2) 3 or 4 ☐ 3) 5 or 6 ☐ 4) 7 or 9 ☐ 5) 10 or more ☐

16)FREQUENCY OF CONSUMPTION OF READY TO EAT FOODS:

Name of the food items	***Daily (1)***	***2-3 Times a week (2)***	***Weekly (3)***	***Fortnightly (4)***	***Monthly (5)***	***Occasionally (6)***	***Seasonal (7)***	***Never (8)***
(a)CHIPS								
(b) FRYUMS								
(c) BISCUITS								
(d) NAMKEENS								
(e) SAMOSA								
(f) KACHORI								

(g) VADAPAV								
(h)DABELI								
(i)SEVUSAL								
(j)SANDWICHES								
(k)BURGERS/HOTDOG								
(l)PIZZA								
(m)FRENCHFRIES								
(n)FRANKIE								
(o)CHINESE FOOD								
(p)KHICHU								
(q)BHAJIYA								
(r)DHOKLA/IDLI								
(s)DOSA/UTTAPAM								
(t)PANI-PURI/ SEV PURI								
(u)CHORAFALI/ CHANAJOR GARAM								
(v)SWEETS								
(w)MILKSHAKES								
(x)COLD DRINKS								
(y)ENERGY DRINKS								
(z) OTHERS (name)								

17) Have you ever consulted a dietician? Yes ☐ No ☐

18) Where have you consulted your dietician?

Online ☐ Dietitian's Private Clinic ☐ Diabetes Clinic ☐

19) Morning ness – Evening ness:

19.1) What time would you get up if you were entirely free to plan your day?	
Time	

1)5:00 – 6:29 am	
2)6:30 – 7:44 am	
3)7:45 – 9:44 am	
4)9:45 – 10:59 am	
5)11:00 – 11:59 am	
19.2) What time would you go to bed if you were entirely free to plan your evening?	
1)8:00 – 8:59 pm	
2)9:00 – 10:14 pm	
3)10:15 pm – 12:29 am	
4)12:30 – 1:44 am	
5)1:45 – 2:59 am	
6)3:00 am – 8:00 pm	
19.3) If there is a specific time at which you have to get up in the morning, to what extent do you depend on being woken up by an alarm clock?	
1)Not at all dependent	
2)Slightly dependent	
3)Fairly dependent	
4)Very dependent	

19.4) How easy do you find to get up in the morning (when you are not woken up unexpectedly)?	
1)Not at all easy	
2)Not very easy	
3)Fairly easy	
4)Very easy	
19.5) How alert do you feel during the first half hour after you wake up in the morning?	
1)Not at all alert	
2)Slightly alert	
3)Fairly alert	

4)Very alert	
19.6) How hungry do you feel during the first half-hour after you wake up in the morning?	
1)Not at all hungry	
2)Slightly hungry	
3)Fairly hungry	
4)Very hungry	
19.7) During the first half-hour after you wake up in the morning, how tired do you feel?	
1)Very tired	
2)Fairly tired	
3)Fairly refreshed	
4)Very refreshed	
19.8) If you have no commitment the next day, what time would you go to bed compared to your usual bedtime?	
1)Seldom or never later	
2)Less than one hour later	
3)1-2 hours later	
4)More than two hours later	
19.9) You have decided to engage in some physical exercise. A friend suggests that you do this for one hour twice a week and the best time for him/her is between 7:00 – 8:00 am. Bearing in mind nothing but your own internal "clock", how do you think you would perform?	
1)Would be in good form	
2)Would be in reasonable form	
3)Would find it difficult	
4)Would find it very difficult	
19.10) At what time of day do you feel you become tired as a result of need for sleep?	
1)8:00 – 8:59 pm	
2)9:00 – 10:14 pm	
3)10:15 pm – 12:44 am	

4)12:45 – 1:59 am	
5)2:00 – 3:00 am	
19.11) You want to be at your peak performance for a test that you know is going to be mentally exhausting and will last for two hours. You are entirely free to plan your day. Considering only your own internal "clock", which ONE of the four testing times would you choose?	
1)8:00 – 10:00 am	
2)11:00 am – 1:00 pm	
3)3:00 – 5:00 pm	
4)7:00 – 9:00 pm	
19.12) If you got into bed at 11:00 pm, how tired would you be?	
1)Not at all tired	
2)A little tired	
3)Fairly tired	
4)Very tired	

19.13) For some reason, you have gone to bed several hours later than usual, but there is no need to get up at any particular time the next morning. Which ONE of the following are you most likely to do?	
1)Will wake up at usual time, but will NOT fall back asleep	
2)Will wake up at usual time and will doze thereafter	
3)Will wake up at usual time but will fall asleep again	
4)Will NOT wake up until later than usual	
19.14) One night you have to remain awake between 4:00 – 6:00 am in order to carry out a night watch. You have no commitments the next day. Which ONE of the alternatives will suite you best?	
1)Would NOT go to bed until watch was over	
2)Would take a nap before and sleep after	
3)Would take a good sleep before and nap after	
4)Would sleep only before watch	

19.15) You have to do two hours of hard physical work. You are entirely free to plan your day and considering only your own internal "clock" which ONE of the following times would you choose?	
1)8:00 – 10:00 am	
2)11:00 am – 1:00 pm	
3)3:00 – 5:00 pm	
4)7:00 – 9:00 pm	
19.16) You have decided to engage in hard physical exercise. A friend suggests that you do this for one hour twice a week and the best time for him/her is between 10:00 – 11:00 pm. Bearing in mind nothing else but your own internal "clock", how well do you think you would perform?	
1)Would be in good form	
2)Would be in reasonable form	
3)Would find it difficult	
4)Would find it very difficult	

19.17) Suppose that you can choose your school hours. Assume that you went to school for five hours per day and that school was interesting and enjoyable. Which five consecutive hours would you select?	
1)5 hours starting between 4:00 – 7:59 am	
2)5 hours starting between 8:00 – 8:59 am	
3)5 hours starting between 9:00 am – 1:59 pm	
4)5 hours starting between 2:00 – 4:59 pm	
5)5 hours starting between 5:00 pm – 3:59 am	
19.18) At what time of the day do you think that you reach your "feeling best" peak?	
1)5:00 – 7:59 am	
2)8:00 – 9:59 am	
3)10:00 am – 4:59 pm	
4)5:00 – 9:59 pm	
5)10:00 pm – 4:59 am	

19.19) One hears about "morning" and "evening" types of people. Which ONE of these types do you consider yourself to be?	
1)Definitely a "morning" type	
2)Rather more a "morning" type than an "evening" type	
3)Rather more an "evening" type than a "morning" type	
4)Definitely an "evening" type	

20)PHYSICAL ACTIVITY:

Questions	**Response**
Activity at work	
20.1) Does your work involve vigorous-intensity activity that causes large increases in breathing or heart rate like [carrying or lifting heavy loads, digging or construction work] for at least 10 minutes continuously?	1)Yes 2)No If no, go to question 20.4
20.2) In a typical week, on how many days do you do vigorous-intensity activities as part of your work?	Number of days: _____
20.3) How much time do you spend doing vigorous-intensity activities at work on a typical day?	Hours: Minutes_____

20.4) Does your work involve moderate-intensity activity that causes small increases in breathing or heart rate such as brisk walking [or carrying light loads] for at least 10 minutes continuously?	1)Yes 2)No If no, go to question 20.7
20.5) In a typical week, on how many days do you do moderate-intensity activities as part of your work?	Number of days: _____
20.6) How much time do you spend doing moderate-intensity activities at work on a typical day?	Hours: Minutes: _____
Travel to and from places	
20.7) Do you walk or use a bicycle (pedal cycle) for at least 10 minutes continuously to get to and from places?	1)Yes 2)No
20.8) In a typical week, on how many days do you walk or bicycle for at least 10 minutes continuously to get to and from places?	Number of days: _____
20.9) How much time do you spend walking or bicycling for travel on a typical day?	Hours: Minutes: _____

Recreational activities	
20.10) Do you do any vigorous-intensity sports, fitness or recreational (leisure) activities that cause large increases in breathing or heart rate like [running or football,] for at least 10 minutes continuously?	1)Yes 2)No
20.11) In a typical week, on how many days do you do vigorous-intensity sports, fitness or recreational (leisure) activities?	Number of days: _____
20.12) How much time do you spend doing vigorous-intensity sports, fitness or recreational activities on a typical day?	Hours: Minutes: _____
Physical Activity (recreational activities)	

20.13) Do you do any moderate-intensity sports, fitness or recreational (leisure) activities that causes a small increase in breathing or heart rate such as brisk walking (cycling, swimming, volleyball) for at least 10 minutes continuously?	1)Yes 2)No If no, go to question
20.14) In a typical week, on how many days do you do moderate-intensity sports, fitness or recreational (leisure) activities?	Number of days: _____
20.15) How much time do you spend doing moderate-intensity sports, fitness or recreational (leisure) activities on a typical day?	Hours: Minutes: _____
Sedentary behaviour	
20.16) How much time do you usually spend sitting or reclining on a typical day?	Hours: Minutes: _____

21) SCREEN TIME:

21.1) Screen time post Dinner: _____pm

21.2) Duration of Screen Time:

< ½ hour/day ☐ ½ -1 hour/day ☐ 1-2 hours/day ☐ >2hours/day ☐

22) STRESS:

0 = Never 1 = Almost Never 2 = Sometimes 3 = Fairly Often 4 = Very Often

22.1) In the last month, how often have you been upset because of something that happened unexpectedly?	0	1	2	3	4

22.2) In the last month, how often have you felt that you were unable to control the important things in your life?	0	1	2	3	4
22.3) In the last month, how often have you felt nervous and "stressed"?	0	1	2	3	4
22.4) In the last month, how often have you felt confident about your ability to handle your personal problems?	0	1	2	3	4
22.5) In the last month, how often have you felt that things were going your way?	0	1	2	3	4
22.6) In the last month, how often have you found that you could not cope with all the things that you had to do?	0	1	2	3	4
22.7) In the last month, how often have you been able to control irritations in your life?	0	1	2	3	4
22.8) In the last month, how often have you felt that you were on top of things?	0	1	2	3	4
22.9) In the last month, how often have you been angered because of things that were outside of your control?	0	1	2	3	4
22.10) In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?	0	1	2	3	4

23) SLEEP:

23.1) During the past month, when have you usually gone to bed at night?
USUAL BEDTIME_____

23.2) During the past month, how long (in minutes) has it usually taken you to fall asleep each night?

NUMBER OF MINUTES _____

23.3) During the past month, when have you usually gotten up in the morning?
USUAL GETTING UP TIME _____

23.4) During the past month, how many hours of actual sleep did you get at night? (This may be different than the number of hours you spend in bed.
HOURS OF SLEEP PER NIGHT _____

23.5) During the past month, how often have you had trouble sleeping because you...

	Not During the past month (1)	Less than one week (2)	Once or twice a week (3)	Three or more times a week (4)
i) Cannot get to sleep within 30 minutes				
ii) Wake up in the middle of night or early morning				
iii) Have to get up to use bathroom				
iv) Cannot breathe comfortably				
v) Cough or snore loudly				
vi) Feel too cold				
vii) Feel too hot				
viii) Had bad dreams				
ix) Have Pain				
x) Other Reasons, please describe				
xi) How often during the past month have you had trouble sleeping because of this?				

	1)Very good	2)Fairly good	3)Fairly bad	4)Very bad
23.6) During the past month how would you rate your sleep quality overall?				
	1)Not During the past month	2)Less than one week	3)Once or twice a week	4)Three or more times a week
23.7) During the past month, how often have you taken medicine to help you sleep?				
23.8) During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activities?				
	1)No problem at all	2) Only a very slight problem	3)Somewhat of a problem	4)A very big problem
23.9) During the past month, how much of a problem it has been for you to keep up enough enthusiasm to get things done?				
	1)Not During the past month	2)Less than one week	3)Once or twice a week	4)Three or more times a week
23.10) During the past month, how much of a problem has it been for you to keep up enough enthusiasm to get things done?				

23.11) If you have a roommate or bed partner, ask him/her how often in the past month you have had….				
	1)No bed partner or roommate	2)Partner/roommate in other room	3)Partner in same room but not same bed	4)Partner in same bed
a) Loud snoring				
b) long pauses between breaths while asleep				
c) legs switching or jerking while you sleep				
d) episodes of disorientation or confusion during sleep				

24)KNOWLEDGE ATTITUDE AND PRACTICES:

Question regarding knowledge:	**1)Yes**	**2)No**
24.1) Glycosylated haemoglobin (HbA1c) is a test that measures your average blood glucose level in the past week.		
24.2) Infection is likely to cause an increase in blood sugar levels.		
24.3) Numbness and tingling may be symptoms of nerve disease.		
24.4) Wearing shoes of size bigger than usual helps prevent foot ulcers.		
24.5) Lung problems are usually associated with having diabetes		
When you are sick with the flu you should test for glucose more often		
24.6) The diabetes diet is a healthy diet for most people.		
24.7) Unsweetened fruit juice raises blood glucose levels		
24.8) Using olive oil in cooking can help lower the cholesterol in your blood.		
24.9) Exercising regularly can help reduce high blood pressure.		
24.10) For a person in good control, exercising has no effect on blood sugar levels.		
Question regarding Attitude:		
24.11) Being drunk while on diabetic drugs is not a serious problem		
24.12) Diet and exercise are not as important as treatment in control of Diabetes.		
Question regarding Practices:		
24.13) Do you regularly check your blood glucose?		
24.14) Do you keep a record of your blood sugar test results?		
24.15) Do you take your medicines regularly?		
24.16) Do you exercise regularly?		
24.17) In the past 1 week have you missed or skipped meals?		
24.18) In the past 1 week have you eaten more than you know you should?		
24.19) In the past 1 week have you eaten high fat foods or like fried items or animal fat?		
24.20) Do you involve your family in helping you follow a meal plan?		
24.21) You are empowered to control/avoid sweets or limit fatty foods?		
24.22) Does diabetes interfere with or prevent you from doing your normal daily activities.		

25)ANTHROPOMETRIC DATA:

25.1) Weight (kg):

25.2) Height (cm):

25.3) Waist circumference(cm):

25.4) Hip circumference(cm):

25.5) Skeletal Muscle (%):

25.6) Visceral fat:

25.7) Body Fat (%):

26)BIOLOGICAL PARAMETERS:

26.1) At what age was your Diabetes detected for the first time? _____

26.2) Kindly fill up the following information from your clinic file:

26.3) Fasting Plasma Glucose (FPG): _____

26.4) Random Blood Glucose (RBG): _____

26.5) Post-Prandial Blood Sugar (PPBS): _____

26.6) HbA1c: _____

26.7) Blood Pressure: (3 readings) _____

26.8) Total Cholesterol: _____

26.9) LDL: _____

26.10) HDL: _____

26.11) TGs: _____

26.12) Are you suffering from any other health problem currently?

1)Yes 2) No

If yes, please mention along with its biological parameters_____

Annexure V

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19.16) તમે સખત શારીરિક વ્યાયામમાં શામેલ થવાનું નક્કી કર્યું છે. એક મિત્ર સૂચવે છે કે તમે અઠવાડિયામાં એક કલાક માટે એક કલાક માટે આ કરો અને તેના માટે શ્રેષ્ઠ સમય બપોરે ૧૦:૦૦ થી ૧૧:૦૦ નો છે. તમારા પોતાના આંતરિક “ઘડિયાળ” સિવાય બીજું કંઇ ધ્યાનમાં રાખીને, તમે કેવી રીતે સારું પ્રદર્શન કરો છો?	
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2)ઠીક સ્થિતિ માં હસો	
3)અઘરું પડશે	
4)ખૂબ અઘરું પડશે	
19.17) ધારો કે તમે તમારા શાળાના સમયને પસંદ કરી શકો છો. ધારો કે તમે દિવસમાં પાંચ કલાક શાળાએ ગયા છો અને તે શાળા રસિક અને આનંદપ્રદ હતી. તમે કયા પાંચ સતત કલાકો પસંદ કરશો?	
1) સવારે 4:00 થી 7:59 દરમિયાન 5 કલાક	
2) સવારે 8:00 થી 8:59 દરમિયાન 5 કલાક	
3)5 કલાક સવારે 9:00 થી 1:59 બપોરે	
4)5 કલાક બપોરે 2:00 થી 4:59 સાંજે	
5)5 કલાક સાંજે 5 થી ૩:૫૯ સવારે	
19.18) દિવસના કયા સમયે તમને લાગે છે કે તમે તમારી “શ્રેષ્ઠ લાગણી” શિખર પર પહોંચી ગયા છો?	

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5)૧૦:૦૦ રાતે - ૪:૫૯ સવારે	
19.19) એક "સવાર" અને "સાંજ" પ્રકારના લોકો વિશે સાંભળ્યું છે. આમાંના કયા પ્રકારનો તમે તમારી જાતને માનો છો?	
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2)તેના કરતા વધુ "સાંજ" પ્રકાર કરતાં "સવાર" પ્રકાર	
3)તેના કરતાં વધુ "સવાર" પ્રકાર કરતાં "સાંજ" પ્રકાર	
4)ચોક્કસપણે “સાંજ” પ્રકાર	

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26.3) Fasting Plasma Glucose (FPG): _____

26.4) Random Blood Glucose (RBG): _____

26.5) Post-Prandial Blood Sugar (PPBS): _____

26.6) HbA1c: _____

26.7) Blood Pressure: (3 readings) _____

26.8) Total Cholesterol: _____

26.9) LDL: _____

26.10) HDL: _____

26.11) TGs: _____

26.12) □□□ □□□ □□□□□□ □□□ □□□□ □□□□□□□□□ □□□□□□□□ □□□□□□ □□? 1)□□ 2) □□

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