Research Article

Prevalence of Excessive Daytime Sleepiness and Risk Factors of Obstructive Sleep Apnea Among Type 2 Diabetes Mellitus at the Korle-Bu Teaching Hospital, Accra Ghana: A Pilot Study

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Received Date: October 20, 2020

Publication Date: November 01, 2020

Abstract

BACKGROUND:

Obstructive sleep apnea (OSA) is a breathing disorder of sleep that is gaining recognition in both developed and developing countries in recent years due to its associated morbidity and mortality worldwide. It contributes to the development of the cardiovascular disease, systemic hypertension and abnormalities in glucose metabolism. The relationship between OSA and Type 2 diabetes mellitus (T2DM) is bidirectional. The majority of studies on sleep-disordered breathing and T2DM have largely in developed countries hence, the need to explore the relationship between these conditions in developing countries like Ghana.

AIM:

This study aimed to determine the prevalence of excessive daytime sleepiness and the risk of obstructive sleep apnea among Type 2 diabetes mellitus patients attending the Korle-Bu Teaching Hospital (KBTH).

METHODS:

This study was a cross-sectional study. Telephone interviews were conducted on Type 2 diabetes mellitus patients attending the National Diabetic Management and Research Centre at the KBTH. These interviews were conducted to complete two validated questionnaires; the STOP-BANG questionnaire and the Epworth Sleepiness Scale (ESS) questionnaire which was used to assess the risk of OSA and the prevalence of excessive daytime sleepiness respectively. Patients' demographic characteristics were also collected using a structured questionnaire and anthropometric measurement extracted from patients' folders. The data was analyzed using SPSS version 22.0.

RESULTS:

The prevalence rate of excessive daytime sleepiness was high, 73.3% among the 60 Type 2 Diabetes patients who took part in the study. By STOP-BANG scores, patients who were at high and medium risk for obstructive sleep apnea were 15.0% and 65.0% respectively. However, a minority of the respondents had a low risk for OSA representing 20.0%. Combining patients with medium and high risk for OSA, the associated factors were found to be age > 55years, overweight, and obesity. Finally, correlation showed a significant linear relationship between STOP-BANG and ESS scores ($r = 0.44$; $p < 0.01$). This showed that there is a likelihood of T2DM patients having obstructive sleep apnea if they have excessive daytime sleepiness.

CONCLUSION:

The prevalence rate of excessive daytime sleepiness in T2DM patients was high as the compared lesser risk of obstructive sleep apnea. It can be concluded that there is a significant relationship between OSA and EDS in Type 2 Diabetes patients.

Introduction

1.1 BACKGROUND

Obstructive Sleep Apnea (OSA) refers to a form of sleep-disordered breathing which is characterized by recurring episodes of partial or complete obstruction of the upper airway during sleep resulting in repeated arousal and lack of restful sleep. OSA is associated with increased morbidity and mortality in the community. Notable clinical presentations of OSA include excessive daytime sleepiness, loud snoring, and observed pauses in a breath when asleep at night. Other symptoms include altered mental status, fatigue, loss of memory, restless sleep, gasping during sleep, and severe morning headaches. All these manifestations are a result of the frequent interruption of quality sleep during the night. There is the induction of nocturnal hypoxemia, hypercapnia, and sleep fragmentation due to recurrent episodes of airway obstruction of such patients (Kim et al., 2019). Evidence from previous studies suggests that obstructive sleep apnea influences the development of abnormalities in glucose metabolism (Punjabi & Polotsky, 2005), hypertension (Peppard et al., 2000), and cardiovascular disease (Peker et al., 2006). Both hospital and population-based investigation of OSA has revealed that about 50% of patients with OSA also have Type 2 Diabetes Mellitus (T2DM) and as much as 50% of patients with Type 2 Diabetes Mellitus have moderate-to-severe OSA (Resnick et al., 2003; Foster et al., 2009).

Type 2 Diabetes Mellitus is a condition characterized by an elevated concentration of glucose in the bloodstream (Cho et al., 2018). This is due to a deficiency in the production of insulin by the islet of Langerhans of the pancreas (WHO, 2018) or the destruction of insulin produced. T2DM is a complex disease that can be inherited or acquired through genetic mutation and also through environmental factors (Bais, 2005). T2DM poses macrovascular complications such as coronary artery disease and stroke (Yen, 2017) and also microvascular consequences that can affect the nervous system, kidney, and retina of the eye (Cho et al., 2018). Statistics show that there is a prevalence rate of 8.4% of diabetes mellitus globally and 3.8% in Ghana (IDF, 2017). Past studies investigating the relationship between OSA and T2DM have revealed a higher prevalence of OSA among T2DM patients even after adjusting for confounding variables like BMI and age.

1.2 PROBLEM STATEMENT

The association between Obstructive Sleep Apnea (OSA) and Diabetes Mellitus (DM) has raised public health concerns worldwide. Notwithstanding, the relationship between these two conditions has not been well understood in developing countries. According to the International Diabetes Federation (IDF), the estimated number of diabetes cases at the outpatient care setting in Ghana was 518,400 in the year 2017 (Primary Care Diabetes Europe: Colophon, 2017). Most of these patients mostly go undiagnosed for OSA and hence management of their condition is problematic. The presence of OSA in DM worsens

glycemic control and further contributes to DM-related cardiovascular complications. Despite the outstanding technological advancement to understand the bidirectional relationship between OSA and type 2 diabetes mellitus, few data are addressing the severity of the effect each condition has on the other (Moon et al., 2015).

A study conducted by Arosohn and colleagues in 2010 among 60 diabetes mellitus patients revealed that increasing severity of OSA was associated with poor glycemic control after adjusting for age, BMI, sex, race, number of diabetes medications, years of diabetes, total sleep, and physical exercise (Aronsohn et al., 2010). OSA and diabetes mellitus share common risk factors of age and obesity, which are also risk factors for cardiovascular disease. Predominantly, obesity is a prevalent risk factor. Studies have shown that a 10% increase in weight increases the risk of getting OSA by six-fold (Peppard, 2000). Hypoxaemia, evident in OSA has been shown to elevate inflammatory mediators in DM patients and this further worsens the condition of such patients. Even though OSA affects 24% of men and 9% of women, it is estimated that about 80 – 90% of patients are undiagnosed. (Young et al., 1997; Hussain et al., 2009). The public health burden of undiagnosed OSA cannot be underestimated due to its relationship with diabetes and cardiovascular diseases. Though, the implications OSA has on the management of T2DM has been elucidated in several studies (Hermans et al., 2009; Pillai et al., 2011) notwithstanding, OSA remains underdiagnosed and under-treated among individual populations with T2DM (West et al., 2006; Hermans et al., 2009; Pillai et al., 2011).

Additionally, the cost of management of DM is very high because of the comorbidities associated with it (Cho et al., 2018). It was therefore needful to investigate the risk of OSA and the prevalence of excessive daytime sleepiness in type 2 diabetes mellitus patients at the KorleBu Teaching Hospital using a questionnaire based approach.

1.3 SIGNIFICANCE OF STUDY

Given the comorbidities and complications associated with diabetes mellitus, patients are advised to adhere to management protocols. Early identification of modifiable risk factors of DM is very relevant in the prevention of long-term cardiovascular risks associated with DM (Go et al., 2017). Information from this study will help factor the treatment of OSA as part of the general management of T2DM. OSA is treatable using weight control and non-invasive ventilation with Continous Positive Airway Pressure (CPAP) device in T2DM patients. The knowledge obtained from this research will also allow relevant stakeholders of health to put preventive measures in place to curb the burden T2DM poses considering its association with sleep-disordered breathing. In effect, there would be a conservation of resources in terms of healthcare delivery. Information from this study will also serve as a reference for further studies for researchers investigating similar research questions.

1.4 AIM

This study aimed to determine the prevalence of excessive daytime sleepiness and the risk of obstructive sleep apnea among Type 2 Diabetes Mellitus patients attending the KorleBu Teaching Hospital (KBTH).

1.5 OBJECTIVES

The objectives of these studies were to:

1.Determine the presence of risk factors for OSA among T2DM patients at the KBTH.

2. Determine the prevalence of EDS among T2DM patients at the KBTH.

3.To determine the relationship between obstructive sleep apnea, excessive daytime sleepiness, and T2DM.

Literature Review

2.1 OBSTRUCTIVE SLEEP APNEA (OSA)

OSA is a sleep disorder that is characterized by a temporal but repetitive cessation of airflow (apnea and hypopnea) in the upper airways during sleep usually resulting in the reduction of blood oxygen levels. In 2012, Valipour indicated that patients with this condition usually experience at least 15 apneas (complete cessation of breath during sleep) and hypopneas (partial cessation of breath during sleep) a night. Patient populations with OSA commonly present with symptoms such as excessive daytime sleepiness, morning headaches, a history of witnessed apneas or gasping, sleep disturbance, and cognitive dysfunction (Parati et al., 2012). Classical symptoms manifested in men with OSA are sleepiness, snoring and witnessed apneas (Arnardottir & Gislason, 2016). However, women with OSA usually present with different symptoms such as nightmares, fatigue, mood disturbances, insomnia and as such are seldom considered for evaluation of sleep-disordered breathing and hence diagnosis mostly missed in women (Basoglu & Tasbakan, 2017).

2.2 OBSTRUCTIVE SLEEP APNEA AND CARDIOVASCULAR DISEASE

A study done by Lurie in 2011, indicated that OSA is associated with an increased risk for cardiovascular diseases. According to WHO (2018), though OSA is not life-threatening, however, if left untreated it can result in detrimental cerebrovascular and cardiovascular problems including hypertension, ischemic heart disease, stroke and diabetes.

OSA is an important subject to consider in hypertensive patients. There is an estimated percentage prevalence of 30 - 70% of hypertension in OSA patients (Kaw, 2014) with about

30% of hypertensive patients with undiagnosed OSA (Kaw, 2014; Anh & Van, 2016). About 50% of hypertensive patients have accompanying OSA with current evidence supporting the claim that OSA is one of the most prevalent secondary causes of elevated blood pressure (BP) in patients with chronic hypertension (Pedrosa et al., 2011). In normal healthy individuals, the physiological BP at night during sleep seems to decrease and is illustrated as a dipping pattern. However, in patients with OSA, this pattern is altered (non-dipping) considerably posing an adverse cardiovascular risk on such individuals (Endeshaw, White, Kutner, Ouslander,

& Bliwise, 2009). The periodic stimulation of carotid baroreceptors during apneic events in OSA patients at night tends to increase the arterial blood pressure gradually. The elevation in the pressure eventually causes hypertension, increases vascular resistance and potentially generates congestive heart failure (CHF). Post apneic hyperventilation with stimulation of carotid baroreceptors usually causes an elevation in blood pressure, which can go up to 240/130 mmHg (Miglis, Muppidi, During, & Jaradeh, 2016). About two-thirds of patients will finally have diurnal hypertension (Mohsenin, 2014).

2.3 CLASSIFICATION OF OBSTRUCTIVE SLEEP APNEA

The International Classification of Sleep Disorders (ICSD) classifies sleep-related breathing disorders into four (4) categories which are; obstructive sleep apnea (OSA) disorders, central sleep disorders, sleep-related hypoventilation disorders, and sleep-related hypoxemia disorder. Usually, more than one or even all these conditions could be present within the same patient, especially, OSA and central sleep apnea often co-exist in an exceedingly obese patient. Four primary contributors to OSA pathogenesis are identified and that they are a narrow, or collapsible upper airway causing “anatomical compromise” and “non-anatomical contributors which are; ineffective pharyngeal dilator muscle function during sleep, a coffee threshold for arousal to airway narrowing during sleep, and unstable control of breathing (Osman, Carter, Carberry, & Eckert, 2018). Each of those phenotypes may be a target during the therapeutic management of OSA.

2.4 RISK FACTORS FOR OSA

The risk factors of OSA are gender, age, obesity, smoking, alcohol intake, stroke, coronary artery disease, hypertension, diabetes mellitus. Previously, OSA was highly recognized in men but recent studies show that OSA is not as rare in women as believed globally (Haqqee, Jordan, & Allen, 2017). OSA is more prevalent in men than women and increases with age and obesity (Franklin and Lindberg, 2012). Male gender from studies has shown to be an independent risk factor for developing the syndrome with a two to three-fold higher prevalence in men than women based on epidemiological studies (Kawada, 2016).

The male-to-female ratio is estimated to be 2:1 in a general population. Relevant explanations with male predominance in a general population include hormonal effects on the upper airway muscles, gender differences concerning body fat distribution and distinct pharyngeal anatomy

and function (Fenik, Penzel, & Malhotra, 2019). However, the prevalence of OSA can be higher in postmenopausal women due to hormonal changes (Kendzerska et al., 2017). The pharyngeal anatomy gradually degenerates with aging in males, and the corresponding increase in upper airway malfunction with advanced age largely contributes to an increase in upper airway collapsibility (Carberry, Jordan, White, Wellman, & Eckert, 2016).

Snoring increases with age up to 50 to 60 years in both men and women presenting with OSA.Nonetheless, not all snoring is suggestive of sleep apnea (Ekbatani, Taavoni, & Haghani, 2012). Snoring is a recurring event (with up to 40% prevalence in men and 20% prevalence in women) which occurs during sleep as a result of the vibration of the oropharyngeal structures and this signifies airflow resistance in the upper airway (Palou & AlonsoFernández, 2009). Snoring does not only create sleep deprivation and cause discomfort to the patient but frequent snoring is associated with a higher risk of cardiovascular disease (Javaheri, Omobomi, & Redline, 2019). Snoring occurs as a result of inflammation of the palate and a study by Grimble in 2002, investigated that habitual snoring is a direct trigger of chronic insulin insensitivity.

Obesity as a risk factor of OSA is a major public health burden globally with increased morbidity or mortality. Obesity can be defined as having a body mass index (BMI) of at least 30 kg/m2. Obesity is the most relevant risk factor of OSA affecting about 70% of patients obese (Tuomilehto, Seppä, & Uusitupa, 2013). McPherson (2014), reports that overweight and obesity were estimated to cause 3.4 million deaths, 3.9% of years of life lost and 3.8% of disability-adjusted years in 2010 globally. The relationship between OSA and obesity has an enormous impact on the cardiovascular system than either condition on their own. According to WHO, there are about 1.6 billion adults who are overweight (BMI > 25 kg/m2) and 400 million obese (BMI > 30 kg/m2). Entirely, it has been estimated that about 20% of individuals in developed countries are obese and 1-2% morbidly obese i.e. BMI > 40 kg/m2. Even though obesity and overweight have raised public health concerns in western countries, low-and middle-income countries (LMICs) especially in urban areas and sub-Saharan African Countries like Ghana are facing a problem as the trend rises. Obesity is believed to incline OSA because of the mass loading in the upper airway regions (Marrone & Vicini, 2010). However, the controversy remains whether a definite measurement of body habitus, such as waist circumference and neck size better predicts OSA as compared with BMI alone. Peppard et al. (2012), in his research, estimated that 58% of moderate to severe OSA cases are a result of a BMI ≥ of 25 kg/m2 (Peppard et al., 2013). It has been previously investigated that a change in BMI affects the severity of OSA types (i.e. mild, moderate, and severe). To this end, as much as changes in BMI and OSA events are both closely related to increased cardiovascular risks, data on the effects of BMI on the severity of individual obstructive

occurrence will give an understanding of the relationship between BMI and the overall severity of OSA (Leppänen, Kulkas, Mervaala, & Töyräs, 2018).

Cigarette smoking remains a serious public health problem and amounts to a large proportion of morbidity and mortality globally. Liao et al. (2019), reports that in 2015 there were about 933.1 million people who smoke daily globally, and 6.4 million deaths (i.e. 11.5% of global deaths) were as a result of cigarette smoking worldwide. Smoking kills one in every 10 adults and causes 5 million deaths annually. Nicotine, the main stimulants in most cigarettes does not only make smoking cessation difficult but also causes withdrawal symptoms which are associated with poor quality of sleep and insomnia (Schnoll et al., 2011). Smoking has been shown to hurt sleep efficiency and sleep latency, contributing to insomnia, unrefreshing sleep and excessive daytime sleepiness, as demonstrated as Deleanu et al., (2012). The possible process describing the association between smoking and OSA include the inflammation of the upper airways and the impairment of the neuromuscular protective autonomic responses. Smoking conceivably leads to chronic inflammation of the upper airways by stimulating epithelium thickening, cellular hyperplasia, edema and ciliary dysfunction (Hsu, Chiu, Chang, Chang, & Lane, 2019). There is a higher prevalence rate of smoking among patients with OSA i.e. 35% as compared to 18% without OSA (Kashyap, Hock, & Bowman, 2001). It is further hypothesized that smoking is perhaps an independent risk factor for OSA as the probability of current cigarette smokers with OSA is 2.5 times greater than nonsmokers and past smokers (OR = 2.5, CI = 1.3 - 4.7, p=0.0049), and a 2.8 times greater probability of having OSA than former smokers alone (OR=2.8, CI:1.4-5.4, p=0.0028) after elimination of different factors (Kashyap, Hock, & Bowman, 2001).

2.5 DIABETES MELLITUS (DM)

Diabetes mellitus (DM), commonly known as diabetes, is a metabolic disease that occurs as a result of the absence of insensitivity of the body to insulin. It is depicted by elevated levels of glucose in general circulation in the body (Cho et al., 2018). The pancreas is a relevant organ in the human body that assists in digestion. It performs both endocrine and exocrine functions hence its division into the endocrine portion (islets of Langerhans) and an exocrine portion (acinar and duct tissue). In performing its exocrine functions, it secretes pancreatic juice which contains enzymes needed for further digestion of useful metabolites in the body (Pandol, 2015). These secreted enzymes are amylase, lipase, chymotrypsin and trypsin (Chen, Xie, Shen, & Xia, 2018).

The endocrine portion of the pancreas produces and secretes five major hormones namely (glucagon, insulin, somatostatin, pancreatic polypeptide and ghrelin) responsible for glucose homeostasis. Notwithstanding, glucagon and insulin are the main hormones involved in controlling glucose homeostasis (Chen, Xie, Shen, & Xia, 2018). The pancreatic islets house three types of cells, namely, the alpha (α)-cells, beta (β)-cells, and delta (δ)-cells. The α-cells of the pancreas are responsible for producing glucose in the bloodstream through the mechanism of hepatic glycogenolysis and gluconeogenesis (Quesada, Tudurí, Ripoll, & Nadal, 2008).

Conversely, the β-cells release insulin which aids in the removal of excess glucose from the blood into cells and also for storage in the liver as glycogen (Cernea and Dobreanu, 2013). βcells dysfunction impedes the secretion of insulin. Due to this, glucose homeostasis and tissue energy metabolism are affected by DM (Chen, Xie, Shen, & Xia, 2018).

2.5.1 TYPES OF DM

The onset of DM encompasses both environmental and genetic factors. The type and duration of the disease determine how severe the clinical signs and symptoms manifest (Kharroubi, 2015). The American Diabetes Association (ADA) in 2014 still considers the suggested classification of diabetes by the association in 1997 as the most recognized and adopted. ADA classifies DM as Type 1, Type 2 and Gestational Diabetes Mellitus. Kharroubi (2015), also includes two additional types, which are, mitochondrial diabetes and monogenic diabetes. Young adult patients may not ideally fit into a single class thereby making the classification difficult at times (ADA, 2014). OSA has been associated with type 2 diabetes mellitus.

2.6 TYPE 2 DM

Type 2 Diabetes Mellitus (T2DM) is a complicated disorder that makes up approximately 90-95% of all DM cases (Kharroubi, 2015). In 2010, the estimated prevalence of T2DM globally among adults was 285 million (6.4%) with this value expected to increase to around 439 million (7.7%) by 2030 (Shaw, Sicree, & Zimmet, 2010). The prevalence estimate rate of T2DM in Africa ranges from 0.3% to 17.9% (Wild et al., 2004) and adults are the most affected population when it comes to T2DM. Notwithstanding, there is an increase in the incidence among adolescents and children (Dabelea et al., 2014). The sequence from Normal Glucose Tolerance (NGT) to T2DM involves a series of stages which are Impaired Fasting Glucose (IFG) and Impaired Glucose Tolerance (IGT) usually called Prediabetes (D'Adamo & Caprio, 2011). Disturbance in the balance between

glucose sensitivity and glucose secretion forms the bedrock in the development of T2DM. Chen et al, (2018) reported that the mechanism involved in the development of the disease is associated with insulin resistance, insulin hypersecretion and impaired function. Genetic and environmental factors play an important and complex role in the pathogenesis of T2DM because they contribute to the growth of insulin resistance in the muscle and liver in addition to β-cell dysfunction, the two (2) principal pathophysiological defects in T2DM (DeFronzo, 2009). Increased risk of morbidity and mortality and a decline in quality of life are associated with early onset of T2DM (Pinhas-Hamiel & Zeitler, 2007). Also, T2DM patients are predisposed to secondary obesity-complications such as metabolic syndrome, hypertension, nonalcoholic fatty liver disease and OSA all increasing cardiovascular risk (Pinhas-Hamiel & Zeitler, 2007).

2.6.1 PATHOGENESIS OF T2DM

The pathogenesis of T2DM is known to be progressive. A study conducted by Harrigan in 2007, shows that the principal mechanism for the development of T2DM is central (abdominal) obesity and insulin resistance however, it has also been established that insulin resistance and insulin secretion are the two ground laying effects involved in the development of T2DM (Bello et al., 2011). Evidence of insulin resistance playing a relevant role in the pathogenesis of the condition demonstrates that insulin resistance takes place 10 – 20 years before the onset of the disease and is the best predictor determining whether an individual would be diabetic or not in the later stages of life (Shulman, 2000). Obesity is identified as the most important factor of insulin resistance and it has been established that the important determining factor of insulin sensitivity is not the degree of obesity in itself but the distribution of fat to the central part of the body (Weiss et al., 2003). Fu et al. (2013), also reported that it is usually associated with deterioration in energy metabolism which results in the accumulation of intracellular fat in various parts of the body such as the pancreatic islets, skeletal muscle and the liver.

The glucose production in the liver after an overnight fast is either increased or remains normal regardless of the presence of hyperinsulinemia in insulin resistance (Otero, Stafford, & McGuinness, 2014). This was attributed to the inability of insulin to balance glucose and uptake. Al Jobori et al. (2018), state that, disruption in glycogen synthesis is an accepted distinctive and early impairment of insulin resistance in T2DM. The insensitivity to insulin in T2DM can be due to an impairment in insulin secretion and also a significant decrease in functional β-cells (Kahn, Hull, & Utzschneider, 2006). In situations of decreased insulin sensitivity, it very important for the pancreatic islets to secrete enough insulin to compensate for this impairment, through an

increase in the amount of insulin secreted (hyperinsulinemia) due to improvement in the function of pre-existing β-cells and/or an increase in the β-cell mass. This finally compensates for the decreased insulin sensitivity by restoring blood glucose levels to normal. Nonetheless, there is the likelihood of chronic insulin resistance progressing into T2DM if the β-cells are unable to secrete enough amounts of insulin to compensate for the impairment (Fu et al., 2013). The aftermath is elevated β-cell apoptosis and reduced β-cell mass and the dysfunction of β-cell characterizes T2DM development (Butler et al., 2003). Furthermore, the long stand subjection of the β-cell insulin secretion to increased quantities of fatty acids and glucose contributes to β-cell failure in the progression of T2DM (Fu et al., 2013).

2.7 OBSTRUCTIVE SLEEP APNEA AND TYPE 2 DIABETES MELLITUS

A large number of studies have shown that OSA has a close association with glucose intolerance, insulin resistance and type 2 diabetes (Pamidi & Tasali, 2012). Epidemiological studies according to Buxton et al, (2010) suggest that disturbed or short sleep has been associated with insulin resistance, glucose intolerance, reduced insulin sensitivity to glucose and increased risk of developing T2DM (Beihl, Liese, & Haffner, 2009; Chao et al., 2011; Chaput, Després, Bouchard, Astrup, & Tremblay, 2009; Tuomilehto et al., 2009). OSA is a common disorder that is often undiagnosed among diabetic patients in clinical practice. About 83% of patients with diabetes mellitus suffer from undiagnosed OSA which increases the severity of glucose tolerance (Pamidi & Tasali, 2012).

Poor concentration, fatigue, postprandial drowsiness and depression are some principal symptoms manifested in diabetic patients with OSA (Iyer & Iyer, 2008). There is repetitive stimulation of the sympathetic nervous in OSA patients and this is believed to be a result of intermittent hypoxia, recurrent arousals from sleep and sleep fragmentation. This recurrent stimulation leads to the release of stress hormones and catecholamines which are known to decrease glucose sensitivity and worsen glucose tolerance in DM patients (Iyer & Iyer, 2008). Furthermore, changes in somatotropic and corticotropic activity elevate levels of circulating adipocytes that alter glucose metabolism (Polotsky, Jun, & Punjabi, 2011). Habitual snoring in patients with OSA is a predictor of the onset of diabetes. According to JOO et al. (2006), habitual snoring is consistent with reduced glucose tolerance, as investigated by abnormal oral glucose tolerance tests (OGTT) and elevated levels of HbA1c. Metabolic complications including type 2 diabetes mellitus, insulin resistance, hypertension and dyslipidemia are connected with visceral adiposity (Klein, 2010). Nocturia (frequent urination at night) is found to be increased in both

OSA and DM patients. This is a result of (1) the release of the atrial natriuretic peptide from the right atrium in patients with OSA (2) urinary tract infection and (3) hyperglycemia (Iyer & Iyer, 2008).

OSA prevalence is predicted to increase with age (Al-Abri, Al-Lawati, & Al-Zedjali, 2017) as well as blood glucose levels increasing with advanced age (Iyer & Iyer, 2017). Central adiposity is usually a peculiar character as individuals advance in age. The fat in the visceral regions of such individuals is metabolically active. An increase in body weight, recurrent upper airway collapsibility, decreased muscular endurance, decreased lung capacity, increased sleep fragmentation, decreased ventilatory control and decreased thyroid function are found to be the possible age-dependent risk factors for developing OSA in elderly patients (Iyer & Iyer, 2008).

2.7.1 COMMON RISK FACTORS FOR TYPE 2 DIABETES MELLITUS AND OBSTRUCTIVE SLEEP APNEA

Common risk factors for both T2DM AND OSA include:

1. Gender – male and postmenopausal females

2. Increase in the prevalence of OSA with advanced aging, the peak being 65 years for females (postmenopausal) and 55 years for males.

3. Metabolic syndrome – central obesity, dyslipidaemias (hypercholesterolemia), DM, hypertension.

4. Obesity

5. Cardiovascular morbidity and mortality.

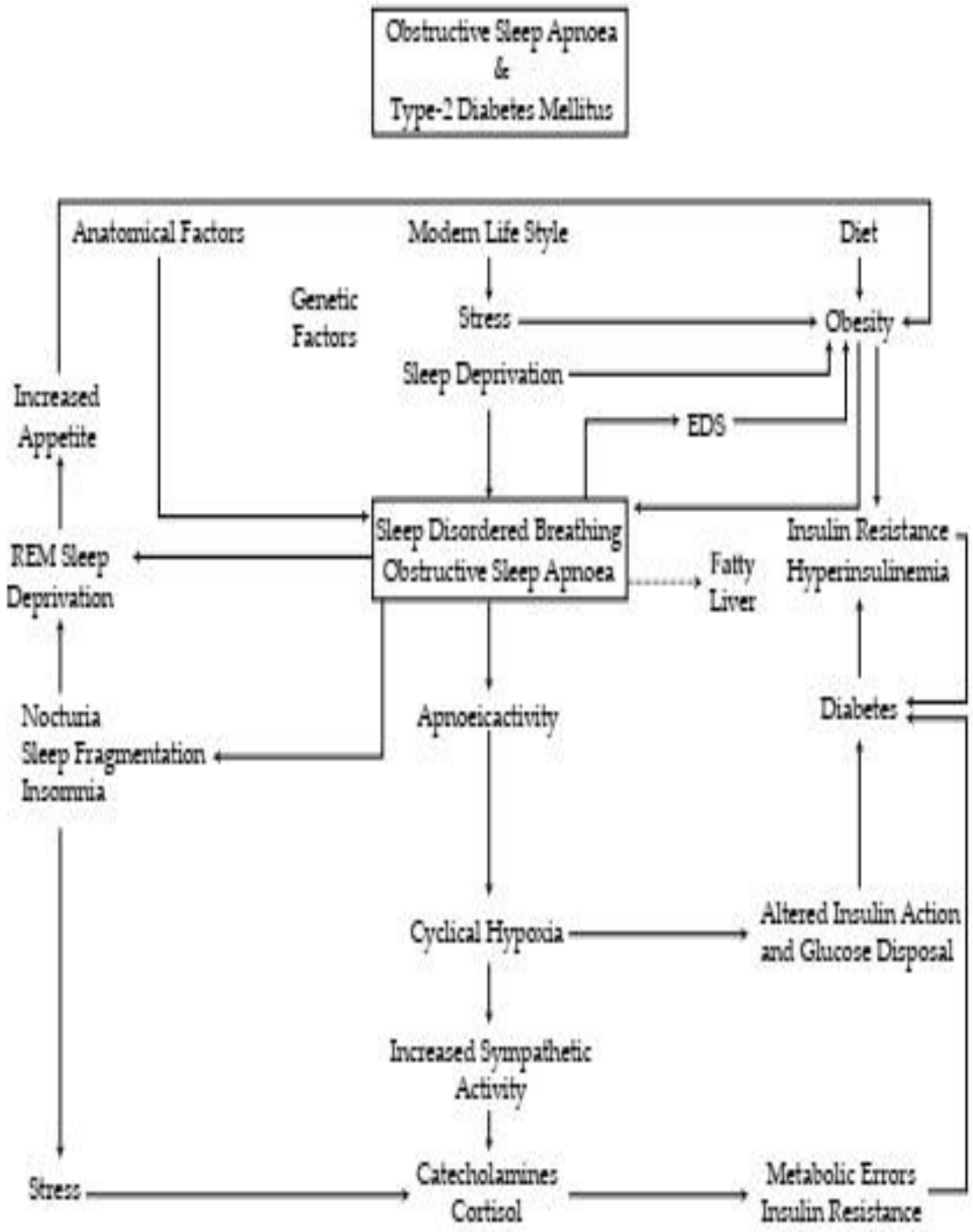


Fig. 1. A flow chart illustrating the close relationship between obstructive sleep apnea and type 2 diabetes mellitus and also the pathways taken by nocturnal events in a patient of obstructive sleep apnea resulting in the development of type 2 diabetes mellitus (Iyer & Iyer, 2008).

Table 1: COMPARISON OF TYPE 2 DIABETES AND OBSTRUCTIVE SLEEP APNEA

Elements	**Type 2 Diabetes Mellitus**	**Obstructive Sleep Apnea**
Obesity	Often	Often
Sleep Disturbances	Usually Insomnia, Excessive daytime sleepiness, early awakenings may be associated with OSA.	Snoring with excessive daytime sleepiness, sleep architecture disrupted. May have associated DM (OSA risk factor for DM).
Metabolic syndrome	Part of metabolic syndrome	A manifestation of metabolic syndrome.
Family history	Yes	Yes
Post Prandial drowsiness	Yes	Yes
Lean subjects	Affected	Affected
Increasing prevalence with advancing age	Yes	Yes
Nocturia	Yes (glycosuria)	Yes (release of atrial natriuretic peptide)
Management of OSA	Rewarding for metabolic	Rewarding and can prevent
	control	The development of DM in IGT.

Table 1 expresses several similarities between type 2 diabetes mellitus and obstructive sleep apnea (Iyer & Iyer, 2006).

2.8 ASSESSMENT AND DIAGNOSIS OF OBSTRUCTIVE SLEEP APNEA

Polysomnography (PSG) has been identified as the gold standard for the diagnosis of OSA, but it's highly expensive, time-consuming, relatively inaccessible and requires trained personnel (Amra, Rahmati, Soltaninejad, & Feizi, 2018). However, various clinical models are developed over the years to effectively screen patients who are at high risk of developing OSA (Kushida et al., 2005; Ramachandran & Josephs, 2009; Manzar, 2015). The adoption of concise and precise screening tools can help medical doctors, respiratory therapists, sleep specialists and surgeons to help in the early recognition of OSA among different patient populations and also assist in the arrangement of PSG examination and OSA treatment strategies, especially in poor- resourced countries and sleep clinics where PSG is rare (Chiu et al., 2017). Validated screening tools like the STOP-Bang questionnaire (SBQ), the STOP questionnaire (STOP) and the Berlin questionnaire (BQ) are the most widely used for the detection of OSA. According to Johns (1991), the Epworth Sleepiness Scale (ESS), which was initially designed to assess the risk of excessive daytime sleepiness in patients has been also proposed to detect OSA.

The BQ developed in the year 1991, is used to determine risk factors for OSA. The Berlin questionnaire is one of the simplest, inexpensive and easily accessible tools used to screen OSA, according to a report from the Sleep in Primary Care Conference which took place in April 1996 at Berlin, Germany (Saleh et al., 2011; Netzer et al., 1999). It consists of 10 questions on the following three categories: snoring characteristic (category 1, items 1-5); daytime sleepiness or fatigue (category 2, items 6-9); medical history and anthropometric measurements like obesity and hypertension (category 3, item 10). Obesity is calculated as a Body Mass Index (BMI) using weight and height. This questionnaire groups patients into two categories or strata, that is, OSA high-risk and low-risk based on the responses provided (Karakoc et al., 2012). Patients are considered high risk for OSA when they show persistent symptoms (i.e. > 3-4 times a week) in at least two of the categories (Netzer, Stoohs, Netzer, Clark, & Strohl, 1999).

STOP-Bang questionnaire (SBQ) on the other hand was first developed in 2008 and used as a preoperative assessment tool to assess the risk of OSA in surgical patients (Chiu et al., 2017; Chung, 2008). Like the BQ, the SBQ is also a simple, convenient to use and self-reported screening tool for OSA. It consists of four subjective (STOP: **S**noring, **T**iredness, **O**bserved apnea and high Blood **P**ressure) and four demographic items (Bang: BMI, age, neck circumference and gender) (Chung, 2008). This questionnaire was initially validated to screen OSA in surgical patient populations with a score of 5-8 classified as high risk for OSA (Chung, 2008). The sensitivity for the SBQ score ≥3 as the cut-off to predict any mild OSA (apnea-hypopnea index

(AHI) >5), moderate-to-severe OSA (AHI >15) and severe OSA (AHI >30) was 83.9%, 92.9% and 100% respectively according to Chung (2008). The high sensitivity and simplicity of the SBQ has made it widely recognized and accepted in sleep clinics (Ong et al., 2010; Farney et al., 2011; & El-Sayed, 2012), preoperative clinics (Chung, 2008; Chung, 2012; & Nunes, 2014), the general population (Silva et al., 2011) and other unique populations (FIRAT et al., 2012 & Nicholl, 2013).

Excessive Daytime Sleepiness (EDS) is a very important symptom in various chronic sleep disorders including obstructive sleep apnea. The social and economic burden of sleep-related casualties are alarming and often unrecognized by both patients and clinicians (DINGES, 1995). The assessment of EDS can be done both subjectively and objectively (Chung, 2000). Of the subjective method, the evaluation of excessive daytime sleepiness is done by the use of the Epworth Sleepiness Scale (ESS). The ESS is accepted to be in the comprehensive sleep assessment (Epstein et al., 2009) and it helps assist in the identifications of individual OSA patients with excessive daytime sleepiness because it can disrupt sleep (Johns, 1994). This is a self-administered, eight-item questionnaire use to estimate the extent of daytime sleepiness in adult patients (Johns, 1991). According to John (1991), the ESS asks patients to rate from a scale of 0-3 the likelihood of falling asleep in eight different circumstances (0 = would never doze; 1 = slight chance of dozing; 2 = moderate chance of dozing; and 3 = high chance of dozing). The ESS is currently the most widely recognized and easiest way of subjectively estimating daytime sleepiness amongst individuals presenting with OSA. Conversely, objective assessment of daytime sleepiness is done by the use of the Multiple Sleep Latency Test (MSLT) (Van den Hoed, 1981). With this method, the extent of daytime sleepiness can be assessed by how quickly a patient falls asleep (sleep latency) when given the chance to do so. The MSLT is cumbersome and less cost-effective, and as such only used to ascertain whether a simple objective scale like the ESS can suitably estimate mean sleep latency of the MSLT (Chung, 2000).

According to Chiu (2017), a suitable screening tool for detecting OSA in patients should consider sleep domains, feasibility and diagnostic accuracy. Regarding the assessment of sleep domains, the variables in the SBQ were developed based on OSA-related symptoms (i.e. snoring, fatigue during the daytime, cessation of breath during sleep, and hypertension) and clinical characteristics (i.e. age, gender, BMI, and neck circumference). Also considering feasibility, the SBQ is made up of four self-administered questions alongside four questions for demographic data and clinical characteristics (i.e. Age, BMI, neck circumference, and gender) (Chiu, 2017), with all responses rated as yes or no (Chung, 2008). Due to the short response time and few questions in the SBQ, there was a high response rate (91.2%–91.5%) based on past studies (Chung, 2008; Ong et al., 2010). Moreover, the SBQ has excellent sensitivity for determining OSA

among diverse patient populations; notwithstanding, the substandard specificity of this questionnaire rendered its practicability limited in previous studies (Chiu, 2017). There is an early and accurate diagnosis of a good number of true-positive cases and thus minimizing medical costs and consequences of undiagnosed patients when a screening tool is highly sensitive (Chiu, 2017).

2.9 MANAGEMENT AND TREATMENT OF OBSTRUCTIVE SLEEP APNEA

Management and treatment of OSA improve the quality of life of patients by reducing the associated comorbidities of the disease. Positive Airway Pressure (PAP) therapies have been investigated as one of the most effective and relatively safe therapeutic methods of addressing OSA globally (Farrell & Richards, 2017). Farrell & Richards (2017), reports that, Continuous Positive Airway Pressure (CPAP), the primary treatment of sleep-disordered breathing like OSA is administered to the patient nasally, using both nasal prongs or nasal mask, or a full-face mask. CPAP is very effective when treating patients with moderate-severe OSA and affords a cost-effective use of resources in the healthcare setting of most developed countries (McDaid, 2009). The effect of CPAP on obesity, a risk factor of OSA and also a common finding in DM cannot be underestimated although the precise mechanism remains debatable.

The use of CPAP in the management of OSA has traditionally been recommended as an adjunct to aid in weight reduction, regardless of the inadequate evidence supporting this strategy (Joosten et al., 2017). The reverse has been established to be true. A post hoc evaluation of a randomized controlled trial (RCT) illustrated a mean weight gain of 0.3kg in patients using CPAP over 6 months while those who receive sham treatment had a mean weight reduction of 0.7kg (Quan, 2013). The mechanisms by which long-term use of CPAP can contribute to weight have recently been explained by Tachikawa et al, (2016). According to them, the use of CPAP leads to a very small decrease in basal metabolic rate without changing physical activity. Entirely, the discovery that prolonged use of CPAP contributes to weight gain emphasizes the relevance of combining weight loss and lifestyle modifications with CPAP treatments for all patients (Chirinos et al., 2014).

Bariatric surgery should be considered as a weight-loss strategy in obese patients with BMI >35 kg/m2 with OSA and other obesity-related complications like arthritis, hypertension and diabetes or patients with BMI > 40 kg/m2 without the aforementioned obesity-associated complications (Mechanick et al., 2008). This surgical procedure aids in caloric restriction,

malabsorption, or both. The combination of weight-loss strategies and CPAP in the management of OSA significantly contributes to the quality of life than either alone in obese patients. In a randomized controlled trial of 136 patients, there was an improvement in blood pressure, lipids and insulin-sensitive with weight loss and/or CPAP than use of CPAP alone (Chirinos et al., 2014).

Surgical management of OSA is usually recommended as an alternative for patients who fail to benefit from the use of CPAP. The main relevance of surgical intervention is to address nasal obstruction, obstruction in the retropalatal, and retroglossal/hypopharyngeal regions, and in numerous patients where multiple levels of obstruction are identified (Randerath et al., 2011). A thorough physical examination is carried on patients who qualify for surgical intervention and this includes an examination of the nose/nasal cavity (i.e. for any external deformity, septal position or deviation, mucosal hypertrophy, nasal valve patency or collapse and nasal polyps), oral cavity (i.e. for trismus, tongue size/position, dental health), oropharyngeal region (i.e. for tonsil size, palatal/uvular elongation, modified mallampati score, and tonsil size), hypopharynx, larynx (i.e. true cord function and arytenoid location/dislocation) and neck for enlarged neck circumference (McNicholas, 2008). Recent evidence shows that effective management of OSA can attenuate the negative implications of untreated OSA and gradually slow the progression of associated comorbidities (Tasali & Ip, 2008; Patel et al., 2010; Kanagala et al., 2003; Fein et al., 2013). Two randomized controlled trials showed an improvement in the left ventricular ejection fraction as well as the overall quality of life in OSA patients with congestive heart failure (CHF) after 1 – 3 months of CPAP therapy (Kaneko et al., 2003; Mansfield et al., 2004). CPAP therapy was recommended as part of the guidelines of the 2010 Heart Failure Society of America Comprehensive Heart Failure (Heart Failure Society of America, 2010) and the 2013 American Heart Association Guidelines (AHA) (Yancy et al., 2013) for OSA patients with heart failure. Also, there is a significant improvement in the cardiovascular events of OSA patients with coronary artery disease after CPAP therapy. One study confirmed a 36% reduction in the risk of fatal and nonfatal cardiovascular events in OSA patients undergoing CPAP therapy as compared to untreated patients, with this finding replicated in studies with prolonged follow-up durations (Cassar et al., 2007; Garcia-Rio et al., 2013; Marin et al., 2005; (Milleron, 2004). Additionally, there is an increasing body of evidence that the treatment of OSA with CPAP tends to lower fasting plasma glucose, postprandial glucose and glycosylated hemoglobin levels in diabetes patients (Tasali & Ip, 2008).

Methodology

3.1 STUDY DESIGN

This study was a cross-sectional study involving type 2 diabetes mellitus patients at the National Diabetic Management and Research Centre (Diabetic Clinic) of the Korle-bu Teaching Hospital. This cross-sectional study sought to examine the relationship between suspected risk factors and the prevalence of a disease in diabetes mellitus patients.

3.2 STUDY SITE

The study was conducted at the Korle- bu Teaching Hospital (KBTH) in the Accra Metropolis. This hospital is the largest premier government hospital in Ghana with about 2000 bed capacity. It serves as the leading tertiary referral center in Ghana. Three centers of excellence, the National Radiotherapy Oncology Centre, the National Cardiothoracic Center and the National Plastic and Reconstructive Centers can be found at the Korle-bu teaching hospital. The hospital has 17 clinical and diagnostic units with an average patient attendance of 1,500 and 250 patient admissions. The National Diabetic Management and Research Centre is the major referral center of diabetic patients at the KBTH. Patients have their usual diabetes clinical days from Mondays to Fridays with an average number of 70 patients reporting at the center each day.

3.3 PARTICIPANTS

Participants were type-2 diabetes mellitus reporting at the center during clinical days. They were the ages of 30 years and above, confirmed type 2 diabetes mellitus patients at the clinic and signed an informed consent to partake in the study.

3.4 SAMPLING PROCEDURE

Participants were recruited based on convenient sampling. It was a convenient sampling of folders of patients attending the diabetic clinic each day based on the inclusion and exclusion criteria. 10 – 15 samples were collected over a 3-day period visit to the center. Additional information was obtained from participants via telephone call interviews.

3.5 SAMPLE SIZE DETERMINATION

The minimum sample size of participants for sampling is determined by the formula

$N= (Z^2_{(1-\alpha/2)} P(1-P)) / d^2$

Where $(_{1-\alpha/2})$, is the standard normal variate at 5% type 1 error with a confidence interval of 95%. p is the expected proportion in population-based on recent surveys.

d is the absolute error.

p= 0.150 (15.0%) from a study conducted on "The risk of obstructive sleep apnea, excessive daytime sleepiness and depressive symptoms in a Nigerian elderly population" (Fawale et al., 2016).

Therefore,

$$N= \frac{(1.96)^2 \times 0.150(1-0.150)^2}{0.05}$$

N= 195.92 = 196. With the minimum sample size, 196 participants were to be recruited for the study but this number was reduced due to limitations imposed by the closure of universities and limited access to the study centre due to the COVID-19 pandemic. A sample size of 60 was selected to conduct a pilot study.

3.6 INCLUSION CRITERIA

1. Confirmed type 2 diabetes mellitus patients

2. Adult patients aged 30 years and above

3. Attendants and new referrals reporting at the diabetes clinic at Korle-bu.

4. Patients who consent to written or verbal consent.

3.7 EXCLUSION CRITERIA

1. Children and adults aged below 30 years.

2. Pregnant women.

3. Patients who are mentally unstable and/or unable to communicate and cooperate.

3.8 SAMPLE COLLECTION PROCEDURE

During routine visits to the diabetes clinic, adult diabetes patients attending the clinic were selected for this study after authorization from relevant authorities of the National Diabetic Management and Research Centre and participants had given verbal consent over the telephone. The COVID-19 pandemic made it necessary for this research to be conducted using telephone call interview to administer questionnaires.

Specific demographic data including age and gender and level of education were obtained together with a background history of type 2 diabetes mellitus (i.e. the duration of disease and current treatment), diagnosis of hypertension or any other cardiovascular or pulmonary disease. Information regarding smoking status, use of caffeine, alcohol and psychoactive substance were also obtained.

Anthropometric measurements like height, weight, and blood pressure were extracted from patients' records. Body Mass Index (BMI) was computed from their height and weight. Two validated questionnaires were completed by interviewing participants by telephone. All 60 participants responded to the request for the telephone interview and the questionnaires were employed on these patients.

One of these questionnaires was the STOP – BANG QUESTIONNAIRE, which is a simple validated 8 item two-part instrument. The first part 'STOP' asks about symptoms of snoring, tiredness, observed apnea, and a history of high blood pressure. The second part includes a section where body mass index (BMI), age, neck circumference in (centimeters) and gender were documented. Neck circumference was however excluded from the questionnaire because of the inability to measure it directly on the patients due to restrictions imposed during the COVID-19 pandemic. A total score of 3 or above in a patient was considered as intermediate or high risk for obstructive sleep apnea.

Scoring for STOP-BANG:

Low risk of OSA: Yes to 0-2 questions.

Intermediate risk of OSA:Yes to 3-4 questions.

High risk of OSA:Yes to 5-8 questions

However Intermediate risk becomes High risk if:

• Yes to 2 or more of STOP questions + Male gender.

• Yes to 2 or more of STOP questions + BMI > 35kg/m2.

• Yes to 2 or more of STOP questions + neck circumference (> 17inches/43cm in male, and 16inches/41cm in females).

The second questionnaire was the EPWORTH SLEEPINESS SCALE (ESS) QUESTIONNAIRE. This is also a validated 8 item instrument that measures the ease of falling asleep during the daytime under various circumstances as a measure of daytime hypersomnolence (Daniłosio et al., 2017). The interpretation of the instrument is as follows:

1. 0 – 5: Good (likely getting restful sleep)

2. 6 – 10: Satisfactory (sleep could be improved but may not be to sleep apnea)

3. Above 10: Bad (likely to have excessive daytime sleepiness; suggestive of a sleep disorder possibly OSA).

3.9 DATA MANAGEMENT PLAN

Data collected in this study was kept confidential in an encrypted personal computer for analysis. Data collected was also stored on an external drive for backup. This external drive was kept inaccessible to non-researchers and non-participants to ensure privacy. Hard copies were kept under lock and key. Information concerning the participants was made accessible to the researchers and participants only to ensure that issues of confidentiality with regards to the information obtained from participants are kept safe.

3.10 STATISTICAL ANALYSIS

The data was analyzed using Statistical Package for Social Sciences (SPSS) version 22.0. Descriptive statistics such as pie chart, frequencies and percentages were used to analyze categorical and continuous variables. Correlation analysis was used to determine the relationship between OSA and EDS among T2DM patients, a comparison was made using chi-square and P-value of more than 0.05 was considered as significant in the analysis.

3.11 ETHICAL APPROVAL

Ethical clearance was sought from the Ethics and Protocol Review Committee of the School of Biomedical and Allied Health Sciences of the University of Ghana before the study. Approval was also sought from the National Diabetic Management and Research Centre at the Korle-Bu Teaching Hospital. The study was also explained to the participants giving them the option to accept or decline the opportunity to be involved in the study. The informed consent of participants was sought before the data was collected. Participation in this study was voluntary and participants were free to withdraw at any point. There was no risk associated with this study. However, much time was required from participants during the telephone call interview session.

3.12 DISSEMINATION OF RESULTS

Copies of the results were submitted to the School of Biomedical and Allied Health Sciences, Department of Respiratory Therapy as well as the School Library. The findings will also be published in peer-review journals.

Results

4.1 Introduction

This chapter focuses on data analysis and presentation of results. The topics covered are respondents' demographic information, observation of lifestyle of patients which includes smoking, alcohol intake, and BMI classification, to enable examination of risk factors of

OSA or prevalence of excessive daytime sleepiness (EDS) among Type 2 Diabetes Mellitus patients, and the relationship between OSA, EDS and Type 2 Diabetes Mellitus. Primary data (questionnaire and interview guide) was employed for the analysis and SPSS was used to analyze and interpret findings.

4.2. Socio-Demographic Data

4.2.1. Gender of Respondents

Out of a total of 60 patients surveyed, 14 of them equaling 23.3 percent, were male while 46 equaling 76.7 percent were female. Thus, more female patients were involved in the study compared to males.

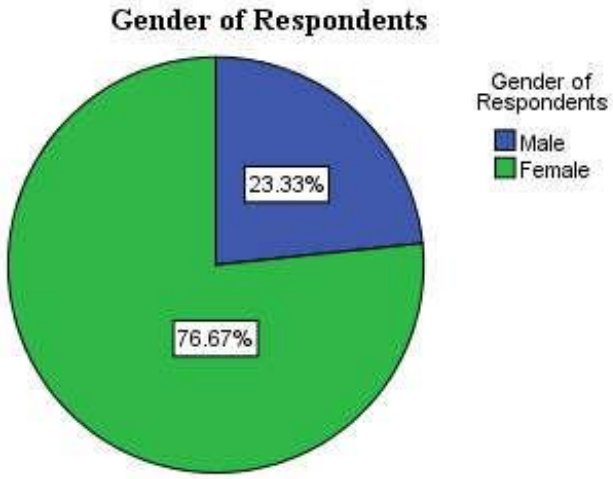


Figure 2.1 Gender of respondent

4.2.2. Age of Respondents

The mean age of patients in this study was 59.8 ± 10.4 years with the mean age of females 60.63 ± 1.97 and the mean age of males 54.77 ± 2.62. The patients were grouped into six (6) major age categories: 30-39, 40-49, 50-59, 60-69, 70-79 and 80 or above.

Table 2: Age groups of patients

AGE GROUP (YEARS)	FREQUENCY (N)	PERCENTAGE (%)	MEAN AGE	STANDARD DEVIATION
30 – 39	3	5.0	38.67	0.58
40 – 49	5	8.3	46.40	2.07
50 – 59	25	41.7	55.24	2.84
60 – 69	19	31.7	64.95	2.71
70 – 79	5	8.3	75.80	2.86
≥ 80	3	5.0	81.67	1.15
TOTAL	**60**	**100.0**		

The findings in Table 2 show that most of the type 2 Diabetic patients interviewed were in the age categories of 50 – 59 and 60 – 69, equaling about 73.4 percent (41.7% and 31.7% respectively) among the interviewed patients. Very few patients represented the age groups 30 – 39, 40 – 49, 70 – 79 and 80 or above.

4.2.3. Educational Level of Patients

From the findings, 18 patients representing 30 percent of the respondents had no formal education. Out of the remaining 70 percent with formal educational background, 25 respondents, representing 41.7 percent were in the Basic level category. While 11 respondents representing 18.3 percent had Secondary level background and 6 respondents equaling 10 percent had tertiary educational level.

Table 3. Educational Level of Patients

EDUCATIONAL LEVEL	FREQUENCY (N)	PERCENTAGE (%)
No Formal Education	18	30.0
Basic Education	25	41.7
Secondary Education	11	18.3
Tertiary Education	6	10.0
TOTAL	**60**	**100.0**

From the findings in table 2.2 above, the modal category for education variable was the Basic level. It could therefore be said that most patient who were interviewed for this study had basic level of education representing 41.7% out of the total sampled population.

4.2.4. Marital Status of Respondents

Out of the total 60 study participants interviewed, one patient, representing 1.7 percent was single. 47 patients, (78.3 percent) were identified as being in marital union while 12 patients (20 percent) who chose the 'others' option (were divorced or widowed).

4.3. Observation of Patients' Characteristics

This portion of the study focuses on lifestyle habits of patients which puts them at high risk for OSA as well as diabetic complications.

4.3.1. Lifestyle Habits of Patients

Specifically, on smoking of tobacco/cigarette, the majority of patients interviewed, 57 of them representing 95%, never engaged in smoking, whereas the remaining 5% (3 patients) smoked infrequently.

Considering alcohol intake majority, 60% of the patients (36 out of the 60 patients), never drank alcohol whereas 13.3% (8 patients) infrequently took alcohol and 16 out of the 60 respondents (17.7%) frequently took in alcohol.

4.3.2. Body Mass Index (BMI) of Respondents

Anthropometric measurements like height and weight were obtained from patients' records to aid computation of the Body Mass Index (BMI).

From the findings, as detailed in table 4, majority 35% of the patients were noticed to be overweight as their BMI fell within the range of 25.0 - 29.9 (kg/m^2). 10 out of the 60 respondents were obese with their BMI greater or equal to 30 kg/m^2 and 7 (11.7%) of the patients were underweight (BMI value < 18.5 kg/m^2). There were no morbidly obese patients (BMI >35 kg/m^2) in this study.

Table 4: BMI of Respondents

BMI Category	Value (kg/m^2)	Frequency	Percentage (%)
Underweight	< 18.5	7	11.7
Normal	18.5 – 24.9	22	36.6
Overweight	25.0 – 29.9	21	35.0
Obese	≥ 30.0	10	16.7
Total		**60**	**100.0**

4.4. Risk of OSA by STOP-BANG score

Information for assessing the risk of OSA was obtained from a validated questionnaire, the STOP-BANG questionnaire. This questionnaire addressed 8 attributes including snoring, tiredness, observation of choking/ceased breath/gasping in sleep, high blood pressure, BMI, age, neck size and gender. Neck circumference was scored as a "No" for all interviewed patients since majority of the them couldn't give an accurate figure. Table 5 presents the scores of the patients.

Table 5: STOP-BANG Score of Patients

Scoring	Frequency	Percentage (%)
Yes to 0-2 questions	12	20.0
Yes to 3-4 questions	39	65.0
Yes to 5-8 questions	9	15.0
TOTAL	**60**	**100.00**

Based on the scoring system of the STOP-BANG questionnaire and findings as shown in table 5, it indicates that the majority of the patients had intermediate risk for OSA with a few having high risk. Specifically, 39 out of 60 (65.0%) patients interviewed had Yes to 3-4 questions, hence were classified as patients with intermediate risk for OSA. Twelve patients (20.0%) had low risk for OSA whereas 9 patients (15.0%) had a high risk for OSA. Overall, including high and intermediate risk scores 48 patients (80.0%) had abnormal STOP-BANG score implying that they had moderate/severe risk for obstructive sleep apnea (OSA) whereas, 12 (20.0%) had a normal STOP-BANG scores signifying low risk for OSA. The mean score of patients with normal STOPBANG score was 1.17 ± 0.58 while that of patients with abnormal scores was 3.71 ± 0.80.

4.4.1 Risk Factors for Medium-High STOP-BANG Scores in T2DM Patients

There were 38 patients (63.3%) aged 55 years and above who had abnormal STOP-BANG scores (moderate-to-severe risk for OSA) compared with 10 patients (16.7%) aged less than55 years with abnormal scores.

Table 6: Body Mass Index (BMI) of Patients with Abnormal STOP-BANG

BODY MASS INDEX (BMI)	FREQUENCY (N)	PERCENTAGE (%)
Overweight	20	33.3%
Obese	10	16.7%

Table. 6 shows that there were 20 patients (33.3%) who were overweight (BMI of 25.0 – 29.9 kg/m^2) and also had medium-to-high risk for OSA. However, obese patients (BMI > 30 kg/m^2) with medium-to-high risk for OSA formed 16.7% of participants.

Table 7: Patients scoring of the 'STOP' risk factors in the STOP-BANG questionnaire

Risk factor	Yes (%)	No (%)	Chi square	P-value
Snoring	50 (83.3%)	10 (16.7%)	11.76	0.02
Tiredness	53 (88.3%)	7 (11.7%)	13.45	< 0.001
Observed Apnea	13 (21.7%)	47 (78.3%)	4.22	0.07
P – High blood pressure	10 (16.7%)	50 (83.3%)	7.5	0.063

Table 7 above shows that majority of patients 50 (83.3%) snored and a few 10 (16.7%) had doctor-diagnosed high blood pressure based on the 'STOP' risk factor in the STOP-BANG questionnaire. The presence of snoring and tiredness were significantly high in T2DM patients in the study with p-values 0.02 and < 0.001 respectively.

4.5. Assessment of Excessive Daytime Sleepiness (EDS)

Under this section, ease of patients to fall asleep during the daytime under various circumstances as a measure of daytime hyper somnolence was determined using Epworth sleepiness scale (ESS).

Table 8 below shows the scores of patients on the ease of them falling asleep under various conditions.

Table 8: ESS Score of Patients

Scoring (Scale)	Frequency (N)	Percentage (%)
≤ 10	16	26.7
> 10	44	73.3
TOTAL	**60**	**100.0**

Table 8 above indicates that 16 patients (26.7%) had a score ≤ 10 and 44 (73.3%) patients had an abnormal score of >10. This implies that the majority of the patients (73.3%) have excessive

daytime sleepiness (EDS) while just over a quarter (26.7%) had no EDS. Patients with no EDS had a mean ESS score of 8.63 ± 1.02 whiles patients with EDS had a mean ESS score of 13.44 ± 2.25.

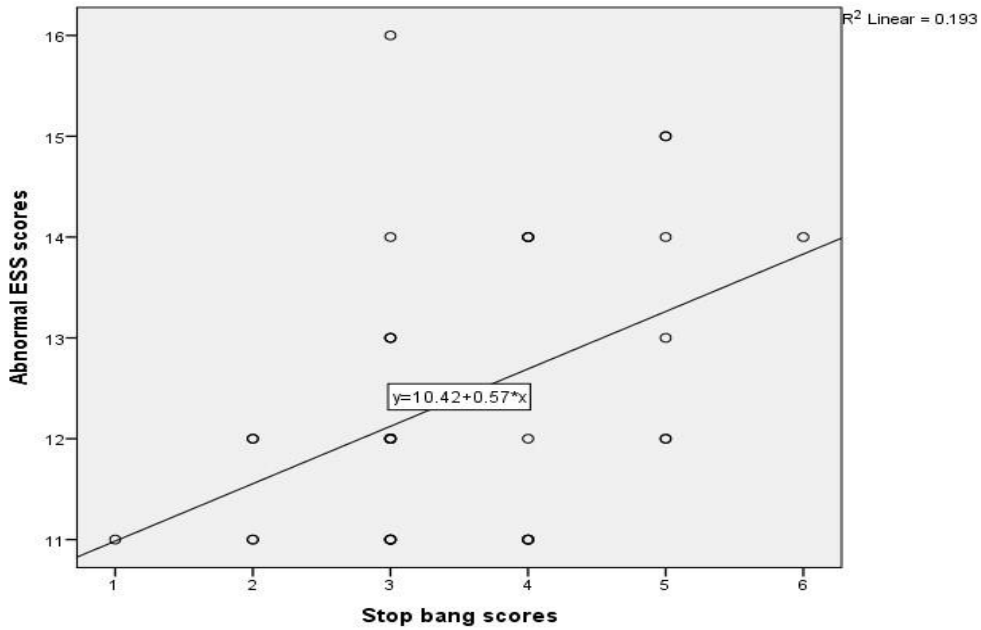
Additionally, comparing patients who answered 'Yes' to snoring, 37 out of 60 (61.70%) had abnormal ESS score and excessive daytime sleepiness (EDS), and 26 of them (70.3%) were females as shown in table 9 below.

Table 9: Gender of Patients with Both Snoring and Abnormal ESS score

SEX	FREQUENCY (N)	PERCENTAGE (%)
MALE	11	29.7%
FEMALE	26	70.3%

4.6 Relationship Between OSA And EDS

Figure 3 below shows the correlation between the STOP-BANG scores and the ESS scores amongst the 60 patients.



Correlation showed a significant linear relationship between the STOP-BANG and ESS scores of patients (r =0.44; p-value < 0.01).

Additionally, comparing the mean difference of both patients with normal and abnormal STOP-BANG and ESS score in tables 10 and 11 below shows there is a significant difference between patient numbers, with significantly more T2DM patients with abnormal scores.

Table 10: Normal versus Abnormal STOP-BANG Scores

STOP-BANG SCORES	NUMBER OF PATIENTS	MEAN DIFFERENCE (X^2)	P – VALUE
0 – 2	12	-2.250	< 0.001
3 – 8	48		

Table 11: Normal Versus Abnormal ESS Scores

ESS SCORE	NUMBER OF PATIENTS	MEAN DIFFERENCE (X^2)	P – VALUE
≤ 10	16	-3.393	< 0.001
> 10	44		

In Table 12, there was a significant difference between the mean ESS scores of patients with normal and abnormal STOP-BANG scores using the student T test (p-value < 0.001), showing that T2DM patients with a high STOP-BANG score and medium-high risk of OSA were significantly more likely to have EDS. This supports the correlation between STOPBANG and ESS scores in Type 2 diabetic patients demonstrated in Fig. 3.

Table 12 Comparison of ESS scores in patients with Normal (Low Risk) and Abnormal

	Mean ESS score Mean (± SD)	T-test	p-value Of OSA
Low risk of OSA	8.4 (-2.159)	-6.37	< 0.001
Medium-High risk	11.8 (-1.884)		

Discussion

5.1 INTRODUCTION

Individual patients affected by OSA mostly suffer from diabetes, hypertension, dyslipidemia, metabolic syndrome and other related medical conditions (Lam et al., 2014; Drager et al., 2010 & Olufemi Adewole et al., 2009). There has been a scarcity of data in the sub-Saharan concerning OSA as compared to developed countries until recently (Mbata & Chukwuka, 2012). This study did not employ the gold standard for the diagnosis of OSA since it mainly focused on the risk factors associated with OSA in T2DM patients. Since OSA and T2DM are associated with increased cardiovascular morbidity and mortality, it is comprehensible that the presence of both conditions results in synergistic risk factors (Greenberg & Rajan, 2015). This study, therefore, determined the prevalence of excessive daytime sleepiness and risk factors of obstructive sleep apnea among type 2 diabetes mellitus patients at the KorleBu Teaching Hospital in the Accra Metropolis, which further establishes an association between the conditions. This chapter discusses the findings about the study objectives and research aim.

5.2. PREVALENCE OF ESS AND RISK FACTORS FOR OSA AMONG T2DM PATIENTS.

5.2.1. AGE AND SEX AS RISK FACTORS FOR OSA AMONG T2DM PATIENTS

In this study, the average age of T2DM patients was 59.8 ± 10.4 years indicating that most patients were middle-aged adults, which is comparable to other works on adult T2DM populations (Akintunde, 2013). However, Wang (2019) reported an average age of 63.5 ± 11.6 of

T2DM patients in his study. In this study, there is a higher proportion (81.7%) of middle and older age groups (50 – 79 years) in comparison with the younger age group (≤ 49 years) among the T2DM patients. There was a higher proportion of females (76.7%) in comparison with males (23.3%). The representation of females in this study was more than that of males possibly because females were more receptive to the interview than males. Age was a predictor of OSA in this study. The number of T2DM patients aged 55 years and above who had abnormal STOP-BANG scores (moderate-to-severe risk of OSA) made up 63.3% of patients in the study. However, a study conducted by Obaseki and colleagues (2014) in Nigeria, on the prevalence of OSA among a sample of 117 T2DM patients revealed a much lower proportion (25.1%) of moderate-to-severe OSA in T2DM patients. Aging causes an alteration in the upper airway muscles leading to greater upper airway collapsibility during sleep and predisposes them to the occurrence of OSA (Strollo et al., 2017).

5.2.2 BMI OF PATIENTS AS RISK FACTOR FOR OSA

This study revealed 31.0% of participants take in alcohol (either infrequently and frequently) as well as 5.0% who smoke. The average BMI of 25.7 kg/m2 recorded in this study is lower than that of a study conducted by Obaseki et al. (2014). This may be because the majority of the patients were more than 60 years of age in that study (Obaseki et al., 2014) as

BMI increases with age (Zhang et al., 2015). The percentage of overweight and obese (BMI ≥ 25 kg/m2) was 51.7% which is lower than was observed in the Nigeria-based study (76%) conducted by Obaseki and colleagues. The proportion of Type 2 diabetes mellitus patients who had abnormal STOP-BANG scores (3 – 8) and were classified to have a moderate-to-severe risk for OSA was 80%. The average STOP-BANG score was 3.71 ± 0.81 for such patients. The 'gold standard' for diagnosis of OSA is overnight Polysomnography. Notwithstanding, questionnaire-based screening tools can be used to assess patients who may have a high risk for obstructive sleep apnea. In this study, 15.0% of patients were at high risk for OSA and 20.0% were at low-risk OSA, however, the majority of patients (65.0%) had an intermediate risk for OSA. West et al, (2009) in a similar study of the prevalence of OSA in men with Type 2 diabetes found that 528 (56.2%) of the patients scored high risk for OSA while 362 (38.6%) were low risk. More patients were at high risk for OSA in their study probably because the sample population was solely male diabetic patients. Since the male gender is one of the predictors for OSA, this may explain the increased prevalence of high-risk patients for OSA in that study.

T2DM patients who were obese (BMI ≥ 30.0 kg/m2) and had a moderate-to-severe risk for OSA were 10 (16.7%). Also, overweight patients (BMI 25.0 - 29.9 kg/m2) who had a moderate-to-severe risk for OSA were 20 (33.3%). Peppard et al, (2016) showed a strong relationship between an increase in BMI and risk of OSA. An increase in weight affects breathing in several ways. For example, the pharyngeal size and upper airway force of patients can be reduced as a result of increased adipose tissue in the upper airway or the muscle and this affects breathing during sleep (Oliven et al., 2016). Epidemiologic studies from around the world have consistently proven that BMI is the strongest predictor for obstructive sleep apnea (Akintunde, 2013). Though the neck circumference of patients in this study was not measured, it is possible most overweight and obese T2DM who had abnormal STOP-BANG scores had large neck circumference.

5.2.3 PREVALENCE OF EXCESSIVE DAYTIME SLEEPINESS (EDS) AMONG T2DM PATIENTS

Assessing the prevalence of excessive daytime sleepiness with the Epworth Sleepiness Scale (ESS) showed that the number of patients with a normal ESS score (≤ 10) was 16 (26.7%). However, there was a significant number, 44 (73.3%) of T2DM patients with abnormal ESS scores and hence classified as having excessive daytime sleepiness (EDS). The mean ESS score for patients without EDS was 8.63 ± 1.02 and that of subjects with EDS was 13.44 ± 2.25. Comparing the prevalence of EDS in this study to a similar study conducted by Obaseki and colleagues (2014), the latter showed a much lower prevalence of (22.0%) EDS among 117 T2DM patients that took part in the study in Nigeria. The reason for this low prevalence in that study was possibly due to a lower number of patients who reported as habitual snorers (35.0%). In this study, the number of patients who reported snoring and had abnormal ESS scores was 37 out of the 60 participants (61.6%) of which 11 (29.7%) were male and 26 (70.3%) were female.

5.2.4 RELATIONSHIP BETWEEN EXCESSIVE DAYTIME SLEEPINESS (EDS), OBSTRUCTIVE SLEEP APNEA (OSA) AND TYPE 2 DIABETES MELLITUS (T2DM)

This study showed that 80% of T2DM patients had a moderate-to-high risk for OSA and 15.0% were at high-risk for OSA based on their STOP-BANG scores. Studies based on full polysomnography suggest that the prevalence of OSA in T2DM is higher than when using questionnaire-based screening tools to assess the risk of OSA (Obaseki et al., 2014). So in this study, patients with intermediate and high STOP-BANG scores were considered a medium-high risk for OSA. Comparing the mean ESS scores of T2DM patients who had low STOP-BANG scores

(0-2) and medium-to-high STOP-BANG scores (3-8), it showed a significant difference between them in the ESS scores ($p < 0.001$).

Correlation analysis (Fig.3) showed that there was a significant relationship between patients' ESS and STOP-BANG scores ($p < 0.01$). Additionally, among T2DM patients interviewed in this study, there were significantly more patients with abnormal STOP-BANG scores and abnormal ESS scores ($p < 0.001$), suggesting a significant association between T2DM, ESS AND OSA.

5.3 CONCLUSION

In conclusion, this study showed that most patients with T2DM had a moderate or high risk for OSA. The prevalence of excessive daytime sleepiness was high in Type 2 diabetes mellitus patients based on this study, and it was a significant risk factor for patients with medium-high risk for OSA. The study further showed that older age, overweight, and obesity had an impact, increasing the risk of OSA in type 2 diabetes patients.

5.4 LIMITATIONS

The limitations of this study were:

1.The sample size was smaller than the calculated sample size due to reduced access to patients and the need to conduct telephone interviews. This could have introduced sample bias.

2. An important parameter in the questionnaire (neck circumference) was ignored in the study because restrictions on access to patients did not make it possible for it to be measured directly on the patients.

3. The use of telephone interviews made it very difficult to assess the true response of patients, or if there was a lack of understanding of questions. There was also in some cases the problem of the language barrier and the use of interpreters in translating the questions.

5.5 RECOMMENDATIONS

The study recommendations are:

1. Recent studies have shown that sleep disorders impact on the development and management of diabetes so these important findings should be considered when managing diabetic patients.

2. The prevention or reduction of overweight and obese patients should be an important target in the treatment of T2DM as it puts them at increased risk of OSA.

Ambulant sleep studies like polygraph or full polysomnography should be conducted on T2DM patients found to have a significant risk of OSA and/or evidence of EDS, for corrective treatment with CPAP to be started.

References

1.Akintunde, A. A. (2013). "Clustering of metabolic syndrome and obstructive sleep apnoea Syndrome Z among adult nigerians with systemic hypertension: Prevalence and clinical correlates". *International Journal of Cardiovascular Research*, *01*(05).

2.Al Jobori, H., Daniele, G., Adams, J., Cersosimo, E., Solis-Herrera, C., Triplitt, C., & AbdulGhani, M. (2018). *The Journal of Clinical Endocrinology & Metabolism*, *103*(4), 1402-1407.

3.Al-Abri, M., Al-Lawati, I., & Al-Zedjali, F. (2017). "Sleep pattern among young and middle aged Omani adults using actigraphy". *Sleep Medicine*, *40*, e9.

4.Amra, B., Rahmati, B., Soltaninejad, F., & Feizi, A. (2018). *Oman Medical Journal*, *33*(3), 184-192.

5.Anh, T. H., & Van, M. H. (2016). Ps 17-21 "effect of obstructive sleep apnea syndrome on essential hypertension". *Journal of Hypertension*, *34*, e479.

6.Arnardottir, E. S., & Gislason, T. (2016). *Sleep Medicine Clinics*, *11*(4), 421-434.

7.Aronsohn, R. S., Whitmore, H., Van Cauter, E., & Tasali, E. (2010). "Impact of untreated obstructive sleep apnea on glucose control in type 2 diabetes". *American Journal of Respiratory and Critical Care Medicine*, *181*(5), 507-513.

8.Bais, R. (2005). Clinical chemistry: Principles, procedures, correlations, 5th ed. Michael L.Bishop, Edward P. Fody, and Larry Schoeff. Baltimore, MD: Lippincott Williams & Wilkins, 2005, 756 pp., $76.95, hardcover. ISBN 0-7817-4611-6. *Clinical Chemistry*, *51*(8), 1567-1567.

9.Basoglu, O. K., & Tasbakan, M. S. (2017). "*Sleep and Breathing"*, *22*(1), 241-249.

10.Beihl, D. A., Liese, A. D., & Haffner, S. M. (2009). "*Annals of Epidemiology"*, *19*(5), 351-357.

11.Bello, A., Adegoke, B., & Emannuel, B. O. (2011). *International Journal of General Medicine*, 723.

12.Buxton, O. M., Pavlova, M., Reid, E. W., Wang, W., Simonson, D. C., & Adler, G. K.(2010). *Diabetes*, *59*(9), 2126-2133.

13.Carberry, J. C., Jordan, A. S., White, D. P., Wellman, A., & Eckert, D. J. (2016). *Sleep*, *39*(3), 511-521.

14.Cassar, A., Morgenthaler, T. I., Lennon, R. J., Rihal, C. S., & Lerman, A. (2007). *Journal of the American College of Cardiology*, *50*(14), 1310-1314.

15.Cernea, S., & Dobreanu, M. (2013). "Diabetes and beta cell function: From mechanisms to evaluation and clinical implications". *Biochemia Medica*, 266-280.

16.Chao, C., Wu, J., Yang, Y.,Shih, C., Wang, R., Lu, F., & Chang,C.(2011). *Metabolism*, *60*(6), 799-804.

17.Chaput, J., Després, J., Bouchard, C., Astrup, A., & Tremblay, A. (2009). "Sleep duration as a risk factor for the development of type 2 diabetes or impaired glucose tolerance: Analyses of the Quebec family study". *Sleep Medicine*, *10*(8), 919-924.

18.Chen, C., Xie, Z., Shen, Y., & Xia, S.F. (2018). *International Journal of Endocrinology*, *2018*, 1-14.

19.Chirinos, J. A., Gurubhagavatula, I., Teff, K., Rader, D. J., Wadden, T. A., Townsend, R., Foster, G. D., Maislin, G., Saif, H., Broderick, P., Chittams, J., Hanlon, A. L., & Pack, A. I. (2014). *New England Journal of Medicine*, *370*(24), 2265-2275.

20.Chiu, H., Chen, P., Chuang, L., Chen, N., Tu, Y., Hsieh, Y., & Guilleminault, C. (2017). *Sleep Medicine Reviews*, *36*, 57-70.

21.Cho, N., Shaw, J., Karuranga, S., Huang, Y., Da Rocha Fernandes, J., Ohlrogge, A., & Malanda, B. (2018). *Diabetes Research and Clinical Practice*, *138*, 271-281.

22.Chung, F., Subramanyam, R., Liao, P., Sasaki, E., Shapiro, C., & Sun, Y. (2012). *British Journal of Anaesthesia*, *108*(5), 768-775.

23.Chung, F., Yegneswaran, B., Liao, P., Chung, S. A., Vairavanathan, S., Islam, S., Khajehdehi, A., & Shapiro, C. M. (2008). *Anesthesiology*, *108*(5), 812-821.

24.Chung, K. (2000). "Use of the Epworth sleepiness scale in Chinese patients with obstructive sleep apnea and normal hospital employees". *Journal of Psychosomatic Research*, *49*(5), 367372.

25.Cummings, K. M. (2010). *Behavioral and Social Science*.

26.Dabelea, D., Mayer-Davis, E. J., Saydah, S., Imperatore, G., Linder, B., Divers, J., & Hamman, R. F. (2014). *JAMA*, *311*(17), 1778.

27.D'Adamo, E., & Caprio, S. (2011). *Diabetes Care*, *34*(Supplement_2), S161-S165.

28.DeFronzo, R. A. (2009). *Diabetes*, *58*(4), 773-795.

Volume 1 Issue 3 November 2020