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Prevalence and Risk Factors of Obstructive Sleep Apnea Among Hypertensive Sudanese Patients Attending Selected Hospital in Khartoum State, Sudan Between February - April 2022

University of Medical Sciences and Technology (UMST)
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ABSTRACT

- ***Introduction***

Obstructive sleep apnea (OSA) is highly relevant to patients with hypertension (HTN). These 2 conditions frequently coexist (an estimated 50% of patients with HTN have concomitant OSA), and recent evidence supports the notion that OSA represents the most prevalent secondary contributor to elevated blood pressure (BP) in patients with resistant HTN.[3] OSA although common and associated with significant cardiovascular morbidity and mortality it still remains widely underdiagnosed, especially in developing countries like Sudan , this is mainly due to the high cost of the gold standard test which is polysomnography and lack of professional sleep study centres. Screening for OSA is essential in order to provide early management and prevent complications, especially with the lack of professional sleep study centres in Sudan.

- ***Objectives***

To assess the risk of OSA among hypertensive patients using the berlin questionnaire, to determine the risk factors for OSA among Sudanese hypertensive patients and to know the most prevalent risk factor.

- ***Methodology***

This was a descriptive cross-sectional facility-based study that took place in the out-patient department of Yastabsheroon and Police hospital, in Khartoum city, Sudan . 230 adult hypertensive patients were interviewed using a questionnaire for symptoms and risk factors of obstructive sleep apnea.

- ***Results***

230 participants were included in the study. 51.3 % were males and 48.7 were females. Gender was not associated with the risk of OSA in our study. As age increases the risk of obstructive sleep apnea increases with a significant P-value of 0.039. The highest risk was seen among participants aged 60 and above. Body mass index was associated with the risk of OSA among participants with a significant a P-value of 0.019. Neck circumference was not associated with the risk of OSA with a p- value of 0.259. 87.8% of participants were at high risk of OSA ,96.5% were adherent to their medication, and 71.7 % claimed to have a well-controlled blood pressure. 50.9% experienced the symptoms of OSA before being diagnosed with hypertension while 40.1% suffered from OSA symptoms after being diagnosed with hypertension.

- ***Conclusion***

Risk of OSA was high among Sudanese hypertensive patients. Age, BMI, heart diseases, stroke and chronic lung diseases were associated with increased risk of OSA among hypertensive Sudanese patients, while gender, neck circumference, smoking, diabetes, chronic nasal congestion or allergies, and thyroid disease were not associated with increased risk of OSA among hypertensive Sudanese patients. Heart disease was the most relevant factor associated with high risk of OSA.

- ***Recommendations***

There is a need to establish sleep study centres and sleep laboratories in Sudan, and to encourage specialization in this field. Until this is achieved doctors should screen suspected patients especially those with hypertension using berlin questionnaire and a trial of C-PAP may be acceptable for high-risk patients. Raising the awareness of sleep apnea among community as well as doctors and the importance of early diagnosis and treatment of obstructive sleep apnea to avoid serious complications. To encourage future researches to study the type of association between hypertensive and OSA among Sudanese.

***Keywords*:-** *Obstructive Sleep Apnea, Sleep Apnea, Sleep, Apnea, Sudanese, Hypertensive.*

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DEDICATION

Every challenging work needs self-effort as well as guidance of seniors especially those who were very close to our heart.

My humble effort I dedicate it to my magnificent parents

Dr. Fathelrahman Ahmed and Ahlam El-Sherif, whose constant affection, support, guidance and prayers make me able to get such success.

I would also like to thank my siblings for being there for me in every step of this journey.

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LIST OF ABBREVIATIONS

AASM	American Academy of Sleep Medicine
AHI	Apnea hypopnea index
BP	Blood pressure
BMI	Body mass index
CMS	Center for medicare and medicaid services
CPAP	Continuous positive airway pressure
HTN	Hypertension
MAD	Mandibular advancement device
OSA	Obstructive sleep apnea
OSAS	Obstructive sleep apnea syndrome
OSAHS	Obstructive sleep apnea hypopnea syndrome
OA	Oral appliances
PSG	polysomnography
RDI	respiratory disturbance index
RERA	respiratory event related arousal
REM	rapid eye movement
UA	upper airways
UARS	upper airway resistance syndrome

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CHAPTER ONE
INTRODUCTION

➢ *Background Information*

Obstructive sleep apnea (OSA) - also known as obstructive sleep apnea hypopnea - is a sleep disorder that involves the cessation or significant reduction of airflow in the presence of exertion respiratory. It is the most common type of sleep-disordered breathing and is characterized by recurrent episodes of upper airway collapse during sleep. [1]

These episodes are associated with periodic desaturation of oxyhemoglobin and awakenings from sleep.

OSAS associated with excessive daytime sleepiness is commonly referred to as obstructive sleep apnea syndrome – also known as obstructive sleep apnea-hypopnea syndrome.

Although OSAS is a common condition, most primary care physicians in the United States recognize OSAS.[2]

The main symptoms of sleep apnea include the "3S": snoring, drowsiness and other significant reports of sleep apnea episodes. This helpful mnemonic has proven invaluable in teaching residents to sensitively identify and appropriately refer these patients for further study.

Obstructive sleep apnea (OSA) is strongly associated with hypertension (HTN). These 2 conditions frequently coexist (an estimated 50% of HTN patients have OSA), and recent evidence supports the idea that OSA is the most common secondary cause of high blood pressure in HTN patients. refractories. [3]

- *Epidemiological Association of OSA and HTN*

Previously published population-based studies have identified an independent association between a higher apnea-hypopnea index and increased blood pressure, both at baseline and over time. term. During follow-up measurements. [4] In contrast, isolated systolic hypertension, which is more common in elderly patients, was not associated with OSA in any age group. [4] A key challenge in deciphering the OSA-HTN link lies in correctly accounting for many confounding variables, including obesity and age. Two recent prospective longitudinal cohort studies have addressed these questions in normotensive subjects and reached opposite conclusions: the first study reported that OSAS was not associated with events of systolic hypertension after adjusting for confounding factors relevant (1180 subjects followed for an average of 7.5 years) [6]. The second study (also from Spain, 1889 participants, 12. median follow-up of 2 years) identified an increased risk ratio for HTN in OSA patients compared to controls, and in this second study, the OSA-HTN association remained independent of confounding factors, including age and obesity. Moreover, the follow-up of this cohort of patients revealed a dose-response relationship between the severity of OSAS and the cumulative incidence of HTN [7]. Given the extended follow-up period, this second study provides relatively strong epidemiological evidence that OSA is a factor in the development of HTN.

- *Pathophysiology*

The pathophysiology of HTN in OSA is complex and depends on several factors such as increased sympathetic tone, peripheral vasoconstriction, increased renin-angiotensin-aldosterone activity, and impaired baroreceptor reflexes. [8] Factors linking the pathophysiology of HTN and OSA are hypoxemia, nocturnal fluid shifts, increased sympathetic tone with decreased parasympathetic tone, impaired sleep quality, and renin- angiotensin-aldosterone (Figure 1).

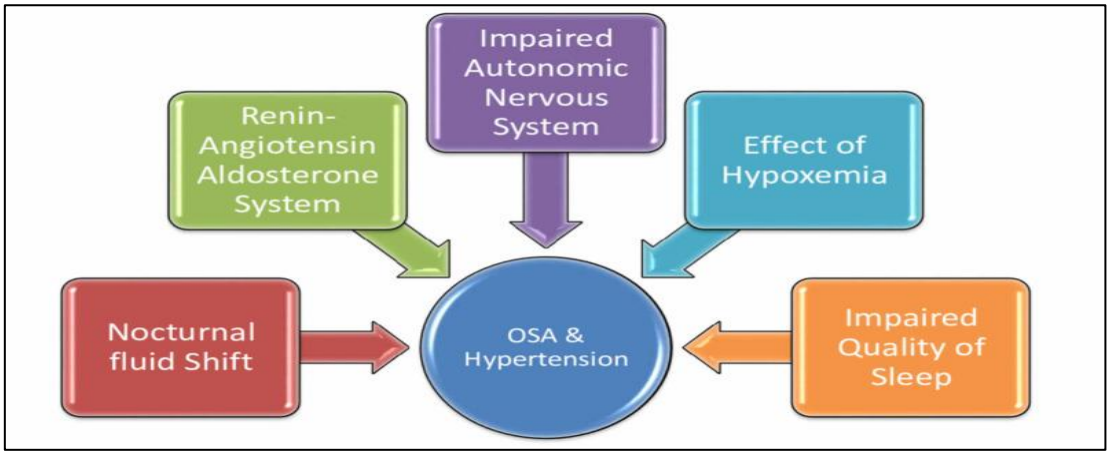

Fig 1 Factors Relating Hypertension and Obstructive Sleep Apnea
Source: PubMed Central, Figure 1: Cureus. 2020 May; 12(5): e8241. Published online 2020 May 22. doi: 10.7759/cureus.8241 (nih.gov)

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A 2016 meta-analysis of 13 studies showed that patients with OSA had higher levels of angiotensin II and aldosterone, especially in cases of concurrent HTN [10]. Excess levels of aldosterone lead to edema of the nasopharyngeal tissue and upper airways, which in turn leads to airway obstruction and subsequent progression of OSA [11]. CPAP treatment was found to be associated with down-regulation of activity of the renin-angiotensin system. [12]

- *Sleep Quality Disorders*

OSA is one of the most important causes of sleep quality disorders [13]. Sleep disturbances or sleep deprivation are also potential contributors to HTN.

Conducted a longitudinal study and concluded that chronic insomnia with short sleep duration increases the risk of HTN, but this effect can largely be explained by obesity control, whereas many other studies showed that sleep deprivation is associated with several risk factors for adverse cardiovascular disease were positively associated: arterial stiffness, endothelial dysfunction, sympathetic activity, nocturnal blood pressure without slope and insulin insensitivity. [14-18]

- *Action of the Autonomic Nervous System*

The sympathetic nervous system is activated and the parasympathetic nervous system is deactivated by changes in CO2 and O2 levels; increases in CO2 and decreases in O2 are caused by apneic events [19]. Elevated levels of catecholamines, along with changes in the autonomic nervous system, persist during the day and may contribute to the development of HTN [20]. During post-apneic hyperventilation, blood pressure can rise to 240/30 mmHg [21,22]. Animal studies suggest that the increase in blood pressure associated with an OSA event may be mediated by renal denervation.[23]

- *Cytokine-Mediated Hypoxemic Effects*

OSA has been observed to be associated with an increased systemic inflammatory load and elevated concentrations of high-sensitivity C-reactive protein (hs-CRP), interleukin (IL)-1, IL-8, IL-6, tumor necrosis factor-α (TNF-α), Rantes and sICAM [24]. OSA-induced oxidative stress behaves like ischemia-reperfusion injury, resulting in the release of reactive oxygen species [25,26]. This overall increase in oxidative stress leads to an increase in cardiovascular risk. Studies in mouse models have shown that atorvastatin reduces inflammation and may prevent several adverse cardiovascular processes associated with intermittent hypoxia. [27]

- *Effect of Age on the Pathophysiology of OSA*

A number of studies have reported that the effect of OSA on cardiovascular diseases such as atrial fibrillation and HTN is more pronounced in young people than in older adults.

- *Symptoms and Signs of OSA During Sleep Include*

✓ *Loud Snoring*
✓ *Stopping Breathing or Struggling to Breathe*
✓ *Feeling of Choking or Gasping*
✓ *Tossing and Turning*
✓ *Sudden Jerky Body Movements*
✓ *Waking Up A Lot During the Night*
✓ *Snorting while You Sleep.*

- *Symptoms of OSA when Awake Include*

✓ *Waking Up Sleepy and Unrefreshed*
✓ *Headache After Wake Up*
✓ *Difficulty Concentrating and Feeling Groggy*
✓ *Poor Memory*
✓ *Feeling Depressed, Irritable or other Changes of Mood*
✓ *Poor Co-Ordination*
✓ *Loss of Libido*

If the patient has a partner, they may be more aware of the snoring and apnea than themselves. It is best if they record (with a cell phone or other recording device) their partner's breathing during the night or record any symptoms their partner is experiencing. [29]

➢ *Risk Factors of OSA:*

Risk factors are included in the figure below

Body mass index (BMI) >30 kg/m^2
Neck circumference >40 cm
Male gender or postmenopausal status in women
Positive family history of OSA
Race
Age >40 years
Alcohol ingestion before bedtime
Underlying hypertension
Metabolic syndrome
Down syndrome

Fig 2 Risk Factors of Obstructive Sleep Apnea
Source: Sleep Apnea Syndrome: More Than Benign Snoring / Implications for the Cardiovascular System - Scientific Figure on ResearchGate. Available from: https://www.researchgate.net/figure/Risk-Factors-for-Obstructive-Sleep-Apnea-OSA_tbl1_256439145 [accessed 14 Mar, 2022]

Other risk factors may include: positive family history of OSA, airway obstruction [especially large tonsils, adenoid, enlarged tongue, enlarged soft palate], hypothyroidism, history of allergy or asthma ,cardiovascular disease including (nocturnal dysrhythmias, CHF, atrial fibrillation, non-dipping BP, refractory hypertension, history of stroke, history and symptoms prompting sleep evaluation by PSG including [daytime sleepiness, habitual snouring ,choking or gasping at night, witnessed apneas decreased concentrations, frequent awaking at night, memory loss].

- *Complications of OSA*

Complications of untreated obstructive sleep apnea include increased risk of premature death, myocardial infarction, dysrhythmias, stroke, hypertension, motor vehicle accidents, metabolic syndrome, and neurocognitive dysfunction.[30] [figure 3]

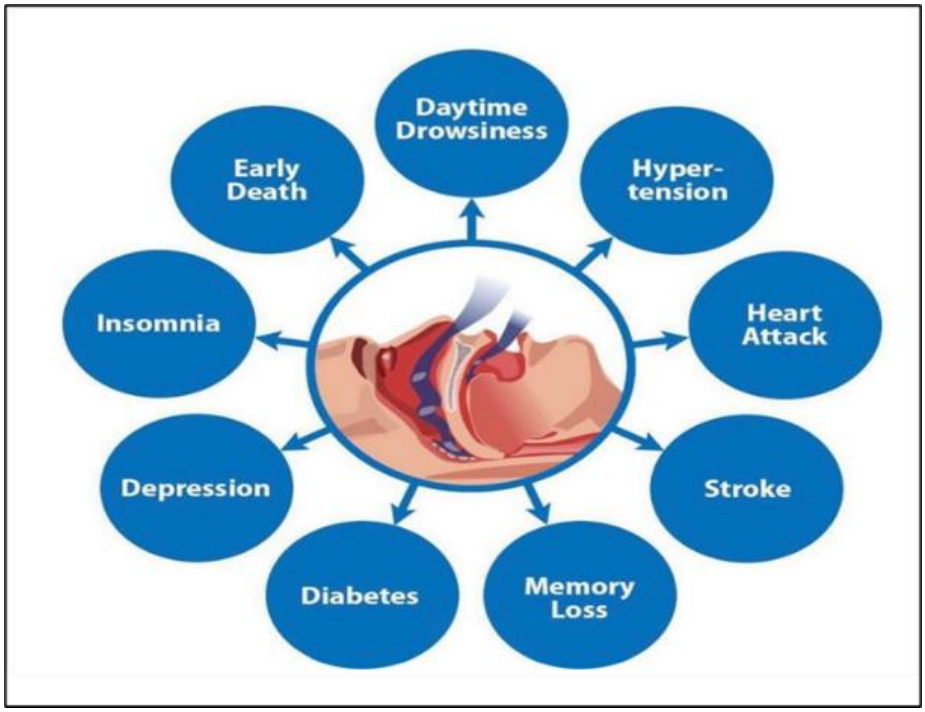

Fig 3 Complication of Obstructive Sleep Apnea
Source: Sleep Apnea Treatment | Sleep Apnea Center Los Angeles (sleepapneacenterla.com)

➢ *Screening*

The American Academy of Sleep Medicine advocates for physicians to ask all adult patients about signs and symptoms of OSA as part of a routine health maintenance evaluation.[31]

2 types of questionnaires are available (BERLIN and STOP BANG) and they are useful for selecting high risk patients for PSG.

➢ *Diagnosis of OSA*

Routine laboratory tests are generally not helpful in OSAS without specific indications. Any patient, especially the elderly, who may have OSA and who have other signs or symptoms of hypothyroidism should be tested for TSH.

A study by Cintra et al studied 150 subjects (75 patients and 75 control subjects, matched for age and sex). They determined that cysteine levels were higher in OSA patients than in controls and that levels decreased after effective OSA treatment. [32] Thus, cysteine may be a potential biomarker of OSA.

➢ *Polysomnography*

There are four types of sleep studies depending on the number of physiological parameters or channels monitored [33]. Nocturnal polysomnography performed in the sleep laboratory in the presence of a chaperone is considered a first-line diagnostic study and is classified as a category I study [33,34,35,36,37-39]. Overnight studies are typically used for diagnosis and follow-up studies for positive airway pressure titration; however, split-night studies, in which diagnosis and positive airway pressure titration are performed on the same night, can also be performed [34,38]. A split-night study is most useful for patients in whom an apnea-hypopnea index greater than 20 events per hour is noted within the first two hours of the study. [38]

In general, home sleep apnea testing is considered less accurate than Class I studies due to loss of data due to separation or malfunction of monitoring equipment [40] .

Also, home monitors with fewer channels cannot distinguish between sleep and wakefulness and therefore can only estimate the apnea-hypopnea index. For patients who cannot be submitted to a sleep laboratory, home sleep apnea testing can replace Type I studies. These tests are more accurate in identifying patients with a high pre-test probability of OSA and may exclude OSA in low-risk patients. [38,40-42] Home sleep apnea testing is not recommended in patients with comorbidities such as congestive heart disease [33,34]

- *PSG is Required for an Accurate Diagnosis of OSA and Determination of Response to Treatment.*

The data were collected in the laboratory in the presence of qualified technicians (i.e. complete PSG and assisted monitoring). This protocol provides the ability to directly observe various sleep-related disorders (e.g., apnea, periodic leg movements, seizures, rapid eye movement [REM] behavior disorder). Patients who frequently work night shifts should receive PSG during the day to match their normal sleep-wake cycle.

- *AASM Criteria and Guidelines for the Diagnosis of PSG*

The AASM has published criteria and guidelines for performing PSG. [43] It is important to conduct patient studies at AASM-accredited sleep disorder centers because these centers meet the criteria established by the AASM.

This includes the standard tests for sleep disorders: PSG Sleep Disorders Centre.

- *AASM PSG Indications and Performance Guidelines Include the following:*

✓ Sleep stages are recorded via an EEG, electrooculogram, and chin electromyogram (EMG).
✓ Heart rhythm is monitored with a single-lead ECG.
✓ Leg movements are recorded via an anterior tibialis EMG.
✓ Breathing is monitored, including airflow at the nose and mouth (using both a thermal sensors and a nasal pressure transducer), effort (using inductance plethysmography), and oxygen saturation.
✓ The breathing pattern is analyzed for the presence of apneas and hypopneas, determined according to definitions standardized by the AASM . [43]

Obstructive apnea is the cessation of airflow for at least 10 seconds with sustained respiratory effort. A respiratory event-related arousal (RERA) is an event in which the patient takes a series of breaths with increased respiratory effort or a flattening of the nasal pressure waveform, resulting in a sleep arousal that would otherwise would not meet the criteria for apnea or hypopnea.

PSG Awakenings detected on the monitor are important in assessing the degree of sleep fragmentation. If esophageal pressures are not monitored, they may be the only clue to UA resistance syndrome (UARS) in patients with daytime sleepiness. Esophageal pressure monitoring is not routinely performed in most laboratories due to the invasive nature of the procedure.

PSG findings characteristic of OSA

- *The following PSG findings are characteristic of OSA:*

✓ Apneic episodes occur in the presence of respiratory muscle effort.
✓ Apneic episodes lasting 10 seconds or longer are considered clinically significant.
✓ Apneic episodes are most prevalent during REM sleep. In some patients, they may occur exclusively during REM sleep.
✓ Patients may have a combination of apneas and hypopneas, or they may have one or the other exclusively.
✓ Mixed apneas may occur.
✓ Sleep disruption due to arousals is usually seen at the termination of an episode of apnea.

The apnea-hypopnea index (AHI) is calculated by dividing the total number of apneas and hypopneas by the total sleep time. Normal thresholds for AHI have never been defined in epidemiological studies on healthy individuals. Most sleep centers use a threshold of 5-10 episodes per hour. The severity of OSA was arbitrarily defined and varied widely between centers. Suggested AHI threshold values include 5-15 attacks per hour for mild cases, 15-30 attacks per hour for moderate cases, and more than 30 attacks per hour for severe cases.

- *When to Repeat PSG*

If symptoms persist despite adequate compliance with prescribed CPAP therapy (see Treatment and Management), PSG should be repeated. PSG can be used to assess response to UA surgery and to assess response to oral appliance (OA) treatment. If body weight continues to change by more than 15%, PSG should be repeated. If the results of the first PSG are of poor quality, the study should be repeated.

Patients who discontinue REM sleep-inhibiting drugs and who develop symptoms during treatment should be reassessed because OSA most often occurs during REM sleep.

OSA occurring during REM sleep should be investigated whenever possible to avoid under-treatment of OSA or false negative diagnoses in diagnostic studies.

- *Management*

The goals of OSA treatment are to treat the signs and symptoms of OSA, improve sleep quality, and normalize the apnea-hypopnea index (AHI) and levels oxyhemoglobin saturation. OSAS should be considered as a chronic disease requiring long-term multidisciplinary care. The potential benefits of successful OSA treatment include clinical improvement (eg, reduction in daytime sleepiness), reduction in healthcare utilization and costs, and potential reduction in morbidity and cardiovascular mortality.

Several national organizations have published clinical practice guidelines for the management of OSAS in adults, including the American Academy of Sleep Medicine (AASM), the American Thoracic Society (ATS), the American College of Physicians (ACP), the International Geriatric Sleep Medicine Force et al [44-52].

A recommendation common to all guidelines is that all patients diagnosed with OSA should receive positive airway pressure as initial treatment, in addition to the behavioral modifications discussed in the next section. Issues with the precise definition of OSA, discrepancies between the consensus definition of OSA and the criteria used by the Centers for Medicare and Medicaid Services (CMS) for reimbursement of positive pressure therapy.

For patients with mild to moderate OSA who are reluctant or unresponsive to positive airway pressure, oral appliances are an alternative therapy that have been shown to improve the signs and symptoms of OSA and , in some patients, may It was better tolerated and was defined as positive airway pressure [53]. Upper airway surgery may be an alternative to oral appliances as an alternative therapy for patients with severe and operable obstructive upper airway injuries.

➢ *Patient Counseling and Life Style Modification*

Patient Education:

Management of patients with OSA begins with establishing the diagnosis and its severity. Disease severity guides management by identifying patients most at risk of adverse effects and providing a benchmark against which to measure treatment efficacy [44]. Diagnosis and severity of the disease are discussed separately.

Once the diagnosis of OSA is confirmed and its severity determined, the results of all tests should be reviewed with the patient. Patients should be informed about the risk factors, natural history and consequences of OSAS [44https://www.uptodate.com/contents/management-of-obstructive-sleep-apnea-in-adults/abstract/1]. It is important that all patients be made aware of the increased risk of motor vehicle accidents associated with untreated OSA, as well as the potential

consequences of driving or operating other hazardous equipment while drowsy [46]. . If drowsy, patients should also be advised to avoid activities that require alertness and vigilance.

Patients should be advised to always tell their healthcare professional that they have sleep apnea, especially if they are about to have surgery or start using opioids [54].

The American Academy of Sleep Medicine states that "Medical marijuana and/or its synthetic extracts should not be used in the treatment of OSA due to unreliable methods of administration and insufficient evidence of efficacy, tolerability and safety" [55]. Therefore, the use of cannabis should not be encouraged at this stage.

- *Weight Loss and Exercise:*

Weight loss and exercise should be recommended for all overweight or obese patients with OSA [44,45,56,57]. Although rarely resulting in complete remission of OSA, weight loss, including following bariatric surgery, has been shown to improve overall health and metabolic parameters, reduce index apnea-hypopnea (AHI, the number of apneas and hypopneas per hour of sleep), Lowering blood pressure, improving quality of life and possibly reducing daytime sleepiness.[44-67]

The initial treatment for weight loss should aim to reduce food intake and, if possible, increase energy expenditure.

Weight loss strategies available include behavior modification, diet therapy, exercise, drug therapy, and surgery. These are discussed in detail separately.

The effect of weight loss on OSAS was illustrated in a trial that recruited 72 consecutive overweight patients (mean BMI 32 kg/m2) with mild OSAS (mean AHI 10 events/sleep) [59]. Patients were randomly assigned to receive a single session of general nutrition and exercise counseling, or a more intensive program consisting of three months of a low-calorie diet plus a year of nutrition and exercise counseling. Patients in the latter group showed significantly greater weight loss (11 kg versus 2 kg) and a decrease in AHI (mean change from baseline, -4 versus 0).

3 events per hour), and a better quality of life compared to the control group. There was no difference in the degree of improvement in daytime sleepiness, but its relevance is uncertain because the degree of daytime sleepiness was rarely abnormal at baseline. Weight loss also improved daytime sleepiness in a small study including patients with more severe OSA and more daytime sleepiness at baseline [68].

Weight loss achieved through bariatric surgery appears to have a similar effect on OSAS, with reductions in AHI proportional to weight loss but rarely complete remission [60]. We consider referral to a bariatric surgeon for adults with OSA and obesity (Class II/III, BMI ≥ 35 kg/m2) who are intolerant or not receiving positive pressure (PAP) therapy [69 , 70].

Patients whose OSA improves or regresses after weight loss should strive to maintain weight loss, as weight gain is associated with worsening or relapse of OSA [71-74] . Additionally, CPAP therapy itself may be associated with weight gain [75–77]. Advice regarding ongoing diet modification and exercise, as well as referral to a nutritionist, may be beneficial. However, long-term follow-up in several randomized studies has shown that the initial improvement in AHI achieved with weight loss can persist for years despite weight gain of up to 50% [57, 63, 78, 79]. This sustained improvement may be more relevant for patients with mild to moderate OSA at baseline rather than patients with severe OSA, who are less likely to achieve clinically meaningful reductions in AHI and complete remission of weight loss at early and late times. 63.80].

Exercise can modestly improve OSA even without significant weight loss. In a 2014 meta-analysis of five small randomized trials, a supervised exercise program was associated with significant improvements in AHI (mean change, -6 episodes/hour), sleep efficiency, subjective drowsiness and cardiorespiratory fitness, with minimal weight change. 81].

- *Sleep Position:*

During diagnostic sleep studies, some patients develop or worsen OSA while sleeping in the supine position. These patients have less OSA severity, are less obese and are younger than non-postural patients [82]. Sleeping in a non-recumbent position (eg, sideways) may correct or improve OSAS in these patients and should be encouraged but generally should not be used as the only therapy [83-87].

There are several commercial devices that use vibration feedback around the chest or neck to limit supine sleep [88-91]. However, non-supine sleep should not be used as primary treatment unless polysomnography demonstrates normalization of AHI during non-supine sleep and compliance can be verified [44, 82]. Additionally, long-term efficacy and compliance data are lacking for these devices.

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- *Avoid Alcohol :*

All patients with untreated OSA should avoid alcohol, even during the day, as it depresses the central nervous system, worsens OSA, increases drowsiness and promotes weight gain . Acute alcohol consumption often exacerbates the duration and frequency of obstructive respiratory events during sleep, as well as the degree of oxyhemoglobin saturation and snoring [92].

In patients who snore but do not initially have OSA, alcohol consumption may lead to overt OSA.

- *Concomitant Medications:*

Any clinician prescribing a patient should be informed that the patient has OSA because certain CNS depressants should be avoided if there are reasonable alternatives. Benzodiazepines should be specifically avoided in untreated patients.

Other drugs that may exacerbate OSAS and theoretically increase daytime sleepiness include benzodiazepine receptor agonists, barbiturates, other antiepileptic drugs, sedating antidepressants, antihistamines, and opioids. Antidepressants that cause weight gain (such as mirtazapine) may be particularly problematic in these patients.

Some antidepressants can cause restless leg syndrome or periodic limb movement, which can make sleep worse.

When such agents are deemed necessary despite a patient's OSAS, their use should be carefully monitored and, if possible, carefully titrated.

- *Positive Airway Pressure Therapy*

Positive airway pressure therapy is the mainstay of treatment for OSA in adults. The continuous positive airway pressure (CPAP) mechanism involves the maintenance of positive transmural pressure in the pharynx, allowing intraluminal pressure to exceed ambient pressure [93]. CPAP also stabilizes the upper airway by increasing end-expiratory lung volume.

As a result, respiratory events due to upper airway collapse (eg, apnea, hypopnea) are avoided.

Most Philips CPAP and Bi-Level PAP devices are being recalled due to potential health risks associated with the use of polyester-based polyurethane foam (PE-PUR) in these devices such as noise reduction device. Potential harms and reported complaints include headaches, airway irritation, coughing, chest tightness, and sinus infections. There may also be a risk of cancer, although no cases attributable to the use of machinery have been reported. The American Academy of Sleep Medicine and the American Thoracic Society advise patients to discuss appropriate action with their providers, which may include switching to an alternative device (if available) or other alternative therapies.

Fig 4 Micro-CPAP
Source: https://www.healthline.com/health/micro-cpap

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Fig 5 Different types of CPAP
Nasal (lower). nasal pillow (upper right), and full face (upper left)
Source: https://www.cpap.com/blog/different-types-cpap-masks/

- *Efficacy*

There is high quality evidence from randomized trials and meta-analyses that in most adults, including the elderly, positive airway pressure therapy reduces the frequency of respiratory events during sleep, decreases daytime sleepiness, improves systemic blood pressure (BP), lowers the risk of crashes, improves erectile dysfunction, and improves quality of life across a range of disease severities [26,94-105]. However, no convincing effect on mortality has been demonstrated.

Direct comparisons of positive airway pressure to mandibular advancement devices (MAD) have used CPAP as the mode of positive airway pressure. Trials indicate that CPAP is more effective than MADs at reducing the frequency and severity of both respiratory events and oxyhemoglobin desaturation episodes during sleep, but symptomatic improvement is similar. Some studies have indicated that patients prefer oral appliances over CPAP therapy, at least with short-term follow-up [53].

- *Indications for Treatment*

The American Academy of Sleep Medicine (AASM) recommends positive airway pressure therapy for all patients diagnosed with OSA [44, 106]. OSAS was defined as an obstructive respiratory disorder index (RDI) ≥ 15 breaths/hour, with or without symptoms, or an obstructive RDI of 5-14 breaths/hour with one of the following: lethargy, non-restorative sleep , fatigue or symptoms of insomnia; waking up gasping, panting, or choking; habitual snoring and/or interrupted breathing; high blood pressure, mood disorders, cognitive disorders, coronary heart disease, stroke, congestive heart failure, atrial fibrillation, or type 2 diabetes [107] . Obstructive RDI is the number of obstructive apneas, obstructive hypopneas, and respiratory effort-related arousals (RERA) per hour of sleep; it is generally higher than the AHI (number of apneas and hypopneas per hour of sleep).

- *Modes of Administration*

The most common modes of positive airway pressure administration include continuous positive airway pressure (CPAP), bilevel positive airway pressure (BPAP), and auto-titrating positive airway pressure (APAP). We generally favor CPAP as initial therapy because it is the most familiar and best studied. However, APAP is an alternative to CPAP in suitable candidates.

- *The Available Modes of Positive Airway Pressure Therapy are [44]:*

✓ CPAP delivers positive airway pressure at a level that remains constant throughout the respiratory cycle. It is used most often because it is the simplest, the most extensively studied, and associated with the most clinical experience. A pressure relief setting (ie, lowers the positive airway pressure at the onset of exhalation) is sometimes used to improve comfort and tolerance of the device.

✓ BPAP delivers a preset inspiratory positive airway pressure (IPAP) and expiratory positive airway pressure (EPAP). The degree of pressure support and consequently tidal volume is related to the difference between the IPAP and EPAP. As an example, the tidal volume is greater using an IPAP of 15 cm H2O and an EPAP of 5 cm H2O (difference of 10 cm H2O), than an IPAP of 10 cm H2O and an EPAP of 5 cm H2O (difference of 5 cm H2O). There is no proven advantage to using BPAP instead of CPAP for the routine management of OSA [108]. BPAP should not be confused with BiPAP, which is the brand name of a single manufacturer and is just one of many devices that can deliver BPAP.

✓ APAP increases or decreases the level of positive airway pressure in response to a change in airflow, a change in circuit pressure, or a vibratory snore (signs that generally indicate that upper airway resistance has changed). The degree of improvement of major outcomes conferred by APAP and CPAP is similar [109-113]. However, the performance of APAP can be highly variable, the body of evidence supporting its efficacy is more limited than that of fixed CPAP, and direct comparisons with fixed CPAP have not identified definitive benefits.

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- ✓ Adaptive servo-ventilation (ASV) provides a varying amount of inspiratory pressure superimposed on a low level of CPAP. It can be helpful in patients who have concomitant central apneas, which may occur as a consequence of CPAP (treatment-emergent central apneas), patients on long-acting opioids (narcotic-induced central sleep apnea), and patients who have had a stroke or kidney disease (central sleep apnea due to other conditions). However, based upon the SERVE-HF trial, caution should be exercised when using ASV in patients with heart failure and a Cheyne-Stokes breathing pattern, specifically those with a left ventricular ejection fraction of less than 45 percent, since a higher cardiovascular mortality in association with ASV use was reported in this population [114].

Selection of a mode, titration of the positive airway pressure level, and other aspects of initiating positive airway pressure therapy are described in detail separately.

- *Adherence:*

Reduced compliance may reduce the potential benefit of CPAP therapy. An estimated 20% to 40% of patients do not use a positive airway pressure device, while many others do not use it all night, every night [115-121]. In most studies, the average CPAP use was only about four hours per night. Identifying non-adherence is important because there are a variety of educational, behavioral, and problem-solving interventions that can help promote CPAP use, including addressing side effects of the device and behavioral therapy. Adherence to positive airway pressure therapy is discussed elsewhere.

- *Follow-up*

Patients who prefer positive airway pressure therapy should be evaluated regularly, especially during the first weeks of therapy [44]. This may include regular phone calls, with opportunities for face-to-face sessions with clinicians as needed. Compliance and validity can be monitored remotely using a PAP device that includes a modem. Communication with the device can be two-way, so the pressure can be adjusted remotely. The purpose of periodic assessments is to quickly identify and manage any side effects that arise, as they may affect long-term compliance with treatment.

Once positive airway pressure side effects have been successfully managed and the patient is on treatment, the patient should be asked if the symptoms of OSA have resolved. Additionally, objective data on the adherence and effectiveness of patient devices can be downloaded and viewed, although research on the accuracy of the information is mixed. If OSA symptoms have resolved, an objective sleep assessment is usually not necessary, but repeat testing is warranted in patients who do not improve or who have recurrent or persistent symptoms (eg. , daytime sleepiness) [44]. Objective tests may include polysomnography or a type 3 home sleep apnea test (HSAT), as well as a CPAP.

The purpose of such testing is to help the clinician determine the reason for the treatment failure. Possible causes of treatment failure include non-adherence or suboptimal adherence, weight gain, an inappropriate level of prescribed positive pressure, or an additional disorder causing sleepiness (eg, narcolepsy) that may require alterations in the therapeutic regimen. A review of medications should also be undertaken since many drugs may lead to sleepiness. Inadequate sleep time may also negate the expected effects from treatment of OSA.

Once the patient's positive airway pressure therapy has been optimized and symptoms have resolved, a long-term follow-up plan should be developed. An annual visit is reasonable, with more frequent visits if new problems arise [44]. The goals of long-term follow-up are to assess use and monitor recurrent OSA, new side effects, air leaks, and weight fluctuations.

OSA is associated with other diseases such as diabetes, high blood pressure, heart failure and ischemic heart disease. After initiation of OSA-specific therapy, any comorbidities that may be affected by OSA should be closely monitored.

Treatment for these comorbidities may need to be adjusted once treatment for OSA has been initiated. For example, a reduction in the dose of antihypertensive drugs may be required after successful treatment of OSA [122].

- *Alternative Therapies:*

Oral appliances (eg, mandibular advancement devices, tongue stops) are alternative treatment strategies for OSA that may be offered to patients with mild to moderate OSA who refuse or non-compliance with positive airway pressure therapy, and a preference for this treatment.

Various surgical approaches have also been studied in OSAS; their role is primarily in the treatment of patients with severe obstructive upper airway disease who have failed positive pressure therapy and oral appliances.

Hypoglossal nerve stimulation is a treatment option in some patients.

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- *Oral Appliance*

Oral appliances are a reasonable alternative to positive airway pressure therapy in patients with mild to moderate OSA who refuse or do not comply with positive airway pressure therapy. This is based on the recognition that although positive airway pressure is generally more effective than oral devices in normalizing respiratory events and oxyhemoglobin saturation during sleep [95,123], most patients prefer oral devices, l Gender is an important aspect of treatment success, both modalities were effective compared to no treatment or sham treatment, and both modalities had similar effects on symptoms and quality of life .

Oral appliances have variable effectiveness in patients with severe OSA and/or severe sleep-related hypoxemia; these patients are not candidates for oral appliances as first-line therapy and positive airway pressure therapy should be encouraged.

An increasing number of oral appliances are designed to extend the mandible forward (i.e. mandibular advancement/repositioning splints, splints, or devices) or to hold the tongue in a more upright position. anterior (e.g. tongue retainers). Both designs hold the oropharyngeal soft tissue away from the posterior pharyngeal wall, thereby maintaining a patent upper airway.

Fig 6 Different types of oral appliance devices
Source: https://www.sleepwise.com.au/appliance-selection-snoring-sleep-apnoea/

Fig 7 Tongue Retaining Device
Source: https://www.sciencedirect.com/science/article/abs/pii/S1073874603000720

Fig 8 Mandibular advancement Device
Source: http://www.researchgate.net/figure/Examples-of-mandibular-advancement-devices-A-Boil-and-bite-device-SleepPro_fig2_322669440

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Oral appliances decrease the frequency of respiratory events, arousals, and episodes of oxyhemoglobin desaturation, compared to no treatment or a sham intervention. They may also improve daytime sleepiness, quality of life, and neurocognitive function. Their impact on mortality is unknown.

Patient assessment, device selection, device titration, follow-up, and adverse effects related to the use of oral appliances are discussed separately.

- *Upper Airway Surgery*

We and others generally consider surgery (after at least three months of treatment trials) when positive airway pressure or oral appliances are rejected or ineffective [69,71].

Optimal screening or imaging procedures that accurately predict which patients will benefit most from surgery have not been established. In our experience, surgical treatment appears to be most effective in patients with OSA due to severe, surgically correctable upper airway disease, although PAP remains the first-line treatment for many patients. patients with upper airway anatomy. Examples of surgically correctable lesions that can obstruct the upper airway include enlarged tonsils, adenoid enlargement, or craniofacial abnormalities [44, 56, 124].

Hypoglossal nerve stimulation via an implantable neurostimulator device is a therapeutic strategy that may be effective in some patients with moderate to severe OSA who lack continuous positive airway pressure and have a body mass index <32 kg/m2, (BMI <35 kg)/m2 used in some centers) and without collapse during drug-induced sleep endoscopy.

Uncontrolled studies and meta-analyses of these studies have shown significant reductions in AHI and oxygen saturation indices and improvements in subjective measures of sleepiness after device implantation in selected patients [125- 135].

- *Pharmacotherapy*

A variety of drugs have been studied in randomized trials as primary treatments for the management of sleep-disordered breathing in OSAS, with the aim of replacing heavier treatments. These include drugs that directly or indirectly stimulate respiratory function (eg, theophylline) or indirectly (eg, acetazolamide), drugs that reduce upper airway collapsibility (eg, desipramine), antimuscarinic drugs (eg, oxoxib, Ning) or noradrenergic drugs (such as atomoxetine) [136,137]. However, no drug has proven effective enough to warrant replacing these therapies [56, 138].

Preliminary results from a phase II study in 73 adults with moderate or severe OSA reported that taking the cannabinoid dranabinol one hour before bedtime increased the apnea-hypopnea index (AHI) reduced by 25.

From 9 events per hour to 15.2 events per hour (2.5 mg dose) and 13.0 events per hour (10 mg dose) [139]. However, mental alertness test scores did not improve significantly, suggesting that the clinical significance of the AHI reduction is uncertain.

Adverse events were similar and rare in all groups and included diarrhea, vomiting, dizziness and visual disturbances. Phase III trials should focus on the drug's effectiveness as a treatment for moderate to severe OSAS. The American Academy of Sleep Medicine position statement does not support the use of medical cannabis and/or synthetic extracts for the treatment of OSA unless there is reliable data supporting the efficacy and safety of these products [55].

- *Persistent Sleepiness After Treatment for OSA*

Excessive daytime sleepiness may be beneficial with pharmacotherapy (eg, modafinil or armodafinil) as an add-on treatment, although well-researched and effective conventional treatments (eg, positive airway pressure, oral devices [14,140]), but this excessive sleepiness persists. diurnal.

➢ *Problem Statement :*

OSA although common and associated with significant cardiovascular morbidity and mortality it still remains widely under-diagnosed, especially in developing countries like Sudan , this is mainly due to the high cost of the gold standard test which is polysomnography and lack of professional sleep study centers.

➢ *Justification:*

Screening for OSA is essential in order to provide early management and prevent complications, especially with the lack of professional sleep study centers in Sudan**.**

➢ *Research Question :*

What is the risk for Obstructive sleep apnea among hypertensive Sudanese patients?

➢ *Objectives :*

- *General Objective:*
  To assess the risk of OSA among hypertensive Sudanese patients attending Yastabsheroon hospital.

- *Specific Objectives:*

✓ To assess the risk of OSA among hypertensive patients using the Berlin questionnaire.
✓ To determine the risk factors for OSA among Sudanese hypertensive patients.
✓ To determine the most prevalent risk factor.

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CHAPTER TWO
LITERATURE REVIEW

A qualitative meta-analysis was conducted by Hou H and his colleagues in June 2018 in Taian, China to estimate pool significant association between obstructive sleep apnea and hypertension concluded that OSA was related to an increased risk of resistant hypertension. mild, moderate, and severe OSA were associated with essential hypertension, as well a dose response manner relationship was manifested .The associations were relatively strong among Caucasians and male OSA patients. [142]

A study titled How common is obstructive sleep apnea in young hypertensive patients? Was conducted by Jinchain J.et al between October 2017 and 2018 in Thailand found OSA to be highly prevalent among hypertensive patients younger than 35-year-old. Increasing age and body mass index were predictors for OSA in young hypertensive patients. [143]

A three-year period retrospective analysis of sleep apnea registry of the cardiology department at Yonsei University College of Medicine, Seoul, Korea was done by Min H et al in 2015 and concluded that higher prevalence and severity of OSA in resistant hypertension may be due to the association of risk factors that are common to both conditions. [144]

A cross-sectional research conducted by Cai A et al aimed to study the epidemiological characteristics and gender-specific differences of obstructive sleep apnea among Chinese hypertensive population ,took place at the department of cardiology, Guangolong Cardiovascular Institute ,China -2016 found OSA to be strikingly high among Chinese hypertensive patients and hypertensive patients with the most severe OSA were at greater cardiovascular risk, there were significant differences in epidemiological characteristics of OSA between male and female. [145]

A cross-sectional study in work-site group was conducted by Yuki Morinaga and his colleagues from 2003-2011 in Japan concluded that OSA is relatively high in middle aged Japanese men and that blood pressures were elevated in patients with severe OSA.[146]

A study was done by Dayna A Johnson and her colleagues on March 2019 to study association of sleep apnea with uncontrolled blood pressure and resistant hypertension in blacks and stated that untreated moderate or severe OSA was associated with increased odds of resistant hypertension. These results suggest that untreated OSA may contribute to inadequate blood pressure control among blacks. [147]

A prospective study conducted by Indira Gurubhagava et al in April 2013 attempted to validate a 2-stage strategy to screen for severe obstructive sleep apnea syndrome among outpatient-hypertensive patients at Philadelphia VA Medical Centre and the hypertensive clinic at the University of Pennsylvania, with polysomnography as the gold standard, found that among hypertensive patients 30% to 40% had OSA, and blood reduction may also be greater in OSA patients who received PAP treatment. These findings were not surprising given the high prevalence of risk factors for OSA among veterans, including hypertension, obesity, male sex , African American race , and habitual alcohol consumption.[148]

In 2014 a cross-sectional analysis was conducted by Elizabeth S Muxfeldt aimed to investigate the prevalence of OSA and its associated factors in a large Cohort of resistant hypertensive patients concluded that resistant hypertensive patients had a very high prevalence of OSA, and patients with moderate/severe OSA had an adverse ambulatory blood pressure profile, with higher night-time systolic pressures and pulse pressures and higher prevalence of non-dipping patterns. Other correlates with OSA severity were mainly demographic-anthropometric variables. [150]

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CHAPTER THREE
METHODOLOGY

➢ *The Study Type :*
Descriptive cross-sectional facility-based study.

➢ *The Study Area :*
Medicine out-patient department in Yastabsheroon hospital and Police hospital. Yastabsheroon hospital is a private hospital located at Al- Riyadh district in Khartoum, Sudan. Police hospital is located at AL-Maarad street, Burri district, Khartoum, sudan.

➢ *The Study Population:*
Adult Hypertensive patients attending the outpatient department of Yastabsheroon hospital and police hospital during the study period (February 2022 - April 2022):

- *Inclusion criteria: Sudanese hypertensive patients aged 18 years old and older.*
- *Exclusion criteria: non Sudanese, non-hypertensive, younger than 18 years.*

➢ *Sampling:*

- *Sample Size :*
The Sample Size was 230 , using the Equation of Unknown Population:

✓ $n=z^2(p)(1-p)/e^2$.
✓ Where:
✓ n is the sample size to be calculated
✓ z is the z-score at 95% confidence interval (1.96)
✓ p is the population proportion (82.2%). [15]
✓ e is the margin of error (0.05).

- *Sample Technique:*
Convenient Sampling.

➢ *Data-Collection Technique :*
Data was collected using the Berlin questionnaire, which was filled by the researcher for each patient and the score was calculated using the Berlin scoring system. Berlin questionnaire is an instrument validated to use in the western populations to determine the occurrence of risk factors for obstructive sleep apnea syndrome, with a sensitivity of 86% and a specificity of 77/%[16].

➢ *Data Analysis and Management:*
Data was analyzed using computer statistical package namely SPSS program (Statistical Package for the social sciences) version 23.

➢ *Ethical Considerations:*

- *Was sought from the Faculty of Medicine Review Board,*
- *Permission was taken from Yastabsheroon and Police hospital.*
- *Respondent's verbal consent was obtained .*
- *Confidentiality of the information and anonymity of respondents was ensured.*

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CHAPTER FOUR
RESULTS

- *Descriptive Statistics*

Table 1 Descriptive Statistics

Descriptive Statistics					
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
Age	230	25.00	80.00	58.7435	9.62163
Height in meters	230	120.00	185.00	163.5852	8.61241
Weight in KG	230	40.00	101.00	72.4087	14.30693
BMI	230	13.15	41.67	27.1927	5.45456
Neck circumference	230	25.00	54.00	37.9870	5.58341
Valid N	230				

Table 2 Gender

Gender			
	Frequency	**Valid Percent**	**Cumulative Percent**
Male	112	48.7	48.7
Female	118	51.3	100.0
Total	230	100.0	

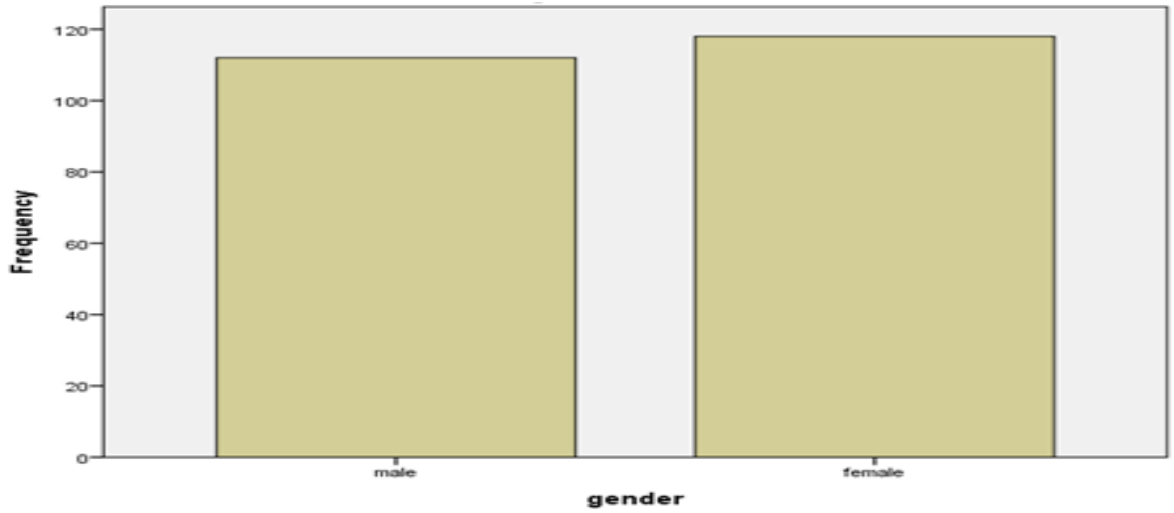

Fig 9 Gender

Table 3 Age

Age				
		Frequency	**Valid Percent**	**Cumulative Percent**
Valid	20 to 29 years	2	.9	.9
	30 to 39 years	11	4.8	5.7
	40 to 49 years	12	5.2	10.9
	50 to 59 years	62	27.0	37.8
	60 and above	143	62.2	100.0
	Total	230	100.0	

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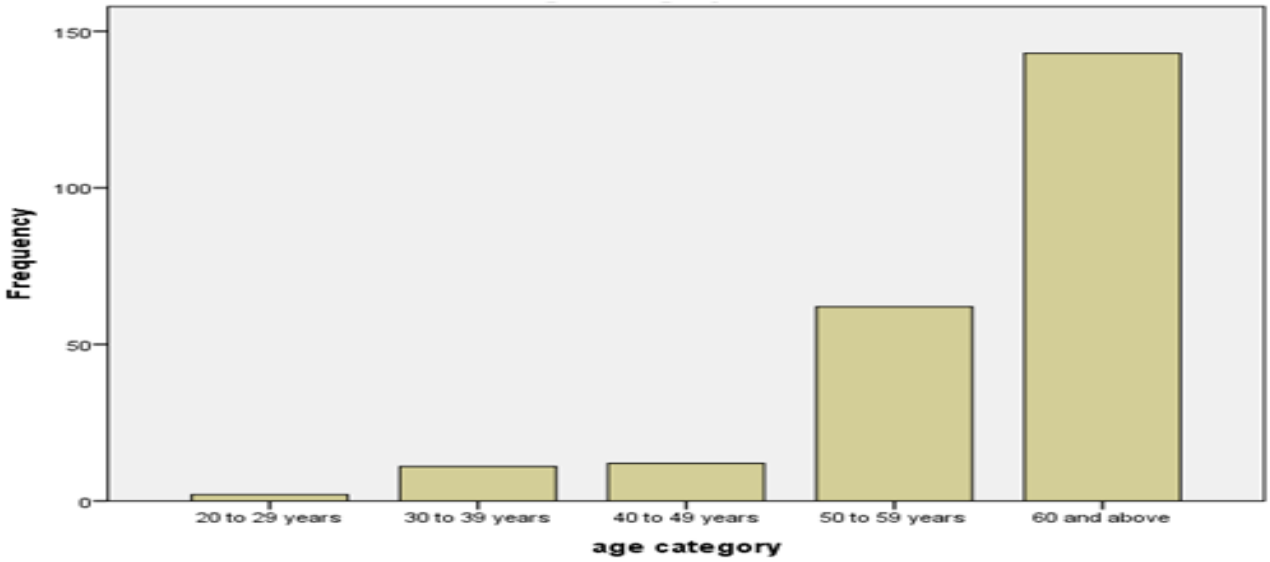

Fig 10 Age

➢ *Body Mass Index*

Table 4 Body Mass Index

		Frequency	Valid Percent
Valid	Underweight	14	6.1
	Normal weight	62	27.1
	Over weight	62	27.1
	Obese	91	39.7
	Total	230	100.0

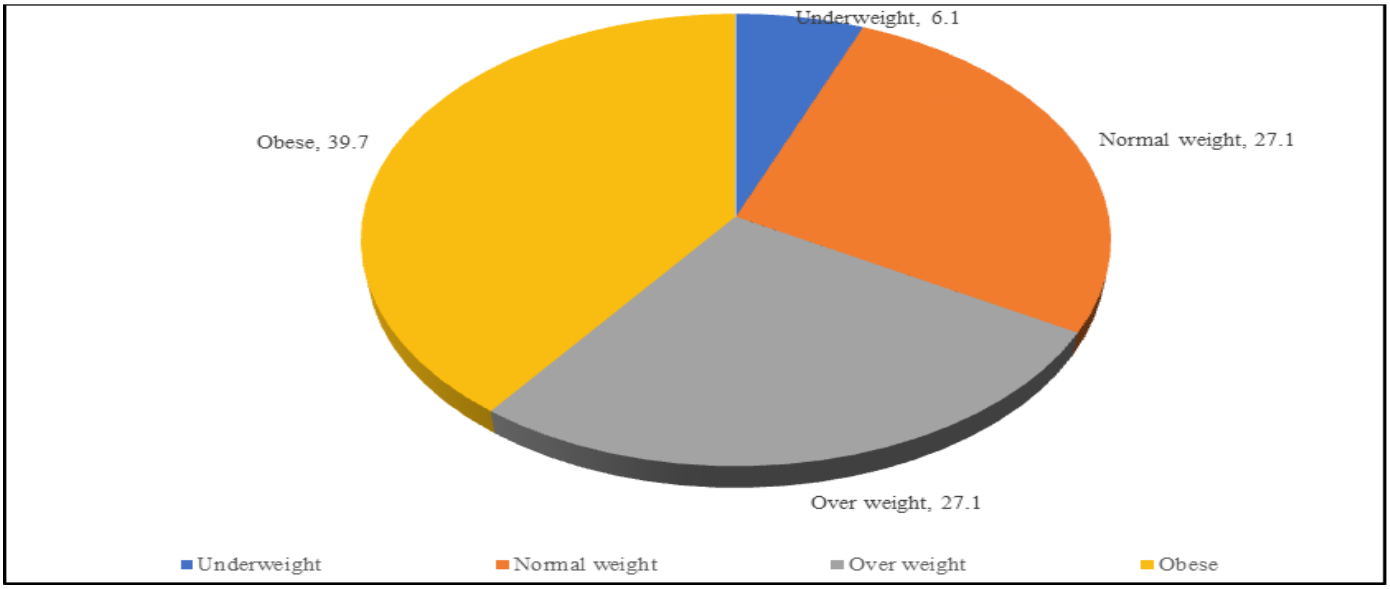

Fig 11 Body Mass Index

➢ *Neck Circumference*

Table 5 Neck Circumference

Neck Circumference			
		Frequency	Valid Percent
Valid	20-30 cm	21	9.1
	30.1-40 cm	121	52.6
	more than 40 cm	88	38.3
	Total	230	100.0

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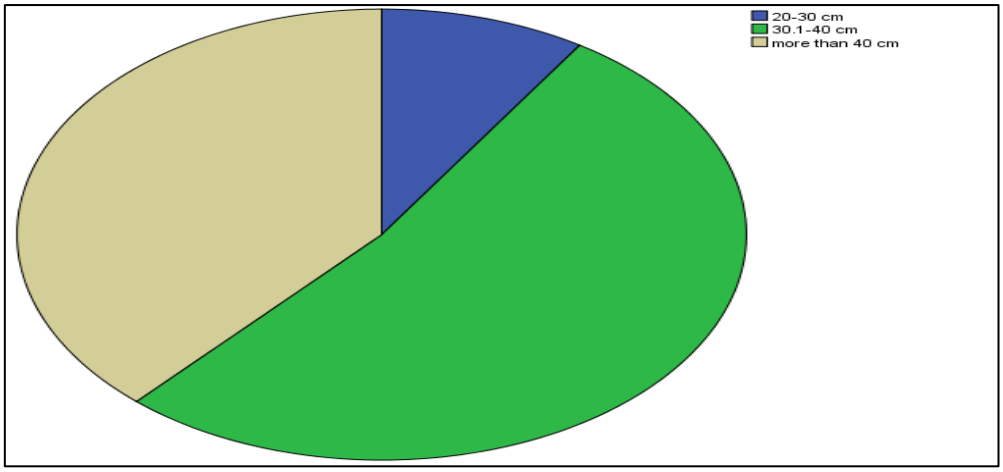

Fig 12 Neck Circumference

➢ *Risk of Obstructive Sleep Apnea*

Table 6 Risk of OSA

Berlin Risk of OSA				
		Frequency	**Valid Percent**	**Cumulative Percent**
Valid	Low risk	28	12.2	12.2
	High risk	202	87.8	100.0
	Total	230	100.0	

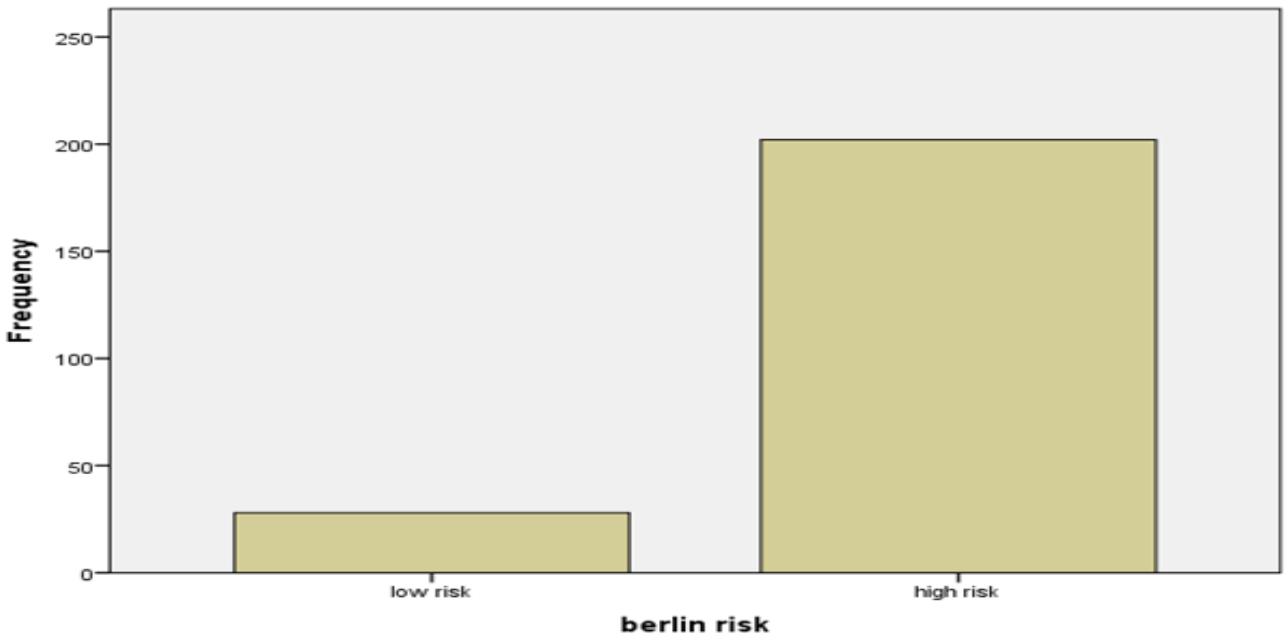

Fig 13 Risk of Obstructive Sleep Apnea

➢ *Statistics of Berlin questionnaire categories*

- *Category 1:*

Table 7 Berlin Questionnaire Category 1 Statistics

		Frequency	**Valid Percent**	**Cumulative Percent**
Valid	Negative	150	65.2	65.2
	Positive	80	34.8	100.0
	Total	230	100.0	

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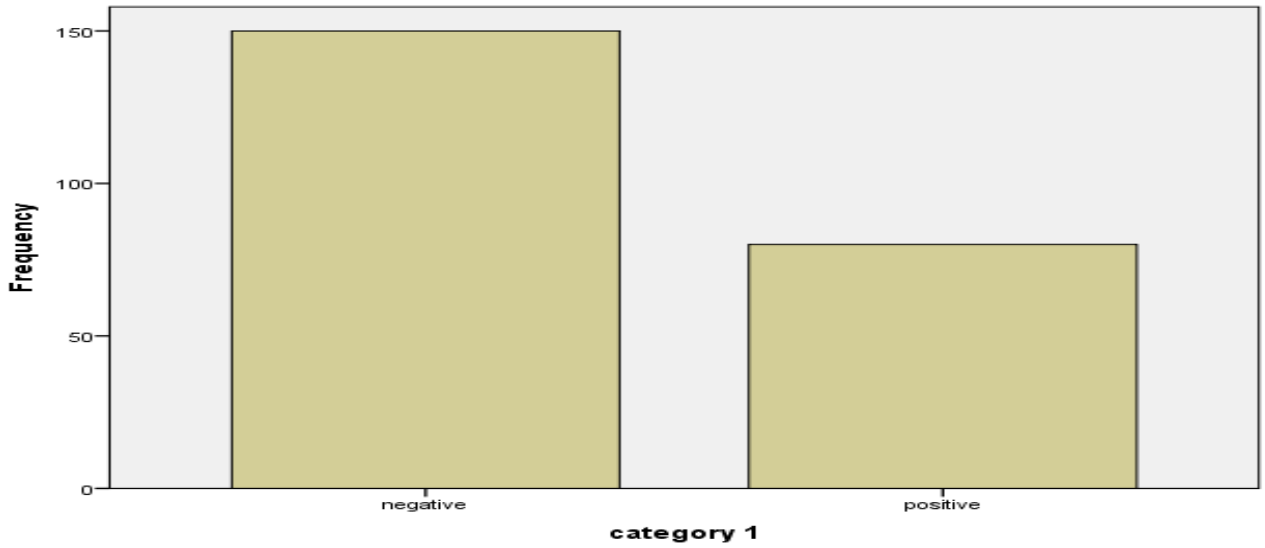

Fig 14 Berlin Questionnaire Category 1 Statistics

- *Category 2:*

Table 8 Berlin Questionnaire Category 2 Statistics

Category 2				
		Frequency	**Valid Percent**	**Cumulative Percent**
Valid	Negative	36	15.7	15.7
	Positive	194	84.3	100.0
	Total	230	100.0	

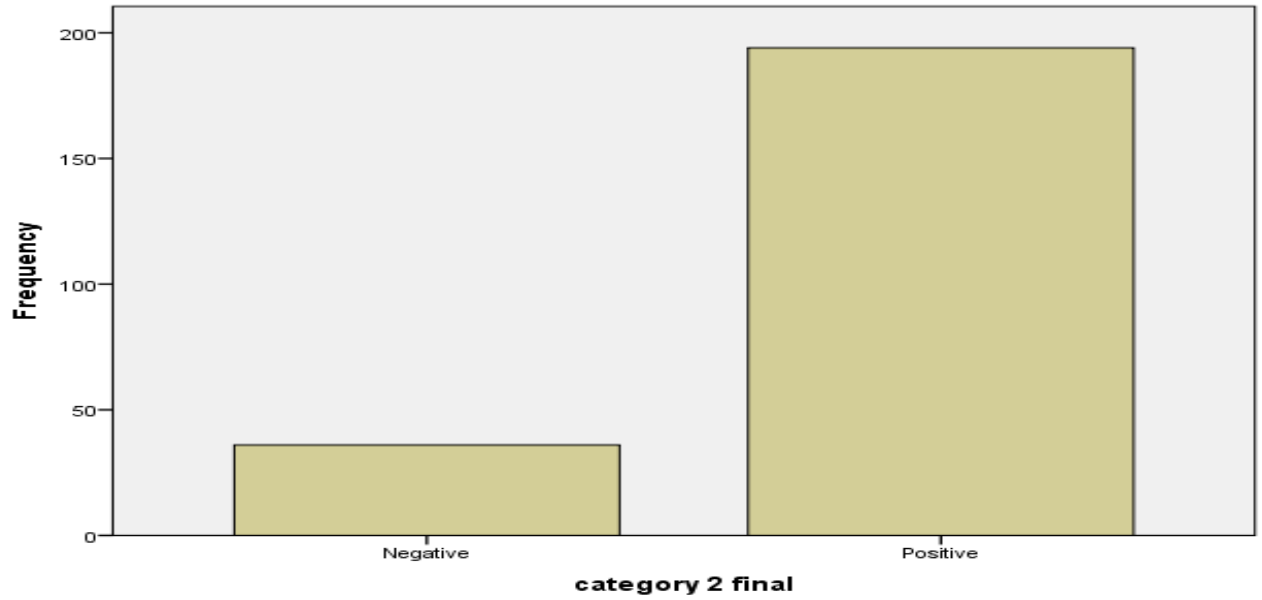

Fig 15 Berlin Questionnaire Category 2 Statistics

- Category 3:

Table 9 Berlin Questionnaire Category 3 Statistics

Category 3				
		Frequency	**Percent**	**Cumulative Percent**
Valid	Positive	230	100	100
Total	230	100		

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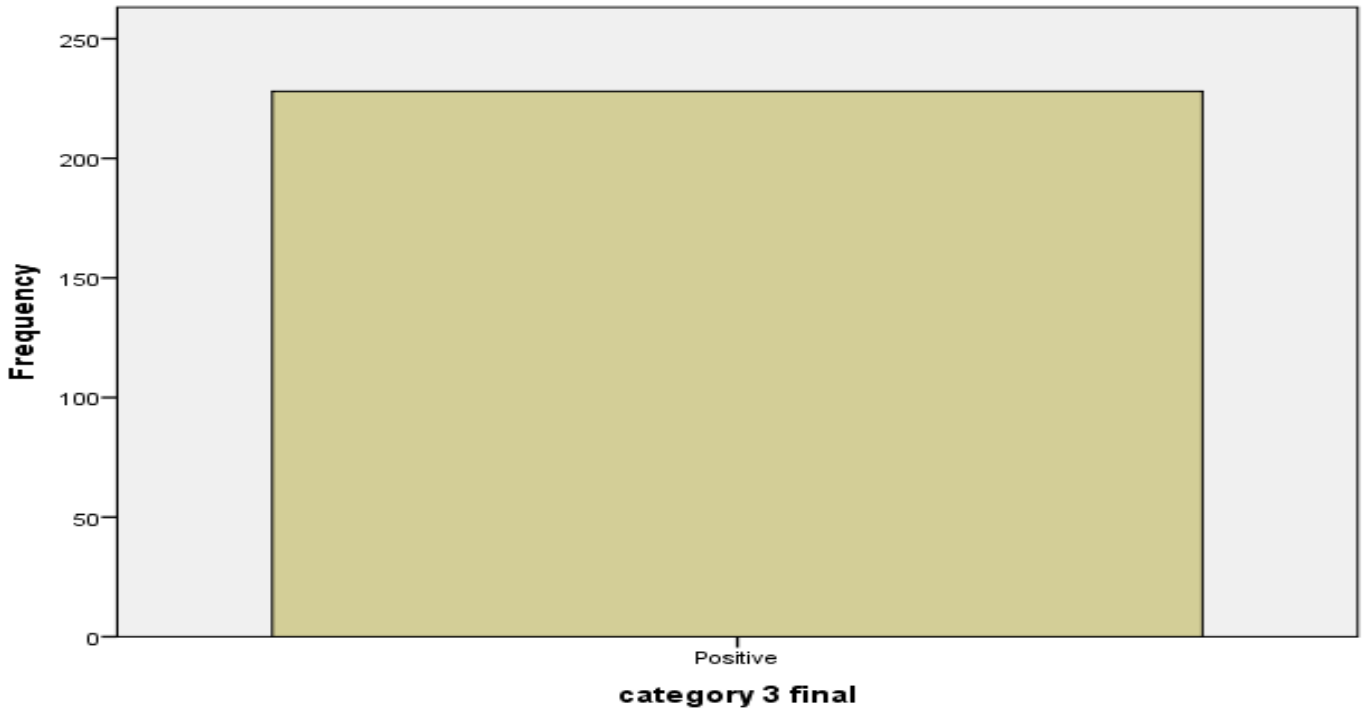

Fig 16 Berlin Questionnaire Category 3 Statistics

- *Question No.18: how Long have you been Diagnosed with Hypertension*

Table 10 How Long have you been Diagnosed with Hypertension Statistics (Summary)

Statistics		
How long have you been diagnosed with hypertension?		
N	Valid	230
Mean		5.5443
Median		5.0000
Mode		4.00
Std. Deviation		2.69608

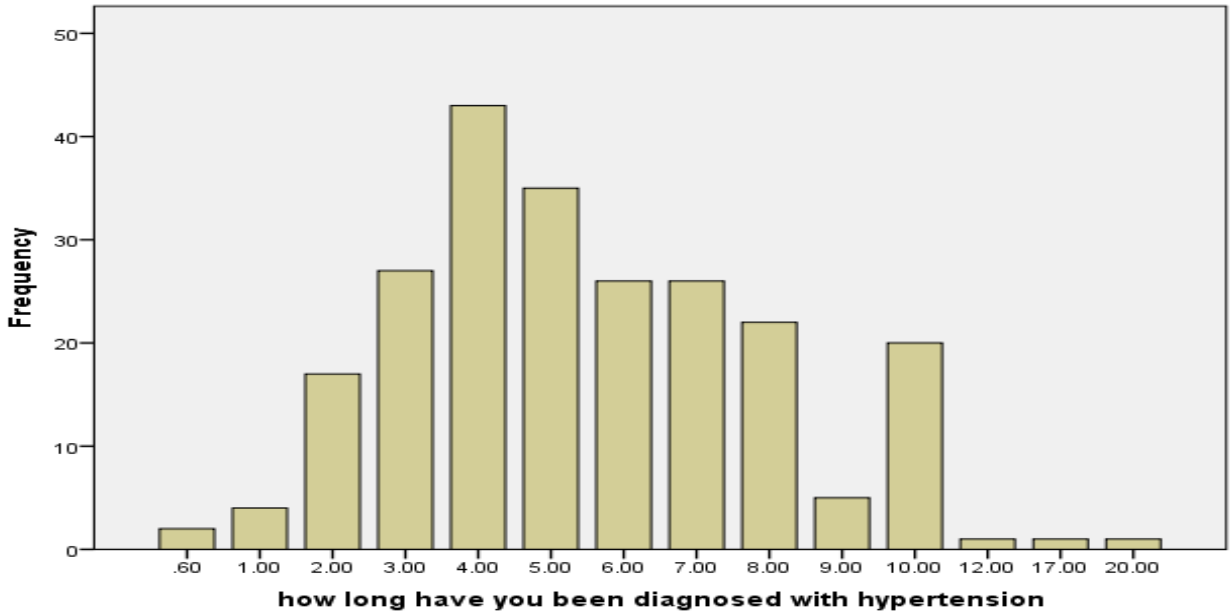

Fig 17 How long have you been diagnosed with hypertension

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Table 11 How Long have you been Diagnosed with Hypertension

How long have you been diagnosed with hypertension?				
		Frequency	Valid Percent	Cumulative Percent
Valid	.60	2	.9	.9
	1.00	4	1.7	2.6
	2.00	17	7.4	10.0
	3.00	27	11.7	21.7
	4.00	43	18.7	40.4
	5.00	35	15.2	55.7
	6.00	26	11.3	67.0
	7.00	26	11.3	78.3
	8.00	22	9.6	87.8
	9.00	5	2.2	90.0
	10.00	20	8.7	98.7
	12.00	1	.4	99.1
	17.00	1	.4	99.6
	20.00	1	.4	100.0
	Total	230	100.0	

- *Question 19: are you Adherent to your Medication*

Table 12 Are you Adherent to your Medication

Are you Adherent to your Medication?		
	Frequency	**Valid Percent**
No	9	3.9
Yes	221	96.1
Total	230	100.0

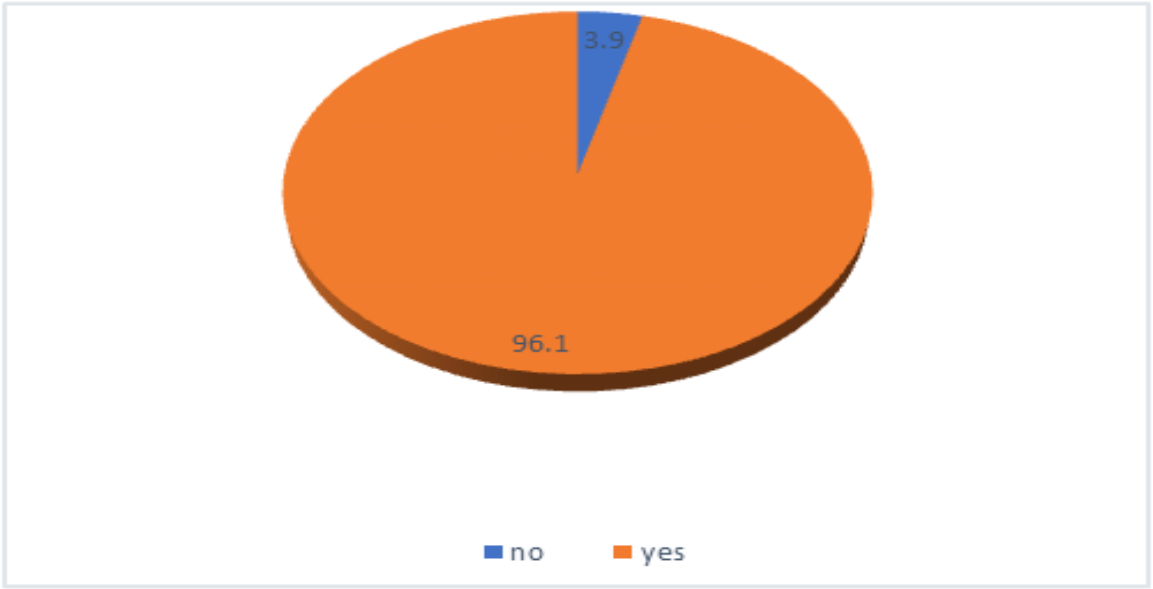

Fig 18 Are you adherent to your medication ?

- *Question No.20: Is your Hypertension Controlled*

Table 13 Is your Hypertension Controlled

Is your hypertension controlled?				
		Frequency	**Valid Percent**	**Cumulative Percent**
Valid	No	65	28.3	28.3
	Yes	165	71.7	100.0
	Total	230	100.0	

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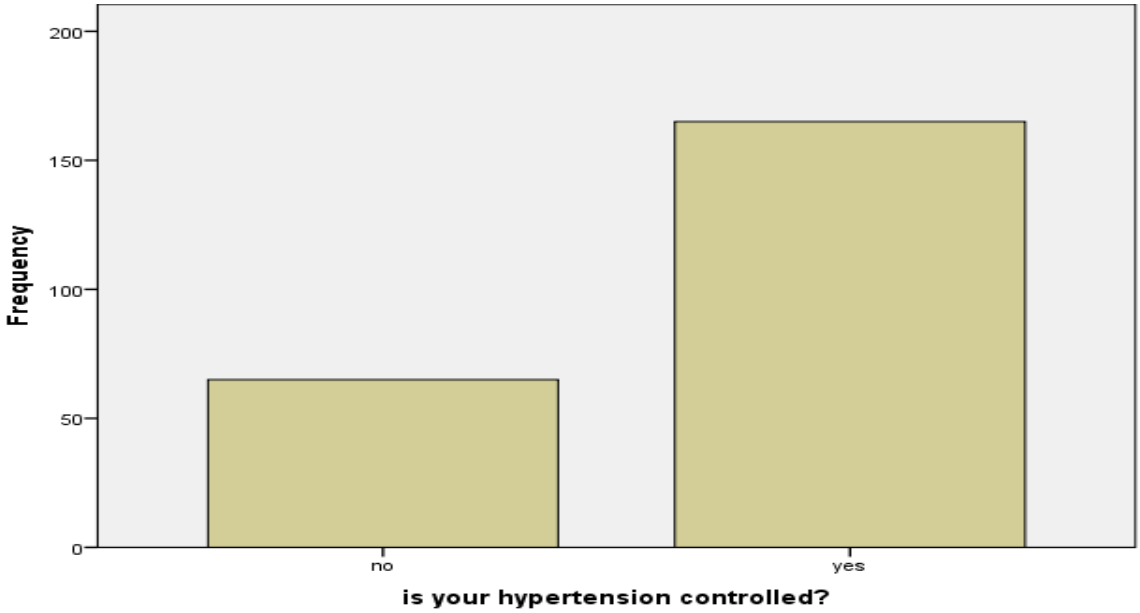

Fig 19 Is your Hypertension Controlled

- *Question No.21: when did your Symptoms Start*

Table 14 When did your Symptoms Start

When did your symptoms start?			
		Frequency	Valid Percent
Valid	before being diagnosed with hypertension	113	49.1
	After	117	50.9
	Total	230	100.0

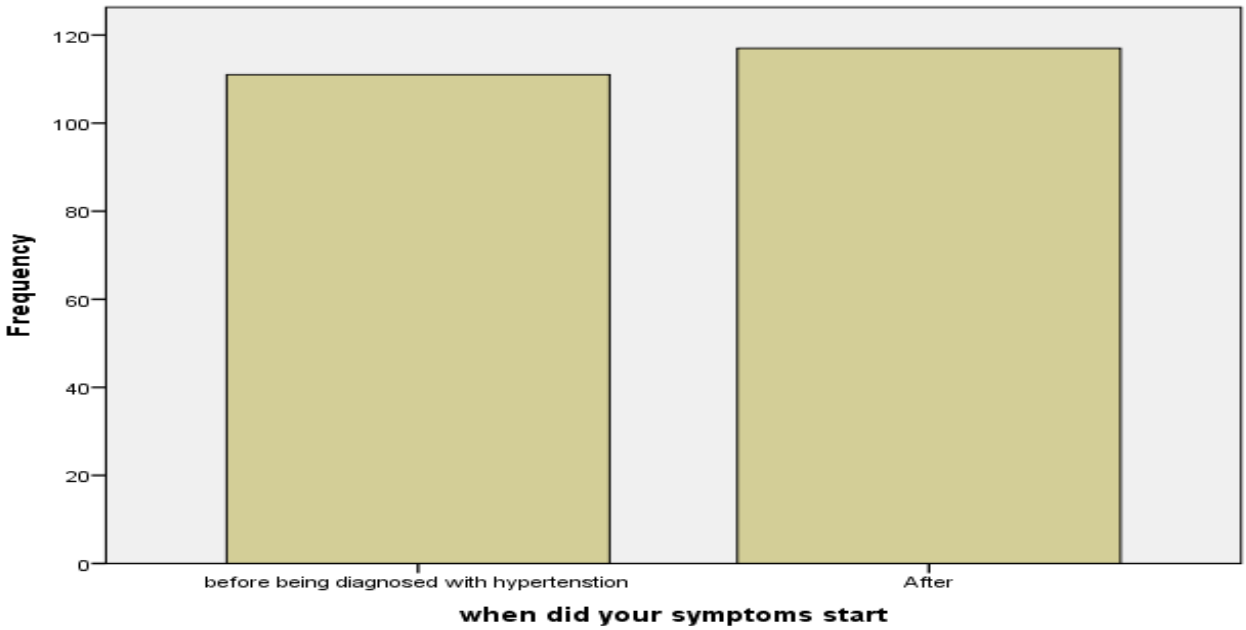

Fig 20 When did your Symptoms Start

➢ *OSA and other Risk Factors*

Table 15 OSA and other Risk Factors

Crosstab					Chi Square P Value
		Berlin risk of OSA			
		Low risk	High risk	Total	
Do you smoke	No	23	151	174	0.054
		82.1%	75.1%	76.0%	
	Yes	5	50	55	
		17.9%	24.9%	24.0%	
Do suffer from heart disease	No	27	191	218	0.028
		96.4%	94.6%	94.8%	
	Yes	1	11	12	
		3.6%	5.4%	5.2%	
Are you diabetic	No	13	124	137	0.100
		46.4%	61.4%	59.6%	
	Yes	15	78	93	
		53.6%	38.6%	40.4%	
Do you suffer from thyroid disease	No	28	183	211	0.112
		100.0%	90.6%	91.7%	
	Yes	0	19	19	
		0.0%	9.4%	8.3%	
Did you suffer from stroke before	No	28	198	226	0.043
		100.0%	98.5%	98.7%	
	Yes	0	3	3	
		0.0%	1.5%	1.3%	
Do you suffer from a chronic lung disease	No	27	194	221	0.002
		96.4%	96.5%	96.5%	
	Yes	1	7	8	
		3.6%	3.5%	3.5%	
Do you suffer from chronic nasal congestion	No	27	184	211	0.059
		96.4%	91.5%	92.1%	
	Yes	1	17	18	
		3.6%	8.5%	7.9%	
Gender	Male	3	109	112	0.283
		10.7%	54.0%	48.7%	

	Female	25	93	118	
		89.3%	46.0%	51.3%	
BMI category	Underweight	1	13	14	0.019
		3.6%	6.5%	6.1%	
	Normal weight	13	49	62	
		46.4%	24.4%	27.1%	
	Obese	12	79	91	
		42.9%	39.3%	39.7%	
	Over weight	2	60	62	
		7.1%	29.9%	27.1%	
Age category	20 to 29 years	0	2	2	0.039
		0.0%	1.0%	0.9%	
	30 to 39 years	0	11	11	
		0.0%	5.4%	4.8%	
	40 to 49 years	5	7	12	
		17.9%	3.5%	5.2%	
	50 to 59 years	8	54	62	
		28.6%	26.7%	27.0%	
	60 and above	15	128	143	
		53.6%	63.4%	62.2%	
Neck circumference	20-30 cm	5	16	21	0.259
		17.9%	7.9%	9.1%	
	30.1-40 cm	22	99	121	
		78.6%	49.0%	52.6%	
	more than 40 cm	1	87	88	
		3.6%	43.1%	38.3%	

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CHAPTER FIVE
DISCUSSION

230 participants were included in the study. 51.3 % were males and 48.7 were females. Gender was not associated with the risk of OSA in our study. this was inconsistent with Hou H [142] findings As well as Cai A et al [145] in both researches male gender was a significant risk factor for OSA.

As age increases the risk of obstructive sleep apnea increases with a significant P-value of 0.039. The highest risk was seen among participants aged 60 and above.

Body mass index was associated with the risk of OSA among participants with a significant a P-value of 0.019.

These findings were Consistent with Jinchain J.et al who found that increasing age and body mass index were predictors for OSA among hypertensive patients. [143]

Neck circumference was not associated with the risk of OSA with a p- value of 0.259.

87.8% of participants were at high risk of OSA this was not surprising given the fact that all participants were hypertensive, and African with disparity in other risk factors of obstructive sleep apnea. Most of participants were hypertensive for 4-5 years, 96.5% were adherent to their medication, and 71.7 % claimed to have a well-controlled blood pressure.

50.9% experienced the symptoms of OSA before being diagnosed with hypertension while 40.1% suffered from OSA symptoms after being diagnosed with hypertension. this is consistent with findings of Elizabeth S Muxfeldt and her colleagues [149] in their paper that aimed to investigate the prevalence of OSA and its associated factors in a large Cohort of resistant hypertensive patients and concluded that resistant hypertensive patients had a very high prevalence of OSA, and patients with moderate/severe OSA had an adverse ambulatory blood pressure profile.

Heart diseases, stroke, and chronic lung diseases were associated with increased risk of OSA with significant p-values of 0.028, 0.043, and 0.002 respectively.

While Smoking, Diabetes, chronic nasal congestion, thyroid diseases were not associated with the risk of OSA among participants with p-values of 0.054, 0.100 ,0.112, and 0.059 respectively.

Heart disease was the most relevant factor associated with high risk of OSA.

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CHAPTER SIX
CONCLUSION and RECOMMENDATIONS

- *Conclusion*

Risk of OSA was high among Sudanese hypertensive patients. Age, BMI, heart diseases, stroke and chronic lung diseases were associated with increased risk of OSA among hypertensive Sudanese patients. While smoking , gender, neck circumference diabetes, chronic nasal congestion or allergies, and thyroid disease were not associated with increased risk of OSA among hypertensive Sudanese patients. Heart disease was the most relevant factor associated with high risk of OSA.

- *Recommendations*

- There is a need to establish sleep study centres and sleep laboratories in Sudan, and to encourage specialization in this field. Until this is achieved doctors should screen suspected patients especially those with hypertension using berlin questionnaire and a trial of C-PAP may be acceptable for high-risk patients.
- Raising the awareness of sleep apnea among community as well as doctors and the importance of early diagnosis and treatment to avoid serious complications.
- To encourage future researches to study the type of association between hypertension and a documented OSA among Sudanese, is it a real association or due to shared common risk factors between these two conditions.

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APPENDICES

➢ *Questionnaire:*

- *Age* ————

  Gender : Male ☐ Female ☐

- *Occupation:* ————————

  Marital status: Single ☐ Married ☐ Widowed ☐ Divorced ☐

- *Berlin Questionnaire*

  Height (m) _____ Weight (kg) _____ BMI _____ Neck circumference ————

Category 1	Category 2
1. Do you snore? □ a. Yes □ b. No □ c. Don't know *If you answered 'yes':*	**6. How often do you feel tired or fatigued after your sleep?** □ a. Almost every day □ b. 3-4 times per week □ c. 1-2 times per week □ d. 1-2 times per month □ e. Rarely or never
2. You snoring is: □ a. Slightly louder than breathing □ b. As loud as talking □ c. Louder than talking	**7. During your waking time, do you feel tired, fatigued or not up to par?** □ a. Almost every day □ b. 3-4 times per week □ c. 1-2 times per week □ d. 1-2 times per month □ e. Rarely or never
3. How often do you snore? □ a. Almost every day □ b. 3-4 times per week □ c. 1-2 times per week □ d. 1-2 times per month □ e. Rarely or never	**8.Have you ever nodded off or fallen asleep while driving a vehicle?** □ a. Yes □ b. No *If you answered 'yes':*
4. Has your snoring ever bothered other people? □ a. Yes □ b. No □ c. Don't know	**9. How often does this occur?** □ a. Almost every day □ b. 3-4 times per week □ c. 1-2 times per week □ d. 1-2 times per month □ e. Rarely or never
5. Has anyone noticed that you stop breathing during your sleep? □ a. Almost every day □ b. 3-4 times per week □ c. 1-2 times per week □ d. 1-2 times per month e. Rarely or never	**Category 3** **10. Do you have high blood** pressure? □ Yes □ No □ Don't know

- **Risk:**

High ☐ **Low** ☐

- **Do you smoke?**

YES ◯ NO ◯

- **Do suffer from any heart disease :**

YES ◯ NO ◯

- **Are you diabetic?**

YES ◯ NO ◯

- **Do you suffer from thyroid disease ?**

YES ◯ NO ◯

- **Did you suffer from a stroke before ?**

YES ◯ NO ◯

- **Do you suffer from a chronic lung disease?**

YES ◯ NO ◯

- **Do you suffer from chronic nasal congestion?**

YES ◯ NO ◯

- **How long have you been diagnosed with hypertension?** _____

- **Are you adherent to your medication?**

YES ◯ NO ◯

- **Is your hypertension controlled?**

YES ◯ NO ◯

- **When did your symptoms start**

Before being diagnosed with hypertension ◯ After ◯

➢ *Scoring of Berlin Questionnaire*

The questionnaire consists of 3 categories related to the risk of having sleep apnea. Patients can be classified into High Risk or Low Risk based on their responses to the individual items and their overall scores in the symptom categories.

➢ *Categories and Scoring:*

- **Category 1:** items 1, 2, 3, 4, and 5;

✓ **Item 1**: if 'Yes', assign 1 point
✓ **Item 2**: if 'c 'or 'd 'is the response, assign 1 point
✓ **Item 3**: if 'a 'or 'b 'is the response, assign 1 point
✓ **Item 4**: if 'a 'is the response, assign 1 point
✓ **Item 5**: if 'a 'or 'b 'is the response, assign 2 points

➢ *Add points. Category 1 is positive if the total score is 2 or more points.*

- **Category 2:** items 6, 7, 8 (item 9 should be noted separately).

✓ **Item 6**: if 'a 'or 'b 'is the response, assign 1 point
✓ **Item 7:** if 'a 'or 'b 'is the response, assign 1 point
✓ **Item 8**: if 'a 'is the response, assign 1 point Add points.

➢ *Category 2 is positive if the total score is 2 or more points.*

- **Category 3 is positive if:**

✓ the answer to item 10 is 'Yes' **or**
✓ if the BMI of the patient is greater than 30kg/m2. (BMI is defined as weight (kg) divided by height (m) squared, (kg/m2).

- **High Risk**: if there are 2 or more categories where the score is positive.
- **Low Risk**: if there is only 1 or no categories where the score is positive.

Additional Question: item 9 should be noted separately