Episode 157 – Sleep – Part Two: Sleep-disordered Breathing

May 22, 2026

Introduction

Sleep is essential for the health and well-being of children, adolescents, and adults. Healthy sleep is vital for cognitive functioning, mood regulation, and mental, cardiovascular,[1] cerebrovascular, and metabolic health. Adequate quantity and quality of sleep reduce the risk of accidents and injuries caused by sleepiness and fatigue, including workplace and motor vehicle accidents.[2] [1]

Short-term sleep deprivation, long-term sleep restriction, circadian misalignment, and untreated sleep disorders can have a significant and detrimental impact on physical health, mental well-being, and public safety. Chronic insufficient sleep is associated with an increased risk of mortality. It also contributes to individual risk and societal burden associated with several medical issues, including cardiovascular disease, diabetes,[3] obesity, and cancer. Research indicates extending the nightly sleep duration for those who regularly get insufficient sleep is associated with health benefits. [1]

Healthy sleep requires adequate sleep duration, appropriate timing, regularity, good quality, and the absence of sleep disorders. While individual sleep needs vary, current Canadian guidelines recommend adults 18 to 64 should regularly sleep 7 to 9 hours per night and those aged 65 and older should regularly sleep 7 to 8 hours per night to promote optimal health. Recommendations for sleep duration in children and adolescents vary based by age group. [1] [2] [3] [4] [5]

Sleep disorders are a group of conditions that disrupt normal sleep patterns. Insufficient or non-restorative sleep can negatively impact physical, mental, social, and emotional functioning. Sleep disorders can affect overall health, safety, and quality of life. [6]

There are many types of sleep disorders. The third edition of the *International Classification of Sleep Disorders* (ICSD-3) classifies sleep disorders into six main categories:

- Insomnia
- Central disorders of hypersomnolence

[1] Refer to Episodes 79, 80, and 81 for additional information on cardiovascular diseases.
[2] Listen to Episode 156 for discussion on sleep disorders, including sleep requirements, sleep hygiene; impact of climate change, teething, and aging on sleep; and various sleep disorders, such as insomnia, circadian rhythm sleep disorders, narcolepsy, and restless leg syndrome.
[3] Refer to Episodes 91, 93, and 94 for additional information on diabetes.

- Circadian rhythm sleep-wake disorders
- Parasomnias
- Sleep-related movement disorders
- Sleep-disordered breathing [6]

Sleep-disordered breathing
Sleep-disordered breathing, also called sleep-related breathing disorders, encompasses a range of conditions that cause abnormal breathing during sleep, such as habitual snoring, central sleep apnea (CSA), and obstructive sleep apnea (OSA). Sleep-disordered breathing, particularly OSA, has become a significant global health issue, with OSA affecting up to a billion people worldwide. Sleep-disordered breathing disrupts nocturnal breathing, fragments sleep, and increases the risk of serious health problems, such as neurodegenerative diseases, heart failure, stroke, and arrhythmias. Sleep-disordered breathing also increases the likelihood of traffic and occupational accidents. Untreated or inadequately treated sleep-disordered breathing is associated with higher healthcare costs, reduced productivity, and decreased quality of life. [7]

Snoring
Snoring is a raspy sound produced in the nasopharynx during sleep. The volume of snoring can range from barely audible to extremely loud, often being noticeable from another room. While snoring primarily disturbs others, such as bed partners or roommates trying to sleep, individuals who snore are usually unaware of their snoring, unless someone informs them. Some individuals may snore loudly enough to wake themselves up.

Snoring can cause dry mouth or a sore, irritated throat upon awakening. Additional symptoms may accompany snoring, including frequent awakenings, gasping or choking during sleep, excessive daytime sleepiness, and morning headaches. These symptoms may be present depending on the severity, cause, and effects of snoring. [8] [9] [10]

About 50% of individuals snore at some point in their lives, and an estimated 25%-50% of adults habitually snore. Snoring tends to become more frequent with age, and it appears to run in families. Snoring is more common in males, though many females snore. About 40% of adult males and 24% of adult females habitually snore. Males become less likely to snore after age 70. Sleeping on the back may increase the likelihood of snoring. It may also occur when throat muscles relax from the use of alcohol or other respiratory depressants. Congestion from a cold or allergies can also cause snoring. [10]

Pathophysiology
Snoring occurs when the soft tissues of the nasopharynx, especially the soft palate, flutter or vibrate due to airflow while breathing. The sound most often occurs with inhalation and can come through the nose, mouth, or both. Snoring can occur during any stage of sleep. Considering individuals do not snore while awake indicates muscle relaxation during sleep is part of the cause. This relaxation is believed to decrease the tissue stiffness, making it more prone to fluttering. Tissue relaxation narrows the upper airway, increasing the likelihood of fluttering. [8] [9] [10]

Snoring is more likely to occur in the upper airway, where structural factors compromise the airway, including:

- Micrognathia (undersized mandible) or retrognathia (mandible posterior to its normal position).
- Nasal septal deviation
- Rhinitis (inflammation of the nasal mucous membranes that causes tissue swelling)
- Obesity[4]
- Macroglossia (enlarged tongue)
- Enlarged soft palate
- Enlarged lateral pharyngeal walls [8]

Etiology

Primary snoring, also known as simple snoring or non-apneic snoring,[5] is snoring that does not cause individuals to wake up more often than normal during the night. During sleep, airflow into the lungs and blood oxygen levels are normal. Because these factors are normal, individuals do not have excessive daytime sleepiness. Primary snoring is considered the first stage of sleep-disordered breathing without severe medical consequences for the person who snores. [8] [9] [11]

Snoring is usually a symptom of sleep-disordered breathing. Sleep-disordered breathing includes a spectrum of conditions ranging from upper airway resistance syndrome to obstructive sleep apnea (OSA). These conditions differ mainly in the degree of airway obstruction and its effects on health, which primarily involves disturbances of sleep and airflow. [8] [9]

Upper airway resistance syndrome causes excessive daytime sleepiness or other symptoms suggesting OSA, but with few episodes of apnea, hypopnea, or significant oxygen desaturation. Therefore, it does not meet the criteria for OSA. Upper airway resistance syndrome occupies a clinical middle ground between primary snoring and OSA. With upper airway resistance syndrome, snoring increases in intensity (crescendo snoring) and terminates with snorts and arousals from sleep due to respiratory efforts (i.e., respiratory effort-related arousals [RERAs]). [8] [9] [12]

Individuals with upper airway resistance syndrome are generally younger and exhibit less obesity than those with OSA. They are more often female, report fatigue, and complain of insomnia. Snoring and upper airway airflow resistance cause noisy inhalation, but without arousals from sleep lasting greater than 2 seconds. Symptoms, evaluation, and treatment of upper airway resistance syndrome are similar to those of OSA. [13]

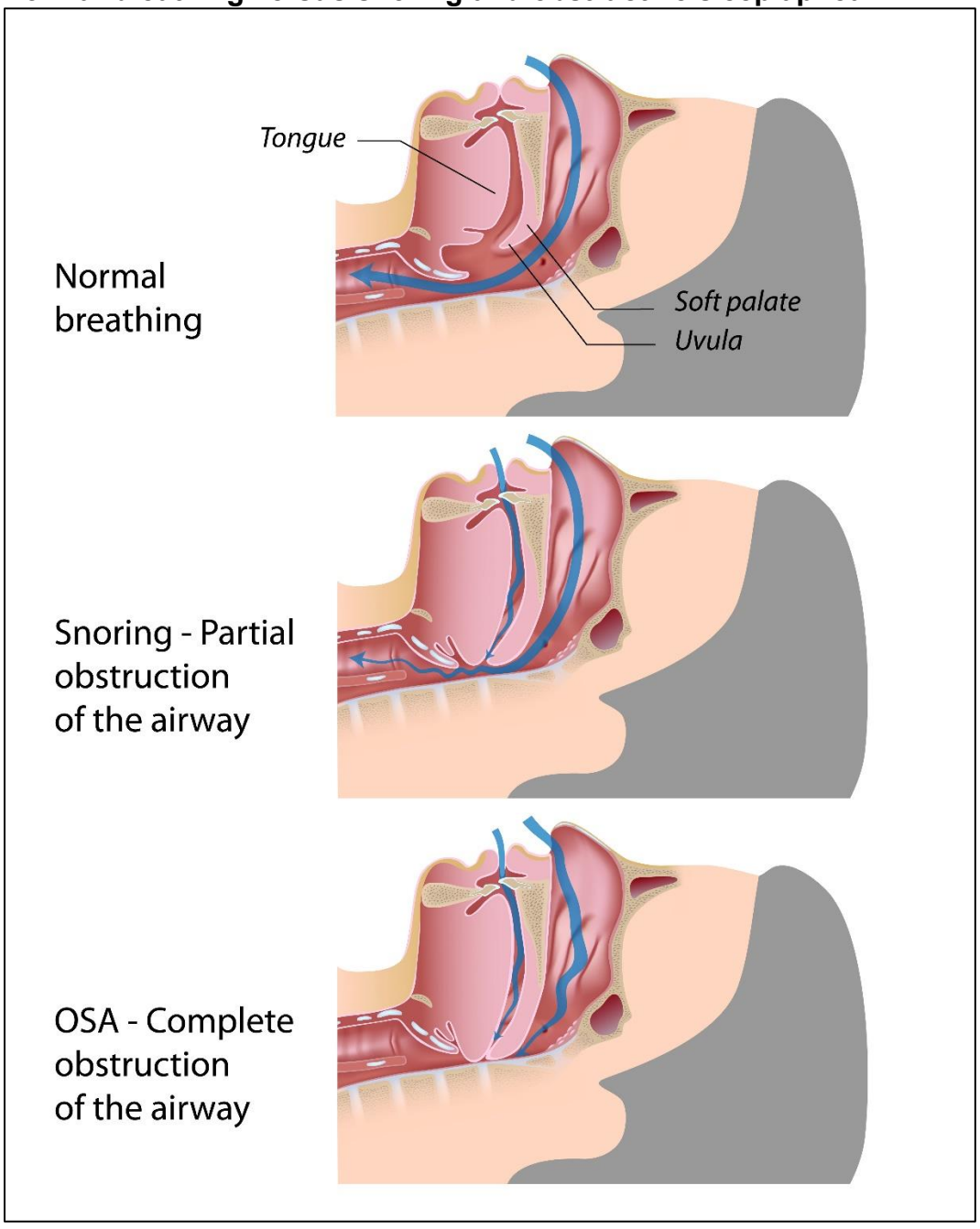
OSA prevents normal breathing during sleep because the airway becomes partly or completely blocked, as the tongue and soft tissues at the back of the throat relax and fall back. Fatty tissue can also contribute to the airway blockage. OSA causes five or

[4] Refer to Episodes 120, 121, and 122 for discussion on obesity.

[5] Non-apneic snoring is snoring without apnea or hypopnea. Apnea is stoppage of breathing. Hypopnea is shallow breathing.

more episodes of apnea or hypopnea per hour, with each episode lasting at least 10 seconds, accompanied by symptoms such as excessive daytime sleepiness, unrefreshing sleep, fatigue, and loud snoring. [8] [9] [14]

Normal breathing versus snoring and obstructive sleep apnea



Complications

Whether snoring itself has adverse effects is unclear. There seems to be a link between snoring and certain health problems. For example, snoring has been associated with the development of carotid atherosclerosis, which, in turn, increases the risk of stroke. [8] [9] [15]

Snoring can also be a sign of OSA. OSA increases the risk of serious complications, such as hypertension,[6] stroke, heart disorders, atrial fibrillation, and diabetes. [16]

Snoring can also disrupt bed partners' or roommates' sleep, affecting their ability to function during the daytime, potentially leading to impaired relationships and embarrassment for individuals who snore. [16]

Risk factors

Risk factors for snoring include:

- Older age (over 50).[7]
- Overweight or obesity, particularly fat distributed around the neck or midriff.
- Use of alcohol (a very common cause of snoring) or other sedatives, which leads to throat relaxation.
- Sleeping on the back. Snoring is typically most frequent and loudest when sleeping on the back, as gravity can affect throat tissues and narrow the airway.
- Chronic nasal congestion or blockage.
- Micrognathia or retrognathia.
- Menopause.
- Male sex.
- Pregnancy.[8]
- Abnormalities that can block airflow, such as large tonsils, adenoids, tongue, or soft palate; deviated nasal septum or nasal polyps.
- Sleep deprivation, which can lead to throat relaxation.
- Family history, as snoring frequently occurs in families. [8] [9] [17]

Assessment

The primary goal of assessing snoring is to identify individuals who are at high risk for OSA. While not everyone who snores has OSA, most individuals with OSA do snore. OSA can increase the risk of conditions such as hypertension, stroke, heart disorders, and diabetes. [8] [9]

Assessment of snoring includes evaluating its severity, including frequency, duration, and loudness. It is also important to consider how snoring affects others, as many significant signs of OSA are often noticed first by bed partners or roommates. Sleep should also be assessed.

The following symptoms should raise concern as they may indicate OSA:

- Episodes of stopping breathing or choking during sleep, as observed by a bed partner
- Headaches when waking in the morning
- Daytime sleepiness
- Obesity
- Very loud, constant snoring

[6] Refer to Episodes 135 and 136 for additional information on hypertension.
[7] Listen to Episode 123 for discussion on aging and longevity.
[8] Refer to Episodes 108, 109, and 110 for discussion on pregnancy.

- Hypertension [8] [9]

Individuals displaying warning signs of OSA should be referred to a medical provider for further evaluation and possible testing. Those without warning signs of OSA are unlikely to require testing and may wish to try general measures to help reduce snoring. If these measures are unsuccessful and snoring is bothersome to bed partners or roommates, individuals should see their medical provider. [8] [9]

Managing primary snoring
Several conservative measures may help reduce primary snoring and should be encouraged in all individuals who snore. While none of these methods are universally effective, some individuals may find them beneficial. These measures include:

- Sleeping with the head elevated. An effective way to elevate the head while sleeping is to place blocks under two of the bed's legs to raise the head of the bed or use a wedge pillow that slants the whole upper body. Individuals should not use pillows to raise only the head.
- Sleeping on one side rather than the back. Measures to encourage side sleeping may include attaching a tennis ball to the back of the nightshirt to help prevent rolling onto the back.
- Avoiding alcohol and sedating medications several hours before bedtime.
- Tobacco cessation.[9]
- Weight loss.
- Avoiding sleep deprivation.
- Treating nasal congestion. [9] [10] [17]

Sleep Apnea
Sleep apnea is a serious disorder in which breathing repeatedly stops long enough to disrupt sleep and often temporarily decrease the oxygen level (oxygen desaturation) and increase carbon dioxide level in the blood (hypercapnia). [18]

The main types of sleep apnea are:

- Central sleep apnea
- Obstructive sleep apnea [19]

Central sleep apnea
Central sleep apnea (CSA) occurs when the brain does not send proper signals to the muscles that control breathing. CSA is different from obstructive sleep apnea (OSA), which causes abnormal breathing due to the collapse of the soft tissues in the back of the throat, leading to blockage of the airway. CSA is not associated with obesity. Some individuals may have a combination of CSA and OSA. CSA is much less common than OSA but is not rare. CSA occurs in approximately 0.9% of individuals. CSA is more common in older adults, males, and individuals with cardiovascular disease (e.g., heart failure). CSA can also occur in children. Left untreated, CSA can result in poor quality

[9] Tobacco products increase the risk of snoring and sleep apnea because the nicotine relaxes the muscles that keep the airways open. [25]

sleep, daytime symptoms, low oxygen level (hypoxemia), and serious medical conditions. [18] [19] [20] [21]

Etiology

CSA is caused by a problem with the brain stem that controls breathing. Normally, the brain stem is very sensitive to changes in the blood level of carbon dioxide. When carbon dioxide levels are high, the brain stem signals the respiratory muscles to breathe deeper and faster to remove carbon dioxide through exhalation, and vice versa. In CSA, the brain stem does not respond appropriately to changes in the carbon dioxide level. Consequently, during sleep, individuals who have CSA may have apnea (pauses in breathing) or may breathe less deeply and more slowly than normal. [18]

There are many reasons why the brain stem may not send out appropriate breathing signals. For example, stroke, encephalitis, or birth defect of the brain may affect the brain stem. Other causes of CSA include:

- Opioids used for pain relief and several other medications.
- Being at high altitude.
- Heart failure.
- Brain tumour (a rare cause). [18]

Types

Types of CSA include:

- Primary CSA (or idiopathic sleep apnea), which is an uncommon type of CSA that has no apparent cause.
- CSA with Cheyne-Stokes Breathing, where breathing goes through cycles of frequent breaths followed by pauses in breathing.[10]
- CSA due to underlying medical conditions, such as heart disease, stroke, neurological conditions, and end-stage kidney disease.
- CSA due to periodic high-altitude breathing.
- CSA from taking pain medication that contains opioids or opioid use disorder.[11]
- Complex sleep apnea, also known as treatment-emergent CSA, sometimes develops in individuals with OSA who are using continuous positive air pressure (CPAP) therapy. [22] [23]

Symptoms

Symptoms of CSA include:

- Irregular breathing tempo interrupted by pauses
- Frequent awakenings from sleep
- Disrupted sleep
- Awakening early
- Insomnia
- Excessive daytime sleepiness

[10] In Cheyne-Stokes respiration, breathing gradually becomes more rapid, then gradually slows, stopping for a short period, before starting again. Then the cycle repeats. Each cycle lasts 30 seconds to 2 minutes. This type of CSA is most associated with congestive heart failure or stroke. [18] [23]

[11] Listen to Episodes 104 and 105 for discussion on substance use disorders.

- Lethargy
- Poor concentration
- Memory problems
- Severe morning headaches
- Dry mouth
- Snoring, but usually not as noticeable as it is with OBS.

Bed partners or care partners may detect CSA in individuals who exhibit long, quiet respiratory pauses and shallow breaths followed by hyperpnea (increased deep breathing), or restless sleep. [18] [20] [21] [22] [23]

Risk factors

Risk factors for CSA include:

- Male sex.
- Older age, especially over 60, can increase the risk of medical conditions or sleep patterns associated with CSA.
- Heart disorders (e.g., atrial fibrillation, congestive heart failure).
- Neurological conditions, such as stroke, amyotrophic lateral sclerosis (ALS), myasthenia gravis, brain tumours, or structural changes in the brainstem, can affect the brain's ability to regulate breathing.
- Kidney failure.
- Inherited disorders (e.g., Rett syndrome,[12] Prader-Willi syndrome,[13] or congenital central hypoventilation syndrome[14]).
- Sleeping at an altitude higher than accustomed to (over 2500 meters [8200 feet])
- Opioid use (e.g., morphine, hydrocodone, oxycodone, fentanyl, methadone) or opioid use disorder.
- Continuous positive airway pressure (CPAP) use for OSA. [21] [22] [23]

Complications

CSA is a serious medical condition. Complications of CSA include:

- Fatigue as repeated awakenings associated with sleep apnea make restorative sleep impossible, resulting in severe fatigue, trouble focusing, and excessive daytime sleepiness, which may lead to falling asleep while working or driving.
- Heart conditions, as sudden drops in blood oxygen levels during CSA can affect heart health and increase the risk of disorders such as arrhythmia. [22] [23]

Diagnosis

The diagnosis of CSA is based on review of the medical history, symptoms, medications, and clinical findings, and, when necessary, is confirmed by a sleep testing

[12] Rett syndrome is a rare neurodevelopmental disorder caused by a genetic problem that occurs almost exclusively in females and affects development after an initial 6-month period of normal development after birth. [34]

[13] Prader-Willi syndrome is a chromosomal deletion syndrome where part of chromosome 15 is missing or malfunctioning. [35]

[14] Congenital central hypoventilation syndrome (also called Ondine curse), which usually occurs in newborns, causes individuals to breathe inadequately or not at all except when they are fully awake. [18]

(polysomnography) in a sleep laboratory. This evaluation can help distinguish between OSA and CSA. However, testing may not be necessary if the cause is evident and reversible (e.g., travel to high altitude). [18] [20]

Treatment

CSA is often more difficult to fully control compared to OSA. Primary treatment of CSA includes managing underlying disorders, such as prescribing medications to reduce the severity of heart failure. It also involves avoiding or reducing opioids, alcohol, and other sedatives that exacerbate sleep apnea.

If CSA persists after primary treatment, other treatment options may include positive airway pressure (PAP) systems, oxygen, medications, or phrenic nerve stimulation. Individuals with minimal symptoms may not require specific therapy.

PAP systems for CSA management include:

- Continuous positive air pressure (CPAP), which involves wearing a mask over the nose or over the nose and mouth while asleep. The mask attaches to a small pump that supplies continuous pressurized air to hold the upper airway open.
- Bilevel positive air pressure (BiPAP), which involves wearing a mask connected to a small pump. BiPAP provides two different pressures: one for inhaling and another for exhaling. BiPAP can be adjusted to deliver a breath if the user has not taken one within a certain number of seconds.
- Adaptive servo ventilation (ASV), which involves wearing a mask connected to a small pump. ASV detects pauses in breathing and adjusts the delivered air pressure accordingly.

Individuals with low oxygen levels during sleep may be prescribed supplemental oxygen, either with or without PAP therapy, depending on their carbon dioxide levels during a sleep study.

Certain medications, such as acetazolamide,[15] theophylline,[16] and caffeine, can stimulate breathing and may be utilized to manage CSA. For example, individuals with CSA due to high altitude or heart failure may find relief with acetazolamide. These medications may also be considered for those who cannot tolerate other therapies, but individuals using them need close monitoring.

Phrenic nerve stimulation may be an option for select individuals with CSA who are unable to tolerate PAP therapy or who continue to experience symptoms despite its use. A phrenic nerve stimulator is a surgically implanted device that stimulates the phrenic nerve, leading to diaphragm contraction. This procedure is performed in specialized centres. Research is currently underway to assess the long-term success and outcomes of this treatment. [14] [20] [21] [24] [25]

[15] Respiratory stimulants such as acetazolamide, a carbonic anhydrase inhibitor, work by causing mild metabolic acidosis, increasing respiratory drive and reducing the frequency of central apneas. [36]

[16] Theophylline, a nonselective adenosine receptor antagonist, has been used to treat central sleep apnea in individuals with heart failure. Its benefits may be attributed to inhibiting adenosine receptors in the medulla, which leads to increased ventilatory stimulation. [36]

Obstructive sleep apnea
Obstructive sleep apnea (OSA) is the most common type of sleep apnea, with the prevalence increasing with rising obesity rates. An estimated one billion people are affected globally, most of whom are undiagnosed and untreated. Some degree of OSA is present in 8 to 16% of adults. OSA is up to 4 times more common among males and 7 times more common among individuals with obesity (i.e., body mass index [BMI] ≥ 30). However, one-third of people with OSA do not have overweight or obesity. [13] [18]

Pathophysiology
OSA is caused by repeated closure of the upper airway during sleep, leading to partial or complete obstruction of the nasopharynx, oropharynx, or both. These obstructions lead to repeated episodes of apnea or hypopnea, resulting in hypoxia and hypercapnia, fragmenting sleep through partial or complete arousals from non-rapid eye movement (NREM) and rapid eye movement (REM) sleep. [13] [18]

Related disorders include:
- Upper airway resistance syndrome
- Obesity-hypoventilation syndrome

Obesity-hypoventilation syndrome, also known as Pickwickian syndrome, is a disorder related to obesity. Individuals with extreme obesity may experience this syndrome on its own or, more often, in conjunction with OSA. In obesity-hypoventilation syndrome, excess body fat limits chest movement, while fat deposits below the diaphragm compress the lungs, leading to shallow and less effective breathing. Excess body fat around the throat compresses the upper airway, reducing airflow. This condition may also disrupt the control of breathing, resulting in CSA. Treating OSA in individuals with obesity-hypoventilation syndrome using positive airway pressure (PAP) therapy can help improve hypoventilation. [13] [18]

Symptoms
Symptoms of OSA may include:
- Loud disruptive snoring. Although loud disruptive snoring is reported by 85% of individuals with OSA, most people who snore do not have OSA.
- Pauses in breathing during sleep, often noticed by a bed partner.
- Choking, gasping, or snorting during sleep.
- Waking during the night gasping or choking.
- Frequent need to urinate at night.
- Restless and unrefreshing sleep.
- Difficulty staying asleep.
- Waking in the morning with a dry mouth or sore throat.
- Morning headaches.
- Excessive daytime sleepiness.
- Fatigue.
- Trouble focusing.
- Mood changes (e.g., depression, irritability).
- Hypertension, especially if taking multiple anti-hypertensive medications. [26]

Risk factors
Anyone can develop OSA. However, certain anatomic risk factors increase the risk of OSA, including:

- "Crowded" oropharynx caused by micrognathia or retrognathia.
- Large tongue base.
- Enlarged tonsils or adenoids, particularly in children.
- Rounded head shape and short neck.
- Neck circumference of >43 cm (>17 in) in males; >41cm (>16 in) in females.
- Thick lateral pharyngeal walls and parapharyngeal fat pads.

Additional risk factors for OSA include:

- Excess weight: Most but not all individuals with OSA are overweight. Fat deposits around the upper airway can obstruct breathing.
- Older age: Risk of OSA increases with aging.
- Male sex: In general, males are 2 to 3 times more likely than premenopausal females to have OSA.
- Post-menopausal status**:** OSA risk increases after menopause.
- Family history of sleep apnea: A family history of OSA is present in 25 to 40% of adult cases.
- Chronic nasal congestion: OSA occurs twice as often in those who have consistent nasal congestion at night, no matter what causes it.
- Smoking: Nicotine relaxes the muscles that keep the airways open.[17]
- Other disorders: Conditions such as nocturnal gastroesophageal reflux, acromegaly, hypothyroidism, polycystic ovary syndrome, and prior stroke can cause or contribute to OSA. OSA and obesity-hypoventilation syndrome frequently coexist. [13] [26]

Complications
OSA is associated with significant health consequences. Complications of OSA include:

- Excessive daytime sleepiness, which increases the risk of automobile crashes, difficulties at work, occupational accidents, and sexual dysfunction.
- Strained relationships with bed partners, roommates, and housemates because their sleep may be disrupted.
- Hypertension is strongly associated with OSA. Individuals with untreated OSA who have normal blood pressure are more likely to develop hypertension.
- Repetitive nocturnal hypoxia and sleep disruption are associated with increased risk of heart failure, coronary artery disease, atrial fibrillation, other arrhythmias, metabolic dysfunction-associated liver disease (MASLD), and stroke. The risk of stroke and all-cause mortality is increased even when controlling for other risk factors (e.g., hypertension, diabetes). However, the contribution of OSA to these common disorders is often underappreciated.
- Eye conditions**.** Some research has found a connection between OSA and certain eye conditions, such as glaucoma. Eye complications can usually be treated.
- Perioperative complications can occur with unrecognized OSA, because moderate or general anesthesia is a risk for airway obstruction. Individuals with diagnosed

[17] Listen to Episode 101 and 131 for discussion on tobacco use and nicotine pouches, respectively.

OSA should inform the anesthesiologist of the diagnosis before undergoing any surgery and should receive CPAP therapy when they receive preoperative medications and during recovery. [13] [26]

OSA in children

OSA can also occur in children, with a prevalence of approximately 2%. OSA in children is often underdiagnosed and can lead to serious sequelae. [27]

Risk factors for OSA in children include:

- Enlarged tonsils or adenoids.
- Obesity.
- Allergic rhinitis that causes significant nasal congestion.
- Craniofacial disorders (e.g., micrognathia, retrognathia, midfacial hypoplasia, excessively angled skull base).
- Medications (e.g., sedatives, opioids).
- Disorders such as Down syndrome, cerebral palsy, muscular dystrophies, sickle cell disease.
- Possibly genetic factors, such as congenital central hypoventilation disorders that can include both OSA and CSA, and Prader-Willi syndrome.
- Low birth weight.
- Family history of OSA. [13] [27] [28]

Symptoms of OSA in children include:

- Snoring reported by parents. However, snoring may not be reported even when OSA is severe. Infants and young children with OSA do not always snore.
- Restless sleep.
- Nighttime sweating.
- Observed apnea.
- Snorting, gasping, coughing, choking during sleep.
- Bedwetting (nocturnal enuresis) that starts after a long period of dry overnights.
- Morning headache.
- Problems concentrating.
- Doing poorly at school.
- Nasal obstruction.
- Mouth breathing.
- Hyperactivity as a manifestation of sleepiness.
- Acting impulsive or aggressive.
- Saying they feel sleepy or falling asleep at school or during short car or bus rides.
- Poor weight gain. [27] [28]

Complications of OSA may include:

- Learning problems.
- Behavioural problems.
- Cor pulmonale (right ventricular enlargement and right heart failure).

- Pulmonary hypertension (i.e., blood pressure in the pulmonary arteries of the lungs is abnormally high).
- Growth disturbance. [27]

Diagnosis of OSA in children includes health history and symptom review, physical examination, including assessment of the head, neck, nose, and oral cavity, and an overnight sleep study (polysomnography) in a sleep lab as indicated. [27] [29]

Treatment of OSA in children includes:
- Sometimes watchful waiting for up to 6 months may be appropriate in young healthy children with mild OSA who do not exhibit daytime symptoms or severe abnormalities on polysomnography.
- Adenotonsillectomy is usually effective for children with OSA who are otherwise healthy and have enlarged tonsils and/or adenoids. This surgery may also improve some behaviours, quality of life and blood pressure compared with watchful waiting. However, adenoidectomy alone is often ineffective. The risk of perioperative airway obstruction is higher in children with OSA than those without OSA undergoing adenotonsillectomy, so close monitoring is essential.
- Alternate surgical procedures may be indicated depending on the anatomic abnormality causing OSA, such as uvulopalatopharyngoplasty, or tongue or midface surgeries and correction of congenital micrognathia.
- CPAP can be used for children who are not candidates for corrective surgery or who continue to have OSA after adenotonsillectomy.
- Weight loss can help reduce OSA severity and provide additional health benefits. However, it is rarely sufficient as a standalone treatment for OSA in the long term.
- Nocturnal oxygen supplementation may help prevent hypoxemia until definitive treatment is provided.
- Treatment of allergic rhinitis. However, corticosteroids and antibiotics are not usually indicated. [27] [28]

OSA Diagnosis in adults
Diagnosis of OSA in adults involves a review of the medical history, symptoms, and sleep history, and a physical assessment.

Medical history
Review of the medical history includes:
- Presence of disorders associated with OSA, particularly hypertension, coronary ischemia, heart failure, stroke, gastroesophageal reflux disease (GERD), atrial fibrillation, depression, obesity, and diabetes.
- Amount of alcohol consumed and when it is consumed in relation to bedtime.
- Medication use to identify sedating or muscle-relaxing drugs. [8]

Review of symptoms includes:
- Severity of snoring, including frequency, duration, and loudness.
- Degree that snoring affects the bed partner or roommate. Bed partners or roommates may be able to provide information about severity of symptoms. [8]

The STOP-BANG questionnaire is a useful tool to determine the risk of OSA in individuals who snore. The questionnaire consists of a brief set of yes-or-no questions. Each "yes" answer scores one point. The total score ranges from 0 to 8. The questionnaire does not diagnose sleep apnea, but it can help determine whether someone needs further testing. [8]

Each letter in STOP-BANG represents a risk factor for sleep apnea:

- **S**noring
- **T**iredness during the day
- **O**bserved pauses in breathing during sleep
- **P**ressure (treated for high blood pressure)
- **B**ody mass index (BMI) more than 35 kg/m^2
- **A**ge older than 50
- **N**eck circumference (16 in/40cm or larger)
- **G**ender (male)

A score of 3 or higher suggests an increased risk for OSA. The STOP-BANG questionnaire is often a first step in identifying people who may have OSA. However, the tool is meant for screening only. A high score does not mean a person has OSA, and a low score does not rule it out completely. A formal sleep evaluation is still needed for a diagnosis. [30]

STOP-BANG Questionnaire [8] [14] [31]

Item	Question	Yes	No
Snoring	Do you snore loudly (loud enough to be heard through closed doors or your bed-partner elbows you for snoring at night)?		
Tired	Do you often feel tired, fatigued, or sleepy during the daytime (e.g., falling asleep during driving or talking to someone)?		
Observed	Has anyone observed you stop breathing or choking/gasping during sleep?		
Pressure	Do you have or are being treated for high blood pressure?		
BMI	Body mass index more than 35 kg/m^2?		
Age	Age older than 50?		
Neck size	Neck or shirt collar size 40 cm /16 in or larger?		
Gender	Male?		
	Total		

Risk of OSA	Scoring
Low	Yes to 0 - 2 questions
Intermediate	Yes to 3 - 4 questions
High	Yes to 5 - 8 questions
	Or yes to 2 or more of 4 STOP questions + male
	Or yes to 2 or more of 4 STOP questions + BMI >35kg/m^2
	Or yes to 2 or more of 4 STOP questions + neck size 40 cm/16 in

Review of sleep history should include:

- Number of awakenings
- Witnessed apneic or gasping/choking episodes
- Presence of unrefreshing sleep or morning headaches
- Excessive daytime sleepiness [8] [13]

Epworth Sleepiness Scale

The Epworth Sleepiness Scale (ESS) can be used to quantify daytime sleepiness. Eight questions ask the person to rate, on a four-point scale (0-3), their usual chances of dozing off or falling asleep while engaged in different activities. The total score ranges from 0 to 24. The higher the ESS score, the higher their daytime sleepiness. [8] [32] [33]

Results from 0 to 10 show average (normal) daytime sleepiness. A result from 11 to 24 indicates excessive (abnormal) daytime sleepiness.

In general ESS scores may be interpreted as follows:

- 0 to 5: Low daytime sleepiness (normal).
- 6 to 10: High daytime sleepiness (normal).
- 11 to 12: Mild excessive daytime sleepiness.
- 13 to 15: Moderate excessive daytime sleepiness.
- 16 to 24: Severe excessive daytime sleepiness. [32] [33]

Epworth Sleepiness Scale [8]

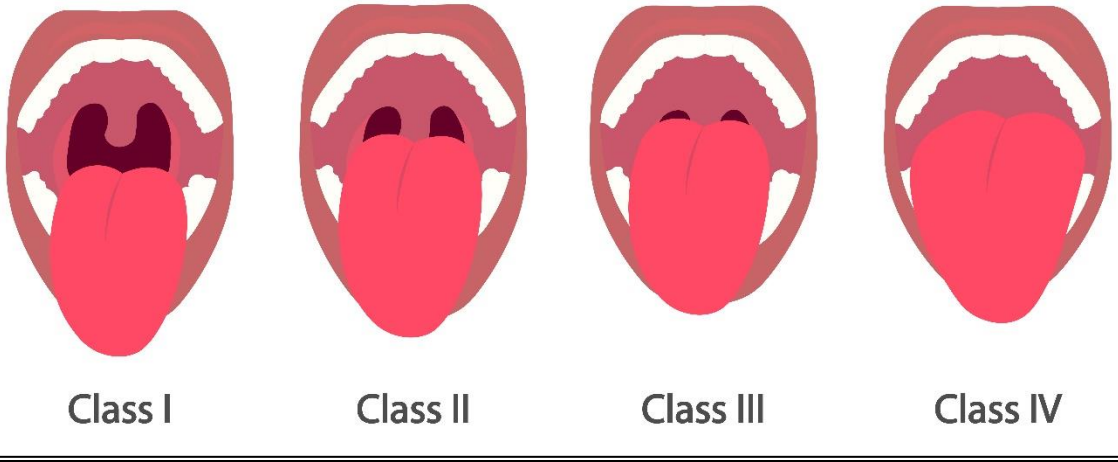
Activity	**Chance of dozing** (0 = no chance; 1= slight chance; 2 = moderate chance; 3 = high chance)
Sitting and reading	
Watching TV	
Sitting inactive in a public place	
Sitting for an hour as a passenger in a car	
Lying down in the afternoon to rest	
Sitting and talking to someone	
Sitting quietly after a lunch without alcohol	
Sitting in a car, stopped for a few minutes due to traffic	
Total	

Physical assessment
A physical assessment typically begins by measuring height and weight, calculating body mass index (BMI),[18] measuring blood pressure, and assessing the head, neck, and oral cavity.

The physical assessment is useful for identifying signs associated with OSA including:
- Obesity with fat distributed around the neck or midriff.
- Hypertension.
- Large neck circumference (≥43 cm [17 in] in males, ≥41 cm [16 in] in females)
- Micrognathia or retrognathia
- Nasal obstruction (e.g., nasal polyps or engorged turbinates)
- High, narrow arched palate
- Enlarged tonsils (palatine or lingual), adenoid, tongue, uvula, soft palate or lateral walls of the pharynx.

Modified Mallampati score can be used to assess the risk of OSA. A score of 3 or 4, where only the base or none of the uvula is visible during an oral examination, indicates an increased risk of OSA. [8] [9]

Modified Mallampati score [8]



Modified Mallampati scoring
Class I: Tonsils, uvula, and soft palate are fully visible.
Class II: Hard and soft palate, upper portion of tonsils, and uvula are visible.
Class III: Soft and hard palate and base of the uvula are visible.
Class IV: Only the hard palate is visible.

[18] BMI is calculated by dividing an adult's weight in kilograms by their height in metres squared. The formula is BMI = kg/m^2. BMI calculator is located at: https://www.diabetes.ca/resources/tools-resources/body-mass-index-(bmi)-calculator

Red flags
The following findings are of particular concern:
- Witnessed apnea or choking during sleep
- Morning headaches
- Epworth sleepiness score ≥10
- BMI ≥35 kg/m^2
- Very loud, constant snoring
- Hypertension [8]

Interpreting findings
The clinical evaluation for diagnosing OSA is not entirely reliable, but it can be suggestive. Red flag symptoms are strongly associated with OSA. However, these findings occur along a continuum, and there is no consensus on specific cut-off points or the importance of each finding. Nevertheless, the more 'red flag' findings a person has and the greater their severity, the higher the likelihood of OSA. [8]

Individuals whose symptoms, screening questionnaires, and risk factors indicate a higher likelihood of OSA should undergo sleep monitoring to determine the apnea-hypopnea index (AHI) or an alternate measure, such as the respiratory disturbance index (RDI), to confirm the diagnosis and grade severity. [13]

The apnea-hypopnea index (AHI) is the total number of apnea and hypopnea episodes during sleep divided by the total hours of sleep. AHI is expressed as the number of episodes per hour. The more events that occur, the more severe the OSA and the greater the likelihood of adverse effects. AHI values can be computed for different sleep stages and body positions (e.g., lying on the side or back). [13]

OSA is categorized by severity:
- Mild: 5 to 15 episodes/hour
- Moderate: 16 to 30 episodes/hour
- Severe: >30 episodes/hour [8]

Testing for OSA
Testing for OSA is recommended when there is a significant suspicion of the condition. This testing typically involves polysomnography (sleep study), which can be conducted in a sleep lab or at home. Polysomnography is indicated if clinical suspicion for OSA is high, particularly in individuals who exhibit red flag symptoms, such as witnessed apneas. This also includes individuals whose scores on screening tools, like the STOP-BANG risk score for OSA, fall just short of a definitive diagnosis. [8]

Home sleep apnea testing may be considered when clinical suspicion for OSA is lower. These tests monitor a limited number of variables to detect breathing pauses during sleep. Individuals with no symptoms or signs of sleep disturbances other than snoring may not need testing. However, they should be monitored for the development of such manifestations. [8]

OSA treatment aims to:

- Reduce symptoms,
- Reduce episodes of hypoxia and sleep fragmentation, and
- Restore sleep continuity. [13]

OSA treatment involves several strategies, such as:

- Control of risk factors (e.g., obesity, alcohol and sedative use)
- Continuous positive airway pressure (CPAP) or oral appliances
- Sometimes surgery or nerve stimulation.[19] [13]

Take home messages:

- Sleep is one of the most essential elements for maintaining good health.
- Sleep-disordered breathing is a common disorder with a range of harmful effects that can significantly impact overall health.
- Snoring is usually a symptom of sleep-disordered breathing. Snoring can disrupt the sleep of bed partners and roommates, affect their well-being, and potentially lead to strained relationships and embarrassment for those who snore.
- Obstructive sleep apnea is the most common sleep-related breathing disorder and is associated with significant health consequences.

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