

Sleep Disordered Breathing After SCI

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Sleep disordered breathing is common after a spinal cord injury (SCI). This page explains what sleep disordered breathing is, why it occurs, what factors influence it, and current management options.

Key points

- Sleep disordered breathing is a family of conditions (including sleep apnea) that involve the interruption of air flow during sleep.
- Symptoms of sleep disordered breathing include feeling tired during the day, snoring, and choking or gasping for air in your sleep.
- Sleep disordered breathing is prevalent after SCI, and can be attributed to the level of injury, weight, sleep position, and medications.
- Lifestyle modifications and the use of continuous positive airway pressure (CPAP) machines are the most common management strategies.

What is sleep disordered breathing?

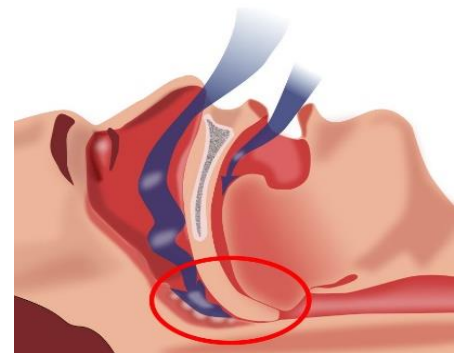
Sleep disordered breathing is an umbrella term for conditions that involve an interruption of breathing throughout the night. In research, sleep disordered breathing is evaluated through observing two key factors:

- *Apnea*, or a loss of air flow for 10 seconds or more, and
- *Hypopnea*, a partial blockage of an airway resulting in decreased air flow to the lungs and decreased oxygen in the blood.

When you sleep, the body normally goes into a state of *hypoventilation*, or a slow and shallow breathing. This results in a decrease in oxygen circulating in the blood. However, weak evidence suggests that after an SCI, hypoventilation becomes more prevalent during sleep when compared to able-bodied people. Among those with SCI, hypoventilation occurs more often in individuals with tetraplegia versus paraplegia.

The two most common disorders under sleep disordered breathing include:

- *Obstructive sleep apnea*, which occurs when the throat muscles relax and temporarily block your airway, and
- *Central sleep apnea*, which occurs when the brain is unable to properly send signals to the breathing muscles. This occurs when your unconscious breathing stops.



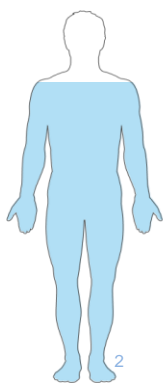
Obstructive sleep apnea occurs when the throat muscles relax (highlighted by the red circle), resulting in a blockage of your airway.¹

For a review of what we mean by "strong", "moderate", and "weak" evidence, refer to the [SCIRE Community Evidence Ratings](#)

Of the two types of sleep apneas, obstructive sleep apnea is more prevalent among individuals with SCI of all levels. However, central sleep apnea is more prevalent among individuals with *cervical* level injuries. Narcotic use can also increase the risk of central sleep apnea. It is important to note that some patients have mixed sleep apnea, a combination of obstructive and central sleep apnea.

The prevalence of sleep apnea in individuals with spinal cord injury is two to five times greater than that in the non-SCI population. In the SCI population, research has found that sleep apnea rates vary from 27-82%. The variation in prevalence can be attributed to different diagnostic measures used in research studies (e.g., evaluating sleep apnea in a lab versus home setting) and the way each study defines sleep apnea. Level of injury and type of injury also influence the prevalence of sleep apnea in the SCI population.

Why is sleep disordered breathing common after SCI?



A few hypotheses have been made by scientists as to why sleep apnea is prevalent in SCI. In general, sleep apnea is attributed to a complex interaction of a variety of factors:

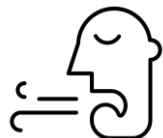
Level of injury

Sleep disordered breathing is more prevalent in individuals with tetraplegia compared to those with paraplegia. Having a higher level of injury is usually associated with decreased muscle functioning and neural control over your organs. These impairments can create troubles with breathing, specifically with inhaling, exhaling, and the amount of air your lung can hold.

Refer to our article on [Respiratory Changes After SCI](#) for more information.



Changes in sensitivity to oxygen and carbon dioxide



After an SCI, your body becomes more sensitive to the amount of carbon dioxide circulating throughout your body. So, when there is a slight increase in carbon dioxide in the body, the brain senses it as a large change, which cues the body to *hyperventilate*, or rapidly breathe. However, since the change in carbon dioxide was small to start with, hyperventilation results in excess removal of carbon dioxide, resulting in very low carbon dioxide levels. During sleep, breathing is dependent on the amount of carbon dioxide circulating in the body. If this level drops below the level required for breathing, then central sleep apnea occurs. While some researchers believe this may be a cause of central sleep apnea, others note that there is currently only weak evidence to support this hypothesis.

Weight



Measures of body composition, including body mass index (BMI), neck circumference, and waist circumference, may be linked to the prevalence of sleep disordered breathing. Weak research evidence has suggested that a greater neck circumference or BMI can increase the odds of having sleep disordered breath. This is concerning for individuals with SCI, as 44-66% of this population are overweight or obese. However, other studies have found no relationship between BMI or neck circumference and sleep disordered breathing in SCI.

Sleeping on your back



One weak evidence study has suggested that there is more than a 50% increase in apneic events that occur when you sleep on your stomach or on your back, rather than on your side. More specifically, tetraplegics who sleep on their backs experienced more apneas and hypopneas per hour compared to those who slept in other positions. Despite this evidence, other researchers found that sleeping on your back enhances overall breathing functions after SCI. More research is required to determine the optimal sleeping position for health benefits, keeping in mind that bed mobility and turns overnight also help to maintain skin health.

Medications



Common medications used by individuals with SCI can also impact breathing during sleep. These include: narcotics, baclofen, benzodiazepines (lorazepam, diazepam, clonazepam), testosterone, and heart medications to treat high blood pressures or arrhythmias. Although medications can cause sleep disordered breathing, they are not likely to be the main contributor to the issue.

Increased Nasal Resistance



Individuals with tetraplegia may find it harder to breathe in with their nose (i.e., *nasal resistance*) because swelling of the blood vessels and a thickening of the mucus in the nose is a common effect of cervical spinal cord injury. One moderate evidence study found that individuals with tetraplegia experienced greater nasal resistance in comparison with able-bodied individuals. Since increases in breathing resistance can cause the airways to collapse, some researchers believe that this may contribute to the higher prevalence of obstructive sleep apnea in individuals with tetraplegia.

What are the symptoms of sleep apnea?

Some of the most common symptoms of sleep apnea in individuals with spinal cord injury include:

- Feeling unrefreshed after a night's sleep
- Difficulty concentrating when you are awake
- Feeling sleepy during the day, as assessed by the Epworth Sleepiness Questionnaire in clinics
- Difficulties falling asleep
- Awakenings multiple times throughout the night
- Snoring during sleep
- Choking or gasping for air during sleep



Although the above are symptoms of sleep apnea, it is important to note that these same symptoms can result from secondary complications from a spinal cord injury (e.g., pain, spasticity, posture).

What treatment is available for sleep disordered breathing?

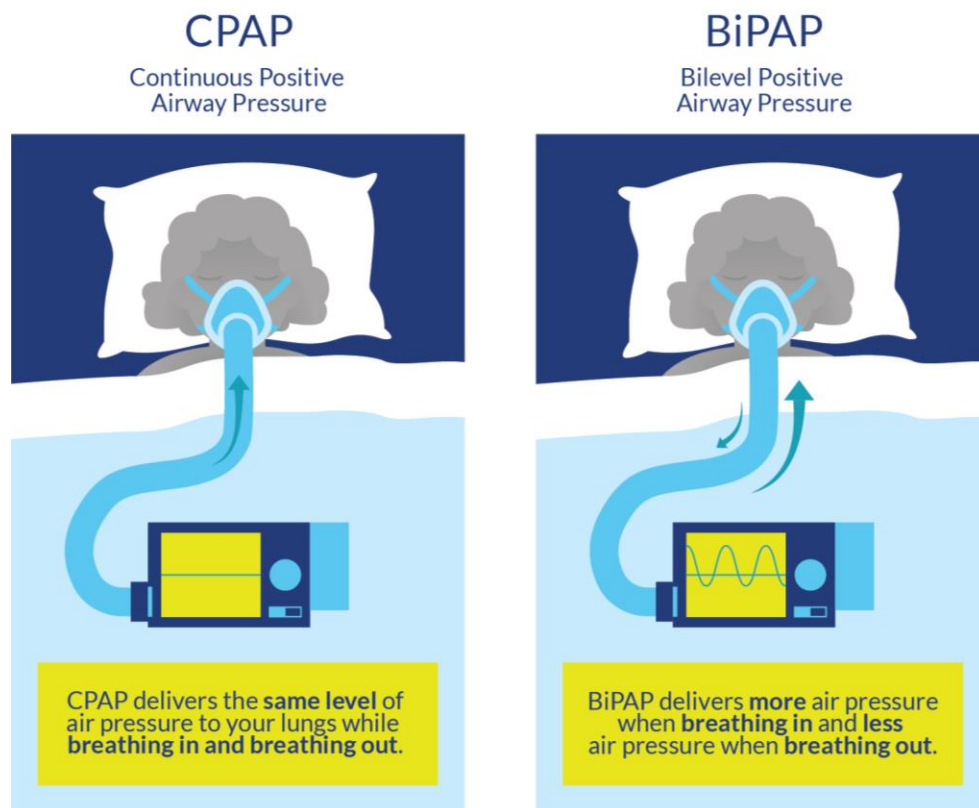
Continuous positive airway pressure machines

The first line of treatment for sleep disordered breathing generally includes lifestyle changes consisting of weight loss and the avoidance of alcohol and smoking. These lifestyle changes are normally done in conjunction with the use of a *continuous positive airway pressure (CPAP) machine*. CPAP machines act as a “pneumatic splint” that holds the airway open using a continuous pressure of air. To use a CPAP machine, a mask or nasal pillows are worn over the face/nose overnight.

CPAP machines are commonly used to address sleep apnea, and their effectiveness for the SCI population is supported by some weak evidence research studies. Although CPAP machines can help with breathing, multiple weak evidence research articles report poor adherence in using CPAP machines. Some of these reasons include:

- Difficulties putting on the mask, especially among individuals with limited hand function
- Mask discomfort
- Feelings of claustrophobia
- Decreased sleep quality/hard time falling asleep with it on

Although CPAP machines have the potential to help with sleep disordered breathing, more research is required to determine how helpful CPAP machines are to individuals with SCI, and how we can improve adherence to this treatment.



CPAP and BiPAP are powered by a machine which regulates the flow of air. These machines are connected via a tube to a mask worn over the nose and mouth.⁹

Bilevel positive airway pressure machines

Bilevel positive airway pressure (BiPAP) machines operate similarly to CPAP machines in that air pressure is used to keep the airway open. However, BiPAP machines do not deliver a constant pressure of air. When using a CPAP machine, exhaling may be difficult since breathing against an inflow of air requires effort. To facilitate breathing both in and out, the BiPAP machine is typically set to exert a higher air pressure for inhalation, and a lower pressure during exhalation. While there have been some evidence that BiPAP machines may benefit the able-bodied population, more research is required to determine the effectiveness of BiPAP machines in an SCI population. If you are not tolerating a CPAP machine, it may be worth discussing with your doctor to trial a BiPAP machine to treat sleep apnea.

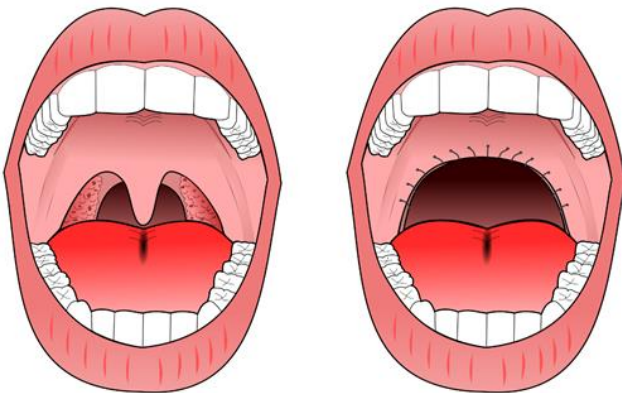
Dental appliances

Dental appliances are sometimes an alternative to CPAP if an individual exhibits mild sleep disordered breathing. Dental appliances fit in the mouth like a mouth guard, and help pull the jaw and the tongue forward to open up the airway and prevent obstructive sleep apnea. Although there has been a lot of literature supporting the use of dental appliances in an able-bodied population, more research needs to be conducted in an SCI population.



An example of a dental appliance. A gap between the teeth helps promote airflow when sleeping.¹⁰

Invasive interventions



In the UVPPP surgical procedure, extra tissue is removed from the roof of your mouth and/or from your throat.¹¹

Surgical interventions for sleep disordered breathing are often the last resort, after CPAP or BiPAP fail to work. There are a variety of surgical procedures that are used to aid obstructive sleep apnea, many of which involve reducing or repositioning the soft tissue at the back of the throat. One of the most common surgical procedures is an *uvulopalatopharyngoplasty (UVPPP)*, whereby the soft tissues at the back of your mouth and throat are reduced and removed. However, the success rate for this procedure is variable, and there is only weak evidence to support this technique in able-bodied populations. Moreover, sleep disordered breathing in SCI may result from complex interactions

between a variety of factors including level of injury, weight, sleep position, and medications. Although obstructive sleep apnea is common in SCI, researchers are unsure whether it stems from the structure of the throat or changes resulting from an SCI. The evidence for surgical procedures to aid obstructive sleep apnea after SCI is sparse and requires more research.

The bottom line

Sleep disordered breathing, or a lack of breathing during sleep, is two to five times more prevalent in the SCI population compared to the able-bodied population. This increase in prevalence is believed to be related to a variety of factors including weight, level of injury, sleep position, and medications. While there are a variety of non-invasive and invasive procedures to manage sleep disordered breathing, more research is required to determine which treatment is most effective in an SCI population.

For a list of included studies, please see the [Reference List](#). For a review of what we mean by “strong”, “moderate”, and “weak” evidence, refer to the [SCIRE Community Evidence Ratings](#).

Related resources

SCIRE Community. “Respiratory Changes After SCI”. Available from: community.scireproject.com/topic/respiratory-changes/

SCIRE Community. “Spinal Cord Injury Basics”. Available from: community.scireproject.com/topic/sci-basics/

Reference List

Parts of this page have been adapted from the SCIRE Professional “Respiratory management” Module:

Sheel AW, Welch J, Townson AF (2018). Respiratory Management Following Spinal Cord Injury. In: Eng JJ, Teasell RW, Miller WC, Wolfe DL, Townson AF, Hsieh JTC, Connolly SJ, Noonan VK, Loh E, Sproule S, Querée M, McIntyre A, editors. Spinal Cord Injury Rehabilitation Evidence. Version 6.0. Vancouver: p. 1-72.

Available from: scireproject.com/evidence/respiratory-management/

Full reference list available from: community.scireproject.com/topic/sleep-disordered-breathing/#reference-list

Glossary terms available from: community.scireproject.com/topics/glossary/

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