

## Thirty Functions of The Nose

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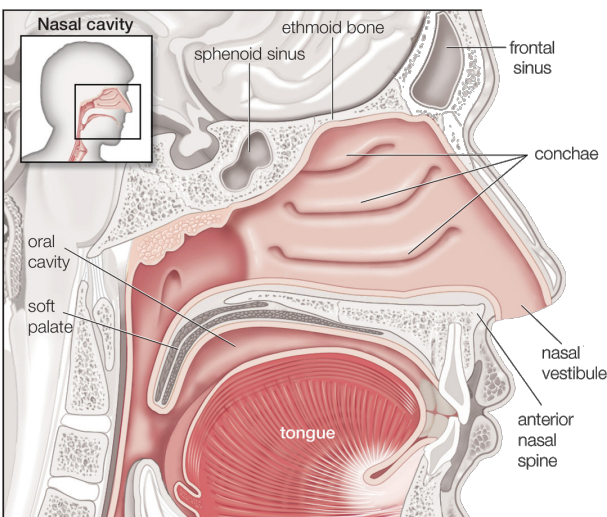
Back in the 1970s, renowned Ear, Nose and Throat Dr Maurice Cottle stated that the nose performs 30 functions in the human body. I wasn't able to locate this list. Hence my efforts below- a compilation of 30 functions of the nose.

### EVERYDAY PERFORMANCE

#### 1. Helps to Induce Relaxation

Nasal breathing also provides resistance to slow down the breathing rate. The nasal passages are smaller than the mouth, which means that air has to pass through them more slowly. This creates a natural resistance that helps to regulate the breathing rate and promote relaxation.

Russo MA, Santarelli DM, O'Rourke D. The physiological effects of slow breathing in the healthy human. *Breathe* (Sheff). 2017;13(4):298-309. doi:10.1183/20734735.009817.



#### 2. Improves cognitive function

Persons with normal function of the nose have improved cognitive function and energy levels in comparison to persons with chronic nasal issues. In a study of 100 persons to investigate cognitive function (50 with chronic rhinosinusitis) persons with nasal congestion were found to have significantly more cognitive dysfunction and fatigue on validated instruments and had worse reaction times on computerized testing.

Soler ZM, Eckert MA, Storck K, Schlosser RJ (2015) Cognitive function in chronic rhinosinusitis: a controlled clinical study. *Int Forum Allergy Rhinol.* 5(11):1010-1017.

#### 3. Smell and Partner Choice

The sense of smell is important in choosing both human and animal mates. Two people with very similar genetic make up could be related, and in breeding increases the risk of unfavourable genes passed down from one generation to another. In relation to its influence

on partner selection, scientists discovered that signals are picked up via smell, otherwise fancily referred to as olfaction. The influence of body odor in mate selection was confirmed in experiments by Wedekind in 1975. Findings show that women prefer the odor of men who are dissimilar to themselves.

Ihara, Yasuo, et al. "HLA and human mate choice: tests on Japanese couples." *Anthropological Science* 108.2 (2000): 199-214.

#### 4. Increased Visuospatial Awareness

In 2019, researchers at the Weizmann Institute in Israel suggested that nasal inhalation could be linked to cognition as part of an evolutionary survival mechanism. A sense of smell is, after all, equated with sniffing out danger. For our distant ancestors, this meant accurately assessing their surroundings to make life-or-death decisions. The Weizmann team theorized that this ancient sensory system might benefit from nasal inhalation and that, in modern life and competitive sports, nasal inhalation might automatically trigger conditions in the brain that optimize visuospatial focus. They demonstrated that nasal breathing synchronized electrical activity in the brain on a wavelength that helped to maximize visuospatial (VS) awareness.

Bergland, Christopher. "Breathe In! Nasal Inhalations Are Linked to Laser-Like Focus." Weizmann Institute of Science. Published March 17, 2019. [www.weizmann-usa.org/news-media/in-the-news/breathe-in-nasal-inhalations-are-linked-to-laser-like-focus](http://www.weizmann-usa.org/news-media/in-the-news/breathe-in-nasal-inhalations-are-linked-to-laser-like-focus) (accessed January 7, 2020).

Perl, Ofer, Aharon Ravia, Mica Rubinson, Ami Eisen, Timna Soroka, Nofar Mor, Lavi Secundo, and Noam Sobel. "Human non-olfactory cognition phase-locked with inhalation." *Nature human behaviour* 3, no. 5 (2019): 501.



#### 5. Mediates Olfactory-induced Behavioral response

The sense of smell, a primary function of the nose, plays a significant role in aiding behavioral response by activating the amygdala and the hippocampus. The amygdala is responsible for the emotional processing of odorant molecules, with odors being able to serve as rewards or punishments in the associative learning process.

This means that odors associated with positive states reinforce behaviors that lead to more of the positive state and vice versa for the negative states. Brain imaging studies have found that activation of the amygdala correlates with pleasant and unpleasant odors, reflecting the link between odors and emotions.

The hippocampus, which is also closely linked to the sense of smell, assists with the learning process and is associated with episodic memory. This is where an odor can lead to the retrieval of a memory from a specific point in time or place, highlighting the complex interplay between the sense of smell, emotion, and our cognitive processes. You might have experienced a time when a particular scent brought you back to some event years ago.

The nose and its functions shape our behavior, memory, and emotional responses.

Kadohisa M. Effects of odor on emotion, with implications. *Front Syst Neurosci.* 2013;7:66. Published 2013 Oct 10. doi:10.3389/fnsys.2013.00066.

#### 6. Reduced Vocal Effort

Professional singers engage in prolonged periods of breathing through the mouth. This increases the minimum pressure required to initiate and sustain vocal fold oscillation.

Compared to oral breathing, nasal breathing can naturally humidify and filter incoming air. This can help to prevent irritation and inflammation of the vocal cords, leading to improved voice quality and a lower risk of developing voice disorders. Therefore, breathing through the nose can help reduce the vocal effort required during speech.

It is important for singers to maintain nasal breathing during their everyday life, including exercise, rest and sleep. Breathing through the nose helps to prevent dryness of the larynx.

Sivasankar M, Fisher KV. Oral breathing increases Pth and vocal effort by superficial drying of vocal fold mucosa. *J Voice.* 2002 Jun;16(2):172-81. doi: 10.1016/s0892-1997(02)00087-5. PMID: 12150370.

## 7. Nasal Resonance

The nose plays a crucial role in speech by creating nasal resonance. This occurs when sound waves from the vocal cords resonate in the nasal cavity, producing a unique quality to the voice.

Without the nose, the voice would sound monotone and lack depth. Additionally, nasal resonance helps to add emphasis and nuance to our speech, allowing us to communicate effectively with others.

Conversely, too much nasal resonance (hyper) decreases speech intelligibility and impairs social interaction.

Young A, Spinner A. Velopharyngeal Insufficiency. 2023 Jan 12. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 Jan-. PMID: 33085296.

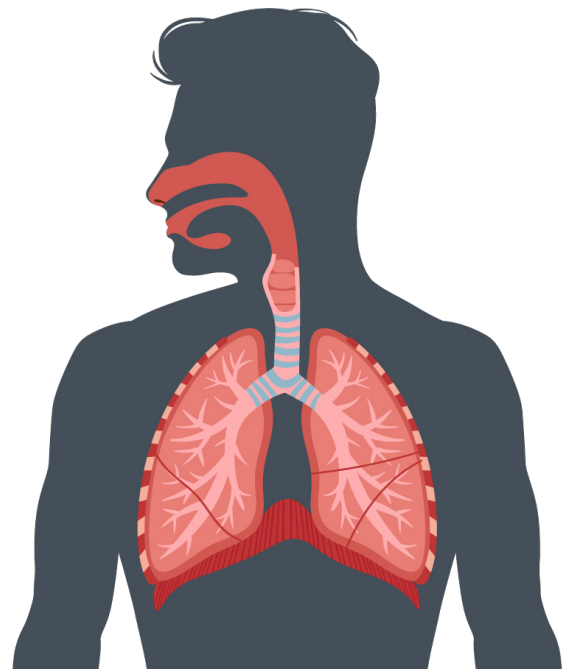


## BREATHING AND THE NOSE

### 8. Improves recruitment of the diaphragm breathing muscle

The diaphragm which separates the chest from the abdomen is the main breathing muscle. Breathing through the mouth causes reduced movement of the diaphragm. Conversely, breathing through the nose increases recruitment of the diaphragm. For persons with upper chest breathing, switching to habitual nasal breathing is important in rehabilitation. This is relevant to all modalities (physiotherapy, physical therapy, yoga, Pilates etc.) working with the biomechanical dimension of breathing.

Trevisan ME, Boufleur J, Soares JC, Haygert CJ, Ries LG, Corrêa EC. Diaphragmatic amplitude and accessory inspiratory muscle activity in nasal and mouth-breathing adults: a cross-sectional study. *J Electromyogr Kinesiol.* 2015 Jun;25(3):463-8. doi: 10.1016/j.jelekin.2015.03.006. Epub 2015 Apr 6. PMID: 25900327.



### 9. Increases Oxygen Uptake in the Blood

Nose breathing is more effective at increasing oxygen uptake than breathing through the mouth. When our nose is blocked, the oxygen uptake in the blood reduces. In a study of individuals who continuously breathe through their noses, arterial pressure of oxygen increased by nearly 10%.

Swift AC, Campbell IT, McKown TM. Oronasal obstruction, lung volumes, and arterial oxygenation. *Lancet.* 1988 Jan 16;1(8577):73-5. doi: 10.1016/s0140-6736(88)90282-6. PMID: 2891980.

### 10. Production of Nitric Oxide

The nose produces a molecule known as nitric oxide, which plays a role in maintaining healthy lung function and may help to protect against certain respiratory infections.

Lundberg JO, Settergren G, Gelinder S, Lundberg JM, Alving K, Weitzberg E. Inhalation of nasally derived nitric oxide modulates pulmonary function in humans. *Acta Physiol Scand.* 1996 Dec;158(4):343-7. doi: 10.1046/j.1365-201X.1996.557321000.x. PMID: 8971255.





### 11. Dilation of blood vessels in the lungs

Breathing through the nose helps dilate blood vessels in the lungs and improves arterial oxygenation compared with oral breathing without lung disease.

Lundberg JO, Settergren G, Gelinder S, Lundberg JM, Alving K, Weitzberg E. 1996d. Inhalation of nasally derived nitric oxide modulates pulmonary function in humans. *Acta Physiol Scand* 158: 343-347.

### 12. Redistribution of blood throughout the lungs

The transition of human beings to standing upright would have negatively impacted gas exchange in the upper regions of the lungs. By breathing through the nose, nitric oxide redistributes blood throughout the lungs increasing blood flow by as much as 24% in the upper regions.

The authors of this paper state that nitric oxide from the nose could have emerged in bipedal mammals not only to improve oxygen transfer from the lungs to the blood but also to protect the body against infection.

Sánchez Crespo A, Hallberg J, Lundberg JO, Lindahl SG, Jacobsson H, Weitzberg E, Nyrén S. Nasal nitric oxide and regulation of human pulmonary blood flow in the upright position. *J Appl Physiol* (1985). 2010 Jan;108(1):181-8. doi: 10.1152/jappphysiol.00285.2009. Epub 2009 Oct 29. PMID: 19875719.

Bartley J., Wong C. (2013) Nasal Pulmonary Interactions. In: Önerci T. (eds) *Nasal Physiology and Pathophysiology of Nasal Disorders*. Springer, Berlin, Heidelberg.

### 13. Defense Against Inhaled Pathogens

Another crucial function of the nose is to act as a line of defense against inhaled pathogens. When we breathe, the air passes through the nasal passages, lined with mucus, hairs, and immune cells.

These mechanisms help to trap and remove harmful particles, such as bacteria and viruses, from the air we breathe, preventing them from entering the lungs.

The nose plays a critical role in the chemical inactivation of pathogens. The nasal cavity contains enzymes and other chemical agents that can destroy harmful substances before they enter the respiratory system. For example, lysozyme is an enzyme found in the nasal mucus that can break down the cell walls of bacteria, rendering them harmless. This chemical defense mechanism is essential to our body's immune system, helping protect us from various airborne threats.

Breathing through the nose harnesses the gas nitric oxide, which is produced in the paranasal sinuses. Higher levels of nitric oxide is associated with fewer cold symptoms and airway infection following periods of stress in daily life.



Andrew B Lumb MB BS FRCA, in *Nunn's Applied Respiratory Physiology* (Eighth Edition), 2017

Nonrespiratory Functions of the Lung. Andrew B Lumb MB BS FRCA, in *Nunn's Applied Respiratory Physiology* (Eighth Edition), 2017

Ritz T, Trueba AF, Vogel PD, Auchus RJ, Rosenfield D. Exhaled nitric oxide and vascular endothelial growth factor as predictors of cold symptoms after stress. *Biol Psychol* 2018;132:116e24.

#### 14. Helping maintain elasticity of the lungs

Maurice Cottle, a renowned rhinologist, includes among the functions of nasal breathing: Breathing through the nose imposes a resistance to both inspiration and expiration which in turn helps to maintain normal elasticity of the lungs, this ensuring optimal conditions for gas exchange.

<https://www.sciencedirect.com/topics/medicine-and-dentistry/nasal-breathing>

Accessed: 29th March 2023

#### 15. Warming

The nose plays a vital role in thermoregulation, or the body's ability to maintain its core temperature within a specific range. The nasal passages are filled with blood vessels that help dissipate heat from the body. As we inhale, the air passing through the nose is warmed by these blood vessels, helping to regulate our body temperature. The nose can also help prevent overheating in hot environments by increasing blood flow to the skin.

Widdicombe J. Microvascular anatomy of the nose. *Allergy*. 1997;52(40 Suppl):7-11. doi: 10.1111/j.1398-9995.1997.tb04877.x. PMID: 9353554. Geurkink N. Nasal anatomy, physiology, and function. *J Allergy Clin Immunol*. 1983 Aug;72(2):123-8. doi: 10.1016/0091-6749(83)90518-3. PMID: 6350406.

#### 16. Humidification of incoming air

The major function of the nose is to humidify air before it reaches the lungs for gas exchange. Conditioning of inspired air is achieved through evaporation of water from the internal surface of the nasal airway. Drawing moist and warm air helps to protect the lungs from drying out and becoming inflamed.

Naclerio RM, Pinto J, Assanasen P, Baroody FM. Observations on the ability of the nose to warm and humidify inspired air. *Rhinology*. 2007 Jun;45(2):102-11. PMID: 17708456.

Rundell KW, Jenkinson DM. Exercise-induced bronchospasm in the elite athlete. *Sports Med*. 2002;32(9):583-600. doi: 10.2165/00007256-200232090-00004. PMID: 12096931.



#### 17. Water Balance

The nose helps regulate water balance in the body by conserving water during exhalation. The air we breathe contains moisture from our respiratory tract as we exhale. The nasal mucosa helps to capture and recycle this moisture, reducing water loss from the body.

Svensson S, Olin AC, Hellgren J. Increased net water loss by oral compared to nasal expiration in healthy subjects. *Rhinology*. 2006 Mar;44(1):74-7. PMID: 16550955.

## NOSE BREATHING FOR IMPROVED SLEEP QUALITY

### 18. Improves Oxygenation During Sleep

The nose is critical during sleep for breathing well to improve oxygenation levels. Studies have shown that nasal breathing during sleep leads to more oxygen uptake than mouth breathing. This is particularly important for people with sleep apnea, a condition characterized by interruptions in breathing during sleep. Proper nasal breathing can help reduce the severity of sleep apnea symptoms and improve overall sleep quality.

Hsu YB, Lan MY, Huang YC, Kao MC, Lan MC. Association Between Breathing Route, Oxygen Desaturation, and Upper Airway Morphology. *Laryngoscope*. 2021 Feb;131(2):E659-E664. doi: 10.1002/lary.28774. Epub 2020 May 30. PMID: 32473063.

### 19. Important for Deeper Sleep Quality

The nose is necessary for proper nasal breathing, which has been shown to contribute to deeper and more restful sleep. This is because breathing through the nose reduces the severity of snoring and obstructive sleep apnea. It is important to wake up with a moist mouth in the morning which is an important indicator of nasal breathing during sleep.

Olsen KD, Kern EB, Westbrook PR. Sleep and breathing disturbance secondary to nasal obstruction. *Otolaryngol Head Neck Surg*. 1981 Sep-Oct;89(5):804-10. doi: 10.1177/019459988108900522. PMID: 6799913.)

Petruson B. Increased nasal breathing decreases snoring and improves oxygen saturation during sleep apnoea. *Rhinology*. 1994 Jun;32(2):87-9. PMID: 7939149.

## SMELL AND TASTE

### 20. Smelling

Humans have approximately 450 types of olfactory receptors. The nose is a complex and multifaceted organ that performs various critical functions. Its most well-known function is the sense of smell, or olfaction, which involves detecting and processing odorant molecules in the air. This intricate process involves a series of receptors and nerve pathways that allow us to distinguish between countless scents, from pleasant aromas to unpleasant odors.

Nagappan PG, Subramaniam S, Wang DY. Olfaction as a soldier-- a review of the physiology and its present and future use in the military. *Mil Med Res*. 2017 Mar 15;4:9. doi: 10.1186/s40779-017-0119-4. PMID: 28344819; PMCID: PMC5359863.

Gillman GS, Bakeman AE, Soose RJ, Wang EW, Schaitkin BM, Lee SE, Chang YF, Mims MM. Will nasal airway surgery improve my sense of smell? A prospective observational study. *Int Forum Allergy Rhinol*. 2022 Nov 22. doi: 10.1002/alr.23115. Epub ahead of print. PMID: 36413461.



## **21. Sense of smell as a test for neurological injury**

The sense of smell is a sensitive test for neurological injury associated with traumatic brain injury (TBI). Impaired ability to smell was the most common neurological deficits, found in 65 veterans.

Ruff RL, Riechers RG 2nd, Wang XF, Piero T, Ruff SS. A case-control study examining whether neurological deficits and PTSD in combat veterans are related to episodes of mild TBI. *BMJ Open*. 2012 Mar 18;2(2):e000312. doi: 10.1136/bmjopen-2011-000312. PMID: 22431700; PMCID: PMC3312078.

## **22. Taste Perception**

Although this might sound counterintuitive since the nose is for smell and the mouth for taste, the nose plays a crucial role in accurately tasting things. This is because the nose communicates with a part of the brain responsible for taste perception called the orbitofrontal cortex. This brain center receives taste and smell signals and processes them together, coupling smell and taste.

This pairing enhances the flavors of our food and beverages, making them much more appetizing. When our sense of smell is impaired due to a common cold or other condition, it affects our ability to perceive flavors, resulting in a less flavorful experience.

Additionally, the orbitofrontal cortex is responsible for odor perception and discrimination, creating a spatial odor map to recognize specific odors. Thus, the nose plays a crucial role in our ability to taste.

Rolls ET. Taste, olfactory, and food reward value processing in the brain. *Prog Neurobiol*. 2015 Apr;127-128:64-90. doi: 10.1016/j.pneurobio.2015.03.002. Epub 2015 Mar 23. PMID: 25812933.



## **NOSE BREATHING FOR ASTHMA, RHINITIS AND HAYFEVER**

### **23. Important in the Control of Asthma**

Asthma is characterized by inflammation and narrowing of the airways, which can lead to breathing difficulties and other symptoms. Studies have shown that nasal breathing can help

reduce the severity and frequency of asthma symptoms, mainly if triggered during exercise. Additionally, some asthma medications are delivered through the nose, highlighting their importance in managing this condition.

Peterson B, Theman K. Reduced nocturnal asthma by improved nasal breathing. *Acta Otolaryngol*. 1996 May;116(3):490-2. doi: 10.3109/00016489609137878. PMID: 8790753.

### **24. Important in the Control of Allergic Rhinitis**

Allergic rhinitis, commonly known as hay fever, is a condition that affects millions of people worldwide. It is an allergic reaction to environmental triggers, such as pollen, dust, or animal dander. Symptoms of allergic rhinitis include sneezing, a runny nose, itchy eyes, and nasal congestion.

The nose plays a vital role in controlling allergic rhinitis, as it acts as a filter, trapping allergens before they can enter the respiratory system. Additionally, the nasal passages produce mucus, which can help remove allergens from the body. Proper management of allergic rhinitis can significantly improve quality of life, and the nose plays a crucial role in achieving this goal.

Widdicombe J. Microvascular anatomy of the nose. *Allergy*. 1997;52(40 Suppl):7-11. doi: 10.1111/j.1398-9995.1997.tb04877.x. PMID: 9353554.

## 25. Nasal Dilation

The nose can dilate, or open wider, to allow for increased airflow during exercise or stress. This is a natural response to increased demand for oxygen and helps to ensure that the body receives enough oxygen during periods of exertion. Holding of the breath for 30 seconds or longer helped to open up the nose to make breathing easier in most of the subjects tested.

Furthermore, it was found that physical exercise also decreased nasal resistance. Nasal resistance decreases linearly as expired CO<sub>2</sub> levels and exercise levels increase.

Hasegawa M, Kern EB. The effect of breath holding, hyperventilation, and exercise on nasal resistance. *Rhinology*. 1978 Dec;16(4):243-9.

## DURING PHYSICAL EXERCISE

### 26. Breathing through the nose during exercise helps decongest the nose

Nasal resistance decreases linearly as expired CO<sub>2</sub> levels and exercise levels increase. The constant relationship between nasal resistance and minute ventilation during hypercapnia and exercise suggests that nasal resistance is regulated by the respiratory center to match the level of respiratory demand.

Otolaryngol Head Neck Surg. 1984 Jun;92(3):302-7. Role of the nasal airway in regulation of airway resistance during hypercapnia and exercise. Second-Place Resident Award at 1982 Research Forum.

### 27. Helps prevent exercise induced bronchoconstriction

Breathing through the nose during physical exercise markedly reduced post exercise airway narrowing as compared to breathing through the mouth. This is relevant to all persons, whether diagnosed with asthma or not.

Shturman-Ellstein R, Zeballos RJ, Buckley JM, Souhrada JF. The beneficial effect of nasal breathing on exercise-induced bronchoconstriction. *Am Rev Respir Dis*. 1978 Jul;118(1):65-73. doi: 10.1164/arrd.1978.118.1.65. PMID: 677559.

### 28. Better utilisation of oxygen during exercise

Breathing through the nose during physical exercise reduces the pressure of oxygen expired from the body. This indicates that breathing through the nose is more efficient at extracting O<sub>2</sub> from the lungs and blood to be used by the working muscles.

Morton, A. R., K. King, S. Papalia, Carmel Goodman, K. R. Turley, and J. H. Wilmore. "Comparison of maximal oxygen consumption with oral and nasal breathing." *Australian journal of science and medicine in sport* 27, no. 3 (1995): 51-55.







## 29. Physical Training with Nasal breathing Reduces ventilation

At first, when one switches to breathing through the nose during exercise, the sensation of air hunger is stronger. With sustained practise of nasal breathing during exercise, the body adapts to a higher tolerance to the accumulation of carbon dioxide. This in turn leads to a reduction in ventilation, leading to reduced breathlessness and greater economy. In a paper by George Dallam, ventilation (volume of breathing) was reduced by 22% in nasal breathing.

Dallam, George M., Steve R. McClaran, Daniel G. Cox, and Carol P. Foust. "Effect of Nasal Versus Oral Breathing on Vo2max and Physiological Economy in Recreational Runners Following an Extended Period Spent Using Nasally Restricted Breathing." *International Journal of Kinesiology and Sports Science* 6, no. 2 (2018): 22-29.



## NOSE BREATHING FOR FACIAL DEVELOPMENT

### 30. Development of the Face

47 children had breathing mode (whether nose or mouth) assessed along with measurements of facial development. The researchers attempted to correlate the effects of nasal obstruction on development of the face. Mouth breathing children, in comparison to nose breathing were more likely to have a longer facial structure.

Baumann I, Plinkert PK. Der Einfluss von Atemmodus und Nasenventilation auf das Gesichtsschädelwachstum [Effect of breathing mode and nose ventilation on growth of the facial bones], *HNO*. 1996 May;44(5):229-34. German. PMID: 8707626.

