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HUMAN HEALTH
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WHY IS SLOW, DEEP BREATHING GOOD FOR YOUR HEALTH?

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YOUNG REVIEWERS:


MERIEM
AGE: 13


SAMI
AGE: 13


SARA
AGE: 12


YAHIA
AGE: 11

The oxygen obtained through breathing is critical for the functioning of the brain and every organ of the body. The body's breathing and blood circulation systems ensure an adequate supply of oxygen to every cell of the body, and they also help to eliminate the waste products of cellular activity, namely carbon dioxide. The heart is the pump for the circulation system, and the heart rate increases every time we breathe in and decreases when we breathe out. Thus, slow, deep breathing is a good exercise for the heart. Research has indicated that deep breathing can change the activity level of our genes and the speed of cerebrospinal fluid flow in the brain. The nose cleans, moistens, and warms air as it moves to the throat. A gas released by the body inside the nose helps the lungs absorb more oxygen. Thus, for our health, breathing through the nose is better than breathing through the mouth.

BREATHE YOUR WAY TO BETTER HEALTH

The human body is a miraculous, self-healing machine made up of an estimated 37 trillion cells that work together in a well-coordinated way. Each cell gets nutrition primarily from two sources: the food we eat and the air that we breathe in. While many discussions revolve around what we eat, little is said about the other equally important type of nutrition for the body—oxygen obtained from the air we breathe in. We inhale and exhale tens of thousands of times each day, probably without thinking about it much. In this article, we explain why breathing is not just life-sustaining but can be a life-enhancing tool. We explain how incorporating slow, deep breathing exercises in our daily lives can promote good health and potentially prevent us from developing certain diseases.

OXYGEN KEEPS THE BRAIN ALIVE

The human brain is a critical part of the body, responsible for understanding the world, learning, memory, movement, and overall survival. Even though the brain makes up only 2% of the body's weight, it uses nearly 20% of the oxygen we breathe in [1]. This shows the extreme importance of oxygen for the brain and, therefore, for our good health. The spinal cord, which is an extension of the brain outside the skull, has 31 pairs of nerves. Out of these, 18 pairs of spinal nerves help to control the muscles involved in breathing. This also illustrates the importance of the breathing process.

HEART AND LUNGS: A CLOSE CONNECTION

The heart and lungs work together constantly to ensure oxygen-rich blood reaches the brain and the rest of the body [2] and cellular waste products, like carbon dioxide, are removed. In the brain, there is an area called the **cardiorespiratory center**, which controls both the heart and the lungs. When your breathing does not match the demands of the physical or mental activity that you engage in, molecular gas sensors present in multiple locations of your body detect the increasing carbon dioxide levels in your blood. Based on the feedback from these sensors, the brain's cardiorespiratory center increases the rate and depth of breathing, which in turn increases your heart rate and blood pressure to increase blood flow.

CARDIORESPIRATORY CENTER

The part of the human brain that regulates heart and breathing rates. It is in the brainstem.

When you concentrate on breathing very slowly and deeply, you fill up the lungs with more oxygen and get rid of more carbon dioxide, maintaining a proper balance between these two gases. Thus, practicing deep breathing can help reduce heart rate and blood pressure.

CHANGES IN HEART RATE DUE TO BREATHING

The normal heart rate of an adult is around 70 beats per minute. For children, this rate is a bit higher: 70–118 beats per minute for kids 5–12 years old. This means that the heart takes less than a second to beat once. The heart rate is controlled by a small area on the top right side of the heart, which creates electric pulses at a constant rate. These pulses spread around the heart muscle and make it pulsate, pumping the blood to the entire body.

When you breathe normally (without paying attention to your breathing, which is called **passive breathing**), your breathing rate is around 12–20 breaths per minute, which is much lower than the heart rate. Suppose someone is breathing at 15 breaths per minute, which means that each breath takes 4 s. At this breathing rate, inhalation and exhalation take roughly 2 s each. So, the heart completes at least 2 beats during each inhalation and exhalation. When you inhale, your heart beats faster (heart rate increases). In other words, the time the heart takes for each pulsation is reduced. When you exhale, the heart beats slower—each beat takes a little longer (heart rate decreases). These breathing-related changes to the heart rate are illustrated in Figure 1. With slow, deep breathing, the maximum difference in the heart rate between inhaling and exhaling can be as high as 20 beats per minute. Thus, slow, deep breathing is an excellent exercise for the heart!

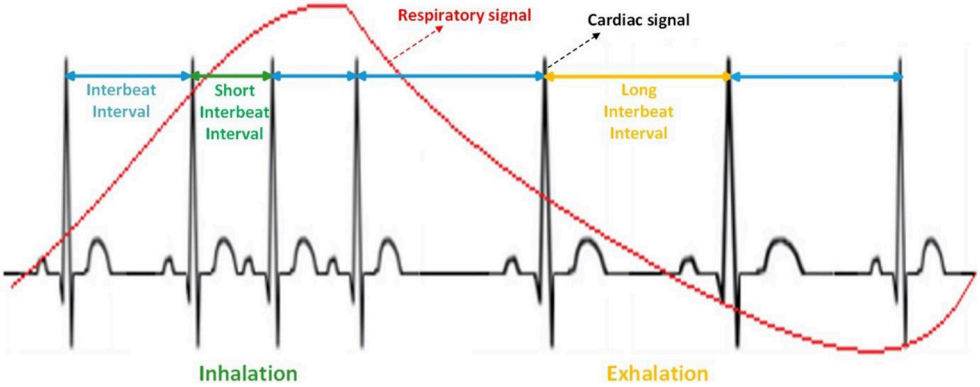

Figure 1

NOSE VS. MOUTH BREATHING

It is important to try to always breathe through your nose. The inside of your nose, called the **nasal cavity**, ensures that the air you breathe in is cleaned and made moist and warm before it goes to your lungs. In addition, a gas called **nitric oxide**, which is released into the nasal cavities, has many properties beneficial to your health. For example, nitric oxide increases the diameter of the tiny blood vessels (capillaries) in the lungs, which enables more oxygen absorption and more carbon

PASSIVE BREATHING

Naturally occurring normal breathing, when we are not observing or changing our breathing. During exhalation in passive breathing, energy is not required to push air out of the lungs.

Figure 1

Breathing and heart rate are related. The red line (called respiratory signal) indicates the breath, with the upward part showing inhalation and the downward showing exhalation. The black line (called cardiac signal) shows the heart's electrical activity over time, with each sharp spike representing a heartbeat. The interbeat interval is the time between heartbeats. As you can see, the time between heartbeats is shorter during inhalation and longer during exhalation. During inhalation, the heart beats faster; during exhalation, it slows down. This changing heart rate is like exercise for the heart muscle.

NASAL CAVITY

The inside of the nose, which provides a passageway for inhaled air from the nostrils to the rest of the respiratory tract.

NITRIC OXIDE

A gas formed by combining nitrogen and oxygen. It reduces blood pressure by expanding blood vessels, kills viruses and bacteria, and can cause new nerve cells to be created.

dioxide release. When you breathe through your mouth, you lose all the advantages the nasal cavities provide.

Interestingly, humming—a sound created by the vibration of air in the nasal passages—has been found to increase nitric oxide release by 15 times [3]. Hence, when you hum, these vibrations cause more of this gas to be released into the stream of air flowing into the lungs.

PASSIVE VS. DEEP BREATHING

In adult men, deep breathing can increase air intake by the lungs up to nine times per inhalation (4,500 ml of air in deep breathing vs. 500 ml in passive breathing). Figure 2 shows the muscle activity during passive and deep breathing, which includes the abdominal muscles and the **diaphragm**.

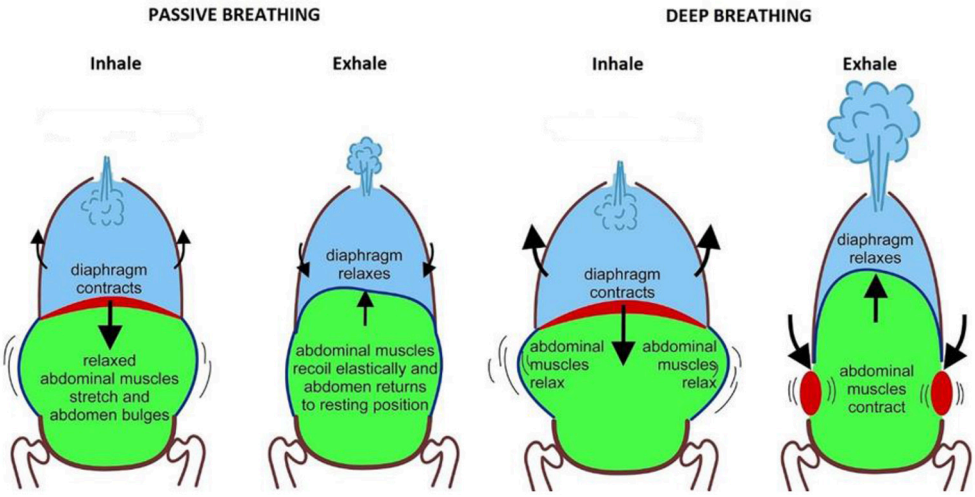

Figure 2

SLOW, DEEP BREATHING CAN BE A GREAT EXERCISE

Passive breathing happens all the time, without our attention—whether we are awake or asleep. In passive breathing, around 23 muscles contract during inhalation, and none during exhalation. However, with certain types of deep breathing exercises, the number of muscles involved can be increased to 89, which is 14% of all the muscles in the body [4]. Including the heart muscle, 90 muscles are exercised. Thus, deep breathing can improve muscle activity like other types of exercise.

BREATHING MAY CHANGE FLOW OF NOURISHING FLUID IN BRAIN

Cerebrospinal fluid (CSF) is a clear liquid surrounding the brain and spinal cord, distinct from blood but crucial for brain health. It circulates

DIAPHRAGM

The thin muscle below the lungs that separates the chest and stomach in humans and mammals. It plays an important role in breathing.

Figure 2

During passive breathing, inhalation is an active process in which a muscle called the diaphragm (red, located between the abdomen and the lung cavity) contracts. Exhalation is a passive process in which air comes out of the lungs when the diaphragm relaxes—think of letting the air out of a balloon. In deep breathing, other muscles are activated, causing the chest and abdomen to expand more during inhalation; the abdominal muscles are actively contracted during deep exhalation. With regular practice, we can considerably increase the amount of air that we inhale in a deep breath.

CEREBROSPINAL FLUID

A clear liquid surrounding the brain and spinal cord, protecting them from injury, removing waste, and providing essential nutrients.

within the brain to protect and nourish it. Recent research has shown that breathing may change the speed at which CSF circulates within the brain [5]. If further studies confirm this, then it has far-reaching significance. Maybe, by increasing CSF circulation within the brain, deep breathing can keep the brain healthier. For example, one explanation for Alzheimer's disease and the resulting loss of memory is that waste products produced by brain cells are not fully "washed out" of the brain. Maybe it will eventually be shown that deep breathing exercises can slow down brain diseases like Alzheimer's.

OTHER POSSIBLE POSITIVE EFFECTS OF DEEP BREATHING

Otto Heinrich Warburg, a scientist who won a Nobel Prize in biochemistry, showed through rat experiments that cancer does not spread if the tissue around the area affected has a good supply of oxygen. In other words, cancer needs an environment of oxygen-deprived tissue. His findings were later named the Warburg Effect [6]. Who knows—slow, deep breathing, when practiced daily, could improve the health of our tissue in many ways. Of course, detailed investigations on humans are required to back up this hypothesis.

A different study [7] showed that gentle yoga postures, deep breathing exercises, and meditation done for 2 h could positively change the activity level of certain genes. The activity of 97 genes belonging to the white blood cells important for the body's immunity was shown to be changed. This ability of various external factors like chemicals, positive or negative experiences, and diet to turn genes on or off or to change their activity level is the focus of an exciting field of research called **epigenetics**.

EPIGENETICS

Study of changes in gene function that do not involve changes in the DNA sequence; implies that one's destiny is not decided just by the presence of a gene.

BREATHING: SIMPLE BUT SO IMPORTANT!

The simple, automatic act of breathing is often overlooked, but it might play a particularly key role in increasing our overall health and wellbeing. The origin of deep-breathing practices can be traced back to ancient traditions, with disciplines like **pranayama** incorporating these techniques. Science has delved deeply into this topic in recent years, and the research is teaching us many things that have long been known by certain cultures regarding the benefits of deep breathing.

PRANAYAMA

Sanskrit word for several techniques used in yoga for regulating breath, which are believed to be good for health.

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YOUNG REVIEWERS

MERIEM, AGE: 13
I am currently 13 years old, studying in the 9th grade. My interests revolve around art, English, and science.

SAMI, AGE: 13

I really like science, math, and design, they are my favorite subjects ! Outside class, I love reading books and drawing but also doing some research about wildlife and especially... animals.

SARA, AGE: 12

I am a Young reviewer studying in an IB School—Mahindra International School, Pune, Maharashtra, India. I am fun loving but diligent, free flowing yet detailed, and open minded enough to be unbiased. I have some pretty cool hobbies including singing Indian classical music, reading, making jigsaw puzzles, creating architecture of Lego blocks, playing tennis, and painting. I love studying, researching, and understanding the basics of any subject being taught. I love all animals and enjoy spending time in nature. I wish peace to the world!

YAHIA, AGE: 11

I am 11 years old, I am a student in the 6th grade at the French school. My favorite subjects are maths, science, and technology. I am very curious about the space and love reading about it. I want to become an astronaut. I also play judo and spend my free time building with Lego bricks.

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