

Carbon dioxide toxicity, masks-wearing, and women on submarines

CO₂ could be toxic during pregnancy for children and adults while wearing masks.

Extraordinary circumstances, such as living on sailing ships without fresh food for weeks and weeks, helped nutritional science to realize that carbohydrates, protein, fat, and minerals are not enough to keep people healthy and alive. The British Navy surgeon James Lind found in 1747 that citrus fruits prevent scurvy. Finally, at the beginning of the 20th century, vitamins were considered essential for human nutrition (1, 2). Living on ships under extraordinary circumstances now is no longer a threat in terms of nutritional deficiencies.

Carbon dioxide volumes in submarines resemble those while wearing masks

However, when it comes to submarines, the air quality is of significant concern. These marine weapons are below water with no fresh air for quite some time. Not only should it be enough to live on, but the relationship between oxygen and carbon dioxide is important. It is suspected that too much of the latter could be harmful to females serving on those boats when they become pregnant. It's ironic to think of women voluntarily on-board threatening opponent regimes with nuclear warheads, who are also very much concerned with the possibility of having a baby. Anyhow, the U.S. Army worked on CO₂ limits for the female crews of submarines. Investigating different CO₂ levels in mice, the supposed acceptable volume was set to be 0.8% for a 90-day continuous exposure (3).

This unexpected military interest motivated a group of scientists to explore the effects of increased carbon dioxide while breathing through masks (4). The extensive document is a challenge to read. It is probably meant to add points of view to the still outstanding reprocessing of the authorities' catastrophic handling of the COVID-19 period, forcing to wear masks.

The habit of masks-wearing in Asia is not without risk

However, compared to Western countries, wearing masks voluntarily is still quite common in certain Asian countries, including Thailand, and should be reconsidered as potentially harmful for various reasons (5). An important additional aspect is the increased carbon dioxide while wearing a mask as part of the Mask-Induced Exhaustion Syndrome (MIES) (6). Conventionally, fresh air contains between 0.03 and 0.04% CO₂. Even a slight increase in carbon dioxide in 0.05% to 0.5% triggers a physiological reaction in increasing the heart rate and blood pressure. Sensitive persons, while under a mask for a longer time, might develop headaches and feel tired. The standard clean air should not exceed a CO₂ volume of 1% (7). A carbon dioxide increase of more than 3% for 15 minutes and 0.5% for eight hours is the limit for a healthy condition (4).

'Low' increased level of CO₂

Kisielinski et al. (2023) (4) conducted a systematic literature research on a relatively low increased level of around 3% of carbon dioxide when wearing masks such as N95 and FFP2 masks. What is termed as 'lower' is meant to be moderately increased above the fresh air CO₂

volume while wearing a mask. From 1653 publications, 43 studies met the criteria for quantitative contemplation because of appropriate methods, valid measurements, subjects of study, and sufficient size.

As expected, mask-wearing results in the re-breathing of carbon dioxide. From eight studies measuring CO₂ experimentally, the inhaled volume varied from 0.22-0.29% to a maximum of 1.28-3.52%. Several studies could confirm a significantly increased difference between mask-wearing and normal breathing without it. The result of a small investigation of fifteen healthy male volunteers is helpful. The partial pressure amounted to 21-24 mmHG after wearing the mask for 30 minutes. That corresponded to 2.8 -3.2% carbon dioxide (8). The rise in CO₂ was highest while wearing N95 masks.

If masks are worn for a longer time, arterial carbon dioxide increases; as a compensatory effect, blood pH is lowered, and ventilation by an increased respiratory rate is activated. Carbon dioxide, derived from the metabolism and because of mask-wearing, is circulated in the blood as bicarbonate. It is ultimately eliminated via the lungs and, in a small amount, by the kidneys. A short inhalation of 2.5 to 3.5% CO₂ increases the blood flow, causes dilatation of blood vessels in the brain, and could result in severe headaches.

Masks-wearing results in kidney stones – an interesting research area?

Metabolic changes include cellular pH change, acidosis, and cyclic organic compounds derived from peptides and proteins related to amino acids. Increasing arterial partial pressure of CO₂ (PaCO₂) and increased bicarbonate levels need to buffer further inhaled CO₂, which changes besides pH, plasma calcium levels, and CO₂ stored in bones, all involved in CO₂ retention and elimination. Of particular interest in this context is the observation of kidney and organ calcification in animal studies. As known for a long time, urolithiasis has been a very common problem since South and Southeast Asia belong to the so-called stone belt, with a prevalence of 10 to 15% (9, 10). It would be interesting to find out whether mask-wearing obsession contributes to the kidney stone problem in Thailand and elsewhere.

Pregnant rats and carbon dioxide toxicity – effects on the offspring

As long as the hypothesis is based on investigation with laboratory animals, the relevance for humans must be kept in mind. According to their evolutionary development, mice and other rodents lived in burrows and caves and probably react differently to carbon dioxide than humans(11).

Pregnant rats exposed to up to 2.5% and 3% CO₂ had significantly lower numbers of offspring (proportion of litter) than the groups of rats below 3% CO₂, and some fetuses had severe defects in the stomach and intestine, hind legs, neck, and thorax (3). The pups of pregnant rats below 3% CO₂ demonstrated deficiencies in learning and memory capacity. It is interesting to know how this is being tested in the laboratory by the 'water maze exercise' in which mice must find a life-saving platform in a water basin. While putting the cage underwater, healthy mice can find the platform after 40 seconds under normal air conditions. The speed declined to 20 seconds once they were trained. Those under increased CO₂ either need much longer to save themselves or

even miss the platform at all. It was found that neurons in the hippocampus were damaged. Despite learning and memory capacity also, mental health in that anxiety increased could be related to an increase in carbon dioxide while the mother animal is pregnant (12, 13).

Studies on 'low' increased CO₂ toxicity before COVID-19 time related to climate change

To study the increase of carbon dioxide long before the COVID-19 period, despite the submarine study, intended to raise awareness about the role of carbon dioxide in climate change. The authors of the key paper reviewed here turned the intention around by hinting at the probability that a moderate increase of carbon dioxide through mask-wearing is harmful during pregnancy for newborns, children, and adolescents (4).

The so-called 'low' CO₂ is close to the volume for those wearing a mask. Those freely breathing were the controls. Circumstantial evidence might be found during the COVID-19 period when mask-wearing in most countries was common and sometimes violently enforced. Valuable information needed for retrospective epidemiological studies is still missing. Relevant attempts to shed light on what happened since 2019 are blogged by the authorities. (Mainly not because of forced mask-wearing but because of the aftereffects of mRNA vaccinations.)

Outcome of pregnancy during the COVID-19 period investigated in Australia and the USA

The suspicion that the fetus could be harmed by an exceeding CO₂ content of the pregnant woman follows the rule that PaCO₂ in the female should be lower than that of the fetus. Otherwise, harmful increased CO₂ in the fetus could not be sufficiently reduced by the fetal-maternal CO₂ gradient (Paragraph 4.1 (4)). Several real live observations points to the risk of mask wearing during pregnancy.

Sweden was one country to appear in public by hiding their mouth and nose with a mask was not required. A difference before and during COVID-19 in terms of stillbirth complications was not found in the country (14). That is not the case for two studies from Australia and the United States. In Australia (Melbourne), a retrospective multi-center cohort study of perinatal outcomes was conducted before and during the COVID-19 lockdown. The lockdown in 2020 required mask-wearing, but virus infection was very low. The stillbirth of preterm from March 2020 to March 2021 was compared with pregnancies two years before the lockdown. The exposed birth amounted to 24.017 females, and the controls to 50.017 women in the group. Preterm stillbirth, but not term stillbirth, were significantly higher in the exposed group (adjusted OR 1.49, 95% CI 1.08-2.05). The proportion of preterm births amounted to 0.26% in the exposed group and was higher than 0.18% in the control group (15).

Exorbitant mask use can be expected from surgeons. From November 2020 to January 2021, pregnancy and neonatal complications were compared between female surgeons and female non-surgeon partners in the USA. Out of 692 female surgeons, 311 (48.3%) experienced major pregnancy complications. Of 158 non-surgents females from surgeons, 43 (27.2%) reported problems during their pregnancy. Controlling for age, work hours, in vitro fertilization use, and multiple gestation, the OR 1.72 (95% CI 1.11-2.66) was highly statistically significant (16).

Conclusion

As established in animal experiments, the risk of increased CO₂ volumes inhaled by mask-wearing during pregnancy for newborns, children, and adolescents has not yet been verified. However, the reaction of the metabolism to pH changes involving the heart, kidney, calcium, and bicarbonate as finally, the bones and soft tissue calcification adds to the assumption that mask-wearing, in the long run, should be considered to be health threatening for pregnant women, newborn, children and adolescents. Even before the COVID-19 disaster, the stillbirth rates in Asia were higher than in Eurasia, Oceania, and North Africa (17). Whether this can be accounted for by extensive mask-wearing in this part of the world might be debatable, but worthwhile to keep in mind. The population should trust more the ability of immunity to fight against infections instead of following a questionable ritual to hide mouth and nose, especially in a country that wants to be known as the 'Land of Smiles.' Who can see the smile behind the mask?

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