

Risks associated with the use of a mouth-nose- cover (MNC) in children and adolescents

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1 Introduction

In recent months, discussions have been held repeatedly about the benefits and harms of a mouth and nose cover¹ (MNC) including community masks. Thus the recommendation changed from "counterproductive in the general population" to "unnecessary", to "possibly protective", to "protective", to "urgently recommended" and finally to "compulsory wearing".

It is not a surprise that this discussion is not only scientific, but also political and emotional. The obligation to wear masks has now been extended in many federal states to include students of different grades. But what about the assessment of the proportionality and, above all, of the safety of the use of an MNB on children and young people?

This compilation highlights various aspects that require the greatest attention. A serious health risk for children cannot be ruled out, in fact it is highly probable.

In order to demonstrate this in an understandable way, two questions are presented below:

- Are existing studies applicable to children and adolescents?
- Is there a direct health hazard?

The following topics are currently being developed and will be published at a later date:

- Is there an indirect health hazard? (contamination, handling etc.)
- Are children and adolescents major pandemic drivers?

¹ In this document, mouth-nose-cover (MNC) refers to masks of any kind as soon as they have a breathing resistance (e.g. masks produced in-house, "community or DIY" masks, medical face masks, particle-filtering half masks (FFP1, FFP2 and FFP3)).

2 Research of literature and existing regulations

2.1 Are existing studies applicable to children and young people?

The available literature and scientific papers are limited to adults for the investigations. There are no studies known to us that involve the specific physiology of children. Furthermore, the existing studies deal with the question of the health safety of MNB within a strictly limited time frame. No study examines the influence of an MNB in adults or children over a longer period of time (days, weeks, months). As an indicator, a study with rats should also be mentioned here, where repeated hypercapnia (paCO₂ 45mmHg) led to irreversible damage in the brainstem area and a concomitant strong reduction in learning performance (Huo, et al., 2014). In addition, all studies on harmfulness were conducted in the laboratory and/or in the clinic. In both settings the climatic conditions remain constant.

Thus, the studies are not designed for children, nor do they represent the current wearing conditions.

However, there are rules in the field of occupational health and safety.

2.2 Is there a direct health hazard?

The following explanations raise the urgent concern of a direct health hazard.

2.2.1 The current work safety regulations

For adults, there are clear rules on wearing respiratory protection mask. In case of a certain respiratory resistance or weight, occupational medical precautions according to ArbMedVV - G26 - must be offered or are mandatory. This is prescribed by the employers' liability insurance associations in BGR 190. Further regulations can be found in the DGUV principles for occupational medical examinations, in DGUV 112-190 and in AMR 14.2.

The reason for this is that wearing respiratory protection means increased physical strain and physical damage can occur. The effects on the body can vary depending on the nature of the additional exposure caused by the environment or physical activity. Of course, this applies all the more in the case of physical limitations or certain pre-existing conditions. For this reason, persons for whom this examination reveals deviating norm parameters may be exempted from wearing a respirator.

Respiratory protection devices up to 3 kg and **without** breathing resistance do not require an examination. However, as soon as a breathing resistance is given, at least one examination must be offered.

There are 3 categories:

G26.1: Weight up to 3kg and a breathing resistance up to 5 mbar from a wearing time of 30 min per day (**obligation to offer examination**)

G26.2: weight up to 5kg and a breathing resistance above 5 mbar (**compulsory examination**)

G26.3: weight over 5kg and a breathing resistance below 6 mbar (**compulsory examination**)

FFP1, FFP2 (e.g. N95 mask) and FFP3 masks are assigned to G26.1 here. Before 2016, FFP3 masks even fell under G26.2 and therefore an examination was mandatory. This also indicates that health damage can occur even in adults. ²

The G26.1 includes at least one examination of lung function, blood pressure, blood and urine tests, a medical history and physical examination. Heart, circulatory and respiratory diseases, for example, can limit the suitability. The gas exchange and fresh air intake depend on the material and density of an MNC. The higher the resistance, the higher the work of breathing to ensure gas exchange. The resistance also influences the composition of CO₂ and O₂ in the gas mixture that forms behind the mask.

Quote from interview with Dr. Christian Zilz (Zilz, 2020, translated in english):

"Mainly the increased airway resistance leads to an increase in work of breathing. In relevant pre-existing conditions such as heart, lung and muscle diseases, but also in cases of severe overweight, the respiratory muscles can be overstrained. This can then lead to an increased carbon dioxide content in the blood and also to respiratory acidosis (acidification of the blood because too little CO₂ is breathed out, editor's note). The increase in CO₂ in the blood can lead to fatigue and even to carbon dioxide anaesthesia."

and

"Depending on the material of an MNC or the class of an FFP mask used, the breathing effort is higher".

Subsequently, the respiratory acidosis can lead to cardiac arrest due to a compensatory influx of potassium from the body cells (in exchange with hydrogen ions) into the blood plasma. Cardiac arrest is the direct result of a disruption of the cardiac conduction system due to a pronounced hyperkalemia. (Larsen, 2012)

It should also be noted that the oxygen consumption in the lung muscles increases disproportionately fast and rises from 5% to a maximum of 20% of the total O₂

² See also (Arbeitsmedizinische Neubewertung von FFP3 Masken, 2016)

consumption. This is of course at the expense of other organs. (According to (Brandes, Lang, & Schmidt, 2019))

Quote from interview of the "Ärzteblatt" with senior physician E. Bülke (Edwin, 2020, translated in english):

"Under heavy physical exertion there is [...] a danger of hypercapnia. If the carbon dioxide (CO₂) cannot be breathed out properly due to the increased air resistance in the mask, it could accumulate in the blood and lower the blood pH. The increased CO₂ partial pressure would then lead to respiratory acidosis".

For the reasons mentioned above, a wearing time limit is mandatory when wearing the mask. (DGUV rule 112-190 - Use of respiratory protective devices (BGR/GUV-R 190), 2011)

For filtering half-masks (FFP1-FFP3) **without** valve, a wearing time of **75 min** and **30 min** wearing break is intended. This is again limited to 5 uses per shift and a maximum of 4 shifts per week.

For filtering half masks (FFP1-FFP3) **with** valve, a wearing time of **120 min** and **30 min** wearing break is intended. This is again limited to 3 uses per shift and a maximum of 5 shifts per week.

Depending on the severity of the work, this wearing time can be shortened, but never the break time.

The study by the University of Leipzig even suggests that the breaks are not sufficient.

Press release of the University Hospital Leipzig (Leipzig, 2020 – translated in english):

"The data show that the so-called cardiopulmonary performance is significantly reduced by both mask types. The masks affect breathing, especially the volume and the highest possible speed of the air when exhaled. The maximum possible force on the bicycle ergometer was significantly reduced. A faster acidification of the blood during exertion was registered in the metabolism (lactate)." The study was limited to a mere 3 x 3 min of exertion with a 10 min break in each case. "

2.2.2 Information from mask manufacturers and filter materials of different MNC

Mask manufacturer 3M writes that they **don't offer masks for children** in some countries because they are designed for adults and that **the misuse of a MNC can result in illness or death**. (Atenschutz - FAQ Allgemeine Öffentlichkeit, 2020)

In individual cases, an FFP3 mask may nevertheless have to be assigned to respirator group 2 (G26.2), e.g. in the case of heavy physical work and/or unfavorable climatic conditions. This would suggest that, in the case of sporting activities, the FFP3 must fall under G26.2. **Thus, a mandatory examination must be performed**. (Mund-Nasen-Schutz oder FFP, 2020)

Moltex specifies a **resistance of 1 mbar** at 30L/min for its **FFP3** mask and a resistance of 3 mbar at 90L/min. (Datenblatt FFP Masks, 2016)

Material tests of other MNCs of the Max-Planck-Institute used in everyday life show values at 50L/min, which are sometimes **above 1 mbar and higher**. (Dr. Drewnick & et al., 2020)
In another study, **values above 2 mbar were also found**. (Konda, et al., 2020)

Community masks with a breathing resistance of 4.7 mbar are offered on the free market.³ This clearly shows **that the resistance of many materials of community masks exceeds that of an FFP3 mask**.

Now people and especially children have to wear masks without knowing that the breathing resistance is an important component of the health hazard. This is not known in the case of most community masks.

Even when asked at the German Federal Press Conference (Youtube, 2020) min. 31, no scientific studies are known that deal with the effects of mask wearing in children. **For these reasons, the magnitude of the risk to children and adolescents cannot even be approximately estimated. However, the probability of a significant health risk is clearly evident**.

³ Example of a community mask (resistance 4,7mbar):

<https://www.shootingstore.at/atenschutz/31300-mns-maske-3-lagig-mund-nasen-schutz-en-zertifiziert.html>

also

<https://www.deinemaske24.de/p/mns-atenschutzmaske-3-lagig-en14683-zertifiziert>

3 Other influences on safety while wearing a MNC

Children or adolescents usually only take the masks off when they notice that they can hardly breathe. A fatigue of the respiratory musculature usually goes unnoticed. Also due to the moral pressure exerted by social mechanisms, children and adolescents rarely take off the mask despite feeling unwell. Many cases are known where children have been told that they might be responsible for the death of other people if they do not put the mask on. Some teachers, being persons of authority, insist on wearing masks despite children's complaints about typical symptoms (headaches, nausea, etc.) that clearly indicate damage and danger caused by impeded breathing. Even in physical education there is often a mask obligation for children. Children could therefore, under this psychological pressure, which legally constitutes coercion, consciously or unconsciously ignore any symptoms of possible hypercapnia as a result of the mask.

Teachers are not trained to judge when CO₂ poisoning exists and what signs require the urgent removal of a mask. **They will therefore not be able to fulfill this duty of care.**

4 Conclusion

The available data indicates a very probable and unacceptable risk, especially for children. It is not known which mask types are used, which pressure differences occur and/or whether children suffer from pre-existing conditions. **Damage to health cannot be ruled out.**

Children wear the masks without interruption and even longer than adults are permitted to do in their working environment (within the framework of occupational health rules and regulations)! **A strict BAN on masks for children and adolescents is therefore advisable until proof of harmlessness has been provided.**

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