

Literature research: Are there Risks associated with the use of a mouth-nose-cover (MNC¹) in children and adolescents?²

Version 2

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¹ For the sake of readability, in this document mouth-nose-cover (MNC) means masks of any kind, as soon as they have a breathing resistance (e.g. masks produced by the manufacturer, "community or DIY" masks, medical face masks, particle-filtering half masks (FFP1, FFP2 and FFP3))

² This is a translation of the original German document. We cannot take responsibility for mistakes in translation. Please do not hesitate to contact us Care4Truth-Press@protonmail.com if you find any mistakes, thank you.

Table of contents

Version History	2
1 Introduction.....	3
2 Research of literature and existing regulations	4
2.1 Are existing studies applicable to children and young people?	4
2.2 Is there a direct health hazard?.....	6
2.2.1 The current work safety regulations in Germany	6
2.2.2 Information from mask manufacturers and filter materials of different MNC.....	9
3 Is there an indirect health risk from contamination?	12
3.1 Proper handling of masks.....	12
4 Other influences on safety when wearing a MNC.....	14
5. Conclusion	15
6. Bibliography.....	16
7 Annex.....	19
7.1 Possible health exclusion and/or restriction criteria according to G26	19
(Deutsche Gesetzliche Unfallversicherung (DGUV) Spitzenverband, 2014)	19

Version History

Version 1: Original

Version 2:

- Additional sources from new science papers published or pre-proofed version from November 2020
- Replacement of terms, which were not up-to-date, thank you M. S. for the feedback
- Deletion and replacement of E. Bölke Interview quote with a scientific paper
- Alphabetic order of Bibliography

1 Introduction

In recent months there have been repeated discussions about the benefits and harms of a mouth-nose-cover² (MNC). For example, the recommendation changed from "counterproductive for the general population" to "unnecessary", to "possibly protective", to "protective", to "urgent recommendation" and finally to "compulsory wearing".

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

This compilation highlights various aspects which require the greatest possible attention. Not only can a health risk for children and adolescents not be ruled out, it is even highly possible according to our findings.

In order to demonstrate this in a comprehensible way, three questions are addressed below:

1. are existing studies applicable to children and young people?
2. is there a direct health risk from wearing MNC?
3. is there an indirect health risk due to contamination?

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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. There are no studies known to us that include the specific physiology of children. In addition, the existing studies deal with the question of the health safety of MNC in a strictly limited time frame. No study examines the influence of a MNC 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 thus to a strong reduction in learning performance (Huo, et al., 2014). In addition, all studies on harmfulness were carried out in the laboratory and/or in the clinic. In both settings the climatic conditions are constant.

Thus, the studies are neither designed for children nor do they reflect the currently prevailing wearing conditions.

However, there are rules in the field of occupational health and safety in Germany. The Federal Office for Occupational Safety and Health (BAUA) writes the following (Bundesanstalt für Arbeitsschutz und Arbeitsmedizin (BAUA), 1989):

Quote³:

"In doing so, [the employer] must take into account all circumstances that influence the safety and health of employees at work. The employer decides which measures are necessary for this on the basis of the risk assessment (§ 5 ArbSchG)."

The following applies:

"In doing so, he must first check all technical and organisational measures. Only when these have been exhausted does he have to take individual protective measures, including PPE [personal protective equipment]."

The DGUV Information 212-515 defines PPE as follows:

*"**Personal protective equipment** is any equipment intended to be used or worn by insured persons to protect themselves against a risk to their safety and health arising from the specific conditions at their workplace, as well*

³ All quotes are translated by the authors from German to English, therefore there can be small discrepancies compared to the original. Please do not hesitate to inform us by email, if you find any mistakes, thank you.

as any additional equipment used for the same purpose and associated with the personal protective equipment."

According to §21 SGB VII the following applies:

Quote:

"(1) The employer is responsible for the implementation of measures to prevent occupational accidents and diseases, for the prevention of work-related health hazards and for effective first aid.

2. ¹In the case of a school, where the employer is not the school authority, the school authority within its jurisdiction shall also be held responsible for the implementation of the measures referred to in paragraph 1. ²The school authority is obliged, in consultation with the accident insurance institution that is responsible for insured persons under Article 2 paragraph 1 number 8 letter b, to make arrangements for the implementation of the measures referred to in paragraph 1 in the internal school area.

(3) The insured persons shall, as far as possible, support all measures for the prevention of occupational accidents, occupational diseases and work-related health hazards as well as for effective first aid and shall follow the relevant instructions of the employer."

Within the framework of the risk assessment, a decision is made on the use of personal protection equipment (PPE) and the resulting occupational medical check-ups are determined.

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 in Germany

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 can be found in the DGUV principles for occupational medical examinations, in DGUV Rule 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.⁴

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 (See Annex 7.1 for full list of possible exclusion criteria). 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.

⁴ See also (Care-for-art, 2016)

Quote from an interview with Dr. Christian Zilz (Zilz, 2020)⁵:

"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 anesthesia."

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)

A cross-sectional study among 158 frontline healthcare workers says.

Quote (Ong, et al., 2020):

*"**De Novo PPE-Associated Headaches.**—Of the 158 respondents, 128 (81.0%) reported de novo PPE associated headaches when they wore either the N95 face mask, with or without the protective eyewear."*

⁵ All quotes are translated by the authors from German to English, therefore there can be small discrepancies compared to the original. Please do not hesitate to inform us by email, if you find any mistakes, thank you.

The safety data sheet for carbon dioxide (Institut für Arbeitsschutz (IFA) der Deutschen Gesetzlichen Unfallversicherung, 2020) states:

"Inhalation of 0.1 vol.% CO₂ has already led to head pressure and headaches in sensitive persons, [...].

The critical effect of short-term inhalation exposure, however, is acidosis, which became apparent in moderately exposed volunteers when they were exposed to 1 vol.% CO₂ (10000 ppm) for 30 minutes. [...]

2 vol.% in the inspiratory air increases the breathing frequency and the breathing volume, 4 - 6 vol.% CO₂ [...] causes headaches, [...] palpitations, increase in blood pressure, psychic excitement [...] as well as dizziness and drowsiness.

In the light of this information, a more detailed examination of children and adolescents who have the above-mentioned symptoms, such as headaches and nausea⁶, when wearing an MNC appears appropriate.

It should also be noted that oxygen consumption in the lung muscles increases disproportionately fast, rising from 5% to a maximum of 20% of total O₂ consumption. This is of course at the expense of other organs. (Correspondingly to (Brandes, Lang, & Schmidt, 2019))

For the reasons mentioned above, a wearing time limit is recommended. (DGUV Regel 112-190 - Benutzung von Atemschutzgeräten (BGR/GUV-R 190), 2011)

For filtering half-masks (FFP1-FFP3) **without** valve, a wearing time of **75 min** and a wearing break of **30 min** is foreseen. 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 a break of **30 min** is foreseen. This is again limited to 3 uses per shift and a maximum of 5 shifts per week.

Due to the high stress caused by heavy work, the maximum wearing time, but not the recovery time [...] must be reduced.

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

⁶ Symptoms that are repeatedly reported by parents, children and young people.

Press release of the University Hospital Leipzig (Leipzig, 2020):

"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 air 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 exercise 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**. (Atemschutz - FAQ Allgemeine Öffentlichkeit, 2020)

Moldex 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**. (Drewnick & al., 2020; Care-for-art, 2016).

On the free market, community masks are frequently offered without specifying the resistance.

The trade association for trade and goods logistics (BGHW) writes quote:

"In areas where mouth-nose-coverings have to be worn, it should be noted that these can be a burden for the wearer and should not be worn permanently for an entire shift. The evidence currently available suggests that cotton, linen or silk mouth-nose masks and medical face masks have similar breathing resistance (pressure difference) to particle filtering half masks with exhalation valves. [Emphasis by authors]."

It is therefore recommended that mouth nose-coverings ("community masks") and medical face masks, if worn in accordance with the SARS-CoV-2 occupational health and safety standard, are subject to wearing time limits and rest breaks, as is the case for filtering half-masks with exhalation valve in accordance with [DGUV Regel 112-190 „Benutzung von Atemschutzgeräten“](#)"
(Berufsgenossenschaft Handel und Warenlogistik (BGHW), 2020)

In addition, the DGUV has updated its explanation regarding the carrying limits on 07.10.2020: quote:

*"For filtering half masks with exhalation valve (including FFP1), DGUV regulation 112-190 recommends the use of respiratory protection equipment for medium-heavy work (AMV [respiratory minute volume] 20 to 40 l/min.) under normal climatic conditions for a wearing time of usually 120 minutes with a recovery time of 30 minutes. Within the framework of the risk assessment, the concrete working conditions (e.g. severity of the work) shall be considered by means of adaptation factors. For light work, for example, the wearing time is extended to 3 hours."
(Deutsche Gesetzliche Unfallversicherung e.V. (DGUV), 2020)*

A new study with adults from November 2020 to be published in the Journal "Medical Hypothesis" is currently in the "pre-proofed" state. Among other interesting points it says the following:

Quote (Vainshelboim, 2020)

"Wearing facemask mechanically restricts breathing by increasing the resistance of air movement during both inhalation and exhalation process [12, 13]. Although, intermittent (several times a week) and repetitive (10-15 breaths for 2-4 sets) increase in respiration resistance may be adaptive for strengthening respiratory muscles [33, 34], prolonged and continues effect of wearing facemask is maladaptive and could be detrimental for health [11-13]. In normal conditions at the sea level, air contains 20.93% O₂ and 0.03% CO₂, providing partial pressures of 100mmHg and 40 mmHg for these gases in the arterial blood, respectively. These gas concentrations significantly altered when breathing occurs through facemask. A trapped air remaining between the mouth, nose and the facemask is rebreathed repeatedly in and out of the body, containing low O₂ and high CO₂ concentrations, causing hypoxemia and hypercapnia [11-13, 35, 36]."

People, especially children and young people, now need to wear masks without knowing that breathing resistance is an important component of the health risk. This is not known in most community masks. There is neither THE mask nor THE wearer. There is a big difference in the load capacity, for example, between a 6-year-old child or 16-year-old adolescent. There is also a difference between wearers. In addition, it does not even take into account previous illnesses that might not yet be known. These can only be determined by a medical examination.

For these reasons, the extent of the risk for children and youths cannot even roughly be estimated. However, the probability of a significant health risk is clearly recognizable.

3 Is there an indirect health risk from contamination?

Warmth and moisture, as well as nutrients from saliva and nasal secretions are an ideal breeding ground in which various pathogens not only survive but can even multiply.

3.1 Proper handling of masks

According to a study from England (Herron, Kuht, Hussain, Gens, & Gilliam, 2020), only 18% of specially trained personnel correctly used masks in surgical areas.

The Federal Institute for Drugs and Medical Devices (BfArM) provides information on the use of "community masks", also with reference to the RKI, among other things:

- When putting on a mask, care must be taken to ensure that the inside is not contaminated. Hands should be washed thoroughly with soap beforehand.
- A soaked mask should be removed immediately and replaced if necessary.
- The outside of the used mask is potentially contaminated with pathogens. To prevent contamination of the hands, they should not be touched.
- After taking off the mask, hands should be washed thoroughly (at least 20-30 seconds with soap) in accordance with general hygiene rules.
- After removal, the mask should be kept in an airtight bag or similar or washed immediately. It should only be stored for as short a time as possible to avoid the formation of mould in particular.
- After a single use, masks should ideally be washed at 95 degrees, but at least at 60 degrees, and then dried completely. Observe any manufacturer's instructions regarding the maximum number of cycles after which the strength and functionality is still ensured.

Status 11.11.2020 (Bundesinstitut für Arzneimittel und Medizinprodukte (BfArM), 2020)

Prof. Dr. Kappstein (Head of Clinical Hygiene Clinical Centre Passau, Teaching Hospital of the University of Regensburg) elaborates on this in her article (Kappstein, 2020):

Masks are contaminated from the inside by the wearer. From the outside, droplet infections and secretions from the environment lead to surface contamination. If these masks are touched with the hands, the contamination can spread to surfaces and be transmitted to other people. Sooner or later, the exhaled air and/or environmental influences lead to moisture penetration with every mask, which limits the barrier function. As a result, potential infectious pathogens from the nasopharynx can also be found on the outside.

Prof. Dr. Kappstein points out: "A correct handling of masks, as already mentioned, is not always easy to achieve for medical staff. But for the general public, all these requirements, which are considered indispensable, are not even remotely achievable."

The following everyday observations are in this respect (ubiquitously) apparent to everyone:

1. masks are often touched from inside and outside
2. the mask is worn under the chin or dangles from one ear.
3. the mask is folded and stowed in the trouser pocket.
4. masks hang from car mirrors, bicycle handlebars or wrists
5. individual masks are used all day
6. masks are repeatedly adjusted with the hands from the outside Especially by spectacle wearers
7. the mask is not covered when it rains.
8. the mask is not changed when sweating and the resulting moisture penetration

You can see everywhere that adults also fail to comply with the necessary hygiene regulations. In this respect, we consider it almost impossible for children and adolescents to comply with all the necessary hygiene regulations that counteract a possible hazard.

It is also not clear how the hygiene instructions are to be implemented at school. This would mean, for example, that every time the mask is taken off and put back on, every person would have to wash their hands for at least 20 seconds before and after. The mask is potentially pathogenic on the outside. It should therefore be touched as little as possible. This is not manageable for the teaching staff with about 30 students/class. During breaks this supervision is hardly practicable. In particular, hygiene regulations are difficult to convey to pupils in the lower classes.

The improper use of an MNC at school could therefore even increase the risk of infectious diseases being endangered and spreading in the population.

4 Other influences on safety when wearing a MNC

Children or adolescents usually only take their masks off when they notice that they can hardly breathe. A fatigue of the respiratory muscles usually goes unnoticed. Also due to the moral pressure exerted by social mechanisms, children and adolescents rarely take the mask off 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, as persons of authority, insist on the wearing of masks despite children's complaints about typical symptoms (headaches, nausea, etc.) which clearly indicate that they are damaged and threatened by the impeded breathing. Even in physical education, children are often required to wear masks. Children could therefore, under this psychological pressure, which may legally be coercion, consciously or unconsciously ignore any symptoms of possible hypercapnia as a result of the mask.

Teachers are not trained to judge, if a symptoms of a CO₂ poisoning exist and what signs require urgent removal of a mask.

They will therefore not be able to fulfil this duty of care.

5. Conclusion

The available data indicate a very probable and unacceptable risk, especially for children and young people. It is not known which types of masks are used, what pressure differences occur and / or whether any previous illnesses exist. Harmful effects on health cannot be ruled out.

Children wear the masks partly without interruption and even longer than adults should in professional life (within the framework of occupational health rules and regulations). In accordance with **the prevention principles, the organisational and technical possibilities should first be exhausted** before the wearing of an MNC for protection against SARS-CoV-2 can be considered. Based on the current status and feedback from everyday school life, there is potential for optimisation here.

A strict BAN on masks for children and adolescents is therefore indicated until scientific studies can sufficiently prove their harmlessness.

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7 Annex

7.1 Possible health exclusion and/or restriction criteria according to G26⁷

(Deutsche Gesetzliche Unfallversicherung (DGUV) Spitzenverband, 2014)

Personen mit...	Gruppe ⁸		
	G26.1	G26.2	G26.3
• Allgemeiner Körperschwäche	+	+	+
• Bewusstseins- oder Gleichgewichtsstörungen	+	+	+
• Anfallsleiden in Abhängigkeit von Art, Häufigkeit, Prognose und Behandlungsstand der Anfälle (siehe auch DGUV Informationen 250-011 "Empfehlungen zur Beurteilung beruflicher Möglichkeiten von Personen mit Epilepsie)	(+)	+	+
• Erkrankungen oder Schäden des zentralen oder peripheren Nervensystems mit wesentlichen Funktionsstörungen und deren Folgezuständen, funktionellen Störungen nach Schädel- oder Hirnverletzungen, Hirndurchblutungsstörungen	+	+	+
• Gemüts- oder Geisteskrankheiten, auch wenn diese abgeklungen sind, jedoch ein Rückfall nicht hinreichend sicher ausgeschlossen werden kann	+	+	+
• Abnormen Verhaltensweisen (z. B. Klaustrophobie) erheblichen Grades	+	+	+
• Alkohol-, Suchtmittel-, Medikamentenabhängigkeit	+	+	+
• Zahnvollprothesen, für das Tragen von Atemschutzgeräten mit Mundstückatemanschluss	+	+	+
• Erkrankungen oder Veränderungen der Atmungsorgane, die deren Funktion stärker beeinträchtigen wie Lungenemphysem, chronisch-obstruktive Lungenerkrankung, Bronchialasthma	+	+	+
• krankhaft verminderter Vitalkapazität und/oder verminderter Einsekundenkapazität oder bei Abweichung vom Normbereich anderer Messgrößen (siehe Anhang1, "Leitfaden für die Lungenfunktionsprüfung")	+	+	+
• Erkrankungen oder Veränderungen des Herzens oder des Kreislaufs mit Einschränkung der Leistungs- oder Regulationsfähigkeit, z. B. Zustand nach Herzinfarkt, Blutdruckveränderungen stärkeren Grades	(+)	+	+

⁷ In original German Version

⁸ + bedeutet, das jeweils aufgeführte Kriterium ist ein Ausschlussgrund
 (+) bedeutet, das jeweils aufgeführte Kriterium kann unter Berücksichtigung der Expositionsbedingungen ein Ausschlussgrund sein
 - bedeutet, das jeweils aufgeführte Kriterium ist kein Ausschlussgrund

• Erkrankungen oder Veränderungen des Brustkorbes mit stärkeren Funktionsstörungen	+	+	+
• Erkrankungen oder Veränderungen des Stütz- oder Bewegungsapparates mit stärkeren Funktionsstörungen	-	+	+
• zur Verschlimmerung neigenden Hautkrankheiten	(+)	+	+
• Veränderungen, die den Dichtsitz des Atemanschlusses beeinträchtigen, z. B. Narben	+	+	+
• Erkrankungen oder Veränderungen der Augen, die eine akute Beeinträchtigung der Sehfunktion bewirken können, z. B. gestörte Lidfunktion	+	+	+
• korrigierter Sehschärfe Ferne unter 0,7/0,7 (unter 0,8 bei langjähriger Einäugigkeit) korrigierter Sehschärfe Nähe unter 0,5/0,5 (unter 0,6 bei langjähriger Einäugigkeit)	-	+	+
• Hörverlust von mehr als 40 dB bei 2kHz auf dem besseren Ohr für den Einsatz im Rettungswesen	-	+	+
• Festgestellter Schwerhörigkeit, für das Tragen von Geräten der Gruppe 2 und 3 mit akustischer Warneinrichtung (Pfeifton), sofern die Schwerhörigkeit die Wahrnehmung des Warnsignals verhindern kann	-	+	+
• Übergewicht von mehr als 30% nach Broca (Körpergröße in cm weniger 100 = kg Sollgewicht) oder vergleichbaren Grenzwerten anderer Indizes (z. B. BMI >30)	-	+	+
• Stoffwechselkrankheiten, insbesondere Zuckerkrankheit oder sonstige Störungen der Drüsen mit innerer Sekretion, insbesondere der Schilddrüse, der Epithelkörperchen oder der Nebennieren, soweit sie die Belastbarkeit stärker einschränken	-	+	+
• Eingeweidebrüchen.	-	+	+