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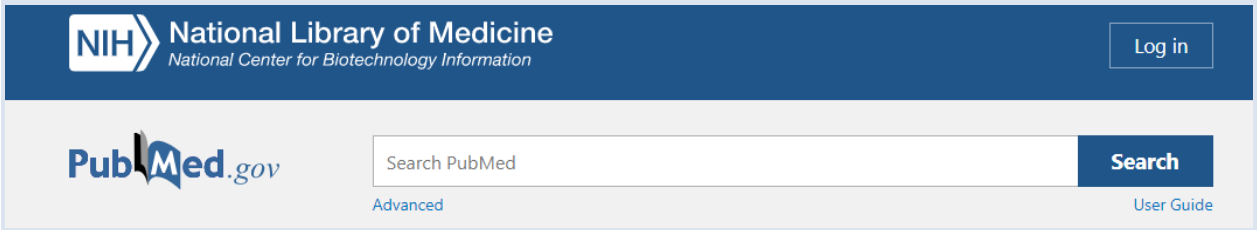

Review

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Is a Mask That Covers the Mouth and Nose Free from Undesirable Side Effects in Everyday Use and Free of Potential Hazards?

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Abstract

Many countries introduced the requirement to wear masks in public spaces for containing SARS-CoV-2 making it commonplace in 2020. Up until now, there has been no comprehensive investigation as to the adverse health effects masks can cause. The aim was to find, test, evaluate and compile scientifically proven related side effects of wearing

masks. For a quantitative evaluation, 44 mostly experimental studies were referenced, and for a substantive evaluation, 65 publications were found. The literature revealed relevant adverse effects of masks in numerous disciplines. In this paper, we refer to the psychological and physical deterioration as well as multiple symptoms described because of their consistent, recurrent and uniform presentation from different disciplines as a Mask-Induced Exhaustion Syndrome (MIES). We objectified evaluation evidenced changes in respiratory physiology of mask wearers with significant correlation of O_2 drop and fatigue ($p < 0.05$), a clustered co-occurrence of respiratory impairment and O_2 drop (67%), N95 mask and CO_2 rise (82%), N95 mask and O_2 drop (72%), N95 mask and headache (60%), respiratory impairment and temperature rise (88%), but also temperature rise and moisture (100%) under the masks. Extended mask-wearing by the general population could lead to relevant effects and consequences in many medical fields.

Keywords: MIES syndrome; N95 face mask; adverse effects; contraindications; dyspnea; headache; health risk assessment; hypercapnia; hypoxia; long-term adverse effects; masks; personal protective equipment; physical exertion; risk; surgical mask.

Conflict of interest statement

The authors declare no conflict of interest.

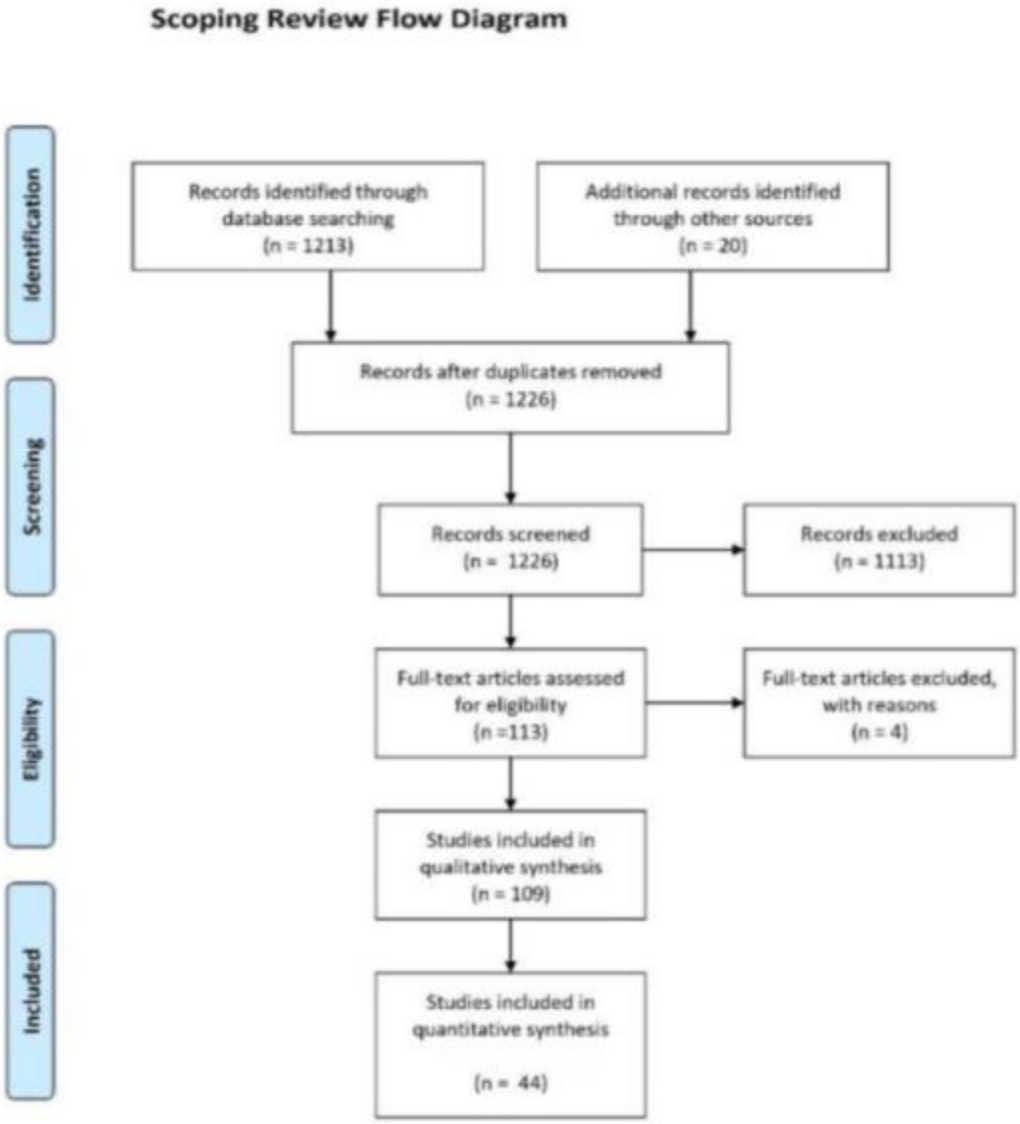

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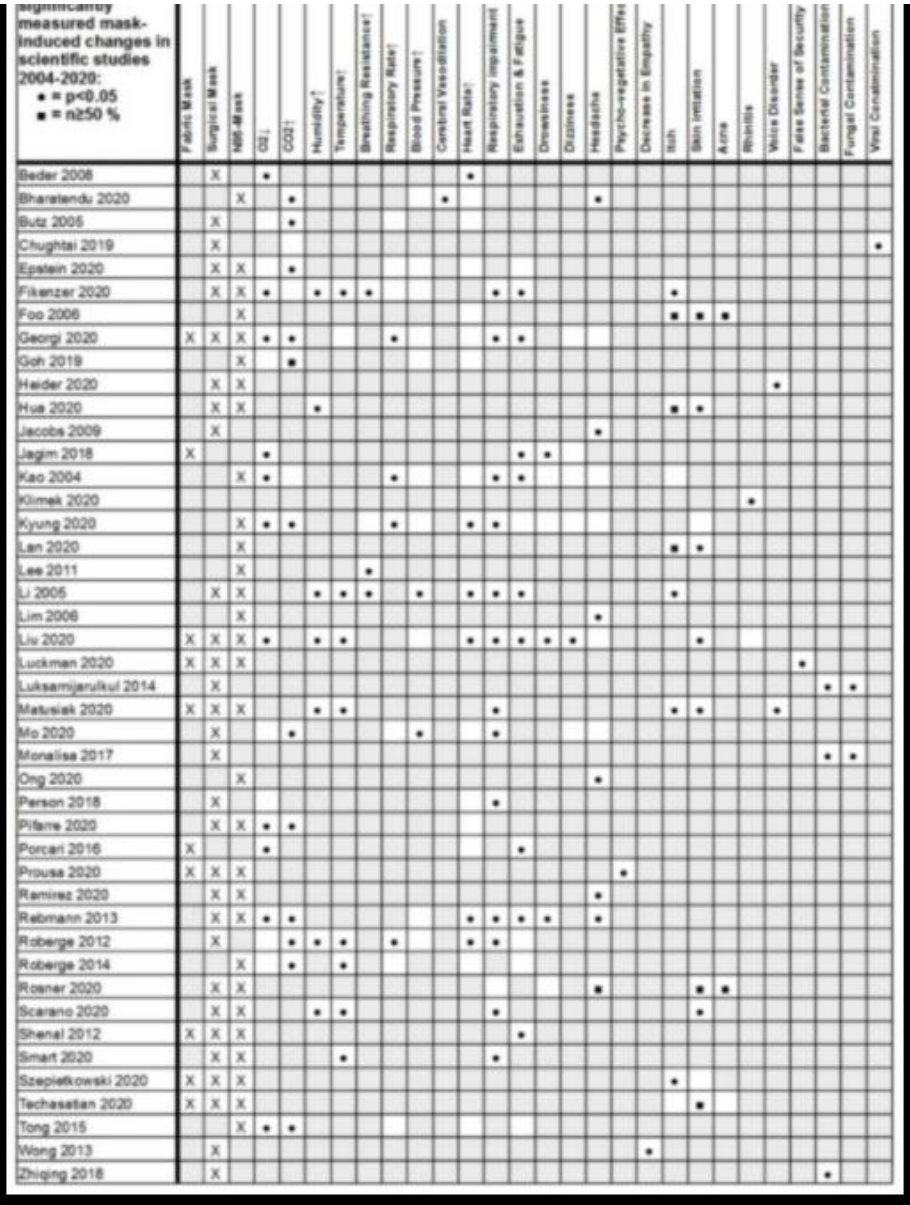
Figure 1 Scoping review flow diagram according to the PRISMA scheme.



significantly measured mask-induced changes in scientific studies 2004-2020: • = p<0.05 ▪ = n≥50 %	Fabric Mask	Surgical Mask	N95-Mask	O2↓	CO2↑	Humidity↑	Temperature↑	Breathing Resistance↑	Respiratory Rate↑	Blood Pressure↑	Cerebral Vasodilation	Heart Rate↑	Respiratory impairment	Exhaustion & Fatigue	Drowsiness	Dizziness	Headache	Psycho-vegetative Effe	Decrease in Empathy	Itch	Skin irritation	Acne	Rhinitis	Voice Disorder	False Sense of Security	Bacterial Contamination	Fungal Contamination	Viral Contamination
Beder 2008		X		•								•																
Bharatendu 2020			X		•						•						•											
Butz 2005		X			•																							
Chughtai 2019		X																										•
Epstein 2020		X	X		•																							
Fikenzer 2020		X	X	•		•	•	•					•	•						•								
Foo 2006			X																	▪	▪	▪						
Georgi 2020	X	X	X	•	•				•				•	•														
Goh 2019			X		▪																							
Haider 2020		X	X																					•				
Hua 2020		X	X			•														▪	•							
Jacobs 2009		X															•											
Jagim 2018	X			•										•	•													
Kao 2004			X	•					•				•	•														
Klimek 2020																							•					
Kyung 2020			X	•	•				•			•	•															
Lan 2020			X																	▪	•							
Lee 2011			X					•																				
Li 2005		X	X			•	•	•		•		•	•	•						•								
Lim 2006			X														•											
Liu 2020	X	X	X	•		•	•					•	•	•	•	•					•							
Luckman 2020	X	X	X																						•			
Luksamijarulkul 2014		X																								•	•	
Matusiak 2020	X	X	X			•	•						•							•	•			•				
Mo 2020		X			•					•			•															
Monalisa 2017		X																								•	•	
Ong 2020			X														•											
Person 2018		X											•															
Pifarre 2020		X	X	•	•																							
Porcari 2016	X			•										•														
Prousa 2020	X	X	X															•										
Ramirez 2020		X	X														•											
Rebmann 2013		X	X	•	•							•	•	•	•		•											
Roberge 2012		X			•	•	•		•			•	•															
Roberge 2014			X		•		•																					
Rosner 2020		X	X														•				▪	▪						
Scarano 2020		X	X			•	•						•								•							
Shenal 2012	X	X	X											•														
Smart 2020		X	X				•						•															
Szepietkowski 2020	X	X	X																	•								
Techasatian 2020	X	X	X																		▪							
Tong 2015			X	•	•																							
Wong 2013		X																	•									
Zhiqing 2018		X																								•		

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Figure 2 Overview including all 44 considered studies with quantified, significant adverse effects of masks (black dots and black rectangles). Not all studies examined each mentioned parameter, as focused or subject-related questions were often in the foreground. Gray fields correspond to a lack of coverage in the primary studies, white fields represent measured effects.

significantly measured mask-induced changes in scientific studies 2004-2020: • = p<0.05 ■ = n≥50 %	Fabric Mask	Surgical Mask	N95-Mask	O_2↓	CO_2↑	Humidity↑	Temperature↑	Breathing Resistance↑	Respiratory Rate↑	Blood Pressure↑	Cerebral Vasodilation	Heart Rate↑	Respiratory impairment	Exhaustion & Fatigue	Drowsiness	Dizziness	Headache	Psycho-vegetative Effect	Decrease in Empathy	Itch	Skin Irritation	Acne	Rhinitis	Voice Disorder	False Sense of Security	Bacterial Contamination	Fungal Contamination	Viral Contamination
Beder 2008		X		•								•																
Bharatendu 2020			X		•						•						•											
Butz 2005		X			•																							
Chughtai 2019		X																										•
Epstein 2020		X	X		•																							
Fikenzer 2020		X	X	•		•	•	•					•	•						•								
Foo 2006			X																	■	■	■						
Georgi 2020	X	X	X	•	•				•				•	•														
Goh 2019			X		■																							
Heider 2020		X	X																					•				
Hua 2020		X	X			•														■	•							
Jacobs 2009		X															•											
Jagim 2018	X			•										•	•													
Kao 2004			X	•					•				•	•														
Klimek 2020																							•					
Kyung 2020			X	•	•				•			•	•															
Lan 2020			X																	■	•							
Lee 2011			X					•																				
Li 2005		X	X			•	•	•		•		•	•	•						•								
Lim 2006			X														•											
Liu 2020	X	X	X	•		•	•					•	•	•	•	•					•							
Luckman 2020	X	X	X																						•			
Luksamijarulkul 2014		X																								•	•	
Matusiak 2020	X	X	X			•	•						•							•	•			•				
Mo 2020		X			•					•			•															
Monalisa 2017		X																								•	•	
Ong 2020			X														•											
Person 2018		X											•															
Pifarre 2020		X	X	•	•																							
Porcari 2016	X			•										•														
Prousa 2020	X	X	X															•										
Ramirez 2020		X	X														•											
Rebmann 2013		X	X	•	•							•	•	•	•		•											
Roberge 2012		X			•	•	•		•			•	•															
Roberge 2014			X		•		•																					
Rosner 2020		X	X														■				■	■						
Scarano 2020		X	X			•	•						•								•							
Shenal 2012	X	X	X											•														
Smart 2020		X	X				•						•															
Szepietkowski 2020	X	X	X																	•								
Techasatian 2020	X	X	X																		■							
Tong 2015			X	•	•																							
Wong 2013		X																	•									
Zhiqing 2018		X																								•		

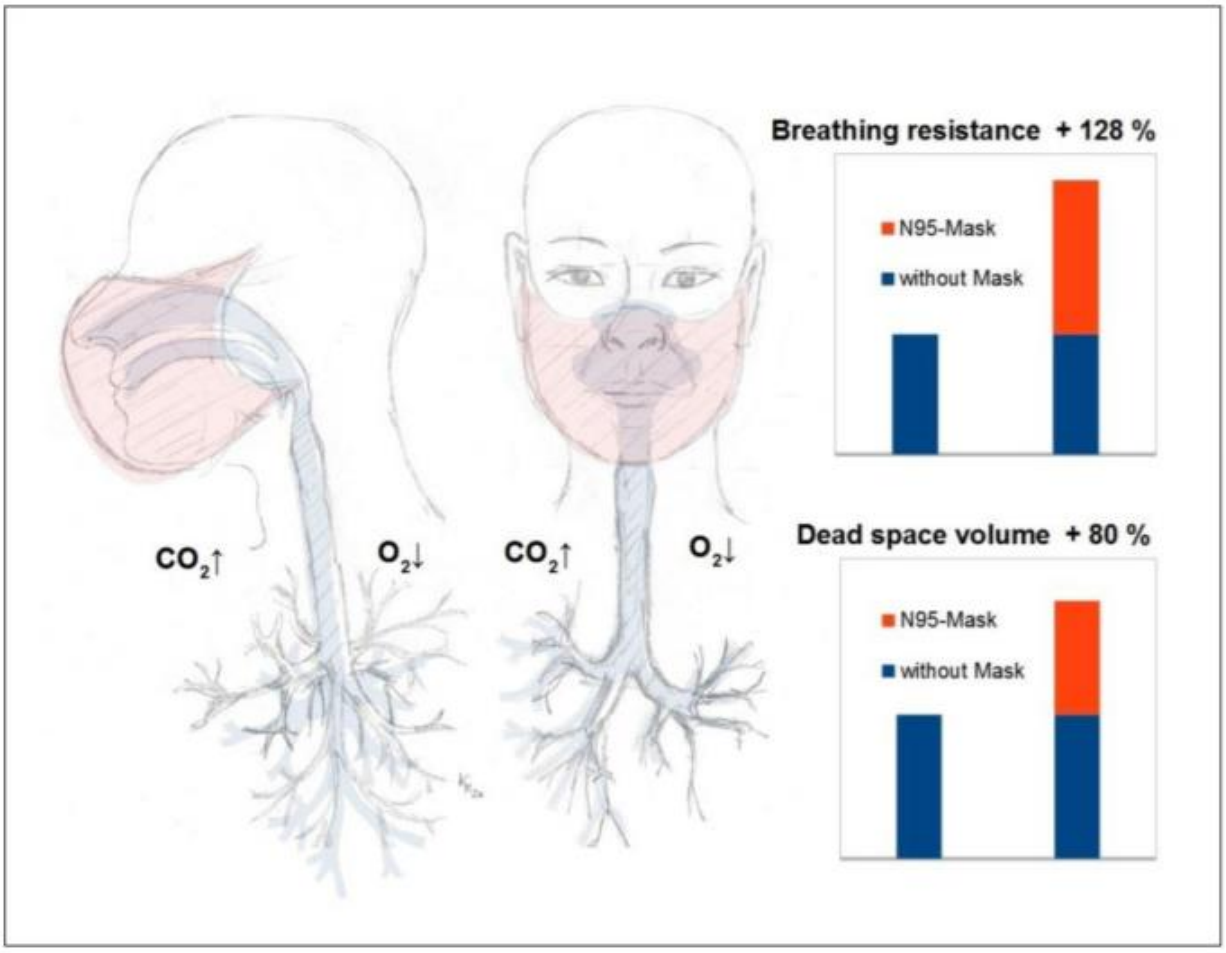

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Figure 3 Pathophysiology of the mask (important physical and chemical effects): Illustration of the breathing resistance* and of the dead space volume of an N95 mask in an adult. When breathing, there is an overall significantly reduced possible gas exchange volume of the lungs of minus 37% caused by the mask (Lee 2011) [60] according to a decrease in breathing depth and

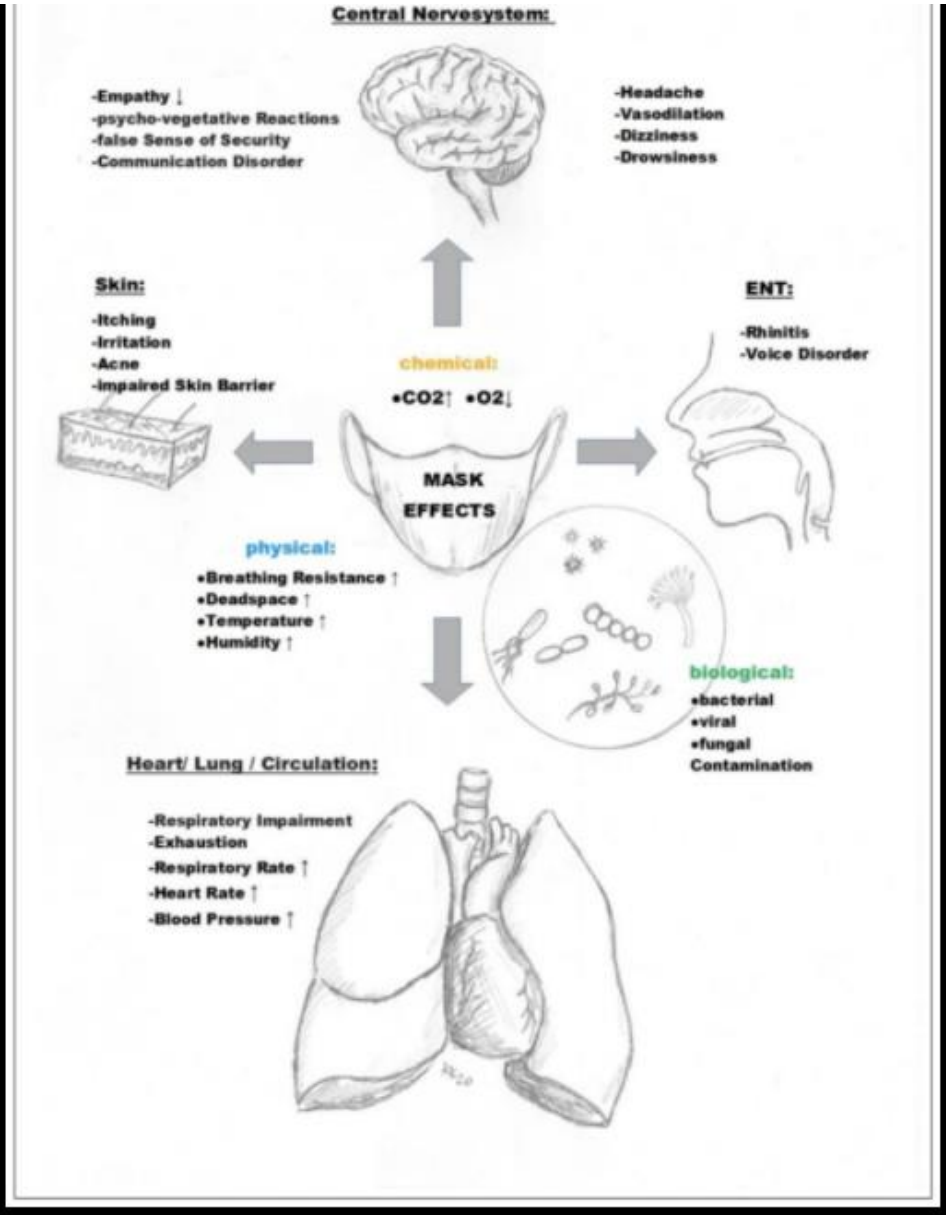

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Figure 4 Unfavorable mask effects as components of Mask-Induced Exhaustion Syndrome (MIES). The chemical, physical and biological effects, as well as the organ system consequences mentioned, are all documented with statistically significant results in the scientific literature found (Figure 2). The term drowsiness is used here to summarize any qualitative neurological deficits described in the examined scientific literature.

Increased risk of adverse effects when using masks:

Internal diseases
COPD
Sleep Apnea Syndrome
advanced renal Failure
Obesity
Cardiopulmonary Dysfunction
Asthma

Psychiatric illness
Claustrophobia
Panic Disorder
Personality Disorders
Dementia
Schizophrenia
helpless Patients
fixed and sedated Patients

Neurological Diseases
Migraines and Headache Sufferers
Patients with intracranial Masses
Epilepsy

Pediatric Diseases
Asthma
Respiratory diseases
Cardiopulmonary Diseases
Neuromuscular Diseases
Epilepsy

ENT Diseases
Vocal Cord Disorders
Rhinitis and obstructive Diseases

Dermatological Diseases
Acne
Atopic

Occupational Health Restrictions
moderate / heavy physical Work

Gynecological restrictions
Pregnant Women

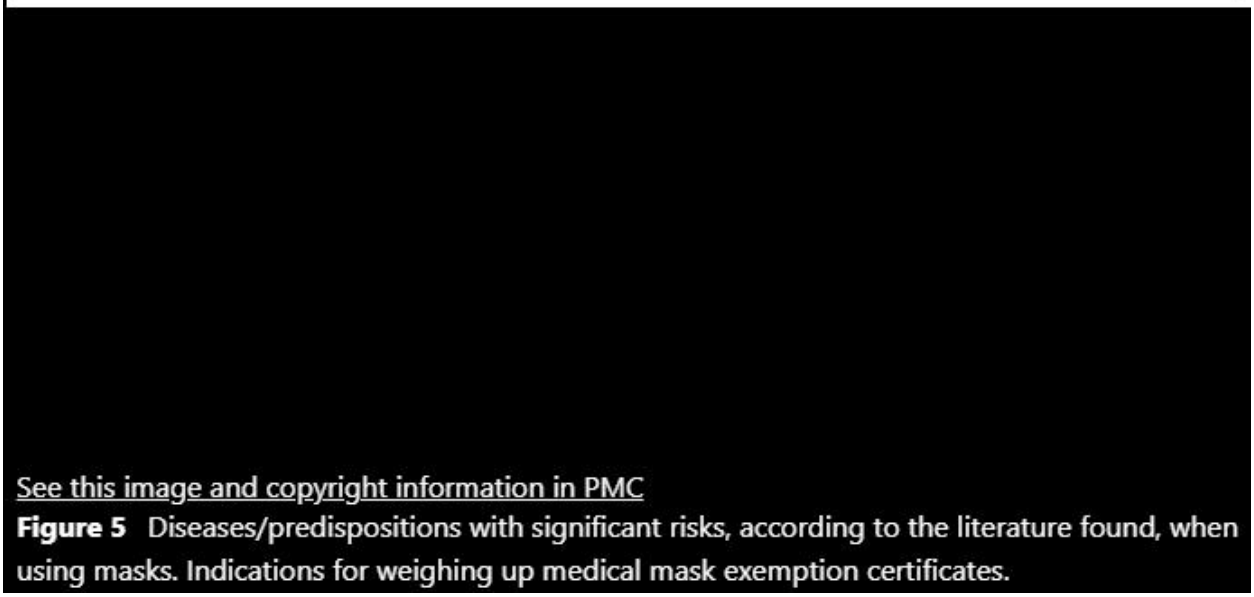

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Figure 5 Diseases/predispositions with significant risks, according to the literature found, when using masks. Indications for weighing up medical mask exemption certificates.