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REVIEW OF CONTRIBUTION OF MASK AND HAND SANITIZER IN THE PREVENTION OF COVID 19 PANDEMIC

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2.Abstract:

The advent of the novel virus, SARS-CoV-2, has presented unprecedented challenges to global public health. By May 7, 2020, there were a reported 3.8 million cases spanning over 200 countries worldwide. COVID-19, an infectious disease triggered by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), was initially identified in Wuhan, Hubei Province, China, on December 12, 2019. Adhering to proper safety protocols is imperative in the battle against this virus. This review highlights the role of masks and hand sanitizers in combating the COVID-19 pandemic. Previous research underscores the significant contribution of masks in preventing COVID-19 transmission, particularly medical masks which are found to be more effective than non-medical alternatives. However, it is crucial to provide appropriate precautions and guidance for mask usage, identify the type of masks to various departmental needs. Respirators such as FFP1 and FFP2, along with face shields, can substitute for medical masks depending on the context. Implementing risk-based strategies for mask use and enhancing compliance are recommended measures. Additionally, ensuring an adequate supply of hand sanitizer is vital for comprehensive hand coverage. Good hand hygiene is contingent upon compliance, with current sanitizers proving effective in neutralizing the virus. Nevertheless, excessive use of hand sanitizers, particularly those containing ethanol or isopropanol, may have adverse health and environmental effects, including potential toxicity and the development of drug resistance. Thus, hand sanitizer should be used when handwashing is impractical or inconvenient. In summary, this review emphasizes the indispensable role of masks and hand sanitizers in managing COVID-19.

Key words: COVID-19, Coronavirus, Mask, Hand Sanitizers, Infection.

3. Introduction

The emergence of the novel SARS-CoV-2 virus has presented unprecedented challenges to global public health. By May 7, 2020, there were a reported 3.8 million cases across more than 200 countries [1]. COVID-19, caused by this virus, is highly infectious and can survive on surfaces for up to 9 days [2]. Recent research indicates that the virus can spread through aerosols and contaminated surfaces, remaining viable for hours in the air and days on various surfaces, depending on the amount of virus shed [3]. Therefore, it is essential to break the transmission chain by implementing measures such as contact isolation and rigorous infection control protocols. Apart from wearing face masks, maintaining proper hand hygiene is paramount, especially considering the potential for contamination from direct contact with infected individuals [4]. Presently, strategies employed to combat COVID-19 primarily focus on supportive and preventive measures aimed at minimizing transmission. A key and straightforward approach to reducing infection spread in both public and healthcare settings is through hand hygiene and mask usage [5]. Research conducted during the SARS-CoV outbreak highlighted the effectiveness of providing adequate handwashing facilities in curbing transmission. The Centers for Disease Control and Prevention (CDC) in the United States have actively promoted and advocated for hand hygiene practices, emphasizing both hand washing and the use of hand sanitizers [6]. Commercially available hand disinfectants come in various types and formulations, including anti-microbial soap, water-based or alcohol-based hand sanitizers, predominantly utilized in hospital environments. These products are offered in different delivery systems such as rubs, foams, or wipes [7]. Consistent with proven benefits of rapid action and broad-spectrum microbicidal activity, the World Health Organization (WHO) recommends the use of alcohol-based hand sanitizers (ABHS), underscoring their efficacy in protecting against bacteria and viruses [5].

This systematic review aims to explore the efficacy of various masks and hand sanitizers against human coronaviruses, along with considerations regarding their formulations, potential adverse effects, and suggestions for enhancing their effectiveness. The hypothesis under investigation is whether face masks and hand sanitizers can mitigate the risk of COVID-19, with the overarching goal of assessing their utility in preventing the spread of the COVID-19 pandemic. Specific objectives include identifying safety protocols related to COVID-19, categorizing types of masks, examining the components of hand sanitizers, evaluating the effectiveness of face masks in preventing COVID-19 transmission, and assessing the efficacy of hand sanitizers in the same regard.

4. Methodology

The present study is an attempt to investigate the contribution of mask and hand sanitizer in the prevention of COVID 19 pandemic. It was conducted through the literature review.

4.1 Study Design

A descriptive reviewed research, thoroughly covers the role of face masks and hand sanitizers in preventing the COVID 19 pandemic.

4.2 Study Duration

Secondary data were collected from 15th of April, 2023 to 25th of December, 2023.

4.3 Method of Data Collection

The data collection takes place through various channels, such as well-known reputed scientific journals, research articles, national and international documents and reports from the World Health Organization.

Articles were gained by using database such as Medline research Gate, PubMed, Medscape, Research Gate, Science Direct.

5. Results and discussion

1. Type of mask

- **Medical mask**

Medical masks need to adhere to international or national standards to guarantee consistent product performance, ensuring that healthcare professionals can rely on them during various medical procedures and in accordance with specific risks [5].

- **Non-medical mask**

on-medical masks, crafted from a range of woven and non-woven materials like polypropylene, typically have lower filtration and air permeability standardization requirements. Their overall expected performance suggests that they are suitable primarily for source control rather than prevention. Therefore, non-medical masks made from fabrics or non-woven materials are recommended for source control purposes, rather than for preventive measures [5].

2. Analysis of risk ratio of medical mask and non-medical mask

Table 01: Result of meta-analysis to determine the effectiveness of medical masks against laboratory confirmed respiratory viral infections

Study group	Total Patient affected with respiratory viral infections	Type of mask that patients used		Risk ratio (Medical mask: Non-medical mask)
		Medical mask	Non-medical mask	
1. Hospital				
• Loeb 2009	221	82	139	0.81 : 1.36
• Macintyre 2011	949	168	781	0.24 : 1.11
• Macintyre 2013	581	112	469	0.33 : 1.38

Subtotal	**1751**	**362**	**1389**	**0.71 : 1.14**
2. Community				
• Macintyre 2009	186	20	166	0.24 : 1.89
Subtotal	**186**	**20**	**166**	**0.24 : 1.89**
Total	**1937**	**382**	**1555**	**0.70 : 1.11**

According to the pie chart of the risk ratio of masks and non-medical masks (table 01), it is clear that the risk ratio is 0.7: 1.11. Therefore, the risk from non-medical masks is twice that of medical masks. That's why medical masks are the most effective.

3. Characteristic features of mask

The efficacy of masks is influenced by several factors, including the material type, number of layers, material combination, mask shape, fabric coating, and maintenance. The type of material used in the mask construction significantly impacts its effectiveness. Moreover, the number of layers and the combination of materials contribute to its filtration capabilities. Different mask shapes may provide varying levels of protection, with some shapes offering better coverage and fit than others. Coating the fabric of the mask can further enhance its filtering properties and durability. Additionally, proper maintenance of masks, including regular cleaning and replacement, is crucial for ensuring continued effectiveness in preventing the transmission of viruses and other pathogens. By considering these factors, the effectiveness of masks in mitigating the spread of infectious diseases can be determined and optimized [4].

4. Effectiveness of mask

Wearing a mask serves as a fundamental non-pharmaceutical measure, effectively thwarting respiratory infections and minimizing the risk of transmission. This research examines the direct transmission of pathogens, assessing various types of masks such as disposable medical masks, surgical masks, and respirators, among others, within the context of established standards. A comprehensive review of physical interventions to curb infectious diseases supports the efficacy of mask-wearing [8].

Table 02: Results of the clinical studies for ensure the effectiveness of the medical masks

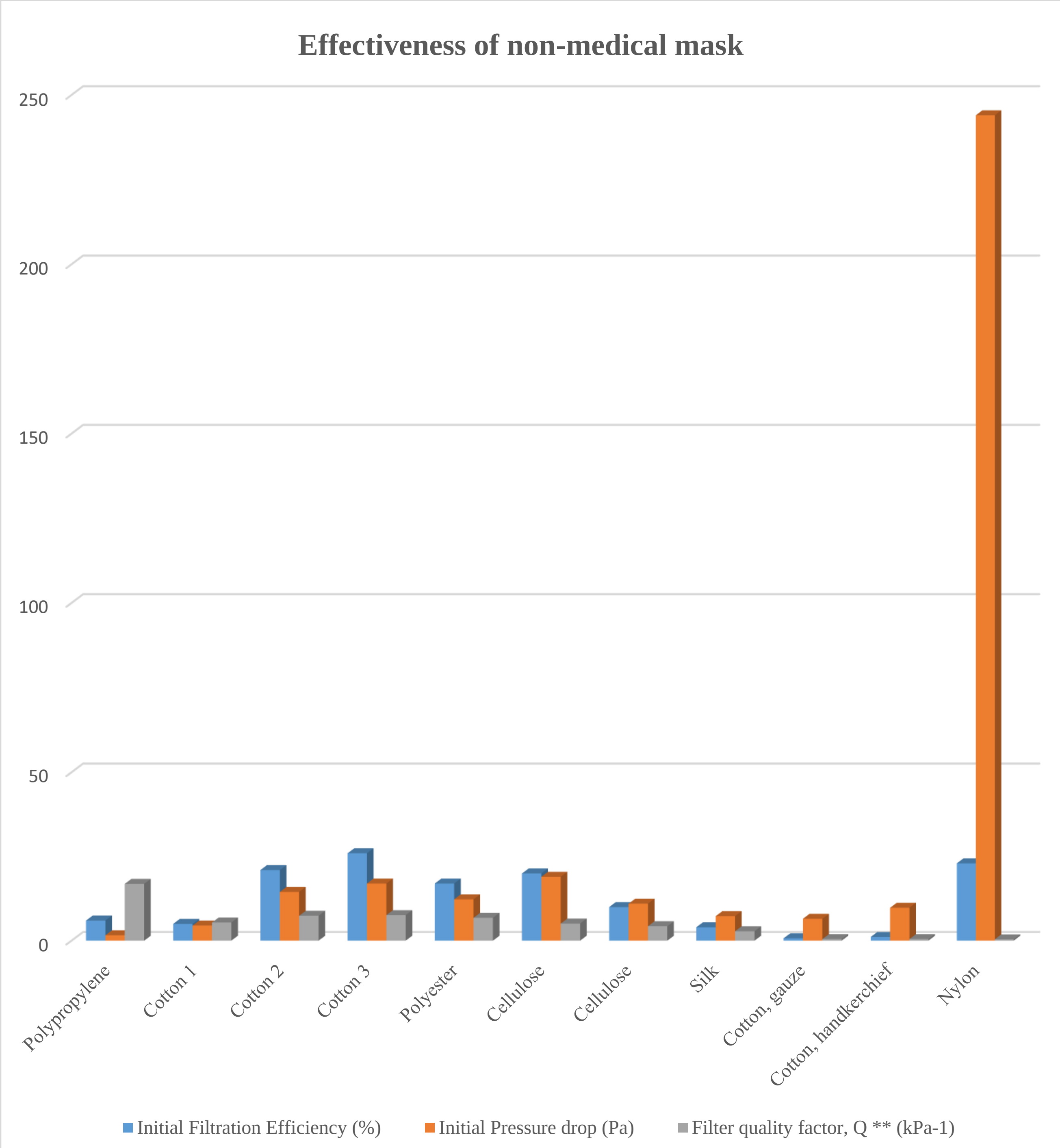
Chart 01: Effectiveness of non-medical mask

Study	Participants	Interventions	Outcomes	Notes
Loeb et al 2009	446 nurses; individual-level randomization	• Intervention: targeted use, fit-tested N95 respirator • Control: targeted use, surgical mask	Laboratory-confirmed respiratory infection, influenza-like illness, workplace absenteeism • 5-week follow-up	• Noninferiority trial • Detection of influenza A and B, respiratory syncytial virus metapneumovirus, parainfluenza virus, rhinovirus-enterovirus, coronavirus and adenovirus
MacIntyre et al 2009	145 index patients and 290 household contacts in 145 households; cluster randomization by household	• Intervention 1: continual use, surgical mask • Intervention 2: continual use, nonfit-tested N95 respirator	• Laboratory-confirmed respiratory virus infection, influenza-like illness • 2-week follow-up	Detection of influenza A and B, respiratory syncytial virus, parainfluenza virus, rhinovirus-enterovirus, coronavirus, coronavirus, adenovirus

		• Control: lifestyle measures		
MacIntyre et al 2011/2014	1441 nurses, doctors and ward clerks; cluster randomization by hospital	Intervention 1: continual use, fit-tested N95 respirator • Intervention 2: continual use, nonfit-tested N95 respirator • Control: continual use, surgical mask	Laboratory-confirmed respiratory infection, influenza-like illness • 5-week follow-up	Detection of influenza A and B, respiratory syncytial virus, metapneumovirus, parainfluenza virus, rhinovirus-enterovirus, coronavirus, adenovirus, streptococcus pneumoniae, bordetella pertussis, chlamydophila pneumoniae, mycoplasma pneumoniae and haemophilus influenzae type B

MacIntyre et al 2013	1669 nurses, doctors and ward clerks; cluster randomization by ward	• Intervention 1: continual use, fit-tested N95 respirator • Intervention 2: targeted use, fit-tested N95 respirator • Control: continual use, surgical mask	• Laboratory-confirmed respiratory infection, influenza-like illness • 5-week follow-up	Detection of influenza A and B, respiratory syncytial virus metapneumovirus, parainfluenza virus, rhinovirus-enterovirus, coronavirus, adenovirus, S. pneumoniae, B. pertussis, C. pneumoniae, M. pneumoniae and H. influenzae type B
Radonovich et al 2019	5180 nurses/nursing trainees, clinical care support staff, , registrations/clerical receptions, social workers/pastoral cares and environmental service workers/housekeepers;	•Intervention: targeted use, fit-tested N95 respirator • Control: targeted use, medical mask	•Laboratory-confirmed respiratory infection, laboratory-confirmed influenza, laboratory-detected	•Effectiveness study • Detection of influenza A and B, respiratory syncytial virus, metapneumovirus, parainfluenza virus, rhinovirus-enterovirus,

	cluster randomization by outpatient clinic or outpatient setting		respiratory illness, influenza-like illness, acute respiratory illness • 12-week follow-up	coronavirus, coxsackie/echovirus



The act of wearing a mask emerges as the optimal strategy for infection reduction, offering the added advantage of being the most cost-effective measure in society due to its simplicity and affordability. Studies conducted during the SARS outbreak revealed that beyond its direct protective function, wearing masks assumed a broader role in raising public consciousness regarding other non-pharmaceutical interventions like isolation.

Research conducted in Hong Kong suggests that the perceived importance or efficacy of mask-wearing in public spaces stands at 0.36, emphasizing its significant value in disease prevention efforts [9].

During the flu season of 2006 to 2007, a randomized intervention trial was carried out within a college dormitory setting. The study revealed that individuals in the group practicing both mask-wearing and hand hygiene experienced a substantial decrease of 35% to 51% in flu-like illnesses (ILI) compared to those who did not wear masks [10].

Moreover, the study also demonstrated that both face masks alone and in combination with hand hygiene can effectively prevent infections within community settings. In summary, this evidence underscores the significant potential of mask-wearing in alleviating the burden of infectious diseases [11].

A recent meta-analysis of observational studies, considering the inherent biases within such data, indicates that both disposable surgical masks and particulate medical masks are linked to the protection of healthy individuals indoors and in settings with case exposure [4].

5. Alternative methods in absence of medical mask.

- Alternatives to medical masks

  To be used only in the critical emergency situation of lack of medical masks

  - FFP1 respirator
  - Face shield with proper design to cover the sides of the face and below the chin [8].

6. Type of Hand Sanitizers

- ✓ Non-Alcoholic Hand Sanitizer (NABHS)

The primary active ingredient found in NABHS (non-alcohol-based hand sanitizers) is typically benzalkonium chloride, which is a quaternary ammonium salt commonly used as a disinfectant. Sanitizers containing benzalkonium chloride are generally considered to be less irritating to the skin compared to those containing alcohol. However, recent evidence suggests that they may be more likely to cause contact dermatitis than previously thought [6].

- ✓ Alcohol-based hand sanitizer (ABHS).

Alcoholic hand sanitizers can include ethanol, isopropanol, n-propanol, or combinations thereof, along with additives and wetting agents. The most common and effective formulations contain alcohol concentrations ranging from 60% to 95% [6].

7. Composition of hand sanitizers

Ethanol Antiseptic 80% Topical Solution [7].

Ethanol 96%	833.3 mL
Hydrogen Peroxide 3%	41.7 mL
Glycerol 98%	14.5 mL
Distilled Water to	1000 mL

8. Analysis the effectiveness of hand sanitizers

Viricidal activity of original and modified World Health Organization (WHO)–recommended hand rub formulations I and II for inactivating severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The means of 3 independent experiments with SDs (error bars) and percentage of inactivation at different concentrations are shown [2].

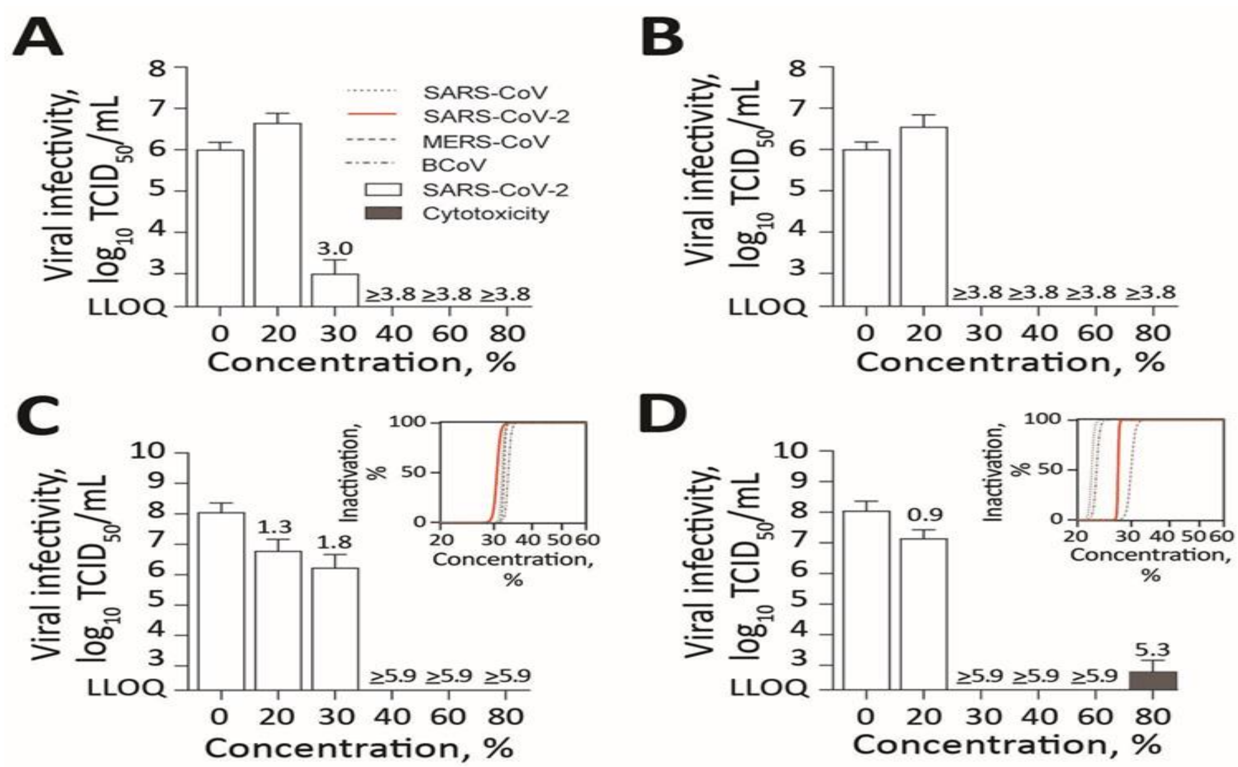
A) WHO original formulation I;

B) WHO original formulation II;

C) WHO modified formulation I;

D) WHO modified formulation II.

Figure 01: Viricidal action of hand sanitizers



- ✓ Insets in panels C and D show regression analyses of the inactivation of coronaviruses.
- ✓ Dark gray bar shows cytotoxic effects, calculated analogous to virus infectivity.
- ✓ Reduction factors are included above the bar.

- ✓ Dilutions of the WHO formulations ranged from 0–80% with an exposure time of 30 s. Viral titers are displayed as TCID50/mL values. BCoV, bovine coronavirus; LLOQ, lower limit of quantification; MERSCoV, Middle East respiratory syndrome coronavirus; SARSCoV, severe acute respiratory syndrome coronavirus; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2; TCID50/mL, 50% tissue culture infectious dose.

Several studies have indicated that contaminated hands possess inherent antibacterial and antiviral properties within the body. Although all alcohol-based hand sanitizers utilize the Kirby-Bauer method to showcase their antibacterial and antiviral efficacy against a spectrum of bacteria and viruses, including gram-positive and gram-negative strains, the sensitivity of strains is tested using antibiotic-impregnated discs. However, it has been found that propanol-based hand sanitizers tend to be more effective in comparison [1]. so propanol exhibits a broader spectrum of inhibition compared to ethanol. As hand sanitizers are increasingly employed for infection control, it becomes crucial to comprehend the potential tolerance mechanisms bacteria may develop. In vitro tests assessing alcohol tolerance with lower concentrations of isopropanol revealed that recent Enterococcus faecalis isolates display greater tolerance compared to earlier isolates. Similar investigations on various pathogens indicate that tolerance escalates with exposure to lower alcohol concentrations. It's worth noting that tolerance isn't exclusive to alcohol but extends to other agents as well [12].

While viruses pose challenges for direct in vivo study compared to bacteria, numerous research endeavors have sought to assess the efficacy of hand sanitizers against viral pathogens. The World Health Organization advocates for the use of alcohol-based hand sanitizers as a preventive measure against a variety of viruses, including bovine diarrhea virus, hepatitis C virus, Zika virus, murine norovirus, and coronavirus (provided they are effective against the specific strains) [3]. While standardized methods may not directly confirm the in vivo efficacy of hand sanitizers against viruses, in vitro studies have consistently demonstrated the ability of alcohol-based hand sanitizers to reduce viral load effectively. Notably, in vitro investigations involving patients infected with SARS-CoV have utilized sputum cultures and four distinct alcohol-based hand sanitizers, successfully inactivating the virus to levels below the detection limit [13]. Alcohol-based disinfectants have also been shown to effectively inactivate SARS-CoV and MERS-CoV (Middle East Respiratory Syndrome-related Coronavirus) on inanimate surfaces such as metal, glass and plastic [14].

9. Analysis the toxicity of hand sanitizers.

Table 03 : Acute and chronic toxicity by active ingredients of hand sanitizers.

Active ingredients	Acute toxicity	Chronic toxicity	Source
Ethanol	Central nervous system and respiratory depression, Lactic acidosis, Ketoacidosis, Nausea Cardiac arrhythmia,	Acute liver injury, Myoglobinuria, Hypokalemia, Hypomagnesemia, Hypocalcemia, Hypophosphatemia, Cardiac arrest and death	Wilson et al., 2015 Vonghia et al., 2008
Isopropanol	Similar to ethanol including central	Death, Ketosis, Osmolal gap ketonemia.	

	nervous system and respiratory depression, skin and mucous membrane irritation	Rhabdomyolysis, Myoglobinuria, Acute renal failure	Zaman.et.al.2020 New Jersey Department of Health (NJH), 2016
3% H_2O_2	Mild gastrointestinal and mucosal irritation, vomiting, skin irritation	Death in rare cases	Moon et al., 2006. ATSDR, 2014 New Jersey Department of Health (NJH), 2016cSung et al., 2018

✓**Ethanol toxicity**

Ethanol is commonly employed as a disinfectant and is also consumed orally in alcoholic beverages. Ingestion or contact with ethanol-based hand sanitizer typically results in minimal systemic toxicity. However, individuals may exhibit varying reactions and tolerances to ethanol, making it challenging to ascertain the exact degree of toxicity associated with ethanol-based wipes or towels [15]. This study affirms that acute exposure to ethanol is generally non-toxic; however, performance may deteriorate if the concentration of ethanol in the blood exceeds 200-300 mg/L. Under experimental conditions where 33% of the skin is damaged, and the skin absorbs 70% (v/v) ethanol, the blood ethanol concentration was measured at 0.046 g/100 ml, equivalent to 30 ml of absorbed surgical alcohol. Moreover, exposure to ethanol on immature skin can lead to adverse reactions and systemic toxicity [16].

✓**Isopropyl toxicity**

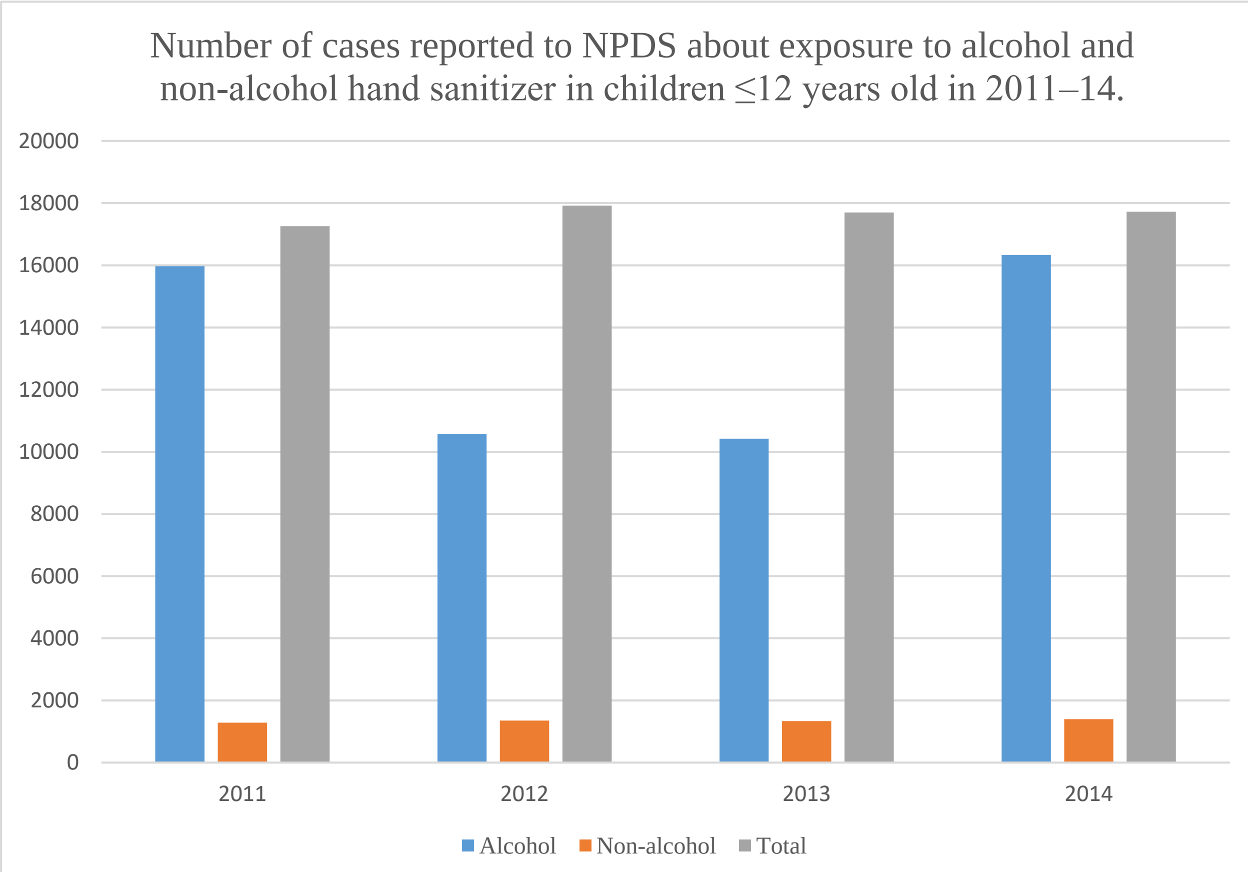
Isopropanol toxicity primarily results from accidental ingestion, occasionally occurring due to rectal or topical administration. Lethal doses of isopropanol are considered to be between 160-240 ml and 250 ml. A dose of approximately 0.5-1 ml/kg of 70% isopropanol-based disinfectant is regarded as toxic, although individual tolerance levels vary. The potentially lethal dose for adults is around 240 ml. Upon oral ingestion, isopropanol is completely absorbed within 2 hours. The liver metabolizes isopropanol into acetone, which is subsequently excreted by the kidneys [17].

✓**Hydrogen peroxide toxicity**

The toxicity of hydrogen peroxide varies based on its concentration. In rare instances, it can lead to complications such as portal vein thrombosis, gastrointestinal issues, mild mucosal irritation, and vomiting. Additionally, bowel dilation has been reported in 3% of patients exposed to hydrogen peroxide [18]. 1 ml of 3% hydrogen peroxide is responsible for generating 10 ml of oxygen at standard temperature and pressure, causing bloating and gas embolism [19]. Recent reports have recognized serious concerns including apnea, acidosis and coma in young children using alcohol (alcohol) hand sanitizer [20].

✓**Risk factor for children**

Chart 02: Analysis of number of cases reported to NPDS about exposure to alcohol and non-alcohol hand sanitizer in children <12 years old in 2011-14.



Most hand sanitizers are packaged in brightly colored bottles and feature appealing scents reminiscent of candy or other food flavors, which can be enticing to young children. If a child ingests a small amount of disinfectant out of curiosity to taste it, they may not necessarily become ill. However, the risk of alcohol poisoning outweighs any potential harm from ingesting the product. Therefore, it's crucial to keep hand sanitizers out of reach of children to prevent accidental ingestion [19].

Compared to adolescents, young children, including babies, are more susceptible to alcohol poisoning. Recent reports have identified serious issues such as apnea, acidosis, and coma in young children who have ingested alcohol-based hand sanitizer. Therefore, it is imperative to exercise caution and keep alcohol-based hand sanitizers out of reach of young children to prevent accidental ingestion and subsequent health complications [20].

- ✓ **Increased risk of other viral diseases**

Excessive use of alcohol-based cleansers can lead to increased skin permeability, stripping the skin of its natural oils and moisture, resulting in roughness and irritation. Dry and damaged skin becomes more susceptible to various diseases, thereby increasing the risk of bacterial infiltration. Research reports suggest that overuse of disinfectants can, in some instances, escalate the risk of virus outbreaks. Therefore, it is important to use these cleansers judiciously to maintain skin health and prevent unintended consequences [21].

A study examining 160 nursing homes sought to uncover the association between the preferential use of alcohol-based disinfectants and norovirus outbreaks. Among the facilities investigated, 91 participated in the study, with 73 outbreaks confirmed. Among these outbreaks, 29 were confirmed to be norovirus-related. Interestingly, workers in facilities affected by norovirus infection were found to use hand sanitizer six times more frequently than soap and water [22].

6. Limitations

The pathology of COVID-19 is not yet fully understood; most journals are based on research on SARS-COV-1 and MERS, which have previously caused epidemics of acute respiratory syndrome.

7. Conclusion

This review extensively examines the efficacy of masks and hand sanitizers in combatting the COVID-19 pandemic. Masks have played a crucial role in preventing the spread of COVID-19, with medical-grade masks proving more effective than non-medical alternatives. The risk associated with non-medical masks is higher compared to medical-grade ones. Additionally, FFP1 and FFP2 respirators, along with face shields, can serve as substitutes for medical masks. Embracing risk-based approaches to mask usage and enhancing adherence to mask-wearing guidelines are recommended strategies. Overall, the protective benefits of masks outweigh the associated risks.

Regarding hand hygiene, ensuring adequate coverage of the hands with a sufficient amount of disinfectant is paramount, alongside fostering compliance with proper hand hygiene practices. Drawing from data on virus inactivation similar to SARS-CoV-2, current hand sanitizers have demonstrated effectiveness in killing the virus. Hand sanitizers have shown superior efficacy to soap, yet their frequent and intensive use can lead to poisoning and potentially fatal outcomes. This risk stems from accidental ingestion, absorption through skin contact, or intentional ingestion. Nonetheless, ethanol-based hand sanitizers pose minimal systemic toxicity when ingested or in contact with the skin.

While ethanol and isopropanol-based sanitizers have adverse effects on human health and the environment, reports suggest that low concentrations of hydrogen peroxide are safe for human use and have minimal environmental impact. However, increased hand sanitizer usage poses risks, particularly for children, including the potential development of viral resistance. Consequently, the risk associated with hand sanitizer outweighs its benefits, suggesting its use only when handwashing is impractical or inconvenient.

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09. Conflict of interest

This is my own work and None to be declared

10. Funding and Support

Self-funding

11. Abbrevations

BC	: Benzyl Chloride
FE	: Filtration Efficiency
NHBHS	: Non-Alcoholic Hand Sanitizer
WHO	: World Health Organization
ABHS	: Alcohol-Based Hand Sanitizer
CDC	: Center For Disease Control
PPE	: Personal Protective Equipment
SD	: Standard
TCID	: Tissue Culture Infective Dose
NPI	: National Provider Identifier
ILI	: Influenza-Like Illness
LTCF	: Long-Term Care Facilities

FFP : Filtering Facepiece Respirators

12. Legend

Table 1	Result of meta-analysis to determine the effectiveness of medical masks against laboratory confirmed respiratory viral infections
Table 2	Results of the clinical studies for ensure the effectiveness of the medical mask
Chart 1	Effectiveness of non-medical mask
Figure 1	Viricidal action of hand sanitizers
Table 3	Acute and chronic toxicity by active ingredients of hand sanitizers.
Chart 2	Analysis of number of cases reported to NPDS about exposure to alcohol and non-alcohol hand sanitizer in children ≤12 years old in 2011–14.

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