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RESEARCH ARTICLE

EFFECT OF WEARING DIFFERENT TYPES OF FACE MASKS FOR PROLONGED PERIOD OF TIME ON BREATHLESSNESS & PERCEPTION IN HEALTH CARE WORKERS - AN OBSERVATIONAL STUDY

Mr. Rohit Sunil Bhavthankar¹, Dr. Arijit Kumar Das² and Dr. Abhijit D. Diwate³

1. Intern Student of Dr. Vithalrao Vikhe Patil College of Physiotherapy, Ahmednagar, Maharashtra, India.
2. Associate-Professor in Dept. of PT in Cardiovascular and Respiratory Sciences, Dr. Vithalrao Vikhe Patil College of Physiotherapy, Ahmednagar, Maharashtra, India.
3. Professor & HOD, Dept of Physiotherapy in Cardiovascular and Respiratory Sciences, DVVPF's COPT, Ahmednagar.

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Abstract

Background- The coronavirus disease, which originated in the city of Wuhan, China, has quickly spread to various countries, with many cases having been reported worldwide. As of May 8th, 2020, in India, 56,342 positive cases have been reported. Masks can help prevent the spread of the virus from the person wearing the mask to others. HCW's need to wear the mask for prolonged period of time as they come in contact with various people and so there are many adverse effects of the mask on the body such as breathlessness etc. Masks include mainly 3 types: N-95 respirators, surgical masks, cloth masks.

Methods- The study was conducted at vikhe patil medical hospital and college of Physiotherapy, Ahmednagar. Pre and Post experiences of breathlessness and perception were compared.

Result- We have analyzed that N-95 Respirators cause maximum Breathlessness compared to Surgical and cloth masks. In case of feeling stress, N-95 Respirators were the major reason, followed by Surgical Masks. Surgical and N95 Respirators create equal difficulties in communication. Causing pain on posterior aspect of the ear, as well as headache is seen more in N-95 respirators. But while using masks, N-95 has created less agitation compared to Surgical and Cloth Masks.

Conclusion- We can conclude that even N-95 is major cause of difficulties, other masks are creating near about same difficulties but N-95 gives maximum safety. So, preferring N-95 Respirators is a good choice even after having more difficulties.

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Introduction:-

The use of facemasks and respirators for the protection of healthcare workers (HCWs) has received renewed interest following the 2009 influenza pandemic and emerging infectious diseases such as avian influenza, Middle East respiratory syndrome coronavirus (MERS-coronavirus) and Ebola virus. Historically, various types of cloth/cotton masks (referred to here after as 'cloth masks') have been used to protect HCWs. Disposable medical/surgical masks (referred to here after as 'medical masks') were introduced into healthcare in the mid-19th century, followed later by respirators. Compared with other parts of the world, the use of face masks is more prevalent in Asian countries, such as China and Vietnam.^[1]

Corresponding Author:- Mr. Rohit Sunil Bhavthankar

Address:- Intern Student of Dr. Vithalrao Vikhe Patil College of Physiotherapy, Ahmednagar, Maharashtra, India.

Corona virus disease which causes SARS COVID-19.

Scientists first identified a human coronavirus in 1965. It caused a common cold. Later that decade, researchers found a group of similar human and animal viruses and named them after their crown-like appearance.

Seven coronaviruses can infect humans. The one that causes SARS emerged in southern China in 2002 and quickly spread to 28 other countries. More than 8,000 people were infected by July 2003, and 774 died. A small outbreak in 2004 involved only four more cases. This coronavirus causes fever, headache, and respiratory problems such as cough and shortness of breath.^[2]

The coronavirus disease (COVID-19) pandemic, which originated in the city of Wuhan, China, has quickly spread to various countries, with many cases having been reported worldwide. As of May 8th, 2020, in India, 56,342 positive cases have been reported. India, with a population of more than 1.34 billion—the second largest population in the world

Masks can help prevent the spread of the virus from the person wearing the mask to others. Masks alone do not protect against COVID-19, and should be combined with physical distancing and hand hygiene. Follow the advice provided by your local health authority.^[3]

Masks include mainly 3 types: N-95 respirators, surgical masks, cloth masks.

Every mask has its own BFE (bacterial filtration efficiency) and PFE (particle filtrate efficiency) and other properties.

1. **Bacterial filtration efficiency in vitro (BFE).** Staphylococcus aureus aerosols, the leading nosocomial (hospital originating) infection, are shot through a mask using a particle size of 3.0 μm and a flow rate of 28.3 L/min. The ratio of upstream staphylococcus aerosols to downstream residual concentration corresponds to the BFE with a high percentage indicating better performance.
2. **Particle filtration efficiency (PFE).** Polystyrene latex (PSL) microsphere aerosols are shot through a mask using a particle size of 0.1 μm and a flow rate of 28 L/min. Similar to BFE calculations, the ratio of upstream PSL aerosols to downstream residual concentration equals the PFE with a high percentage indicating better performance.
3. **Breathing resistance.** Airflow is controlled, and the pressure difference is measured over the mask's surface area to determine its resistance to airflow. A low breathing resistance indicates better user breathability and mask shape maintenance.
4. **Splash resistance.** High velocity streams of fluid are shot through a mask using human blood pressures of 80, 120, and 160 mmHg to simulate blood and other bodily fluid impact. The fastest of these three velocities that does not allow fluid penetration to the opposite side of the mask is then assigned a number.
5. **Flammability.** Masks are set on fire and the time it takes for their flames to spread is measured. They are subsequently classified from class 1 to 4 depending on different organizations' criteria with class 1 indicating the least flammability.

Following the results of the mask's barrier properties, they are classified according to ASTM guidelines into 3 categories: low barrier (level 1), moderate barrier (level 2), and high barrier (level 3).

1. **Level 1** masks have a BFE $\geq 95\%$, no PFE requirement, and a fluid resistance of 80 mmHg; they also have a class 1 flammability, similar across all three levels. These masks are the main standard for surgical masks and are used during low-risk aerosol, fluid, or potential spray situations.
2. **Level 2** masks have a BFE $\geq 98\%$, PFE $\geq 98\%$, and a fluid resistance of 120 mmHg. They tend to be utilized for protection in light to moderate aerosol, fluid, or spray scenarios.
3. **Level 3** masks have a BFE and PFE $\geq 98\%$, similar to Level 2, but a fluid resistance of 160 mmHg. They are designed for usage during moderate to heavy aerosol, fluid, or spray situations.^[4]

N-95 Respirators:

consist of multiple layers. The outer layer on both sides is a protective non-woven fabric between 20 and 50 gsm density to create a barrier both against the outside environment plus on the inside, to protect from the wearer's own exhalations. A pre-filtration layer then follows, which can be as dense as 250 gsm. This is usually a needled non-woven structure which is produced through hot calendaring, during which plastic fibers are thermally bonded by

running them through high pressure heated rolls. This makes the pre-filtration layer thicker and stiffer to form while maintaining the desired shape.

The innermost layer is a high efficiency melt-blown electric non-woven material, which determines the level of filtration efficiency.

N:

This is a Respirator Rating Letter Class. It stands for “Non-Oil” meaning that if no oil-based particulates are present, then you can use the mask in the work environment. Other masks ratings are R (resistant to oil for 8 hours) and P (oil proof).

95:

Masks ending in a 95, have a 95 percent efficiency. Masks ending in a 99 have a 99 percent efficiency. Masks ending in 100 are 99.97 percent efficient and that is the same as a HEPA quality filter.

.3 microns:

The masks filter out contaminants like dusts, mists and fumes. The minimum size of .3 microns of particulates and large droplets won’t pass through the barrier, according to the Centers for Disease Control and Prevention (CDC.)

Material:-

The filtration material on the mask is an electrostatic non-woven polypropylene fiber.

Valve:

Some disposable N95 masks come with an optional exhalation valve. “The presence of an exhalation valve reduces exhalation resistance, which makes it easier to breathe (exhale,)” according to the CDC.

Surgical Masks:

A surgical mask is a loose-fitting, disposable device that creates a physical barrier between the mouth and nose of the wearer and potential contaminants in the immediate environment.

Surgical masks are made in different thicknesses and with different ability to protect you from contact with liquids. These properties may also affect how easily you can breathe through the face mask and how well the surgical mask protects you.

If worn properly, a surgical mask is meant to help block large-particle droplets, splashes, sprays, or splatter that may contain germs (viruses and bacteria), keeping it from reaching your mouth and nose. Surgical masks may also help reduce exposure of your saliva and respiratory secretions to others.

Surgical face masks are manufactured into a multi-layered structure, generally by covering a layer of textile with non-woven bonded fabric on both sides. Non-woven materials, which are inexpensive to make and clean due to their disposable nature, are made up of three or four layers. These disposable masks are often fabricated with two filter layers effective at filtering out extremely small particles such as bacteria above 1 µm in size.

The filtration level of a mask depends on the type of fiber, the manner by which the fabric is manufactured, the web’s structure, and the fiber’s cross-sectional shape. For example, the material most commonly used to make surgical masks is polypropylene, either 20 or 25 grams per square meter (gsm) in density; however, masks can also be made from polystyrene, polycarbonate, polyethylene, or polyester composition. The 20 gsm mask material is made from a spun-bond process, which involves extruding the melted plastic onto a conveyor. The material is extruded into a web, in which strands bond with each other as they cool. On the other hand, the 25 gsm fabric is made via melt-blown technology, a similar process by which plastic is extruded through a die with hundreds of small nozzles and blown by hot air to become tiny fibers, again cooling and binding on a conveyor belt.^[5]

Cloth Masks:

The cotton cloth face masks which are made up of multiple alternative layers of cotton and any of these-silk, chiffon, or flannel fabric that are well fitted on face to ensure minimal or no leak may provide filtration efficacy as high as >90%. The two-layered cotton fabric face mask with 240 threads per centimeter reported a filtering efficiency of 99.5 ± 0.1%; which is close to that of N95 masks (99.9% ± 0.1%) for >300 nm size particle.

According to an estimate by the CDC, approximately 1.5 billion masks plus 90 million respirators would be required by the health sector, and about 1.1 billion masks would be needed by the public for a six-week influenza pandemic. In light of the current rapidly depleting medical supplies nationally, concerns have been raised that HCP may run out of face masks. In such a shortage event the CDC has suggested the following options:²

1. Exclude HCP at higher risk for severe illness due to COVID-19 from contact with known or suspected COVID-19 patients.
2. Designate convalescent (clinically recovered) HCP for provision of care to known or suspected COVID-19 patients.
3. Utilize a face shield that covers the entire front (extends to the chin or below) and sides of the face without a face mask.
4. Consider use of expedient patient isolation rooms for infectious risk reduction.
5. Consider usage of ventilated headboards.
6. Have HCP wear homemade masks.

Of interest is the CDC's provision that if no face masks are available, HCP might use homemade masks (e.g., bandana, scarf) as a last resort for the care of patients with COVID-19. However, the CDC also warns that homemade masks are not considered PPE, since their capability to protect HCP is unknown. In addition, the CDC recommends that masks made at home should ideally be used in conjunction with a face shield that covers the entire front and both sides of the face. Although the CDC offers homemade masks as an option, the World Health Organization (WHO) states that cloth (e.g., cotton or gauze) masks are not recommended under any circumstances. As a result of these conflicting guidelines from the CDC and the WHO, it is necessary to provide more information about the efficacy of cloth masks.

Although data are limited with regard to the use of cloth masks for HCP as PPE, some research has been conducted on the efficacy of cloth masks in protecting against pollution. Shayka et al. tested 3 different types of cloth masks for filtration efficiency against polluted particulates ranging in size from 30 nm to 2.5 μm , then compared these values to the filtration efficiency of surgical masks. These investigators found the filtration efficiency of cloth masks to be only 39–65% for polystyrene latex (PSL) microsphere aerosols, whereas the surgical masks performed statistically significantly better at 78–94% efficiency against the same particles. This led researchers to conclude that disposable surgical masks are more effective than cloth masks in reducing particulate exposure, and that cloth masks are only marginally beneficial in protecting individuals from particles smaller than 2.5 μm .⁴⁸ Due to the microscopic nature of bacteria and viruses, these results support both the WHO's caution against cloth masks and the CDC's guidelines for considering homemade masks as a "last resort".

The need of study is, as the coronavirus is spreading all over the world, everyone is following the precautionary measures and wearing the mask is one of the most important measures to control the spread of the coronavirus. so, the Health Care Workers need to wear the mask for prolonged period of time as they come in contact with multiple people including their colleagues and other staff and the patients.

As they wear the mask for prolonged period, they suffer from hypoxia as they inhale the already exhaled CO₂ and so, they don't get enough oxygen supply which causes breathlessness and discomfort due to tight fittings of the mask. It is the major issue which also affect their perception and so this study is to find out the effect of wearing different Face masks for prolonged period of time on Breathlessness & perception in HCW's

Material And Methods:-

Methodology:-

An Observational study is conducted at Dr. Vitthalrao Vikhe Patil college of Physiotherapy, Ahmednagar. Purposive Sampling is used in 57 normal Individual.

Inclusion criteria are Qualified medical professional, Age 20-60, Both genders, who wear mask for 7-8 hrs. daily. Exclusion criteria are Already diagnosed with Cardiovascular & Respiratory Diseases, Diagnosed Neurological condition, Individual not willing to participate

Procedure-

The ethical clearance from the Institutional Ethical Committee of college of physiotherapy will be obtained. Subjects fulfilling the inclusion and exclusion criteria will be included in the study. The entire procedure involved in the study will be explained to each subject.

Breathlessness-

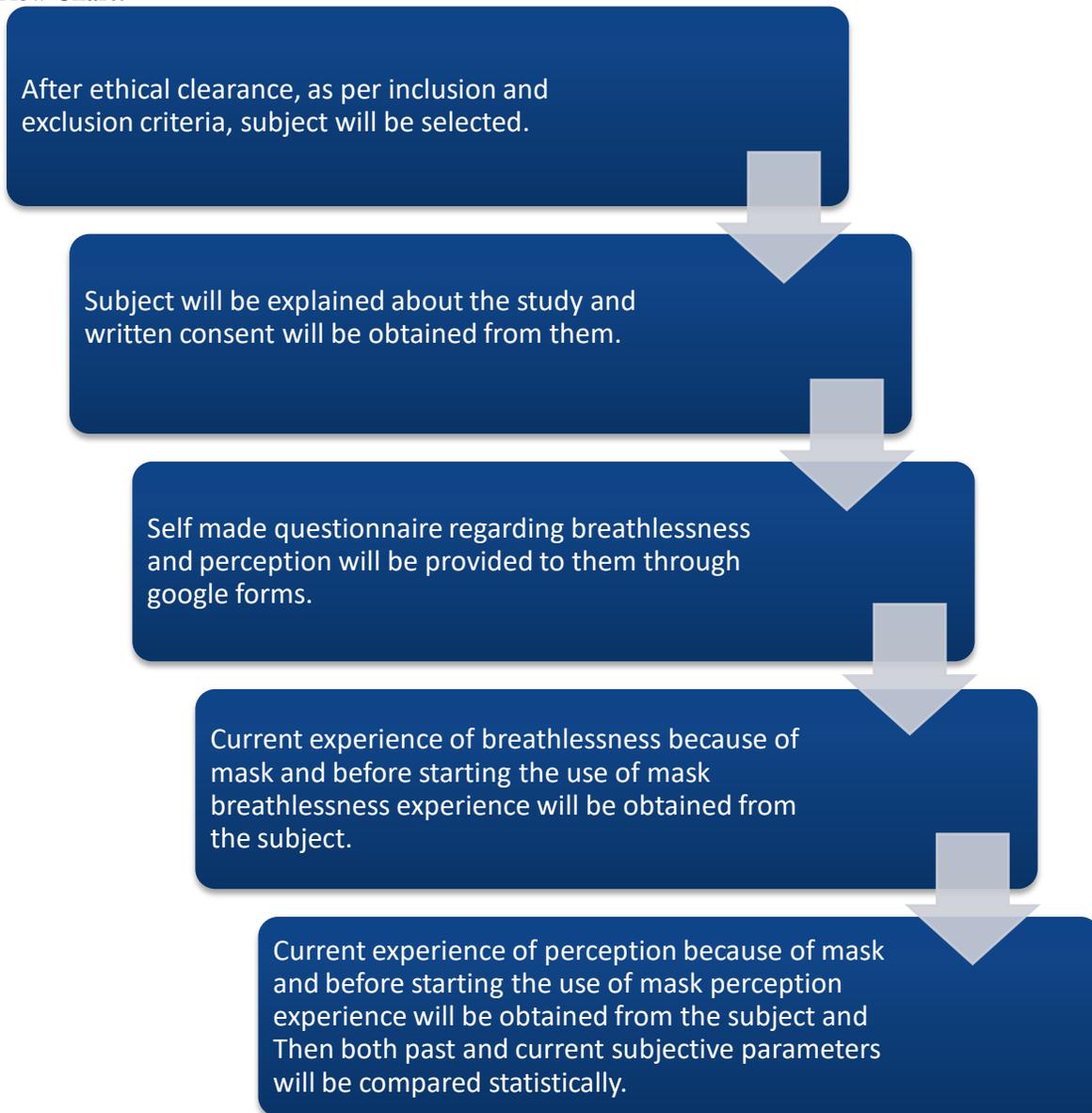
Borg Scale will be used which will be used to obtain data about breathlessness.

Perception-

Self-made questionnaire will be provided to the subject through google forms.

Self-made questionnaire and Borg scale regarding breathlessness and perception will be provided to the subject through google forms. Current experience of breathlessness and perception because of mask and before starting the use of mask breathlessness and perception experience will be obtained from the subject. and then both past and current subjective parameters will be compared statistically.

Flow Chart:



Outcome Measures-

1. Borg scale (an article Validity and Reliability of Subjective Ratings of Perceived Exertion During from journal Work Ergonomics published on 1976 Jan 1 concludes that category ratings of perceived exertion according to the Borg (RPE) Scale offer a sensitive and reliable measure of stress encountered during work.)^[5]

2. Self-made questionnaire for perception.

Results:-

In the survey, there were total of 57 participants.

In which, it was divided in 3 groups. i.e., surgical mask, cloth mask, N-95 Respirators. The number of participants per group was 19 and the mean age was 27 years in Surgical mask group, 28 years was in cloth mask group and 24 years in N-95 respirators group.

Both Males and Females were included in the survey [Table 1]. They were asked to fill the google forms Pre on day 1 i.e., their experience before wearing the mask and approximately after 7 days, HCW's were requested to fill up the post form i.e., their experience after they started to use the mask.

In results, both the experiences were compared and the data was analyzed.

It was observed that Health Care Workers (HCW's) wearing mask feel Breathlessness and other problems including

1. Stressful Breathing.
2. Difficulty in Communicating with others.
3. Agitation.
4. Headache.
5. Pain behind ear.

It was observed that majority of people felt Breathlessness, difficulty in communication and pain behind the back of ear due to tight fittings of the mask.

Table 1:- Baseline characteristics of participants.

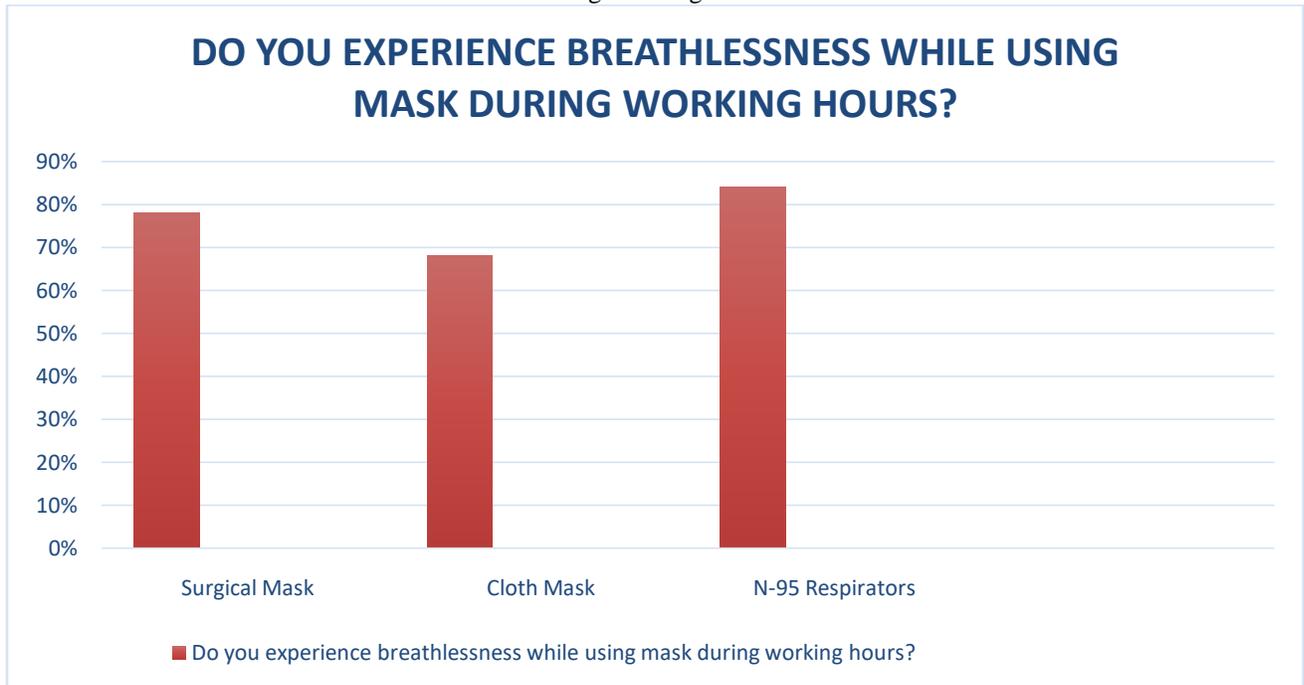
Groups	Male	Female	age
	Mean \pm SD		
Group a (surgical mask) n=19	10(52.6%)	9(48%)	27.947 \pm 11.360
Group B (cloth mask) n=19	12(63.15%)	7(36.84%)	28.526 \pm 11.834
Group C (N95 Respirators) n=19	5(26.31%)	14(73.6%)	24.578 \pm 4.087

This above graph shows percentage of male and female HCW's using Surgical Mask. In which 53% were Males and 47% were Female HCW's.

This above table also shows percentage of male and female HCW's using Cloth Masks. In which 79% were Males and 21% were Female HCW's.

This table also shows percentage of male and female HCW's using N-95 Respirators. In which 26% were Males and 74% were Female HCW's.

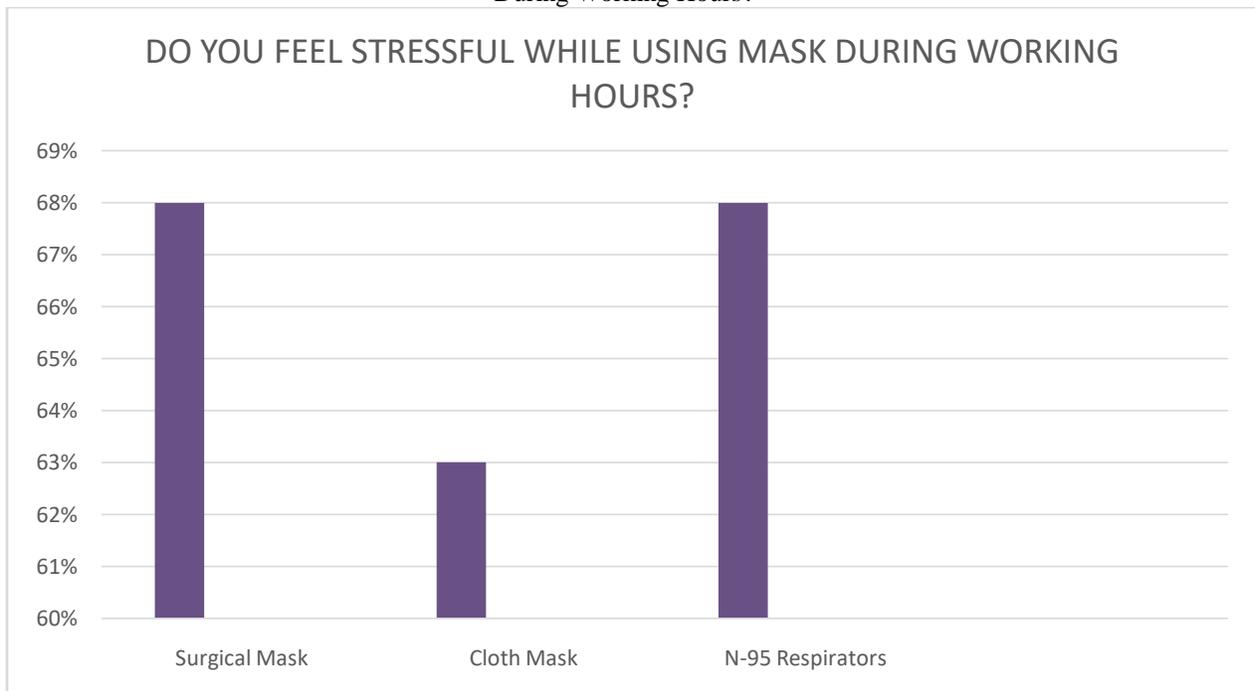
Graphno. 1:-Showing Comparison Between 3 Group Of Masks In;Do You Experience Breathlessness While Using Mask During Working Hours?



In graph 1,

3 groups of masks were compared on the basis of breathlessness experienced by HCW’s during working hours. In survey, it was seen that people using N-95 respirators feel more breathlessness (84%) as compared to both the groups i.e., surgical mask (78%) and cloth mask (68%)

Graphno. 2:- Showing Comparison Between 3 Group Of Masks In;Do You Feel Stressful While Using Mask During Working Hours?

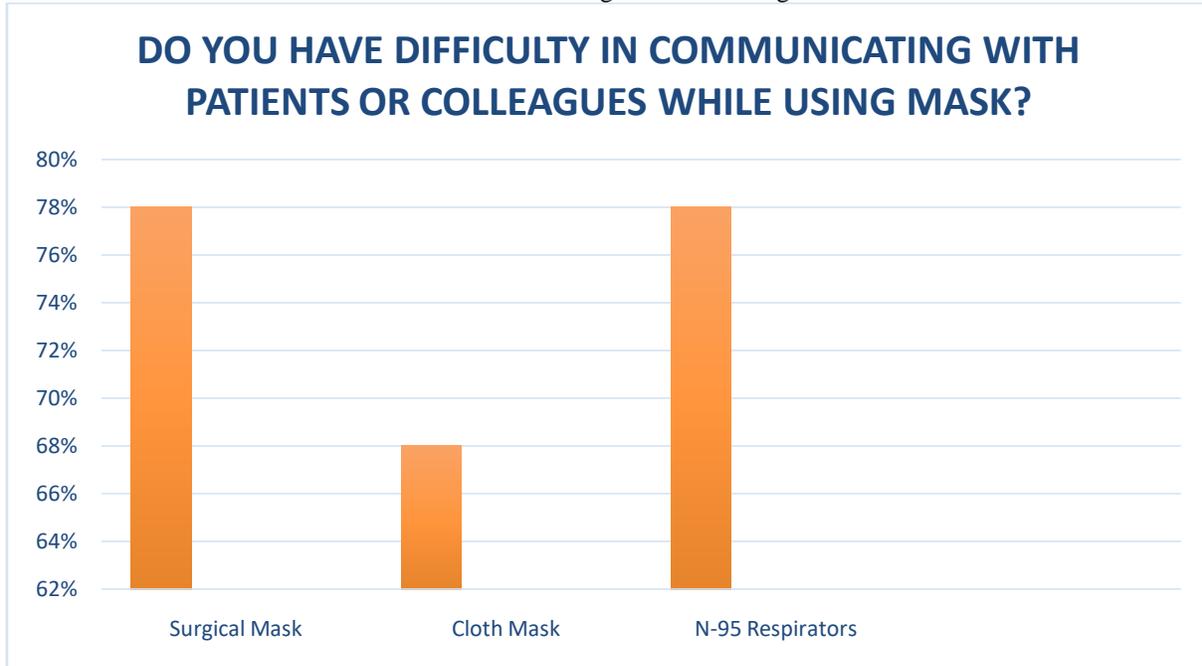


In graph 2,

3 groups of masks were compared on the basis stress they experience during working hours.

In which, people wearing N-95 respirators (68%) and Surgical mask (68%) experience more stress than people using Cloth Masks (63%)

Graphno. 3:- Showing Comparison Between 3 Group Of Masks In;Do You Have Difficulty In Communicating With Patients Or Colleagues While Using Mask?

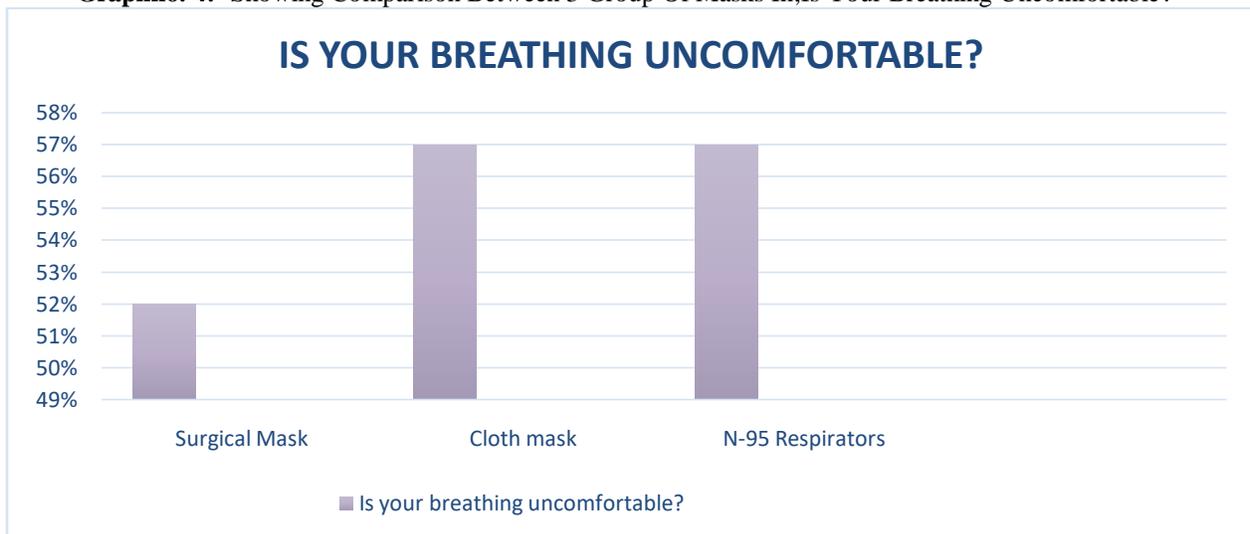


In graph 3,

3 groups of masks were compared on the basis of difficulty they feel while communicating with their colleagues.

In which it was observed that in which, people wearing N-95 respirators (78%) and Surgical mask (78%) experience more difficulty while communicating with others than people using Cloth Masks (68%)

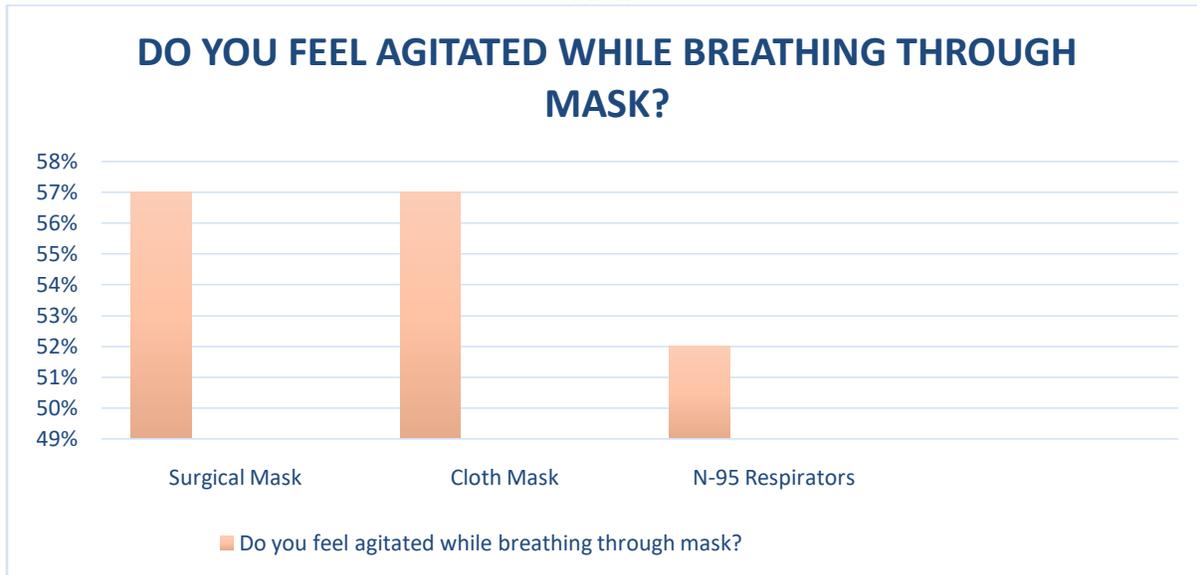
Graphno. 4:- Showing Comparison Between 3 Group Of Masks In;Is Your Breathing Uncomfortable?



In graph 4,

3 groups of masks were compared on the basis of how uncomfortable their breathing is while wearing the masks. In which it was observed that in which, people wearing N-95 respirators (57%) and Cloth mask (57%) are more uncomfortable while wearing mask than people using surgical Masks (52%)

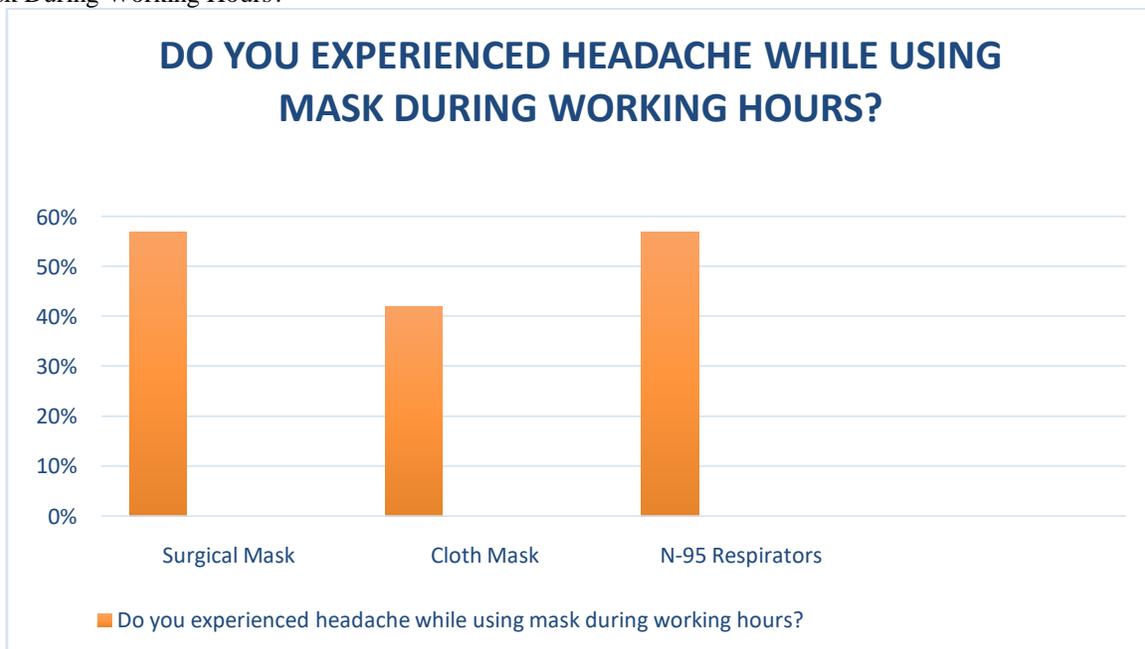
Graphno. 5:- Showing Comparison Between 3 Group Of Masks In;Do You Feel Agitated While Breathing Through Mask?



In graph 5,

3 groups of masks were compared on the basis of Agitation HCW’s feel while wearing mask. In which it was observed that in which, people wearing Cloth Mask (57%) and Surgical mask (57%) experience more difficulty while communicating with others than people using N-95 Respirators (52%).

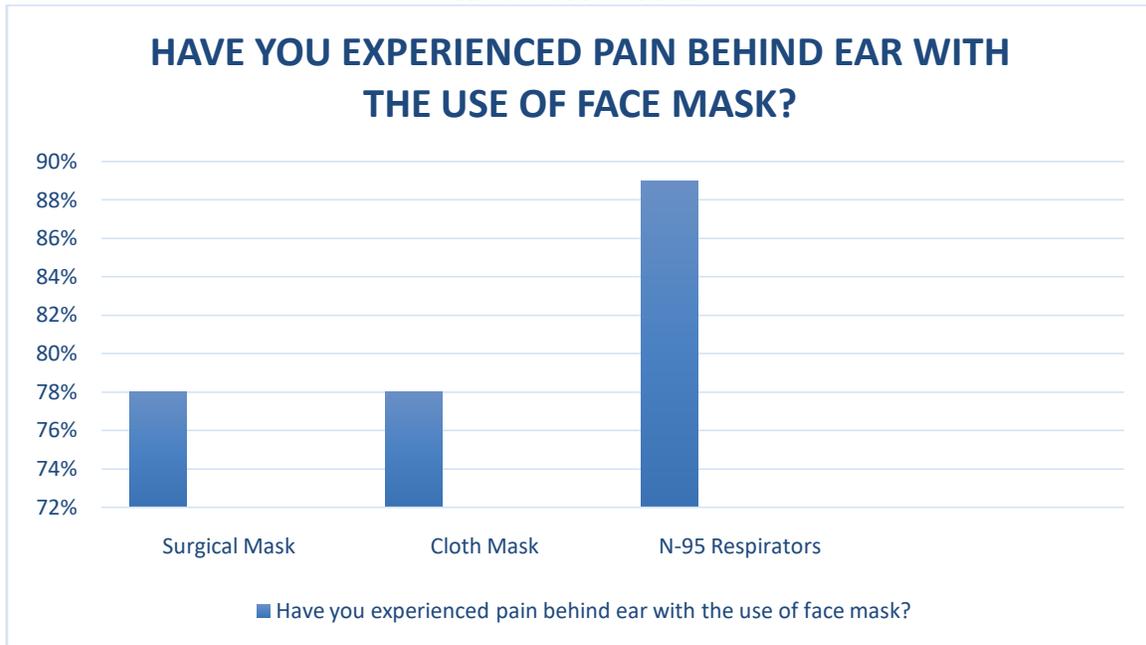
Graphno. 6:- Showing Comparison Between 3 Group Of Masks In;Do You Experienced Headache While Using Mask During Working Hours?



In graph 6,

3 groups of masks were compared on the basis of Headache HCW’s experience while wearing mask. In which it was observed that in which, people wearing N-95 respirators (57%) and Surgical mask (57%) experience more difficulty while communicating with others than people using Cloth Masks (42%).

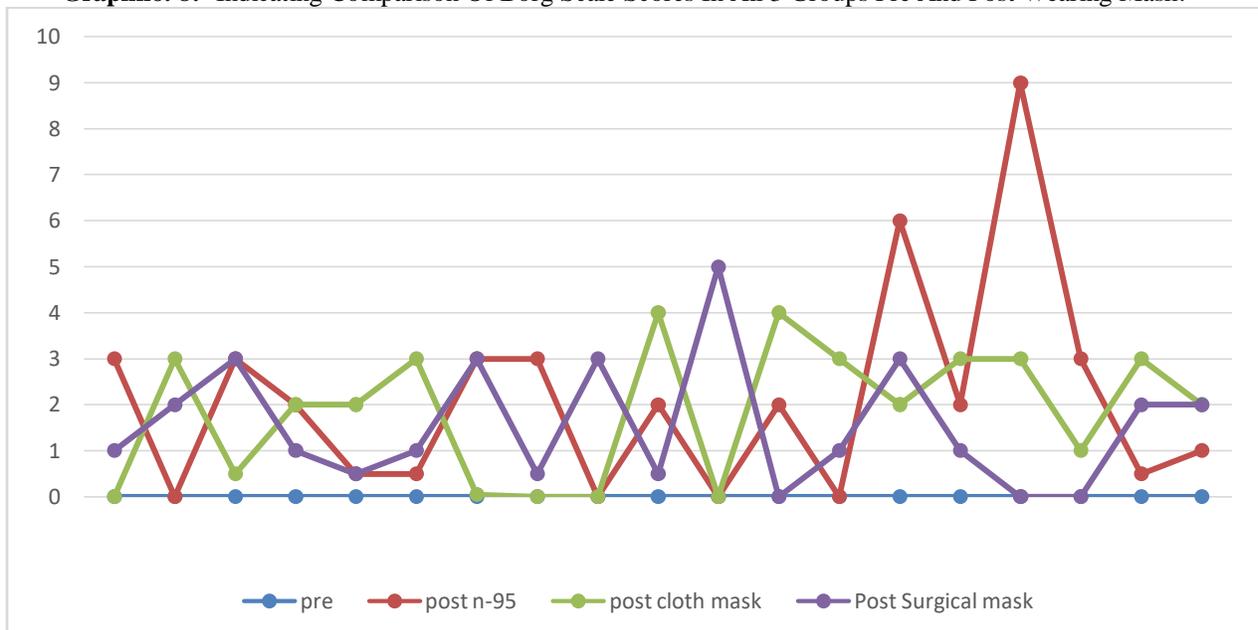
Graphno. 7:- Showing Comparison Between 3 Group Of Masks In;Have You Experienced Pain Behind Ear With The Use Of Face Mask?



In graph 7,

3 groups of masks were compared on the basis of Pain HCW’s feel behind ear due to tight fittings of the mask. In which it was observed that in which, people wearing N-95 Respirators (89%) experience more pain behind ear than people using Cloth Mask (78%) and Surgical mask (78%).

Graphno. 8:- Indicating Comparison Of Borg Scale Scores In All 3 Groups Pre And Post Wearing Mask.



In Graph 8,

3 groups of masks were compared on the basis of breathless experienced by HCW's during working hours. We can see that People wearing N-95 masks have increased breathlessness as compared to Surgical mask and Cloth Mask.

Discussion:-

As the coronavirus is spreading all over the world, everyone is following the precautionary measures and wearing the mask is one of the most important measures to control the spread of the coronavirus. so, the Health Care Workers need to wear the mask for prolonged period of time as they come in contact with multiple people including their colleagues and other staff and the patients.

So, we decided to compare between the 3 types of masks and we analyzed some of the components.

According to the results, We have analyzed some of the components and in that the Breathlessness was the major component which gives us the idea that N-95 Respirators cause maximum Breathlessness compared to Surgical and cloth masks.

Even in case of feeling stress, N-95 Respirators were the major reason, whereas Surgical Masks also create stress among HCW's.

Surgical and N95 Respirators both create equal difficulties in communication.

Causing pain on posterior aspect of the ear, as well as headache is seen more in HCW's wearing N-95 respirators.

But while using masks, N-95 has created less agitation compared to Surgical and Cloth Masks.

So, in each and every aspect, N-95 which gives maximum safety also restricts maximum air which is inspired by an individual. It creates more difficulties compared to Surgical and cloth mask.

But this difficulty faced while wearing N-95 Respirators are more / less same for Surgical and Cloth Masks. So, when it is matter of safety, N-95 Respirators gives maximum safety in current scenario.

So, we can conclude that even N-95 is major cause of difficulties, Other masks are creating near about same difficulties but N-95 gives maximum safety. So, we can say, preferring N-95 Respirators is a good choice even after having more difficulties. "SAFETY FIRST!"

Conclusion:-

As we saw in results, we can conclude that N-95 Respirators cause many difficulties such as Stressful breathing, pain behind ear, more breathlessness. But the same mask gives maximum safety.

So, using N-95 respirators as your daily face mask will be a good choice rather than selecting cloth mask or Surgical mask.

Conflit Of Interest:-

None.

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