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Comparative Effect of Fabric Type on the Protection and Comfort Properties of Fabric Face Mask: A Contribution to Surveillance Against Covid-19

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ABSTRACT.: *The purpose of this study was to investigate the effect of fabric type on the protection and comfort properties of fabric face masks against covid -19. Five different fabrics; Cotton, Poly-cotton blend, Light Neoprene, Polyester, Neoprene were purchased from Gashua market and 500 fabric face masks were produced. Three parameters; air permeability, elongation, and tensile strength were used to determine its fabric functional and quality properties. Laboratory tests as well as structured questionnaires were used as instruments for data collection. Polyester has the highest tensile strength of 1214.02N, followed by poly-cotton blends and the lowest being cotton 714.80N. Neoprene has the highest elongation of 78.81%, followed by light Neoprene and the least is 20.29%. Cotton has the highest air permeability of 118.36 ft3/ft2min, followed by Neoprene and light Neoprene respectively; the lowest is poly cotton blends. The cotton face mask has the best characteristics in terms of ease of breathability, can easily be washed and does not fog on the glass of the wearer. Poly-cotton blends face masks follow cotton in all the three characteristics stated above and it was adjudged to be the best in fitness for wearing. Polyester face mask produces the lowest result in breathability and fog production in the glasses.*

KEYWORDS: covid-19, fabrics, tensile strength, air permeability, face mask.

INTRODUCTION

The outbreak of COVID-19 in the global world has brought with it an unprecedented mortality and world downturn to the world. In general, an outbreak has caused catastrophic mortality and economic damage around the world. SARS-CoV-2, commonly known as COVID 19, is a coronovirus, like many other infectious diseases, that can be spread by respiratory droplets in the air, especially by people that are close to one another. Therefore, it is an airborne pathogen that can be transmitted between humans through droplets and aerosols that can travel 1–8 meters. The virus is transmitted by both symptomatic and asymptomatic individuals.

The effect of COVID-19, as well as the severe long-term aftermath including death, has seriously impacted communities including Gashua, a smalltown in Yobe state of Nigeria. Reports from Gashua general hospital that each patient with COVID -19 brought to their hospital dies within forty-eight hours of arrival as they were brought to their critical stage and 57 deaths were recorded in 6 days, mostly elderly people. Therefore, one of the major difficulties in containing the COVID-19 pandemic is the no detection of infected asymptomatic or pre-symptomatic individuals, who are believed to be responsible for most if not all the transmissions. Most infected people do not show any signs of the infection. As such, they go about their normal business and interaction with healthy individuals, spreading the virus without manifesting any signs of the disease. These healthy carriers represent a crucial variable in prevention of COVID-19.

A report has shown that despite the introduction of vaccines against SARS-CoV-2, most of the vaccinated individuals still go down with COVID-19, indicating that the vaccines are not effective. In addition to the absence of an effective vaccine or antiviral, personal and community effort, including government policy, needs to be enhanced and pulmogated to control the spread of the infection. Most countries, including Nigeria, have implemented interceptive efforts-both pharmaceutical and non-pharmaceutical-to curb the spread of COVID-19, such as closure of schools, workplaces, churches, offices, factories and other social venues. However, these preventive measures of lockdown cannot continue forever, if life must go on. Therefore, while encouraging preventative measures ranging from maintaining social distancing (SD, usually 2 m/6 ft between individuals) to total quarantine and societal lockdowns. These measures aim to reduce the effective contact rate of the population, which in turn decreases the disease reproductive number R0. These NPIs limit the epidemic, but they present important drawbacks. Total lockdown can only be implemented for short periods, due to its severe impact on the social fabric and economy of a country. This then calls for serious protective measures such as the use of fabric face-masks.

Face masks covering the nose and mouth area also provide a level of filtration that blocks virus transmission to a certain extent. Masks prevent the spread of droplets and aerosols generated by an infected individual, reducing viral transmission by 95%. Uninfected individuals wearing a mask are about 85% protected against infection. Masks may be more effective to control the source of infectious virus because they prevent the larger expelled droplets from being converted into smaller droplets that can travel farther. Accordingly, face masks reduce the spread of other airborne diseases such as flu, cold catarrh and cough.

Cloth masks are made from fibrous material, such as cotton, towels, pillow towels, and T-shirts, and can be homemade. Cloth masks have relatively low filtration efficiency and limited protective effects and are generally recommended for protection against community transmission. Steffens J., and Coury J.R. (2007). However, cloth masks cannot be efficient for filtration of fine particulate matter, owing to the thick fiber diameters and large pore sizes. Improving the efficiency of these filters usually relies on increasing the number of mask layers, reducing the fiber diameter, and reducing and changing the fiber structure's density, which leads to increases in respiratory

resistance and discomfort from thermal and moisture perspectives, making them difficult to wear for a long time. Zhao M., et.al (2021) leads.

After wearing the mask, the person feels more hot and humid, and the discomfort is significantly increased. At the same time, the mean skin temperature increases, the heart rate increases, and the blood oxygen saturation level decreases. This ultimately leads to a decline in health and comfort levels. Cong Liu et.al 2020. Breathability is typically measured by the pressure differential (also called "pressure drop") between the two sides of a mask as air flows through it at a rate similar to that during breathing and should be tested at a specified face velocity perpendicular to the plane of the tested material or at a specific flow rate across a specified material surface area.

The Differential Pressure (DP) is a test that measures how easily air is passed from one side of the mask to the other. This indicates how easily the wearer can breathe through the mask and is indicated by the Delta P. Higher DP indicates air is more difficult to push through. This could result in a "blow-by" effect (escape of air, and contamination from the sides of an improperly working mask), or even incorrect use by the wearer.

Comfortability of face mask

A comfortable face mask is one of the most effective ways to limit SARS-CoV-2 transmission. If it is discomfort, there will be noncompliance in mask wearing. Further, through these surveys, three critical predicting variables that dictate mask comfort were identified: air resistance, water vapor permeability, and face temperature change. In this research, five different types of fabrics; Cotton, Poly-cotton blend, Light Neoprene, Polyester, Neoprene were purchased from the market. A mechanical and functional test of tensile strength, elongation and air permeability was carried out at Standard Organization of Nigeria, Kaduna State, Nigeria and the face mask produced was tested for breathability and comfortability by the students and some staff Federal university, Gashua Yobe State, Nigeria.

MATERIALS AND METHODS

Study Area

The study area for this research was the federal university, Gashua, and its environs of Gashua town in Yobe State of Nigeria. For the purpose of this study, it is necessary to explain the topography of Gashua to be able to understand the extremes of weather conditions in the period of the research. Gashua is located at an elevation of zero meters (0 feet) above sea level. Gashua has a Subtropical steppe climate (Classification: BSh). The district's yearly temperature is 32.78ºC (91.0ºF) and it is 3.32% higher than Nigeria's average. Gashua typically receives about 50.77 millimeters (2.0 inches) of precipitation and has 70.66 rainy days (19.36% of the time) annually. It is located between the geographical coordinates of Gashua, which are 12.870 deg latitude and 11.040 longitude, and 1,112 ft elevation. The cool season lasts for 1.7 months, from December 10 to February 2, with an average daily high temperature below 89°F. The coldest month of the year in Gashua is January, with an average low of 60°F and high of 87°F. The windier part of the year

lasts for 5.9 months, from October 29 to April 26, with average wind speeds of more than 8.4 miles per hour. The windiest month of the year in Gashua is February, with an average hourly wind speed of 11.0 miles per hour. The topography within 2 miles of Gashua is essentially flat, with a maximum elevation change of 72 feet and an average elevation above sea level of 1:104 feet. Within 10 miles it is also essentially flat (72 feet). Within 50 miles is essentially flat (213 feet). (Statistical analysis of historical hourly weather reports and model reconstructions from January 1, 1980 to December 31, 2016).

Study Population

The study population comprises all the students of Federal University Gashua, Yobe state, Nigeria. (FUGA), who are living in the hostel aged 18- 30 years, who indicated their consent to participate in the study. Five hundred fabric face mask specimens were constructed for his study and given to the participants to use for a stipulated period of time. 450 pieces were given to the students and 50 pieces to the staff. They were also given questionnaires to respond to in relation to their experience during use. All the specimens together with their questionnaires were recovered.

Study Design

The study was a cross-sectional study of laboratory experiments and a subsequent survey method was used to elicit responses from the participants. Five different types of fabrics commonly used for making face masks were used. These fabrics namely: Cotton, Poly-cotton blend, Light Neoprene, Polyester and Neoprene. Each participant's consent was sought and socio-demographic and health information was obtained by means of a structured questionnaire.

Inclusion and Exclusion Criteria

The participants at the age of 18 – 35 years' resident in the hostel were included in the study while those that are off campus were excluded. Ethical approval for this research was obtained from the Specialist Hospital, Gashua Ethical Committee.

Experimental Method

The researchers, with the help of two research assistants who are also lecturers of Clothing and Textile in Home Science and Management Department of the institution, conducted the practical work of constructing 500 fabric face mask for a period of one month.

Equipment / Tools

Fabrics, elastic string, sewing thread, scissors, sewing pins, sewing machine and iron.

Materials

25 Meters of Cotton, Poly-cotton blend, Light Neoprene, Polyester and Neoprene
Each of the fabric will produce 100 pieces of mask which will be made in two different sizes. small size: 10 inches by 6 inches and big Size is 12 inches by 7.25 inches.
The elastic 1/8 inch size

Step one

- Each of the fabrics was cut as stipulated above (12 inches long and 7.5 inches wide).
- Two pieces of elastic were cut, each at least seven inches or longer to allow for an adjustable fit.

The fabrics were doubled

One side was stitched at a 1/2-inch dart, which becomes the top of the mask. (that covers the nose). The other side was stitched at 3/4-inch dart. (the chin). Note that these can be adjusted to be smaller or larger to fit the wearer.

Step two

Zigzag curved lines were stitched across the edges on the wrong side of the fabrics.

Step three

The mask was turned to the right side and topstitching was done across the circumference.

Step four

The elastic straps was attached to mask

The edges of your fabric were turned at 1/2 of an inch or more and stitch 1/4 of an inch from the edge to create a tunnel for the elastic. Feed the elastic through the tunnel (a safety pin attached to one end will help with threading). Try on for size, and adjust the length as needed. Stitch or tie the ends of the elastic together. The same process was followed for the small size

Mechanical and functional tests

Air permeability tests.

Air permeability tester, Param T QD-G1 was used for the test. A specimen size of 52 mm x 52 mm was cut and fixed inside the pot and constant air flux was applied through the specimen vertically. The air permeability was obtained by the pressure difference measurement.

Tensile strength test

YG26D multi- functional electronic fabric strength machine

Fabric samples are cut to 4 x 6 inches in both the length and cross directions. The machine is set at 12 inches per minute and the specimen is inserted into the 1 x 1 inch grips. The sample is pulled until break, and the breaking force and elongation were measured.

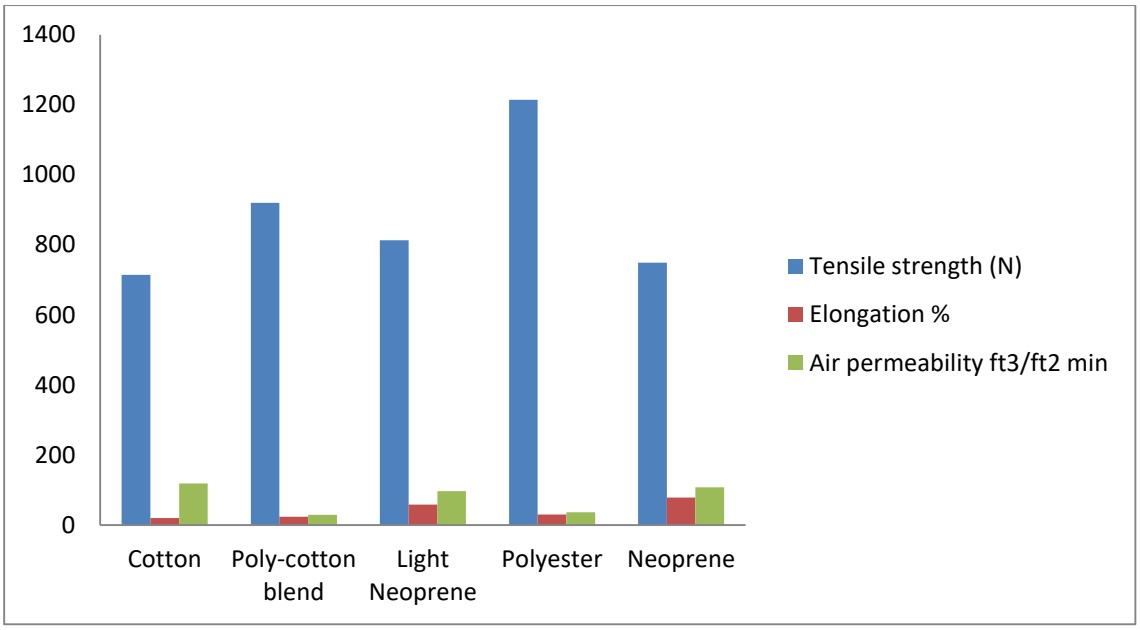

Figure 1. Tensile Strength, Elongation and Air permeability of different types of fabrics

RESULTS AND DISCUSSION

Socio-demographic

Table 1: Socio-demographic of the respondents

Gender	Frequency	Percentage
Male	270	55.1
Female	220	44.9
Ages (years)		
18 – 25	392	80
26 – 35	65	13.3
36 & above	33	6.7

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As shown in Table 1, there are more males 55.1% than females who are 44.1%. The age distribution indicates that, most of the respondents (45.9%) fell within the age range of 18 to 25years while 13.3% of the respondents fell within the age range of 26 - 35years and 6.7% fall above 36 years. All the respondents were either students or staff of Federal University, Gashua, Yobe State.

Breathability and Comfortability

Table 2, Breathability and Comfortability of different types of fabrics

Variables	Fabrics Types					
	Cotton	Poly-cotton blend	Light neoprene	Polyester	Neoprene	Total
Do you have trouble breathing? %	09	12	18	27	24	100
Ear loops hurts my ear %	21	18	20	19	22	100
Can easily wash my face mask (%)	26	25	21	18	12	100
When I wear face mask, my glass fog (%)	10	16	23	31	20	100
The face mask fits well on wearing (%)	20	25	20	15	20	100

In table 2, section B, 27% of the respondents had difficulty breathing, followed by Neoprene 24%, while cotton fabrics had the lowest of 9%. This implies that 91% of the respondents enjoy good breathability while using a cotton face mask. Gbagede R.S et.al asserted that fabric to be considered as appropriate for the production of cloth face masks, it must be breathable, which means air permeable, comfortable in terms of feel and smell and, above all, the fabric must have the capability to protect the wearer from infestation. Cotton is one of the most common fabrics for masks. It's also commonly available and inexpensive, making it an ideal choice for masks made by hand or by small businesses.

All the respondents agreed with the fact that the entire face mask can easily be washed, cotton, poly cotton blends and light neoprene have 26, 25 and 21% respectively, while Neoprene has the lowest ease of wash of 12%.

All the respondents were indifferent as to having problems with the face mask ear loop, irrespective of the face mask, the same type of loop was used. Hence, not much difference in their reaction, the highest being Neoprene with 22% while poly-cotton blends is lowest with 18%.

However, the way the face masks were made, it extends over the nose and mouth so as to reduce the fog builds up on glasses and sunglasses. However, fog still builds up in some of the respondents that use glasses. The fog may be as a result of the fabric and air permeability. Polyester fabrics have 31%, followed by light Neoprene at 22% and the least is cotton which is 10%. All the respondents agree that the face mask fits well on wearing. However, poly cotton blends have the

highest percentage of 25, while cotton, Neoprene and light Neoprene have the same percentage of 20, the least is polyester with 15%.

CONCLUSION

The study shows that different fabrics can be used to produce face masks and each had its own peculiar characteristic. The cotton face mask has the best characteristics in terms of ease of breathing, can easily be washed and does not fog on the glass of the wearer. Poly-cotton blend face masks follow cotton in all the three characteristics stated above and it is adjudged to be the best in fitness for wearing. Polyester face masks produce the worst result in breathability and fog production in the glasses. Light Neoprene and Neoprene have average results of all the variables tested. This means that low-coverage cloth face masks made of 100% cotton and other textile materials provide moderate protection against-covid 19 and other air-transmitted diseases, especially in the student hall of residence where live and sleep very close to one another. The comfortability of the face mask, especially breathability, is one of the reasons why students find it difficult to use the face mask. A 100% cotton face mask produces the best results.

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