



Relationship of bizygomatic and bigonial breadth with the suitability of surgical masks

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ABSTRACT

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Use of masks is mandatory to prevent the transmission of COVID-19. Appropriate masks that match the face size is very important to avoid leakage. This study aimed to evaluate the relationship between bizygomatic and bigonial breadth with the suitability of surgical masks. It was an analytic observational study with a cross-sectional design conducted at the Occupational Medicine Laboratory, Faculty of Medicine, Universitas Trisakti, Jakarta during March to April 2021. A total 132 employees of Faculty of Medicine, Universitas Trisakti aged from 20 to 64 y.o. who meet the inclusion and exclusion criteria participated in this study. No significantly difference in age ($p=0.248$) and body mass index (BMI) ($p=0.226$) was observed. However, there was a significantly difference in bizygomatic width ($p=0.000$) and bigonial width ($p=0.001$) between men and women. The use of appropriate surgical masks was observed in 89 respondents, but not suitable for 43 respondents. There was no significantly difference between BMI, bizygomatic width and bigonial width with the suitability of surgical masks. However, old age was significantly more appropriate for using surgical masks than young people. In conclusion, BMI, bizygomatic width, and bigonial width are not substantially different with the suitability of surgical masks. However, older age is more suitable for employing surgical masks than younger age.

ABSTRAK

Penggunaan masker diwajibkan untuk mencegah penularan COVID-19. Penggunaan masker yang sesuai dengan ukuran wajah sangat penting agar tidak terjadi kebocoran. Penelitian ini bertujuan untuk mengetahui hubungan antara lebar bizygomatic dan bigonial dengan kesesuaian masker bedah. Ini adalah penelitian observasional analitik dengan dengan rancangan potong lintang dilakukan di Laboratorium Kedokteran Kerja, Fakultas Kedokteran, Universitas Trisakti, Jakarta selama Maret sampai April 2021. Total sebanyak 132 pekerja di Fakultas Kedokteran Trisakti berumur 20 sampai 64 tahun yang memenuhi kriteria inklusi dan eksklusi berpartisipasi dalam penelitian. Tidak dijumpai perbedaan nyata pada umur ($p=0.248$) dan indeks masa tubuh (IMT) ($p=0.226$). Namun demikian, terdapat perbedaan nyata pada lebar bizygomatik ($p=0.000$) dan bigonial ($p=0.001$) antara pria dan wanita. Pemakaian masker bedah yang sesuai dijumpai pada 89 pekerja dan yang tidak sesuai pada 43 pekerja. Tidak ada perbedaan bermakna antara IMT, lebar bizygomatik, dan bigonial dengan kesesuaian masker bedah. Namun, usia tua secara bermakna lebih sesuai dalam penggunaan masker bedah dibandingkan usia muda. Dapat disimpulkan IMT, lebar bizygomatik, dan lebar bigonial tidak berbeda secara substansial dengan kesesuaian masker bedah. Namun, usia yang lebih tua secara lebih cocok menggunakan masker bedah dibandingkan usia yang lebih muda.

Keywords:
bizygomatic breadth;
bigonial breadth;
surgical mask;
suitability;
age

INTRODUCTION

Sars-CoV-2 is a new coronavirus strain that is responsible for the respiratory illness named corona virus disease 2019 (COVID-19).¹ This disease is very contagious and caused mortality in more than 2.9 million people worldwide.² The transmission of COVID-19 is primarily through the respiratory droplet. Therefore, wearing face masks during the COVID-19 pandemic is mandatory in some countries.¹ The widespread use of face masks in the community has successfully prevented the spread of Sars-CoV-2 and reduced the incidence of COVID-19.³ However, wearing face masks could become useless if they are not worn properly and the materials are not suitable to prevent droplets.⁴

One of the recommended face masks for daily use in this situation is surgical masks. According to the American Industrial Hygiene Association (AIHA), a surgical mask is an infection control device designed to prevent the spread of infection from the wearer's exhaled breath to potentially susceptible individuals. It provides a barrier to reduce environmental contamination from materials exhaled by the wearer.⁵ Milton *et al.*,⁶ proved that surgical masks could reduce the amount of virus on fine particles (< 5mm): OR 2.8 (95% CI 1.5 - 5.2) and on coarse particles (> 5mm): OR 25 (95% CI 3.5 to 180). Overall, the masks can provide 3.4 fold reduction in viral aerosol release (95% CI 1.8 to 6.3).⁶

Two factors that play an essential role in determining the function of a mask. The first one is the efficiency of the filter material, which depends on the particle size, and the second one is the suitability of the mask. Therefore the ineffectiveness of face masks can be influenced by a person's face or facial anthropometry.⁷ In this study, two measurements of face anthropometry were carried out i.e. bizygomatic breadth and bigonial breadth. The bizygomatic

breadth was obtained by measuring the distance between the most prominent structure of left and right zygomatic bones. The bigonial breadth is the straight distance between the most lateral points of the two mandibular angles.^{8,9} There are other face dimensions, but we choose these two dimensions because the two face dimensions show the length of the face and it should be covered when one is wearing a mask. Facial anthropometry not only being influenced by race, but also by age and gender. Omotoso *et al.*,¹⁰ study proved a significant difference in all facial anthropometric measurements except facial width between men and women in the age group of 16-20 yr. The results in the higher age group also got similar results. For age, there was an average increase in all facial sizes and an increase in the age group.

A study examining the connection between the bizygomatic and bigonial breadth and the appropriateness of the surgical mask has not yet been conducted. The aim of this study was to compare the bizygomatic and bigonial breadth and the suitability of the surgical mask. The surgical mask was chosen because they are commonly used. The results of this study are expected to determine the size of surgical masks suitable for Indonesian facial anthropometry so that they can effectively minimize the spread of COVID-19 or other droplet transmission diseases.

MATERIALS AND METHODS

It was an analytic observational study with a cross-sectional design conducted at the Occupational Medicine Laboratory, Faculty of Medicine, Universitas Trisakti, Jakarta during March to April 2021. A total 132 employees of Faculty of Medicine, Universitas Trisakti aged from 20 to 64 y.o. who meet the inclusion and exclusion criteria participated in this study. Subjects with a history of facial trauma, facial aesthetic surgery, facial

reconstruction and orthognathic surgery as well as orthodontic treatment were excluded in this study.

Measurements

Demographic data, including age and gender, were obtained through interviews. The age of the subjects was life span as measured by the year listed on the identity card. Gender was male or female written on the identity card. Body mass index (BMI) was calculated by dividing a person's weight in kg by their height in square m. Body height was measured using a height measuring device (microtoise).

Bizygomatic and bigonial breadth measurement

Bizygomatic and bigonial breadth measurements were carried out using the Martin GPM Anthropometer Kit.

The measurement was conducted under strict health protocols where researchers wore complete personal protective equipment (PPE). Measurements were made using a small spreading caliper (FIGURE 1A) and following the method developed by Farkas (1994).⁹ Subjects were in a sitting position, relaxed, with the head in the correct anatomic position (neutral head position). Bizygomaticum breadth measurement was carried out first by determining the most lateral point of the left and right zygomaticum bones and then measuring the distance between those two points. Bigonial breadth measurements were performed by determining the mandibles's left and right most lateral angles and then measuring the distance between those two points (FIGURE 1B). The measurements were made twice by two different researchers and the mean value was taken for further analysis.⁹

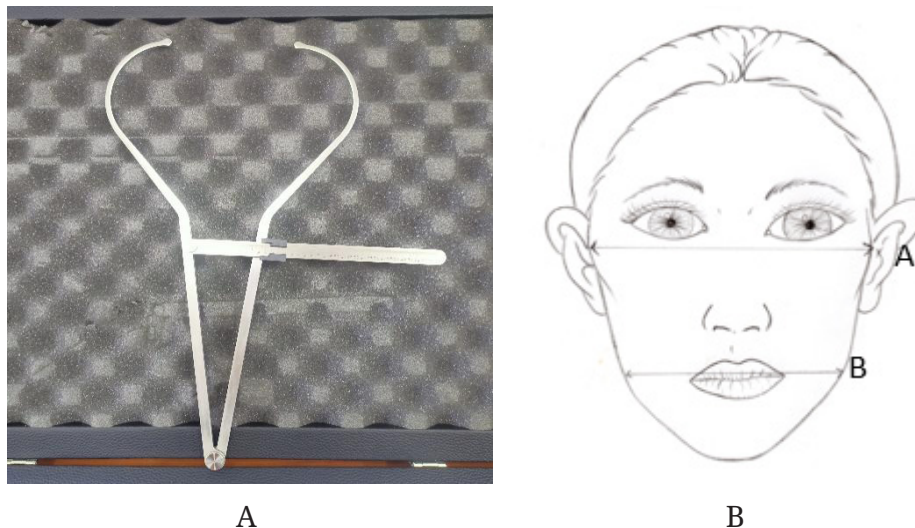


FIGURE 1. A) Small spreading caliper (personal property). B) A is bizygomaticum breadth, B is bigonial breadth.⁹

Surgical mask suitability test

The surgical mask suitability test was performed using 3M Qualitative Fit Test Apparatus FT -30 (FIGURE 2A). A head loop surgical mask was provided, and the individual was instructed to

wear it. (FIGURE 2B), and then they had to wear a unique head covering. The fit test was carried out by spraying a special liquid with the tip of the spray located approximately 5 cm in front of the mask at a position of 40° downward. After the first spraying, if the subject could feel a

sensation on the tongue and/or throat, the results were non-fit/not passed. If the subject doubted the sensation, the spraying could be repeated up to three times. If it was confirmed that there was

no sensation at all, then the examination results was fit/passed and it's called suitability. The masks used were Sensi® three layers surgical masks sized 90 x 175 cm.



A



B

FIGURE 2. A) Subject was tested with 3M Qualitative Fit Test Apparatus FT-30 (personal property), B) Surgical mask (personal property)

Statistical analysis

Data analysis in this study was carried out using the Statistical Package for Social Sciences (SPSS) program version 20.0. Normal distribution was determined by the Kolmogorov Smirnov test. Some variables such as body mass index (BMI), bizygomatic and bigonial breadth had normal distributions, while the age variable was not. For the comparison test, variables with normal distribution were analyzed with t test and the age variable was analyzed with Mann-Whitney as not-normal distribution data.

Ethical clearance

This study has been approved by the Health Research Ethics Committee, Faculty of Medicine, Universitas Trisakti

(Number 168/KER/FK/XII/2020).

RESULTS

Characteristics of subjects

This study was carried out at the Faculty of Medicine, Universitas Trisakti, Jakarta from March to April 2021 involving 132 subjects. Fifty eight of them were male, and 74 were female. No significant difference in age and BMI between male and female ($p > 0.05$). However, the bizygomatic and bigonial breadth of males were significantly wider than females ($p < 0.005$). The male bizygomaticum was about 0.6 cm wider than that of the female ($p = 0.000$). Likewise, the bigonial breadth was wider in males than females, about 0.5 cm ($p = 0.001$) (TABLE 1).

TABLE 1. Characteristics of subjects [(mean ± SD or median (range))]

Variables	Men (n =58)	Women (n =74)	p
Age (year)	41.50 (18-64) [#]	40 (20-56) [#]	0.248 ¹
Body mass index	25.43 (15.97-42.96) [#]	26.07 (17.97-37.70) [#]	0.226 ¹
Bizygomaticum breadth (cm)	13.12 ±0.85 (11.3-15.6)	12.51 ± 0.72 (11.0 – 14.2)	0.000 ^{2*}
Bigonial breadth (cm)	11.73 ± 0.94 (9.35-14.95)	11.23 ± 0.73 (9.15-13.90)	0.001 ^{2*}

Note: [#]median (range); ¹Mann Whitney test; ²t test; p significant if < 0.05

Comparison age, BMI, bizygomatic breadth, bigonial breadth, and suitability of surgical masks

The surgical mask compatibility test was passed by 89 participants, while 43 were deemed to have failed it. A

significant difference between suitability and inappropriateness of surgical masks based on age was observed (p=0.026). However, there were no significant difference based on BMI, bizygomaticum breadth, and bigonial breadth (p> 0.05) (TABLE 2).

TABLE 2. Comparison between age, body mass index, bizygomatic breadth, bigonial breadth [mean ± SD or media (range)] and suitability of surgical masks.

Variables	Men (n =58)	Women (n =74)	p
Age (year)	43.00 (18-64) [#]	34 (20-54) [#]	0.026 ^{1*}
Body Mass Index	25.40 (15.97-37.70) [#]	26.12 (18.74-42.96) [#]	0.263 ¹
Bizygomaticum breadth (cm)	12.74 ±0.82 (11.1-14.8)	12.88 ± 0.85 (11.0-15.6)	0.381 ²
Bigonial breadth (cm)	11.30 (9.15-13.90) [#]	11.60 (10.3-14.95) [#]	0.412 ²

Note: [#]median (range); ¹Mann Whitney test; ²t test; p significant if < 0.05

DISCUSSION

Characteristics of subjects

The results showed a significant difference between males and females in bizygomaticum and bigonial breadth. In this study, both dimensions were wider in males than in females. Lin & Chen also reported the same result where the average of bizygomatic breadth in males (128.2±6.6 cm) was wider than in females (122.7±7.0 cm) as well as bigonial breadth (males 114.0±8.8 cm vs females 105.5±7.9 cm).¹¹ The same results were also proved by Vinay *et al.*,⁸ their study showed that the average of bigonial breadth in males was 9.45±0.53 cm, which was wider than in females (8.74±0.53 cm). Abitha *et al.*¹²

found that the average of bizygomatic measurement in men was significantly wider (10.63±0.78 cm) compared to women (10.37±0.73 cm).

Comparison age, BMI, bizygomatic breadth, bigonial breadth, and suitability of surgical masks

The results of this study showed no relationship between the size of the bizygomaticum and bigonial breadth and the compatibility of the surgical mask, indicating that staff of Faculty of Medicine, Universitas Trisakti could generally use surgical masks without being affected by the width of the bizygomatic and bigonial. Likewise, the BMI did not affect the suitability of the

surgical mask. This could be because the surgical mask is large enough to encompass the face and prevent exhalation leaks.

In comparison to younger subjects, older subjects demonstrated greater surgical mask suitability, suggesting that older individuals are more likely to wear masks correctly and consistently due to their greater awareness of the fact that they face a greater risk of morbidity and mortality from COVID-19 diseases. Education and information about the importance and proper way to wear masks during the COVID-19 pandemic are highly needed these days. Public health education plays a role in effective-hygiene behavioral changes.¹³ A surgical mask can effectively reduce droplet transmission up to 80%.¹⁴ Droplets are respiratory particles with a diameter greater than 5 µm and can disperse around 1 m (close contact) to a maximum of 6 feet (1.83 m) in the air before falling.^{15,16} However, in order to minimize the transmission of COVID-19, apart from wearing surgical masks, it is necessary to maintain distance and wear effective eye protectors to protect against respiratory tract diseases that are transmitted by droplets.^{16,17}

There has never been any research about the relationship between bizygomatic and bigonial breadth and surgical mask suitability. However, a study about respiratory masks found that more subjects with significantly larger facial width, bigonial breadth, and facial length passed the respirator fit test than those who failed the fit test when using cup-shaped respirators.¹⁸ This study with a surgical mask showed no difference between subjects with wider faces and subject with narrower faces. This is because the size of the surgical mask is wider, so it can adequately cover the nose and mouth, both in narrow and wide faces. These results are important for the user of surgical mask, so they don't have to worry about

the leakage when they wear the surgical mask. The limitation of this study is that the bizygomatic and bigonial breadth measurements were not carried out by three-dimensional measurements so that accurate measurement may not be obtained.

CONCLUSION

This study proves that there is no relationship between bizygomatic and bigonial size and the suitability of the mask, but there is a relationship between age and the suitability of the mask. Thus, it can be said that currently the surgical masks available on the market still match the face sizes of employees of Faculty of Medicine, Universitas Trisakti, Jakarta.

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REFERENCES

1. UNICEF. Frequently Asked Questions about coronavirus disease (COVID-19). UNICEF Indonesia. 2020:1-12.
2. Cascella M, Rajnik M, Aleem A, Dulebohn S, Di Napoli R. Features, evaluation, and treatment of coronavirus (COVID-19). In: StatPearls [internet]. Treasure Island (FL): StatPearls Publishing; 2023.
3. Brienens NCJ, Timen A, Wallinga J, Van Steenbergen JE, Teunis PFM. The effect of mask use on the spread of influenza during a pandemic. *Risk Anal* 2010; 30(8):1210-8. <https://doi.org/10.1111/j.1539-6924.2010.01428.x>
4. Aiello AE, Murray GF, Perez V, Coulborn RM, Davis BM, Uddin M, *et al.* Mask use, hand hygiene, and seasonal influenza-like illness

- among young adults: a randomized intervention trial. *J Infect Dis* 2010; 201(4):491-8.
<https://doi.org/10.1086/650396>
5. Colton CE, Townsend MC. Respirators and surgical masks-exploring the differences. *Workplace Health Saf* 2013; 61(3):99-101.
<https://doi.org/10.1177/216507-991306100302>
 6. Milton DK, Fabian MP, Cowling BJ, Grantham ML, McDevitt JJ. Influenza virus aerosols in human exhaled breath: particle size, culturability, and effect of surgical masks. *PLoS Pathog* 2013; 9(3):e1003205.
<https://doi.org/10.1371/journal.ppat.1003205>
 7. Cappa CD, Asadi S, Barreda S, Wexler AS, Bouvier NM, Ristenpart WD. Expiratory aerosol particle escape from surgical masks due to imperfect sealing. *Sci Rep* 2021; 11(1):12110.
<https://doi.org/10.1038/s41598-021-91487-7>
 8. Vinay G, Mangala Gowri SR, Anbalagan J. Sex determination of human mandible using metrical parameters. *J ClinDiagn Res* 2013; 7(12):2671-3.
<https://doi.org/10.7860/JCDR/2013/7621.3728>
 9. Gabarre J, Pastor JBN, Gabarre-Armengol C, Estaún-Ferrer S. Bizygomatic width and its association with social and personality traits in males. *Int J Morphol* 2017; 35(3):1037-42.
<https://doi.org/10.4067/S0717-95022017000300036>
 10. Omotoso D, Oludiran O, Sakpa CL. Nasofacial anthropometry of adult Bini tribe in Nigeria. *Afr J Biomed Res* 2011; 14(3):219-21.
 11. Lin YC, Chen CP. Characterization of small-to-medium head-and-face dimensions for developing respirator fit test panels and evaluating fit of filtering facepiece respirators with different face seal design. *PLoS One* 2017; 12(11):e0188638.
<https://doi.org/10.1371/journal.pone.0188638>
 12. Abitha T, Santhanam A. Correlation between bizygomatic and maxillary central incisor width for gender identification. *Braz Dent Sci* 2019; 22(4):458-66.
<https://doi.org/10.14295/bds.2019.v22i4.1775>
 13. Tso RV, Cowling BJ. Importance of Face Masks for COVID-19: A call for effective public education. *Clin Infect Dis* 2020; 71(16):2195-8.
<https://doi.org/10.1093/cid/ciaa593>
 14. MacIntyre CR, Chughtai AA. Facemasks for the prevention of infection in healthcare and community settings. *BMJ* 2015; 350:h694.
<https://doi.org/10.1136/bmj.h694>
 15. Zhou J, Wei J, Choy KT, Sia SF, Rowlands DK, Yu D, et al. Defining the sizes of airborne particles that mediate influenza transmission in ferrets. *Proc Natl Acad Sci* 2018; 115(10):E2386-E92.
<https://doi.org/10.1073/pnas.1716771115>
 16. WHO. Advice on the use of masks in the context of COVID-19: interim guidance, 5 June 2020. World Health Organization; 2020.
 17. Azap A, Erdiñç FŞ. Medical mask or N95 respirator: When and how to use? *Turk J Med Sci* 2020; 50(SI-1):633-7.
<https://doi.org/10.3906/sag-2004-199>
 18. Cheng WJ, Yu YY, Yu D, Ping J, Chen WH. The relationship between fit characteristics of two kinds of self-inhalation air-purifying dust respirators and head-face dimensions of subjects. *Zhonghua Lao Dong Wei Sheng Zhi Ye Bing Za Zhi* 2012; 30(5):352-5.