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The facial measurements in health workers at Dr. Sardjito General Hospital, Yogyakarta

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ABSTRACT

The appropriate mask is based on facial anthropometric measurements that may be affected by sex, race, age, and body mass index (BMI). This study aimed to determine the difference and relationship between the bizygomatic width (BW) and nasion-menton height (NMH) with sex and BMI in health workers. This descriptive-analytical study used a cross-sectional method. The subjects were 39 health workers (nurses and doctors) at Dr. Sardjito General Hospital, Yogyakarta consisting of 15 male subjects and 24 female subjects, aged between 25-55 years old. Anthropometric measurements were performed on the subjects, including body weight, height, NW, and NMH. The data were analyzed using the Shapiro-Wilk test, independent t-test, and Pearson's test. There was a significant difference in the BW between male and female subjects ($p<0.05$), with the males' BW (13.1 ± 0.76 cm) being larger than that of the female subjects (12.35 ± 0.62 cm). There were no differences in the BMI and nasion-menton height between the male and female subjects ($p>0.05$). The Pearson's test results showed no significant relationship between the BW with BMI in both the male subjects ($r=0.351$; $p=0.199$) and the female subjects ($r=0.349$; $p=0.094$), and between the nasion-menton height with BMI in both the male subjects ($r=0.101$; $p=0.721$) and the female subjects ($r=0.390$, $p=0.060$). In conclusion, the males' BW was larger than the female health workers. It is necessary to consider facial anthropometric measurements in face mask manufacturing to provide comfort and good protection.

ABSTRACT

Kesesuaian penggunaan masker didasari oleh adanya variasi ukuran antropometri wajah yang dapat dipengaruhi oleh jenis kelamin, ras, usia, dan indeks massa tubuh (IMT). Tujuan penelitian ini untuk mengetahui perbedaan dan hubungan antara ukuran lebar bizigomatik dan panjang menton-nasion dengan jenis kelamin dan IMT pada tenaga kesehatan. Penelitian ini merupakan penelitian deskriptif analitik dengan metode potong lintang. Subjek adalah 39 orang tenaga kesehatan (perawat dan dokter) di RSUP Dr. Sardjito, Yogyakarta yang terdiri dari 15 laki-laki dan 24 perempuan, berusia antara 25-55 tahun. Pada subjek dilakukan pengukuran antropometri meliputi berat tubuh, tinggi tubuh, lebar bizigomatik, dan panjang nasion-menton. Data dianalisis menggunakan uji Shapiro Wilk, uji t independen, dan uji Pearson. Terdapat perbedaan nyata pada lebar bizigomatik laki-laki dan perempuan ($p<0,05$), dengan lebar bizigomatik laki-laki (13,1 ± 0,76 cm) lebih besar dibanding perempuan (12,35 ± 0,62 cm). Tidak terdapat perbedaan antara IMT dan panjang menton-nasion pada laki-laki dan perempuan ($p>0,05$). Hasil uji Pearson menunjukkan tidak ada hubungan yang signifikan antara ukuran lebar bizigomatik dengan IMT pada laki-laki ($r=0,351$; $p=0,199$) dan perempuan ($r=0,349$; $p=0,094$), serta antara panjang menton-nasion dengan IMT pada laki-laki ($r=0,101$; $p=0,721$) dan perempuan ($r=0,390$, $p=0,060$). Dapat disimpulkan bahwa lebar bizygomatic tenaga kesehatan laki-laki lebih besar dibanding lebar bizygomatic tenaga kesehatan perempuan. Ukuran-ukuran antropometri wajah perlu diperhatikan dalam pembuatan masker supaya nyaman digunakan dan dapat memberikan perlindungan yang baik.

Keywords:
anthropometry;
bizygomatic width;
body mass index;
health workers;
nasion-menton height

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INTRODUCTION

Coronavirus Disease 2019 (COVID-19) is an infectious disease that is caused by a new variant of coronavirus, i.e., Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2). Health workers as the frontline of COVID-19 are at a higher risk from SARS-CoV-2.[1] One of the efforts to protect and minimize the risks for health workers from COVID-19 is to wear personal protective equipment such as an N95 mask. Nevertheless, prolonged use of the N95 mask may cause discomfort due to mask pressure in the face, difficult movement of facial muscles, and itching.[2] Besides, a mask size problem may also lead to a mask leak.[3] On the other hand, a mask size that fits facial characteristics can provide good protection.[4] Differences in the mask fit are based on different facial anthropometric measurements that may be affected by sex, race, age, and body mass index (BMI).[5,6]

Anthropometry is the measurements of the body dimensions or other physical characteristics of the body that are useful in designing objects that a person wears.[7] Facial anthropometric measurements can be useful in mask manufacturing. There are 12 facial dimensions that are related to the performance of a respirator, including bi-ectoorbital width, bizygomatic width, bigonial width, nasion-menton height, menton-subnasal height, subnasal-nasion height, biocular width, nasal root width, nasal width, lip width, bitragion-menton arc, and bitragion-subnasal arc.[8] Research results showed that bi-ectoorbital width, bizygomatic width, bigonial width, nasion-menton height, lip width, and bitragion-menton arc are good predictors for a respirator mask fit because, based on a mask fit testing, these facial anthropometric measurements affect a respirator leak in the nose, cheeks, and chin.[3,8]

A face shape depends on the structure of hard tissues (bone) and soft tissues. Facial soft tissue thickness is affected by gender, age, race, and nutritional status.[9] The BMI is an important factor that contributes to accurately determining the differences in facial soft tissue thickness among individuals.[10]

Bizygomatic width and nasion-menton height were selected as the dependent variables because some previous studies showed that bizygomatic width and nasion-menton height were good predictors for a respirator fit and there was a significant difference in the bizygomatic width and nasion-menton height of males and females.[8,11]

Based on the above-mentioned description, this study was conducted to determine the differences and relationship between facial anthropometric measurements, i.e., the bizygomatic width and nasion-menton height with sex and BMI. Health workers at Dr. Sardjito General Hospital, Yogyakarta were chosen as the research subject because it is one of the referral hospitals for handling patients with COVID-19 in the Special Region of Yogyakarta. Therefore, the facial anthropometric measurements obtained in this study expectedly can be useful for developing an N95 mask that can provide both comfort and good protection for health workers.

MATERIALS AND METHODS

Subjects

This descriptive-analytical study used a cross-sectional method. The data were the facial anthropometric measurements of the health workers at Dr. Sardjito General Hospital, Yogyakarta in October-November 2021. A total of 39 subjects (15 males and 24 females) included nurses and doctors at Dr. Sardjito General Hospital, Yogyakarta who were between 25-55 years old.

Protocols of study

The inclusion criteria for this study were: having no facial trauma, having no facial surgery, and having willingness to participate in the study. The exclusion criteria for this study were: having a head and facial fracture, having congenital bone diseases, and having a history of vertebral, pelvic, or lower limb fractures. The instruments used were a sliding caliper to measure facial anthropometry, an anthropometer to measure body height, and a body weight scale. Before the measurements were conducted, all the subjects had signed an informed consent form. BMI was determined by the formula of body weight divided by height squared (kg/m^2), with the categories according to WHO.[12] This research was approved by the Medical and Health Research Ethics Committee of the Faculty of Medicine, Public Health, and Nursing, Universitas Gadjah Mada, Yogyakarta, Indonesia with the approval number KE-FK-1388-EC-2021.

Statistical analysis

The normality of the data was tested using the Shapiro-Wilk method. The hypothesis was tested using the independent t-test to see any differences between the male and female subjects. The Pearson correlation test was used to determine the relationship between gender and with bizygomatic width (BW) and nasion-menton height (NMH).

RESULTS

The frequency distribution of the research subject characteristics based on sex, age, and profession are presented in TABLE 1, whereas the frequency distribution of the research subject characteristics based on BMI categories are presented in TABLE 2. Most of the subjects (16 people or 41%) were categorized as slightly overweight.

TABLE 1. Characteristics of gender, age, and profession in subjects

Characteristics	n (%)
Gender	
• Male	15 (38.5)
• Female	24 (61.5)
Age (years)	
• 25-29	6 (15.4)
• 30-39	20 (51.3)
• 40-49	8 (20.5)
• 50-55	5 (12.8)
Profession	
• Doctor	13 (33.3)
• Nurse	26 (66.7)

TABLE 2. Frequency distribution of BMI category in subjects

Gender	Normal n (%)	Overweight n (%)	Obesity I n (%)	Obesity II n (%)
Male	2 (5.1)	3 (7.7)	9 (23.1)	1 (2.6)
Female	6 (15.4)	4 (10.3)	7 (17.9)	7 (17.9)
Total	8 (20.5)	7 (17.9)	16 (41.0)	8 (20.5)

Based on the normality test using the Shapiro-Wilk method, the data were normally distributed. The results of the independent t-test (TABLE 3) show that there was a significant difference in the BW between the male and female subjects ($p<0.05$), with the BW of the male subjects being greater than that of the female subjects. There was no significant difference in the NMHt and BMI between the male and female groups. The results of the Pearson's correlation test (TABLE 4) show that there was no significant relationship between the BW and the NMH with BMI in both the male and female subjects.

TABLE 3. Mean ± SD of BMI), BW and NMH in subjects

Variables	Male (n=15)	Female (n=24)	Total (n=39)	Independent t-test	
				t	p
BMI (kg/m²)	25.98 ± 2.90	26.51 ± 4.40	26.31 ± 3.86	-0.455	0.652
BW (cm)	13.1 ± 0.76	12.35 ± 0.62	12.64 ± 0.76	3.348	0.002*
NMH (cm)	11.45 ± 0.54	11.11 ± 0.53	11.24 ± 0.55	1.925	0.062

BMI: body mass index; BW: bizygomatic width; NMH: nasion - menton height; *p <0.05; the data are partly taken from Aliya.[13]

TABLE 4. The correlation coefficient of BW and NMH with BMI in subjects (Pearson's correlation test)

Variable	BMI					
	Male		Female		Total	
	r	p	r	p	r	p
BW	0.351	0.199	0.349	0.094	0.261	0.109
NMH	0.101	0.721	0.390	0.060	0.265	0.103

BMI: body mass index; BW: bizygomatic width; NMH: nasion - menton height; *p <0.05; the data are partly taken from Aliya.[13]

DISCUSSION

The prevalence of overweight (BMI ≥25 kg/m²) in this study was 61.5%, with the prevalence of overweight in the female subjects (35.8%) being higher than in the male subjects (25.7%). Based on the Basic Health Research in 2018, the prevalence of overweight (BMI ≥25 kg/m²) in the population aged >18 years old in Indonesia was 26.6% for men and 44.4% for women.[14] Compared to a study by Kunyahamu *et al.*[15] few reports are available on Malaysian health-care workers' obesity and whether different health-care job categories are related to workers' obesity. This study aimed to determine the prevalence of obesity among HCWs and the association between various HCW job categories and obesity. A cross-sectional study was conducted by analyzing secondary data from the 2019 annual cardiovascular health screening program, which included information regarding all government health-care workers in the east coast region of Peninsular Malaysia. The subject's body mass index (BMIconducted on health workers in Malaysia, 33.1% of the study subjects had a BMI of 25-29.9 kg/m^2 and at a high risk of being overweight. This difference might be due to various factors related to the shift-working conditions that nurses have to undergo that disrupt sleep patterns, dietary patterns, and physical activity.[15]

A study by Adaja and Idemudia[16] conducted on the health workers in Nigeria revealed that based on the classification as set by the World Health Organization,[17] 31.7% of the health workers were overweight (BMI 25–29.9 kg/m^2) and 25.5% were obese (BMI ≥30 kg/m^2), in which the overweight and obese categories were more common in female health workers.[16] Other studies also mentioned that the higher prevalence of overweight and obesity in female health workers is because female health workers perform fewer physical activities than male health workers.[18,19] A high energy intake with minimum physical activity could increase the risk of being obese among health workers.[20] A study by Kit in 2019 revealed that 45.6% of health workers were categorized as physically inactive and had a sedentary lifestyle with a mean daily duration of 5 hours. In addition, vitamin E and zinc deficiency, less than 7-hour sleep duration, and non-smokers are significantly associated with a high body fat percentage.[21]

Based on the result of this study, there was no significant difference in the mean BMI of the male subjects (25.98 ± 2.90 kg/m^2) and the female subjects (26.51 ± 4.40 kg/m^2). This result is in line with a study by Asil *et al.,*[22] showing that there was no difference in the mean BMI based on gender, but there was a significant difference in the mean BMI based on age, education level, marital status, parity, smoking status, and sleep duration. However, these results are different from a study by Xiao *et al.*,[23] showing a significant difference in the mean BMI of the male subjects (21.74 ± 1.74 kg/m^2) and the female subjects (24.39 ± 3.54 kg/m^2).

In fact, muscular people or athletes may have a high BMI due to the volume of muscle mass; women have a higher fat percentage than men; older adults have a higher body fat than young adults.[24] Decreased physical activity, slowing metabolism due to old age, menopause and physiological changes in women can increase body weight.[25] A pregnancy or weight gain due to pregnancy can trigger obesity; even in women with a poor dietary pattern, the BMI can also increase after childbirth.[26,27] The basal metabolic rate of women is 10% smaller than men. Thus, women are likely to turn food into fat, while men are more likely to turn food into muscle and energy reserves. In addition, women have fewer muscles than men. Meanwhile, muscle cells are able to burn more fat than other cells.[28]

In addition, the education level of an individual affects the dietary pattern, where the higher the education level, the lower the BMI. Marriage, divorce, or a loss of a spouse also affects body weight. Unmarried individuals are likely to have a lower BMI than those who are married or have lost a spouse.[22] Smokers have a lower BMI than non-smokers.[22] Smoking can help weight loss by increasing the metabolism rate and suppressing appetite.[29] However, it is necessary to analyze the effect of genetic and environmental factors on obesity to reveal more details about the factors that affect BMI in individuals.[22] But, these factors were not examined in this study.

Sex influences the facial profile because the soft tissues that cover the hard tissues in men are thicker than those in women. In addition, the chin growth in men forms a greater jaw angle than in women, causing women in general to have a more convex facial profile than men.[30] Regarding the facial anthropometric measurements, the results of the study showed that the bizygomatic width of the male group (13.1 ± 0.76 cm) was larger and significantly different than the female subjects (12.35

± 0.62 cm). This result is consistent with some previous studies,[8,11,31] showing that the average BW of males is greater than in females, but the zygomatic bone of females is more prominent than that of males. In addition, there was no significant difference in the NMH of the male subjects (11.45 ± 0.54 cm) and female subjects (11.11 ± 0.53 cm). This is different from some studies,[8,32,33] showing that the average NMH in male subjects is significantly higher than that in female subjects. Various factors cause differences in facial dimensions, including genetics and race. In addition, the hormone testosterone in men can increase the size and mass of muscles and bones, leading to differences in the facial shape between men and women.[33] A higher testosterone to estradiol ratio (T/E ratio) in men is related to the size of the cheekbones, mandible, chin, and face height. Testosterone can affect on facial development through an increased level of growth hormone (GH) which plays an important role in regulating growth, body development, and body composition.[34] A study conducted in Korea showed that there was a significant difference between 11 facial dimensions of men and women, two of which were the BW and NMH.[8] Women have smaller facial dimensions than men, particularly in terms of the bigonial width, BW, and facial height.[11]

The results of the Pearson's test showed no significant relationship between the BM with BMI in both the male ($r=0.351$; $p=0.199$) and the female subjects ($r=0.349$; $p=0.094$), and no significant relationship between the NMH with BMI in the male subjects ($r=0.101$; $p=0.721$) and female group ($r=0.390$, $p=0.060$). The insignificant result obtained in this study might be due to the uneven distribution of the BMI categories. In this study, there were 31 subjects (79.4%) who were in the overweight and obese categories, and only 8 subjects (20.5%) in the normal category. The results of this study are different from some previous studies, such as a study by Nádaždyová *et al.*[10] showing that the group with BMI >25.0 kg/m^2 had a larger nasal width, BW, total facial height, mouth width, and morphological facial height compared to the group with BMI of 18.6–24.9 kg/m^2. Facial soft tissues fluctuate according to the nutritional status of a person. The BMI is a key factor in accurately determining the difference in the facial soft tissue thickness among individuals.[35] Additionally, nutritional status also affects cheek width and the relative width of the lower face.[36]

According to a study by Windhager *et al.*,[37] body fat percentage leads to 8.7% variation in facial shape and it has a significant correlation with BMI. Facial width and height are significantly related to BMI, in which an increased BMI has more effect on facial width than on facial height. An increase in BMI leads to a relative widening of the midface and lower face. Someone with a lower body fat percentage tend to have angular face with relatively small cheeks, pointy chin, relatively big eyes, and a pointy nose.[36,37] According to a study by Dong *et al.*,[35] that was conducted using a 3D skull model in North China, the soft tissue thickness is increased along with an increasing BMI, in which the thickest soft tissues were found at landmarks in the cheeks for all the BMI categories in both men and women. Sex affects facial profiles because the soft tissues that cover the hard tissues in most areas of male face are thicker than in female faces.[30,38]

Based on the results of this study, the BW of the male group was greater the female subjects, therefore, it is necessary to consider different N95 mask sizes based on sex. Based on a study conducted by Solano *et al.*,[39] the standard N95 mask size recommended by the Centre for Disease Control and Prevention (CDC) is too big for women, causing a mask leak, especially in the chin. Therefore, women need smaller N95 mask size than men.

CONCLUSION

There is no correlation between the BW and NMH with sex and BMI. However, there are differences in BW between male and female health workers at Dr. Sardjito General Hospital, Yogyakarta. It is crucial to consider facial anthropometric measurements in mask manufacturing to manufacture masks that are both comfortable to wear and provide good protection.

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