



Somatotype and Ratio of Chest Circumference to Height in Asthma Patients and Its Relation to Asthma Control Level

Prima Aprilia Rosyadah¹, Selfi Handayani², Yunia Hastami², Dhoni Akbar Ghozali²

¹Faculty of Medicine, Universitas Sebelas Maret, Surakarta, Indonesia

²Department of Anatomy and Embryology, Faculty of Medicine, Universitas Sebelas Maret, Surakarta, Indonesia

Abstract

Background: Asthma control level is related to body composition. Somatotype is a body shape classification that is used to measure body composition indirectly using anthropometry. As far as we know, no studies are related to somatotype and asthma control levels. This study aims to describe the somatotype and the ratio of chest circumference to height and its relation to asthma control level.

Methods: This research is an observational study at Surakarta in September-December 2022. The subjects were 51 asthma patients under control and met the criteria. Measurement of somatotype and the ratio of chest circumference to height was carried out by anthropometric methods. The Asthma Control Test (ACT) questionnaire assessed the asthma control level. The collected data were analyzed using SPSS 26 software with Fisher's test and unpaired t-test.

Results: out of 51 asthmatic patients, 43 (84,3%) had endomorphic and 8 (15,7%) ectomorphic. Fisher's test showed no significant relationship between somatotype and asthma control level ($P=0.56$). Meanwhile, the mean ratio of chest circumference to height in controlled patients was 0.54, while those who were uncontrolled were 0.58. The results of the unpaired t-test showed that there was a significant difference between the ratio of chest circumference to height and asthma control level ($P=0.03$).

Conclusion: There is no significant relationship between somatotype and asthma control level, but there is a significant relationship between the ratio of chest circumference to height and the asthma control level.

Keywords: asthma, asthma control level, ratio of chest circumference to height, somatotype

Corresponding Author:

Prima Aprilia Rosyadah | Faculty of Medicine, Universitas Sebelas Maret, Surakarta, Indonesia | primaapriliar@student.uns.ac.id

Submitted: February 21st, 2023

Accepted: January 29th, 2025

Published: January 31st, 2025

J Respiri Indones. 2025

Vol. 45 No. 1: 38–46

<https://doi.org/10.36497/jri.v45i1.450>



[Creative Commons Attribution-ShareAlike 4.0 International License](#)

INTRODUCTION

Globally, the prevalence and cases of asthma deaths have increased in the last 30 years from 1990 to 2019. There were 262 million cases of asthma in 2019 with a death rate of 461 million. Middle-income countries tend to have a low prevalence of asthma but a high number of asthma deaths. This is because medical care for asthma patients was generally poor.¹ In Indonesia, the prevalence of asthma decreased by 2.1% in 2013–2018, but 57.5% of them suffered from uncontrolled asthma, which indicates a huge asthma burden.²

In Surakarta itself, there has been an increase in the prevalence of asthma from 5.8–7.8% in 2019–2020.³ Data on asthma control levels in Surakarta is limited, meanwhile, there has been a trend of increasing cases of asthma in Surakarta. So, it is important to know the asthma data especially the asthma control level to help reduce the burden of

asthma in Surakarta.

So far, asthma cannot be cured but can be controlled with appropriate and adequate treatment so that asthma symptoms can be reduced or lost. This can be assessed based on the level of asthma control.⁴ Asthma control level is influenced by several factors, such as obesity and lung function. Patients who are obese or overweight tend to have uncontrolled asthma.⁵

However, it turns out that uncontrolled asthma can also occur in asthma patients with a normal or underweight Body Mass Index (BMI).⁶ This is because the BMI cannot describe the distribution of fat-free mass and fat mass in the body. Lung function is related to body size (anthropometric), physical condition, and physical fitness which are affected by body composition.^{7,8} A cohort study in Germany stated that body composition is more related to the level of asthma control than BMI. Uncontrolled

asthma patients tend to have low muscle mass and high-fat mass.⁹

Somatotype is a classification of body shape based on the relative growth of one of the embryonic layers, which can describe body composition indirectly by anthropometric measurements and observing physical characteristics.^{10–12} Research by Cherkashina et al in Kukes et al shows that asthma tends to occur in women with thin, non-muscular, and non-fatty bodies, while in men with little body fat and moderate muscle.¹³ However, until now there has been no research that examines the relationship between somatotype and the level of asthma control.

Chest circumference is an anthropometric measurement dimension but is not included in the measurement to determine somatotype. Chest circumference is related to the Asthma Control Test (ACT) score, which can be used as a predictor of clinical control of asthma.¹⁴ This study aims to determine the description of the somatotype and the ratio of chest circumference to height in asthma patients and its relationship with the asthma control level.

METHODS

The type of research used is an analytical observation method with a cross-sectional design. The subject population in this study were asthma patients who came for routine control at the Surakarta pulmonary clinic in September-December 2022.

The samples were selected by a purposive sampling technique based on certain criteria.¹⁵ The inclusion criteria for this study were asthma patients ≥ 18 years with duration of being diagnosed with asthma and who received asthma medication for at least 3 months, whose degrees of severity ranged from intermittent to persistent, whose levels of asthma control ranged from controlled to uncontrolled, patients were in stable condition and filled out informed consent.

Meanwhile, the exclusion criteria of this study were asthmatic patients with chronic obstructive pulmonary disease (COPD), pneumonia, tuberculosis, bronchiectasis, pulmonary embolism,

lung cancer, diabetes mellitus, heart failure, kidney failure, and other cancers, pregnant, smoking, and not willing to fill out informed consent.

Somatotype is defined as a classification of body shape by measuring height and weight using a stature meter with a vertex as the landmark and automatic body scales. Then, the biceps muscle circumference by positioning the flexed forearm to form a 90° angle to the upper arm and lateral calf muscle circumference at the widest part using a measuring tape (Medline).¹⁶

Next, measure the skinfold using a skinfold caliper. Skinfold measurements included triceps skinfolds on the posterior midline between the acromion and radius, subscapular skinfolds by making a 2 cm line towards 45° at the inferior angle of the scapula, supraspinal skinfolds at the intersection of the crista iliac line and supra iliac anterior superior, and medial calf skinfold, which has the maximum width. Then, the diameter of the elbow bone by positioning the right hand forward and the forearm flexed at 90° and the diameter of the knee with the patient in a sitting position and the knee joint flexed at 90° using a sliding caliper.¹⁶

The calculation was carried out three times, and the average was calculated and then entered into the Heath-Carter rating form and plotted on stomatopods to determine the type of somatotypes. Ectomorphy is defined as dominant ectomorphy, while endomorphy and mesomorphy are lower by one-half unit. Mesomorphy is defined as dominant mesomorphy, while endomorphy and ectomorphy are lower by one-half unit. Endomorphy is defined as dominant endomorphy, while ectomorphy and mesomorphy are lower by one-half unit.¹⁷

Meanwhile, chest circumference is defined as an anthropometric measurement (not included in the somatotype) measured at the mesosternal level and perpendicular to the long axis of the thorax using a Medline. Each was measured three times, and the average was calculated. The ratio of chest circumference to height was calculated by comparing the chest circumference with body height. Asthma control level was defined as an assessment of daily and nighttime symptoms of asthma and the impact on

daily activities using the Asthma Control Test (ACT) questionnaire. The level of asthma control in this study was categorized into 2, namely uncontrolled asthma and controlled asthma, with the cut-off point of the Asthma Control Test (ACT) questionnaire being <20 as uncontrolled asthma.^{9,18}

The measurement data were then described and analyzed using SPSS 26 software with a Fisher's test and an unpaired t-test. This research has received permission from the dr. Moewardi General Hospital Health Research Ethics Commission (1.152/IX/HREC/2022).

RESULTS

Based on a study of 51 asthmatic patients who met the inclusion and exclusion criteria, 32 patients (62.7%) were female and 19 patients (37.3%) were male. This shows that there are more female asthma patients than male.

Table 1. Characteristics of Asthma Patients

Characteristics	n	%
Gender		
Female	32	62.7
Male	19	37.3
Age (years old), Mean±SD, Median (Min-Max)	42.84±12.95	43 (19-68)
18-40	19	37.3
41-63	27	52.9
≥64	5	9.8
Duration (months), Mean±SD, Median (Min-Max)	212.78±226.78	96 (3-732)
<12	6	11.8
12-120	23	45.1
132-360	8	15.6
>360	14	27.5
Somatotype		
Endomorphic	43	84.3
Ectomorphic	8	15.7
Asthma Control Level		
Uncontrolled	40	78.4
Controlled	11	21.6

In this study, the minimum age of the patients was 19 years and the maximum was 68 years with a mean age of 42±12.95 years. The most common age range of asthma patients is 41-63 years (52.9%), while the least is more than 64 years, (9.8%). Based on the duration of asthma, most asthma patients have suffered for 12-120 months (45.1%) and at least

have suffered from asthma for less than 12 months (11.8%). The minimum duration of asthma suffered was 3 months, while the longest was 732 months, with an average of 96 months of asthma (Table 1).

Based on the analysis using the somatotype software, it was found that 43 patients (84.3%) had endomorphic and as many as 8 patients (15.7%) had ectomorphic. So, it can be said that asthmatic patients in this study tended to have endomorphic body types. Table 1 shows that 40 patients (78.4%) had uncontrolled asthma, while 11 patients (21.6%) had controlled asthma. Based on these data, it can be said that more patients whose asthma is not controlled than patients whose asthma is controlled.

Table 2. Relationship between Somatotype and Asthma Control Level (n=51)

Somatotype	Asthma Control Level		P
	Controlled	Uncontrolled	
Endomorphic	9 (20.9%)	34 (79.1%)	0.56
Ectomorphic	2 (25%)	6 (75%)	

Table 2 in this study shows that Fisher's test results between somatotype and asthma control levels were not significant with a significance value of 0.56. The test showed that of the 43 endomorphic patients, 34 of them had uncontrolled asthma, and of the 8 asthmatic patients with ectomorphic bodies, 6 of them had uncontrolled asthma (75%), and the other 2 patients had controlled asthma (25%). Based on this, it can be said that the asthma patients in this study tended to have endomorphic and uncontrolled asthma, although not significantly.

Table 3. Relationship between The Ratio of Chest Circumference to Height, Chest Circumference, and Body Mass Index with Asthma Control Level

Characteristics	Asthma Control Level		P
	Controlled	Uncontrolled	
The ratio of Chest Circumference to Height	0.54±0.06	0.58±0.05	0.03
Chest Circumference	88.49±8.74	92.51±7.11	0.12
Body Mass Index	23.28±5.02	25.30±4.94	0.24

Table 3 shows data from unpaired t-test analysis between the ratio of chest circumference to height, chest circumference, and BMI with the level of asthma control. Based on these data, there was no significant relationship between chest circumference and BMI with the level of asthma control (P=0.12 and P=0.24). However, significant results were found

between the ratio of chest circumference to height and the level of asthma control ($P=0.03$). This shows that there is a significant relationship between the ratio of chest circumference to height and the level of asthma control, where asthma patients with a smaller chest circumference ratio (0.54 ± 0.06) tend to have controlled asthma.

DISCUSSION

Heath-Carter divides somatotypes into 13 categories. However, this study found 7 categories of body types.¹⁷ There are 32 people (62.7%) with mesomorph-endomorphic, 8 people (15.7%) with ectomorph-endomorphic, and 5 people (9.8%) with ectomorphic, endomorphic, and mesomorph-ectomorphic, each as many as 1 person (2%). Based on this, it can be said that the body type of asthma patients in this study tended to be endomorphic and ectomorphic.

Based on gender, there were 8 men with mesomorph-endomorphic (42.1%), 5 ectomorphic (26.3%), ectomorph-endomorphy and mesomorph-ectomorphy each as many as 2 people (10.5%), central and endomorphic each as many as 1 people (5.3%), and there are no men with endomorph-mesomorphic. It can be said that the male asthma patients in this study tended to have endomorphic (11 patients) and ectomorphic (8 patients). Meanwhile, there were 24 women with mesomorph-endomorphic (75%), ectomorph-endomorphic as many as 6 people (18.8%), endomorphic and endomorph-mesomorphic each as many as 1 person (3.1%), and no women with central and ectomorphic type. Based on this, it can be said that asthmatic women patients in this study tend to have endomorphic body types.

It is supported by research by Shimrah in India which also states that both men and women aged 18–73 years tend to have an endomorphic (mesomorph-endomorphic). Endomorphic and mesomorphic increase with age until 55 and then decrease thereafter. Meanwhile, the ectomorphic will decrease until the age of 55 and increase at an older age. This is related to the aging process which is

characterized by changes in size, proportion, body composition, decreased growth, and muscle mass.¹⁹ Muscle mass decreases per decade after the age of 30 years by approximately 3–8% and the rate of decline decreases even more after the age of 60 years.²⁰

Higher stature and more fat-free mass in men cause a tendency to have an ectomorphic. Meanwhile, women with mesomorphic are probably caused by women's tendency to multitask on household chores.¹⁹ In addition, research on university students in India who live in urban areas also shows that both women and men tend to have mesomorph-endomorphic, even though women tend to be more endomorphic than men.²¹ This study was also supported by research by Rahmawati et al in Rahmawati and Hastuti which stated that people who live in cities with high incomes tend to have an endomorphic body, while people who live in rural or fishing villages with low incomes tend to be ectomorphic (32 patients).²²

The results of this study are different from the results of several other studies, which state that male adolescents tend to be mesomorphic, where these components will increase until a certain age and then decrease. Research on adolescents in Chile for 20 years shows a change from balanced mesomorphic and ectomorph-mesomorphic to mesomorph-endomorphic (both components are balanced or no more than one and a half units).²³

For 20 years, research in Yogyakarta has shown that there is a change in body shape from the ideal type to endomorph-mesomorphic in men, but it tends to decrease with increasing age.²² This is due to the influence of the hormone testosterone, which causes an increase in the rate of anabolic metabolism by 10–15% thereby increasing skeletal muscle mass. Research in Bulgaria on men aged 30–50 years also showed mesomorphic as the main component and endomorphic dominates in the second place. The component of endomorphic in males hardly changes after the age of 30 years, while ectomorphic itself decreases at the age of 30–50 years because it is related to a person's height and

weight. Mesomorphic itself tends to develop until the late 50s.²⁴

Based on the explanations from the several studies above, the authors agree that girls tend to have endomorphic bodies, while boys tend to be mesomorphic as teenagers. It will increase with age and decrease thereafter. The component of ectomorphic diminishes during adolescence but increases as you get older. This is in line with research on adolescents for 20 years in Yogyakarta, which showed a tendency for endomorphic and mesomorphic, while ectomorphic decreased during adolescence.²²

Male body shape is more varied than female. It can be said that the results of this study tend to be linear with research conducted in India, where, when compared to countries in Asia, men in India and this study tend to be more ectomorphic and less mesomorphic than Japan, China, and Papua New Guinea.²⁵ This shows that somatotype is influenced by ethnicity, physical activity, diet, and one's economic condition.

In this study, there was no significant relationship between somatotype and asthma control level ($P=0.56$). This has clinical implications that asthmatic patients, both those with endomorphic and ectomorphic bodies, have low lung function. Improvements in lung function can reduce asthma symptoms and improve a person's level of asthma control as measured by the ACT.²⁶ This is supported by Efzah's research (2016) regarding the relationship between ACT and spirometry, which states that an increase in ACT value will be followed by an increase in predicted 1% Forced Expiratory Volume (FEV).¹⁸

The existence of mechanical respiratory disorders in asthmatic patients with endomorphic bodies results in limited movement of the diaphragm muscles so that the chest cavity does not expand completely due to the distribution of a lot of fat in the abdominal area. As a result, lung compliance is not perfect and results in limited air intake and exhalation, which results in asthma symptoms.²⁷

Meanwhile, the asthmatic patients with ectomorphic body types who should have good

levels of asthma control, apparently in this study, also had poor asthma control. This is possible because the respiratory muscles of asthma patients are rarely used, so the respiratory muscle strength becomes weak and the chest does not expand optimally.²⁸

This was seen in asthma patients who in this study tended to have a sedentary lifestyle, where 60.8% of patients had low physical activity and 77.4% of them had uncontrolled asthma. This is supported by Cay et al who stated that there is no difference in lung function between the somatotypes of healthy people who live sedentarily because a person's need for air ventilation is directly proportional to his lung capacity. People who live sedentarily tend to have weak diaphragm muscle strength due to low physical activity, so the lung capacity tends to be lower, and there is no significant difference between the somatotypes.²⁹

In addition, a study by Katiyar et al also stated that a person with an ectomorphic tend to have a narrow chest and body surface area and a low Forced Vital Capacity (FVC) value.³⁰ Other studies suggest that lean mass in men is not significantly related to FEV₁ and FVC in asthmatic patients.³¹ This is in line with this study, where all ectomorphic were male and 75% of them had uncontrolled asthma.

Cay et al said that compared to somatotype, chest circumference tends to have more influence, although it's lower in people who live sedentarily than athletes.²⁹ Research related to anthropometric variables on lung parameters in normal people in Nigeria shows that a wide chest circumference will increase the volume of the chest cavity so that the lung capacity and volume of incoming air will increase, and eventually, there will be an increase in FVC and FEV₁.³²

However, in this study, there was no significant relationship between chest circumference in asthma patients and their level of asthma control ($P=0.12$). This is due to airway or systemic inflammation in asthmatic patients, which causes ventilation defects so that even though the volume of the thorax and lungs increases, there is no increase in air volume because the diameter of the airways of asthmatic patients has narrowed.³³

Therefore, one of the mechanisms of asthma treatment is to loosen the narrowed airway so that the volume of incoming air can increase and asthma symptoms can be reduced. However, if the asthma patient's inhaler is not used correctly, it can cause the absorption and distribution of the drug to be low so that the drug's effect decreases and consequently asthma symptoms become uncontrolled.^{26,34}

This is supported by several studies that state that asthma control is also influenced by inhaler use techniques, medication adherence, which is affected by age, Gastroesophageal Reflux Disease (GERD) which has symptoms resembling respiratory symptoms, rhinitis/sinusitis, obesity, and physical activity, which affects lung function, age, gender, and others.^{26–28,33,34}

However, a significant relationship was found between the ratio of chest circumference and height of asthmatic patients to the level of asthma control (ACT score) with a value of $P=0.03$ in this study. Based on the researcher's knowledge, no similar research has been conducted. In this study, 11 controlled asthma patients had a lower ratio of chest circumference to height (0.54 ± 0.06) when compared to patients who were not controlled (0.58 ± 0.05) although the difference was not too great. This is because a person's height is related to lung function, where the taller a person is, the higher the lung function value will be.³⁵

In this study, height was inversely related to the value of the chest circumference ratio. Based on this, the lower the ratio of chest circumference to height, the higher the pulmonary function value. There are also other studies regarding the relationship between the ratio of 1/3 of the upper and lower chest circumference in asthmatic patients with an ACT score, which shows a significant value.¹⁴ This shows that measuring the ratio of chest circumference to height can also be a good indicator showing the physiological and clinical condition of asthma patients.

In this study, there was no significant relationship between BMI and asthma control ($P=0.24$). This result is supported by a study stating that there was no difference in serum adiponectin in

obese and non-obese asthmatic patients, which implies that asthma can also occur in people with low adiponectin.³⁶ This has led to the presence of several asthmatic patients with normal or underweight who also have uncontrolled asthma.

According to Sood, Perseghin, and Weiss et al in Scott, the presence of intramyocellular fat, namely fat droplets in the skeletal muscle that are very active metabolically, is closely related to leptin and adiponectin so that even though the person has a normal BMI, they can still have frequent BMI. Complaints of asthma symptoms. This has been observed in asthmatic patients with neutrophilic airway inflammation.³⁷

LIMITATION

To the best of the researcher's knowledge, this is the first study conducted on the relationship between *somatotype* and asthma control. Therefore, the researcher is well aware of the shortcomings of this study, such as the difficulty in finding reading references, and did not include other confounding factors related to the level of asthma control. Furthermore, it is necessary to carry out other studies related to somatotype and its relationship with other diseases, such as metabolic or cardiovascular diseases, to add to reading references.

CONCLUSION

Based on the results of the study, it can be concluded that asthmatic patients tend to have endomorphic and ectomorphic, whereas 79.1% of patients with endomorphic have uncontrolled asthma. There was no significant relationship between somatotype and asthma control level. However, a significant relationship was found between the ratio of chest circumference to height and the level of asthma control. This suggests that a lower chest circumference to height ratio is associated with well-controlled asthma. It could be considered a predictor of clinical control of asthma.

ACKNOWLEDGMENTS

The author would like to thank Ms. Ria as the

staff of the Diklit, Ms. Sulis, Ms. Rina, Mr. Latif, and Mr. Rosid as a nurse at the Pulmonary Polyclinic at Surakarta Hospital who have helped in the smooth collection of research data. As well as 51 asthma patients who have been willing to take their time to become respondents to this study.

CONFLICT OF INTEREST

None.

FUNDING

None.

REFERENCES

1. Wang Z, Li Y, Gao Y, Fu Y, Lin J, Lei X, et al. Global, regional, and national burden of asthma and its attributable risk factors from 1990 to 2019: A systematic analysis for the Global Burden of Disease Study 2019. *Respir Res.* 2023;24(1):169.
2. Kementerian Kesehatan Republik Indonesia. Hasil utama riset kesehatan dasar tahun 2018. Kementerian Kesehatan Republik Indonesia. 2018.
3. Prasetya A. Hubungan obesitas terhadap derajat obstruksi saluran napas pada penderita asma di RSUP Surakarta. [Surakarta]: Universitas Sebelas Maret; 2021.
4. Reddel HK, Bacharier LB, Bateman ED, Brightling CE, Brusselle GG, Buhl R, et al. Global initiative for asthma strategy 2021 executive summary and rationale for key changes. *Am J Respir Crit Care Med.* 2022;205(1):17–35.
5. Hashmi MF, Tariq M, Cataletto ME. Asthma. StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022.
6. Nurdin K, Heriyani F, Nurasyidah I. Literature review: Hubungan Indeks Massa Tubuh (IMT) dengan tingkat kontrol asma pada penderita asma. *Homeostasis.* 2021;4(1):181–8.
7. Benck LR, Cuttica MJ, Colangelo LA, Sidney S, Dransfield MT, Mannino DM, et al. Association between cardiorespiratory fitness and lung health from young adulthood to middle ages. *Am J Respir Crit Care Med.* 2017;195(9):1236–43.
8. Costanzo LS. Respiratory physiology. In: *Physiology*. 6th ed. Elsevier Health Sciences; 2017. p. 197.
9. Abdo M, Waschki B, Kirsten AM, Trinkmann F, Biller H, Herzmann C, et al. Persistent uncontrolled asthma: Long-term impact on physical activity and body composition. *J Asthma Allergy.* 2021;14:229–40.
10. Pizzorno JE, Murray MT. Asthma. In: *Textbook of Natural Medicine*. 5th ed. Churchill Livingstone Publisher; 2021. p. 1118–30.
11. National Library of Medicine. Somatotypes [Internet]. [cited 2022 Mar 18]. Available from: <https://www.ncbi.nlm.nih.gov/mesh?Db=mesh&Cmd=DetailsSearch&Term=%22Somatotype%22%5BMeSH+Terms%5D>
12. Patwardhan B, Mutalik G, Tillu G. Personalized approaches for health. In: *Integrative Approaches for Health*. 1st ed. ScienceDirect; 2015. p. 293–318.
13. Kukes VG, Nikolenko VN, Pavlov CS, Zharikova TS, Marinin VF, Gridin LA. The correlation of somatotype of person with the development and course of various diseases: Results of Russian research. *Russian Open Medical Journal.* 2018;7(3):e0301.
14. Foumani AA, Amin A, Nejad AT, Kazemnejad E, Salamat F, Massahnia S, et al. Correlation of the ratio of upper third to lower third circumferences of the chest with obstructive pattern in spirometry. *Tanaffos.* 2015;14(4):222–6.
15. Widhi Kurniawan A, Puspitaningtyas Z. Populasi, sampel, dan teknik pengambilan sampel. In: *Metode penelitian kuantitatif*. 1st ed. Yogyakarta: Pandiva Buku; 2016. p. 66–75.
16. Norton KI. Standards for anthropometry assessment. In: *Kinanthropometry and Exercise Physiology*. 4th ed. London: Routledge; 2018. p. 68–137.

17. Carter JEL. The heath-carter anthropometric somatotype. Instruction Manual -. 2002. p. 1–25.
18. Efzah. Hubungan antara asthma control test (ACT) dengan spirometri sebagai alat pengukur tingkat kontrol asma. Universitas Sumatera Utara; 2016.
19. Shimrah C, Kaur S, Kaur G, Chandel S. Somatotype characteristics of Sunni Muslim population: A cross-sectional study. *The Oriental Anthropologist*. 2020;20(1):113–24.
20. dos Santos Marques SG, Villar R, de Faria Marcon L, João GA, Rica RL, Bocalini DS, et al. Determination of somatotype and physical activity level in frailty older adults. *Motriz Revista de Educacao Fisica*. 2022;28(Spe2):e10220002921.
21. Chakrabarti D, Kundu S, Adhikari A. Somatotype traits of college students of urban areas near Kolkata, West Bengal, India. 2020;9(4):334–43.
22. Rahmawati NT, Hastuti J. Secular change in body size and somatotype of Indonesian children aged 7–15 years (1999–2019). *Open Access Maced J Med Sci*. 2021;9(E):419–27.
23. Lizana Arce P, Almagiâ Flores A, Simpson Lelievre C, Ivanovic Marincovic D, Binvignat Gutiérrez O, Berral de la Rosa F. Changes of somatotype in high school students, V region, Chile: 1985-2010. *Nutrición hospitalaria : organo oficial de la Sociedad Española de Nutrición Parenteral y Enteral*. 2012;27(1):270–5.
24. Andreenko E, Mladenova S. Cambios en las características del somatotipo en hombres Búlgaros de mediana edad. *Nutr Hosp*. 2015;32(6):2910–5.
25. Gaur R, Talwar I, I D, V N. Age and sex variations in the somatotypes of Rajput Adolescents of the Kullu District of the Himachal Pradesh Province, North India. *Int J Anthropol*. 2014;29(4):227–44.
26. Tomisa G, Horváth A, Szalai Z, Müller V, Tamási L. Prevalence and impact of risk factors for poor asthma outcomes in a large, specialist-managed patient cohort: A real-life study. *J Asthma Allergy*. 2019;12:297–307.
27. Gebremariam TH, Binegdie AB, Mitiku AS, Ashagrie AW, Gebrehiwot KG, Huluka DK, et al. Level of asthma control and risk factors for poor asthma control among clinic patients seen at a Referral Hospital in Addis Ababa, Ethiopia. *BMC Res Notes*. 2017;10(1):558.
28. Ghanname I, Chaker A, Cherkani Hassani A, Herrak L, Arnaul Ebongue S, Laine M, et al. Factors associated with asthma control: MOSAR study (Multicenter Observational Study of Asthma in Rabat-Morocco). *BMC Pulm Med*. 2018;18(1):61.
29. Cay M, Yilmaz N, Senol D, Cevirgen F, Ucar C, Ozbag D. An analysis of the relationship between pulmonary-aerobic capacity variables defined via pulmonary function tests and anthropometric measurements of different somatotypes. *Ann Med Res*. 2021;23(4):387–93.
30. Katiyar N, Negi S, Negi SL, Puri GD, Thingnam SKS. Assessment of factors affecting short-term pulmonary functions following cardiac surgery: A prospective observational study. *Asian Cardiovasc Thorac Ann*. 2022;30(2):156–63.
31. John Jeneviv N, Nwosu Chiamaka J, Okezue Obinna C, Anyachukwu Canice C, John Davidson O, Mgbeojedo Ukamaka G. Relationship between anthropometric variables and lung function parameters among apparently healthy adults in a Nigerian University. *Int J Respir Pulm Med*. 2022;9(2).
32. Donohue KM, Hoffman EA, Baumhauer H, Guo J, Ahmed FS, Lovasi GS, et al. Asthma and lung structure on computed tomography: The multi-ethnic study of atherosclerosis lung study. *Journal of Allergy and Clinical Immunology*. 2013;131(2):361–8.
33. Ribó P, Molina J, Calle M, Maiz L, Campo C, Ryttilä P, et al. Prevalence of modifiable factors limiting treatment efficacy of poorly controlled asthma patients: EFIMERA observational

- study. NPJ Prim Care Respir Med. 2020;30(1):33.
34. Yan B di, Meng S shan, Ren J, Lv Z, Zhang Q hua, Yu J yan, et al. Asthma control and severe exacerbations in patients with moderate or severe asthma in Jilin Province, China: A multicenter cross-sectional survey. BMC Pulm Med. 2016;16(1):130.
 35. Talaminos Barroso A, Márquez Martín E, Roa Romero LM, Ortega Ruiz F. Factors affecting lung function: A review of the literature. Arch Bronconeumol. 2018;54(6):327–32.
 36. Subarjo M, Amin M. Hubungan kadar adiponektin serum dan nilai volume ekspirasi paksa detik pertama (VEP1) pada pasien asma. Jurnal Respirologi Indonesia. 2019;39(2):113–20.
 37. Scott HA, Gibson PG, Garg ML, Pretto JJ, Morgan PJ, Callister R, et al. Relationship between body composition, inflammation and lung function in overweight and obese asthma. Respir Res. 2012;13(1):10.