

Original Article

Cardiorespiratory responses to incremental exercise in dominant somatotypes

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ABSTRACT

Objectives: Somatotype rating is used to categorise human physiques using parameters related to body shape and composition. These parameters are adiposity, musculoskeletal robustness, and linearity. Somatotype rating is based on anthropometric dimensions that influence a person's ability to perform physical activity. This study aimed to measure cardiorespiratory responses to incremental exercise in different somatotypes.

Materials and Methods: Fifty (50) healthy male participants with a mean age of 24.10 ± 4.55 years were recruited in this study. The dominant somatotype was determined using the Heath and Carter method. Cardiopulmonary exercise testing was done to measure peak VO_2 , peak VO_2/kg , metabolic equivalents (METs), breathing reserve (BR), minute ventilation (V.E), oxygen pulse (VO_2/HR), and heart rate.

Results: The cardiorespiratory parameters showed significant differences between the endomorphs and mesomorphs. Mesomorphs showed significantly higher peak oxygen consumption (mL/min) (2487 ± 364.3 vs. 2151 ± 287.8 ; $P = 0.013$) and exhibited significantly higher peak $\text{VO}_2\%$ predicted values (78.13 ± 10.11 vs. 66.92 ± 10.09 ; $P = 0.003$) than the endomorphs. METs % predicted was significantly higher in mesomorphs than endomorphs (78.13 ± 11.95 vs. 66.92 ± 10.09 ; $P = 0.003$). Similarly, the V.E (L) of mesomorphs was also higher than that of endomorphs (95.32 ± 18.63 vs. 71.13 ± 25.39), but the BR (L) of mesomorphs was lower than endomorphs (38.38 ± 11.87 vs. 53.80 ± 17.16) and ectomorphs (38.38 ± 11.87 vs. 52.79 ± 9.47). Mesomorphs showed higher O_2 pulse than endomorphs ($14.8 [10.3-24.0]$ vs. $12.8 [9.2-21.9]$; $P = 0.02$); they also showed significantly higher respiratory frequency than endomorphs (1/s) (48.25 ± 11.34 vs. 38.19 ± 6.89 ; $P = 0.001$) and ectomorphs (48.25 ± 11.34 vs. 40.92 ± 7.03 ; $P = 0.03$).

Conclusion: Cardiorespiratory responses to exercise vary among different somatotypes. Exercise capacity, as measured by VO_2 peak, is higher in mesomorphs.

Keywords: Cardiopulmonary exercise test, Peak oxygen uptake, Somatotypes

INTRODUCTION

Somatotype rating is used to categorise human physiques using parameters related to body shape and composition. These parameters are adiposity, musculoskeletal robustness and linearity or slenderness. W.H. Sheldon first used the word "somatotype" in 1940.^[1] The word 'somatotyping' today refers to a variety of method-specific procedures, all of which are based on the original Sheldonian notions and use a three-component rating system. Heath and Carter pioneered the most frequently utilised somatotyping technique. This technique has three components – endomorphy, mesomorphy and ectomorphy – that empirically characterise relative fatness, relative musculoskeletal development and relative body linearity, respectively.^[2] For example,

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a 2-5-1 rating expressed in this form would read as two for endomorphy, five for mesomorphy and one for ectomorphy. Thus, these figures indicate the magnitudes of the three components. A rating of $\frac{1}{2}$ – $2\frac{1}{2}$ for a component is considered low, 3–5 is considered moderate, $5\frac{1}{2}$ –7 is high, and $7\frac{1}{2}$ and above is very high.^[3]

It is known that anthropometric parameters influence the ability to perform physical activity. Heath and Carter's anthropometric method of somatotype determination takes into consideration ten anthropometric parameters. These are height, weight, skinfold thickness (triceps, subscapular, supraspinal and medial calf), bone breadth (bi-epicondylar humerus and femur) and limb girth (arm flexed and tensed calf). It is a better predictor of body composition than other methods.^[4] Compared to only using body mass index (BMI) and waist-hip ratio, this technique provides more accurate data on body composition. Thus, somatotype is a crucial component of someone's physical fitness and health profile. During physical activity and training, people of various somatotypes exhibit unique performance capabilities.^[5] It has been demonstrated that the dominant somatotype affects functional responses during maximal exercise.^[5,6]

Cardiopulmonary exercise testing (CPET) offers a comprehensive evaluation of integrative exercise responses encompassing the pulmonary, cardiovascular, hematopoietic, neuropsychological and skeletal muscle systems that are not adequately reflected by the measurement of individual organ system function.^[7] Hence, the objective of the present study was to measure cardiorespiratory responses to incremental exercise in different somatotypes.

MATERIALS AND METHODS

This study was approved by the Institute Ethics Committee for Human Subjects (Ref. No.: IECPG-520/23.09.2021, RT-02/28.10.2021 dated 29.10.21).

Written informed consent was taken from all participants as per the institute's ethical norms.

Participants

This is an observational and cross-sectional study. After screening 75 healthy volunteers, 50 participants were enrolled in the study. A detailed history was recorded, and a physical examination was conducted to rule out the presence of any disease. Healthy volunteers who were willing to participate in the study were enrolled based on the following inclusion and exclusion criteria – the young (age group 18–35 years) healthy male (as exercise capacity is affected by gender) participants having only dominant somatotypes were recruited. Somatotype dominance is defined as a component rating for one somatotype that is at least 0.5 points greater

than the rating of the other two components (for example, 5,2,1 represent dominant endomorphs). The subjects who do regular physical exercise or have cardiovascular, respiratory and musculoskeletal disorders, as well as active smokers, were excluded from the study.

Somatotype determination

The most popular approach for determining a person's somatotype is the Heath-Carter somatotyping method. All participants were subjected to the following anthropometric measurements to determine their somatotype: Height, body weight, four skinfold thicknesses (triceps, subscapular, supraspinal and medial calf), two bone breadths (bi-epicondylar humerus and femur) and two limb girths (arm flexed and tensed calf).^[2]

A small sliding calliper (Dasqua Monoblock 1380 Series [0–150 mm], UK) was used to measure bone breadths. A Harpenden calliper (British Indicators, c/o Assist Creative Resources, Wrexham, UK) was used to measure skinfold thicknesses, which can read to 0.1 mm by interpolation. The girths of the limbs were measured using fibreglass tape (Zyuu's Tailor Inch [150 cm], In).

The somatotype components were derived using the equations given in the Heath-Carter somatotyping method.^[2]

Measurement of cardiopulmonary parameters

Cardiopulmonary exercise test parameters were measured according to ATS guidelines using the Cosmed Quark breath-by-breath CPET system (Cosmed, Italy).^[8] The goal of CPET was to implement an exercise program with progressively higher intensities until fatigue and the onset of limiting symptoms and indications. On a treadmill (Trackmaster, Full Vision Inc., USA), participants underwent a symptom-limited exercise test using the Bruce protocol. During the test, 12 lead electrocardiograms were recorded. The oxygen saturation of the blood was measured using a pulse oximeter placed on the finger. The participant wore a reusable oro-nasal mask during testing and breathed through a flow meter to measure breath-by-breath ventilation (VE) (L/min). A gas analyser and an open-circuit sampling system were used to calculate gas exchange. The test began with a 3-minute warm-up phase at 2.7 km/h and 0 % inclination, which was followed by the Bruce Protocol. It was terminated when the individual was unable to continue the exercise due to limiting symptoms such as fatigue, dyspnoea and pain in the legs. Following the exercise session, there was a 2-minute recovery period at the speed of 2 km/h with 0 % inclination. At the end of the exercise, a modified Borg dyspnoea scale was used to assess breathlessness.

The following parameters were measured using Omnia software: peak oxygen uptake ($\dot{V}O_2$), peak $\dot{V}O_2$ /kg, metabolic equivalent (METs) in exercise testing, respiratory

quotient (VCO_2/VO_2), VO_2 at anaerobic threshold (VAT), minute ventilation (V.E), breathing reserve (BR), tidal volume (VT), O_2 pulse, ventilatory equivalent for oxygen (VE/VO_2), ventilatory equivalent for carbon dioxide (VE/VCO_2), heart rate (HR), HR reserve, HR recovery in 1min, end-tidal partial pressure of carbon dioxide, end-tidal partial pressure of oxygen, respiratory compensation and oxygen uptake efficiency slope (OUES).

Statistical analysis

The Shapiro–Wilk test was used to assess the distribution of the data. A comparison was done among somatotypes using the one-way analysis of variance test and the Kruskal–Wallis test for parametric and non-parametric data, respectively. Based on distribution, the data are provided as mean \pm standard deviation or median (min. to max. range). The results were considered significant when $P < 0.05$. GraphPad Prism 9.0 (GraphPad Software, San Diego, California) software was used for the statistical analysis.

RESULTS

Demographic profile of subjects

Young males with a mean age of 24.10 ± 4.55 years ($n = 50$) took part in the study. Table 1 presents the demographic information as well as the parameters required to calculate an individual's somatotype, duration of exercise and modified Borg dyspnoea scale. Age was comparable among the somatotypes. Ectomorphs were significantly taller than endomorphs and mesomorphs. In terms of weight, endomorphs were significantly heavier than ectomorphs.

As compared to mesomorphs and ectomorphs, endomorphs had significantly higher triceps, subscapular, supraspinal and calf skinfold thickness. Mesomorphs had significantly thicker subscapular skinfolds than ectomorphs do and significantly greater humerus breadth than endomorphs and ectomorphs. Arm and calf girths were significantly lower in ectomorphs than in endomorphs and mesomorphs.

CPET finding in different somatotypes

We examined the absolute values and percentage predicted values of CPET parameters in various somatotypes, as shown in Table 2 and Figures 1-3. We found that mesomorphs significantly outperformed endomorphs in terms of peak VO_2 , peak VO_2 %predicted, peak VO_2/kg , peak VO_2/kg %predicted, METS, METS %predicted, V.E, oxygen pulse (O_2 pulse) and VE/VO_2 values. In contrast, ectomorphs significantly outperformed endomorphs in terms of peak VO_2/kg and METS values. Mesomorphs achieved significantly lower maximum HR during exercise than ectomorphs and had significantly smaller BR than endomorphs and ectomorphs but significantly higher %predicted O_2 pulse compared to endomorphs and ectomorphs. Other parameters were comparable.

Correlation between determinants of somatotype and the parameters of CPET

We investigated the correlation between somatotype determinants and the cardiopulmonary exercise test parameters listed in Table 3 and Figure 4. Weight had a positive correlation with O_2 pulse and OUES. BR, VO_2 at anaerobic threshold, VO_2 at anaerobic threshold %predicted,

Table 1: Demographic details and parameters used for somatotype calculation among different somatotypes as well as, exercise duration and modified Borg dyspnoea scale.

Parameters of somatotype	Endomorphs (n=20)	Mesomorphs (n=15)	Ectomorphs (n=15)	P-value
Age (yrs.)	26.00 (18.00–34.00)	25.00 (18.00–33.00)	21.00 (18.00–34.00)	$P=0.07$
Height (cm)	168.3 (161.3–184.9)	167.5 (154–177)	178.8 (165.8–190.5)	$P^b=0.0104$ $P^c=0.0018$
Weight (kg)	74.03 \pm 11.51	69.74 \pm 8.90	61.31 \pm 8.92	$P^b=0.0004$
Triceps skinfold (mm)	19.84 \pm 4.338	13.92 \pm 4.536	10.59 \pm 3.231	$P^a=0.0001$ $P^b<0.0001$
Subscapular skinfold (mm)	19.24 \pm 4.135	15.04 \pm 4.170	9.906 \pm 3.144	$P^a=0.0044$ $P^b<0.0001$ $P^c=0.0010$
Supraspinale skinfold (mm)	16.15 \pm 4.077	9.814 \pm 2.183	7.156 \pm 2.277	$P^a<0.0001$ $P^b<0.0001$
Calf skinfold (mm)	16.20 (9.800–27.00)	10.50 (6.200–18.60)	11.50 (6.800–17.20)	$P^a=0.0002$ $P^b=0.0006$
Humerus breadth (cm)	6.629 \pm 0.3986	6.935 \pm 0.4295	6.596 \pm 0.2605	$P^a=0.0372$ $P^c=0.0339$
Femur breadth (cm)	7.885 \pm 0.5176	8.113 \pm 0.9032	7.824 \pm 0.5727	$P=0.4156$
Arm girth (cm)	32.55 (28.20–39.70)	33.10 (29.00–36.50)	27.65 (21.80–29.50)	$P^b<0.0001$ $P^c<0.0001$
Calf girth (cm)	36.84 \pm 2.852	36.91 \pm 2.430	33.53 \pm 2.055	$P^b=0.0002$ $P^c=0.0010$
Modified Borg dyspnoea scale	3.00 (0.50–6.00)	2.00 (0.50–5.00)	2.00 (0.50–4.00)	$P=0.41$
Mean duration of exercise (min: sec)	07:46	08:54	09:35	

^aEndomorphs vs. Mesomorphs, ^bEndomorphs vs. Ectomorphs, ^cMesomorph vs. Ectomorphs. Values presented are mean \pm standard deviation or median (minimum–maximum), analysed by one-way analysis of variance (*post hoc*-Tukey) or Kruskal–Wallis test (*post hoc*-Dunn's), respectively

Table 2: This graph displays the parameters of the cardiopulmonary exercise test in different somatotypes.

Cardiopulmonary exercise testing parameters	Endomorphs (n=20)	Mesomorphs (n=15)	Ectomorphs (n=15)	P-value
Peak oxygen consumption (mL/min)	2151±287.8	2487±364.3	2342±403.8	$P^a=0.01$
Peak oxygen consumption (%predicted)	66.96±10.11	78.13±11.95	70.06±8.18	$P^a=0.003$
Peak oxygen consumption/kg	30.11±5.52	36.04±6.16	38.32±5.38	$P^a=0.0057$ $P^b<0.0001$
Peak oxygen consumption/kg (%predicted)	66.96±10.11	78.13±11.95	70.06±8.18	$P^a=0.003$
METS	8.77±1.86	10.29±1.74	10.95±1.54	$P^a=0.026$ $P^b=0.0004$
METS %predicted	66.92±10.09	78.13±11.95	70.06±8.18	$P^a=0.003$
RQ	1.27 (1.05–1.58)	1.31 (1.15–1.58)	1.26 (1.09–1.44)	$P=0.80$
BR	53.80±17.16	38.38±11.87	52.79±9.47	$P^a=0.004$ $P^c=0.001$
Tidal volume (L (btps))	1.78±0.50	2.03±0.41	1.99±0.40	$P=0.17$
V.E	71.13±25.39	95.32±18.63	80.29±14.43	$P^a=0.002$
Respiratory frequency (1/min)	38.19±6.89	48.25±11.34	40.92±7.03	$P^a=0.001$ $P^c=0.03$
O ₂ pulse (mL/beat)	12.80 (9.20–21.90)	14.80 (10.30–24.00)	12.85 (10.10–18.50)	$P^a=0.02$
O ₂ pulse %predicted	77.50 (51.00–115.00)	90.00 (67.00–147.00)	76.50 (17.60–98.00)	$P^a=0.006$ $P^c=0.033$
HR (bpm)	171.5 (142.00–194.00)	166.00 (125.00–186.00)	178.00 (159.00–189.00)	$P^c=0.04$
HR % predicted	87.23±8.673	82.67±10.55	88.94±5.418	$P=0.097$
HRR (bpm)	23.00 (5.00–54.00)	20.50 (9.00–55.00)	17.00 (4.00–36.00)	$P>0.99$
VE/VO ₂	34.24±5.99	39.40±7.02	35.80±5.82	$P^a=0.03$
VE/VCO ₂	27.45 (19.50–42.40)	29.10 (25.60–40.50)	26.55 (23.00–34.50)	$P=0.17$
OUES	2550±422.9	2647±414.2	2645±447.8	$P=0.70$
OUES (%predicted)	81.00±14.04	83.80±10.01	83.72±12.23	$P=0.70$
VO ₂ at anaerobic threshold (mL/min)	1686±406.1	1651±326.2	1795±382.5	$P=0.51$
VO ₂ at anaerobic threshold (%pred)	75.40±16.02	66.73±11.02	76.89±13.93	$P=0.09$
End-tidal PO ₂ (PetO ₂)	105.7±6.41	109.7±4.60	106.2±4.60	$P=0.07$
End-tidal PCO ₂ (PetCO ₂)	44.04±6.26	39.87±4.82	42.78±4.50	$P=0.06$

^aEndomorphs vs. Mesomorphs, ^bEndomorphs vs. Ectomorphs, ^cMesomorph vs. Ectomorphs. Values presented are mean±standard deviation or median (minimum–maximum), analysed by one-way Analysis of Variance (*post hoc*-Tukey) or Kruskal–Wallis test (*post hoc*-Dunn's), respectively. OUES: Oxygen uptake efficiency slope, METS: Metabolic equivalent, RQ: Respiratory quotient, BR: Breathing reserve, HR: Heart rate, HRR: Heart rate reserve, VE/VO₂: Ventilatory equivalents for oxygen, VE/VCO₂: Ventilatory equivalent for carbon dioxide, O₂: Oxygen pulse, V.E: Minute ventilation, PO₂: partial pressure of O₂, PCO₂: partial pressure of CO₂

and OUES all showed positive correlations with height. Humerus breadth was positively correlated with OUES. Arm girth was inversely associated with HR but positively correlated with O₂ pulse and VE/VCO₂ slope. Calf girth was positively correlated with oxygen pulse but negatively correlated with peak VO₂/kg, METS, breathing reserve, heart rate and heart rate % predicted.

DISCUSSION

In the present study, cardiorespiratory responses to incremental exercise have been investigated in young adults having dominant somatotypes.

Compared to other approaches, the Heath and Carter method is a better predictor of body composition since it accounts for variables including height, weight, skinfold thickness, bone width and limb girths. This approach offers more precise information on body composition than BMI and waist-hip ratio alone.

Mesomorphs having higher muscle mass compared to endomorphs may explain their significantly higher peak VO₂, peak VO₂% predicted, peak VO₂/kg and peak VO₂/kg% predicted compared to endomorphs. Imms *et al.* have reported greater oxygen consumption during contraction of the large mass muscle (quadriceps) than that during small mass muscle (hand gripping) at 20% maximum

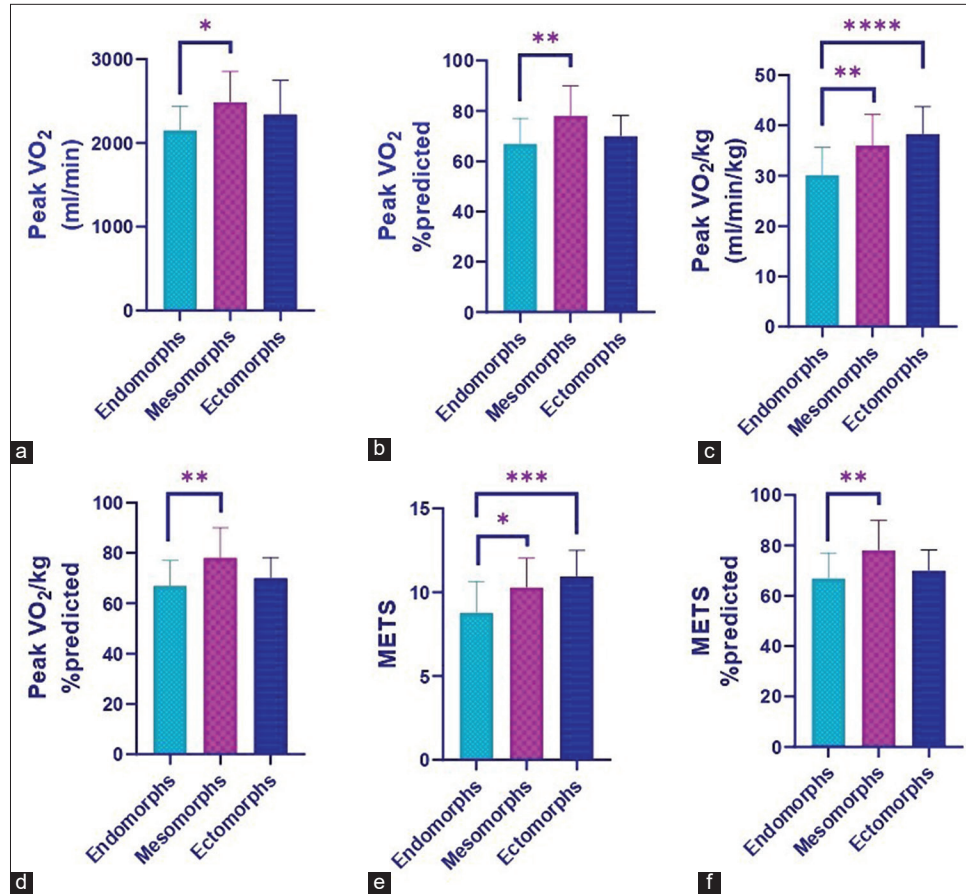


Figure 1: The graphs depicting cardiopulmonary exercise parameters in different somatotypes: (a) Peak VO₂ (b) Peak VO₂ %predicted (c) Peak VO₂/kg (d) Peak VO₂/kg % predicted (e) METS (f) METS % predicted Values are plotted as mean \pm standard deviation or median (minimum to maximum). * $P < 0.05$, ** $P < 0.01$ and *** $P < 0.001$, **** $P \leq 0.0001$ for inter group comparison. VO₂: Peak oxygen consumption; METS: Metabolic equivalent in exercise testing.

voluntary contraction.^[9] The significantly lower values in endomorphs may be explained by their comparatively slower metabolism, which causes more fat accumulation in the body. Pourhassan *et al.* studied the relationship between submaximal oxygen uptake and body composition and reported a strong association between VO₂submax and fat-free mass (FFM) and concluded that FFM is the determinant of VO₂ submax.^[10] Saha has determined the impact of somatic and body composition variables on aerobic capacity in different somatotypes. She observed a negative correlation between VO₂ max and body fat percentage, body surface area and endomorphy component of somatotype, while it correlated positively with the lean body mass, percentage of skeletal muscle mass and mesomorphy component of somatotype.^[11] Oda *et al.* also reported a significant negative correlation between peak oxygen uptake with total body fat percentage.^[12] These findings suggest that VO₂max is influenced by the total active muscle mass being recruited during exercise, where the more muscle mass is involved during exercise, the higher the VO₂max.^[13]

A MET is the quantity of oxygen consumed while at rest, the value of which is around 3.5 mL O₂/kg/min (1.2 kcal/min for a person weighing 70 kg). The MET concept offers a straightforward, understandable method for describing the energy expenditure of physical activity as a multiple of resting metabolic rate. The energy cost of an activity may be calculated by dividing the relative oxygen cost of the activity (ml O₂/kg/min) by 3.5.^[14] In the present study, METS values were significantly lower in endomorphs than other somatotypes for maximum physical activity. The amount of skeletal muscle is a key factor in the rise in metabolism during exercise and the absolute maximum oxygen consumption. Lean tissue has a significant relationship with basal metabolism, and skeletal muscles are the source of energy used during physical activity.^[15] This might be the reason why mesomorphs achieved higher METS than endomorphs. Thus, higher VO₂peak/kg and METS values observed in mesomorphs may be explained by the higher muscle mass in these individuals.

In an exercising person, maximal oxygen uptake is limited by the ability of the cardiorespiratory system to deliver

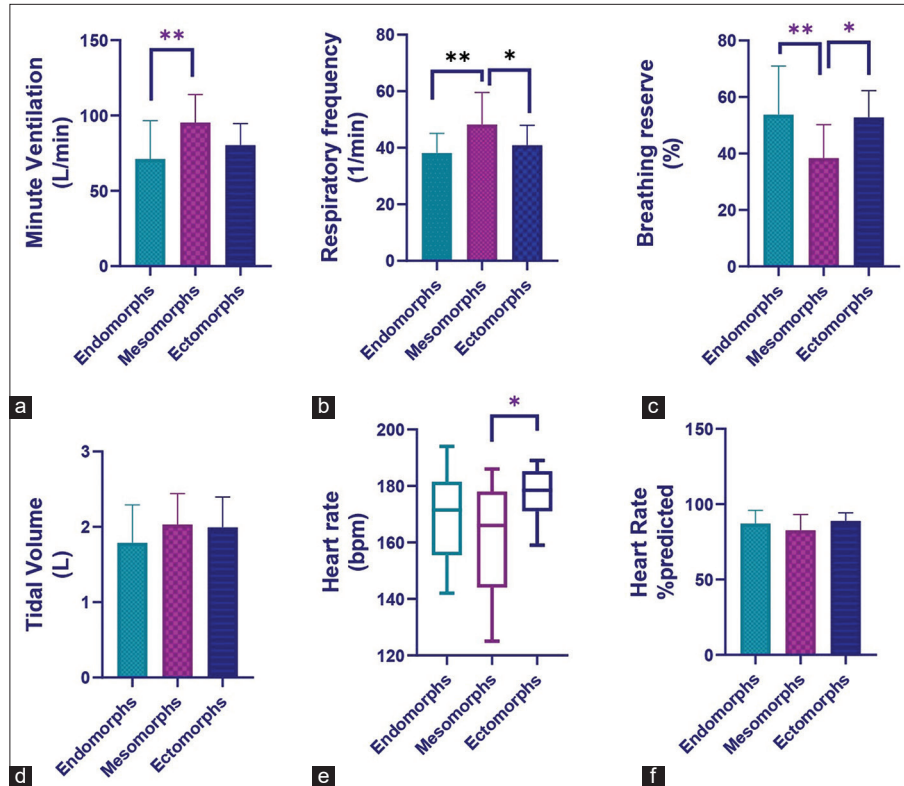


Figure 2: The graphs depicting the cardiopulmonary exercise parameters in different somatotypes: (a) Minute ventilation, (b) Respiratory frequency (c) Breathing reserve (d) Tidal volume, (e) Heart rate, (f) Heart rate % predicted. Values are plotted as mean \pm standard deviation or median (minimum to maximum). * $P < 0.05$, ** $P < 0.01$ for inter group comparison.

oxygen to the exercising muscles.^[16] The increase in the O_2 pulse after the training session may reflect the degree of peripheral and cardiac adaptation to training. In our study, we observed that O_2 pulse (the amount of oxygen consumed per heartbeat during exercise), which can be used as an indirect indicator of cardiac stroke volume,^[17] was significantly higher in mesomorphs as compared to endomorphs. Chaouachi *et al.* have also reported higher values of O_2 pulse in mesomorphs in comparison to the endomorphs and ectomorphs' groups.^[18] We also observed that O_2 pulse significantly correlated with arm and calf girths. The calf muscle pump plays a very important role in increasing venous return, which can also affect the cardiac output.

We found that mesomorphs had significantly higher V.E than endomorphs, and respiratory frequency was significantly higher compared to endomorphs and ectomorphs, but the BR was significantly lower as compared to endomorphs and ectomorphs. While exercising, VTs and respiratory rates are increased, increasing oxygen consumption. This is generally achieved by raising the respiratory rate because VTs are frequently not raised. Uneven body fat distribution may restrict diaphragmatic excursion and impede further VT augmentation

during exercise.^[19] Mesomorphs have a significantly smaller BR, which may be related to their increased V.E.

Subhan *et al.* reported that there is no significant difference in maximal HR achieved during exercise among persons who are overweight, normal weight and obese as determined by BMI.^[20] Nevertheless, we noticed that ectomorphs achieved significantly higher maximal HR during exercise than mesomorphs. The reason behind this is not yet clear.

High airway resistance might be the cause of the VE/VO_2 and VE/VCO_2 not rising with maximum activity.^[21] We found that VE/VO_2 was significantly higher in mesomorphs than in endomorphs. This may be a result of their significantly higher respiratory frequency and V.E. One of the possibilities might be that endomorphs have a significantly higher peripheral airway resistance, leading to a decreased VE/VO_2 ratio.

Mesomorphs have a higher percentage of muscular components, and endomorphs have relatively more body fat than mesomorphs.^[22] Excess body fat may exert an unfavourable burden and a hindering action on cardiac function, particularly during exhausting exercise when excessively hyperactive body muscles fail to uptake enough oxygen due to the deposition of a proportionately higher amount of fat mass. Extra body fat

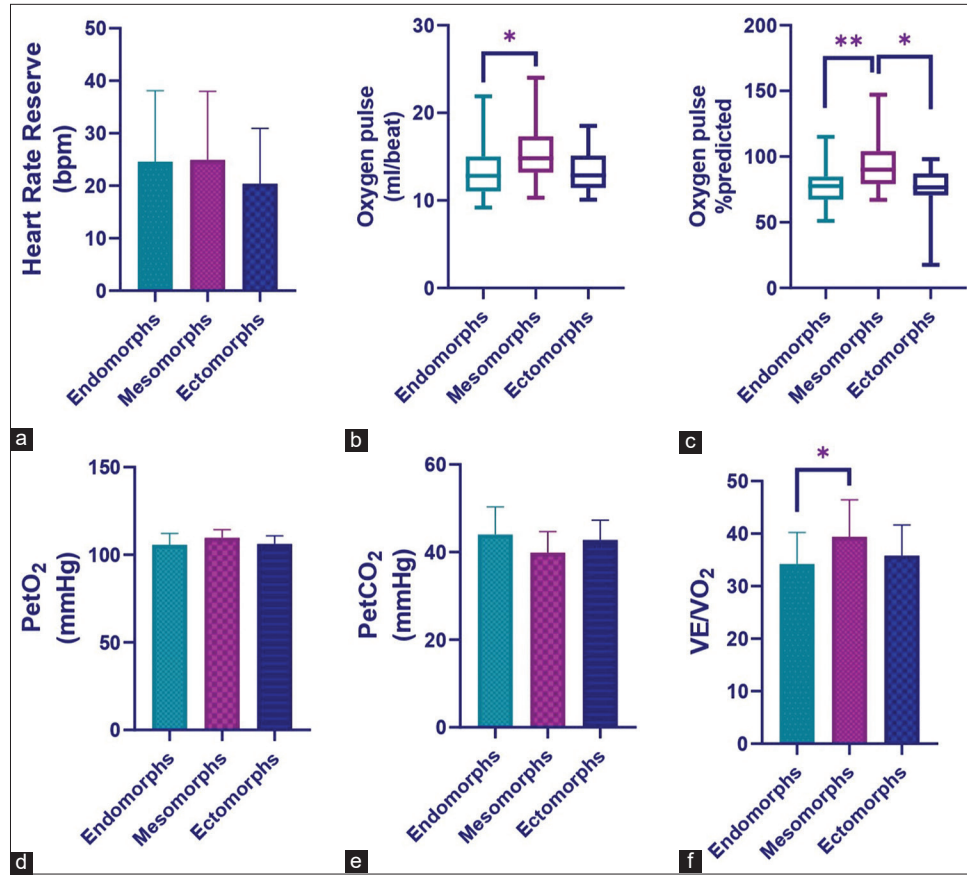


Figure 3: The graphs depicting the cardiopulmonary exercise parameters in different somatotypes: (a) Heart rate reserve (b) Oxygen pulse (c) Oxygen pulse % predicted (d) PetO₂ (e) PetCO₂ (f) VE/VO₂. Values are plotted as mean ± standard deviation or median (minimum to maximum). **P* < 0.05, ***P* < 0.01 and for inter group comparison. petO₂: End-tidal PO₂; PetCO₂: End-tidal PCO₂; VE/VO₂: Ventilatory equivalent for oxygen.

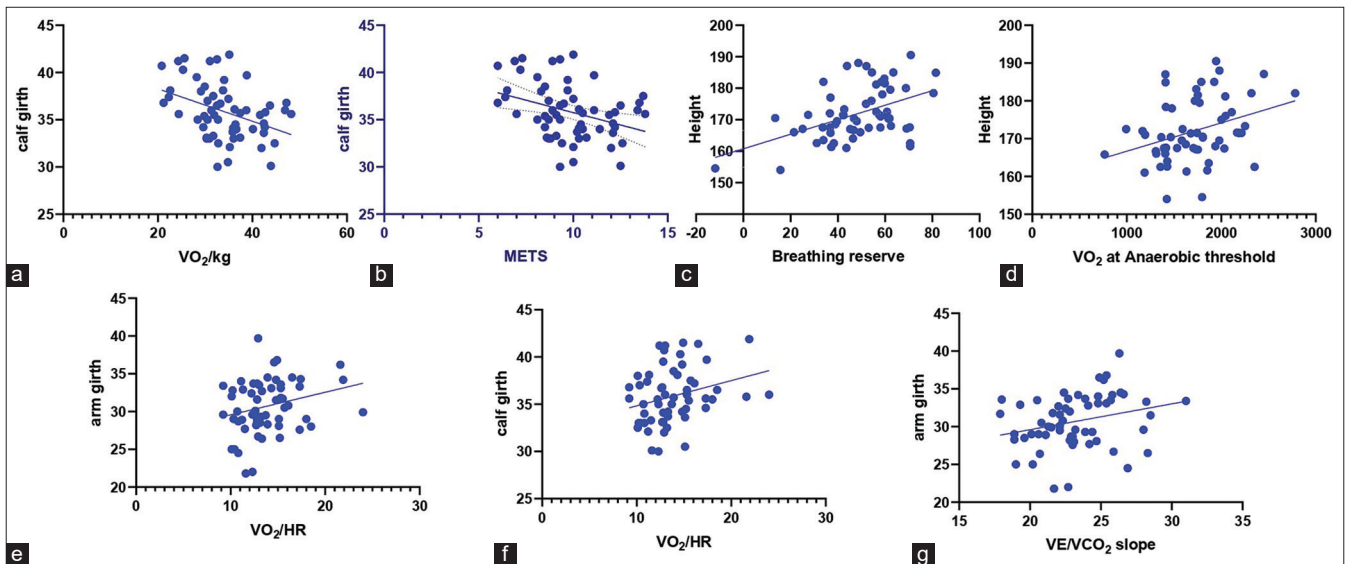


Figure 4: The graphs show correlation between somatotype dimensions and cardiopulmonary exercise test parameters. Calf girth correlates negatively with (a) peak VO₂/kg and (b) METS. Height correlates positively with (c) breathing reserve and (d) VO₂ at anaerobic threshold. Arm girth correlates positively with (e) VO₂/HR. Calf girth correlates positively with (f) VO₂/HR. Arm girth correlates positively with (g) VE/VCO₂ slope.

Table 3: Correlation between determinants of somatotype and cardiopulmonary exercise test parameters.

Spearman correlation	Weight	Height	Humerus breadth	Arm girth	Calf girth
Peak VO ₂ /kg	r=-0.55 P=5.48	r=0.02 P=0.86	r=-0.11 P=0.40	r=-0.49 P=7.73	r=-0.37 P=0.003
METS	r=-0.50 P=3.82	r=0.06 P=0.62	r=-0.05 P=0.70	r=-0.48 P=1.08	r=-0.33 P=0.009
BR	r=0.03 P=0.77	r=0.39 P=0.002	r=0.01 P=0.91	r=-0.22 P=0.08	r=-0.10 P=0.45
HR	r=-0.18 P=0.16	r=0.12 P=0.28	r=-0.17 P=0.18	r=-0.35 P=0.005	r=-0.34 P=0.007
HR %pred	r=-0.03 P=0.79	r=-0.11 P=0.33	r=-0.16 P=0.22	r=-0.19 P=0.14	r=-0.26 P=0.04
VO ₂ /HR	r=0.29 P=0.02	r=0.14 P=0.26	r=0.21 P=0.09	r=0.26 P=0.04	r=0.29 P=0.02
VO ₂ at AT	r=0.24 P=0.06	r=0.36 P=0.004	r=0.13 P=0.29	r=0.05 P=0.69	r=0.15 P=0.23
VO ₂ at AT %pred	r=0.15 P=0.24	r=0.27 P=0.03	r=0.07 P=0.55	r=3.80 P=0.99	r=0.09 P=0.47
Respiratory compensation	r=0.29 P=0.02	r=0.17 P=0.18	r=0.01 P=0.89	r=0.22 P=0.08	r=0.15 P=0.23
VE/VCO ₂ slope	r=0.11 P=0.40	r=-0.14 P=0.27	r=0.08 P=0.54	r=0.29 P=0.02	r=0.17 P=0.18
OUES	r=0.32 P=0.01	r=0.35 P=0.006	r=0.27 P=0.03	r=0.12 P=0.33	r=0.27 P=0.03

In this correlation, *P* values and *r*-values are presented, and the bold text represents a significant correlation analysed by the Spearman correlation test. METS: Metabolic equivalent, HR: Heart rate, BR: Breathing reserve, AT: Anaerobic threshold, VE/VCO₂: Ventilatory equivalent for carbon dioxide, OUES: Oxygen uptake efficiency slope, VO₂: Oxygen consumption

affects mechanical efficiency for a given workload and impairs cardiorespiratory functions.^[23]

CONCLUSION

Mesomorphs have higher peak oxygen consumption than endomorphs, along with higher METS, V.E and O₂ pulse. Clinicians should consider somatotype when interpreting the results since, even though all the participants were in good health, there is still variation in their cardiorespiratory responses.

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