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Expert Opinion Article

The Biomechanical Advantage Of Key Anthropometric Variables On Aerobic Performance And Perceived Exertion In Adolescent Swimmers.

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Abstract

Background/Introduction: The differential training techniques and environment makes swimming an exclusive sport domain having predominant effects on biomechanical, physiological and biochemical parameters providing an apt area for dynamic research.

Objectives: To study the effect of anthropometric parameters on aerobic performance and perceived exertion in adolescent swimmers.

Methods: A pilot study, where 52 adolescent elite swimmers (21F and 32M) were assessed for anthropometric parameters like sitting height, leg length, waist to hip ratio, using standard procedures. Aerobic performance was assessed by analyzing VO2 max and blood lactate levels, modified Borg's scale was used to assess the rate of perceived exertion. Pearsons correlation was used to study associations between anthromteric measurements and VO2 Max, blood lactate and perceived exeretion.

Results: VO2 max is negatively correlated (-0.03) with Cormic index.
Waist to hip ratio has a strong positive correlation (+0.74) with blood lactate levels.

Conclusions: Adolescents with longer limb lengths have a biomechanical edge over normal peers since they show a better oxygen utilizing capacity and increased aerobic performance, also factors such as increasing waist line and regional fat distribution have a predominant role in the swimmer's ability to handle exertion.
In conclusion, identification of specific anthropometric variables with optimization of training can help in identifying talent and predict performance. Physical characteristics can be the basis for tailoring programs and strategies for swimming as an individual sport.

Key words RPE-Rate of perceived exertion, VO2 max, modified BORG'S scale, elite adolescent swimmers, cormic index

INTRODUCTION- The differential training techniques and environment makes swimming an exclusive sport domain having predominant effects on biomechanical, physiological, psychological and biochemical parameters providing an apt and fertile area for dynamic research. The horizontal position of the body, synchronous breathing pattern along with the various forces which act on the body including the drag force and buoyancy make cardiovascular and respiratory adjustments that are unique to this sport.

Objectives

- To study specific anthropometric variables in adolescent swimmers and their effect on aerobic endurance in adolescent swimmers.
- To assess the role of limb length on perceive exertion in adolescent swimmers.

Materials and methods:

Study design: Cross sectional pilot study

Study Source: Swimmers of Suvarna JNMC swimming pool, RPD swimming pools, Mohite swimming pool, corporation swimming pool, Galaxy swimming pool, BUDA swimming pool in BELAGAVI.

Sample size: since it's a pilot study, based on thumb rule and minimum sample size estimate, 52 participants were recruited.

Study population: Competitive Swimmers aged 10-19 years of both genders.

❑ **Inclusion Criteria**

- Competitive Swimmers aged 10-19 years of both genders.
- Competitive swimmers with minimum 6 months of swimming training (>7 hours per week) [14].

● Being trained professionally.

❑ **Exclusion Criteria**

- Recreational swimmers.
- Swimmers complaining of Respiratory ailments /musculoskeletaldisorders/non-communicable diseases.
- Swimmers practicing intermittent swimming.
- Any chronic diseases restricting physical activity.
- Drug abuse, alcohol, smokers.

Data collection tools:

Anthropometric parameters:

Height: Stadiometer
Weight: Standardized weighing machine
BMI = Quetlet index
Sitting height: SH
Waist circumference
Hip circumference
Waist to hip ratio: W/H
Leg length: LL
Sitting height/ Leg length: SH/LL
Sitting height/ Height: SH/Ht

Aerobic parameters:

Lactate level – Blood lactatemeter.

Perceived exertion: Modified Borg scale

ANTHROPOMETRIC VARIABLES

HEIGHT: The subject was asked to remove his footwear and heavy clothing, he was asked to stand straight on a stadiometer with he back of the head, back, buttocks, calves and heels inline and feet together. The measurement was taken.

WEIGHT: After removing the footwear and with light clothing subject stood on the weighing scale with his head straight and the body weight equally distributed on both the legs.

BMI was calculated using Quetlet index: weight (kg) / height (mts)2

Sitting height: It was measured from the highest point on the head to the base of sitting surface. The subject sat with both feet on the floor, the lower back and shoulders against the wall, looking straight ahead.

Waist circumference: Waist circumference was measured at a level midway between the lower rib margin and iliac crest with the tape all around the body in horizontal position.

Hip circumference: Hip circumference was measured as the maximal circumference over the buttocks.

Waist to hip ratio: Waist–hip ratio is the ratio of the circumference of the waist to that of the hips.

- **Leg length:**
- The subject was asked to stand straight with hips and knee extended, one end of the tape was placed in the anterior superior iliac spine and the other end of the tape was extended till medial malleolus and measurement was noted.

VO2max – Bicycle ergometer using Astrand Rhyming Nomogram protocol

The test procedure was explained to the subject and all the basic parameters and vitals were recorded. The subject was allowed to warm up for 2-3 minutes with 0 kg resistance and at a cadence of 50. Following this, the subject pedalled for 6 mins at a workload selected so that a steady heart rate was achieved between the range of 125-170 beats/min. During this period the heart rate was measured at the end of every minute, if the difference in heart rate between the end of 5^{th} and 6^{th} minute was not less than 5 beats, the subject was asked to continue for another minute. The average heart rate of 5^{th} and 6^{th} minute was taken. The average heart rate was used to applied to the nomogram which was then used to find out the VO2max of the subject.

Lactate level – The subject was made to understand the test procedure. The blood drop was collected using standard procedures after following the precautions. A portable lactometer was used (LACTOSPARK) to determine the blood lactate levels.

Rate of perceived exertion- A standard 10-point questionnaire, modified Borgs scale was used to determine the rate of perceived exertion after a 50m freestyle swim.

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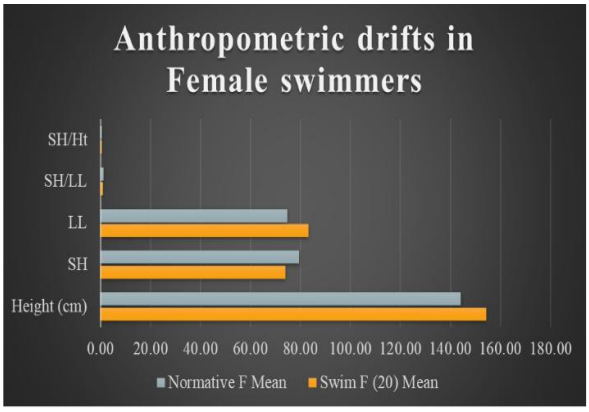
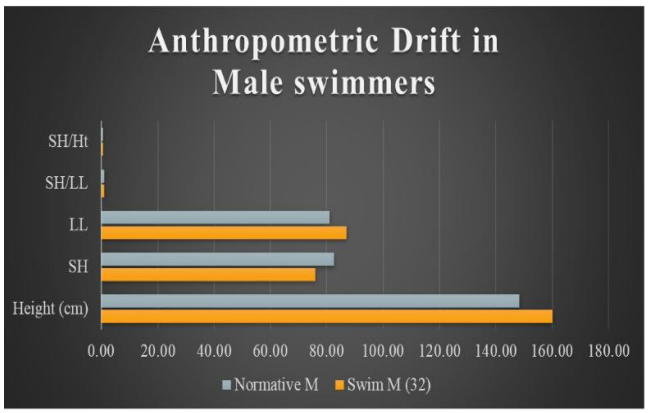
Statistical Analysis

Data were entered and analysed using Microsoft Excel and IBM SPSS software (version 23) respectively. Quantitative variables were expressed as mean ± standard deviation. Pearson's correlation was used to analyse relation between any 2 variables. A *p*-value of < 0.05 was contemplated as statistically significant.

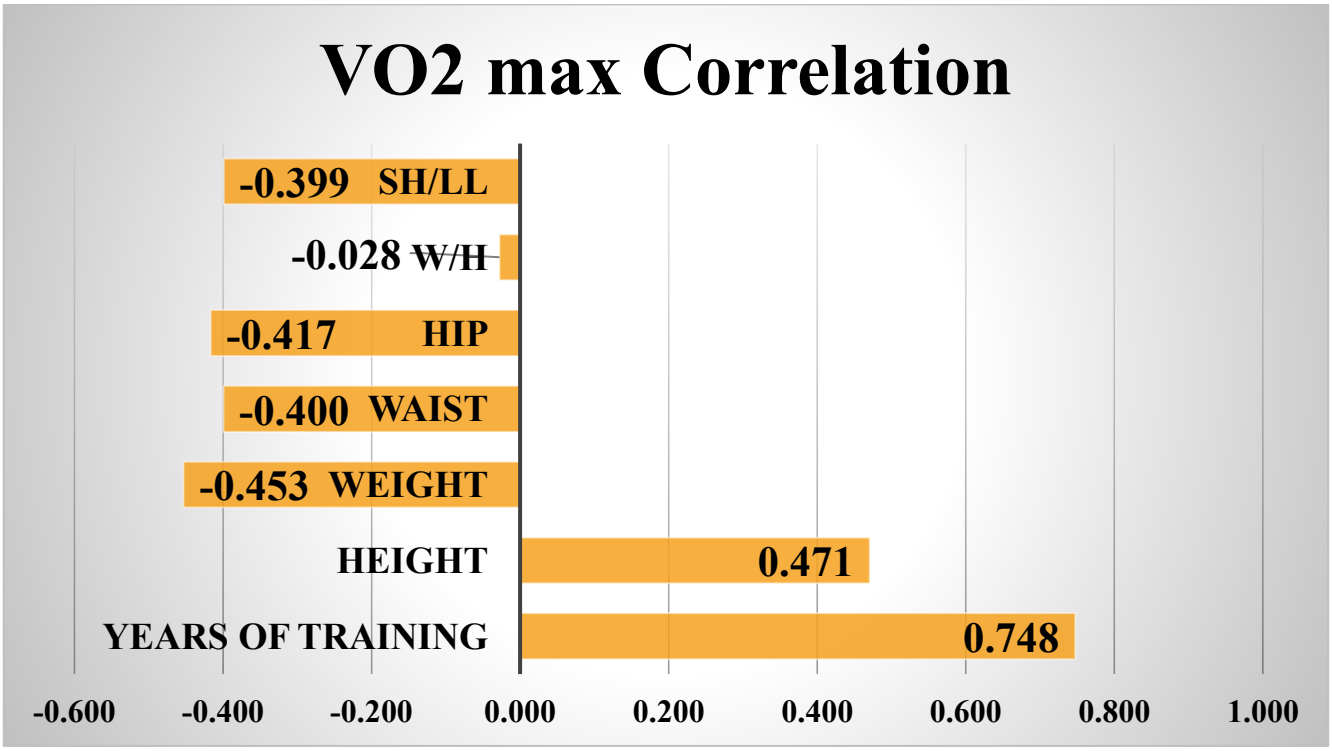
Results:



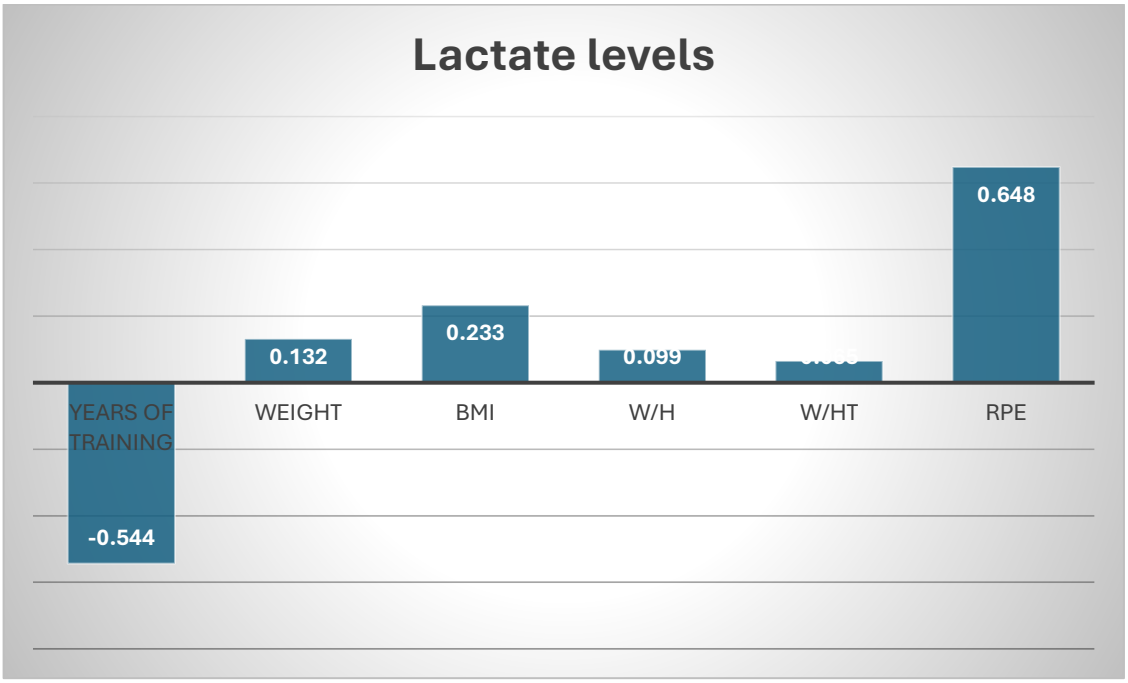


	Height (cm)	SH	LL	SH/LL	SH/Ht
Swim F (20)	154.20	73.80	83.00	0.89	0.48
SD	5.19	4.72	4.83	0.04	0.02
Normative F	144	79.4	74.5	1.07	0.5
SD	6.7	3.4	4.4	0.07	0.02

	Height (cm)	SH	LL	SH/LL	SH/Ht
Swim M (32)	160.00	75.88	86.94	0.87	0.47
SD	12.059	7.352	7.649	0.027	0.015
Normative M	148.3	82.5	81	1.02	0.52
SD	6.6	4.7	5.5	0.07	0.02

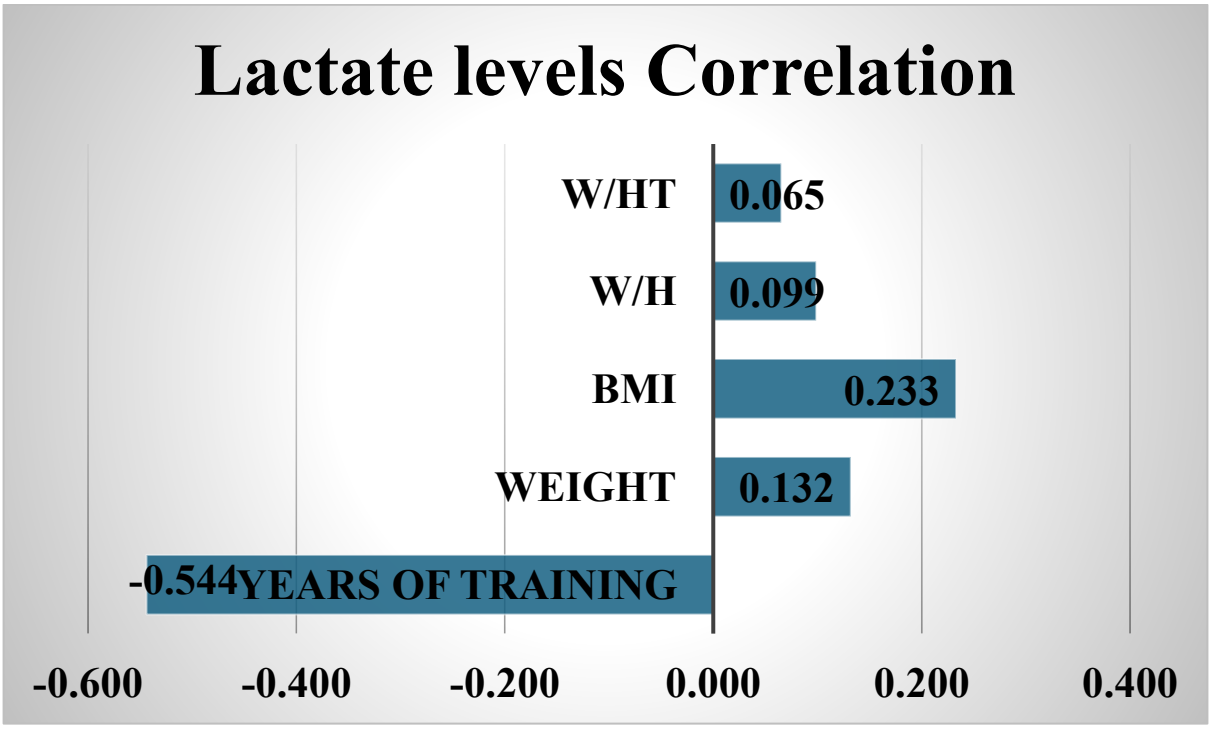


	Years of training	*Height*	*Weight*	*Waist*	*Hip*	*W/H*	*SH/LL*
VO2 max	0.748	0.471	-0.453	-0.400	-0.417	-0.028	-0.399
t	7.958	3.775	3.594	3.082	3.242	0.197	3.077
p value	**0.000**	**0.000**	**0.001**	**0.003**	**0.002**	0.845	**0.003**



	Years of training	Weight	BMI	W/H	W/Ht	RPE
Lactate levels	-0.544	0.132	0.233	0.099	0.065	0.648
t	4.582	0.942	1.694	0.703	0.463	6.045
p value	**0.000**	0.351	0.096	0.485	0.646	**0.000**

VO2 max is



Discussion

The data of the anthropometric variables from 52 subjects (20 females and 32 males) when analyzed showed superior values from their peers. The average height obtained from the normative data when age and gender matched is around 144cm in females and 148.3 cm in males but in this study, it was higher as 154.2cm and 160cm respectively indicating that the swimmers were taller than their peers of the same age group.

The average sitting height in females is 79.4 cm and limb length is 74.5, whereas when measured on swimmers in this study it was 73.80 and 83 cm respectively clearly showing

The average sitting height in males was 82.5cm and limb length was 81cm as obtained from normative data of the population and in swimmers the value was 75.88 cm and 86.94 cm respectively indicating that that both male and female swimmers had longer limb length over their peers.

The average Vo2max in male swimmers was about 53ml/kg/min and in female swimmers it was 39.5ml/kg/min which is much higher compared to normal peers suggesting that early exposure to swimming and a good training protocol can help in increasing overall aerobic fitness in young adults.

Blood lactate levels are negatively correlated with years of training and positively correlated with weight, BMI and waist to hip ratio and perceived exertion indicating that the earlier switching from aerobic to anaerobic cycle are affected by all the above factors

The VO2 max was positively correlated with duration of training and height whereas it was negatively correlated with waist circumference hip circumference and sitting height/ leg length ratio showing that students who start training early have a definite advantage over the general population

Conclusion

Adolescents with longer limb lengths have a biomechanical edge over normal peers since they show a better oxygen utilizing capacity and increased aerobic performance, also factors such as increasing waist line and regional fat distribution have a predominant role in the swimmer's ability to handle exertion.

Long and rigorous training in adolescent swimmers stimulates variable growth spurts compared to normative data. The factors affecting it should be studied in detail

Anthropometric variations are significant in adolescents who start training early for swimming

In conclusion, identification of specific anthropometric variables with optimization of training can help in identifying talent and predict performance. Physical characteristics can be the basis for tailoring programs and strategies for swimming as an individual sport.

Limitations – Since it is a pilot study and a part of a larger study, the effects of it need to be studied in detail with a larger sample size.

DECLERATION

Ethics approval and consent to participate: Ethical clearance obtained from institutional ethics committee Ref. No. KAHER/EC/22-23

Availability of data and material: Available on request.

Competing interests: Not applicable

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