



Evaluating the Relationship between Physiological Parameters and Performance of Female Swimmers in the 200 m Individual Medley

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Abstract

Objectives. The primary objective of this study was to evaluate the selected physiological parameters and performance of female swimmers in the 200 m individual medley, analysing the contribution of selected physiological variables and construction of predictive model.

Materials and methods. The study involved forty female swimmers, who were recruited from the state of West Bengal, India. This selection specifically targeted individuals who had actively engaged in the demanding disciplines of the 200 m individual medley swimming events. Furthermore, subjects were carefully selected from the age group spanning 17 to 25 years. After quantifying physiological parameters, swimmers performed a 200 m individual medley test. A value of $\alpha = 0.05$ was used for all tests as the criterion to determine the presence or absence of significance. Pearson's product moment correlation coefficient (r) was used for assessing the various relationships of the selected variables towards the performance in the 200 m individual medley.

Results. A significant relationship was found between VO_{2max} ($r = -0.562$), body fat percentage ($r = -0.643$) and swimming performance in the 200 m individual medley event at the 1 % significance level. Multiple linear regression was used for evaluating the contribution of identified physiological variables and construction of predictive model. The regression equation was found to be reliable, as demonstrated by the value of r^2 being 0.54. The two independent variables explain 54.00 % variations in the 200 m individual medley event among female swimmers.

Conclusions. The F-value for the regression model was determined as highly significant, indicating the reliability of the model. This study provides a further understanding of the physiological variables associated with skilled performance in the women's 200 m individual medley event, which coaches should consider when training less skilled female swimmers.

Keywords: individual medley, female swimmer, VO_{2max} , body composition, regression.

Introduction

Swimming is a famous game and early beginning specialization in spite of the fact that exhibition and progress in world class swimmers rely upon different elements. Competitive swimming is formed by 50 to 1,500 m distances utilizing four individual and combined (medley) swimming methods (Pyne & Sharp, 2014). Medley swimming is a difficult and flexible discipline inside serious swimming that includes a mix of four different swimming styles in a single race. In the medley, swimmers should perform equivalent distances of every one of the four strokes in the

accompanying request: butterfly, backstroke, breaststroke, and freestyle. One of the vital physiological boundaries in sports is high-impact limit, frequently estimated through boundaries like VO_{2max} (maximal oxygen utilization) and VO_{2max} reflects the most extreme measure of oxygen a competitor can use during extraordinary activity and is an essential determinant of perseverance and cardiovascular wellness. A higher VO_{2max} shows a more noteworthy vigorous limit and the capacity to support focused energy endeavours for longer terms. VO_{2max} is utilized to assess physiological capacity and is connected with oxygen take-up, transport and use by the body, deciding as far as possible for oxidative energy creation (Poole & Jones, 2017). At the point when it is unimaginable to expect to notice a VO_{2} level, oxygen consuming capacity can be assessed by the

most elevated enrolled esteem VO_2 peak (Ribeiro et al., 2015). Body composition implies the sort and proportion of tissues which make up the body. It contains the degrees of muscle versus fat and fit body weight. Complete body weight is considered as a construction of "fat" weight and "lean" weight. Muscle to fat ratio is organized as either central or amassing fat (McArdle, Kalch & Katch, 1991). The use of skinfold thickness in the assessment of no less than one body districts is a strong strategy for perceiving the percent of muscle versus fat from lean body mass (Hoeger & Hoeger, 1992). Body composition is a term that depicts the overall extents of all fundamental parts of the body, including fat, bone, muscle, and water accumulation (Ratamess, 2012). Assessing the relationship of body composition to swim execution on the example of 280 serious female swimmers it was found that Body Level, Weight, Lean Weight (LBM), and Residual Lung Volume were in connection, which is genuinely huge yet backwards to the time recorded for the 100-yard swim (Stager & Cordain, 1984). During competitive swim season, huge increment of Lean Weight and reduction of fat mass has happened basically during the piece of the time while preparing was extreme (Meleski & Malina, 1985). Lean body mass, which essentially reflects bulk, starts to increment during early adolescence in the two genders. Fat mass, nonetheless, increments during the late phases of adolescence in young ladies. A further expansion in fat mass after pubescence might hinder swim execution in ladies. Moreover, development is prior in ladies than in men (Wheeler, 1991).

Physiological boundaries are fundamental to sports execution as they give fundamental data to competitors and mentors. Evaluations of physiological boundaries of swimmers assist with fitting preparation programs, further develop execution, and limit the risk of injuries. Competitors with an extensive comprehension of their physiological profiles are better prepared to succeed in their particular games and arrive at their maximum capacity. As far as anyone is concerned, no examinations have researched the impact of various physiologic and specialized boundaries together to decide 200 m medley swimming performance in young female swimmers. Likewise, the reason for this study was to explore the physiological boundaries as indicators to swimming execution in individual 200 m medley event. Thus, we expect to assess the distributed proof and research the connection between physiological boundaries and execution of female swimmers in 200 m individual medleys. The following research questions were examined: (I) what were the various relationships of the identified parameters with the swimming performance in 200 m Individual Medley Event of female swimmers? (II) is there the contributions of identified parameters towards the 200 m Individual Medley Event of female swimmers?

Materials and Methods

Study Participants

Forty young adult female swimmers (19.0 ± 1.0 years) took part in the study. All swimmers had a preparation foundation of five to six years and throughout the past one year they had been rehearsing for six to seven hour/week. Swimmers were enlisted from the province of West Bengal,

nearby swimming clubs on a voluntary basis. Swimmers who did not prepared for over about a month and introduced wounds or infection that could think twice about tests were barred. Furthermore, a composed informed assent was gotten from the subjects before participation.

Study Organization

Physiological Parameters Measurement and 200 m Individual Medley Swimming Test

Cardio-respiratory Fitness (VO_{2max}) was estimated by the accompanying method $VO_{2max} = 15.3 \times (HR_{max}/HR_{rest})$. MHR in this formula is calculated through $208 - (0.7 \times Age)$ and Body Composition (Body Fat %, Lean Body Mass) was estimated by Omron Karada Scan Body Composition Monitor (Model HBF-375), furnished with exclusive programming. The 200 m Individual Medley swimming performance was performed in a swimming pool, with the start of the trial taking place in the water. 200 m Individual Medley swimming performance was taken following appropriate measures as per official regulation of World Aquatics formerly known as FINA in Standard Swimming Pool and the timing was taken.

Statistical Analysis

The normality of distribution was surveyed on all information utilizing the Shapiro-Wilk test. Means, standard deviations, minimum and maximum values were calculated for all parameters. Pearson's Product Moment Correlation was applied to assess how effectively the distinguished boundary is related with the swimming performance in 200 m Individual Medley Event of female swimmers. Stepwise linear regression analyses were utilized for assessing the commitment of distinguished factors and development of prescient model. A value of $\alpha = 0.05$ was used for all tests as the criterion to determine the presence or absence of significance. SPSS for Windows, version 20.0; (SPSS Inc.; Chicago, IL) was utilized for all examinations.

Results

Before discussing the research issues the nature of the variable were analysed through Descriptive Statistics which have been presented in Table 1. Pearson's Product Moment Correlation which has been presented in Table 2. Multiple Linear Regression analysis which have been presented in Table 3.

The mean and standard deviation scores of VO_{2max} of the subjects was 36.20 ± 5.45 , standard error of mean, variance of VO_{2max} was 0.86, 29.70, for Body Fat Percentage mean and standard deviation of subjects was 15.56 ± 4.14 , standard error of mean, variance of Body Fat % was 0.65, 17.11, and for Lean Body Mass mean and standard deviation of subjects was 50.18 ± 5.35 , standard error of mean, variance of Lean Body Mass was 0.85, 28.63.

For testing the normality of the data skewness and kurtosis has been carried out. The data was found normal in the variables of Physiological parameters of female swimmers, it can be purely considered as a normal because the data sets skewness was within the permissible limit as

Table 1. Descriptive statistics on selected physiological parameters of the examined swimmers

Variables	Minimum	Maximum	Mean		Std. Deviation	Variance
	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic
VO ₂ max	26.00	52.00	36.20	0.86	5.45	29.70
Body Fat Percentage	7.20	22.40	15.56	0.65	4.14	17.11
Lean Body Mass	40.18	60.60	50.18	0.85	5.35	28.63

Valid N (listwise) 40

Table 2. Normality distribution of data

Skewness		Kurtosis	
Statistic	Std. Error	Statistic	Std. Error
0.73	0.37	1.69	0.73
-0.40	0.37	-0.71	0.73
-0.19	0.37	-0.47	0.73

the values of skewness for the data sets were less than twice the value of standard error of skewness, and hence all the variables were symmetrically distributed. Similarly, Kurtosis was also within the permissible limit as the values of kurtosis for the data sets were less than twice the value of standard error of Kurtosis. Except the variable VO₂max the value of kurtosis for the data sets were more than twice the values of standard error of Kurtosis. This demonstrates that less variety exists around their mean value.

Table 3. Pearson's correlation coefficient between physiological parameters and performance in 200 m individual medley event

Identified Variables	Correlation Coefficient female (n=40)
VO ₂ max	-0.562**
Body Fat %	-0.643**
Lean Body Mass	-0.080

** p < 0.01(2-tailed). * p < 0.05 (2-tailed). **Significant value of the correlation coefficient at 0.01 level with 38 df = 0.403.

*Significant value of the correlation coefficient at 0.05 level with 38 df = 0.312

In female swimmers, significant correlations were found between the VO₂max (r = -0.562), Body Fat % (r = -0.643) and the swimming performance in 200 m Individual Medley Event at 1 % level; found greater than critical value of r. A negative correlation was found in female between the identified parameters and swimming performance in 200 m Individual Medley Event. Whereas no significant correlations were revealed between Lean Body Mass (r = -0.080) and the

swimming performance in 200 m Individual Medley Event of female swimmers. Thus, r values of Lean Body Mass were found less than critical values of r at 5 % and 1 %, respectively.

Table 4 reveals that 200 m Individual Medley swimming performance on the basis of identified Physiological parameters. Two regression models have been presented in Table 3. After analyzing with stepwise multiple regressions method, the value of R² in the first model is 0.41. But in the second model, the value of R² is 0.54, which was highest and, therefore, second model was used to build up the regression equation. The second model two independent variables, viz. Body Fat Percentage, Lean Body Mass have been identified and therefore, the regression equation was developed based on these two variables only. Since, these two independent variables explain 54.00 % variations in 200 m Individual Medley event of female swimmers.

Table 5. ANOVA table showing F-values for all the two models

Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	9281.37	1	9281.37	26.76	0.000 ^b
1 Residual	13180.53	38	346.86		
Total	22461.90	39			
2 Regression	12129.55	2	6064.78	21.72	0.000 ^c
2 Residual	10332.35	37	279.25		
Total	22461.90	39			

a. Dependent Variable: 200 m Individual Medley (Seconds)

b. Predictors: (Constant), Body Fat Percentage

c. Predictors: (Constant), Body Fat Percentage, Lean Body Mass

n = 40; *Significant at 0.05 level

Table 5 reveals that F-values for all the models have been shown. The F-value for the second model was highly significant; it concluded that the model selected was highly efficient also. Also, the other model has significant but the value of R² for this model was less than second model.

Table 4. Model summary along with the values of R and R² for female swimmers

Model	R	R ²	Adjusted R Square	Std. Error of the Est.	Change Statistics				
					R ² Chg.	F Chg.	df1	df2	Sig. F Chg.
1	0.643 ^a	0.41	0.40	18.62	0.41	26.76**	1	38	0.00
2	0.735 ^b	0.54	0.52	16.71	0.13	10.20**	1	37	0.00

a. Predictors: (Constant), Body Fat Percentage

b. Predictors: (Constant), Body Fat Percentage, Lean Body Mass

Dependent Variable: Swimming performance in 200 m Individual Medley Event. n = 40; ** p < 0.01 and * p < 0.05

Table 6. Regression coefficients of physiological parameters to the swimming performance on 200 m individual medley event of female swimmers

	Model	Unst. Coeff.		St. Coeff.	t	Sig.	Correlations		
		B	SE	Beta			r _{xy}	Partial	Part
1	(Constant)	261.46	11.60		22.55	0.00			
	Body Fat Percentage	-3.73	0.72	-0.64	-5.17	0.00	-0.64	-0.64	-0.64
2	(Constant)	361.86	33.11		10.93	0.00			
	Body Fat Percentage	-4.60	0.70	-0.79	-6.55	0.00	-0.64	-0.73	-0.73
	Lean Body Mass	-1.73	0.54	-0.39	-3.19	0.00	-0.08	-0.47	-0.36

a. Dependent Variable: 200 m Individual Medley (Seconds)

** p < 0.01 and * p < 0.05. (Abbreviations: Unst. Coeff. – Unstandardized Coefficients, St. Coeff. – Standardized Coefficients, SE – standard error, r_{xy} – Zero-order)

Table 6 reveals that the unstandardized and standardized regression coefficient in all the two models. In the second model t-values for the entire regression coefficient were significant as there significant values (p-values) were less than 0.01. Thus, it concluded that the variables; Body Fat Percentage, Lean Body Mass significantly explains the variations in the 200 m Individual Medley swimming performance of female swimmers. In order to know which is the most contributing predictor in the model out of those two variables we should look for Beta Coefficient in Table 6. Larger the absolute value of Beta coefficient more is the contribution of that variable in the model. Thus, Body Fat Percentage is the most contributory predictor in the model.

Regression Equation

The unstandardized regression coefficients (B) of the second model shown in Table 5, the regression equation was developed which was:

$$\text{Performance in 200 m Individual Medley Event (Female)} = 361.86 - 4.60 \times (\text{Body Fat \%}) - 1.73 \times (\text{Lean Body Mass})$$

Discussion

Present study was directed with the reason to research the connection between physiological parameters and performance of female swimmers in 200 m individual medleys. For simplicity of conversation and lucidity in understanding the discoveries has been talked about. Results uncovered that some of the physiological parameters, significant correlations were found between the VO₂max (r = -0.562), Body Fat % (r = -0.643) and the swimming performance in 200 m Individual Medley Event at 1% level; found greater than critical value of r. One more review showed relationship between ladies' swimming presentation and level, percent body endlessly fat free weight in competitive collegiate swimmers (Siders, Lukaski, & Bolonchuk, 1993). Youth swimming performance might be impacted by anthropometric, physiology and specialized factors. Execution of youthful swimmers in the 100 meters front crawl is resolved overwhelmingly by physiological factors and swimming procedure (Vitor & Böhme, 2010). The hypothesis as stated earlier that there may be significant relationship of identified variables to the performance in 200 m individual medleys and the identified variables may significant contributors of 200 m individual medleys. Whereas no significant correlations were revealed

between Lean Body Mass (r = -0.080) and the swimming performance in 200 m Individual Medley Event of female swimmers. The detriment of having higher fat mass proposes that swimmers require more prominent lean body mass and more prominent muscle solidarity to push them quicker through the water. In equal, higher fat mass might force expanded upsides of body cross-sectional region and, thusly, complete drag. A bigger lean weight and, in this manner, a more prominent bulk, could emphatically impact biomechanical values by upgrading the power applied in every upper appendages cycle (Pelayo, Sidney, Kherif, Chollet, & Tourny, 1996). Expanding muscle size and improvement of muscle contractile quality, and diminishing fat mass, at a degree of ideal equilibrium, may affect swimming execution, and is probably going to be significant for boosting serious swimming execution. Also, occasional swim execution changes will generally follow changes in bulk, so customary control of body piece during the season might be useful and helpful to progress preparing and execution (Roelofs, Emith-Ryan, Trexler, & Hirsch, 2017). Table 3 reveals that 200 m Individual Medley swimming performance on the basis of identified Physiological parameters. After analyzing with stepwise multiple regressions method the value of R² in the first model is 0.41. But in the second model, the value of R² is 0.54, which was highest and, therefore, second model was used to build up the regression equation. The second model two independent variables, viz. Body Fat Percentage, Lean Body Mass have been identified. Since, these two independent variables explain 54.00% variations in 200 m Individual Medley event of female swimmers which are relatively excellent. Jürimäe et al. (2007) uncovered that in-water VO₂peak (R² = .358), and arm span (R² = .454) were the best indicators of swimming execution. The retrogressive extrapolation technique could be utilized to survey VO₂peak in youthful swimmers. Arm span, and VO₂peak give off an impression of being the significant determinants of front-crawl swimming performance in youthful swimmers. In our study, the F-value for the second model was highly significant; it concluded that the model selected was highly efficient also. In the second model t-values for the entire regression coefficient were significant as there significant values (p-values) were less than 0.01. Thus, it concluded that the variables; Body Fat Percentage, Lean Body Mass significantly explains the variations in the 200 m Individual Medley swimming performance of female swimmers. In order to know which is the most contributing predictor in the model out of those

two variables we should look for Beta Coefficient in Table 5. All the more by and large many swimming trainers regularly advocate around 15 % body fat as an upper-end cut-off for elite female swimmers. The body fat percentage of a functioning competitor is many times below the normal individual. Anyway, in our review we can obviously saw that the mean worth of Body Fat Percentage was 15.56 %, which is good enough. From the investigation of Santos et al. (2014), showed that the worldwide sprint swimmers both men and women are taller, with less body fat, with lower body mass index, yet with a more significant level of contractile, i.e., muscle mass, than national level swimmers. Body fat influences swimming pace in various ways. Since fat is less thick than other body constituents, expanding body fat will in general make you lighter, which can lift you higher in the water, diminish drag and maybe make swimmer quicker. In competitors, weight can be a mark of the dynamic bulk. In any case, an expansion in weight can likewise be a mark of high upsides of muscle mass. However, an increase in body mass can also be an indicator of high values of body fat mass. Muscle mass can represent body strength of the swimmer; on the off chance that these qualities are low, a decline in swimming execution might be normal. It ought to be viewed as that weight doesn't recognize and address lean weight or muscle versus fat mass extents thus, for a more definite assessment; these factors ought to be estimated freely.

Conclusions

Considering the purpose along with objectives of the study, based on the analysis and within the limitations of present investigation, conclusions derived were: The selected average values of different identified variables had contribution at the time of 200 m individual medley. Result of the minimum and maximum scores was provided a boundary of identified variable scores at the time of swimming. The physiological parameter namely VO_2 max, and Body Fat Percentage was found significantly related with the swimming performance in 200 m Individual Medley Event at 1 % level. Body Fat Percentage and Lean Body Mass were valid in estimating the performance in 200 m individual medley swimming. The model developed in the present study helps the professionals for predicting the swimming performance of the female in 200 m medley. In this dimension there is lack of critical literature and thus demands focus for future researches. Such research is essential to develop separate coaching protocols for 200 m individual medley and should be pursued in many aspects of sports physiology. We hope this study has distinguished the need to make more extensive the strategy utilized while attempting to improve any brandishing execution.

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Conflict of Interest

The authors declare that they have no conflicts interests.

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Оцінювання взаємозв'язку між фізіологічними параметрами та результативністю плавчинь в індивідуальному комплексному плаванні на дистанції 200 м

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; Е – збір коштів

Реферат. Стаття: 6 с., 6 табл., # рис., 15 джерел.

Мета дослідження. Основна мета цього дослідження полягала в оцінюванні обраних фізіологічних параметрів і результативності плавчинь, які беруть участь в індивідуальному комплексному плаванні на дистанції 200 м, аналізуючи вплив обраних фізіологічних змінних і побудову прогностичної моделі.

Матеріали та методи. Для проведення дослідження було відібрано сорок плавчинь зі штату Західна Бенгалія (Індія). Даний відбір був спеціально орієнтований на осіб, які активно брали участь у змаганнях з індивідуального комплексного плавання на дистанції 200 м, що є складною дисципліною, яка вимагає від спортсменів значних зусиль. Крім того, суб'єктів дослідження було ретельно відібрано з вікової категорії від 17 до 25 років. Після проведення кількісної оцінки фізіологічних параметрів, плавчині виконали тест на дистанції 200 м індивідуальним комплексним плаванням. Значення $\alpha = 0,05$ було застосовано для всіх тестів як критерій визначення наявності або відсутності значущості. Коефіцієнт кореляції Пірсона (r) застосовувався для оцінки різних взаємозв'язків обраних змінних стосовно показників результативності в індивідуальному комплексному плаванні на дистанції 200 м.

Результати. Встановлено значущий взаємозв'язок між показниками максимального споживання кисню (VO_{2max}) ($r = -0,562$), відсоткового вмісту жиру в організмі ($r = -0,643$) та результативністю в індивідуальному запливі на дистанції 200 м комплексним плаванням на рівні значущості 1%. З метою оцінки впливу ідентифікованих фізіологічних змінних та побудови прогностичної моделі застосовано метод множинної лінійної регресії. Регресійне рівняння виявлено достовірним, про що свідчить значення r^2 , яке становить 0,54. Дві незалежні змінні пояснюють 54,00% варіацій у змаганнях з індивідуального комплексного плавання на дистанції 200 м серед жінок.

Висновки. Встановлено високу значущість F-критерію для регресійної моделі, що вказує на її достовірність. Представлене дослідження забезпечує подальше розуміння фізіологічних змінних, пов'язаних з кваліфікованим виступом у змаганнях з індивідуального комплексного плавання на дистанції 200 м серед жінок, що тренери мають враховувати у процесі підготовки менш кваліфікованих плавчинь.

Ключові слова: індивідуальне комплексне плавання, плавчиня, максимальне споживання кисню (VO_{2max}), композиція тіла, регресія.

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