Effect of Specific Training Program on Selected Performance Related Parameters of Young Swimmers: An experimental Study

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Abstract

Background/objective: This study aimed to examined the effects of specific training on the swimming performance, stroke rate, swim velocity, stroke length and stroke index of young swimmers. Methods: Fifteen (n=15) male young swimmers (age: 15.21±0.77 years, height: 166.06±3.86 cm, weight: 53.62±2.44 kg, 74.60 ± 3.64 sec) was purposively selected for this study. The experimental group performed swimming training (5 session per week of 80 min to 130 min for 24 weeks). Swimming performance, stroke rate, swim velocity, stroke length and stroke index were recorded during 100m free-style time trails. All performance related parameters were evaluated before, after twelve weeks and after end of twenty-four weeks of specific training. Results: the results showed a significant improvement in swimming performance (p<0.04), swim velocity (p<0.03), stroke length (p<0.001) and stroke index (p<0.002) but no significant changes in stroke rate (p>0.16). Conclusions: From the findings, of the present study it may be safely concluded that considerable time of training period may have a significantly enhanced of performance related parameters. The swimmers were able to perform at the same physiological intensity at higher velocities and with lower stoke rate.
Keywords: *Swimming Performance, Stroke Rate, Stroke Length, Swim Velocity, Stroke Index*

1. Introduction

Swimming is an individual or team sport that requires the use of one’s arms and legs to move the body through water with unique physiological and biomechanical demands due to the different racing distances. Despite the short distance of the majority of racing events, the traditional training practice of competitive swimmers mainly involve high training volume. This is mainly evident that the young level, where training volume may range from 11 to 20 hours per week and 6 to 11 training sessions (Nugent, et al., 2019).

Swimming performance is determinates by a number of different physiological and biomechanical parameters (Barbosa, et al., 2019) biomechanical parameters such as swim velocity (SV), stroke rate (SR), stroke length (SL) and stroke index (SI) are the best determinants of swimming performance (Barbosa, et al., 2019). It is seemed that the various factors affecting swimming performance in swimmer may help in developing appropriate training plans that may facilitated long-term success at a later age. A well-planed training plan is a key factor for competitive performance and this should be effectively applied early age (Costa, et al., 2011; Smith, 2003). The long-term training plan is normally divided into shorter periods, swimming performance changed occurring within a specific training period in swimmers may be attributed to a combination of factors such as physical, anthropometry, biomechanics, hydrodynamic and physiological changes that may be vital in some training periods but not in others depending on the periodization applied (Silva, et al., 2012; Morais, et al., 2016; Clemente-Suarez, et al., 2018).

Previous some research reports in swimming training including children and young swimmers focused mainly on short duration performance relative to change in anthropometric, hydrodynamic biomechanical variables (Silva, et al., 2012; Morais, et al., 2016; Barbosa, et al., 2019; Sperlich, et al., 2010; Gourgoulis, et al., 2019). The results of these studies highlight the importance of the hydrodynamic factors change relative to training periodization (Barbosa, et al., 2019), despite a great intra-swimming variation in technical variables (Morais, et al., 2016).

To achieve the competition success at any level of competition, swimmers must include a specific training schedule to maintain or increased strength and power, improve movement pattern and limit the risk of injury (Newton, et al., 2002; Pelot & Darmiento, 2012). The application of muscular force in swimming results in a horizontal displacement of the swimmers at a velocity proportional to the magnitude, and duration of the resulting force. The prime objectives of the mechanical work performed by an athlete are to overcome hydrodynamic resistance, which increased proportionally with the square of velocity. Therefore, any increase in swimming velocity demands a proportional increment of muscular force to overcome active drag and increase propulsive force (Vorontsov, 2011). Increments in muscle strength should theoretically translate into increased ability to generate propulsive force in the water, but theoretical aspects of swimming stroke mechanics were also determined the extent to which increased force transfers into faster swimming velocity (Riewald & Rodeo, 2015; Girold, et al., 2007; Hawley, et al., 1992; Tanaka & Swensen, 1998).

2. Materials and Methods

2.1. Study location

The present study was carried out in the Nimpith Vivekananda Sports Association, South 24 Parganas, West Bengal, India.

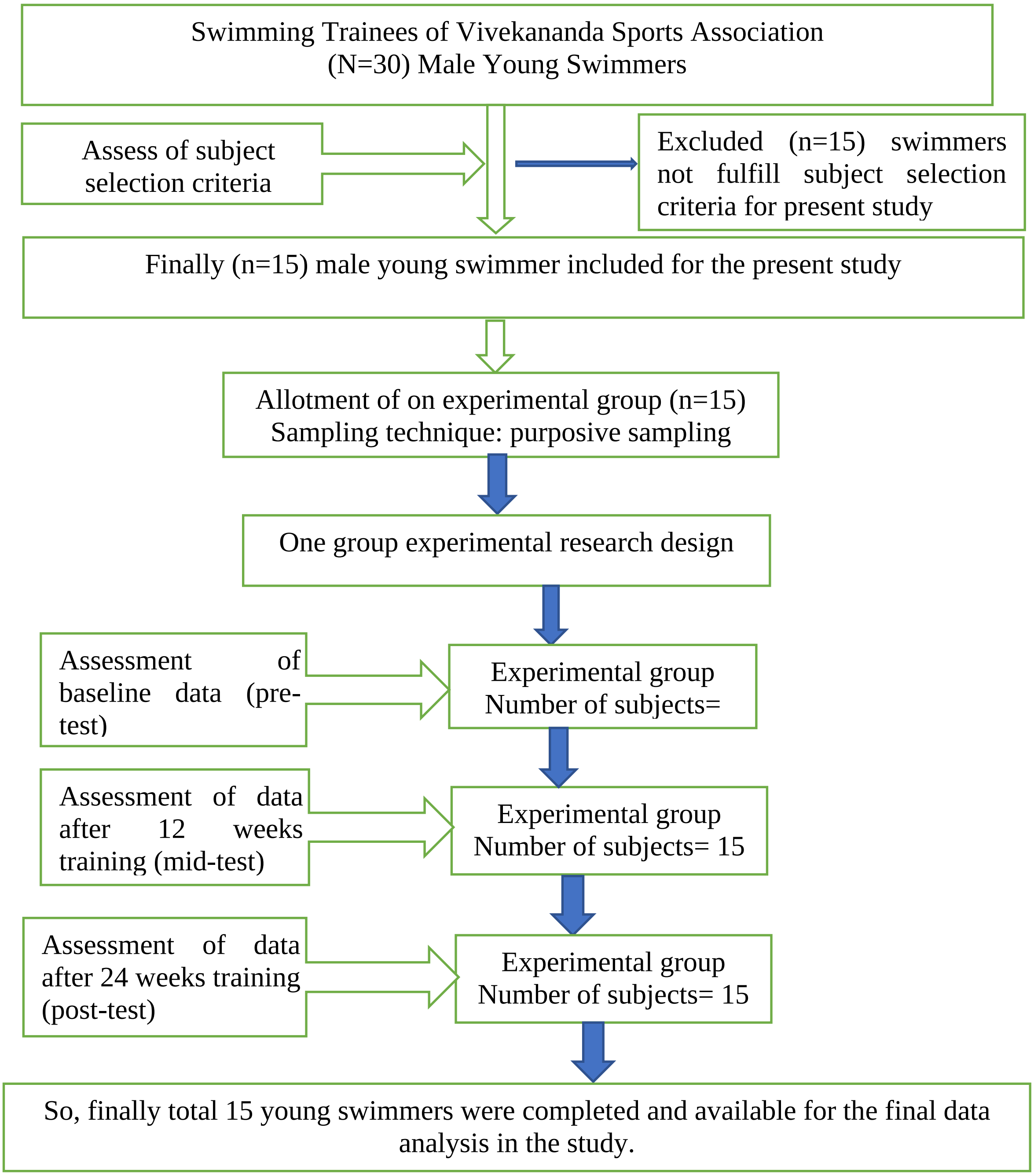
2.2. Population

The target population was young male sprint swimmers.

2.3. Subjects:

Fifteen (n=15) districts level male swimmers were participated in the present study (mean ± SD were: age 15.21±0.77 yrs., height 166.06±3.86 cm, weight 53.62±2.44 kg, tanner age 3.53±0.51 yrs.). All swimmers of the south 24 parganas districts sports association, participated in the study. All swimmers' parents were informed about the purpose and design of the study and signed informed consent prior to commencement of the study which was conducted in accordance with the declaration of Helsinki for research with human subjects and approved by the Institutional Bioethical Committee (Hurip Independent Bioethics Committee, 2018).

2.4. Experimental design:
The study was assigned as a one group experimental design consisting of a pre-test, mid-test and post-test. Within twenty-four weeks training period, swimmers were tested in three different moments: at the beginning of the training period (T1), at the end of twelve weeks (T2) and at the end of twenty-weeks (T3). The training content of each period is indicated in Table 2. All testing procedures mentioned in Table 3.



2.5. Swimming Training:
a self-design training program for young swimmers was employed for 24 weeks. The training program segregated into 3 phases (a) general preparation, (b) specific

preparation and (c) pre-competition. Further training program subdivided into 5 training zones (i) aerobic training zone (aerobic-1, aerobic-2, aerobic-3), (ii) anaerobic threshold training zone, (iii) high-performance endurance training zone (critical speed, lactate removal, MVO_2), (iv) anaerobic training zone (lactate production, lactate tolerance, peak lactate) and (v) sprint training zone. The training intensities and volume of the training elements changed in each phase of training. In general preparation, training intensity and volume progressively increased. In specific preparation, training volume decreased and training intensity gradually increased. In pre-competition, training volume gradually decreased and training intensity progressively increased. The swimmers were participated in their specific training program under the supervision of expert by given respective training to the subjects 5 sessions of swimming training programme (off Monday & Thursday) per week.

Table 1 Anthropometric characteristics of young swimmers that participated in the present study

Sl. No.	Measured variables	Mean ± Standard deviation
1.	Chronological age (years)	15.21±0.77
2.	Height (cm)	166.06±3.86
3.	Weight (kg)	53.62±2.44
4.	Tanner stage (years)	3.53±0.51

Table 2 Allotment of duration and for each part of the training programme

Phase of training	General preparation		
Training zone	**Aerobic** (Aerobic-1, Aerobic-2, Aerobic-3)		
Content of training	1st - 4th weeks	5th - 8th weeks	9th - 12th weeks
Duration/day	**80 mins**	**100 mins**	**120 mins**
Warm-up	50 mins	50 mins	50 mins
Technical (skills)	100 mins	150 mins	175 mins
Aerobic Endurance	100 mins	125 mins	150 mins

Strength endurance	75 mins	100 mins	125 mis
Anaerobic power	25 mins	25 mins	50 mins
Speed	25 mins	25 mins	25 mins
Tactical	-	-	-
Recovery	25 mins	25 mins	25 mins
Duration/week	**400 mins**	**500 mins**	**600 mins**
volume	40%		
Intensity	60-75%		

Phase of training	**Specific preparation**		**Pre-competition**	
Training zone	**Anaerobic threshold**	**High-performance endurance** (critical speed, lactate removal, MVO_2)	**Anaerobic** (lactate production, lactate tolerance, peak lactate)	**Sprint**
Content of training	13th - 16th weeks	17th - 20th weeks	21st - 22nd week	23rd - 24th week
Duration/day	**130 mins**	**120 mins**	**110 mins**	**90 mins**
Warm-up	50 mins	50 mins	50 mins	75 mins
Technical (skills)	175 mins	150 mins	60 mins	-
Aerobic Endurance	150 mins	125 mins	50 mins	25 mins
Strength endurance	125 mis	100 mins	75 mins	-
Anaerobic power	75 mins	100 mins	150 mins	100 mins
Speed	50 mins	50 mins	100 mins	150 mins

Tactical	-	-	20 mins	50 mins
Recovery	25 mins	25 mins	50 mins	50 mins
Duration/week	**650 mins**	**600 mins**	**555 mins**	**450 mins**
Volume	35%		25%	
Intensity	75-85%		85-95%	95-100%

Table 3 measurement procedure of performance related parameters in the present study

Sl. No.	parameters	Tests /Tools Administered	Unit of measurement
1.	Swimming performance	100m freestyle	Time (Sec)
2.	Stroke rate	Stroke Rate = 60x3/tSR	cycle.m
3.	Swim velocity	Swim velocity $=\frac{S}{t}$	(m · s-1).
4.	Stroke length	Stroke Length= $\frac{Vx60}{SR}$	m.cycle
5.	Stroke index	Stroke Index = V x SL	m2. (s. cycle)-1

2.5. Statistical Analysis

The data collected from the different tests and measurements were statistically treated for analyses adopting procedure. Mean and standard deviations was first computed for each variable separately.

For comparison among the means of a variable within the group Analysis of Variance (One-Way ANOVA) was applied. Wherever the F-ratio was found significant, Least Significant Difference (L.S.D) Post Hoc test was applied. Significance for all analyses was set at $p<0.05$.

3. Results

This study enrolled a total of fifteen (n=15) young competitive swimmers. The mean and standard deviation values for all outcome measures 100m swimming performance, swim velocity, stroke rate, stroke length and stroke index are summarized in **Table 4**.

Table 4 shows the effect of 24 weeks self-designed swimming training program on swimming performance, swim velocity, stroke length and stroke index in young swimmers.

In the present study, swimming performance, swim velocity, stroke length and stroke index statistically significant increased from T1 to T2 and T3, In, stroke rate no statistically changes from T1 to T2, and T2 to T3.

Table 4. effect of 24 weeks swimming training on swimming performance, Swim Velocity, Stroke Rate, Stroke Length and Stroke Index young swimmers

Variables	T1	T2	T3
Swimming performance (sec)	74.60 ± 3.64	73.06 ± 3.67*	71.13 ± 3.71†
Swim velocity (m · s-1)	1.34 ± .06	1.37 ± .07*	1.41 ± .07†
Stroke rate (cycle.m)	63.93 ± 2.96	62.80 ± 3.16*	61.73 ± 3.19†
Stroke length (m.cycle)	1.26 ± .07	1.31 ± .08*	1.37 ± .08†
Stroke index (m2. (s. cycle)-1)	1.69 ± .16	1.80 ± .18	1.95 ± .20‡

T1= before training, T2= after 12 weeks of training, T3= end of 2 weeks of training
*** significant difference (p<0.05) from T1 to T2**
†significant difference (p<0.05) from T2 to T3
‡ significant difference (p<0.05) from T1 to T3

4. Discussion

The result of the study indicates that swimming performance, swim velocity, stroke length and stroke index significantly increased and stroke rate no significantly changes during the specific training period.

The result of the study indicate that swimming performance significantly increased through over the specific training period. Regarding effect of training on swimming performance change may be observed among the researchers while, Strzala & Tyka (2007) observed that significantly influences somatic and functional factors on freestyle swimming techniques in case of young swimmers. Strass (1986), reported that the 7.3% improved in 50m freestyle with the intervention group after a heavy, explosive strength training program.

Many researchers reported that specific different swimming training program significantly enhanced the swimming performance of different ages of swimmers (Ferreira, et al., 2019; Gourgoulis, et al., 2019; Patel, et al., 2019; Girold, et al., 2012). Other some studies consistent with present finding (Arroyo -Toledo, et al., 2013; Darchini, et al., 2019; Garrido, et al., 2010; Karpinski, et al., 2019).

The result of the study indicate that swim velocity significantly increased through over the specific training period. Regarding effect of training on swim velocity change may be

observed among the researchers while, some research reports consistent with present study (Karpinski, et al., 2019; Patil, et. al., 2014; Toussaint & Vervoorn, 1990; Girold, et al., 2006; Strzala & Tyka, 2007). These studies observed that significantly increased in swim velocity after half year training period of young swimmers. (Wakayoshi, et al., 1993; Gourgoulis, et al., 2019; Stachowicz, et al., 2011; Garrido, et al., 2010; Morais, et al., 2016).
The result of the study indicate that stroke rate slightly decreased, but statistically no significant decreased through over the specific training period. Regarding effect of training on stroke rate change may be observed among the researchers (Karpinski, et al., 2019; Patil, et al., 2014; Strzala & Tyka, 2007; Aspenes, et al., 2009; Schnitzler, et al., 2014). A study from (Girold, et al., 2006) compared weight assisted training to dry-land strength training in an addition to common swimming training in highly trained collegiate swimmers. It was observed that no changes accrued in stroke rate. Sadowski, et. Al. (2012), (Sadowski, et al., 2012) randomly assigned twenty-six male swimmers to either a swimming or dry-land power training (experimental group) or swimming only (control group). it was observed that stroke rate decreased, but statistically insignificant.
The result of the study indicate that stroke length significantly increased through over the specific training period. Regarding effect of training on stroke length change may be observed among the researchers (Patil, et al., 2014; Arroyo -Toledo, et al., 2013; Strzala & Tyka, 2007; Wakayoshi, et al., 1993; Schnitzler, et al., 2014). These studies opined that high velocity resistance training more beneficial for improvement in the efficiency of swimming elements, which translated into the final swimming performance (Ferreira, et al., 2019; Nugent, et al., 2019; Roberts, et al., 1997).

The result of the study indicate that stroke length significantly increased through over the specific training period. Regarding effect of training on stroke length change may be observed among the researchers while, some research reports consistent with present study (Ferreira, et al., 2019; Nugent, et al., 2019) opined that stroke index, recognized practical and valid index of technical efficiency that improves with swimming training progression, showed the best correlation with 400m swimming speed. It mentioned that stroke index was a significant determinant of swimming performance chances. Researchers opined that swimming performance is determined by a number of different physiological and biomechanical parameters such as stroke index and other strike mechanics (Lopes, et al., 2020; Morais, et al., 2016; Patil, et al., 2014).

Limitations of the study

i. There have no control group.
ii. The study participants did not attend any residential camp.

5. Conclusion

According to the results of the present study, it is possible to assumed that the increments in intensity and volume of training that normally occur during a swimming training period may lead to swimming performance, that is strictly related to the stroke rate, stoke length, swim velocity and stroke index. It was assumed that technical ability was improved during the specific training period. The swimmers were able to perform at the same physiological intensity at higher velocities and with lower stoke rate.

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Conflicts of Interest: the authors declare no conflict of interest.

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