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Effects of 3 month dietary intervention on nutritional & fitness profiles of 8-21y old competitive swimmers

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Abstract
Aim: To study the effects of 3 months dietary intervention on Nutrition Knowledge, Pre-During-Post Swim Nutritional Intake & Fitness profiles of 8-21 y old Competitive Swimmers.
Methods: 29 competitive swimmers were selected via purposive sampling. Nutrition knowledge survey was administered, 3d diet recall was analyzed for pre-during-post swim meal intake and fitness profile was assessed (body composition, swimming performance and fitness tests). Individualized diet plan (CHO: 5-7g/Kg/BW/d, Protein: 1.2-1.4g/kg/BW/d, Fat: 20-35% and pre-training: low GI, moderate protein, low fat, during: isotonic drink/water, post training: high GI, high protein, low fat) was prescribed & monitored weekly for 3 mo. Six Nutrition education sessions were arranged, post which all above parameters were re-assessed.
Observations: Significant improvements in macronutrient intake and quality of pre-during-post swim meals were observed post intervention. Mean swimming performance of all swimmers improved by 1.56 ± 2.58 seconds.
Results: Nutrition knowledge score improved significantly (Paired $t_{\text{two tailed}} = -5.97$, p=0.000). In males, significant improvements were noted in critical swim speed (Paired $Z_{\text{two tailed}} = -2.93$, p=0.003), sit & reach (Paired $Z_{\text{two tailed}} = -2.65$, p=0.008), sit ups (Paired $Z_{\text{two tailed}} = -2.99$, p=0.003), squats (Paired $Z_{\text{two tailed}} = -3.06$, p=0.002), right (Paired $Z_{\text{two tailed}} = -0.80$, p=0.421) and left (Paired $Z_{\text{two tailed}} = -2.76$, p=0.006) hand grip strength; for females, in sit & reach (Paired $Z_{\text{two tailed}} = -2.02$, p=0.043), push-ups (Paired $Z_{\text{two tailed}} = -2.0.3$, p=0.042) & squats (Paired $Z_{\text{two tailed}} = -2.02$, p=0.043). No significant improvements in body composition were observed.
Conclusion: The 3 month dietary intervention program improved nutrition knowledge, composition & nutrient intake of pre-during-post swim meals, swimming performance and fitness profile of 8-21y old competitive swimmers.

Keywords: Competitive swimmers, dietary intervention, pre-during-post swim meals, fitness status

Introduction
Swimming is an Aquatic Sport, internationally managed by the World Governing Body for Aquatic Sports; Federation Internationale De Natation (FINA) and by The Swimming Federation of India (SFI) in India [1, 2]. Swimming involves four strokes which are Free Style, Back Stroke, Breast Stroke and Butterfly. Competitive races involve 50, 100, 200 m for all strokes with free style being additionally competed at 400, 800 & 1500 m distances. Individual Medley (a combination of all four strokes) and Relays are organized at distances of 200, 400 m and 100 and 200 m respectively [2]. Most swimmers learn to swim at an early age, transitioning to competitive training involving large volume and high intensity practice sessions to develop biomechanical technique, physiological abilities and speeds [3]. A Swimmer with an ideal fitness profile is likely to perform better than a swimmer with a disturbed one. Anthropometry has been positively related to stroke rate, stroke length and stroke velocity [4-7]. Highly significant relationships were found between the 50 & 400 m freestyle sprint and the mean power of arms & legs [8]. Flexibility is important for stroke form especially in the recovery and pull phase. It reduces injury and prevents asymmetry [9-11]. Vo2 max is very closely related to a 400 m swimming performance [12] & critical swim speed is often 91-95% of the 400 m swim in trained swimmers [12-14]. Being deficient in one of the most important aspects; Nutrition, would certainly expose the competitive swimmer at risk of physical injury, psychological harm [15] along with poor recovery, diminished health and ultimately altered performance.

Nutrition knowledge of swimmers has been found to be average or poor [16-19], but Athletes, who had higher nutrition knowledge, had better dietary practices [17, 20]. Macronutrient distribution involved carbohydrates as 36% of total energy intake & fats as 42% of total energy intake [21-22]. As per the FINA-Yakult Consensus Statement on Nutrition for the Aquatic Sports 2014, "An effective nutrition plan is critical to success in all aquatic sport disciplines for athletes at every stage of their development'' [15]. There is no "one particular diet" for optimal sports performance. However, sound nutritional guidelines must be followed in planning and evaluating food intake of an athlete [23]. Energy demands vary from day to day, across the season and depend on training load and competition schedules [24]. A diet that provides adequate energy from a wide range of commonly available foods can meet the macronutrient and micronutrient requirements of training and competition and help athletes reach optimum body size and body composition to achieve greater success in their sport [24]. Young high performance swimmers often spend their early mornings in swimming practice followed by attending schools or colleges, then returning back home, going to a gymnasium or undergoing dry land training, followed by another 2 hours of practice late evening [25pp240]. Poor hydrated states develop lower blood volumes, and force the heart to work harder to bring oxygen and nutrients to the cells producing faster increase of metabolic waste products. Higher muscle glycogen synthesis is needed to re-fuel lost muscle glycogen for the next training session and support anaerobic glycolysis observed during 50 and 100 m sprints [25]. Higher Protein synthesis rates are important since higher amounts of stress during training lead to breakdown of lean body mass [26]. Globally, research regarding nutrition and aquatic sports is under-developed with a few evidence based essential principles being established [2, 3, 24, 27-31]. Hence, this study was carried out to study the effects of 3 months dietary intervention program on Nutrition Knowledge, Pre-During-Post Swim Nutritional Intake & Fitness profile of 8-21 y old District, State, National & International Swimmers from Mumbai and Thane.

2. Materials and Methods

2.1 Study design & subjects

This study has a pre-experimental (one group pre test post test), descriptive and action research design. Twenty-Nine competitive swimmers were selected via purposive sampling from different sports clubs in Mumbai & Thane out of which 18 completed a dietary intervention program. 7 lacked time and 4 were withdrawn due to failure of adherence to the program. The inclusion criteria involved the subjects to be between the age group of 8-21 years, District/ State/ National/ International level swimmers, without medical condition(s) and disability and members of a Swimming Pool. Subjects who failed to qualify in the inclusion criteria were excluded from the study. The study extended from July 2015 to January 2016 including the 3 month dietary intervention protocol. Written informed consent was obtained from all participants or from their parents. The study was approved by Nirmala Niketan College of Home Science- Institutional Ethics Committee (NNCHIEC-2015-MSSN-01)

2.2 Baseline: Nutrition Knowledge and Nutrient intakes

The survey instrument was developed from a combination of previously administered questionnaires [16, 18, 20, 32, 33, 34]. The questionnaire had 68 nutrition knowledge questions to which participants answered 'true'/ 'false'/ 'I don't know'. For the assessment of nutritional knowledge, correct answers were given a score of '1' and incorrect answers a score of '0'. A three day diet recall involving two weekdays and one weekend was obtained from the participants through interview method. The three day diets were then analyzed for energy and nutrient intake (protein, fat, carbohydrate, calcium, phosphorous, iron, carotenoid, Vitamins B1, B2, B3, B6, folate, Vitamin C and total dietary fiber) including pre-during-post swim meals (energy, protein, fats, carbohydrates) using Nutritive Value of Indian Foods, NIN (2011) [43]

2.3 Baseline: Fitness Profile

Anthropometric measurements {Height (cm), BMI [Weight (kg)/ height (m2)]} were assessed as per 'Kinanthropometric Assessment, Guidelines for Athlete Assessment in New Zealand Sport' [35]. Body Weight (kg) & Composition [Body fat & skeletal muscle distribution in arms, trunk, legs, and whole body, Resting Metabolic Rate (kcal)] was assessed using Bioelectrical Impedance Analysis (BIA) method with the Omron Body fat analyzer. Aerobic capacity was assessed through 'critical swim speed' (CSS) as per the norms provided by Ginn, 1993 [13, 14]. Muscle strength was assessed using hand grip dynamometer for which procedures were adapted from the Lafayette Instrument Owner's Manual from tests on more than 2000 subjects, 1986 [36]. Muscle endurance was assessed with curl up, pushups & squat tests according to the procedures given by the Government of India National Physical Fitness Program for school children [37], ACSM's Guidelines for Exercise Testing & Prescription [38] and brainmac sports coach [39] respectively. Flexibility was assessed through sit and reach test as per the procedures and norms given by The Government Of India, National Fitness Program for School children [37]. Swimming performance was assessed through the improvement in time (seconds) from the first (pre-study) and last (post-study) swimming competition.

2.4 Dietary Intervention

2.4.1 Individualized Diet Plan with focus on pre-during-post swim meals

Post the evaluation of nutritional habits, an individualized diet plan modifying daily dietary habits was prescribed for each swimmer. The recommended energy requirements, macronutrient quality & quantity including pre-during-post swim meals and hydration guidelines were determined through, NCAA Sports Medicine Handbook (2010-2011) [40] & Hydration Guidelines for Excellence in Sports Performance (ILSI- India, NIN, SAI) [23]. A 3 month diet monitoring sheet in order to record pre-during-post training meals was provided to swimmers and was checked weekly.

2.4.2 Nutrition Education Sessions

Six Nutrition education sessions were arranged discussing significance & effect of macronutrients & micronutrients on performance, supplement intake & effects on health & performance, pre-during-post swim meal recipes & nutrient composition, body weight regulations and food label reading.

Post the completion of 3month dietary intervention & nutrition knowledge sessions; nutrition knowledge, 3d diet recall for energy & nutrient intake including pre-during-post swim meals and fitness profiles were re-assessed.

2.5 Statistical Analysis

Eighteen subjects who completed the intervention were analyzed, following per-protocol analysis through a statistical package of Social Sciences (SPSS) version 16. Descriptive statistics- Frequencies, percentages, measures of centre & measures of variability were computed & Advance statistics-

Check for normality & equality of variances, non-parametric tests were used to check if the departure from normality and homogeneity was significant. Paired t test & Paired Z test was used for contrasting dependent variables.

3. Results and Discussions

3.1 Demographic & Training Related Information

Twenty (69%) male and 9 (31%) female swimmers participated in the study. Of those, 22 (75.9%) went to school and 7 (24.1%) were college-goers. The most recent grade achieved by 6 (20.7%) swimmers was highest grade 'O', 15 (51.7%) received 'A' and 1 received 'D'. This data may suggest the contribution of sports towards cognitive development.

At baseline the mean body weight (Kg) of male swimmers was 50.70 ± 12.11s.d. And of females, was 47.28 ± 16.51 s.d. Mean height (cm) of male swimmers was 160.19 ± 14.88 s.d. and of females was 151.20 ± 15.89 s.d. Six (20.7%) competed at District, 7 (24.1%) at State, 15 (51.7%) at National and 1 (3.4%) at International level. Training schedule involved 22 (75.9%) swimmers practicing 6-7 times/week, 5 (17.2%) for 4-5 times/week and 2 (6.9%) for 2-3 times/week with 26 (89.7%) swimmers practicing once/day. Duration of swimming practice was 1-2 hours for 18 (62.1%) swimmers, 2-2.5 hours for 10 (34.5%) swimmers and 2.5-3 hours for 1 (3.4%) swimmer.

3.2 Effect of 3 month Dietary Intervention

18 swimmers who completed the dietary intervention failed to attend swimming practice for 1 week to 1 month because swimming pools stayed shut due to drought. Of the total 3 months intervention, swimmers followed the diet for a mean of 45 days with the lowest reported diet followed days of 18 and highest reported days of 69.

3.2.1 Nutrition Knowledge

Nutrition awareness plays a crucial role for athletes as they are required to follow a daily diet for performance improvement. In this study, 28 (96.6%) swimmers were unaware of the amount of calories to be consumed/ day to promote athletic performance. The National Institute of Nutrition recommends consumption of 70 and 80 kcal/ kg body weight/day for sprint swimmers (< 200m) and long distance swimmers (> 200m) respectively. Twenty five (86.2%) swimmers felt having a Sports Nutritionist at their clubs would be helpful to them while 4 (13.8%) were unsure. Eating habits of swimmers differed with 16 (55.2%) being omnivorous, 7 (24.1%) lacto-vegan, 5 (17.2%) semi-vegetarian and 1 (3.4%) lacto-ovo-vegetarian. The impact of 6 nutrition education sessions on nutrition awareness of 18 swimmers was assessed through changes in nutrition knowledge questionnaire score from baseline to post intervention. An improvement from pre nutrition knowledge score to post was observed. The mean nutrition knowledge paired difference was -11.0556 ± 7.85510 standard deviation of difference. Mean nutrition knowledge score at baseline was 33.2222 and the same improved to 44.2778 post intervention and this increment was very highly significant (Paired $t_{\text{two tailed}} = -5.971$, $p<0.001$). There is an increased need for sports nutrition counseling in order to improve nutrition knowledge of many athletes [16, 41pp560]. Misinformation spreads at a higher rate through electronic and print media and there is faddism and ignorance [41pp560].

3.2.2 Daily Energy & Nutrient Intake

The mean total daily energy (kcal) intake was observed to be 2295.3 ± 444.64 s.d. for male and 1707.1 ± 437.39 s.d. for female swimmers. Daily mean protein (gm) intake for males and females was 69.97 ± 16.63 s.d. and 46.63 ± 8.64 s.d. respectively. Daily mean fat (g) intake for male and female swimmers was 83.75 ± 15.94 s.d. and 60.19 ± 13.02 s.d. respectively. Male and Female swimmers had a daily carbohydrate (g) intake of 313.76 ± 76.70 s.d. and 248.88 ± 85.59 s.d. respectively. Daily mean Calcium (mg) and Phosphorous (mg) intake for males was 941.52 ± 185.60 s.d. and 149.42 ± 300.20 s.d. respectively; for females it was 696.83 ± 100.55 s.d. and 100.64 ± 170.69 s.d. respectively. Daily mean iron (mg) intake for males and females were 16.50 ± 4.38 s.d. and 12.47 ± 4.41 s.d. respectively. The mean carotene (µg) intake per day was found to be 2952.4 ± 2647.33 s.d. for males and 2065.8 ± 1107.28 s.d. for females. The daily mean intakes of B1 (mg), B2 (mg), B3 (mg), Total B6 (mg) for males were 1.46 ± 0.38 s.d., 1.47 ± 0.36 s.d., 10.92 ± 3.25 s.d., 0.0081 ± 0.0174 s.d. respectively and for females they were 1.09 ± 0.25 s.d., 1.03 ± 0.28 s.d., 8.52 ± 2.50 s.d., 0.0484 ± 0.0562 s.d. respectively. Mean free folate (µg) intake and Vitamin C (mg) intake per day was recorded to be 92.83 ± 27.83 s.d. and 117.71 ± 54.56 s.d. respectively for males and 61.40 ± 14.76 s.d. and 92.31 ± 49.65 s.d. respectively for females.

The mean total fiber (g) intake per day for males was 29.10 ± 12.50 s.d. and for females it was 24.23 ± 9.59 s.d. The daily mean Soluble and Insoluble fiber (g) intakes for males was 6.92 ± 3.13 s.d. and 22.18 ± 9.38 s.d. respectively and for females was 5.18 ± 2.45 s.d. and 19.05 ± 7.27 s.d. respectively. The 3 months dietary intervention involved a distribution of macronutrients as CHO: 5-7g/Kg/BW/d, Protein: 1.2-1.4g/kg/BW/d, Fat: 20-35%.

3.2.3 Nutrient Quality & Quantity of Pre-During-Post Swim Meals

The major focus of the diet intervention involved improving the nutrient quality & quantity of pre-during-post training meals. It comprised of a low glycemic index, moderate protein, low fat meal pre-training, an isotonic drink & water during training, a high glycemic index, high protein, low fat post training meal. The pre swim options suggested were thalipeeth with curd/ mix vegetable paratha with curd/ methi thepla with curd/ naachni porridge/ chapatti with dal/curd and vegetable preparation. During swim hydration regime suggested was 1l of isotonic sports drink and 0.5-1l plain water. Post swim options suggested were 1-2 small bananas and 2 egg-whites + 1 whole egg/ 1 scoop whey protein powder/ 2 scoop pea protein powder. Compliance to the pre-during-post swim meal guidelines influences the body energy stores and fuel usage.

3.2.3.1 Pre Swimming Meal (1.5-2h pre)

Males (n=13)

Before intervention, 10 swimmers consumed milk/tea with cornflakes/chivda/cheese sandwich/biscuits, 1 consumed plain milk, 1 consumed chocolate & 1 consumed nothing prior to swimming training. Post intervention, energy (kcal) improved significantly from 201 ± 110 s.d. to 404 ± 111 s.d. (Paired $t_{\text{two tailed}} = -3.94$, p=0.002**); protein (g) improved significantly from 7.43 ± 4.38 s.d. to 12.54 ± 4.23 s.d. (Paired $t_{\text{two tailed}} = -2.49$, p=0.028*); carbohydrates (g) improved significantly from 21.43 ± 15.78 s.d. to 50.99 ± 16.44 s.d. (Paired $t_{\text{two tailed}} = -3.86$, p=0.002**); fat (g) improved significantly from 7.85 ± 4.42 s.d. to 16.44 ± 3.90 s.d. (Paired $t_{\text{two tailed}} = -4.90$, p=0.000***)

Females (n=5)
Before intervention, 3 swimmers consumed milk with wheatabix/ Jam sandwich/cheese sandwich, 1 consumed milk & banana while 1 consumed nothing. Post intervention, energy (kcal) improved significantly from 218 ± 57 s.d. to 349 ± 79.45 s.d. (Paired $t_{\text{two tailed}}$ = -8.03, p=0.001***); protein (g) improved, however not significantly from 8.54 ± 2.34 s.d. to 11.45 ± 3.26 s.d (Paired $t_{\text{two tailed}}$ = -2.08, p=0.105); carbohydrates (g) improved significantly from 23.94 ± 10.43 s.d. to 36.28 ± 11.33 s.d. (Paired $t_{\text{two tailed}}$ = -4.99, p=0.008**); fats (g) improved significantly from 11.10 ± 4.36 s.d. to 17.40 ± 2.46 s.d. (Paired $t_{\text{two tailed}}$ = -3.58, p=0.023*)

3.2.3.2 Durin %g Swimming Meal
Males (n=13)
Before intervention, 11 swimmers consumed 0.5-1l of plain water, 1 consumed 1l plain water & 0.5l sports drink, 1 consumed 1l plain water & 1 banana. Post intervention energy (kcal) improved significantly from 20 ± 49 s.d. to 246 ± 19 s.d. (Paired $t_{\text{two tailed}}$ = -15.15, p=0.000***); carbohydrates (g) improved significantly from 4.86 ± 12 s.d. to 62 ± 4.45 s.d. (Paired $t_{\text{two tailed}}$ = -15.59, p=0.000***)
Females (n=5)
Before intervention, 3 swimmers consumed 0.5-1l of plain water, 1 consumed 0.5l plain water & 0.5l sports drink, 1 consumed 1l water & 1 banana. Post intervention energy (kcal) improved significantly from 47 ± 65 s.d. to 242 ± 2 s.d. (Paired $t_{\text{two tailed}}$ = -6.83, p=0.002**); carbohydrates (g) improved significantly from 11.54 ± 15.84 s.d. to 60.60 ± 0.54 s.d. (Paired $t_{\text{two tailed}}$ = -7.08, p=0.002**)

3.2.3.3 Immediately consumed Post Swimming Meal (within ½ hour)
Males (n=13)
Before intervention, 9 swimmers consumed nothing, 1consumed 30g whey with milk & boiled chana, 1 consumed 2 boiled eggs, 1 consumed 1 banana & 1 consumed chapatti & dry dal roll. Post intervention energy (kcal) significantly improved from 41 ± 67 s.d. to 269 ± 39 s.d. (Paired $t_{\text{two tailed}}$ = -9.22, p=0.000***); protein (g) improved significantly from 3.43 ± 7.38 s.d. to 14.79 ± 4.22 s.d. (Paired $t_{\text{two tailed}}$ = -6.67, p=0.000***); carbohydrate (g) improved significantly from 4.44 ± 10.42 s.d. to 31.13 ± 7.12 s.d. (Paired $t_{\text{two tailed}}$ = -8.83, p=0.000***); fat (g) improved significantly from 1.14 ± 3.69 s.d. to 4.71 ± 3.10 s.d. (Paired $t_{\text{two tailed}}$ = -2.88, p=0.014*)
Females (n=5)
Before intervention, 4 swimmers consumed nothing & 1 consumed a banana. Post intervention energy (kcal) improved significantly from 23 ± 51 s.d. to 269 ± 44 s.d. (Paired $t_{\text{two tailed}}$ = -10.44, p=0.000***); protein (g) improved significantly from 0 ± 0 s.d. to 13.8 ± 3.83 s.d. (Paired $t_{\text{two tailed}}$ = -8.04, p=0.001***); carbohydrates (g) improved significantly from 5.44 ± 12.16 s.d. to 33.76 ± 8.98 s.d. (Paired $t_{\text{two tailed}}$ = -3.55, p=0.024*); fat (g) improved however not significantly from 0 ± 0 s.d. to 4.02 ± 3.66 s.d. (Paired $t_{\text{two tailed}}$ = -2.44, p=0.070)
Beat *et al*, 2007 investigated the nutritional practices of extreme endurance swimmers before, during and post the marathon swim in the lake of Zurich-2006 and found that majority followed pre-during-post event nutritional guidelines similar to the findings of this study. Nutrition knowledge and pre-competition dietary practices of 110 under 14 football players in India suggested athletes have misconceptions of knowledge of foods and hence had poor nutrition knowledge in relation to especially pre- competition meals and consumed junk foods (Ahuja and Bharti, 2014) [44].

3.2.4 Fitness status
Fitness status of swimmers was assessed through changes in body composition, a battery of fitness tests (critical swim speed for aerobic capacity, sit-ups, pushups and squats for muscle endurance, hand grip strength for muscle strength and sit and reach test or flexibility) and swimming performance.

3.2.4.1 Body Composition
The mean body fat % for males and females was observed to be 19.07 ± 8.30 s.d. and 24.16 ± 2.00 s.d. respectively. Whole body, trunk, legs and arms mean subcutaneous fat % for males was found to be 13.16 ± 5.26 s.d., 11.06 ± 4.63 s.d., 19.59 ± 7.47 s.d. and 20.40 ± 6.98 s.d. respectively and for females it was 20.80 ± 3.85 s.d., 16.28 ± 3.48 s.d., 31.84 ± 4.02 s.d. and 35.20 ± 2.79 s.d. respectively. The mean whole body, trunk, legs and arms skeletal muscle mass % for males was 35.62 ± 3.26 s.d., 29.13 ± 4.66 s.d., 52.33 ± 3.95 s.d. and 41.90 ± 2.15 s.d. respectively and for females it was 27.64 ± 2.27 s.d., 23.16 ± 1.82 s.d., 39.18 ± 4.51 s.d. and 32.42 ± 2.51 s.d. respectively. The mean body fat % of male swimmers reduced from 19.07 ± 8.30 s.d. to 18.78 ± 6.69 s.d. and of female swimmers from 24.16 ± 2.00 s.d. to 23.12 ± 3.08s.d. However, these improvements for both males and females were not significant.

3.2.4.2 Swimming Performance
Improvement in swimming performance was assessed through changes in swimming times from base-line competition to the latest competition in a span of approximately 6 months. Two Swimmers failed to participate in any competition during the study period. The overall improvement in seconds from their first to last event ranged from 0 to 9 seconds with a mean improvement of 1.5645 ± 2.58876s.d.

3.2.4.3 Fitness Tests
The results of the improvements in fitness test performance have been documented (Table 1 & 2).

Table 1: Mean Critical Swim Speed (CSS) (m/s), Sit and Reach Average of 3 attempts (cm), Sit up (No.), Push up (No.), Squats (No.), Hand grip muscle strength Average of 3 attempts (Kg) of Male Swimmers post intervention.

	Males (n=13)				
Variables	**Mean ± s.d.**	**Min**	**Max**	**Z Value**	**Sig (2 tailed)**
Aerobic Capacity					
CSS (m/s) PRE	0.99 ± 0.25	0.45	1.30	-2.934	0.003**
CSS (m/s) POST	1.20 ± 0.32	0.46	1.59		
Flexibility					
Sit & Reach (cm) PRE	29.49 ± 7.34	16.60	44.00	-2.657	0.008**
Sit & Reach (cm) POST	32.42 ± 6.78	23.60	47.60		
Muscle Endurance					
Sit up (no.) PRE	26.61 ± 6.62	13.00	38.00	-2.995	0.003**

Sit up (no.) POST	30.15 ± 5.44	20.00	41.00		
Push up (no.) PRE	25.07 ± 13.00	4.00	46.00	-1.826	0.068
Push up (no.) POST	28.07 ± 12.57	5.00	48.00		
Squat (no.) PRE	35.38 ± 6.77	25.00	50.00	-3.066	0.002**
Squat (no.) POST	45.15 ± 7.50	32.00	58.00		
Muscle Strength					
Right hand grip (Kg) POST	25.27 ± 10.92	9.00	42.00	-0.805	0.421*
Right hand grip (Kg) PRE	26.48 ± 9.40	8.10	38.00		
Left hand grip (Kg) PRE	26.10 ± 8.23	12.00	37.00	-2.760	0.006**
Left hand grip (Kg) POST	28.20 ± 7.74	13.80	39		

**p< 0.05, **p<0.01*

Table 2: Mean Critical Swim Speed (CSS) (m/s), Sit and Reach Average of 3 attempts (cm), Sit up (No.), Push up (No.), Squats (No.), Hand grip muscle strength Average of 3 attempts (Kg) of Female Swimmers post intervention.

	Females (n=5)				
Variables	**Mean ± s.d.**	**Min**	**Max**	**Z Value**	**Sig (2 tailed)**
Aerobic Capacity					
CSS (m/s) PRE	0.851 ± 0.310	0.42	1.23	-1.604	0.109
CSS (m/s) POST	0.859 ± 0.359	0.45	1.14		
Flexibility					
Sit & Reach (cm) PRE	34.50 ± 3.89	27.80	37.60	-2.023	0.043*
Sit & Reach (cm) POST	39.44 ± 3.27	34.80	43.00		
Muscle Endurance					
Sit up (no.) PRE	29.80 ± 5.54	23.00	36.00	-1.633	0.102
Sit up (no.) POST	30.80 ± 4.65	25.00	36.00		
Push up (no.) PRE	22.60 ± 10.66	10.00	32.00	-2.032	0.042*
Push up (no.) POST	30.60 ± 8.96	15.00	37.00		
Squat (no.) PRE	28 ± 5.00	20.00	33.00	-2.023	0.043*
Squat (no.) POST	35.60 ± 3.91	30.00	39.00		
Muscle Strength					
Right hand grip (Kg) POST	15.44 ± 8.60	2.60	23.30	-1.214	0.225
Right hand grip (Kg) PRE	17.20 ± 11.02	1.30	27.80		
Left hand grip (Kg) PRE	21.66 ± 6.17	11.00	27.00	-0.271	0.786
Left hand grip (Kg) POST	21.98 ± 8.73	7.00	29.60		

**p<0.05*

This study reported significant improvement in fitness variables. Improved critical swim speed suggests an improvement in endurance. On comparison with the National Physical Fitness School Program for school children, Ministry of youth affairs and sports, Government of India reference values, it was observed that 5 (38.5%) male swimmers would be graded to have good and another 5 (38.5%); excellent flexibility. Only 2 females out of 5 were graded in excellent category. A study on 37 competitive Indian female swimmers found that many of them had poor abdominal muscle strength [22].This is similar to the present study although hand grip strength was measured instead of abdominal strength. But male swimmers improved significantly on hand grip strength suggesting a more powerful pull. A study that compared the level of flexibility between the four swimming styles in female athletes stated that in butterfly, good shoulder flexibility is needed to recover arm stroke and a good hip and trunk flexibility is needed for broad waving- dolphin like movements and in breast stroke swimmers, the hip and shoulder flexibility is important to thrust the body forward. Flexibility in ankle, calf, hamstring, hips and lower back muscles as per the sit and reach test for males was found to improve, and this may suggest better butterfly and breast stroke performance [11].

4. Summary and Conclusion

This study further supports the role of healthy dietary habits and importance of pre-during-post training meals in improving sports performance. The 3 month dietary intervention program and nutrition counseling via nutrition education sessions improved nutritional knowledge, composition and nutrient intake of pre-during-post swim meals, swimming performance and fitness profile of 8-21y old competitive swimmers. Swimming practice of athletes was affected as most government swimming pools stayed shut due to drought that affected Maharashtra. Longer intervention to study extensive effects of the diet intervention could be conducted. The present study also had a smaller sample size. This was due to lack of permissions to carry out research at various swimming pools. A higher sample size could have allowed for more parametric tests. Future research could include a sample size higher than the present study for which the study could be carried out at a sports residential center. A randomized control trial could be designed for the study in order to compare the effects of intervention. Also, Specific age groups could be studied in order to compare the degree of improvements.

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