Comparing the Effect Two Different Concurrent Training Styles on Some Specific Physical Abilities and TechnicalPerformance Level of Junior Squash Players

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Introduction and Research Problem:

During the past twenty years, sports training methods became more since-based. Coaches continually concentrate on even minimal factors that can improve their athletes' performance even with least percentages in competition. even established training methods are being reconsidered to gain any possible advantage.

Murlasits et al (2017) indicated the importance of using modern training methods due to its positive effects on on specific physical abilities and technical performance according to the requirements of competitive sport. Concurrent training is a modern training method that recently led to effective results in strength and endurance training for athletes (23: 2).

Robineau et al (2016) and Murlasits et al (2017) agreed that concurrent training means the use of endurance drills along with muscular strength drills at the same training unit or in isolated units inside the same training program (resistance units followed by endurance units) or even dividing the program duration equally between strength and endurance drills (32) (23).

Aagaard & Andersen (2010) indicated the strength and endurance requirements differ according to the sports activity itself as some sports require more strength than endurance while other

sports require more endurance than strength. But most sports require both strength and endurance equally with the same degree of importance (1: 41).

Pontus Löfving et al (2018) indicated that performance in most sports activitiesdepends on interaction among several physiological variables. The challenge faced by coaches and athletes is manifested in finding the suitable combination and work load during exercise to enhance the long-term training for all factors. Basic principles followed by coaches are based on warnings against applying endurance drills after strength drills or vice versa at the same unit. This principle was based on the idea that these two types of drills are contradicted and cannot be used together at the same training unit. According to these warnings, some coaches think that strength and endurance exercises cannot be synchronized together at the same training unit (30:139).

Stafford Murray et al (2016) indicated that squash is a sport characterized by the inability of players to predict the path of the match like the duration of each point during rally in addition to choosing suitable strikes, playing strategies according to the opponent's strength and the match length. All these factors affect the physical and technical aspects of performance in squash. Therefore, success of the squash player depends on the efficiency of his/her specific physical abilities and high technical performance of skills (35: 27).

Peter A. Hirst (2011) indicated that forehand and backhand strokes, with all itstypes, dominate most of the game performance as the strongest strokes during rally with the opponent. They work on

directing the opponent's strokes towards the back and sidewalls of the court to turn the play into attack and force the opponent back. This performance manifests several major specific physical abilities like enduring therepeated strong strokes for several times in addition to speed strength to move to courtcenter (T). furthermore, the player should be able to endure technical performance without fatigue nor even minimal decrease in technical accuracy (27: 36).

The researcher thinks that squash match lasts for prolonged time during which both players are in continuous condition of performance and physical effort to fulfill the tactical requirements like back defense then move to attack on the front wall from the court center. This is clear in using major skills like forward and backward strokes repeatedly by squash players during the match in addition to directing strokes to the front or side walls accurately to force the opponent back and turn into defense or evenas a defensive mode against an opponent who uses the same attack mode. The distinct squash performance mechanism requires performance that depends on muscular strength for prolonged durations. This is what squash coaches look for during training and preparing players. That is to improve both strength and endurance together so thatthe player can fulfill the technical requirements in places that are considered hard for the opponent, in addition to improving the player's abilities to endure repeating these technical requirements and strokes erformed alternatively with the opponent and enduring this physical and technical burdens. Therefore, the researcher sought to use a training method that basically merge strength and endurance in one training frameworkin accordance with the performance system of

squash.

The researcher asserts that during training and preparing players, squash coaches look for improving both strength and endurance together so that the player canfulfill the technical requirements in places that are considered hard for the opponent, in addition to improving the player's abilities to endure repeating these technical requirements and strokes performed alternatively with the opponent and enduring this physical and technical burdens. Therefore, the researcher sought to use a training method that basically merges strength and endurance in one training framework in accordance with the performance system of squash. Optimum performance of forehandand backhand strokes requires strength and endurance. The player can keep up with it if he/she acquires these two characteristics as major and well-defined muscle groups are involved in performance for prolonged periods to fulfill the desired objective. Therefore, it is important to improve strength and endurance concurrently for squash players.

Several studies dealt with concurrent training of strength and endurance, eitheraccording to their order and sequence inside the training unit, rest intervals or which isfirst endurance or strength drills. But none of these studies dealt with concurrent training of these two components inside the same training unit or in separate units during the training week. The researcher will design two separate concurrent training programs that are equal in unit number, training volume and training intensity of endurance and strength. The difference will be in the concurrence style and execution. The first program will combine strength and endurance drills in the same

unit (inter- unit concurrence) while the second program will dedicate separate units for each component inside the same training week (inter-week concurrence) to identify the beststyle for improving strength and endurance together.

The problem of this research is clear in that it is a scientific experiment to verifywhich of the two concurrent training programs is better in improving specific physicalabilities of strength and endurance and their effects on the technical performance of essential skills during matches like the strength, speed and accuracy of forehand and backhand straight strokes according to the requirements of squash. This will befollowed by notifying coaches in general, and squash coaches in specific, about the optimum program for best improvements.

Aims:

The current research aims to design two separate concurrent training programs(inter-unit vs. inter-week) to:

1. Compare their effects on improving some specific physical abilities of junior squash players less than (17) years.
2. Compare their effects on improving the technical performance level of junior squash players less than (17) years.

Hypotheses:

- There are statistically significant differences between the pre- and post- measurements of the first experimental group (inter-unit concurrence) on some

specific physical abilities and the technical performance level of junior squash players in favor of post-measurements.

- There are statistically significant differences between the pre- and post- measurements of the second experimental group (inter-week concurrence) on some specific physical abilities and the technical performance level of junior squash players in favor of post-measurements.

- There are statistically significant differences between the post-measurements ofthe first experimental group (inter-unit concurrence) and the second experimental group (inter-week concurrence) on some specific physical abilities

and the technical performance level of junior squash players.

Terminology:

Concurrent Training: is performing muscular strength drills along with endurance drills at the same training program or the same training unit (11: 294).

Methods:

Approach:

The researcher used the experimental approach (two-group design) with two experimental groups (inter-unit / inter-week) and pre- and post-measurements.

Participants:

The researcher purposefully chose (22) junior squash players less than (17) years from Tanta Sports Club to be recruited as a main sample while (12) other playerswere recruited as a pilot sample, according to the following criteria:

- All players were registered at the Egyptian Federation of Squash during thetraining season 2019-2020.

- All players had at least (8) years of training experience.
- All players were not participating in any other sports activities during theprogram.

The main sample was divided into two equivalent groups (E 1 = E 2 = 11) and the researcher verified their homogeneity for the following variables:

- **Growth factors** (age – height – weight – training experience)
- **Specific physical abilities** (grip strength – medicine ball throwing with both hands – vertical jump – trunk flexion from standing – 20 m running – multi- directional repeated runs – muscular endurance – aerobic endurance).
- **Technical variables** (strength, velocity and accuracy of forehand straight and backhand straight strokes).

Table (1) shows descriptive data of participants.

Table (1): descriptive data of participants on all research variables (n = 22)

	Variable	Measurement	Mean	SD±	Median	Squewness
Growth factors						
1	Age	Year/month	15.666			
2	Height	Cm	165.0			
3	Weight	Kg	58.4			
4	Training age	Year/month	8.677			
Physical tests						
1	Grip strength of used arm	Kg	36.045	1.290	36.00	0.385
2	Medicine ball throwing with bothhands	M	6.482	0.0301	6.485	0.081
3	Vertical jump	Cm	29.818	1.097	30.0	0.559
4	Trunk flexion from standing	Cm	7.136	0.774	7.00	0.249
5	20 m running	Sec	3.393	0.0139	3.390	0.646
6	Multi-directional repeated run	Duration	87.52	0.048	87.53	0.207
7	Muscular	Sec	137.38	0.1222	137.42	0.299

	endurance				0	
8	Aerobic endurance	Mm	1628.63	1.255	1628.00	0.454
Technical tests						
1	Straight forehand strength	Cm	147.272	0.550	147.00	0.109
2	Straight forehand velocity	Number	19.090	0.867	19.00	0.187
3	Straight forehand accuracy	Degree	89.181	0.795	89.00	0.352
4	Straight backhand strength	Cm	144.68	0.716	145.00	0.565
5	Straight backhand velocity	Number	14.590	0.666	14.500	0.699
6	Straight backhand accuracy	Degree	92.636	0.581	93.00	0.212

Table (1) indicates squewness values ranged between (0.081) and (0.699) (between ±3). This means that all values are inside the normal curve indicating the homogeneity of participants.

Table (2): description of sample groups on all research variables(E G 1 = E G 2 = 11)

S	Variable	Measurement	E G 1 (n = 11)				E G 2 (n = 11)			
			Mean	SD±	Median	Squewness	Mean	SD±	Median	Squewness
Growth factors										
1	Age	Year/month	15.66	0.456	15.80	0.452	15.66	0.457	18.80	0.453
2	Height	Cm	165.09	0.700	165.0	0.123	164.9	0.943	165.0	0.663
3	Weight	Kg	158.45	1.034	58.00	0.147	58.363	1.120	58.0	0.155
4	Trainingage	Year/month	8.690	0.122	8.700	0.206	8.663	0.120	8.60	0.864
Physical tests										
1	Grip strength of used arm	Kg	36.181	1.181	36.00	0.422	35.90	1.446	36.00	0.295
2	Medicine ball throwing With bothhands	M	6.484	0.029	6.480	0.101	6.480	0.032	6.490	0.186
3	Verticaljump	Cm	29.72	1.103	0.30	0.437	29.90	1.136	30.0	0.789
4	Trunkflexionfrom standing	Cm	7.181	0.750	7.00	0.329	7.090	0.831	7.00	0.190
5	20 m running	Sec	3.39	0.015	3.390	0.558	3.391	0.122	3.390	0.599
6	Multi- directional repeated run	Duration	87.52	0.052	87.50	0.354	87.52	0.047	87.51	0.066

7	Muscular endurance	Sec	137.35	0.129	137.1	0.525	137.42	0.109	137.43	0.346
8	Aerobic endurance	Mm	1628.6	1.286	1628.0	0.493	1629.6	1.286	1628.0	0.493
Technical tests										
1	Straightforehand strength	Cm	147.18	0.603	147.0	0.028	147.36	0.504	147.0	0.661
2	Straightforehand velocity	Number	19.181	0.873	19.0	0.409	19.00	0.894	19.03	0.361
3	Straightforehand accuracy	Degree	89.09	0.831	89.0	0.190	89.27	0.786	89.0	0.574
4	Straight backhand strength	Cm	144.63	0.674	145.0	0.593	144.72	0.786	145.0	0.575
5	Straight backhandvelocity	Number	14.545	0.687	14.0	0.932	14.63	0.674	15.0	0.593
6	Straight backhand accuracy	Degree	92.727	0.646	93.0	0.291	92.54	0.522	93.0	0.213

Table (2) indicated that squewness values ranged from (0.028) to (0.923) (between ±3). This means that all values are inside the normal curve indicating the homogeneity of participants.

Table (3): Comparison of the two experimental groups on all pre-measurements(E G 1 = E G 2 = 11)

S	Variable	Measurement	E G 1 (n = 11		E G 2 (n = 11)		Means Difference	T
			Mean	SD±	Mean	SD±		
Growth factors								
1	Age	Year/month	15.66	0.456	15.66	0.457	0.0009	0.500
2	Height	Cm	165.09	0.700	164.9	0.943	0.1818	0.513
3	Weight	Kg	158.45	1.034	58.363	1.120	0.090	0.198
4	Training age	Year/month	8.690	0.122	8.663	0.120	0.272	0.527
Physical tests								
1	Grip strength of used arm	Kg	36.181	1.181	35.90	1.446	0.272	0.487
2	Medicine ball throwing with both hands	M	6.484	0.029	6.480	0.032	0.0036	0.277
3	Vertical jump	Cm	29.72	1.103	29.90	1.136	0.818	0.381
4	Trunk flexion from standing	Cm	7.181	0.750	7.090	0.831	0.90	0.269
5	20 m running	Sec	3.39	0.015	3.391	0.122	0.0045	0.757
6	Multi-directional repeated run	Duration	87.52	0.052	87.52	0.047	0.0018	0.085
7	Muscular endurance	Sec	137.35	0.129	137.42	0.109	0.0727	1.421
8	Aerobic endurance	Mm	1628.6	1.286	1629.6	1.286	0.3636	0.585
Technical tests								
1	Straight forehand strength	Cm	147.18	0.603	147.36	0.504	0.181	0.767
2	Straight forehand velocity	Number	19.181	0.873	19.00	0.894	0.1818	0.482
3	Straight forehand accuracy	Degree	89.09	0.831	89.27	0.786	0.181	0.527
4	Straight backhand strength	Cm	144.63	0.674	144.72	0.786	0.090	0.291
5	Straight backhand velocity	Number	14.545	0.687	14.63	0.674	0.091	0.313
6	Straight backhand accuracy	Degree	92.727	0.646	92.54	0.522	0.181	0.725

(T) table values on P ≤ 0.05 = 2.10

Table (3) proved that both groups are equivalent as (T) calculated values for allmeasurements were not statistically significant.

The Training Program:

Aim:

The recommended training program aimed to identify the effects of two different concurrent training methods (inter-unit vs. inter-week) on improving some ofthe specific physical abilities and technical performance level of junior squash players less than (17) years.

Program Basics:

According to review of literature and websites related to this type of drills, the researcher chose the most important drills that can measure the components of concurrent training and chose the best drills for the program. Each training unit includedwarm-up, main part where concurrent drills are applied and cool down. The program was applied during the preparation stage and pre-competition stage for (8) weeks (4 units per week) from 3-8-2019 to 27-9-2019.

Program Principles:

The researcher followed principles of designing training programs in designingthe program using two different concurrent training methods as one of them depends on inter-unit concurrence while the other depends on inter-week concurrence. Training loads should be suitable for the age group of participants. Drills should flexible and modifiable through adding or omitting according to the training conditions. Theresearcher chose the drills and the application stage according to review of literature and performed pre- and post-measurements accordingly.

Controlling the Training Load:

The researcher used the training load components (intensity –

volume – density) so that the coach can formulate the training program correctly through knowing the type of load during the daily, weekly and stage unit. The coach can increase one or two components at max according to the objective desired, the player's training condition, the season stage and the type of sport (2: 171).

Methods of Controlling Training Load:

To control the training loads in both programs, the researcher used the following methods:

- Variation of load intensity
- Variation of performance speed through increasing the speed of physical and technical drills
- Variation of performance difficulty through increasing drills intensity
- Variation of running paths or resistances through changing running paths during speed endurance drills and directional endurance drills like running in squares,

  rectangles or progressive shapes. It can also be done through increasing resistance number in muscular strength of arms and legs and strength drills.
- Variation of load volume:

❖ Changing the duration of drill as a means for increasing or decreasing

load volume while performing drills.

❖ Changing number of repetitions for a drill to improve physical and technical variables

❖ Changing rest intervals according to load intensity and volume during the stages of both programs (2: 25).

Program Components:

The recommended two programs included sets of drills for improving some muscular strength variables (arms muscular strength – legs muscular strength – legs speed strength) and some muscular endurance variables (speed endurance – multi- directional endurance – strength endurance). Both programs depend on concurrent training. Each program was divided into three main parts:

1. **Warm-up:** This part aims to prepare the player's body to accept the training ormatch effort. It is divided into

a) General warm-up: to prepare the whole body for activity

b) Specific warm-up: to prepare the player physically, functionally, technically, tactically and mentally for the upcoming effort. It is preferred to individualize this part of warm-up.

2. **Main Part:** This part works on fulfilling the objectives of training through improving the player's condition. It takes nearly 75-80% of the unit duration. The researcher worked on unifying the duration of this part in both programs asit includes the strength and endurance drills in one unit (inter-unit concurrence)or in separate units (inter-week concurrence) so that the only variable is the method of concurrent training.

a) Technical drills: the researcher chose the technical drills after reviewing thefollowing studies: Yarrow (2009), Wilstrop & Gilmour (2012), Hirst, P. (2014). Donnelly, S. (2014), Jehad, A. & Saeb, M. (2015) and Murray & Hughes (2016) (29) (12) (28) (33) (13) (35).

b) Competitive matches: this is a major part of the training unit where junior squash players apply all skills and tactical patterns

3. **Cool-Down:** This part aims to return the player to normal condition.

The researcher presented the components of the recommended training programs to a group of squash experts who showed agreement percentages between 85% and 100% as seen in table (4).

Table (4): Experts Opinions about the training program components

S	Component	Details
1	Number of weeks	8 weeks
2	Number of units per week	4 units
3	Mean of unit duration	90 min
	a- Warm-up	10 min
	b- Main part	70 min
	c- Cool down	10 min
4	Total number of units	4 x 8=32 units
5	Total training volume	4 x 8 x 90= 2880 min

According to experts' opinions the researcher designed the final version of the program so that it can fulfill its objectives. The researcher followed the following steps:

1. The researcher identified the training stage to be planned as the preparation stage during 2019-2020 season
2. Players trained (4) times per week with (4) training units per week. Unit duration was set on (90) minutes
3. The first experimental group (E G 1) trained on Saturday, Monday, Wednesday and Friday.
4. The second experimental group (E G 2) trained on Sunday, Tuesday, Thursday and Friday.
5. Training loads were set according to (Fig. 1)

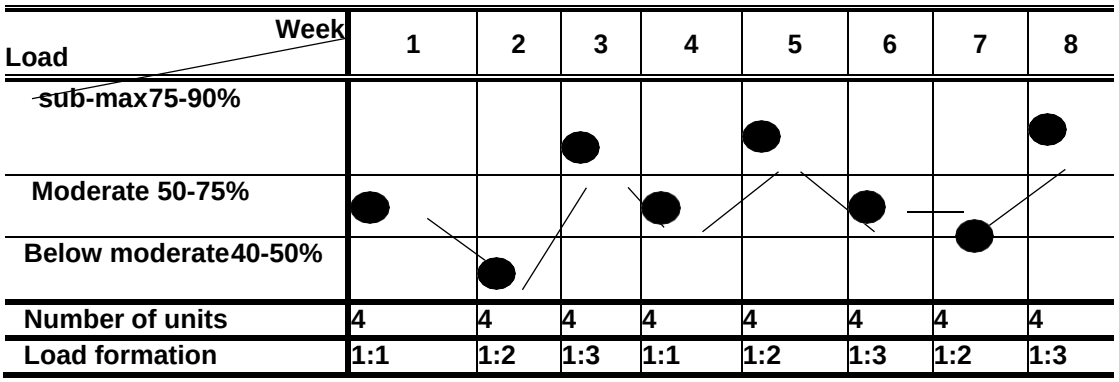


Fig. 1: Load Formation and Load Intensity for each unit and Number of Units

(6) Rest intervals and recovery rates were measured for each player individually after below moderate, moderate, sub-max and max loads. Pulse rate was calculated on (6) seconds and training was organized accordingly.

Table (5) shows percentages of preparation and durations for physical, technical and tactical preparation.

Table (5): Percentages of Preparation Components

	Physical Drills	Technical Drills	Tactical		Drills	Total
			Tactical patterns	Competitive matches		
Percentages	30%	35%	15%	15%	5%	100%
Units duration	864 min	1008 min	432 min	432 min	144 min	2880 min
Unit duration	27 min	32 min	13 min	13 min	5 min	90 min

It is clear from table (5) that mental and psychological preparation was not included when calculating durations of training units as it is mostly done outside the units. In squash, technical and tactical preparation are mixed in one unit as tactics are actually the proper application of technical skills and its physical and mental requirements on different parts of the court wall.

Data Collection Tools:

1. A restameter for measuring heights
2. A medical balance for measuring weights
3. A 50 m measuring tape
4. Colorful sticker tape
5. Stop-watch
6. Squash court
7. Squash racquets
8. Yellow-point squash balls
9. Multi-color cones
10. Sports mat
11. Graded box (50 cm) and a ruler for measuring trunk flexibility.
12. hand-grip dynamometer Research tests:

According to review of literature, the researcher used the following tests:

A. Growth factors (age – weight – height)

B. Training experience

C. Physical test:

1. Grip strength of used arm for measuring muscular strength
2. Medicine ball throwing with both hands for measuring arms and shoulder muscular strength
3. Vertical jump for measuring leg speed strength
4. Trunk flexion from standing for measuring flexibility
5. 20 m running for measuring motor speed
6. Multi-directional repeated run for measuring agility endurance
7. Muscular endurance for measuring upper and lower body endurance

8. Aerobic endurance for measuring aerobic power.

All tests were applied according to the directions of Reiman & Manske (2009),Wilkinson et al (2009), Squash Canada (2010). Ismail, K. (2016), Kane et al (2017) and Shahnaz Begum (2019) (20) (21) (34) (10) (3) (14).

D. Technical tests:

1. Straight forehand strength
2. Straight forehand velocity
3. Straight forehand accuracy
4. Straight backhand strength
5. Straight backhand velocity
6. Straight backhand accuracy

All tests were applied according to the directions of Ramadan, A. (2011), Ismail,I. (2015), Kane et al (2017) and Shahnaz Begum (2019) (31) (9) (3) (14).

Validity and Reliability of Tests:

To calculate the validity and reliability of physical and technical tests, the researcher applied them on 13-7-2019 and 15-7-2019.

First: Validity

The researcher calculated distinction validity through applying the tests to two groups. The distinct group (n=12) was from Lion Squash Academy – Tanta – Egypt while the non-distinct group (n=12) was the pilot sample. Difference significance between the two groups was shown in table (6).

Table (6): Difference Significance Between the Distinct and Non-Distinct Groupson all Research Tests

S	Variable	Distinct (n=6)		Non-distinct (n=6)		T
		Mean	SD±	Mean	SD±	
Physical tests						
1	Grip strength of used arm	43.01	1.296	33.73	1.520	7.368
2	Medicine ball throwing with both hands	7.68	0.186	6.41	0.199	10.375
3	Vertical jump	42.83	2.197	22.77	1.586	8.122
4	Trunk flexion from standing	8.33	0.193	6.52	0.151	7.299
5	20 m running	3.27	0.421	3.464	0.548	8.062
6	Multi-directional repeated run	83.193	0.638	91.821	1.272	11.156
7	Muscular endurance	131.08	1.865	140.56	1.99	7.654
8	Aerobic endurance	1644.38	2.840	1621.22	3.574	12.680
Technical tests						
1	Straight forehand strength	159.330	2.951	142.870	2.157	6.755
2	Straight forehand velocity	21.165	1.147	15.775	0.762	7.170
3	Straight forehand accuracy	92.630	2.465	81.230	2.147	5.313
4	Straight backhand strength	167.460	3.447	140.460	3.951	7.666
5	Straight backhand velocity	17.652	1.631	13.595	1.182	6.185
6	Straight backhand accuracy	97.218	2.168	90.645	2.153	5.544

(t) table value on P ≤0.05 = 2.12

Table (6) showed statistically significant differences between the distinct and non-distinct groups on all physical and technical tests in favor of the distinct group. This clearly indicates tests validity.

Second: Reliability

To calculate reliability of physical and technical tests, the researcher applied alltests to a pilot sample (n=6) through test/retest procedure with time interval of (3) days. Results are shown in table (7)

Table (7): Correlation Coefficients between test and retest for all research tests(n=6)

S	Variable	Test		Retest		R
		Mean	SD±	Mean	SD±	
Physical tests						
1	Grip strength of used arm	43.01	1.296	42.77	1.200	0.920
2	Medicine ball throwing with both hands	7.68	0.186	7.63	0.180	0.993
3	Vertical jump	42.83	2.197	41.77	2.587	0.780
4	Trunk flexion from standing	8.33	0.193	8.26	0.204	0.975
5	20 m running	3.27	0.421	3.21	0.055	0.891
6	Multi-directional repeated run	83.193	0.638	82.65	1.349	0.754
7	Muscular endurance	131.08	1.865	131.00	2.279	0.723
8	Aerobic endurance	1644.38	2.840	1645.22	2.635	0.906
Technical tests						
1	Straight forehand strength	159.330	2.951	160.645	5.558	0.911
2	Straight forehand velocity	21.165	1.147	19.75	1.347	0.928
3	Straight forehand accuracy	92.630	2.465	93.455	4.408	0.916

4	Straight backhand strength	167.460	3.447	166.3	5.732	0.907
5	Straight backhand velocity	17.652	1.631	16.901	1.486	0.924
6	Straight backhand accuracy	97.218	2.168	96.33	3.067	0.931

Significance on P ≤0.05 = 0.666

Table (7) showed statistically significant correlations between test and retest forall physical and technical tests used in this research indicating that all tests are reliable.

Main Study:

Pre-measurements:

After verifying the validity and reliability of all physical and technical tests, theresearcher took pre-measurements from 21-7-2019 to 22-7-2020.

Program application:

The researcher applied the two recommended concurrent training programs to the two experimental groups from 3-8-2019 to 27-9-2019 in Tanta Sports Club.

Post-measurements:

The researcher took post-measurements according to the same protocol of pre-measurements from 1-10-2019 to 2-10-2019.

Statistical Treatments:

The researcher used SPSS Software to calculate the following: Mean – SD – Median – Squewness – Correlation Coefficient – (t) test – variance (improvement percentage).

Results:

Table (8): Difference Significance between the pre- and post-measurements ofthe first experimental group on all research variables (n=11)

S	Variable	Pre-		Post-		Means Difference	T	Variance rate(%)
		Mean	SD±	Mean	SD±			
Physical tests								
1	Grip strength of used arm	36.181	1.181	42.90	0.832	6.72	16.54	34.99
2	Medicine ball throwing with both hands	6.484	0.029	6.76	0.092	0.280	12.01	4.32
3	Vertical jump	29.72	1.103	38.81	1.328	9.090	16.53	30.58
4	Trunk flexion from standing	7.181	0.750	10.090	1.044	2.909	10.22	40.51
5	20 m running	3.39	0.015	3.306	0.016	0.0890	11.59	2.69
6	Multi-directional repeated run	87.52	0.052	83.590	1.147	3.938	11.28	4.71
7	Muscular endurance	137.35	0.129	145.74	2.416	8.388	11.90	6.10
8	Aerobic endurance	1628.6	1.286	1657.36	1.804	28.72	17.53	1.76
Technical tests								
1	Straight forehand strength	147.18	0.603	162.36	0.924	15.181	17.62	10.31
2	Straight forehand velocity	19.181	0.873	23.181	0.981	4.00	8.94	20.85
3	Straight forehand accuracy	89.09	0.831	102.0	0.894	12.909	11.136	14.48
4	Straight backhand strength	144.63	0.674	161.090	0.831	16.45	19.87	11.38
5	Straight backhand velocity	14.545	0.687	17.909	0.831	3.363	10.86	23.12
6	Straight backhand accuracy	92.727	0.646	96.00	0.774	3.273	9.83	3.52

(t) table value on P ≤0.05 = 2.20

Table (8) indicated statistically significant differences on P ≤0.05 between the pre- and post-measurements of the first experimental group on all research variables infavor of post-measurements.

Table (9): Difference Significance between the pre- and post-Measurements ofthe second experimental group on all research variables (n=11)

S	Variable	Pre-		Post-		Means Difference	T	ance rate(%)
		Mean	SD±	Mean	SD±			
Physical tests								
1	Grip strength of used arm	35.90	1.446	49.181	0.981	13.27	23.81	36.96
2	e ball throwing withboth hands	6.480	0.032	6.99	0.135	0.513	14.08	7.92
3	Vertical jump	29.90	1.136	43.18	1.537	13.27	27.20	44.38
4	Trunk flexion from standing	7.090	0.831	13.63	1.689	6.545	13.80	92.31
5	20 m running	3.391	0.122	3.242	0.034	0.148	13.05	4.57
6	Multi-directional repeated run	87.52	0.047	81.04	1.380	6.481	15.440	7.41
7	Muscular endurance	137.42	0.109	150.57	1.512	13.15	19.28	9.57
8	Aerobic endurance	1629.6	1.286	1682.27	2.068	53.63	17.36	3.29
Technical tests								
1	Straight forehand strength	147.36	0.504	164.90	0.70	17.54	16.184	11.90
2	Straight forehand velocity	19.00	0.894	26.54	0.935	7.545	16.60	39.71
3	Straight forehand accuracy	89.27	0.786	106.181	0.750	16.909	13.128	18.94
4	Straight backhand strength	144.72	0.786	164.090	0.831	19.363	17.33	13.37
5	Straight backhand velocity	14.63	0.674	21.36	0.924	6.727	12.11	45.98
6	Straight backhand accuracy	92.54	0.522	100.909	1.221	8.363	19.35	9.04

(t) table value on P ≤0.05 = 2.20

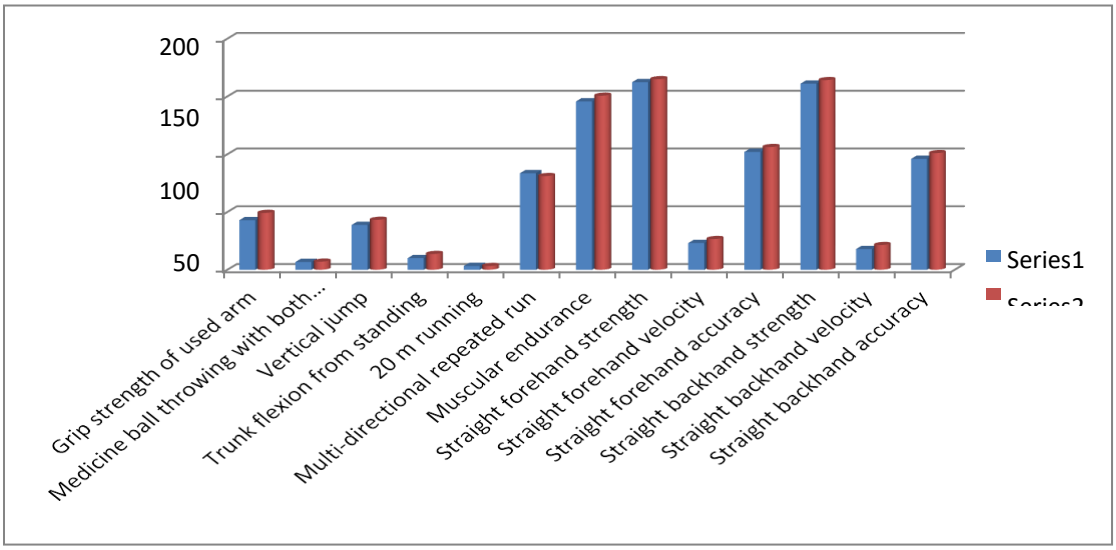
Table (9) indicated statistically significant differences on P ≤0.05 between the pre- and post-measurements of the second experimental group on all research variablesin favor of post-measurements.

Table (10): Difference Significance between the post-measurements of the firstand second experimental groups on all research variables (n=22)

S	Variable	First group		Second group		Means Difference	T	ance rate(%)
		Mean	SD±	Mean	SD±			
Physical tests								
1	Grip strength of used arm	42.90	0.832	49.181	0.981	6.273	16.171	14.62
2	e ball throwing withboth hands	6.76	0.092	6.99	0.135	0.229	4.640	3.39
3	Vertical jump	38.81	1.328	43.18	1.537	4.363	7.124	11.24
4	Trunk flexion from standing	10.090	1.044	13.63	1.689	3.545	5.920	35.13
5	20 m running	3.306	0.016	3.242	0.034	0.063	5.473	1.91
6	Multi-directional repeated run	83.590	1.147	81.04	1.380	2.545	4.703	3.05
7	Muscular endurance	145.74	2.416	150.57	1.512	4.837	5.627	3.32
8	Aerobic endurance	1657.36	1.804	1682.27	2.068	24.90	11.298	1.51
Technical tests								
1	Straight forehand strength	162.36	0.924	164.90	0.70	2.545	7.278	1.57
2	Straight forehand velocity	23.181	0.981	26.54	0.935	3.363	8.232	14.51
3	Straight forehand accuracy	102.0	0.894	106.181	0.750	4.181	11.877	4.10
4	Straight backhand strength	161.090	0.831	164.090	0.831	3.0	8.464	1.86
5	Straight backhand velocity	17.909	0.831	21.36	0.924	3.454	9.216	19.28
6	Straight backhand accuracy	96.00	0.774	100.909	1.221	4.909	11.260	5.11

(t) table value on P ≤0.05 = 2.07

Table (10) indicated statistically significant differences on P ≤0.05 between thepost-measurements of the first and second experimental groups on all research variables.



Discussion:

Table (8) showed statistically significant differences between the pre- and post- measurements of the first experimental group that followed the inter-unit mode (concurrence of endurance drills first, followed by strength drills) on all physical variables under investigation as (t) calculated values ranged from 10.22 to 17.53 in favor of post-measurements. This indicates the high level of effectiveness for this recommended program.

Results of table (8) indicated that motor speed (20 m running) improved by 2.69%. this type of speed requires leg power that characterizes the sudden moves of squash players. Strength drills in this program improved leg speed strength and in turn it improved leg power expressed in short bursts or power during short sprints performed by squash players. This is due to the use of concurrent training drills inside the same training unit (inter-unit mode) for the first experimental group.

The researcher thinks that concurrent training through continuous drills of endurance and strength led to improvements in test results due alternating loads of endurance and strength drills. This is consistent with Cadore et al (2012) and Nevin et al (2018) who indicated that (8) weeks of concurrent training represented the most effective training mode for improving performance. They also indicated that (8) weeks of concurrent training are more effective than endurance training only in improving muscular strength, power and technical performance endurance. (6: 165) (24: 1665)

Kang & Ratamess (2014) and Muralsi et al (2018) indicated that

concurrent training (training sequence) of strength and aerobic endurance directly improved muscular power, aerobic power and anaerobic power if endurance and strength are used together instead of of using each one of them alone. In addition, this mode of training improved the competitive performance level of players due to linking exercises to technical performance (16: 11) (36: 96).

Table (8) also showed statistically significant differences between the pre- and post-measurements of the first experimental group (inter-unit) on all technical variables under investigation in favor of post-measurements as (t) calculated values ranged from (8.94) to (19.87). Improvement percentages for strength, velocity and accuracy of the straight forehand stroke and strength, velocity and accuracy of the straight backhand stroke were (3.52%) and (23.12%) respectively. The researcher thinks that this is due to the improvements in specific physical abilities of the players in the first experimental group like strength endurance and grip strength of the used arm. Improvements in these specific physical abilities due to concurrent training had positive effects on improving strength, velocity and accuracy of the straight forehand stroke and strength, velocity and accuracy of the straight backhand stroke. This is consistent with the results of Hussain, A. (2017) who indicated that concurrent training improves strength, velocity and accuracy of the straight forehand stroke (7: 22).

The researcher thinks that these improvements are due to combining endurance drill with strength drills alternatively in the same training unit in addition to training various muscular groups, especially leg and arm muscles while concentrating on muscles

directly involved in the performance of forehand and backhand strokes. This increase in working muscles strength during specific preparation stage through concurrent training led to improvements in specific physical abilities of squash playersthrough improving muscular strength and endurance.

This is consistent with Murlasi et al (2018) who indicated that every specific sports activity depends on muscular endurance and cardio-respiratory endurance as theyare essential components that improve physical and technical performances (36: 18).

This proves the first hypothesis stating that: There are statistically significant differences between the pre- and post-measurements of the first experimental group (inter-unit concurrence) on some specific physical abilities and the technical performance level of junior squash players in favor of post-measurements.

Table (9) showed statistically significant differences on P ≤0.05 between the pre- and post-measurements of the second experimental group (inter-week concurrence) on all physical tests in favor of post-measurements as (t) calculated valuesranged from (13.05) to (27.20). this indicates the effectiveness of the recommended training program.

Table (9) showed statistically significant differences between the pre- and post-measurements of the second experimental group (inter-week concurrence) on 20 m running with improvement percentage of (13.05%) after concurrent training. This is due to the start speed drills as this type of speed requires leg muscular power

and explosive power that characterize squash players. Strength and endurance drills used inthe concurrent training program improved leg speed strength and this affected anotherphysical ability which is "power" as an expression of explosive power during sudden sprints inside the squash court. This is consistent with Gabler et al (2018) who indicatedthat concurrent training improves neuromuscular abilities of junior players representedin quick changes of direction and explosive speed (19: 355).

This is also consistent with Labib, H. (2011) who indicated that concurrent training improved muscular strength and endurance for technical performance ofplayers (18: 75).

Blamey et al (2010) indicated that muscular strength is a major physicalcomponent with major effects on sport as muscles control body movement through contractions. With stronger muscles, these contractions become fore effective and thisincreases resultant strength and, in turn, increases speed, power and agility. In addition, many skills are improved and the player becomes less vulnerable to injuries in all sportsactivities, especially in track and field (4: 65).

The researcher thinks that improvements in endurance for the second experimental group (inter-week recurrence) where endurance drill are used in a separateunit from strength drills are dueto improvements in energy systems and enzymes related to both qualities. Endurance variables related to strength depend on the player'sability to perform under the lack of oxygen. This leads to adaptations that increase thevolume of muscle fibers and enzyme activity. This led to improvements in specific strength as a result of

concurrent training as various types of muscular strength, including max strength, power and strength endurance, are major components of muscular fitness of squash players where players are required to continue striking till they win the point all along match rounds with the same level of strength and without fatigue. This can never happen unless a suitable level of strength and endurance is available. This is the idea behind concurrent training reflected in improvements of both qualities at the same time through improving the aerobic endurance variables. This is consistent with Khribet & Abd El-Fattah (2016) who indicated that the relation among speed, strength and endurance is crucial for reaching elite performance. In addition, the good understanding of relations among different qualities helps coaches to improve these qualities according to the requirements of the specific activity, like the relation between strength and endurance that results in strength endurance or the relation between speed and endurance leading to speed endurance.

(17: 595).

Table (9) also showed statistically significant difference on P ≤0.05 between the pre- and post-measurements of the second experimental group (inter-week concurrence) on the technical variables under investigation as (t) calculated values were between (12.11) and (19.35) in favor of post-measurements. Improvement percentages for velocity, accuracy and strength of straight forehand stroke and velocity, accuracy and strength of straight backhand stroke were (9.04%) and (45.98%) respectively. The researcher thinks that this is due to improvements in specific physical qualities of the second experimental group like strength endurance and grip

strength of the used arm asthese improvements led to concurrent improvements in velocity, accuracy and strength of straight forehand stroke and velocity, accuracy and strength of straight backhand stroke. This is clear in the results of velocity of straight forehand and backhand strokes.This is consistent with Mohamed, W. N. (2009) who indicated that the recommended programs positively affected the technical performance level of squash players (22: 22).

This proves the second hypothesis stating that: There are statistically significantdifferences between the pre- and post-measurements of the second experimental group(inter-week concurrence) on some specific physical abilities and the technical performance level of junior squash players in favor of post-measurements.

Table (10) showed statistically significant difference on P ≤0.05 between the post-measurements of the first (inter-unit) and second (inter-week) experimental groupson the physical tests with (t) calculated values ranging between (4.640) and (8.171).

According to table (10) there were statistically significant differences in favor of the second experimental group on 20 m running as (t) calculated value (5.06) was higher than its table value (2.07). this was true for trunk flexion and medicine ball throwing with (t) calculated value (4.640). improvement rates for the second experimental group (inter-week) were higher than the first experimental group (inter- unit).

This is consistent with Kamel & Mostafa (2013) who indicated that concurrenttraining is effective in improving strength, agility,

cardio-respiratory endurance, speedstrength of hands, speed strength of legs, reaction speed of hand and reaction speed forlegs in handball players (15: 116).

The researcher thinks that these improvements in specific physical abilities andtechnical performance of speed, accuracy and strength of forehand and backhand strokes depend on forming and organizing loads inside the training units and grading of loads according to the use of strength and endurance in addition to improving specificphysical abilities like strength endurance and speed endurance. Technical drills throughdirecting the forehand and backhand strokes targeted these abilities. It is clear that the second experimental group (inter-week) was superior to the first experimental group (inter-unit) in these abilities.

Brad et al (2015) indicated that concurrent resistance training with endurance training improves max strength, aerobic endurance and anaerobic endurance. These results appear when some variations are added to the style of initiating loads. This includes the number of sets, intensity of each set and rest intervals as these variables may lead to new different results. They also indicated that the initial advantage from concurrent training of resistance and endurance is the improvement of neuromuscular control. This can be done through increasing the number of active motor units (5).

Table (10) showed statistically significant differences on all physical variablesin favor of the post-measurements of the second experimental group (inter-week) compared with the first experimental group (inter-unit).

Berryman et al (2018) indicated that endurance drills during concurrent training can lead to significant adaptations in the physical and technical performances while strength drills may be harmful stimulus for endurance performance if the training plan is not suitable (25: 56).

Mujika et al (2016) indicated that training methods similar to resistance training, like concurrent training, may improve muscular endurance and cardio-respiratory endurance as they use high intensities and few repetitions (8: 22).

Senthil & Arul (2012) indicated that these different results may be due to the differences in the nature of training programs use, like differences in intensity, frequency, rest intervals and training objectives of concurrent training. These differences may be due to differences in initiation style (26: 91).

The researcher asserts that both modes of concurrent training led to improvement rates. But when comparing both modes, inter-week mode was better than inter-unit mode as coaches concentrate on one particular factor that may improve their players' abilities, even with minimal percentages, in competition.

This proves the third hypothesis stating that: There are statistically significant differences between the post-measurements of the first experimental group (inter-unit concurrence) and the second experimental group (inter-week concurrence) on some specific physical abilities and the technical performance level of junior squash players.

Conclusions:

According to this research aims, hypotheses, methods and results, the researcher concluded the following:

1. The second experimental group (inter-week concurrence) surpassed the first experimental group (inter-unit concurrence) in some physical abilities and the technical performance level of junior squash players.
2. Both programs had positive effects on strength, endurance and technical performance of forehand and backhand strokes for junior squash players.
3. The recommended concurrent training program used with the first experimental group (inter-unit) used muscular endurance and cardio-respiratory endurance drills alternatively inside the same unit and led to improvements in physical and technical variables under investigation. Improvement rates ranged from (1.67%) to (40.51%) for aerobic endurance as least value and trunk flexion as highest value. The program also improved the forehand and backhand strokes with improvement rates ranging from (20.85%) to (23.12%) as accuracy of backhand stroke was the least value and speed of backhand stroke was the highest value.
4. The recommended concurrent training program used with the second experimental group (inter-week) used muscular endurance and cardio-respiratory endurance drills alternatively inside the same training week and led to improvements in physical and technical variables under investigation. Improvement rates ranged from (3.29%) to (92.31%) for aerobic endurance as the least value and trunk flexion as the highest value. The program also improved the

forehand and backhand strokes with improvement rates ranging from (9.04%) to (45.98%) as accuracy of backhand stroke was the least value and speed of backhand stroke was the highest value.

Recommendations:

According to these conclusions, the researcher concludes the following:

1. Well-balanced concurrent training that alternates between strength and endurance drills should be used inside the training week.
2. Performing similar studies on other modes of concurrent training.
3. Performing similar studies using concurrent training on other age groups and other sports.
4. Performing similar studies on concurrent training using specific methods for improving strength like weight training and plyometrics concurrent with muscular endurance.
5. Coaches should concentrate on concurrent training to improve the physical andtechnical conditions of junior squash players in addition to integrating specific programs for that in the annual training plan.

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