Effect of SAQ training program on BDNF response, correlated to some physical and skills of gymnastics of the Floor Exercise-elements

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Introduction

Regular exercise can positively affect brain health through promoting synaptic plasticity, growth, and the survival of neurons (**Vaynman and Gomez-Pinilla, 2006**). Acute physical exercise increases brain-derived neurotrophic factor (BDNF) levels in the brain, leading to enhanced cognitive functions (**Roig et al., 2013**).This could be achieved by increasing the expression of (BDNF). It is a natural protein found in the brain (**Saucedo Marquez et al., 2015**). BDNF is a neurotrophin that regulates fundamental functions of the central nervous system including neurogenesis, neuroprotection, neuroregeneration, cell survival, and the development and maintenance of synaptic connections between neurons (**Lipsky and Marini, 2007**).

Gymnastics fitness requires **c**oordination as a vital part of training since it is multi dimensional game. Players' performance includes short spiriting with jumping and multi change of direction. To execute the right session of a gymnastic set, explosive power plays a vital role with synchronized movements between legs, hands and trunk. Hence, progression requires continuous training for complex skills sets with high performance physical demands. For the long-term, athlete importance development of strength and power is emphasized **(Ford et al, 2011).** All of these skills are in need to neuromuscular coordination under control of BDNF to regulate, develop and improve their execution.

It is supposed that plyometric training (PT) is one of the most affordable

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programs for gymnastics. PT is a specialized, high-intensity training method which aims to increase sport-specific explosive power and the rate of force development (**Hall et al, 2016)**. PT directs muscle action to a fast eccentric pre-stretch and well storage of elastic energy. This results in a powerful explosive concentric contraction, greater force and power output (**Makanuk and Sacewicz, 2010).** PT also enhances muscle motor unit which leads to enhanced rate and force of coordinated neuromuscular contraction (**Potteiger et al., 1999).** Speed**,** agility**,** and quickness (SAQ) training program is one of PT can be considered gymnastics specific. SAQ elements are very important in training and performance in gymnastics. Speed acquired by sprinting training can increase gymnast momentum useful for running towards a vault, tumbling pass, and/or a dismount. Agility developed through practice of skills to get the remarkable cognition of the body should to be, can improve gymnast's ability to rapidly adjust the body's position in balance and control. Quickness is required to improve the skills' ability to move rapidly. It is useful to react to visual, auditory, and kinesthetic information. Quickness also is required for the subconscious decision-making process during the execution of skills (**Karthick et al, 2016)**.

The aim of this study is to investigate student female gymnastic players for significantly improved parameters of speed, agility and jump in a gymnastic performance by combining routine faculty technical and tactical sessions with a SAQ training program through 8 weeks period. Improvement may be correlated to BDNF enhancing their skills by SAQ program. Therefore, the object of this study was to investigate the changes in the proposed parameters including Muscular power , Agility, Flexibility neuromuscular coordination beside parameters of gymnastics skills measured after 8 weeks of SAQ training in an experimental group against control group trained according to the normal faculty program.

Subjects And Methods

Participants

Twenty-seven female gymnasts from grade two, gymnastics group, Faculty of physical education, Sultan Kabous University, Amman Sultanate were recruited for this study. They were randomly sub grouped into experimental group (14 students) versus 13 students as control group. The participants were regional standard as a minimum, and engaged in at least six hours of gymnastics training a week, appearing healthy. Participants provided written informed consent to participate in the study. The study was approved by the faculty department of Sport and Exercise Science ethics committee reviewed and audited by the University according to the Helsinki Declarations for research with human volunteers.

Exercise protocol design:

This study was proposed to investigate the effect of SAQ training program for eight weeks during the first session of the education year 2015/2016 (from 1/10/2015 to 26/11/2015) on the adaptation process for BDNF and its effect on some physical and skill parameters. Physical parameters include Muscular power (vertical jump & standing broad jump), Agility by Barrow test, coordination (Arm-eye coordination، and foot-eye coordination), Balance, Flexibility (Forward flexion of trunk). Skill parameters include Leap with turn, Switch leap, stage leap, Tuck jump, Ring jump, Cat leap with turn and Grand jute.

Experimental group subjects were subjected to specialized SAQ program for 8 weeks at 75% of VO2 max at 110 min./ 3 days/ week. The training SAQ program exercise session was partitioned into 10 min. for warming up, 35 min for the SAQ exercise, 20 min for gymnastic skills explanation, 35 min for gymnastic skills training and 10 min for active cool down. Control group was trained in the same program but without SAQ session.

Blood Analyses

Blood was sampled from an antecubital vein at rest and after the end of the exercise session before and after the training program. Plasma was immediately separated by centrifugation and stored at -20 °C for later analysis. Plasma BDNF was analyzed by using an ELISA kit.

Statistical analysis

All values were reported as the means ± SD. Data are represented with resting samples and compared post-exercise samples. Mean values for the two experimental conditions were compared by using t paired sample by using (SPSS V.17) computer designed statistical program. Specific differences were assigned with a significance level of 0.05.

Results:

Table (1) represents the anthropometric results of both groups. There is no any significant differences in all parameters indicating homogeneity of all players participated in this study.

Table (1)

Anthropometric results (Mean ± SD) for investigated players

	Exp. group	Con. group	t	p	Significance
Height (cm)	164.73 ± 1.91	164 ± 1.46	0.19	0.85	NS
Weight (kg)	59.2 ± 2.11	59.2 ± 1.26	-0.10	0.93	NS
Age (years)	19.33 ± 0.62	19.2 ± 0.77	-0.47	0.64	NS

Exp: Experimental group Con: Control group

Physical and biochemical results of table (2) are expressed as Mean ± SD revealed that both of the two groups have improvement in all investigated measurements except agility and flexibility in the control group after the 0program. All results showed higher adaptation in the Experimental group compared to that of control group.

Table (2)

Comparison between obtained physical and biochemical results (before program to after program) expressed as (Mean ± SD) control group

(N=13)	Before	After	t	p	Significance
vertical jump (cm)	16.69 ± 1.44	22.46 ± 2.11	-7.500	.000	S
standing broad jump (cm)	154.76 ± 8.62	169.15 ± 6.5	-5.490	.000	S
Agility (sec)	14.92 ± 1.32	14.30 ± 1.44	1.145	.275	NS
eye-hands coordination (degree)	9.15 ± 1.21	14 ± 1.68	-10.428	.000	S
eye-legs coordination (sec)	24.84 ± 2.12	23.30 ± 1.18	2.993	.011	S
balance (Sec)	11.46 ± 1.13	14.23 ± 1.48	-7.015	.000	S

FollowTable (2)

Comparison between obtained physical and biochemical results (before program to after program) expressed as (Mean ± SD) control group

(N=13)	Before	After	t	p	Significance
flexibility (cm)	9.92 ± 1.19	10.92 ± 3.15	-1.048	.315	NS
BDNF (ng/ml)	852.61 ± 58.4	954.85 ± 67.41	-8.247	.000	S
vertical jump	17.14 ± 1.99	30.85 ± 1.95	-15.267	.000	S
standing broad jump	153.5 ± 9.95	201.21 ± 12.5	-10.491	.000	S
Agility	15.14 ± 1.17	12.38 ± 1.44	4.991	.000	S
eye-hands co-ordination	9.42 ± 1.4	14.92 ± 1.27	-11.250	.000	S
eye-legs co-ordination	24.71 ± 1.68	19 ± 2.22	7.753	.000	S
balance	11.28 ± 1.44	19.14 ± 2.74	-12.881	.000	S
flexibility	10.21 ± 1.42	11.85 ± 1.56	-4.414	.001	S
BDNF	867.35 ± 78.28	1152.71 ± 121.25	-11.535	.000	S
vertical jump	16.69 ± 1.44	17.14 ± 1.99	-.344	.737	NS
standing broad jump	154.76 ± 8.62	153.5 ± 9.95	.249	.807	NS
Agility	14.92 ± 1.32	15.14 ± 1.17	-.135	.895	NS
eye-hands co-ordination	9.15 ± 1.21	9.42 ± 1.4	-.154	.880	NS
eye-legs co-ordination	24.84 ± 2.12	24.71 ± 1.68	.095	.926	NS
balance	11.46 ± 1.13	11.28 ± 1.44	.743	.472	NS
flexibility	9.92 ± 1.19	10.21 ± 1.42	-.671	.515	NS
BDNF	852.61 ± 58.4	867.35 ± 78.28	-.535	.602	NS
vertical jump	22.46 ± 2.11	22.46 ± 2.11	-13.732	.000	S
standing broad jump	169.15 ± 6.5	169.15 ± 6.5	-7.788	.000	S
Agility	14.30 ± 1.44	14.30 ± 1.44	3.187	.008	S
eye-hands co-ordination	14 ± 1.68	14 ± 1.68	-1.280	.225	S
eye-legs co-ordination	23.30 ± 1.18	23.30 ± 1.18	-2.502	.028	S
balance	14.23 ± 1.48	14.23 ± 1.48	-7.500	.000	S
flexibility	10.92 ± 3.15	10.92 ± 3.15	-.817	.430	S
BDNF	954.85 ± 67.41	954.85 ± 67.41	-5.592	.000	S

Gymnastics skills results were compared in table (3) and using student t test differences. Control group was compared to experimental group before and after the SAQ training program. All results revealed no significant differences between the two groups before the training program but significant after program. All skills adaptations were higher in experimental group except tuck and ring jumps including Leap with turn, Switch leap, stage leap, cat leap with turn, Grand jute and cross forward backwards kills.

Since gymnastic skills require high neuromuscular compatibility, they are found to be higher in experimental group subjected to SAQ training program.

Table (3)

Comparison between obtained gymnastic skills results (before program to after program) expressed as (Mean ± SD) for control group

N=13	Before	After	t	p	Significance
Leap with turn	0.54 ± 0.06	1.25 ± 0.7	-23.277	.000	S
Switch leap	0.5 ± 0.08	1.24 ± 0.07	-21.533	.000	S
stage leap	0.72 ± 0.09	1.04 ± 0.1	-8.766	.000	S
Tuck jump	0.73 ± 0.07	1.73 ± 0.13	-24.343	.000	S
Ring jump	0.53 ± 0.09	1.52 ± 0.12	-20.126	.000	S
cat leap with turn	0.7 ± 0.10	1.25 ± 0.08	-15.228	.000	S
cross forward backward	0.72 ± 0.12	1.01 ± 0.11	-5.588	.000	S
Grand jute	0.75 ± 0.08	1.22 ± 0.10	-15.165	.000	S
Leap with turn	0.56 ± 0.08	1.74 ± 0.12	-41.450	.000	S
Switch leap	0.52 ± 0.08	1.71 ± 0.14	-30.451	.000	S
stage leap	0.716 ± 0.12	1.717 ± 0.11	-19.295	.000	S
Tuck jump	0.72 ± 0.11	1.71 ± 0.12	-22.995	.000	S
Ring jump	0.54 ± 0.09	1.50 ± 0.12	-23.473	.000	S
cat leap with turn	0.74 ± 0.11	1.71 ± 0.12	-24.988	.000	S
cross forward backward	0.73 ± 0.12	1.56 ± 0.11	-18.412	.000	S
Grand jute	0.72 ± 0.14	1.52 ± 0.10	-20.407	.000	S
Leap with turn	0.54 ± 0.06	0.56 ± 0.08	-.587	.568	NS

Follow Table (3)
Comparison between obtained gymnastic skills results (before program to after program) expressed as (Mean ± SD) for control group

N=13	Before	After	t	p	Significance
Switch leap	0.5 ± 0.08	0.52 ± 0.08	-.808	.435	NS
stage leap	0.72 ± 0.09	0.716 ± 0.12	.726	.482	NS
Tuck jump	0.73 ± 0.07	0.72 ± 0.11	.610	.553	NS
Ring jump	0.53 ± 0.09	0.54 ± 0.09	-.587	.568	NS
cat leap with turn	0.7 ± 0.10	0.74 ± 0.11	-.879	.397	NS
cross forward backward	0.72 ± 0.12	0.73 ± 0.12	-.227	.824	NS
Grand jute	0.75 ± 0.08	0.72 ± 0.14	.923	.374	NS
Leap with turn	1.25 ± 0.7	1.74 ± 0.12	-12.195	.000	S
Switch leap	1.24 ± 0.07	1.71 ± 0.14	-10.178	.000	S
stage leap	1.04 ± 0.1	1.717 ± 0.11	-15.183	.000	S
Tuck jump	1.73 ± 0.13	1.71 ± 0.12	.488	.635	NS
Ring jump	1.52 ± 0.12	1.50 ± 0.12	.261	.799	NS
cat leap with turn	1.25 ± 0.08	1.71 ± 0.12	-11.516	.000	S
cross forward backward	1.01 ± 0.11	1.56 ± 0.11	-14.646	.000	S
Grand jute	1.22 ± 0.10	1.52 ± 0.10	-10.653	.000	S

N.B. All gymnastics skills are measured as fraction of two degrees

There was a positive correlation between vertical jump and flexibility (r=0.718, p=0.006) for the investigated gymnastic students as a whole before the training program. This can be explained as the general training system of the faculty help to increase the muscle capacity for executing such skills as an adaptation.

After the SAQ training program, experimental group showed correlation between vertical jump and standing broad jump (r=0.533, p=0.049) and eye-legs co-ordination (r=0.638, p=0.014). Also, between eye-hands co-ordination and flexibility (r=0.654, p=0.011) and BDNF (r=0.591, p=0.019). That is to say SAQ affect leg muscles capacity as a whole and neuromuscular coordination using BDNF as mediator for their synchronization.

Discussion

This study was proposed to investigate effect of SAQ training program on the adaptation of some physical and gymnastic skills parameters and correlate them to plasma levels of BDNF. In the present study, the subject sport activity was gymnastics as a course of the faculty of physical education syllabus on average for 110 min with moderate intensity 3 days per week.

Results revealed general improvement in all physical and skills characteristics in the investigated female gymnastic students. Students in grade two are still untrained well. To upgrade their gymnastic physical fitness, it is recommended to practice exercise programs for the development of endurance, mobility and coordination. One of these programs is the SAQ training model, which develops aerobic endurance, strength, mobility and coordination **(Boeva et al.; 2003).**

This study comprised three main results; the first is the elevation of speed**,** agility and quickness adaptation parameters in experimental group more than that of control group. Another manifestation of this study is that the increased skills adaptation parameters in the experimental group more than that of control group. The third and most profound result is that the increase in skill was correlated with BDNF levels.

Exercise can promote brain health and function by protecting neurons and improving neuronal plasticity **(Cotman and Berchtold, 2002).** The novel finding of the present study is that in SAQ training exercise blood BDNF concentration elevation is found but not in control group to the same extent, pointing to exercise-type dependent transient neurotrophic factor induction in humans.

Since SAQ concentrate on speed, agility and quickness which is principal for gymnastic skills execution, all neuromuscular coordination required skills including Muscular power, Agility, Flexibility and Skill parameters include Leap with turn, Switch leap, stage leap, Tuck jump, Ring jump, Cat leap with turn and Grand jute are more adapted more than that found in control group who subjected to the routine program. This results mean the routine faculty program increased these parameters adaptation but to a lower extent.

Guruvupandian and Murugavel (2017) found improved adaptation in **s**peed, agility and vertical jump performance in response to high intensity plyometric training program on male handball players. **Howe et al. (2017)** results indicated more powerful effects of SAQ on sprint performance in athletes' activity in general. In the vice versa, **Diswar et al, (2016)** concluded that SAQ training program was significantly powerful than circuit training program regarding speed and agility which is important for gymnastics whereas circuit training program was more profound for abdominal, arms & shoulder endurance capacity but no significant difference was found in explosive strength between both the training programs.

Findings of this study revealed significant elevation in adaptation physical parameters in the all investigated subjects of the study. BDNF levels were elevated post-exercise either before or after program with highest significant levels after program for experimental group. The significant increase in plasma BDNF after exercise and after training program suggests that BDNF could possibly be an important tool for monitoring and quantification of neuromuscular compatibility.

The physiological function of the acute response of serum BDNF concentration may contribute to promote synaptic plasticity and to improve cognitive functions **(Cho et al., 2012)** as well as to enhance exercise performance**.** Chronic response may affect neural regeneration and remyelination to be promoted because the activation of the BDNF signal is also required for the priming effect of exercise on axonal regeneration **(Correia et al., 2010).**

An acute bout of exercise induced an enhancement in cognitive function, as shown by the improvement in face-name task performance. This is in agreement with previous studies which suggest that intense acute exercise enhances learning and memory as assessed by a language-learning model **(Ferris et al., 2007).**

In agreement with the literature, the serum analysis revealed an acute exercise-induced increase in BDNF concentration in sedentary young men. According to a previous review, 69% of studies in healthy human subjects reported a 'mostly transient' increase in peripheral BDNF concentration following acute exercise **(Knaepen et la., 2010).** In the present study, acute exercise induced an increase in BDNF, however given that increases in basal BDNF concentrations were found in the chronic analysis, it may be presumed that the increase in serum BDNF reported here is correlated to chronic adaptation of neuromuscular compatibility.

The source of the BDNF increase remains unclear. Evidence indicates that the brain is a major, but not the sole contributor to circulating BDNF and platelets also represent a likely source of serum BDNF, as has consistently been reported **(Goekint et al., 2010).** In this context, reports of the ability of BDNF to cross the blood-brain barrier may be of relevance, with movement of BDNF from brain to blood said to occur via bulk flow associated with the re-absorption of the cerebrospinal fluid **(Griffin et al., 2011).** It has also been suggested that exercise transiently increases the permeability of the blood brain barrier **(Watson et al., 2006).**

Conclusion

The eight-week SAQ training program improved neuromuscular junction in gymnastics and found to be more effective more that the faculty program. BDNF help improving the force generating capacity and neuromuscular development, which consequently improved aspects of the physical and skills performance. As these variables are associated with successful gymnastic performance, it can be suggested that the implementation of a SAQ program can contribute to improving gymnastic performance and prepare youth gymnasts for the progression of vaulting in the future. However, further research should aim to examine whether the incorporation of other programs may provide similar benefits to SAQ programs.

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