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The Effect of Vitamin B_{12} Deficiency on Balance among Competitive Jordanian Top Athletes

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Abstract: Our main objective in this study is to assess the relationship between the serum levels of vitamin B_{12} and balance time and balance frequency among Jordanian top athletes. For this purpose, Force Platform, model (1603 stability) is used. The study group consists of 119 Jordanian top athletes, 67 males and 52 females, mean age 18.6±1 year, with training experience at least 5 years and with a minimal training load of 20 training h/week participated in different competitive sports (aerobic, aerobic-anaerobic and anaerobic). A group of healthy 35 male and 46 female adolescents (control group), matched for age and gender was also, included (n = 81). Significant differences ($p<0.05$) between experimental and control groups were detected for vitamin B_{12} (379.79±141.89, 148.81±23.83 pg mL^{-1}, respectively), balance time (16.68±6.28, 8.96±0.57, respectively) and balance frequency (4.94±4.16, 7.59±4.16, respectively). No significant differences ($p>0.05$) were observed for the measured variables between males and females in the experimental group. Females have shown higher values both in vitamin B_{12} and balance frequency compared to males in the control group. Sheffe post hoc test and correlation values did not show any statistical difference between the levels of vitamin B_{12} from one side and balance time and balance frequency from the other side. We conclude that the Jordanian top athletes have higher values of B_{12} compared to none athletes, without any effects on the balance time and balance frequency.

Key words: Vitamin B_{12}, balance platforms, balance time, balance frequency, significant difference, jordonian top, athletes

INTRODUCTION

Vitamin B_{12} is one of the most important micronutrients. It plays a functional role in various organs and body systems (Hung *et al*., 2008; Volkov, 2008). It affects the peripheral and central nervous system, bone marrow, bones and vessels, as well as normal development during childhood (Volkov, 2008). The deficiency of vitamin B_{12} from inadequate dietary intake or impaired absorption is commonly asymptomatic, but can also cause anemia characterized by enlarged blood corpuscles, so-called megaloblastic anemia (McBride, 2000). Vitamin B_{12} deficiency remains one of the most common nutritional deficiency in the world and it is frequent among elderly patients (Gupta and Powers, 2008). Recent researches indicate that B_{12} deficiency is far more widespread than formerly believed. In the developing world, Vitamin B_{12} deficiency is very widespread, with significant levels of deficiency in Africa, India and South and Central America. This is due to low intakes of animal products (McBride, 2000). Most studies of vitamin B_{12} deficiency in elderly patients correlated this problem with nutritional or hematological factors (Hao *et al*., 2007; Khanduri and Sharma, 2007). Although, vitamin B_{12} deficiency is not common in youth, the prevalence of vitamin B_{12} deficiency in Jordanian youth has increased at an alarming rate. Several earlier reports have linked behavioral and learning problems among children, adolescents and young adults to vitamin B_{12} deficiency (Hoist-Schumacher *et al*., 2007; Thauvin-Robinet *et al*., 2007; Strassburg *et al*., 2004). Many researchers reported that, nutritional and hematological observations cannot explain prevalence of vitamin B_{12} deficiency in young people. Quinlivan (2008) noted that, in vitamin B_{12} deficiency, high serum folate is associated with increased homocysteine and methylmalonic acid concentrations. Besides, a potential adverse interaction between vitamin B_{12} and folic acid is pointed out (Johnson, 2007). Elevated homocysteine in blood indicates decrease in vitamin B_{12} levels in most cases (Fakhrzadeh *et al*., 2006; Meertens *et al*., 2007). The functions of vitamin B_{12} are numerous; those important to bodybuilders include

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carbohydrate metabolism and maintenance of nervous system tissue (Riggs *et al*., 1996). Stimulation of muscles via nerves is a critical step in the contraction, coordination and growth of muscles. Vitamin B_{12} is needed to reduce homocysteine levels, which may become elevated after strenuous levels. Mechanical vibration has recently aroused large interest, because it has been hypothesized that a low-amplitude, high-frequency stimulation of the whole body could positively influence many risk factors of falling and related fractures by simultaneously improving muscle strength, body balance and mechanical competence of bones (Bosco *et al*., 1998, 1999a, b).

In recent years, the measurement of balancing performance has attracted considerable attention, both in theoretical research and clinical circles. This attention has been generated by and in turn was instrumental in the development of various balance measurement systems, some of which are commercially available. Studies based on these systems have indicated that the maintenance of balance under static or dynamic conditions is a complex function involving major sensory and motor contributions (Kkinen *et al*., 1985). Among the former, the visual, vestibular and proprioceptive systems provide the neural input necessary to continuously adjust and correct body position in relationship to the supporting surface and the surrounding environment (Rubin *et al*., 2001).

Positioning of the body is achieved by means of the muscular system, which by way of displacing or arresting the motion of various body segments, enhances and maintains balance or prevents its loss (Coyle *et al*., 1981). Functional balance measures usually lack the ability to capture balance impairment at its early phase when no manifest balance problem yet exists. Thus, these tests are prone to a ceiling effect (Jarnlo, 2003; Boulgarides *et al*., 2003).

Postural control is a product of the central nervous system, the musculoskeletal system and the sensory system. With force platform-based measures, it is possible to obtain itemized information about integrated functioning of the balance control systems and to identify those individuals who still can successfully perform functional balance tests regardless of the incipient deficiency in balance control (Piirtola and Era, 2006). A number of different methods are used to assess balance: technical methods, such as sway magnetometery, which is use for the determination of the range of sway values. The magnetometer system, previously shown to be highly successful in distinguishing sway with and without the eyes open in individual subject, with the subject standing on a firm base the pathlength and area enclosed by movement of the hips in the horizontal plane were measured over 30 sec periods with eyes open and eyes closed (Clive *et al*., 1998).

Ataxia method was documented and quantified by means of static posturography using a force-measuring platform using an on-line computer program which calculated sway path, sway area; antero-posterior and lateral sway components and the amount of visual stabilization (Marcos and Vladimir, 2002) for diagnoses of the clinical rating which include the modified ataxia score of Biodex expanded to include items to assess noncerebellar effects of SCA3/MJD, e.g., dysphagia, visual impairment, peripheral neuropathy, spasticity, incontinence and sleep disorders.

The most frequently used technical method is the force platform. There are 2 types of force platforms, a static and a dynamic force platform, of which the dynamic force platform has been found to be more sensitive to detect impaired balance (Jacinta and Neil, 2000).

Our study aimed to assess the relationship between the serum levels of vitamin B_{12} and balance time and balance frequency among Jordanian top athletes using Force Platforms.

MATERIALS AND METHODS

Experimental subjects: One hundred nineteen Jordanian top athletes, 67 males and 52 females, mean age 18.6±1 year with training experience at least 5 years and with a minimal training load of twenty training h/week participated in competitive different sports (aerobic, aerobic-anaerobic and anaerobic) were included in this study.

A group of healthy males and females (n = 90) of matched age and gender were also included in the study. No subject revealed evidences of cardiovascular disease, diabetes (fasting glucose <7 mmol L^{-1}) or hypertension (blood pressure $<130/80$ mm Hg) when tested by specialized physicians.

Athletes included in this study represented all types of sport metabolisms; aerobic (long distance swimming, long distance running), aerobic-anaerobic (football) and anaerobic (basketball, taekwondo, volleyball, short distance running). All subjects submitted their written consents to a single blood sampling. None of the athletes participating in this study was using any type of special diets in the last 2 months prior to the study as they were out of the competitive phase and as they responded to the special questioner prepared for this goal. The study was approved by the Institutional Review Board of the Faculty of Physical Education, University of Jordan, Amman-Jordan.

Blood collection: Five milliliter of venous blood were withdrawn from each subject early in the morning between 8-10 am after 15-18 h rest and 12 h of fasting. The samples were centrifuged for 15 min at 3000 rpm in order to provide an appropriate amount of serum to use in measuring the serum B_{12}.

B_{12} concentrations were measured with the chemiluminescent method using an E170 immunoassay analyzer (Roche Diagnostics Corp., Indianapolis, IN). The electrochemiluminescence immunoassay was used on a Roche Modular Analytics E170 immunoassay analyzer (Roche Diagnostics). The ability to balance and maintain a stable posture is integral to the execution of most movement sand stance on movable force platforms, model (1603 stability). A force platform is a technical method of quantitatively assessing balance indirectly. The subjects tried to maintain the unstable balance platform in the horizontal position. Any balance platform deviations where reported numerically by the system in degrees.

RESULTS

The balance results are considered normal when balance time increases and balance frequency decreases. Results were average of 2 trials. According to t-values and its related ($p<0.05$) in Table 1, significant differences for B_{12}, balance time and balance frequency, between the experimental and control group are in favor of the experimental group ($p<0.05$). According to gender in the experimental group, t-values and its related p-values in Table 2 proved that there were no significant differences ($p>0.05$) for B_{12}, balance time and balance frequency between males and females. There were significant differences ($p<0.05$) for B_{12} in favor of females and for balance frequency in favor of males, while no significant differences ($p>0.05$) were observed for balance time in the control group.

One way analysis of variance of B_{12}, balance time and balance frequency among the sub groups (aerobic, anaerobic and aerobic-anaerobic) of the experimental group in Table 4 concluded that the significant differences ($p>0.05$) appeared for balance time, balance frequency and not for the levels of B_{12}. The correlation coefficient between B_{12} and balance time, balance frequency in each sub group in Table 5 indicate that correlation values were statistically not significant (all p-values were >0.05) indicating no relationship between B_{12} on the one hand and balance time and balance frequency on the other hand.

Table 1: Means, SD and t-test for vitamin B_{12}, balance time and balance frequencies according to group (exp/cont)

Variables	Groups	N	Mean	SD	t-value	Sig.
B_{12}	Exp	119	379.79	141.89	14.50	0.000
	Cont	81	148.81	23.83		
Balance time	Exp	119	16.68	6.28	11.00	0.000
	Cont	81	8.96	0.57		
Balance frequency	Exp	119	4.94	4.16	4.42	0.000
	Cont	81	7.59	4.16		

t-values and its related ($p>0.05$) proved that there were no significant differences for B_{12}, balance time and balance frequency between males and females in the experimental group

Table 2: Means, SD and t-test for B_{12}, balance time and balance frequency according to gender in the experimental group

Variables	Gender	N	Mean	SD	t-value	Sig.
B_{12}	Male	67	366.25	167.25	1.18	0.239
	Female	52	397.23	99.17		
Balance time	Male	67	17.10	5.99	0.84	0.403
	Female	52	16.13	6.65		
Balance frequency	Male	67	4.70	3.99	0.71	0.478
	Female	52	5.25	4.40		

There were significant differences for B_{12} in favor of females, while no significant differences were observed for balance time. For balance frequency $p<0.05$ and thus, significant differences exist between males and females in favor of the experimental group ($p<0.05$)

Table 3: Means, SD and t-test for B_{12}, balance time and balance frequency according to gender in the control group

Variables	Gender	N	Mean	SD	t-value	Sig.
B_{12}	Male	35	139.22	18.37	3.35	0.001
	Female	46	156.10	25.07		
Balance time	Male	35	8.99	0.58	0.38	0.700
	Female	46	8.94	0.56		
Balance frequency	Male	35	9.03	4.37	2.82	0.006
	Female	46	6.50	3.68		

Table 4: One way analysis of variance for B_{12}, balance time and balance frequency among the sub groups (aerobic, anaerobic and both) of the experimental group

Variables	Groups	N	Mean	SD	F-value	Sig.
B_{12}	Aero	40	409.18	128.60	1.30	0.275
	An	32	362.44	92.83		
	Aero + An	47	366.60	175.15		
Balance time	Aero	40	21.23	4.84	91.80	0.000
	An	32	19.83	3.54		
	Aero + An	47	10.65	3.30		
Balance frequency	Aero	40	3.73	3.59	16.34	0.000
	An	32	2.97	1.49		
	Aero + An	47	7.32	4.71		

Table 5: Sheffe post hoc test for balance time and balance frequency among the sub groups (aerobic, anaerobic and both) of the experimental group

Mean	Groups	An	Aero + An
21.23	Aero	1.40	10.58*
19.83	An		9.18*
10.65	Aero + An		
3.73	Aero	0.76	-3.59*
2.97	An		-4.35*
7.32	Aero + An		

Table 6: Correlation coefficient between B_{12} and balance time, balance frequency in each sub group

	Balance time		Balance frequency	
Gruops	r	Sig.	r	Sig.
Exp.	0.123	0.184	- 0.045	0.630
Cont.	0.024	0.831	- 0.084	0.456
Aerobic	0.229	0.154	-0.161	0.322
Anaerobic	- 0.117	0.522	- 0.096	0.603
Both	0.045	0.762	0.053	0.724

DISCUSSION

The results of this study indicate that both balance training frequencies were effective in improving balance ability for both lower limbs, adding another important parameter in designing balance exercise programs. Although, several studies propose that these exercises can increase balance ability, because of the injury rate reduction recorded (Caraffa *et al*., 1996; Wedderkopp *et al*., 1999; Chong *et al*., 2001), there were no studies? measuring balance parameters to assess the relationship between the serum levels of vitamin B_{12} and balance time and balance frequency in Jordanian top athletes. Our results show, significant differences ($p<0.05$) for B_{12}, balance time and balance frequency, between the experimental and control group in favor of the experimental group. The significant increase in the level of B_{12} in our athletes compared to the control subjects (379.79±141.89, 148.81±23.83 pg mL^{-1}, respectively) could be associated with the individual vitamin supplement of a complete Vitamin B complex given the increased stressors on the bodies of athletes in intense training, which should provide a good insurance level. The functions of vitamin B_{12} are numerous; those important to bodybuilders include carbohydrate metabolism and maintenance of nervous system tissue and stimulation of muscles via nerves is a critical step in the contraction, coordination and growth of muscles (Melzer *et al*., 2004). Vitamin B_{12} is needed to reduce homocysteine levels, which may become elevated after strenuous levels. One study's findings suggested that vitamin B_{12} metabolism may be altered in ultra-endurance runners (Lord *et al*., 2007). The balance time and balance frequency increased significantly in experimental subjects compared to control subjects (16.68±6.28, 8.96±0.57, respectively), (4.94±4.16, 7.59±4.16, respectively). Balance is the ability to maintain equilibrium, while sitting or standing. Dynamic sport participation requires stability, which serves as the resistance to the disruption of equilibrium. Balance exercises aimed at improving proprioceptin train the brain to recognize the body's segment position every moment. Therefore, a balance exercise program will train proprioception pathways more effectively under competitive circumstances. Specifically, in order to prevent limb injuries, peripheral and central nervous system receptors (Hauer *et al*., 2001) mechanoreceptors within muscles, tendons and ligaments have to be activated. Balance exercises seem to help this activation occur faster and more effectively (Gerdhem *et al*., 2003). In other words, the goal of balance exercises should be to reduce the time between neural stimuli and muscular response (Zachazewski, 1996). Although, many studies propose that these exercises can increase balance ability because of the injury rate reduction recorded (Caraffa *et al*., 1996; Wedderkopp *et al*., 1999; Chong *et al*., 2001). Balance platforms present convenient tools for investigating balance and there are a few studies, which have shown that force platform measurements provide data that can predict to some degree, whether a person belongs to the high risk group of fallers or not mainly among elderly people (Piirtola and Era, 2006). Poor balance was identified as a risk factor for ankle injury in basketball (Rozzi *et al*., 1999). Athletes can improve their ability to withstand body checks, incidental body contact, force absorption and power production by performing balance training (Heidt *et al*., 2000). During tight turns or high-speed maneuvers, a well-balanced athlete will be able to regain their balance after momentarily losing body control or having their mechanics break down, rather than falling. With training, mini brain sensors become more sensitive (Morgan and Oberlander, 2001), identifying deviations sooner and the information loop from sensor to brain and back to the muscles becomes shorter. Therefore, the information is processed quicker and response accuracy is improved. The muscles are given precise and accurate instructions appropriate to the sport challenge (Arnold and Schmitz, 1998). The results from the study, support findings from previous studies suggesting that the strength-generating capacity of the distal musculature is important for maintaining older adults' balance. Thus, exercise is important in maintaining functional independence among the athletes because it improves muscle strength, coordination and balance performance and decreases the risk of falls and fractures (Cahalan *et al*., 1989). More specifically, injury rate reduction on professional athletes after the application of balance exercise programs has been recorded by many authors. Caraffa *et al*. (1996) in a prospective controlled study of 600 soccer players mentioned the positive effects of a specific balance-training program on the decrease of the different injuries. Similarly, Wedderkopp *et al*. (1999) mentioned that the application of a balance training program on balance boards by healthy female hand ball players, for 10 months resulted in a decrease of frequency of lower limb injuries. As regards the assessment of balance ability after an application of a specific balance exercise program there were studies performed not on professional athletes but on healthy people. Hoffman and Payne (1995), investigated the effects of ankle disk training (BAPS) on postural sway of healthy subjects (n = 28) and showed significant improvements. They concluded that 10 weeks of proprioception ankle disk training can decrease postural sway parameters significantly. Chong *et al*. (2001) also applied a balance program on healthy people using balance boards (4 weeks, 3 times/week). The program was carried out and the participants improved their balance ability. Pafis *et al*. (2007) concluded in their study that the application of a 216 min balance-training program can improve body control and increase proprioceptive ability. The daily balance program and the program with a frequency of 3 times/week had the same result on balance improvement. The results by Edit Nagy (2004) indicated that ironmen are more stable and less dependent on vision for postural control than the control subjects and the prolonged stimulation of the proprioceptive, vestibular and visual inputs in the endurance race causes a significant disturbance in postural control. We hypothesized that vitamin B_{12} deficiency may lead to poor balance and poor postural balance is one of the major risk factors for falling. A great number of reports have analyzed the risk factors and predictors of falls but the results have for the most part been unclear and partly contradictory (Binder *et al*., 2002).

A variety of balance assessment tests are therefore found in the sporting literature, such as postural sway during bilateral stance or during unipedal stance and stance on movable platforms (Navega *et al*., 2003).

Balance platforms present convenient tools for investigating balance and there are a few studies which have shown that force platform measurements provide data that can predict to some degree whether a person belongs to the high risk group of fallers or not mainly among elderly people (Steadman *et al*., 2003). Poor balance was identified as a risk factor for ankle injury in basketball (Hauer *et al*., 2001).

Significant differences in B_{12}, balance time and balance frequency between the experimental and control group in favor of the experimental group (<0.05) (Table 1), can be explained based on the fitness of the participations.

Athletic males and females did not show any differences concerning the three parameters, while females in the control group have shown higher vitamin B_{12} levels and this may be due to vitamin supplements (Table 3).

The results also indicate that there is no correlation between vitamin B_{12} and balance time and frequency in the subgroups in experimental group (Table 4 and 5).

The differences in results between the aerobic and mixed (aerobic and anaerobic) subgroups and anaerobic group suggest that other factors may be contributing to the presence of significant difference (>0.05) in the balance time and balance frequency between the subgroups. Correlation values were statistically not significant which means that no relation between B_{12} from one side and balance time and balance frequency from the other side (Table 6).

CONCLUSION

We did not confirm our hypothesis and no direct relation is observed between vitamin B_{12} levels and both balance time and frequency using platform balance tests. We recommend further tests on vitamin B_{12} deficient patients or athletes to see how this will affect them. We also recommend other balance tests using different instruments and techniques.

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