The Journal of Eurasia Sport Sciences & Medicine

ISSN: 2687-265X

J Eurasia Sports Sci Med
http://dergipark.gov.tr/jessm

Volume 3, Issue 1
April 2021, 33-40.

ORIGINAL RESEARCH

The Comparison of Trail Making Test Scores of Open and Closed Skill Sports Athletes

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Received: 21.04.2021

Accepted: 26.04.2021

Abstract

The aim of this research was to compare the Trail Making Test (TMT) scores of open and closed skills sports' athletes. Total of 85 volunteers who are footballers, track and field athletes and sedentary participated. Participants performed the short form of International Physical Activity Questionnaire (IPAQ) and TMT (A/B). The statistical package program "SPSS 22.0" was used to analyze the data. In the analysis of categorical data, independent-t test and one-way analysis of variance were used to examine the statistical difference between independent groups. Correlations between continuous variables were performed using Pearson's corelation analysis. There was no statistically significant difference between the TMT score of footballers and track and field athletes ($p>0.05$). While there was no statistically significant difference between the metabolic equivalent (MET) levels of football players and track and field athletes ($p<0.05$), the MET levels of both groups were significantly higher than those of sedentary group ($p>0.05$). As a result, there was no difference between open skill athletes (footballers) and closed-skill athletes (track and field athlete) in terms of motor processing speed, attention, number sorting (form A) and task-switch, cognitive flexibility, functioning memory, visual scanning (form B) skills.

Keyword: Open skilled, closed skill, Trail Making Test.

To cite this article; Tokgöz, O, Korkmaz, N, H., & Pancar, S. (2021). The comparison of trail making test scores of open and closed skill sports athletes. *The Journal of Eurasia Sport Sciences and Medicine, 3*(1), 33-40.

INTRODUCTION

Although optimum performance in sport is associated with physical performance, cognitive abilities of athletes can determine the level of performance. Cognitive processes such as decision-making, problem-solving, cognitive flexibility in response to sudden and ever-changing situations, focused attention, and inhibition control determine the level of executive functions that athletes will be able to process and take many stimuli under time pressure (Krenn et al., 2018; Miyake et al., 2000; Vestberg et al., 2017).

Executive functions which are controlled by frontal lobe of the brain are influence by such varies like physical activity (Deslandes et al., 2009; Kvalø et al., 2017) age (Harada and Triebel, 2013), nutrition (Thodarkathai, 2018; Richard et al., 2018), sleep (Kasenova et al., 2017), smoking (Yolton et al., 2004) alcohol (Evert et al., 1995), athletes level and training year (Cona et.al, 2015; Hygiene et al., 2015; Lundgren et al., 2016; Paşaoğlu et al., 2019) and the type of sport skill (Di Russo et al., 2010; Jacobson and Matthaeus, 2014; Wang et al., 2013).

In recent years many stuedies revealed that participation in physical activity effects executive functions such as working memory, attention, mental flexibility in addition to academic achievement. (Davis et al., 2011; Kashihar et al., 2009; Niederer et al., 2011; Xiong, Li and Tao, 2017). Sport-related physical activities that require coordinating and problem-solving are known to activate brain regions used to control high-grade cognitive processes (Best, 2010; Diamond and Lee, 2011; Zhao et al., 2016).

It is reported that more cognitive functions are needed in branches that require the ability to adapt to situations where environmental factors change frequently and abruptly like basketball, football, and tennis than in branches where similar conditions are constantly repeated like athletics and swimming (Bianco Di Russo et al., 2017; Voss et al., 2010; Alvurdu et.al., 2019). The sport branches which require complex cognitive functions such as strategic thinking, process information from an opponent and the ball, intuition, spatial perception need open skills. But predictable, repetitive movements and continuous similar changes require closed skills (Wang, 2013).

Wang et al. (2013) revealed that tennis players are more successful in inhibition control skills than swimmers and sedanters. It is thought that open skill athletes' cognitive functions such as problem-solving and inhibition control (Jacobson and Mattheus, 2014), visual attention, decision making-and motor skills (Taddei et al., 2012) are better than closed skill athletes and sedentary. Yu et al. (2017) indicated that badminton athletes are better than swimmers in their ability to use initiative to create new conditions or change the course of existing conditions, whether positive or negative. When these data are evaluated, the higher the cognitive demands in the sport branch, the higher the cognitive skills of the athletes. Athletes are seen to be more likely to restore and transfer these skills when practicing cognitive tasks that are not related to sport. Particularly sports that require strategic thinking and problem solving have high demands on inhibition, working memory and mental flexibility. It is well known that demands open skill athletes must adapt to variable changing situations in order to react to teammate’s movement, decision and behavior. In this respect, the athletes of this branch should perform better in TMT than the athletes who perform stationary and predetermined tasks with repetitive movements. In this study, it aimed to compare TMT performance of athletes’ in sports branches involving open and closed skills.

METHOD

Participations

Sample of this research were composed of 85 voluntary participants. Sample was made up 30 footballers, 25 track and field athletes, 30 sedentary. Footballers were in an amateur team in Bursa, (age:20.23 ± 2.34 years, height:172.73 ± 8.89 cm, weight: 66.20 ± 9.68 kg), track and field athletes from Turkey Olympic Preparation Center who performs in different branches such as sprint, long distance, high jump, javelin throw, put (age:19.58 ±. 2.4 years, height: 176.62 ± 7.89 cm, weight 66.55 ± 9.99 kg) and 30 sedentary students (age: 20.31 ± 4.83 years, height: 169.16 ± 8.05 cm, weight 65.74 ± 8.47 kg) from Uludag University in Bursa (Table 1). Participants stated that not smoke or drink alcohol, while athletes declared and confirmed that they had been actively engaged in sports for the past two years Our study was produced from master thesis and approved by the Ethics Committee of Bursa Uludag University with decision number 2019-2/14 dated 29.01.2019.

Table 1. General characteristics of participants

Variables	Football (n=30)	Track and Field (n=25)	Sedentary (n=30)
Age (year)	20.23 ± 2.34	19.58 ± 2.24	20.31 ± 4.83
Height (cm)	172.73 ± 8.89	176.62 ± 7.89	169.16 ± 8.05
Weight (kg)	66.20 ± 9.68	66.55 ± 9.99	65.74 ± 8.47
MET	5019.83 ± 4060.35	6897.86 ± 3042.54	2732.70 ± 2433.05
BMI (kg/m^2)	22.05 ± 2.30	21.34 ± 1.98	23.04 ± 2.47

Procedure

Participants performed The TMT A/B and IPAQ short form were applied at Uludag University Faculty of Sports Sciences on the same day and time to the participants who were divided into three groups such as footballers (open skill group), track and field athletes (closed skill group) and sedentary (control group). Before the test day participants avoided from severe physical activity for at least 24 hours and sleepless. Participants were also asked to refrain caffeine, nicotine and alcohol for at least 12 h before testing. Participants performed the TMT (A/B) and IPAQ in between 09.00-10.00 am. The temperature of the test room was kept at 24 ^{0}C (degrees celcius) and lightened sufficiently. Each participant performed on comfortable chair and a suitable table. Before applied the test, sample of the TMT A and B was performed by researchers. Standard procedures were used for TMT; if a participant made an error by reaching an incorrect target, it was immediately called to his/her attention with instructions to proceed from the point where the mistake occurred. A second research assistant who independently timed and/or tracked errors observed the evaluation; participants were not aware that they were being observed. The duration of the participants during the application was measured with an electronic hand stopwatch (Casio Hs-70w-1DF-Japan) with a precision of 0.01 seconds. After TMT was completed, all participants were administered the IPAQ brief form to determine the physical activity level of the volunteers at the same time.

The participants' body weights were measured with a digital scale with a sensitivity of 0.1 kg. Height lengths were measured with electronic height measuring equipment with sensitivity of 0.01 cm. Participants were asked to go barefoot to the measuring device. The measurements were performed with the participants ' heads in an upright position, their soles in a straight position on the scale, their knees stretched, their heels in contact with each other, and the body in an upright position.

Trail Making Test A/B

Developed by Reitan (1958), it is a test that can be applied on paper. It consists of two forms A and B. Section A contains numbers scattered on paper from 1 to 25. Form a assesses attention, visual scanning, motor speed and coordination. In Form B, there are numbers 1 through 13 on the paper and letters A through L. Participants are asked to combine numbers and letters on paper in the form of 1-a,2-B,3-C respectively. Form B also assesses cognitive flexibility and functioning memory in addition to form A.

IPAQ

The survey consists of 7 questions and 4 separate sections and consists of sections bar FA-related questions that have been conducted at least 10 minutes in the last 7 days. It is stated that it is appropriate to apply to adults in the 18-69 age range. 7 days in the survey with how many days and how long for each day;

A) heavy physical activities (HVA),
B) medium intensity physical activities (MIPA),
C) walking is determined (Y).

The last question is, on a daily basis, still (sitting, lying, etc.) time spent is determined.

Statistical Analysis

The statistical package program "SPSS22.0" was used to analyze the data. In the analysis of categorical data, statistical difference between independent groups was examined; Independent t test, one-way variance analysis, correlation between continuous variables, Pearson correlation analysis.

RESULTS

TMT A form completion time was 24.08 ± 9.15 SEC in football players, 23.97 ± 10.96 seconds in track and field athletes and 23.13 ± 7.52 seconds in sedanters and there was no statistically significant difference between groups ($p>0.05$). When completion times of TMT B form were examined, the difference was 69.84±35.55 seconds in footballers, 57.08±22.58 seconds in track and field athletes and 49.95±27.78 seconds in sedanters and statistically significant difference was found between groups ($p<0.05$). There was a statistically significant difference between football and sedentary groups in TMT B form completion time ($p<0.05$). However, there was no statistically significant difference compared to other groups ($p>0.05$), (Table 2).

Table 2. Participants TMT A and B Form Durations

Variable	Group	*N*	X	*SD*	*F*	*p*
A Duration	Football	30	24,08	9,15	,096	0,91
	Track and Field	25	23,97	10,96		
	Sedentary	30	23,13	7,52		
B Duration	Football	30	69,84	35,55	3,625	0,03
	Track and Field	25	57,08	22,58		
	Sedentary	30	49,95	27,78		

There was no statistically significant difference between footballers and track and field athletes (p>0.05), (Table 2).

Table 3. Participants' MET levels

Variables		Groups	*A.D.*	S.E.	*p*
MET	Football	Track and Field	-1878,03	844,49	0,09
	Football	Track and Field	2287,12*	830,52	**0,02***
	Football	Track and Field	4165,15*	837,76	**0,00***

AD: Average Difference SE: Standart Error

There was no statistically significant difference between the MET values of football and track and field athlete groups (p>0.05). However, statistically significant difference was found between football and sedentary and athletics and sedentary groups (p<0.05), (Table 3).

Table 4. Relationship between MET levels and TMT performances of participants

Variables	*TMT*	*N*	*R*	*p*
MET	A Duration	85	-0,036	0,74
	B Duration		0,166	0,12

There was no statistically significant correlation between the participants' MET levels and TMT Division A completion time and Division B completion time (p>0.05), (Table 4).

DISCUSSION

In this study, the TMT performance of open skill (football) and closed skill (track and field athletes) was compared. Open skill sport which involves suddenly and frequently changing external factors that are difficult to foresee is expected to be more effect cognitive functions than closed skill sport which involves predictable situations and enviromental factors. Many studies revealed that the performance of open skill athletes in executive function is better than that closed skill athletes. Krenn et.al (2018) found that open skill athletes' reaction time and working memory performances were better than closed skill athletes'. Wang et.al (2013) found that tennis players who are open skill athletes have better reaction time performance compared to swimmers and sedanters. Jacobson and Matthaeus (2014) examined the impact of different sports branches on executive function performance by 54 participants and found that open skill athletes were more successful in problem solving skills compared to closed skill athletes. Chen et.al (2019) used fMRI to monitor brain activities of prefrontal lobe executive functions of middle-aged people. Sample divided three groups as open skill exercise, closed skill exercise and irregular exercise. After 3 month, they showed that open skill exercise group had higher neural activation in inferior frontal gyrus, talamus and hippocampus during working memory task compared to closed skill group.

It is well documented that open skill athletes good at decision-making under time pressure, to quickly locate opponents or teammates and objects around them, and to use their bodies to manipulate the movements of opponents and objects. But controversially the published literature, Ting-Yu et.al (2017) showed that both open and closed skill athletes. were better at visual spatial intelligence, attention, reaction time and memory skills than sedentary-while no significant differences were found between skill types.

In conclusion, this study presented similar results with Ting-Yu et al. there was no statistically significant difference between open skill players and closed skill athletes in terms of motor processing speed, visual scanning, attention, number sorting (Form A) and set changing ability, cognitive flexibility, functioning memory (Form B) based on visual scanning ability. The fact that athletes are closer to the elite level than footballers may have affected these results. In addition, football is generally preferred by lower socio-cultural communities. Insufficient alphabet knowledge and reading habits of football players who came from these communities can be caused in these results.

Experimental qualitative studies on large and homogeneous sample in term of athlete's level and training age can clearly expose open or closed skill sport's effects on cognitive abilities. Also the addition of more cognitive predictor tests in future studies will be important to assess the complex structure of cognitive processes. Cognitive function tests can be specified for the open or closed skill branches to well identify what is the cognitive requirements of sport branches are.

REFERENCES

Alvurdu, S., Keskin, K. C., Koçak, M., Şenel, Ö., & Günay, M. (2019). Is Vertical Jump Associated with Change of Direction Ability in Soccer Players? A Pilot Study. *The Journal of Eurasia Sport Sciences and Medicine*, *1*(2), 57-64.

Best, J. R., & Miller, P. H. (2010). A developmental perspective on executive function. *Child development*, *81*(6), 1641-1660.

Bianco, V., Di Russo, F., Perri, R. L., & Berchicci, M. (2017). Different proactive and reactive action control in fencers' and boxers' brain. *Neuroscience*, *343*, 260-268.

Chueh, T. Y., Huang, C. J., Hsieh, S. S., Chen, K. F., Chang, Y. K., & Hung, T. M. (2017). Sports training enhances visuo-spatial cognition regardless of open-closed typology. *PeerJ*, *5*, e3336.

Cona, G., Cavazzana, A., Paoli, A., Marcolin, G., Grainer, A., & Bisiacchi, P. S. (2015). It's a matter of mind! Cognitive functioning predicts the athletic performance in ultra-marathon runners. *PloS one*, *10*(7), e0132943.

Davis, C. L., Tomporowski, P. D., McDowell, J. E., Austin, B. P., Miller, P. H., Yanasak, N. E., ... & Naglieri, J. A. (2011). Exercise improves executive function and achievement and alters brain activation in overweight children: a randomized, controlled trial. *Health Psychology*, *30*(1), 91.

Deslandes, A., Moraes, H., Ferreira, C., Veiga, H., Silveira, H., Mouta, R., ... & Laks, J. (2009). Exercise and mental health: many reasons to move. *Neuropsychobiology*, *59*(4), 191-98.

Di Russo, F., Bultrini, A., Brunelli, S., Delussu, A. S., Polidori, L., Taddei, F., ... & Spinelli, D. (2010). Benefits of sports participation for executive function in disabled athletes. *Journal of Neurotrauma*, *27*(12), 2309-2319.

Diamond, A., & Lee, K. (2011). Interventions shown to aid executive function development in children 4 to 12 years old. *Science*, *333*(6045), 959-964.

Evert, D. L., & Oscar-Berman, M. (1995). Alcohol-related cognitive impairments. *Alcohol Research*, *19*(2), 89

Paşaoğlu H, Günay M, Paşaoğlu, Ö, Keskin K. (2019) Egzersiz Biyokimyası: Spor Egzersiz, Sağlık: İnsan Performansının Biyokimyasal Temelleri. Ankara: Gazi Kitapevi

Harada, C. N., Love, M. C. N., & Triebel, K. L. (2013). Normal cognitive aging. *Clinics in geriatric medicine*, *29*(4), 737-752

Huijgen, B. C., Leemhuis, S., Kok, N. M., Verburgh, L., Oosterlaan, J., Elferink-Gemser, M. T., & Visscher, C. (2015). Cognitive functions in elite and sub-elite youth soccer players aged 13 to 17 years. *PloS one*, *10*(12), e0144580.

Jacobson, J., & Matthaeus, L. (2014). Athletics and executive functioning: How athletic participation and sport type correlate with cognitive performance. *Psychology of Sport and Exercise*, *15*(5), 521-527.

Kasenova, A. S., Eszhanova, L. E., Tursbekova, D. D., & Durmanova, A. K. (2017). The influence of sleep disorders on cognitive functions of a brain at patients with Type 2 diabetes. *Drug Invention Today*, *9*(3).

Kashihara, K., Maruyama, T., Murota, M., & Nakahara, Y. (2009). Positive effects of acute and moderate physical exercise on cognitive function. *Journal of physiological*, *28*(4), 155-164.

Khodarahimi, S. (2018). Self-reported nutritional status, executive functions, and cognitive flexibility in adults. *Journal of Mind and Medical Sciences*, *5*(2), 210-217

Krenn, B., Finkenzeller, T., Würth, S., & Amesberger, G. (2018). Sport type determines differences in executive functions in elite athletes. *Psychology of Sport and Exercise*, *38*, 72-79.

Kvalø, S. E., Bru, E., Brønnick, K., & Dyrstad, S. M. (2017). Does increased physical activity in school affect children's executive function and aerobic fitness?. *Scandinavian journal of medicine & science in sports*, *27*(12), 1833-1841.

Lundgren, T., Högman, L., Näslund, M., & Parling, T. (2016). Preliminary investigation of executive functions in elite ice hockey players. *Journal of clinical sport psychology*, *10*(4), 324-335.

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex “frontal lobe” tasks: A latent variable analysis. Cognitive psychology, 41(1), 49-100.

Niederer, I., Kriemler, S., Gut, J., Hartmann, T., Schindler, C., Barral, J., & Puder, J. J. (2011). Relationship of aerobic fitness and motor skills with memory and attention in preschoolers (Ballabeina): a cross-sectional and longitudinal study. *BMC pediatrics*, *11*(1), 34 *PLoS One*, *12*(2), e0170845.

Reitan, R.M. (1958). Validity of the Trail Making Test as an indicator of organic brain damage. Perceptuals and Motor Skills, 8, ss. 271-276.

Richard, E., Laughlin, G., Kritz-Silverstein, D., Reas, E., Barrett-Connor, E., & McEvoy, L. (2018). Dietary Patterns and Cognitive Function among Older Community-Dwelling Adults. *Nutrients*, *10*(8), 1088

Taddei, F., Bultrini, A., Spinelli, D., & Di Russo, F. (2012). Neural correlates of attentional and executive processing in middle-age fencers. *Medicine & Science in Sports & Exercise*, *44*(6), 1057-1066.

Vestberg, T., Reinebo, G., Maurex, L., Ingvar, M., & Petrovic, P. (2017). Core executive functions are associated with success in young elite soccer players. PLoS One, 12(2), e0170845.

Voss, M. W., Kramer, A. F., Basak, C., Prakash, R. S., & Roberts, B. (2010). Are expert athletes 'expert'in the cognitive laboratory? A meta-analytic review of cognition and sport expertise. *Applied Cognitive Psychology*, *24*(6), 812-826.

Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex "frontal lobe" tasks: A latent variable analysis. *Cognitive psychology*, *41*(1), 49-100.

Wang, C. H., Chang, C. C., Liang, Y. M., Shih, C. M., Chiu, W. S., Tseng, P., ... & Juan, C. H. (2013). Open vs. closed skill sports and the modulation of inhibitory control. *PloS one*, *8*(2), e55773.

Xiong, S., Li, X., & Tao, K. (2017). Effects of Structured Physical Activity Program on Chinese Young Children's Executive Functions and Perceived PhysicalCompetence in a Day Care Center. *BioMed research international*, *2017*.

Yolton, K., Dietrich, K., Auinger, P., Lanphear, B. P., & Hornung, R. (2004). Exposure to environmental tobacco smoke and cognitive abilities among US children and adolescents. *Environmental health perspectives*, *113*(1), 98-103

Yu, Q., Chan, C. C., Chau, B., & Fu, A. S. (2017). Motor skill experience modulates executive control for task switching. *Acta psychologica*, *180*, 88-97.

Zhao, E., Tranovich, M. J., DeAngelo, R., Kontos, A. P., & Wright, V. J. (2016). Chronic exercise preserves brain function in masters athletes when compared to sedentary counterparts. *The Physician and Sportsmedicine*, *44*(1), 8-13.