COMPARISON OF BALANCE BETWEEN GENDERS OF CROSSFIT ATHLETES

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ABSTRACT

The purpose of this study was to determine which gender had better balance among CrossFit athletes. Balance is a fundamental skill required to complete activities of daily living that is reduced with age, subjecting a person to potential injury. The CrossFit population was studied due to the variety in age, training principles incorporating stability and lack of information in this area. Participants had at least six months CrossFit experience from a CrossFit box in NJ (n=52, 26 men and 26 women), were ages 18–70 and completed the Y Balance Test. Data were normalized (reach distance divided by leg length multiplied by 100), and six independent *t*-tests (a Bonferroni correction was used with $p<0.008$) were conducted to compare the scores for each direction (left and right anterior, posterolateral, posteromedial). A composite reach score was created for each leg to identify those with possible poor balance (composite score <89.6% of limb length) and compare between genders using independent *t*-tests ($p<0.05$). There was no significant difference in individual reach directions, but significantly more men ($p=0.02$) had a normalized composite right reach score less than 89.6% compared with women. Future research should determine if increased balance training should be implemented for male CrossFit athletes in general.

Keywords: kinesiology, Y Balance Test, fitness, injury prevention

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INTRODUCTION

Deterioration of balance may result in falls in the elderly (Vestibular Disorders Association, 2016; Palumbo, Palmerini, Bandinelli, & Chiari, 2015; Hausdorff, Rios, & Edelberg, 2001; Talbot, Musiol, Witham, & Metter, 2005). The elderly appear to be the most common population for falls due to poor balance (Palumbo, Palmerini, Bandinelli, & Chiari, 2015). Approximately 57 million people were 60 years of age or older in 2010 (United States Census Bureau, 2010). As time goes on, this number and the number of injuries due to falls will only increase.

Balance is the ability to maintain a stable position even when the centre of gravity has shifted. Balance relies on three sensory outputs from the sensorimotor control systems: vision, proprioception and the vestibular system (Vestibular Disorders Association, 2016). These three sensory components, in conjunction with motor outputs from the eyes and muscles, are essential for good balance, and they interact with a variety of other factors, such as processing time, muscle strength and sociodemographic characteristics that influence balance function (Bressel, Yonker, Kas & Health, 2007; Pu, Sun, Wang, Lee, Yu, Yao, Zhang, & Li, 2015).

Quality of life and injury appear to be affected by balance (Hausdorff, Rios, & Edelberg, 2001; Talbot, Musiol, Witham, & Metter, 2005); for this reason, it is essential to determine if gender is a factor. Research appears to suggest that men score higher on balance tests than women (Erkmen, Taskin, Kaplan, & Sanioglu, 2009; Piech, Andzel, & Spaccarotella, 2015). In addition, young athletes have been shown to have better balance than non-athletes (Steinberg, 2016). Athletes appear to score better on balance tests than non-athletes (Pandey & Venugopal, 2016; Kang, Kim, Kim, Kim, Lee, & Shin, 2013). This could be because athletes are exposed to running, jumping, throwing, etc. that non-athletes are not exposed to (Pandey & Venugopal, 2016). Balance appears to be a skill that needs to be learned and practiced to reduce the likelihood of falls and/or poor balance (Pandey & Venugopal, 2016; Palumbo, Palmerini, Bandinelli, & Chiari, 2015; Bressel, Yonker, Kras, & Heath, 2007).

CrossFit was developed by CEO and founder Greg Glassman in 2002. CrossFit is defined as constantly varied functional movements performed at high intensity (Glassman, 2002). CrossFit is a core stability and strength training programme. The workouts are a combination of gymnastics, weightlifting, and metabolic conditioning or cardiovascular training. Since the functional movements are constantly varied, every day is a different combination of movements and repetition schemes intended to promote the achievement of optimum fitness levels (Glassman, 2002). All movements are scalable meaning children, elite athletes, elderly and everyone in between can partake in the same workouts. The load and intensity are changed, not the specific programming.

CrossFit is founded on 10 fitness domains: cardiovascular/respiratory endurance, stamina, strength, flexibility, power, speed, coordination, agility, balance and accuracy (CF-L1 Trainer Manual, 2017). Considering balance is a core fundamental for athletes participating in CrossFit and is important for daily living, it is imperative to acquire and maintain good balance. Although there are limited data on CrossFit participants, adults over the age of 30 are the largest group of customers in the fitness industry (Kilgore, 2015). Further, the CrossFit Games have divisions based on age group, and the master's division (35–60+ years old) has the most individual competitors (Games.CrossFit.com). These people will only get older with time. Given that participation in physical and sports activities throughout life has been associated with improved postural stability during later years among the elderly (Perrin, Gauchard, Perrot, & Jeandel, 1999), determining which gender has better balance could potentially lead to balance training for the opposing gender and a reduction of falls later in life.

Balance is assessed with a variety of measurements. One commonly used method is the Balance Error Scoring System, which requires participants to stand in three positions (double leg-hands on hips and feet together, single leg non-dominant leg with hands on hips and tandem non-dominant foot behind dominant foot heel to toe with hands on hips) on a firm, foam surface with their eyes closed and hands kept on their hips (Bell, Guskiewicz, Clark, & Padua, 2011). Any deviation from this during the trial is considered an ‘error’ (Bell, Guskiewicz, Clark, and Padua, 2011). Another well-known balance assessment, the Y Balance Test, is a three-point (anterior, posterolateral and posteromedial) tool used to determine potential balance deficits while allowing participants to keep their eyes open and hands off their hips (Alnahdi, Adleraa, Aldali, & Alsobayel, 2015), eliminating the possible influence of vision on equilibrium that occurs when eyes are closed (Vestibular Disorders Association, 2016). This test is a modified version of the Star Excursion Balance Test (SEBT), an eight-point balance assessment (anterior, anteromedial, anterolateral, medial, lateral, posterior, posteromedial and posterolateral (Gribble, Hertel, & Plinsky, 2012)). The Y Balance Test was created due to the redundancy of all eight directions in the SEBT (Hertel, Braham, Hale, & Olmsted-Kramer, 2006), and research indicates that it appears to be reliable for balance assessment (Lieshout et. al., 2016; Clark, Saxion, Cameron, & Gerber, 2010).

Given the importance of balance as a fundamental skill required to complete CrossFit activities as well as activities of daily living and the potential effects balance may have on present and future quality of life and injury risk, determining if gender is a factor seems essential. Therefore, the purpose of this study is to compare balance between genders in a sample of CrossFit athletes. This population is being studied due to its variety in age, training principles and lack of information in this area.

METHOD

Participants

Participants (n=52) consisted of males (n=26) and females (n=26) between 18–70 years of age. The mean age of the male participants was 33.9 years (SD 7.10). The mean age of the female participants was 30.7 years (SD 7.81). The mean age of the total participants was 32.3 years (SD 7.56). This sample size gave 80% power to detect differences in balance at $p<0.05$. Participants were recruited from a CrossFit box in New Jersey, and had at least six months of CrossFit experience. Participants were required to have no previous lower body injuries or concussions in the last 12 months. Participants were required to fill out a CrossFit waiver of participation prior to any CrossFit activities at a registered affiliate. In addition, participants were required to fill out an informed consent form and a Physical Activity Readiness Questionnaire (PAR-Q) to determine eligibility to participate in this study (Canadian Society for Exercise Physiology, 2002). Participants received medical clearance from a physician if necessary, determined by their PAR-Q responses. Written informed consent was obtained for each participant. Approval for this study was granted by the Kean University Institutional Review Board (IRB #00005689).

Procedure & Protocol

All testing was done on one day. First, measurements of height, weight and body mass index (BMI) were gathered for each participant. Height was measured using a Stanley 30’ Leverlock Tape Measure, 30-830W measuring tape according to a previously validated protocol (Yorkin, Spaccarotella, Martin-Briggers, Lozada, Hongu, Quick, & Byrd-Bredbenner, 2015). Weight was measured using a Taylor Model 7506 Glass Electronic

Bath Scale bathroom scale on a floor free of debris and belongings using a previously validated protocol (Yorkin, Spaccarotella, Martin-Briggers, Quick, & Byrd-Bredbenner, 2013).

Warm-Up

Prior to performing the Y Balance Test participants performed a dynamic warm-up. This warm-up was familiar to the participants as it is what they do as a warm-up for regularly scheduled CrossFit classes. A 10 minute warm-up was administered and included the following in order: 5 minute jog around the gym, then walking high knees (pull knee to chest, release, then alternate legs) for 50 feet, quadriceps pulls (pull heel to buttocks, release, then alternate legs) for 50 feet, hamstring stretch (with straight legs, step one foot forward and try to touch palms to floor, stand up, then alternate legs) for 50 feet, calf stretch (step one foot forward with heel on ground, pull toes to shin, release, then alternate legs) for 50 feet and ended with 10 air squats (full depth squat).

Y Balance Test

The Y Balance Test was administered following the protocol previously used (Clark, Saxion, Cameron, & Gerber, 2010). A yard stick and tape were placed on the floor in anterior, posteromedial and posterolateral directions forming a Y shape. Participants were instructed to stand in the middle of the three points on one leg. Participants were then instructed to reach in each direction as far as possible with the leg not on the ground. A light tap and then retraction of the leg was required. If the participant lost his/her balance or rested the free foot on the ground, the trial was discarded, and a new trial was administered. Three practice trials were administered in each direction of the Y Balance Test before three documented trials were administered and averaged together. This was done for both legs. The Y Balance Test lasted approximately 15–20 minutes. The data were normalized by measuring both participants' leg lengths at the anterior superior iliac spine to the centre of the medial malleolus while standing and dividing the average reach distance by leg length then multiplying by 100 (Clark, Saxion, Cameron, & Gerber, 2010).

Statistical Analysis

Balance (anterior, posteromedial and posterolateral) was normalized (reach distance divided by leg length multiplied by 100) according to the protocol previously used (Clark, Saxion, Cameron, & Gerber, 2010). Normalizing the data gives the composite score. Six independent *t*-tests were run to compare individual reach scores in each direction (left and right anterior, posteromedial and posterolateral) between men and women. A Bonferroni correction level of significance was used with $p<0.008$ (0.05 divided by six reaching directions). A composite score was then created to identify and compare those with possible poor balance between men and women. In accordance with Butler, Lehr, Fink, Kiesel, and Plisky (2013), composite scores <89.6% of limb length were considered to indicate poor balance. The difference in composite scores between legs was then compared (Plisky, Rauh, Kaminski, & Underwood, 2006). Independent *t*-tests were used to compare composite scores and test for differences in composite scores between legs. The level of significance was set at $p<0.05$. The data were processed using SPSS version 22.0.

RESULTS

Demographic Data

Twenty six men (n=26) and 26 women (n=26) for a total of 52 participants were recruited and served as participants in this study. Data collected for total participants including gender (M/F), age (years), height (cm), weight (kg), body mass index (BMI)(kg/m^2) and leg length (cm) are listed in Table 1.

Table 1: Demographic Data of Participants

	Gender	*M*	*SD*
Age (years)	Male	33.9	7.10
	Female	30.7	7.81
	Total	32.3	7.56
Height (cm)	Male	175.3	2.27
	Female	164.7	2.67
	Total	170.0	3.23
Weight (kg)	Male	96.0	32.45
	Female	76.8	32.74
	Total	86.4	38.70
BMI (kg/m^2)	Male	31.2	4.42
	Female	28.2	4.72
	Total	29.7	4.77
Leg Length (cm)	Male	34.1	1.70
	Female	32.2	1.39
	Total	33.1	1.80

Data collected for total participants' balance including distance reached in the left anterior (cm), left posterolateral (cm), left posteromedial (cm), right anterior (cm), right posterolateral (cm) and right posteromedial (cm) directions are listed in Table 2.

Table 2: Descriptive Statistics of the Y Balance Test Reach Distances Between Genders

	Gender	*M*	*SD*
L Anterior (cm)	Male	101.2	16.75
	Female	95.6	13.11
	Total	98.4	15.16
L Posterolateral (cm)	Male	112.6	17.23
	Female	102.9	18.58
	Total	107.8	18.40
L Posteromedial (cm)	Male	103.7	15.71
	Female	98.0	16.20
	Total	100.8	16.05
R Anterior (cm)	Male	101.3	17.78
	Female	96.1	12.90
	Total	98.7	15.60
R Posterolateral (cm)	Male	105.4	15.66

	Female	94.9	16.89
	Total	100.2	16.97
R Posteromedial (cm)	Male	110.4	14.96
	Female	101.7	17.10
	Total	106.0	16.50

Data collected for male and female participants' Y Balance Test composite scores including total composite score (cm) between legs and composite score difference of less than 89.6% (cm) between legs are listed in Table 3.

Table 3: Descriptive Statistics of the Y Balance Test Composite Scores Between Genders

	Gender	*M*	*SD*
L Total Composite Score (cm)	Male	101.06	13.78
	Female	98.89	13.61
L Difference Score (cm)	Male	1.69	0.47
	Female	1.88	0.33
R Total Composite Score (cm)	Male	105.56	14.07
	Female	97.56	13.64
R Difference Score (cm)	Male	1.96	0.20
	Female	1.62	0.50

n=26 male and female participants, 52 total participants

Table 4 indicates that there were no significant differences in reach distances between genders for the anterior or medial directions.

Table 4: Independent Samples *t*-Test Comparing Balance Between Genders

	t-test for Equality of Means						
						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
L Anterior	-1.35	50	.18	-5.63	4.17	-14.00	2.75
L Posterolateral	-1.94	50	.06	-9.65	4.97	-19.63	.33
L Posteromedial	-1.27	50	.21	-5.64	4.43	-14.53	3.25
R Anterior	-1.21	50	.23	-5.21	4.31	-13.88	3.47
R Posterolateral	-2.31	50	.03	-10.43	4.52	-19.51	-1.36
R Posteromedial	-1.20	50	.06	-8.71	4.45	-17.66	.23

Table 5 indicates the data for total composite score right leg for males, $t(50)=-2.08$, $p=0.04$, were significantly different. Table 5 indicates the data for composite score difference right leg for males, $t(32.63)=-3.31$, $p=0.00$, were significantly different.

Table 5: Independent Samples *t*-Test Comparing Total Composite Score and Difference of Less Than 89.6% Between Legs

		t-test for Equality of Means						
							95% Confidence Interval of the Difference	
		t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Total Composite Score	L Leg	-.57	50	.57	-2.17	3.80	-9.80	5.46
	R Leg	-2.08	50	.04	-7.99	3.84	-15.71	-.27
Difference Score	L Leg	-1.71	50	.09	-.19	.11	-.42	.03
	R Leg	-3.31	50	.00	-.35	.11	-.56	-.13

DISCUSSION

The purpose of this study was to determine if male or female CrossFit athletes had better balance, which was assessed utilizing the Y Balance Test Protocol.

The results show that there was not a significant difference in individual reach directions between men and women. Although there was not a significant difference between genders, there appears to be a significant difference between legs for men. When compared with women, significantly more men had a normalized composite right reach score less than 89.6%. These results, compared with Butler, Lehr, Fink, Kiesel, & Plisky (2013), denote 'poor balance' and a likelihood of injury on the right side and suggest that men have better balance and less likelihood of injury on the left side of their body compared with the right side. According to Plisky, Rauh, Kaminski, & Underwood (2006), when considering unilateral discrepancies, increased stress and absorption of excessive force may be placed upon the limb with better balance to compensate for lesser balance on the opposing side; participants in this category may also appear to have a weaker base on the side with poor balance, specifically when landing and pivoting (Plisky, Rauh, Kaminski, & Underwood, 2006). Indeed, research with high school basketball players and with a sample of 184 collegiate athletes representing various sports (e.g., track, football, golf, tennis, soccer, volleyball, cross-country and swimming) reported an increased risk of injury with anterior right/left reach distance differences of 4 cm or greater (Plisky, Rauh, Kaminski, & Underwood, 2006; Smith, Chimera, & Warren, 2014).

Compared with previous research, our study differed. Erkmen, Taskin, Kaplan, & Sanioglu (2009), showed that males had better balance than females. In this study, recreational athletes performed the Bruce Protocol, and balance was assessed via the Balance Error Scoring System (Erkmen, Taskin, Kaplan, & Sanioglu, 2009). Another study, performed by Piech, Andzel, & Spaccarotella (2015) showed that men scored higher on balance tests and ultimately had better balance than women. The Star Excursion Balance Test and Balance Error Scoring System were used to compare recreational exercisers (Piech, Andzel, & Spaccarotella, 2015). Combined, both studies had a total of 44 participants (19 and 25 respectively); our study had a total of 52 participants. In addition, CrossFit is a core stability and strength programme encompassing weightlifting, gymnastics and metabolic conditioning (cardio) (Glassman, 2002). It is constantly varied functional movements performed at a high intensity (Glassman, 2002). This method of training exposes athletes to multiple movement patterns, whereas individual or recreational sport is specific to that activity. Most importantly, both of the previously mentioned studies used the Balance Error Scoring System. In comparison, the Y Balance Test allows participants to keep their eyes open and hands off their hips during the trials. Since equilibrium is supplemented with vision (Vestibular Disorders Association, 2016), balance could potentially be compromised when eyes are closed compared with when they are open (Cohen, Mulavara, Peters, Sangi-Haghpeykar, & Bloomberg, 2014).

This study did not collect data on injury rate as did some other studies. However, this could be means for future studies. According to Teyhen et al. (2016), soldiers having one to four risk factors, (such as physical inactivity, being overweight, smoking and/or prior injury) produced shorter reach distances on the Y Balance Test compared with participants with no risk factors. This study suggests that performance decreased as risk factors increased. According to Montalvo, Shaefer, Rodriguez, Li, Epnere, & Myer (2017), participants who reported a CrossFit-related injury had significantly higher years of training, weekly training hours and weekly athlete exposure as competitors compared with non-competitors. This study showed consistency with other similar sports, such as gymnastics, Olympic lifting and powerlifting (Montalvo, Shaefer, Rodriguez, Li, Epnere, & Myer, 2017). This could suggest that increased training leads to increased injury or potential for injury. It may also be beneficial to take in to account time of day if performing a balance assessment in the future. According to Gribble, Tucker, & White (2007), balance assessment scores appear to be better in the morning compared with the afternoon and night. This could be due to fluctuations in cognitive and metabolic processes that affect mental and physical activities (Gribble, Tucker, & White, 2007). Essentially, participants are well rested and better prepared in the morning compared with fatigued and tired in the afternoon and night (Gribble, Tucker, & White, 2007). Our study did not take into account what time of day participants were tested.

Finally, participants were not entirely representative of the entire CrossFit population and probably had varying abilities. There is still limited research on CrossFit athletes and virtually no data on this population related to balance and gender, making this an emergent population that is necessary to study. Increasing balance training or conducting a balance assessment to individualize training for male CrossFit athletes in general should be taken into consideration based on our findings. In addition, given that CrossFit is marketed as a fitness programme for all ages that emphasizes balance training as a key component (Glassman, 2002) and that participation in physical and sports activities throughout life has been associated with better balance in the elderly (Perrin, Gauchard, Perrot, & Jeandel, 1999), further research could clarify what role CrossFit can play in improving outcomes such as balance that are related to quality of life as their clientele ages.

CONCLUSION

In conclusion, this study found that there was no difference in Y Balance Test composite scores between genders, but men had an increased likelihood of poor balance on their right side compared with women. Future studies should determine if male CrossFitters should implement additional balance training and assessment.

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Brittany F. Morrone is a doctoral student at East Tennessee State University, USA. At the time of the study, she was a graduate student at Kean University, USA. This research was conducted at a CrossFit box in New Jersey in partial fulfilment of the requirements for the MSc in Exercise Science. Data were collected from March to May 2017.

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