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Functional Movement Testing and Subjective Well-Being of Female Track and Field Athletes: Pre- and Post- Indoor Season

Aliyah Gustafson

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Project Advisor
Dr. Lynn A. Darby, Professor, School of HMSLS ______________________________________

Second Reader
Dr. Bonnie G. Berger, Professor, School of HMSLS ____________________________________

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Abstract

Track and field is a sport that is comprised of running events and field events. Running events include sprints, middle- and long-distances, and hurdles. Field events are comprised of throwing and jumping events (e.g., shot put, discus, javelin, and high-jump). Track and field athletes have a wide range of body types, energy system demands, and specific skills/techniques during performance of these varied events. The purposes of this study were to evaluate functional movements and subjective well-being (positive affect and satisfaction with life) of female track and field athletes at Bowling Green State University prior to and following the 7-week indoor track and field season. The Functional Movement Screen (FMS) (Cook, 2010) includes seven tests designed to identify muscle and movement imbalances, and compensatory motions (Frost, Beach, Callaghan & McGill, 2012). The Y-Balance Test (YBT) is a measure of dynamic balance and imbalance in the lower extremities. Subjective well-being can be evaluated using the Physical Activity Enjoyment Scale (PACES-T), a Trait measure of overall feelings of enjoyment, (Kendzierski & DeCarlo, 1991) and the Satisfaction with Life Scale (SWLS) (Diener, Emmons, Larsen & Griffin, 1985). Twenty-four female college track and field athletes (*Mean* ± *S.D.* Age: 19.9 ± 1.3 yrs) were recruited. Quantitative data were collected from each athlete prior to the beginning and at the conclusion of the indoor season and included administration of the FMS, YBT, PACES-T, and SWLS. The participants were grouped by their track and field events: throwers; sprinters, hurdlers, and jumpers (SHJ); and distance runners. Two-way, mixed model ANOVAs were calculated to determine the effects of Group (3) and Time (2; pre- and post-season) on functional movement and subjective well-being scores. Pearson correlations were utilized to identify any relationships between scores from the FMS, YBT right and left leg, PACES-T, and SWLS both for pre- and post-season. There was a significant difference between pre- and post-season FMS scores (N=21; n=3 athletes were injured and did not complete post-testing). FMS scores significantly improved as the 7-wk season of seven meets was completed (*Mean* ± *S.D.* FMS: Pre-season, 14.8 ± 2.5 Post-season, 15.6 ± 2.2; $p = .03$). The YBT data revealed that imbalances existed between the right and left lower extremities. The posteromedial distance (PMD) was significantly different between the right and left legs (*Mean* ± *S.D.* PMD reach distance: Right, 88.9 ± 9.2; Left, 90.9 ± 9.7 cm). The relationships were significant at pre-season for FMS score and PACES-T (r =.404, $p < .05$), and at the post-season for both left and right YBT scores and the PACES-T (right, r = .451, $p < .05$ and left, r = .400, $p < .05$). In addition, there were significant correlations for PACES-T with SWLS (Pre-season, r = .507, $p < .01$; Post-season, r = .596, $p < .01$). Most indoor track and field athletes had muscle or movement imbalances bilaterally; however, most athletes improved their FMS scores pre- to post-season. In addition to the physical components, the more indoor track and field athletes enjoyed physical activity, the more likely they were to be satisfied overall with their life.

Keywords: Functional Movement Screen, Y-Balance Test, physical activity enjoyment, satisfaction with life, track and field athletes

Introduction

Track and field is composed of racing events and field events. There are sprints, middle- and long-distances, along with hurdling which are all won by achieving the fastest time. For field events, throwing and jumping are won by having the greatest distance measured (all types of throws, long jump and triple jump) or highest height (high jump and pole vault). Official events for collegiate indoor track and field events include the following: mile, 60 meter (m), 60m hurdles, 800m, 200m, 5000m, Distance Medley Relay (DMR), 3000m, and 4x400m Relay, shot put, weight throw, long jump, triple jump, high jump, pole vault, heptathlon (men) and pentathlon (women) (NCAA, 2017). This sport is composed of a very physiologically diverse set of athletes.

Track and field athletes have a wide range of body types, energy system demands, and required techniques. A majority of track and field athletes partake in very repetitive movements both in training sessions and competition performances. The indoor season is operated from November until March, while outdoor season begins in March and extends into June at the collegiate level. The biomechanical bases of throwing and jumping events require a strong, dominant side, and might lead these athletes to be more susceptible to imbalances between the left and right sides of their bodies. Cross country and distance runners might face restrained mobility resulting from high work volume of the same motion for a long period of time most days of the week. These considerations of imbalances or restricted functional movement may be overlooked in strength and conditioning especially if weaknesses are undetected.

The Functional Movement Screen (FMS) is an assessment that could be utilized to assess track and field athletes. The Functional Movement Screen often is used as a pre-participation exercise assessment tool. A movement screen should be performed between the pre-participation medical examination and performance testing (Cook, 2010). The FMS incorporates fundamental movements, motor control within a movement pattern, and competence of basic movements (Cook, 2010). The fundamental movement patterns in the FMS require joint mobility and neuromuscular control (Frost, Beach, Callaghan & McGill, 2012). Joint mobility and neuromuscular control entails muscle strength, flexibility, range of motion, coordination, balance, and proprioception (Teyhen et al. 2014).

The Functional Movement Screen can be used to determine the movement deficiency, limitations, and left to right side or muscle agonist to antagonist asymmetries when administered to participants (Cook, 2010). Seven functional movement tests that are rated on a scale 0-3 and three clearing tests compose the FMS. These seven tests include the deep squat, hurdle step, in-line lunge, shoulder mobility, active straight leg raise, trunk stability push-up, and rotary stability which can total to a maximum of 21 points. The ratings are as follows: score of zero, if a person experiences pain, a score of one if the individual was unable to perform the movement, a score of two if exercise is performed with compensation, and finally a score of three reveals the movement was completed correctly (Beardsley & Contreras, 2014). In addition, the three clearing tests are designed to measure active scapular stability, spinal extension, and spinal flexion. If any pain is observed on any of these, the individual will receive a score of zero for the clearing test (i.e., shoulder mobility, trunk stability push-up, and rotary stability, respectively) (Cook, 2010).

In 2011 using the FMS, Chapman tested 109 track and field athletes who were at the time ranked in the top 20 in the world from each of the track and field event areas. Thirty-three percent of track and field athletes had an overall FMS score less than 14 while two-thirds of the athletes also had bilateral asymmetry identified, both indicative of increased risk of injury

(Chapman, 2011). The athletes with identifiable issues were given corrective exercises to address their limitations in hopes of preventing injury and improving their movement patterns for better performance. No follow-up was done after corrections were prescribed, however injury rates and performance data were analyzed.

In another study conducted by Chapman (2014), elite track and field athletes were screened and had an average score of 15.4 ± 1.9. The only significant differences for total FMS score noted by Chapman (2014) were apparent in the throws group compared to jumps, distance, and sprints/hurdles event group. The sprints/hurdles, jumps, and distance groups comparisons were not significantly different. The highest FMS score average was in jumps group (15.9 ± 2.1), followed by sprints/hurdles group (15.5 ± 1.9), distance (15.4±1.8), then the throws (14.6 ± 1.8) (Chapman, 2014). This information is important because it identifies how the event groups differ. However, Chapman (2014) did not explain which exercises needed the most work and why these differences exist.

Using the FMS, Loudon, Parkerson-Mitchell, Hildebrand & Teague (2014) evaluated 43 male and female runners who at minimum ran 30 km/week. The average age of the 16 women in this study was 33.5 ± 8.7 years and these women had an FMS mean score of 16.2 ± 2.5. The researchers also grouped the participants in to age groups above and under 40 years of age. The under 40 years of age mean score was 16.4 ± 1.9 compared to the runners over the age of 40 whose mean score was 13.9 ± 2.3 (Loudon, Parkerson-Mitchell, Hildebrand & Teague, 2014). The results of this study indicated that the FMS is a reliable screen for long distance runners.

Bring, Chan, Devine, Collins, Diehl & Burkam (2018) conducted a three-year study to describe the functional movement characteristics of high school and collegiate cross country and track runners. Collegiate runners had a mean age of 19.3 years, (95% CI, 19.2-19.5 years). The college mean FMS scores was 15.0 (95% CI, 14.6-15.4), the cross country runners mean was 15.1 (95% CI, 14.7-15.5), while the track mean was 15.3 (95% CI, 14.6-15.9), suggesting the track athletes averaged higher FMS scores than cross country runners (Bring, Chan, Devine, Collins, Diehl & Burkam, 2018).

In addition, Hotta et al. (2014) collected Functional Movement Screen scores for sprint, hurdle, middle- and long-distance track and field athletes. One hundred ninety-three athletes with mean age of 20.0 ± 1.1 years were recruited and screened. Their results were divided into two groups, the sprint/hurdle group and the middle/long distance group. The sprint/hurdle group had a mean score of 14.6 ± 2.4 while the middle/long distance group had 14.1 ± 2.3 as their mean score. The lower FMS score in sprint/hurdle group indicated more risk for injury while a lower score in middle/long distance suggested more risk for serious injury (Hotta et al. 2014).

Previous researchers using the FMS have reported scores for throwers, sprints/hurdles/jumpers, and distance runners with results from high school, collegiate, recreational, and elite female runners, jumpers, and throwers. The gathered data range of mean scores were as low as 13.9 and as high as 16.2. The diversity of track and field athletes' training, event demands, and performance requirements are appropriate for functional movement screens to identify deficiencies and imbalances in functional movement.

The FMS has been used for non-athletic individuals, but primarily for athletes in all types of sports. The FMS is of value to athletes because of the association of low FMS scores and low risk of injury. Any scores less than perfect suggest that there are compensatory movements, which in turn indicates that efficient movements are sacrificed for inefficient ones (Beardsley & Contreras, 2014). Total scores that are equal to or less than 14 signify that compensation patterns are prevalent (Beardsley & Contreras, 2014). These are predictive of an increased risk of injury and decreased athletic performance. Corrective exercises to alter these muscle weaknesses or imbalances can be prescribed to the athlete. The average FMS score in healthy untrained people is 14.1 ± 2.9 to 15.7 ± 1.9 points on a 20 point scale (Beardsley & Contreras, 2014). Utilizing 14 points as a criterion score for injury predictability has been scrutinized to determine if it is an accurate value or if it needs to be adjusted or even adjusted based on an individual's sex. Based on a meta-analysis, Bonazza, Smuin, Onks, Silvis and Dhawan (2017) indicated that participants who were either athletes (major junior hockey, professional football, or Division I/II) or service workers (firefighters, Coast Guard, or Marine officers) and did not meet the 14 point cut off were 2.74 times more likely to sustain an injury compared to those who scored greater than 14 total points. Underdevelopment and increased body mass indexes have shown some correlation to decreased FMS scores. Even nonspecific exercises of any type have been shown to increase FMS scores (Beardsley & Contreras, 2014).

The FMS has been used with various levels of athleticism, from children to high school athletes, college athletes, and even elite performers. Anderson, Neumann, and Huxel Bliven (2015) screened high school athletes (sports not specified) and found mean scores in the female athletes to be 13.8 ± 1.8. Eighteen of the 29 girls tested had a FMS score ≥14. Teyhen et al. (2014) used the FMS as a tool to assess healthy military members. The 107 females in the military study were 28.3 ± 5.7 years of age and had a mean score on the FMS of 16.5 ± 2.2. Lockie, Schultz, Callaghan, Jordan, Luczo and Jeffriess (2015) screened nine females with the mean age 22.67 ± 5.1 years who participated in team sports such a soccer, netball, basketball, and softball. The mean FMS score of these participants was 13.4 ± 2.9. The FMS has also been used in other professions that are very physical during performance of the work tasks. Frost, Beach, Callaghan and McGill (2012) evaluated 60 firefighters who had a pre-intervention FMS mean of 13 (2.3 S.D.) and post-intervention of 13.2 (2.2 S.D.). Additional studies have utilized the FMS to assess athletes, safety personnel, and military soldiers for functional movement. There is a wide variety of individuals and professions for whom this assessment could be used.

The Y-Balance Test (YBT) much like the FMS, identifies imbalances in functional movement with the lower extremities (Lisman, Nadelen, Hildebrand, Leppert & de la Motte, 2018). It is composed of three lower extremity reaching tasks to assess dynamic balance. There are three directions of balance: anterior, posteromedial, posterolateral. All balance assessments are completed in the three directions three times with both legs, right then left in the order of anterior, posteromedial, and posterolateral. The balance test is done with hands on the hips, and failed attempts occur when a person loses balance, places the foot on top of a measurement indicator, or kicks the indicator to improve the score. There are three ways to score the YBT: 1) absolute reach distance in centimeters; 2) relative reach distance percentage (absolute reach distance/limb length*100); 3) composite reach distance percentage (sum of three reach directions/3 times the limb length*100) (Walker, 2016). No current research has assessed only track and field athletes with the YBT. Smith, Chimera and Warren (2015) assessed Division I college athletes, and of the 184 participants both men and women, a total of 10 were track and field athletes. The athletes were divided into two groups in the final results, injured and uninjured, the uninjured athletes had a mean age of 20.0 ± 1.4 years and composite scores of 101.2 ± 7.1, which is right and left reach distance in each direction divided by three times the leg length (Smith, Chimera & Warren, 2015). Butler, Lehr, Fink, Kiesel & Plisky (2013), found that a composite score less than 89.6% increases risk of injury by 3.5%. Taking the results from Smith, Chimera, and Warren (2015) and using significant findings from Butler, Lehr, Fink, Kiesel and Plisky (2013), suggested that the uninjured athletes and those who have increased balance are not at an increased risk for injury.

In addition to functional movement, subjective well-being (positive affect and satisfaction with life) is important for all individuals including track and field athletes. One way to measure subjective well-being is with the Physical Activity Enjoyment Scale (PACES). The PACES has been used to measure state (at the moment) or trait (in general, most of the time) feelings of enjoyment (Kendzierski & DeCarlo, 1991). The PACES has 18 items and these are ranked on a seven-point scale. The PACES questions are considered bipolar and reflect opposite feelings on each end of an item (e.g., boredom versus enjoyment). Trait qualities suggest that this may be the individual’s consistent feelings of enjoyment for nearly all types of physical activity. In contrast, state enjoyment represents the feeling that it is how the person feels just in a particular moment about the specific type of exercise he or she has been performing (Kendzierski & DeCarlo, 1991).

Another way to measure subjective well-being is by administering the Satisfaction With Life Scale (Berger, Weinberg & Eklund, 2015). Life satisfaction is a cognitive, judgmental process also known as an assessment of one’s quality of life according to their own criteria (Diener, Emmons, Larsen & Griffin, 1985). The Satisfaction with Life Scale (SWLS) is a scale that asks for an overall judgment in order to adequately measure if the individual’s defined life satisfaction is being met. Research has not yet been done working with track and field athletes, however Surujlal, Van Zyl and Nolan (2013) surveyed 281 first, second, and third year post-graduate university student athletes. The athletes represented in the study by Surujlal, Van Zyl and Nolan (2013) were mostly full-time (93.3%), first year university students (56.7%), female (56.9%), and soccer players (54.3%). The results of SWLS indicated the student-athletes were moderately satisfied with their life. It was noted that 12.1% of participants were athletes of a sport categorized as “other” which did not include soccer, hockey, rugby, athletic, basketball, cricket, or tennis (Surujlal, Van Zyl & Nolan, 2013).

As a track and field season progresses volumes of sets and repetitions of exercises typically decrease as peak fitness has already been achieved. Athletes generally work on skills and technical critiques as the season progresses because a very heavy and challenging work load is potentially more detrimental to elite performance during the championship season than are the technical cues. It is hypothesized that as the increased focus on technical cues and not functional movement, fitness, or strength maintenance occurs during the indoor competitive season that the mean scores of athletes will decrease post-season compared to the pre-season screen scores.

Therefore, the purposes of this study are to use the FMS and Y-Balance Tests, and measures of exercise enjoyment and satisfaction with life to evaluate the functional movement and subjective well-being of female collegiate track and field athletes before and after the indoor season, seven weeks of competition. The study will investigate the possibility that the functional movement of female collegiate track and field athletes decreases as the indoor season progresses, whether the indoor season influences physical activity enjoyment or satisfaction with life of female collegiate track and field athletes, and if psychological factors have an influence on female collegiate track and field athletes’ functional movement performance.

Methods

Participants

Female collegiate indoor track and field athletes (*N* = 24) at Bowling Green State University participated in this study. The athletes were categorized into event groups: 1) throwers, 2) sprinter/hurdlers/jumpers (SHJ), and 3) distance runners. The throws group included women who competed in the shot put and/or weight throw throughout the indoor season. The SHJ group includes athletes who ran short sprints, long sprints, and jumping events. The distance group was composed of athletes who ran the longer distance races (800-m or more) during the indoor season. Participants in the groups included 9 throwers, 7 sprinters/hurdlers/jumpers, and 8 distance runners. The mean age of each group were 20.1 ± 1.7, 19.6 ± 1.1, and 20.0 ± 1.1 years, respectively. In the same order, mean body mass index (BMI) values were 34.1 ± 8.0, 21.7 ± 1.9, and 19.8 ± 2.1 kg/m^2. There were significant differences for BMI between the throwers and the sprinters/hurdlers/jumpers, and between the throwers and distance runners. Examining the groups as a whole team, the mean age was 19.9 ± 1.3 years and BMI was 25.7 ± 8.3 kg/m^2 (Table 1). It is important to note that two athletes from SHJ group and one from distance group were unable to completed post-season functional movement tests due to injury, but they did complete the post-season questionnaires.

Research Design

This was an experimental pre-test/post-test research design with three groups of track and field athletes who were tested on the FMS, Y-Balance Tests, and subjective well-being on two occasions: pre-season and post-season.

Equipment, Materials, & Measures

The FMS tool kit (*Perform Better*; East Greenwich, RI) and Y-Balance Test (YBT) kit (*Perform Better*; East Greenwich, RI) were used to assess the athletes (Appendices A & B). FMS scores were out of maximum score of 21, and YBT composite scores were calculated by taking the sum of each direction reach divided by three times the length of the right limb.

Previously, Bonazza, Smuin, Onks, Silvis & Dhawan (2017) reported that nine of 10 studies found that the FMS was reliable, while an additional four of five studies that compared experience levels of the test administrators also supported acceptable interrater reliability based on intraclass correlation coefficients (ICC) of 0.76 to 0.98. In addition to interrater reliability, intrarater reliability was also reported to have acceptable ICC values of 0.81 (95% CI, 0.69-0.92). All of the studies examined by Bonazza, Smuin, Onks, Silvis & Dhawan (2017) found acceptable intrarater reliability and that the level of experience did not consistently affect this reliability. The YBT has been reported to have very good levels of interrater test-retest reliability with intraclass correlation coefficients (ICC) of 0.80-0.85 while other studies reported intrarater reliability ranged from 0.85-0.91 and interrater reliability ranged from 0.99-1.00 (Walker, 2016).

A physician's scale (kilograms) and a stadiometer (centimeters) were used to collect body mass and height. BMI values were calculated from these measurements for all athletes. The Physical Activity Enjoyment Scale (PACES) and Satisfaction with Life Scale (SWLS) were two questionnaires that were administered (Appendices C & D).

The PACES has 18 items that are considered bipolar on a scale that is 1-7; some items are scored in the reverse. The lowest score possible is 18 and the maximal score is 126; the greater the score, the increased level of physical activity enjoyment (Kendzierski & DeCarlo, 1991). The Satisfaction with Life Scale is a five-item questionnaire that asks individuals to rank their level of agreeance with the five statements. The statements inquire about individuals' own assessments of quality of life using their own criteria (Diener, Emmons, Larsen & Griffin, 1985). The SWLS is based on a scale of 1-35. The SWLS benchmarks are as follows: 31-35 = extremely satisfied, 26-30 = satisfied, 21-25 = slightly satisfied, 20 = neutral, 15-19 = slightly dissatisfied, 10-14 = dissatisfied, 5-9 = extremely dissatisfied.

Procedures

After approval of the study from the Institutional Review Board and the Intercollegiate Athletics Committee, participants were recruited from the track and field team at Bowling Green State University.

An information session was held at a team meeting where all team members were in attendance. A presentation of the research protocol, benefits, and risks of participation in the study were highlighted. Contact information for volunteering for the research study was distributed for athletes to sign-up later or ask further questions.

Volunteers attended an acclimation session time in December and January prior to their pre-season testing session. At this session, each volunteer signed an informed consent form, and practiced the Functional Movement Screen (www.functionalmovement.com) and Y-Balance Test, in order to reduce the practice effect on the scores of the FMS and YBT. The informed consent form included the purpose, benefits, procedures, confidentiality protection, and risks of study participation.

When the female track and field athletes returned to campus January 7 for their indoor season practice sessions, they completed the pre-testing prior to the first competition of the indoor season on January 12. During the pre-season testing, the paper version of PACES-T and SWLS were administered prior to the Functional Movement Screen and Y-Balance Testing (see

Appendices). The seven tests and three clearing tests from FMS were done individually and in the privacy of the Exercise Physiology Laboratory to maintain confidentiality. During each session, height, body weight, age, dominant leg length, dominant hand length, and FMS test scores were measured. In addition, balance measurements for the Y-Balance Test (www.scienceforsport.com/y-balance-test/) were completed.

The protocol for FMS was followed as Cook (2010) recommended and the tests were presented in the order of, deep squat, hurdle step, inline lunge, shoulder mobility, impingement clearing test, active straight-leg raise, trunk stability pushup, press-up clearing test, rotary stability, and the posterior rocking clearing tests (see Appendix A). The participant had a maximum of three attempts for each test prior to moving to the next test.

After the FMS, the YBT was administered using the recommended protocol. The right foot was used to push the indicator box three times followed by the left foot for three attempts in the order of anterior, posteromedial, and posterolateral directions.

The track and field athletes were then encouraged to continue through their event coach's prescribed training regimen and competition as normal during the competitive, indoor season. Following the conference championships February 22-23, the same athletes were asked to return for a post-season assessment session the week of February 25-March 1 to again complete all measurements that were taken at the initial testing session. After these sets of data were collected, each athlete had her results explained, and corrective exercises were provided for each athlete to use at their own discretion. Each athlete was advised to discuss her exercise correctives with her event coach to ensure both the coach and athlete understood the results and corrective exercises.

Statistical Analysis

In order to compare dependent variables at the pre- and post-indoor seasons, two-way mixed model ANOVAs were calculated to determine the main effects of Group (3: throwers; sprinters, hurdlers, and jumpers (SHJ); and distance runners) and Time (2: pre- and post-season) for the dependent variables. The dependent variables were: FMS composite score, YBT-right composite scores, YBT-left composite scores, PACES-Trait scores, and SWLS scores. The *p* value was set *a priori* at $p < 0.05$. Pearson correlations were utilized to identify any relationships between FMS scores, Y-Balance Test scores, exercise enjoyment, and satisfaction with life.

Results

There were 24 female indoor track and field athletes at Bowling Green State University who were participated in this study. Demographics data for the athletes is shown in Table 1. A frequency table with athletic characteristics displayed is shown in Table 2. Approximately 50% of the participants were first- and second-year collegiate track and field athletes. Twenty-two of the 24 participants were right leg dominant.

Table 1

Demographics of the Female Track & Field Athletes (N=24)

Variable	Mean ± SD
Age (years)	19.9 ± 1.3
Height (cm)	168.1 ± 6.4
Weight (kg)	73.2 ± 26.0
Body Mass Index (kg/m^2)	25.7 ± 8.3
Right Hand Length (in)	7.2 ± 0.6
Right Leg Length (cm)	84.8 ± 5.6

SHJ= sprints, hurdles, jumps; Note: Event grouping includes throws (shot put, weight throw), SHJ (60-m, 200-m, 400-m, high jump, long jump, and triple jump), and distance (800-m, mile, 3000-m, and 5000-m)

Table 2

Athletic Characteristics (N=24)

Characteristic	*n*
Event Grouping	
Throws	9
SHJ	7
Distance	8
Year in Collegiate Track	
First	5
Second	8
Third	6
Fourth	3
Fifth	1
Sixth	1
Leg Dominance	
Left	2
Right	22

The results of the 3 × 2, two-way ANOVAs for the FMS composite scores, YBT right and left composite scores, PACES-T, and SWLS scores of the participants pre- and post-season are shown in Table 3. A main effect was found for Time for the pre- to post-season test scores of FMS and PACES-T. The FMS scores were found to be statistically significantly greater during the post-season testing, while the PACES-T scores were statistically significantly lower at post-season testing compared to the pre-season test results.

The PACES-T and SWLS scores included three athletes who had become injured during season. Therefore, one-way ANOVAs comparing pre- and post-season PACES-T and SWLS were calculated with and without the injured athletes. There was a statistically significant decrease in PACES-T scores pre- to post-season when the injured athletes were included. However, when these injured athletes (n =3) were excluded for the subjective well-being measures there was not a difference in the PACES-T and SWLS scores between the pre- and post-season. Table 4 shows the results of these analyses comparing the PACES-T and SWLS from pre- to post- season with and without the injured athletes.

Table 3

Mean and Standard Deviation Scores Pre- to Post-Season for the Functional Movement Screen (FMS) Composite Scores, Y-Balance Test (YBT) Left and Right Composite Scores, Physical Activity Enjoyment Scales Trait (PACES), and Satisfaction with Life Scales (SWLS) for Female Collegiate Indoor Track and Field Athletes.

Time	FMS*[b]	YBT-R[b]	YBT-L[b]	PACES*[a]	SWLS[a]
<u>Pre-Season</u>					
All Subjects	14.8 ± 2.5	0.96 ± 0.07	0.96 ± 0.08	106.6 ± 10.3	27.7 ± 4.8
<u>Post-Season</u>					
All Subjects	15.6 ± 2.2	0.96 ± 0.07	0.97 ± 0.07	102.5 ± 16.6	27.0 ± 5.0

Note: FMS scores are out of maximum score of 21. YBT composite scores are calculated by taking the sum of each direction reach divided by three times the length of the right limb. The PACES trait scale is out of a maximum of 126. The SWLS is on a scale 1-35. The SWLS benchmarks are as follows: 31-35=extremely satisfied, 26-30=satisfied, 21-25=slightly satisfied, 20=neutral, 15-19=slightly dissatisfied, 10-14=dissatisfied, 5-9=extremely dissatisfied.
* $p<0.05$; [a] N=24; [b] N=21

Table 4

Mean and Standard Deviation Scores Pre- to Post-Season Physical Activity Enjoyment Scales Trait (PACES) and Satisfaction with Life Scales (SWLS) in Female Collegiate Indoor Track and Field Athletes Including and Excluding Injured Athletes

Time	PACES	SWLS
<u>Pre-Season</u>		
All Subjects, *N=24*	106.6 ± 10.3*	27.7 ± 4.8
Excluding Injured, *N=21*	106.0 ± 10.3	27.6 ± 5.1
<u>Post-Season</u>		
All Subjects, *N=24*	102.5 ± 16.6*	27.0 ± 5.0
Excluding Injured, *N=21*	102.5 ± 17.4	27.1 ± 5.1

Note: Through the course of the season, three athletes became injured and could only complete post-season survey data. There was a significant decrease in PACES-T scores pre-post season including the injured athletes but not excluding them. Means and standard deviation are presented here for ease of comparison.
* $p<0.05$

Mixed-design, two-way, 3 (Group) × 2 (Time) ANOVAs were calculated to examine the effects of the event Group (throws, SHJ, distance) and Time (pre-season and post-season) on scores of FMS composite score, YBT-right composite score, YBT-left composite score, PACES-Trait, and SWLS. Only two significant main effects or interactions were found. For the FMS composite score dependent variable, the Group × Time interaction (F (2,18) = .33, $p > 0.05$, partial $\eta^2 = .04$, 1-β = .09) and the main effect for Group (F (2,18) = 3.03, $p > 0.05$, partial $\eta^2 = .25$, 1-β = .51) were not significant, however the main effect for Time (F (1,20) = 5.59, $p < 0.05$, partial $\eta^2 = .22$, 1-β = .61) was significant. For the YBT right composite score dependent variable, the Group × Time interaction (F (2,18) = .10, $p > 0.05$, partial $\eta^2 = .01$, 1-β = .06), the main effect for Time (F (1,18) = .07, $p > 0.05$, partial $\eta^2 = .00$, 1-β = .06), and the main effect for Group (F (2,18) = .81, $p > 0.05$, partial $\eta^2 = .08$, 1-β = .17) were not significant. For the YBT left composite score dependent variable, the Group × Time interaction (F (2,18) = .25, $p > 0.05$, partial $\eta^2 = .03$, $1-\beta = .08$), the main effect for Time (F (1,18) = .42, $p > 0.05$, partial $\eta^2 = .02$, $1-\beta = .09$), and the main effect for Group (F (2,18) = .19 $p > 0.05$, partial $\eta^2 = .17$, $1-\beta = .33$) were not found to be statistically significant.

In the 3 × 2 ANOVAs for the psychological variables, the PACES-Trait scores for the Group × Time interaction (F (2,21) = 2.35, $p > 0.05$, partial $\eta^2 = .18$, $1-\beta = .42$) and the main effect for Group (F (2,21) = 1.60, $p > 0.05$, partial $\eta^2 = .13$, $1-\beta = .30$) were not found to be significant. However, the main effect for Time (F (1,21) = 5.36, $p < 0.05$, partial $\eta^2 = .20$, $1-\beta = .60$) was statistically significant. In the 3 × 2 ANOVA for Satisfaction With Life scores, the Group × Time interaction (F (2,21) = .53, $p > 0.05$, partial $\eta^2 = .05$, $1-\beta = .13$), the main effect for Time (F (1,21) = 1.87, $p > 0.05$, partial $\eta^2 = .08$, $1-\beta = .26$), and the main effect for Group (F (2,21) = 1.06 $p > 0.05$, partial $\eta^2 = .09$, $1-\beta = .21$) were not statistically significant. Three of the dependent variable scores were not influenced by event Group or Time. However, the Functional Movement Screen composite and the PACES-Trait scores were only influenced by Time, but not by event Group. Means and standard deviations for all of the dependent variables pre- and post-season in each of the three event groups are shown in Table 5.

Table 5

Mean and Standard Deviation Scores Pre- to Post-Season Functional Movement Screen (FMS) Composite Scores, Y-Balance Test (YBT) Left and Right Composite Scores, Physical Activity Enjoyment Scales Trait (PACES), and Satisfaction with Life Scales (SWLS) between Female Collegiate Indoor Track and Field Event Groups

Time	FMS[b]	YBT-R[b]	YBT-L[b]	PACES[a]	SWLS[a]
Pre-Season					
Throws	13.4±3.0	0.99±0.05	1.00±0.05	102.0±12.1	27.2±5.6
SHJ	16.4±2.2	0.94±0.07	0.94±0.08	107.7±10.6	26.1±5.5
Distance	15.3±1.3	0.94±0.08	0.93±0.09	110.9±5.9	29.5±2.6
Post-Season					
Throws	14.6 ± 2.6	0.99 ± 0.06	1.00 ± 0.05	98.8 ± 19.0	27.2 ± 5.8
SHJ	16.8 ± 1.8	0.95 ± 0.06	0.96 ± 0.05	97.6 ± 18.3	24.9 ± 4.8
Distance	16.1 ± 1.2	0.95 ± 0.1	0.94 ± 0.1	111.0 ± 8.8	28.6 ± 4.0

Note: FMS scores are out of maximum score of 21. YBT composite scores are calculated by taking the sum of each direction reach divided by three times the length of the right limb. The PACES trait scale is out of a maximum of 126. The SWLS is on a scale 1-35. The SWLS benchmarks are as follows: 31-35 = extremely satisfied, 26-30 = satisfied, 21-25 = slightly satisfied, 20 = neutral, 15-19 = slightly dissatisfied, 10-14 = dissatisfied, 5-9 = extremely dissatisfied.
[a] $N = 24$; [b] $N = 21$

A one-way ANOVA comparing the anterior, posteromedial, and posterolateral scores in the Y-Balance Test of the participants right and left leg was calculated (see Table 6). A significant difference was found between the right and left leg scores in the posteromedial direction. The posteromedial scores were found to be statistically significantly greater when using the left leg to push the indicator box in the posteromedial direction.

Table 6

Means and Standard Deviations for Reach Distance in Centimeters for Each Direction of the Y-Balance Test with Right and Left Legs in Female Collegiate Indoor Track and Field Athletes (N=21)

Leg	Anterior	Posteromedial*	Posterolateral
Right	60.1±6.6	88.9±9.2	94.4±8.6
Left	61.2±8.1	90.9±9.7	94.1±8.8

* $p<0.05$

A Pearson correlation coefficient was calculated for each relationship between the five dependent variables, FMS total, YBT-R, YBT-L, PACES, and SWLS in the pre-season (Table 7). Strong positive correlations were found between FMS Total and PACES ($r(22)= .404$, $p<.05$), YBT-R and YBT-L ($r(22)= .891$, $p<.01$), YBT-R and PACES ($r(22)= .352$, $p<.05$), YBT-R and SWLS ($r(22)= .371$, $p<.05$), YBT-L and SWLS ($r(22)= .419$, $p<.05$), and PACES and SWLS ($r(22)= .507$, $p<.01$), indicating a significant linear relationship between the two variables. As one score increased so did the score of the second variable in the pre-season.

Table 7

Pre-Season Pearson Correlations for Dependent Variables

	FMS Total	YBT-R	YBT-L	PACES	SWLS
FMS Total	1	-.012	.064	.404*	.242
YBT-R	-	1	.891**	.352*	.371*
YBT-L	-	-	1	.319	.419*
PACES	-	-	-	1	.507**
SWLS	-	-	-	-	1

* $p<0.05$; ** $p<0.01$

A Pearson correlation coefficient was calculated for each relationship between the five dependent variables, FMS total, YBT-R, YBT-L, PACES-T, and SWLS in the post-season (Table 8). Strong positive correlations were found between YBT-R and YBT-L (*r*(19)= .890, *p<.01),* YBT-R and PACES-T (*r*(19)= .451, *p<.05),* YBT-L and PACES-T (*r*(19)= .400, *p<.05),* and PACES-T and SWLS (*r*(19)= .596, *p<.01),* indicating a significant linear relationship between the two variables. As one score increased so did the score of the second variable in the post-season.

Table 8

Post-Season Pearson Correlations for Dependent Variables

	FMS Total	YBT-R	YBT-L	PACES	SWLS
FMS Total	1	.032	.037	.309	.224
YBT-R	-	1	.890**	.451*	.201
YBT-L	-	-	1	.400*	.164
PACES	-	-	-	1	.596**
SWLS	-	-	-	-	1

** p<0.05; **p<0.01*

Discussion

The purposes of the study were to evaluate functional movement and subjective well-being of female track and field athletes before and after the seven-week indoor season. The results of the dependent variables: FMS, YBT, PACES-Trait, and SWLS prior to and following the indoor track and field competition season indicated that significant differences exists pre- to post-season for FMS composite scores and PACES-Trait scores. The results were also indicative of significant differences in right and left leg in the posteromedial direction of the YBT. The data collected also produced no evidence of significant differences in the five dependent variables for Group or for Group by Time. The Pearson correlations were indicative of significant correlations between right and left YBT scores, as might be expected. Another significant correlation that was not as expected, was that PACES-Trait was positively correlated with SWLS in both the pre- and post-season.

Functional Movement Testing

Functional Movement Screen

There were statistically significant improvements in the FMS composite scores from the indoor track and field pre- to post- season. There are only a few current studies to compare these results to other similar sample track and field groups. A factor that could have influenced these increased scores of the FMS composite scores pre- to post-season is the timing of the assessments. In the pre-season, many athletes were still doing many repetitions and the strength phases of their off-season training. As they approached the championship season, they began to taper their volume and focus on the quality rather than the quantity of the training. The tapering started to take place about three weeks prior to the championship. This intentional peaking for championship season helps the athletes feel better physically for the most important meet of the indoor season. The pre-season scores for FMS could be lower also due to the fact the screening session was completed after the athlete’s return from the winter break, during which athletes took no classes and were not on-campus for a three-week period.

The Functional Movement Screen mean scores of track and field athletes have been reported in a few previous studies. Bring, Chan, Devine, Collins, Diehl and Burkam (2018) conducted a study with runners who participated in track and field or cross country. The female mean for FMS composite score was 15.2 with a 95% confidence interval of 14.7-15.6. This is comparable to the female indoor track and field athletes in the current study both in the pre- and post-season, 14.8 ± 2.5 and 15.6 ± 2.2, respectively (see Table 3).

Hotta et al. (2014) used the FMS as an assessment tool for male and female track and field athletes, however they assessed college-aged sprinters, hurdlers, and middle- and long-distance runners. The sprint and hurdles were grouped together as were the middle- and long-distance runners. The sprint hurdle group had a composite score mean of 14.6 ± 2.4 while the middle- and long-distance runners had an average of 14.1 ± 2.3 (Hotta et al., 2014). The results of the Hotta et al. (2014) study are comparatively lower than the same measure for the same groups in the present study; pre-season: SHJ 16.4 ± 2.2 and Distance 15.3 ± 1.3; post-season: SHJ 16.8 ± 1.8 and Distance 16.1 ± 1.2.

At a more elite level, track and field professionals have also been assessed utilizing the FMS. Chapman, Laymon and Arnold (2014) found that women U.S.A. track and field athletes had an overall FMS score of 15.6 ± 1.9 which aligned with the data collected in the current study for all athletes in the pre-season (14.8±2.5) and post-season (15.6±2.2). Results reported by Chapman, Laymon, and Arnold (2014) for U.S.A. track and field athletes are similar with the present study in female collegiate indoor track and field athletes; the composite scores of the FMS were greatest in the sprinters, hurdlers, and jumpers, the least amount of variance in FMS composite scores was found in the distance group, while the throwers scored the lowest on the FMS.

Previously reported FMS data have not been specific to track and field athletes, but have been reported for individuals who are physically active and healthy. Schneiders, Davidsson, Hörman and Sullivan (2011) used the FMS to assess 209 physically active men and women, ages 18 to 40 years, in the greater southern region of New Zealand from a tertiary student population, sports clubs, and the general public. The mean score and standard deviation for the 108 women participants was 15.6 ± 2.0. The collective results of the BGSU indoor track and field team were similar to the findings of Schneiders, Davidsson, Hörman and Sullivan (2011) in the post-season (15.6 ± 2.2), but not the pre-season results (14.8 ± 2.5).

Y-Balance Test

Dynamic balance of the right and left leg in three directions can be measured by utilizing the Y-Balance Test. The left leg scores in each direction are indicative of total distance pushed with left leg, meaning balance is taking place on the right foot, and vice versa for right leg scores. There was a significant difference found between left and right leg in the posteromedial direction. There are two main factors that could contribute to the difference between legs. The first factor is leg dominance; 22 of 24 participants had right leg dominance. This means they prefer right leg when making sporting decisions or in directional lead.

In the current study, the posteromedial direction had a significantly greater score in the left leg than the right, meaning the dynamic balance on the right leg was better than the dynamic balance on the left leg. The other factor that could be a contributing factor to this significant difference is the direction itself. The forward direction and posterolateral direction in single leg support is familiar from walking or even movement to step to the side. The third direction posteromedial is not as familiar to linear athletes, meaning that athletes who only move in one direction (i.e., a sprinter or distance runner). Whereas, this movement would be familiar to an athlete such as a hockey player who pushes off their skates in many directions including the posteromedial. The unfamiliarity with this movement may have had an influence on the scores for dynamic balance in the posteromedial direction.

When comparing results of the YBT in the current study to other investigations, there are conflicting results. Smith, Chimera and Warren (2015) assessed 184 Division I athletes who participated in a variety of sports, 10 were track and field athletes and of those 10, only three were females. Smith and colleagues (2015) investigated directional asymmetry and composite scores of the Y-Balance Test in both injured (N = 81) and uninjured (N = 103) athletes. The results indicated that there were not significant differences between right and left leg in any of the three directions (Smith, 2014). Unlike the current study, 124 of the 184 participants in the Smith, Chimera and Warren (2015) study participated in sports that require quick redirected movements (basketball, football, tennis, volleyball, and soccer), and this could be a possible explanation as to why no significant differences were observed.

The Y-Balance Test is a tool that has not been utilized often in track and field specific studies, however the research that has been done has shown that although asymmetries are existent, many are not found to be significantly different.

Subjective Well-Being

Physical Activity Enjoyment Scales

The trait version of Physical Activity Enjoyment Scales was used in this study. Trait qualities suggest that this may be the individual's consistent feelings of enjoyment for nearly all types of physical activity. Athletes' Physical Activity Enjoyment Scale scores decreased significantly from pre-season scores to post-season scores when including the injured athletes. However, when the injured athletes were excluded from statistical analysis no significant differences were present (see Table 4). Comparisons with and without injured athletes were analyzed because unfortunately, injuries are a part of the risks associated with sport. The subjective well-being scores can be greatly impacted by the negative affect associated with injury. Including the injured athletes is the truest results of this particular sample, however excluding the injured athletes allowed comparisons to be made between only healthy athletes.

The time point in the indoor season could play a critical role in physical activity enjoyment. The "big" meets that carry the most importance and excitement take place at the end of the season rather than the beginning of the season. If athletes did not compete well at the end of the season or sustained an injury, their enjoyment of the physical activity could decrease significantly. The pre-season scores for this could be greater also because the surveys were filled out after the return from the winter break in classes, when athletes took no classes or were not on campus for three weeks. The athletes' return to campus was specifically for track and field training, and at the start of the season, more feelings of enjoyment could have occurred because the track season was about to begin. The compiled stress of the semester and track season could have had an impact on lower PACES scores post-season.

Subjective Well-Being Correlations

The mean SWLS for the track and field athletes (pre-season; 27.7 ± 4.8 post-season; 27.0 ± 5.0) in this study are comparable with SWLS scores of 474 female college students (27.1 ± 5.6) (Coccia & Darling, 2016). There was a significant positive correlation found between PACES-Trait and SWLS both pre- and post-season which emphasizes that both measures capture portions of satisfaction with life (Berger et al., 2015). Physical activity is a big part of the athletes' day-to-day operations at BGSU. When the athletes enjoy what they are doing in training or perceive the exertion as making them better athletes, there is an increased chance that they are going to be satisfied with life. In addition, exercise has been reported to increase enjoyment levels more than non-exercise activities (Greene, Greenlee & Petruzzello, 2018). Overall satisfaction with life increases as individuals enjoy the activities in which they participate.

Between Groups Interactions

There were no significant differences between groups (Throws; SHJ; Distance) in the pre- or post-season sessions for any of the dependent variables; FMS, YBT-R, YBT-L, PACES-T, and SWLS. One factor that could influence this is similar athletic levels. Most of the athletes compete at the same level (Division I), and they are able to qualify for the conference championships, but they are often not able to make the podium (finishing eighth place or higher). Six of the 24 participants were able to score points at the indoor championship meet which supports the rationale that many of the athletes were of similar athletic caliber compared to athletes in the Mid-American Conference. Another factor that could have impacted this difference is the mean age of the athletes. There was not much variance in the age of the subjects or years of collegiate varsity track and field competition, 19.9 ± 1.3 years and 2.6 years, respectively. This may suggest that all of the athletes have been involved with collegiate track and field approximately the same amount of time, and therefore they may not accurately depict specific athletic characteristics of their event group. The sample sizes of the groups were also small; this may have contributed to a lack of differences among the event groups. In addition, all the athletes attend the same university and share the same teammates and coaches. Sharing these training and competitive experiences may also have resulted in a lack of variance in test results among the athletes, as compared to data collection that included many athletes from track and field programs at different universities.

Conclusion

The functional movement of the athletes improved from the pre- to post-season of the indoor track and field season. This is supported by improved FMS composite scores from the beginning of the season to the conclusion of the indoor season. The differences pre- to post-season in the FMS scores may be a result of the athletes' bodies "feeling better" after the championship meet. The decrease in PACES-Trait scores was likely observed because three athletes became injured or some athletes did not end the indoor season as well as they wanted. There were differences between the left and right leg in the posteromedial direction for all participants that may be attributed to leg dominance and the unfamiliarity of the movement pattern. In addition to differences in the dependent variables, there were also similarities present. The positive correlation between physical activity enjoyment and satisfaction with life indicates that athletes who enjoyed participation in physical activity were more satisfied with their lives. As physical activity enjoyment increased, the subjective "feeling" on total life satisfaction also increased as supported by both the pre-season and post-season results. Because physical activity is a large portion of college athletes' lives, it is logical to assume that if they enjoy what they are doing, this enjoyment contributes to their positive perception of life satisfaction.

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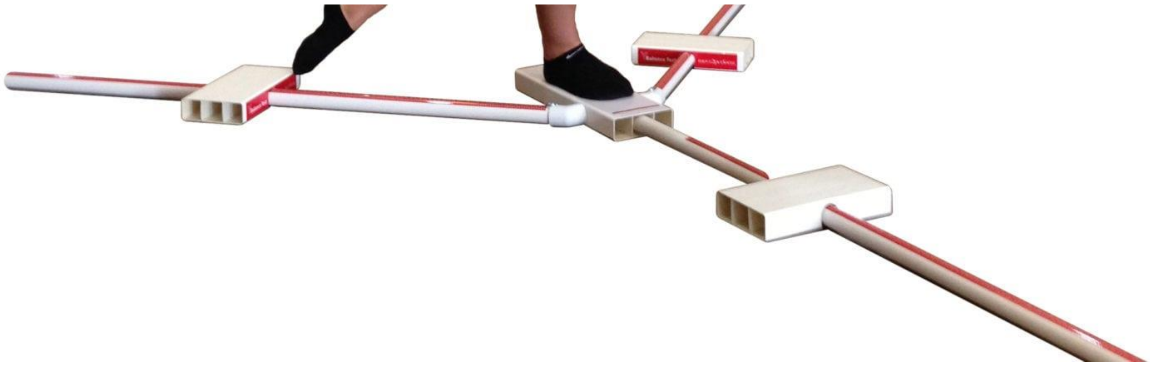
Appendix A

Images are from data collection (hurdle step, inline lunge, rotary stability).

All of the seven tests and clearing tests with scoring criteria and the scoring sheet can be retrieved from Gray (2010) or online from http://www.functionalmovement.com.

Appendix B



Retrieved from http:// www.scienceforsport.com/y-balance-test/

Photos are from data collection (anterior right, posteromedial right from behind and in front).

Appendix C

Physical Activity Enjoyment – Trait

Please rate how you feel about **most types of physical activity** in general, **most of the time.**

Circle your response to each of the following items.

1. I enjoy it	1	2	3	**4**	5	6	7	I hate it
2. I feel bored	1	2	3	**4**	5	6	7	I feel interested
3. I dislike it	1	2	3	**4**	5	6	7	I like it
4. I find it pleasurable	1	2	3	**4**	5	6	7	I find it unpleasurable
5. I'm very absorbed in this activity	1	2	3	**4**	5	6	7	I'm not at all absorbed in this activity
6. It's not fun at all	1	2	3	**4**	5	6	7	It's a lot of fun
7. I find it energizing	1	2	3	**4**	5	6	7	I find it tiring
8. It makes me depressed	1	2	3	**4**	5	6	7	It makes me happy
9. It's very pleasant	1	2	3	**4**	5	6	7	It's unpleasant
10. I feel good physically while doing it	1	2	3	**4**	5	6	7	I feel bad physically doing it
11. It's very invigorating	1	2	3	**4**	5	6	7	It's not at all invigorating
12. I'm very frustrated	1	2	3	**4**	5	6	7	I'm not at all frustrated
13. It's very gratifying	1	2	3	**4**	5	6	7	It's not at all gratifying
14. It's very exhilarating	1	2	3	**4**	5	6	7	It's not at all exhilarating
15. It's not at all stimulating	1	2	3	**4**	5	6	7	It's very stimulation
16. It give me a strong sense	1	2	3	**4**	5	6	7	It does not give me any

of accomplishment								sense of accomplishment
17. It’s very refreshing	1	2	3	**4**	5	6	7	It’s not all at refreshing
18. I felt as though I would rather be doing something else	1	2	3	**4**	5	6	7	I felt as though there was nothing else I would rather be doing

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Appendix D

Directions: Below are five statements with which you may agree or disagree. Using the 1 -7 scale below, indicate your agreement with each item by placing the appropriate number on the line preceding that item. Please be open and honest in your responding. The 7-point scale is as follows:

1 = strongly disagree
2 = disagree
3 = slightly disagree
4 = neither agree nor disagree
5 = slightly agree
6 = agree
7 = strongly agree

1. In most ways, my life is close to my ideal. __________

2. The conditions of my life are excellent. __________

3. I am satisfied with my life. __________

4. So far I have gotten the important things I want in life. __________

5. If I could live my life over, 1 would change almost nothing. __________

(Diener, Emmons, Larsen & Griffin, 1985)