

Effects of the FIFA11+ warm-up program on speed, agility and vertical jump performance in adult female amateur soccer players

Abstract

Objective: Performance benefits related to the FIFA11+ may encourage program endorsement from coaches and athletes and improve warm-up adherence. The objective of this novel pilot study is to determine the performance-related effects of the FIFA11+ on adult female amateur soccer players as it is largely unknown.

Equipment and Methods: A parallel, two-group, pre-post, single-blind comparative trial design was implemented. Players between 19–42 years of age, from two adult female amateur soccer teams (n=21) participated in the pilot study. Agility T-test, squat jump, and 10m sprint tests were performed prior and subsequent to participants completing the FIFA11+ or a time-matched warm-up three times per week for eight weeks. Nonparametric tests were used to determine within- and between-group differences between pre-post testing.

Results: The between-group testing results for the 10m sprint, agility T-test and squat jump in the FIFA11+ group trended favorably relative to the control group but statistical significance was not achieved. Within-group testing results were statistically significant for the agility T-test and squat jump for both the FIFA11+ and control group. Although statistical significance was not achieved, the FIFA11+ trends toward greater improvement in speed, agility and vertical jump performance when compared to a traditional warm-up. This study provides the impetus for additional larger scale and adequately powered trials in an understudied soccer population.

Keywords: soccer, football, physical functional performance, warm-up exercise, training

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Abbreviations: 11+, FIFA11+; PMs, performance metrics; NSGSC, North Shore Girls Soccer Club; SJ, squat jump

Introduction

Soccer is the most popular sport worldwide with a combined 270 million players, referees, and officials actively engaged in the sport.¹ Despite the many health benefits reported in those playing soccer recreationally² and at elite levels of competition,³ noncontact lower extremity injury rates are reportedly higher in soccer than many other sports including field hockey, volleyball and basketball.⁴

Sport injuries such as Anterior Cruciate Ligament tears can lead to decreased sport participation as well as immediate and long-term morbidities such as pain, decreased function, and osteoarthritis.⁵ These injuries come with substantial direct and indirect costs.⁶ Recently, the incidence of injury in soccer has been acknowledged⁴ and a focus has been put on preventing injuries through various mediums, one of which is the creation of exercise-based injury prevention warm-ups.⁷

The FIFA11+(11+) is an injury prevention program that was disseminated worldwide in 2009.⁸ The 11+ is comprised of a series of speed, agility, balance and strength drills, and has demonstrated its ability to reduce noncontact soccer injuries by 20-70% in various soccer populations.^{9,10}

The effects of the 11+ on various performance metrics (PMs) such as balance, jump height, and strength¹¹ have been studied over the last decade. It has been proposed that understanding the short-term neuromuscular and long-term training effects of exercise-based injury

prevention programs may help in understanding why these programs effectively reduce noncontact injuries.¹² Furthermore, demonstrated improvements in physical performance, along with injury prevention, may encourage program endorsement from coaches and athletes and improve warm-up adherence.^{10,13,14}

Most of the performance-related 11+ research has studied male players with only two groups having examined PM changes in female players.^{10,15} These two studies assessed agility, balance and strength changes and did not address other PMs integral to the sport of soccer such as speed and vertical jump height. Furthermore, these studies focused on U16/U18¹⁰ and collegiate¹⁵ players and does not account for the performance effects of the 11+ on females over the age of 23. The PM response to the 11+ program is therefore largely unknown for the estimated 18 million females playing in senior divisions (18 years of age and older) worldwide.¹⁶

The purpose of this pilot study is to investigate the effects of the 11+ on speed, agility and vertical jump height in adult female amateur soccer players when compared to a traditional time-matched soccer warm-up. We hypothesized that adult female amateur soccer players performing the 11+ three times per week for eight weeks would demonstrate greater improvement in PMs when compared to players performing a traditional time-matched soccer warm-up.

Methods

The pilot study was approved by the North Shore Girls Soccer Club (NSGSC) in March, 2018 and by the University of British

Columbia’s Clinical Research Ethics Board (H18-00383) in May, 2018. Participants were informed orally and via written consent regarding study procedures one week prior to the initial performance testing session.

Thirty-two female amateur soccer players from two NSGSC Selects “A” teams were contacted to participate in the pilot study. Eligible participants had to be between the ages of 18 and 45 and play on one of the identified NSGSC Selects “A” amateur soccer teams. Participants were excluded from the study if they had any one of the following: played goal keeper, missed a PM testing session, missed three or more consecutive warm-ups due to injury or other cause, were pregnant or became pregnant during the study. Goal keepers were omitted due to the drastically different training and in-game demands of the position relative to other player positions. Missing three or more consecutive warm-ups resulted in exclusion as a training cycle break of this length may lead to de-conditioning and therefore an inaccurate influence on testing results.

Potential participants were pursued through convenience sampling based on previous experience one of the authors had with the NSGSC. Participant recruitment was carried out by AE and MW during the first week of the 2018-2019 soccer seasons. Recruitment was delegated based on the assurance that the recruiting author had no prior involvement with their assigned team. Participant allocation

to the intervention (11+) and control group was predetermined and team-based before participant recruitment commenced to avoid contamination by having players from the same team get exposure to both warm-up programs. One of the authors had regular paramedical involvement with one of the teams, thus allowing him to administer the 11+ warm-up for this team. Participants provided their number of years of soccer experience and their number of hours of moderate to high intensity activity per week. All participants were encouraged to maintain their regular eating, exercise and sleep habits throughout the duration of the study.

The intervention group was familiarized with the 11+ program one week before the performance testing commenced to ensure players were comfortable with performing the warm-up exercises correctly. The 11+ was led by one of the authors three times per week for 8 weeks. The 11+ is approximately 25 minutes in length and is comprised of 27 exercises that challenge the user’s balance, speed, agility, strength and jumping ability. The 11+ offers difficulty level progressions for a number of exercises so that the warm-up consists of 15 exercises at any one time and can be made more or less challenging, depending on the capacity of the athlete (Table 1). Week 1 and 2 consisted of Level 1 exercises, Weeks 3 to 5 consisted of Level 2 exercises and Weeks 6 to 8 consisted of Level 3 exercises as described in the open access 11+ Manual (www.f-marc.com/11plus).

Table 1 Components of FIFA I+ Warm-up

Identical regardless of warm-up difficulty level			
Running exercises	Straight running, hip out, hip in, circling partner, shoulder contact, quick forwards & backwards 2 sets per item		
	Level 1	Level 2	Level 3
Strength, plyometrics, balance	Bench, static	Bench, alternate legs	Bench, one leg lift & hold
	3 sets x 20-30 sec. each	3 sets x 40-60 sec. each	3 sets x 20-30 sec. each
	Sideways bench, static	Sideways bench, raise & lower hips	Sideways bench, with leg lift
	3 sets per side x 20-30 sec. each	3 sets per side x 20-30 sec. each	3 sets per side x 20-30 sec. each
	Hamstring, beginner	Hamstrings, intermediate	Hamstrings, advanced
	1 set x 3-5 reps	1 set x 7-10 reps	1 set x 12-15 reps
	Single-leg stance, hold the ball	Single-leg stance throwing ball with partner	Single-leg stance, test your partner
	2 sets x 30 sec. per leg	2 sets x 30 sec. per leg	2 sets x 30 sec. per leg
	Squats, with toe raise	Squats, walking lunges	2 sets x 30 sec.
	2 sets x30 sec.	2 sets x 30 sec.	Squats, one-leg squats
Jumping, vertical jump	Jumping, vertical jump	Jumping, lateral jumps	Jumping, box jumps
	2 sets x 30 sec.	2 sets x 30 sec.	2 sets x 30 sec.
	Identical regardless of warm-up difficulty level		
	Running exercises Running across the pitch, bounding, plant & cut 2 sets per item		

The control group was asked to continue with their regular warm-up which was time-matched with the 11+. The control warm-up included stretching, running and ball-oriented drills. Before performance testing commenced, participants were allocated a study number via a random number generator. The random study number was the only identifier documented on each PM testing sheet. PM testing was administered by three blinded testers.

Participants received identical instructions on how to complete each test and were given an opportunity to ask questions to ensure they understood each task. Participants completed a 5 minute warm-up prior to the testing consisting of three 1 minute jog intervals, separated by two 30-second-per-side lateral shuffles at a comfortable pace. Testing was performed in an indoor soccer facility, allowing for identical pre- and post-testing conditions.

The 10-meter (10m) sprint has been touted as a relevant soccer test since it measures both acceleration and short distance speed.¹⁷ Testing was performed with Brower TC Timing gates setup at a height of 1m above field-level and at a distance of 10m. Participants were positioned behind a piece of tape marked 50cm in front of the start gate. Sprint times were digitally recorded by the timing system to one hundredth of a second. Participants could choose their start position but were required to use the same start position for all testing trials. Participants were asked to run as fast as possible between both timing gates.

The T-test is a valid, reliable and commonly used agility test amongst soccer populations^{18,19} and is depicted in the Figure 1. Participants were asked to sprint forward from a stationary position (cone 1) to a cone 10 yards away (cone 2), side shuffle to a cone 5 yards to the left (cone 3), side shuffle to a cone 10 yards to the right (cone 4), side shuffle back to the central cone to the left (cone 2), and then back-peddle to the start position (cone 1) as fast as possible. A Brower TC Timing System was used to measure agility times to one hundredth of a second.

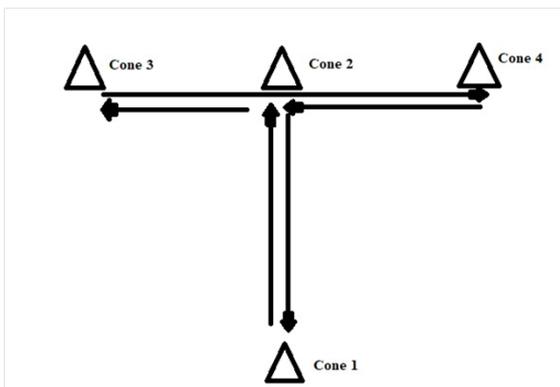


Figure 1 Agility T-Test.

The squat jump (SJ), using a contact mat has been shown to be a valid and reliable measure of vertical jump height²⁰ and is an integral soccer skill for demands such as heading a ball. SJ testing was performed using a Probotics Just Jump System with contact mat. Participants were asked to stand on the contact mat with their feet shoulder width apart and their hands on their hips. Participants were then asked to lower their center of mass until 90 degrees of knee flexion was achieved, pause for 1 second, then maximally propel themselves vertically with their hands remaining on their hips.

Each participant had three trials for each test with a 2-minute rest

interval between trials. All trial times and heights were recorded with the best pre-post times and jump height selected for the statistical analysis. The R software (Version 3.5.1) was used for within-group and between-group data analyses. Demographic characteristics (e.g. age, weight) were summarized by group using mean (standard deviation).

The Mann-Whitney U test was used to test the null hypotheses that the mean percent change in 1) 10m sprint, 2) agility T-test and 3) squat jump were not statistically different between groups. A secondary sensitivity analysis was performed for each PM which re-ran the Mann-Whitney U test for the sample of participants who attended at least 75% of the practices. The Wilcoxon signed-rank test was used to determine within-group statistical significance for all PMs. A level of significance was accepted using a 95% confidence interval for all statistical parameters.

Results

Twenty-one players volunteered to participate in the pilot study. Participants ranged in age from 19 to 42 and all had over a decade of competitive soccer experience. Both teams practiced two times per week and played one game per week. Participant demographic data for both groups showed they were similar in age, weight, height, years of experience and weekly activity level (Table 2).

Table 2 Subject demographics by group (n=21)

Group	11+ (n=11)	Control (n=10)
Age (years)	28.1(6.6)	27.1(3.2)
Weight (kg)	62.7(5.7)	60.2(8.2)
Height (cm)	169.3(5.4)	163.3(5.6)
Years of experience	20.9(6.3)	20.1(1.8)
Moderate/high intensity activity per week (hours)	7.0(3.4)	6.9(3.5)

Values are mean±(standard deviation)

Agility, squat and 10m sprint mean percent change(standard deviation) and median percent change(range) for the 11+ and control group are found in Table 3. Positive values denote improvements in each respective PM whereas negative values denote a decrease in performance.

Table 3 Percent change by intervention group

Exercise	Intervention		Control	
	Mean percent change (standard deviation)	Median percent change (range)	Mean percent change (standard deviation)	Median percent change (range)
10m Sprint	4.13 (5.85)	3.67(-3.06,13.19)	-1.08 (4.38)	1.01(-9.3)
Agility	8.18 (2.35)	8.5(4.82,11.68)	5.89 (2.12)	6.28(3.06,8.84)
Squat	11.88 (6.9)	11.03(2.26,24.13)	7.54 (7.1)	5.99(0.51,21.04)

Note negative values denote a decrease in performance.

The 11+ group yielded a mean percent change in 10m sprint times of 4.13 while the control group produced a mean percent change -1.08. The p-value for the Mann-Whitney U test between intervention

groups for the 10m sprint was 0.189. A p-value of 0.329 was obtained following a secondary sensitivity analysis. Sprint % change by group is depicted in the Figure 2.

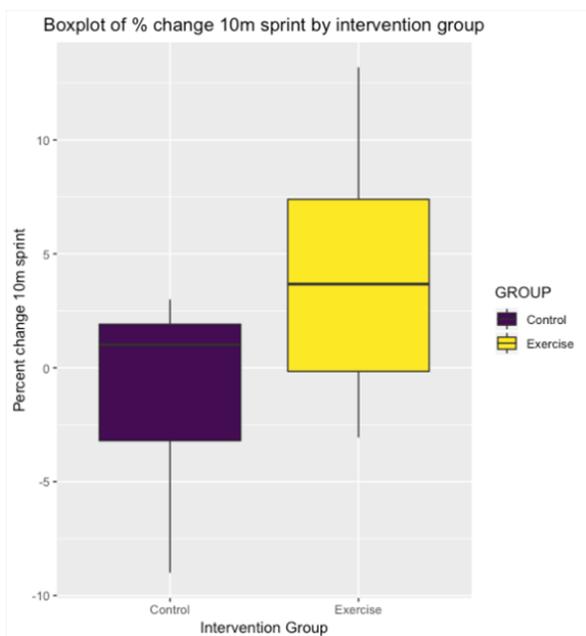


Figure 2 Boxplot of percent change 10m sprint by intervention group.

Agility testing yielded a mean percent change of 8.18 for the 11+ group while the control group produced a mean percent change of 5.89. The p-value for the Mann-Whitney U test between intervention groups for the agility T-test was 0.072. The secondary sensitivity analysis yielded a p-value of 0.082. Agility percent change by group is depicted in the Figure 3.

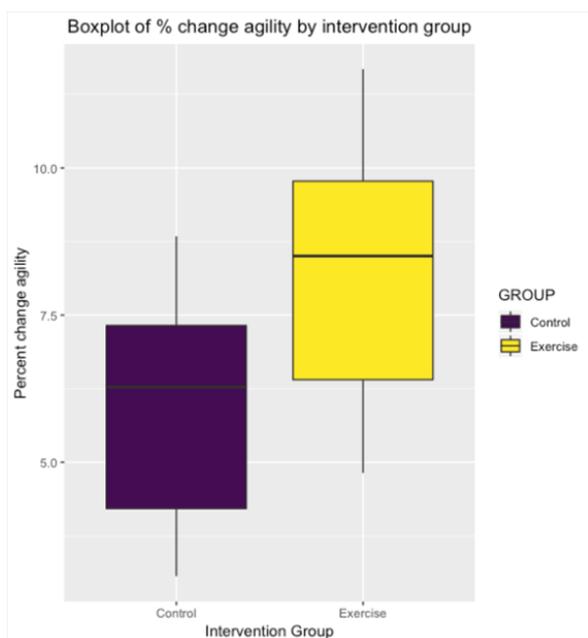


Figure 3 Boxplot of percent change agility by intervention group.

The 11+ group yielded a mean percent change of 11.88 for the squat jump while the control group produced a mean percent change of 7.54. The Mann-Whitney U test between intervention groups for the squat jump yielded a p-value of 0.152. A p-value of 0.1775 was achieved following the secondary sensitivity analysis. Squat jump percent change by group is depicted in the Figure 4. Across all three tests, positive mean percent change values denote a favorable but non-significant increase in jump height.

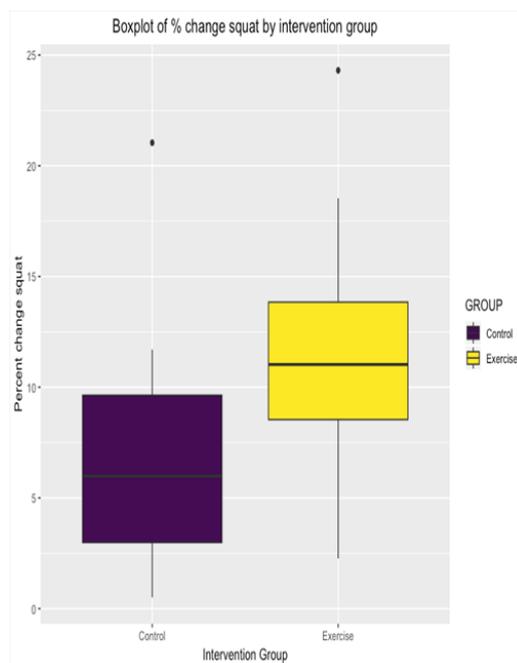


Figure 4 Boxplot of percent change squat jump by intervention group.

Within-group statistical significance was achieved ($p < 0.001$) for the agility T-test and squat jump for both groups. Within-group statistical significance was not achieved for the 10m sprint test in either group.

A post hoc power calculation using the clincalc.com power calculator was performed to determine the minimum mean percent change required for the pilot study to detect a difference between the 10m sprint, agility T-test and squat jump tests for both groups. Post hoc power calculations revealed that a minimum mean percent change of 51% was required for the agility T-test and 22.3% for the squat jump. Assuming the real change experienced by the control group was 0 for the 10m sprint and the control group didn't get slower over the study period, a minimum mean percent change of 34.4% was required.

Discussion

The purpose of this pilot study was to preliminarily explore the effects of the 11+ on speed, agility and vertical jump height in adult female amateur soccer players relative to a traditional time-matched soccer warm-up and provide the impetus for further research with this soccer demographic. Results for the 10m sprint, agility T-test and squat jump trended favorably for the 11+ group relative to the control group but statistical significance was not achieved. This is a novel study given that the PM response to the 11+ has not been previously studied in female amateur soccer populations ranging from 18-40 years of

age and therefore direct comparisons cannot be drawn. To the authors knowledge, vertical jump and sprint tests have not previously been performed in relation to the 11+ with any female soccer populations but several authors have examined these changes using male players of various ages and skill levels.²¹⁻²³ Previous studies involving male players have reported significant improvements in sprint performance ranging from 1.8%²¹ to 24.2%²⁴ following implementation of the 11+, whereas other studies reported no change in sprint times.^{11,13,25} Although studies using younger populations did not yield favorable changes in sprint results,^{13,25} it has been postulated that the 11+ may not be demanding enough to elicit a favorable change in sprint time in adult populations.²¹ This may be the case for this pilot study as the mean age for both groups was 28.1±6.6 and 27.1±3.2 respectively. Intervention duration was likely not a factor influencing the results of this study since the frequency and duration of the 11+ employed were comparable to those of other studies^{23,25} and favorable changes in sprint performance were reported in studies using a shorter exposure time.²¹

Several studies using male players have reported an improvement in vertical jump height following several weeks of exposure to the 11+.^{23,24,26} Reports of vertical jump height improvement were found in studies using the squat jump,^{23,24,26} counter movement jump,^{22,26} drop jump,²¹ and Sargent jump.^{14,17} The improvement in jump performance reported by some of these articles may be attributed to the lunge and squat variations in the 11+. The Nordic Hamstring Exercise which is included in the 11+ has also been shown to have a favorable effect on jump performance.²⁸ Bizzini et al.²² and Silva et al.²⁶ both measured changes in vertical jump height using the squat jump and counter movement jump.^{22,26} Greater vertical jump improvement was found with the squat jump test, suggesting that the 11+ has a greater effect on the concentric muscle action of squat jump over the rapid eccentric-concentric muscle action of the counter movement jump. The squat jump was utilized in this pilot study, however the between-group changes in jump height were non-significant. This finding may be due to differences in the populations studied such as gender, age and skill level.

A single study has reported statistically significant improvement in agility in using the 11+ in a younger female soccer population following an 8 week intervention.¹⁵ Although an identical warm-up frequency and duration was employed in this pilot study, we did not find a significant change in agility times. Other studies have measured changes in agility in relation to the 11+ in male populations with mixed results.^{22,23,27} It is possible the training stimulus from the 11+ was adequate to create a favorable response in agility for some, but not all individuals. Demographic variables such as gender and age may also explain the inconsistencies in agility results across these studies.

The timing of the pilot study coincided with the beginning of the 2018-2019 soccer season. Despite the trend of increased performance across all PMs in the 11+ group, it is possible that the improvements seen in both groups may in part be due to players being relatively deconditioned at the start of the season and subsequently experience a training effect from the soccer practices and matches they attended over the 8 week intervention period.

Several limitations of this pilot study must be acknowledged. This study was underpowered given the small sample size. Although other studies have used similar sample sizes,^{21,26,29} we were powered to

detect very large changes in all PMs and were unsuccessful in doing so. Greater participation was anticipated for the pilot study, but many potential subjects could not attend one or both testing sessions due to non-soccer commitments. A larger sample size may have been obtained if time and resources allowed for additional PM testing sessions. Given that the results of the three PMs trended towards significance, it is possible the changes observed in the intervention group may have been statistically significant with a larger sample size. Despite this sample size limitation, this pilot study provides good preliminary evidence that larger studies are needed that investigate this population.

Additionally, although a control group was utilized, a sham intervention was not integrated into the control warm-up. We therefore cannot be certain of how motivation or expectations would influence the two groups with respect to their performance testing. Efforts were taken to avoid contamination by having the teams perform their warm-ups at different times and locations. Although unlikely, it is possible members of the control group explored the 11+ and emulated some of the exercises outside of the soccer setting.

Conclusion

This pilot study found eight weeks of the 11+ program resulted in improvements that trended towards significance in speed, agility and vertical jump PMs relative to a time-matched soccer warm-up in adult female amateur soccer players. In light of the limitations related to the small sample size used for this pilot study, these findings are encouraging and warrant larger scaled and adequately-powered studies in this soccer population. Although this pilot study found a lack of significant change in PMs with the 11+, it is still an appropriate warm-up for female soccer populations given its proven protective effect against non-contact musculoskeletal injuries and the positive trend towards improvements in PMs.

Practical implications

1. Previous research has demonstrated improvements in different measures of performance (e.g. jump height, hamstring strength) after implementing the FIFA11+.
2. Despite limitations with sample size, the FIFA11+ trends towards greater improvements in PMs in adult female amateur soccer players relative to a traditional warm-up.
3. The findings of this study relative to the finding of previous research may in part be due to differences in gender, age, and skill level.

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Conflicts of interest

The authors declare that there is no conflict of interest.

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