The Effectiveness of the FIFA11+ at Improving Sport Performance Metrics: A Systematic Review

Dr. Matt Wentzell

ABSTRACT

Objective: To conduct a systematic review of the short- and long-term effects of the FIFA11+ warm-up on performance metrics (PMs) including strength, speed, agility, jump height, balance, motor control, and kicking skill/accuracy in football players.

Eligibility Criteria: Eligible studies were written in English; involved testing adolescent or young adult competitive football players; and included same-group pre- and post-test data on measurable PMs related to the FIFA11+.

Results: 20 articles met the inclusion criteria. Synthesis found evidence that long-term FIFA11+ exposure resulted in improvements in hamstring strength-related measures; as well as some evidence for improvements in agility, jump height, and static and dynamic balance; limited or conflicting evidence for speed, conventional strength ratio, and quadriceps strength; insufficient evidence for dynamic control ratio and kicking skill/accuracy; and no evidence for motor control. Evidence for PM improvements following a single FIFA11+ exposure was limited or conflicting. Overall, PM improvements were most consistent in male professional athletes.

Conclusion: There is evidence that long-term exposure to the FIFA11+ is related to improved hamstring strength. However, given the heterogeneous nature of the studies, further research is warranted to understand the programs' effects on PMs in different populations, with consideration of program dosage and athlete's baseline skill.

Keywords: warm-up exercise, football, training

1. INTRODUCTION

The FIFA11+ is an internationally recognized warm-up program designed to reduce the incidence of noncontact football injuries.[1] The program is the brainchild of the FIFA Medical Assessment and Research Centre, the Oslo Sports Trauma Research Centre, and the Santa Monica Sports Medicine Research Foundation[2] and is comprised of three parts that include aerobic, strength, agility, and plyometric exercises.[3] Since its inception, the injury preventative effects of the FIFA11+ have been examined extensively in different football populations. Studies involving adolescent and young adults consistently reported a reduction in lower extremity injuries with regular program use,[4, 5] with a recent systematic review reporting an overall noncontact injury reduction of 30%.[5] Over the last decade, researchers have also been studying the short- and long-term effects the FIFA11+ on various physical performance metrics (PMs) in different populations.[2, 6] Studies looking at the short-term effects of the FIFA11+ have done so by measuring one or more PMs before the warm-up and again within seconds[7] to several minutes[6, 7] after the warm-up concluded. The long-term effects of the FIFA11+ have been assessed by changes in PMs after performing 3-6 sessions per week for several weeks[2] to several months.[8] By understanding of the short- and long-term performance effects of the FIFA11+, the underlying protective mechanism responsible for its injury prevention effectiveness may be better understood.[9] In addition, the combination of injury prevention and physical performance improvement could be used to encourage program 'buy-in' from coaches and athletes and improve adherence to the program.[8, 10]

A previous systematic review examined the impact of the FIFA11+ on PMs.[11] It reported significant improvements in dynamic balance and agility, as well as non-significant improvements in jump height and sprint times in FIFA11+ groups compared to control groups.[11] However, it excluded non-randomized controlled trials, studies with interventions of less than four weeks, and some key PMs (e.g. strength). The present review addresses these limitations and takes a more comprehensive examination of the influence of the FIFA11+ on PMs by including: 1) observational studies; 2) studies that explore immediate performance changes after athlete exposure to the FIFA11+; 3) additional PMs such as strength-related measures. Thus, the aim of this systematic review is to synthesize the evidence to determine if the FIFA11+ improves short- and long-term PMs (speed, agility, jump

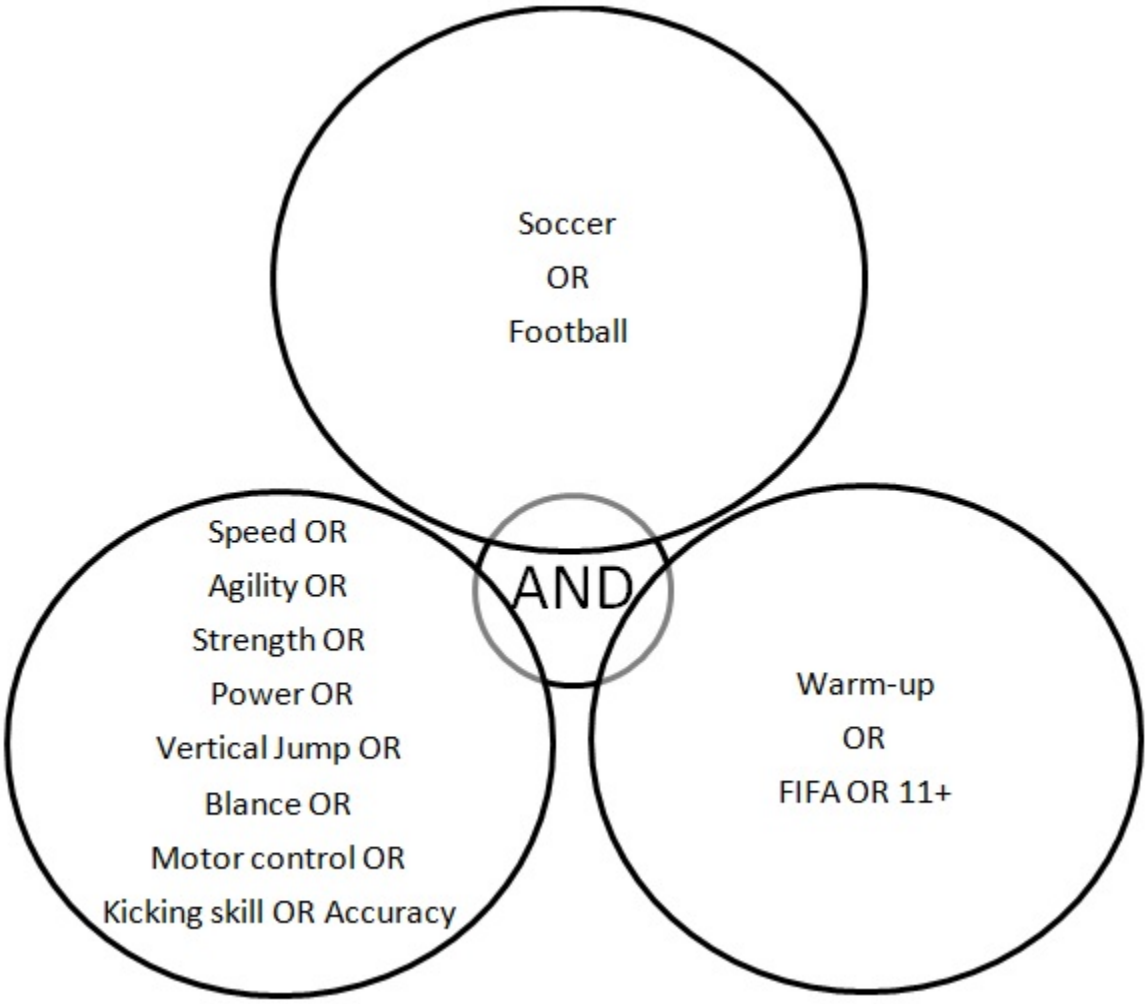
height, balance, motor control, strength, and kicking skill/accuracy) in competitive adolescent and young adult football players.

2. METHODS

2.1. Data sources and search strategy

Article collection was performed using the steps outlined by PRISMA.[12] Two reviewers (MW, GR) independently performed identical database searches (January 1, 2008 to September 1, 2018) from the following five electronic databases: Medline, CINAHL, EMBASE, Google Scholar, and SPORTDiscus. Keywords, subject headings and Boolean operators were used in the search strategy. The search focused on three main concepts: 1) the target sport; 2) PMs of interest; 3) the target warm-up **(Figure 1)**. A detailed search history of the five databases is provided in **Supplementary File 1**. Search limits were imposed when search results retrieved 800 or more articles. Databases were limited to studies involving human adolescents, young adults, or adults (10-44 years of age) that were written in English. PMs were defined as speed, agility, jump height, balance, motor control, strength, and kicking skill/accuracy. Only studies utilizing a testing method that could objectively measure one of the above PMs were included. Only peer-reviewed articles and dissertations were included. Study duplicates from each database search were removed.

Figure 1. Conceptual model of the implemented search strategy



2.2. Selection of studies

Abstracts were independently screened by two reviewers (MW and GR) for eligibility, followed by an independent full-text review for all articles that met inclusion criteria, or it was unclear based on abstract. The two reviewers compared their eligible studies and came to a consensus for inclusion. In the event of discrepancy between the two reviewers, a third reviewer (AE) was available to make a final decision for inclusion. For inclusion, articles had to: 1) be a prospective, randomized controlled trial, quasi-experimental, or cohort study with or without controls; 2) use the FIFA11+ warm-up in its entirety (i.e. all 3 three parts of the warm-up); 3) study healthy adolescent (10-19 years of age) and young adult (19-40 years of age) competitive football players. Competitive football was defined as professional, national, amateur, varsity, club, and rep levels of play.

2.3. Data extraction and quality assessment

One reviewer (MW) extracted data from the studies including study design, subject demographics, program dosage and progression, PMs, statistical analysis, and mean percent change (MPC) with confidence intervals (CI) or *p*-values when available. MPC and 95% CI were calculated by the authors if this information was not provided in the article, but the data was available to do so.

The Modified Downs and Black (D&B) checklist was used to assess the methodological quality of the included studies.[13] Two reviewers (MW and GR) independently applied the D&B criteria to each article for a score ranging from 0 to 28 points. The reviewers compared their scores for individual studies and disagreements were resolved by a third reviewer (AE) if necessary.

2.4. Data synthesis

A priori, meta-analyses were to be conducted for all PMs. However, given the heterogeneous nature of studies, the authors concluded that a meta-analysis was not appropriate and that the PMs would be qualitatively synthesized and presented via tables. MPC was used to compare the results across the studies a priori, as it can be calculated by the authors if pre- and post-test PM values are provided.

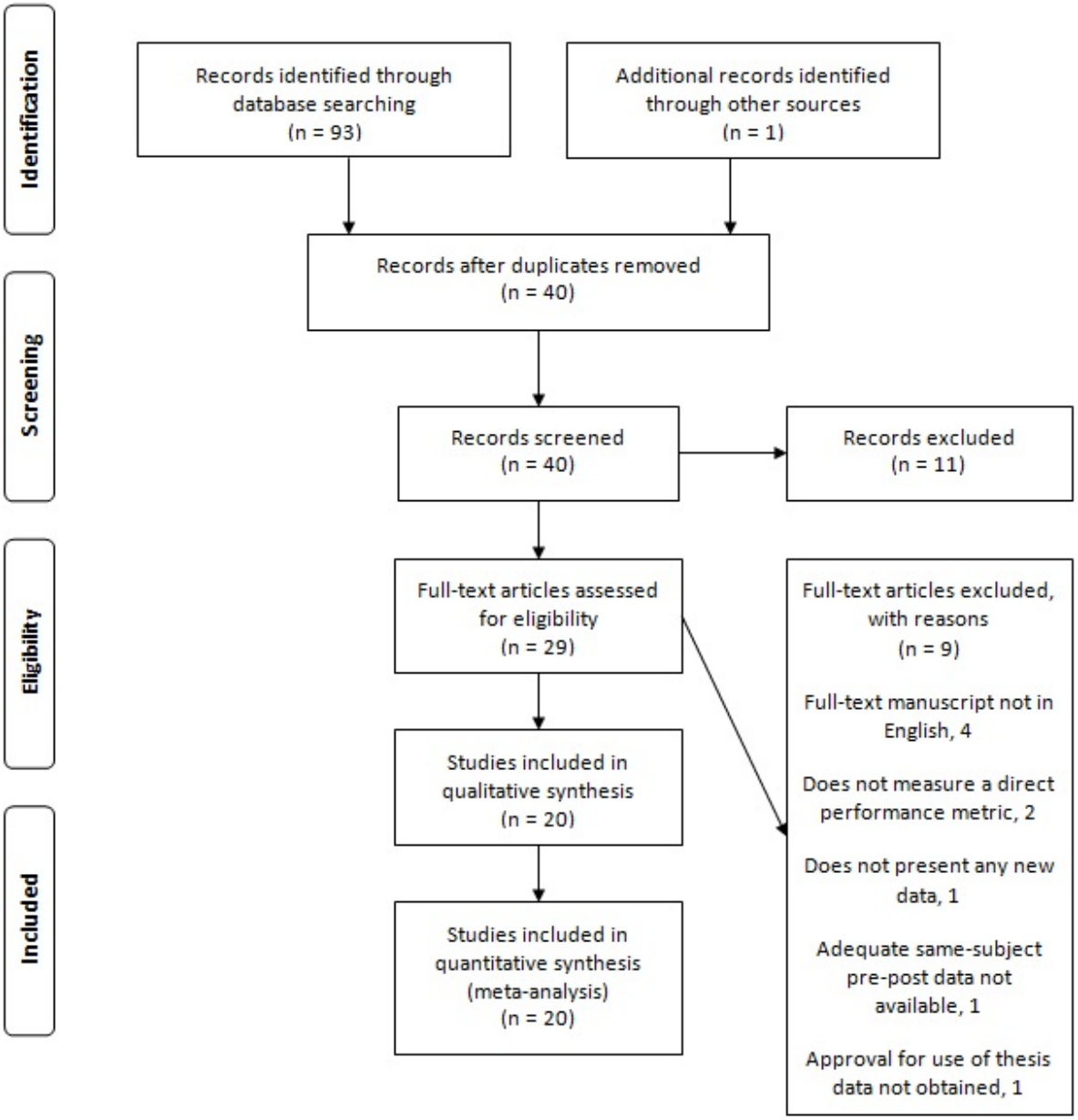
3. RESULTS

3.1. Literature search

Ninety-three articles were retrieved in the initial literature search of which 54 were duplicates. An additional article was retrieved through a reference list check. Of the forty titles and abstracts screened 11 articles were removed for not meeting inclusion criteria. A total of 29 full-text articles and dissertations were reviewed. An additional 8 articles were removed for not meeting inclusion. The author of one dissertation that met inclusion criteria did not provide approval for use of their data, leaving 20 articles included in this review. The article selection process is illustrated in a PRISMA flow diagram in **Figure 2**.

Study designs were randomized controlled trials (n=7) and within-group pre-post designed trials (n=13). Nineteen articles studied male populations and 1 article studied female populations. Professional and amateur player

Figure 2. Article Selection Process using PRISMA Flow Diagram



cohorts were used in 7 and 5 articles, respectively. The remaining 9 articles used a mix of skill level cohorts ranging from high school to collegiate levels of play. Speed (n=9), agility (n=7), vertical jump (n=10), balance (n=8), kicking skill and accuracy (n=3), quadriceps concentric strength (n=4), hamstrings concentric strength (n=4), and

other strength measures (n=9) were addressed. The median value for the D&B scores of all the included studies was 21 with a range from 13-26. Additional characteristics of all included studies are summarized in **Table 1**.

Of the 20 included studies, 11 studies and one unpublished theses by Rolstad-Martinez (2017) contained MPC values.[2, 6, 14-22] Seven studies did not provide MPC values, but included the data for them to be calculated. Another study provided pre and post-test data for some PMs, but not all.[3] For consistency, the authors calculated the MPC values for the PMs from all the included studies when pre and post test data was available. The formula [(posttest score - pre-test score)/posttest score x 100] was used to do so. Both MPC values as determined by each study and as determined by the authors of this manuscript are provided in **Table 2** through **Table 9**.

Table 1: Characteristics of Included Studies (n=21)

Author, year (country)	Design	Age: mean (SD)	Sex, n	Level	Intervention frequency, duration and difficulty level progression	Outcome	Down's & Black score
Akbari et al, 2018 (Iran)[24]	Pre-post RCT	16.79 (1.18)	M, 12	Elite U19	3x/week for 8 weeks Undisclosed difficulty	SGJ	16
Zarei et al, 2018 (Iran)[23]	Pre-post clustered RCT	15.6 (0.5)	M, 34	U16 premier	2-3x/week for 30 weeks Undisclosed difficulty	9.1m, 36.6m sprint, Illinois agility test, BCMJ, SGJ	21
Ayala et al, 2017 (Spain)[15]	Pre-post RCT, double baseline	16.8 (0.7)	M, 10	Amateur	3x/week for 4 weeks Level 2	Illinois agility test, DJ, YBT 10m, 20m sprint	25
Harøy, 2017 (Norway)[22]	Pre-post RCT	16.9 (1.0)	M, 16	Regional Elite U19	3x/week for 8 weeks Undisclosed difficulty	HEcc corrected for bodyweight, AddEcc, 10m, 20m sprint	25
Dunsky et al, 2017 (Israel)[26]	Within-group pre-post design	12.91 (0.26)	M, 10	Amateur	3x/week for 6 weeks Bi-weekly difficulty increase	BESS, YBT Target accuracy test	13
Ghareeb et al, 2017 (USA)[3]	Within-group pre-post design	16.52 (1.08)	M,17	Varsity high school	3x/week for 3 weeks Subject-matched difficulty	QConPT 60, 180, 300°•s-1 HConPT 60, 180, 300°•s-1 Biodex balance system Stability test protocol	15
Rolstad-Martinez, 2017 (Norway) [UT]	Pre-post RCT	16.9 (0.9)	M, 14	Regional elite	3x/week for 8 weeks Undisclosed difficulty	10m, 20m sprint	22
Robles-Palazón et al, 2016 (Spain)[10]	Pre-post RCT	16.4 (1.3)	M, 10	Amateur	3x/week for 4 weeks Level 2	DJ, YBT, 10m, 20m sprint	19
Sharma and Sayyad, 2016 (India)[14]	Within-group pre-post design	18-25 (NA)	M, 15	Professional	6x/week for 9 weeks Subject-matched difficulty	Illinois agility test, SJ, 20m sprint Wall-volley test	16
Silva et al, 2015 (Brazil)[16]	Within-group pre-post design	18.3 (1.6)	M, 9	Professional	3x/week for 9 weeks Level increase every 3 weeks	SJ CMJ	19
Cloak et al, 2014 (UK)[7]	Within-group pre-post design	20 (1.2)	M, 24	Collegiate	Single session Undisclosed difficulty	RSI, 505 agility test, DJ	16
Bizzini et al, 2013 (Italy)[6]	Within-group pre-post design, double baseline	25.5 (5.1)	M, 20	Amateur	Single session Level 3	MVC, RFD, Agility T-test, SJ CMJ, SEBT, 20m sprint	14
Daneshjoo et al, 2013 (Malaysia)[20]	Within-group pre-post design	18.9 (1.4)	M, 12	Professional	3x/week for 8 weeks Subject-matched difficulty	QConPT 60, 180, 300°•s-1 HConPT 60, 180, 300°•s-1 QEccPT 120°•s-1 HEccPT 120°•s-1	21
Daneshjoo et al,	Within-group	18.9	M, 12	Professional	3x/week for 8 weeks	QIsoNetPT30°, 60°, 90°	21

2013 (Malaysia)[18]	pre-post design	(1.4)			Subject-matched difficulty	HIsoNetPT30°, 60°, 90°	
Daneshjoo et al, 2013 (Malaysia)[19]	Within-group pre-post design	17-20 (NA)	M, 12	Professional	3x/week for 8 weeks Subject-matched difficulty	Illinois agility test, SJ, 10m cone sprint w ball, 10m cone sprint w/o ball, 20m sprint, Wall-volley test	23
Impellizzeri et al, 2013 (Italy)[2]	Pre-post RCT	23.7 (3.7)	M, 42	Amateur	3x/week for 9 weeks Level increase every 3 weeks	QConPT 60, 180°•s-1 HConPT 60, 180°•s-1 QEccPT 60°•s-1 HEccPT 60°•s-1 Agility T-test, CMJ, SEBT, 20m sprint	23
Steffen et al, 2013 (Canada)[8]	Within-group pre-post design	13-18 (NA)	F, reg 68 comp 78	U16/U18	Reg 1.5x/week for 4.5 months Comp 2.2x/ week for 4.5 months Undisclosed difficulty	SEBT, SL-EC-AP	26
Daneshjoo et al, 2012 (Malaysia)[21]	Within-group pre-post design	17-20 (NA)	M, 12	Professional	3x/week for 8 weeks Undisclosed difficulty	HCon/QCon 60, 180, 300°•s-1 QNetPT 300º•s-1/QNetPT 60º•s-1 HNetPT 300º•s-1/HNetPT 60º•s-1 HEcc120°•s-1/QCon120°•s-1	22
Daneshjoo et al, 2012 (Malaysia)[25]	Within-group pre-post design	17-20 (NA)	M, 12	Professional	3x/week for 8 weeks Subject-matched difficulty	SEBT, ST-EO, ST-EC	22
Brito et al, 2010 (Portugal)[17]	Within-group pre-post design	22.3 (4.2)	M, 18	Sub-elite	3x/week for 10 weeks Undisclosed difficulty	QConPT 60, 180°•s-1 HConPT 60, 180°•s-1 QEccPT 30°•s-1 HEccPT 30°•s-1 HCon/QCon 60, 180°•s-1 HEcc/QEcc 30°•s-1 HEcc 30°•s-1/Q Con 30°•s-1	17

UT = Unpublished thesis; QConPT = quadriceps concentric peak torque; HConPT = hamstring concentric peak torque; QEccPT = quadriceps eccentric peak torque; HEccPT = hamstring eccentric peak torque; HCon:QCon = conventional strength ratio; HEcc:QCon = dynamic control ratio; F/S = fast/slow; HIsoNetPT = hamstring isometric net peak torque; QIsoNetPT = quadriceps isometric net peak torque; AddEcc = adductor eccentric strength; RSI = reactive strength index; MVC = maximal voluntary contraction; RFD = rate of force of development; DJ = drop jump; CMJ = countermovement jump; SJ = squat jump; SGJ = Sargent jump; BCMJ = Bosco Counter Movement Jump;YBT = Y-balance test; BESS = balance error scoring system; ST-EO = stork test eyes open; ST-EC = stork test eyes closed; SEBT = star excursion balance test; SL-EC-AP = single leg eyes closed on Airex pad; reg. = regular group; comp. = comprehensive group

3.2. Strength

Ten articles measured strength changes in relation to the FIFA11+ program and are presented in **Table 2**, **Table 3**, and **Table 4**.[2, 3, 6, 7, 17, 18, 20-23] A variety of measures were used including peak torque through isokinetic[2, 3, 17, 21] and isometric strength testing,[6, 18] dynamic control ratio (DCR),[17, 21] reactive strength index (RSI),[7] and anaerobic power via the Bosco Counter Movement Jump 15s (BCMJ),[23] hamstring/quadriceps (H:Q) strength ratio,[17, 21] eccentric adductor strength and eccentric hamstring strength corrected for body weight.[22] Two studies looked at the immediate effects of one FIFA11+ session on strength performance[6, 7] while the others measured strength changes after performing the FIFA11+ for 3 to 30 weeks.[3, 6, 17, 18, 20-23]

The FIFA11+ was consistently associated with a statistically significant improvement in hamstring peak torque at various isokinetic speeds, particularly concentric peak torque in all 4 studies in which it was measured, with MPC improvement ranging from 6.2% to 32.7%.[2, 3, 17, 21] Mixed results were reported across four studies regarding concentric and eccentric quadriceps peak torque production at various isokinetic speeds after several weeks of the FIFA11+.[2, 3, 17, 21] Peak torque production through isometric muscle testing, eccentric hamstring strength corrected for bodyweight, and eccentric adductor strength were studied in one article each. A statistically significant increase in peak torque production through isometric muscle testing[18] and eccentric hamstring strength corrected for bodyweight have been reported, while no change in eccentric adductor strength was been observed following implementation of the FIFA11+.[22] Several studies found improvements in (H:Q) strength ratio with and without statistical significance, with larger improvements seen in the non-dominant leg at slower isokinetic speeds.[17, 21] Statistically significant decreases in the DCR of the dominant and non-dominant leg following the FIFA11+ were reported in one study[21] while another study reported a statistically significant improvement in non-dominant leg only.[17] A single study examined each of anaerobic power measured through the BCMJ, force production through isometric testing and RSI scores following FIFA11+ with a positive statistically significant finding for the former and non-significant negative effect for the latter two.[6, 7, 23]

Of the 20 studies, 6 examined hamstring strength and all found the FIFA11+ led to statistically significant improvement. Five of the 20 studies examined quadriceps strength and 4 found the FIFA11+ led to statistically significant improvement in a minimum of one strength measurement. Fewer measurements within each respective study were statistically significant for quadriceps strength relative to hamstrings strength. No studies found significant improvement in short-term strength-related PMs following the FIFA11+.[6, 7]

Table 2: Quadriceps Concentric Strength (n=4)

Author, year	**Degrees/Leg**	**% Mean change (95%CI where available)**	**% Mean change as calculated through data provided in original manuscript**	**Statistically Significant Improvement**
Brito et al, 2010	60°•s-1;D 60°•s-1;ND 180°•s-1; D 180°•s-1; ND	6.9(0.6, 13.1) 1.2(-4.5, 7.0) 8.3(0.8, 15.8) 3.2(-3.5, 9.9)	4.6 1.7 6.5 3.5	Y•[1] N[1] Y•[1] N[1]
Daneshjoo et al, 2013	60°•s-1; D 60°•s-1; ND 180°•s-1;D 180°•s-1; ND 300°•s-1;D 300°•s-1;ND	22.6(-5.2, 50.4) 6(-17.9, 29.9) 20.6(-4.1, 45.3) 17.3(-4.9, 39.6) 27.7(3.6, 51.8) 22(-2.2, 46.2)	10.4 2.6 14.2 11.9 28.6 21.8	N[2] N[2] N[2] N[2] Y•[2] N[2]
Ghareeb et al, 2017	60°•s-1;D 60°•s-1;ND 180°•s-1 300°•s-1	Not Reported Not Reported Not Reported Not Reported	-1.5 -3.0 Not Enough Data Not Enough Data	N[1] N[1] Y•••[1] Y••[1]
Impellizzeri et al, 2013	60°•s-1 180°•s-1	3.7(1.8, 6.0*) 6.2(3.6, 8.4*)	3.4 6.5	N[3] N[3]

* = 90%CI; • = p≤0.05; •• = p≤0.01; ••• = p≤0.001; •••• = p≤0.0001; [1] = determined by t-test; [2] = determined by ANOVA; [3] = determined by linear mixed-effects model.

Note: Positive values for % mean change denotes favorable improvements in quadriceps concentric strength

Table 3: Hamstrings Concentric Strength (n=4)

Author, year	**Degrees/Leg**	**% Mean change (95%CI where available)**	**% Mean change as calculated through data provided in original manuscript**	**Statistically Significant Improvement**
Brito et al, 2010	60°•s-1;D 60°•s-1;ND 180°•s-1; D 180°•s-1; ND	20.4(1.5, 39.3) 14.6(3.8, 25.3) 6.5(-3.3, 16.2) 15(0.8, 29.2)	14.0 9.8 4.9 9.0	Y•[1] Y•[1] N[1] Y•[1]
Daneshjoo et al, 2013	60°•s-1; D 60°•s-1; ND 180°•s-1;D 180°•s-1; ND 300°•s-1;D 300°•s-1;ND	22(9.5, 34.5) 22.3(10.5, 34.1) 21.4(4.4, 38.5) 15.7(6.2, 25.2) 22.1(5, 39.2) 15.2(-3.3, 33.8)	19.5 20.3 27.5 19.5 32.7 20.4	Y•[2] Y•[2] Y•[2] Y•[2] Y•[2] N[2]
Ghareeb et al, 2017	60°•s-1;D 60°•s-1;ND 180°•s-1 300°•s-1	Not Reported Not Reported Not Reported Not Reported	9.8 7.8 Not Enough Data Not Enough Data	Y•[1] Y•[1] Y•••[1] Y••[1]
Impellizzeri et al, 2013	60°•s-1 180°•s-1	5.9(3.7, 8.0*) 7.1(4.7, 11.1*)	6.2 7.3	Y[3] Y•[3]

* = 90%CI; • = p≤0.05; •• = p≤0.01; ••• = p≤0.001; •••• = p≤0.0001; [1] = determined by t-test; [2] = determined by ANOVA; [3] = determined by linear mixed-effects model

Note: Positive values for % mean change denotes favorable improvements in hamstrings concentric strength

Table 4: Other Strength (n=9)

Author, year	Degrees/Leg	% Mean change (95%CI where available)	% Mean change as calculated through data provided in original manuscript	Statistically Significant Improvement
Brito et al, 2010	QEcc PT 30°•s-1;D	6.4(-7.2, 20.1)	2.2	N[1]
	QEcc PT 30°•s-1;ND	7.7(-3.6, 18.9)	5.4	N[1]
	HEcc PT 30°•s-1;D	-3.3(-12.6, 6)	-3.6	N[1]
	HEcc.PT 30°•s-1;ND	14.3(3.7, 24.7)	13.3	Y•[1]
	H/Q Con 60°•s-1;D	10.8(-5.4, 27)	5.8	N[1]
	H/Q Con 60°•s-1;ND	14.8(1.7, 27.9)	9.8	Y•[1]
	H/Q Con 180°•s-1;D	-0.9(-10.6, 8.8)	-3.2	N[1]
	H/Q Con 180°•s-1;ND	-0.9(-10.6, 8.7)	10.5	N[1]
	H/Q Ecc 30°•s-1;D	-5.9(-16.5, 4.7)	-5.5	N[1]
	H/Q Ecc 30°•s-1;ND	7.9(-0.8, 16.6)	9.8	N[1]
	HEcc 30°•s-1/QCon 30°•s-1;D	-8.4(-18.7, 1.9)	-11.8	N[1]
	HEcc 30°•s-1/QCon 30°•s-1;ND	13.8(1.5, 26)	11.1	Y•[1]
Daneshjoo et al, 2012	H/Q Con 60°•s-1;D	0.04(-0.1, 0.2)	7.6	N[1]
	H/Q Con 60°•s-1;ND	-0.08(-0.13, 0.02)	14	Y••[1]
	H/Q Con 180°•s-1;D	0.7(-0.001, 0.13)	13	N[1]
	H/Q Con 180°•s-1;ND	-0.04(-0.1, 0.02)	7.1	N[1]
	H/Q Con 300°•s-1;D	0.005(-0.13, 0.14)	1.4	N[1]
	H/Q Con 300°•s-1;ND	0.01(-0.12, 0.14)	-1.3	N[1]
	QNetPT 300º•s-1/QNetPT 60º•s-1;D	-1.08(-0.16,0.004)	17.8	N[1]
	QNetPT 300º•s-1/QNetPT 60º•s-1;ND	-0.08(-0.16,-0.01)	20	Y•[1]
	HNetPT 300º•s-1/HNetPT 60º•s-1;D	-0.07(-0.18, 0.3)	11.7	N[1]
	HNetPT 300º•s-1/HNetPT 60º•s-1;ND	-0.01(-0.17,0.15)	-1.5	N[1]
	HEcc 120°•s-1/QCon 120°•s-1;D	-0.4(0.1, 0.7)	-45.4	Y•[1]
	HEcc 120°•s-1/QCon 120°•s-1;ND	-0.3(0.1, 0.5)	-41.5	Y••[1]
Daneshjoo et al, 2013	HEccPT 120°•s-1; D	-7.5(-16.7, 1.7)	4.7	N[2]
	HEccPT 120°•s-1; ND	-10.1(-23.9, 3.9)	-6.3	N[2]
	QEccPT 120°•s-1; D	7.2(-8.0, 22.3)	4.7	N[2]
	QEccPT 120°•s-1; ND	13.1(2.3, 24.0)	9	N[2]
Daneshjoo et al, 2013	QIsoPT30°; D	0.4(-12.5, 13.3)	0.5	N[2]
	QIsoPT30°; ND	16.0(1.8, 30.3)	19.3	Y•[2]
	QIsoPT60°; D	19.1(1.7, 36.4)	10.6	Y•[2]
	QIsoPT60°; ND	35.3(13.9, 56.7)	20.8	Y•[2]
	QIsoPT90°; D	47.8(21.3, 74.3)	17.8	Y•[2]

	QIsoPT90°; ND HIsoPT30°; D HIsoPT30°; ND HIsoPT60°; D HIsoPT60°; ND HIsoPT90°; D HIsoPT90°; ND	78.1(44.4, 111.9) 24.8(7.1, 42.6) 28.7(13.0, 44.3) 19.8(7.4, 32.3) 13.7(4.9, 22.4) 10.2(-0.7, 21.1) 4.5(-2.4, 11.5)	31.5 17.5 23.7 17.4 13.5 11.3 5.4	Y•[2] Y•[2] Y•[2] Y•[2] Y•[2] N[2] N[2]
Impellizzeri et al, 2013	H EccPT 60°•s-1 Q EccPT 60°•s-1	5.9(3.7, 7.6*) 2.4(0.2, 4.0*)	6.0 2.3	Y•[3] N[3]
Bizzini et al, 2013+	RFD MVC	-10(-26, 6) -1.3(-4.7, 2.8)	-7.5 -0.8	N[1] N[1]
Cloak et al, 2014+	RSI	0	0	N[2]
Harøy et al, 2017	HEcc corrected for bodyweight; D HEcc corrected for bodyweight; ND AddEcc; D AddEcc; ND	7.5 7.9 0 -1.8	7.5 7.9 0 -1.9	Y•[1] Y••[1]
Zarei et al, 2018	Bosco Counter Movement Jump (N) Bosco Counter Movement Jump (W/kg)	Not Reported* Not Reported*	0.9 13.1	N[3] Y•••[3]

QEccPT = quadriceps eccentric peak torque; HEccPT = hamstring eccentric peak torque; H/QCon = conventional strength ratio; HEcc/QCon = dynamic control ratio; HIsoPT = hamstring isometric net peak torque; QIsoPT = quadriceps isometric net peak torque; AddEcc = adductor eccentric strength; RSI = reactive strength index; MVC = maximal voluntary contraction; RFD = rate of force of development; * = 90%CI; + = single session; NED = Not Enough Data; • = p≤0.05; •• = p≤0.01; ••• = p≤0.001; •••• = p≤0.0001; [1] = determined by t-test; [2] = determined by ANOVA; [3] = determined by linear mixed-effects model; # = reported as significant but p-value was greater than 0.05

Note: Positive values for % mean change denotes favorable improvements across all strength measures provided.

3.3. Agility

Seven articles examined changes in agility following exposure to the FIFA11+ and are presented in **Table 5.**[2, 6, 7, 14, 15, 19, 23] Four articles used the Illinois Agility test,[14, 15, 19, 23] two used the Agility T-test,[2, 6] and one used the 505 Agility test.[7] Two articles focused on immediate changes in agility performance following a single FIFA11+ session[6, 7] with one reporting favorable and significant changes[6] while the other reported no benefit.[7] Five articles focused on agility changes following 4 to 30 weeks of the FIFA11+.[2, 14, 15, 19, 23] Four articles reported favorable and significant improvements in MPC ranging from -1.7% to -19.7%[14, 19, 23] while two reported a favorable but statistically non-significant trend in agility performance.[2, 15]

Table 5: Agility (n=7)

Author, year	Test	% Mean change (95%CI where available)	% Mean change as calculated through data provided in original manuscript	Statistically Significant Improvement
Ayala et al, 2017	Illinois Agility	-2.4	-2.4	N[1]
Bizzini et al, 2013+	Agility T-test	-1(-1.5,-0.5)	-2	Y•••[1]
Cloak et al, 2014+	505 Agility	Not Reported	3.6	N[2]
Daneshjoo et al, 2013	Illinois Agility	-1.7(-2.6, -0.8)	-11.1	Y••[2]
Impellizzeri et al, 2013	Agility T-test	-3.1(-4.2, -1.9*)	-2.8	N[3]
Sharma and Sayyad, 2016	Illinois Agility	-19.7	-19.7	Y•••[1]
Zarei et al, 2018	Illinois Agility	Not Reported*	-4.2	Y••[3]

* = 90%CI; + = single session; • = p≤0.05; •• = p≤0.01; ••• = p≤0.001; •••• = p≤0.0001; [1] = determined by t-test; [2] = determined by ANOVA; [3] = determined by linear mixed-effects model

Note: Negative values for % mean change denotes favorable decreases in agility test time

3.4. Vertical jump height

Ten studies examined change in vertical jump height following exposure to the FIFA11+ and are presented in **Table 6**.[2, 6, 7, 10, 14-16, 19, 23, 24] Vertical jump height was assessed using drop vertical jump (DVJ).[7, 10, 15] squat jump (SJ),[6, 14, 16, 19] counter movement jump (CMJ),[2, 6, 16] and Sargent jump tests.[23, 24] Two studies focused on immediate changes in vertical jump height following a single FIFA11+ session with one reporting favorable and significant improvement in jump performance,[6] although recalculation suggests one of the two tests used resulted in a decreased jump performance. The other study on immediate jump height changes reported a negative and non-significant performance trend.[7] Eight articles measured jump performance after their subjects completed between 4 and 30 weeks of the FIFA11+ program.[2, 10, 14-16, 19, 23, 24] Six studies reported favorable and significant improvement in jump performance with some studies reporting an MPC from 3.7% to 12.9%,[14-16, 19, 23, 24] one study had a negative value indicating a decrease in jump height performance,[15] and two studies reported no change in jump height.[2, 10]

Table 6: Vertical Jump (n=10)

Author, year	Test	% Mean change (95%CI where available)	% Mean change as calculated through data provided in original manuscript	Statistically Significant Improvement
Akbari et al, 2018	Sargent Jump	Not reported	12.5	Y•••[2]
Ayala et al, 2017	Drop Jump	-0.4	-0.4	Y •[1]
Bizzini et al, 2013+	Counter Movement Jump Squat Jump	5.5(3.2, 7.8) 6.2(3.6, 8.7)	-5.2 6.6	Y•••[1] Y•••[1]
Cloak et al, 2014+	Drop Jump	Not reported	-0.8	N[2]
Da Costa Silva et al, 2015	Squat Jump Counter Movement Jump	12.92 11.39	12.9 11.3	Y•[2] Y•[2]
Daneshjoo et al, 2013	Squat Jump	3.7(1.2, 6.3)	7.9	Y••[2]
Impellizzeri et al, 2013	Counter Movement Jump	1.4(-0.2, 2.6*)	1.5	N[3]
Robles-Palazón et al, 2016	Drop Jump	Not Reported	-1.1	N[2]
Sharma and Sayyad, 2016	Squat Jump	9.06	8.9	Y•••[1]
Zarei et al, 2018	Sargent Jump	Not Reported*	9.5	Y•••[3]

* = 90%CI; + = single session; • = p≤0.05; •• = p≤0.01; ••• = p≤0.001; •••• = p≤0.0001; [1] = determined by t-test; [2] = determined by ANOVA; [3] = determined by linear mixed-effects model

Note: Positive values for % mean change denotes favorable improvements in jump height

3.5. Balance

Eight studies looked at measures of static and dynamic balance and are presented in **Table 7.**[2, 3, 6, 8, 10, 15, 25, 26] Dynamic balance was measured using the Y-Balance test[10, 15, 26] and the Star Excursion Balance Test (SEBT).[2, 6, 8, 25] Static balance was measured using the Biodex Balance System,[3] the Balance Error Scoring System,[26] single-leg eyes closed balance on Airex pad,[8] and the Stork test.[25] A single article looked at the immediate effects the FIFA11+ has on dynamic balance and reported a favorable and significant change.[6] Of the six studies measuring dynamic balance change between 4 and 18 weeks of the FIFA11+, four reported favorable and significant improvement in MPC ranging from 2.1% to 10.2%.[8, 15, 25, 26] Five studies measured static balance change after 3 to 18 weeks of the FIFA11+ and three reported favorable and significant improvement.[8, 25, 26] The significant improvements in static balance MPC ranged from 4.1% to 69.3%.[8, 25]

Table 7: Balance (n=8)

Author, year	Test	Leg	% Mean change (95%CI where available)	% Mean change as calculated through data provided in original manuscript	Statistically Significant Improvement
Ayala et al, 2017	YBT - Anterior	NA	-0.3	-0.3	Y•[1]
	YBT - Postmed	NA	2.1	2.1	Y•[1]
	YBT - Postlat	NA	0.3	0.3	N[1]
	YBT - Composite	NA	1	1	N[1]
Bizzini et al, 2013+	SEBT	NA	2.9(1.9, 3.9)	2.9	Y••••[1]
Daneshjoo et al, 2012	SB-EO	NA	10.9	25.8	Y•[2]
	SB-EC	NA	12.4	69.3	Y[2]
	SEBT	NA	6.7	6.9	Y••[2]
Dunsky et al, 2017	BESS	NA	Not Reported	4.8	N[2]
	YBT	R	Not Reported	5.1	N[2]
	YBT	L	Not Reported	6.1	Y•[2]
Ghareeb et al, 2017	Biodex Overall Stability Index	D	Not Reported	-13.1	N[1]
	Biodex Overall Stability Index	ND	Not Reported	0	N[1]
	Biodex AP Index	D	Not Reported	-15.0	N[1]
		ND	Not Reported	-15.4	N[1]
	Biodex AP Index	D	Not Reported	-13.8	N[1]
		ND	Not Reported	6.8	N[1]
	Biodex ML Index				
	Biodex ML Index				
Impellizzeri et al, 2013	SEBT	NA	1.9(0.8, 2.8*)	1.9	N[3]
Robles-Palazón et al, 2016	YBT - Anterior	NA	Not Reported	-0.4	N[2]
	YBT - Postmed	NA	Not Reported	1.4	N[2]
	YBT - Postlat	NA	Not Reported	-0.4	N[2]
	YBT - Composite	NA	Not Reported	0.2	N[2]
Steffen et al, 2013	SEBT - Ant (Reg)	L	Not Reported	7.5	Y•[4]
		L	Not Reported	9.2	Y•[4]
	SEBT - Ant (Comp)	L	Not Reported	2.6	Y•[4]
		L	Not Reported	7.5	Y•[4]
	SEBT - Postlat (Reg)	L	Not Reported	8.5	Y•[4]
		L	Not Reported	7.3	Y•[4]
	SEBT - Postlat (Comp)	R	Not Reported	6.5	Y•[4]
		R	Not Reported	10.2	Y•[4]
	SEBT - Postmed (Reg)	R	Not Reported	3.8	Y•[4]
		R	Not Reported	7.4	Y•[4]
	SEBT - Postmed (Comp)	R	Not Reported	10.1	Y•[4]
		R	Not Reported	7.2	Y•[4]
	SEBT - Ant (Reg)	L	Not Reported	-14.5	N[4]
		L	Not Reported	8.3	Y•[4]
	SEBT - Ant (Comp)	R	Not Reported	-7.6	N[4]
		R	Not Reported	4.1	Y•[4]
	SEBT - Postlat (Reg)				

	SEBT - Postlat (Comp) SEBT - Postmed (Reg) SEBT - Postmed (Comp) SL-EC-AP (Reg) SL-EC-AP (Comp) SL-EC-AP (Reg) SL-EC-AP (Comp)				

YBT = Y-balance test; BESS = balance error scoring system; ST-EO = stork test eyes open; ST-EC = stork test eyes closed; SEBT = star excursion balance test; SL-EC-AP = single leg eyes closed on Airex pad; reg. = regular group; comp. = comprehensive group; * = 90%CI; + = single session; • = p≤0.05; •• = p≤0.01; ••• = p≤0.001; •••• = p≤0.0001; [1] = determined by t-test; [2] = determined by ANOVA; [3] = determined by linear mixed-effects model; [4] = determined by linear three-way mixed regression model

Note: Positive values for % mean change denotes favorable improvements in balance performance, with exception of positive Biodex and BESS scores which denotes decreased balance performance.

3.6. Speed

Eight studies and one unpublished thesis by Rolstad-Martinez (2017) examined changes in speed following the implementation of the FIFA11+ program and are presented in **Table 8**.[2, 6, 10, 14, 15, 19, 22, 23] Rolstad-Martinez (2017) and seven other studies focused on speed-related changes following 4 to 30 weeks of the FIFA11+,[2, 10, 14, 15, 19, 22, 23] with five reporting statistically significant posttest improvements in MPC ranging from -1.8% to -24.2%.[2, 14, 15, 19, 23] Three studies, including the Rolstad-Martinez (2017) thesis, reported no change in posttest times.[10, 22] One study addressed short-term changes in speed following a single FIFA11+ session and reported favorable and significant improvement of -2.2% compared to pretest values.[6]

Table 8: Speed (n=9)

Author, year	Test	% Mean change (95%CI where available)	% Mean change as calculated through data provided in original manuscript	Statistically Significant Improvement
Ayala et al, 2017	10m 20m	5.2 -1.8	5.2 -1.8	Y•[1] Y•[1]
Bizzini et al, 2013+	20m	-2.2(-3.1,-1.3)	-2.1	Y•••[1]
Daneshjoo et al, 2013	10m with ball 10m 20m	-0.6(-1.2, 0.01) -0.3(-0.7, 0.007) -0.3(-0.64, 0.003)	-6.9 -5.4 -12.9	Y•[2] Y•[2] Y•[2]
Harøy et al, 2017	10m 20m	0.5 0.2	0.6 0	N[1] N[1]
Impellizzeri et al, 2013	20m	-2.8(-3.7,-2.0*)	-2.7	N•[3]
Robles- Palazón et al, 2016	10m 20m	Not Reported Not Reported	7.4 -0.9	N[2] N[2]
Rolstad-Martinez, 2017	10m 20m	0.6 0	0.6 0	N[1] N[1]
Sharma and Sayyad, 2016	20m	-24.2	-24.3	Y•••[1]
Zarei et al, 2018	9.1m 36.6m	Not Reported* Not Reported*	0 -1.8	N[3] Y•[3]

* = 90%CI; + = single session; • = p≤0.05; •• = p≤0.01; ••• = p≤0.001; •••• = p≤0.0001; [1] = determined by t-test; [2] = determined by ANOVA; [3] = determined by linear mixed-effects model

Note: Negative values for % mean change denotes favorable decreases in sprint time

3.7. Kicking skill/accuracy

Three studies looked at the FIFA11+ warm-ups impact on kicking skill and accuracy and are presented in **Table 9**. [14, 19, 26] Two studies used the wall-volley test[14, 19] while the other used a novel test using a limited number of kicks to contact targets with varying point values.[26] Improvement in kicking skill and accuracy was only found in one study.[19]

Online Resource 9: Kicking Skill and Accuracy (n=3)

Author, year	Test	% Mean change (95%CI where available)	% Mean change as calculated through data provided in original manuscript	Statistically Significant Improvement
Daneshjoo et al, 2013	Wall-Volley Test	5.4(3.0, 7.8)	17.4	Y•••[2]
Dunsky et al, 2017	Target Accuracy Test	Not Reported	13.8	N[2]
Sharma & Sayyad, 2016	Wall-Volley Test	-2.24	-2.3	N[1]

• = p≤0.05; •• = p≤0.01; ••• = p≤0.001; •••• = p≤0.0001; [1] = determined by t-test; [2] = determined by ANOVA

Note: Positive values for % mean change denotes favorable improvements in kicking skill and accuracy

3.8. Motor control

No studies were found that looked at the FIFA11+ warm-ups impact on motor control.

4. DISCUSSION

The main finding of this review is that there is consistent evidence for significant improvements in hamstring-related strength measures in the majority of studies (6 of 6 = 100%) that examined them.[2, 3, 17, 18, 20, 22] There is also some evidence for improvements in agility, jump, speed, static and dynamic balance measures after the long-term implementation of the FIFA11+. The evidence supporting improvements in the remainder of the PMs in both the short-term and long-term is limited, conflicting, or insufficient.

The FIFIA11+ consists of a series of exercises that may help to improve measures of strength such as squat and lunge variations, as well as the Nordic Hamstring Curl.[1] Favorable improvements in concentric hamstring torque were found at slow,[2, 3, 17, 20] medium,[2, 3, 17, 20] and high speeds[3, 20] suggesting both concentric slow-speed strength and explosiveness and power improve with the 11+.[3] Harøy et al. (2017) reports the Nordic Hamstring Curl is designed to primarily target eccentric hamstring strength and the findings of the current review support improvement in this metric, albeit less consistently than the improvements seen in concentric hamstrings strength.

The findings for concentric quadriceps peak torque production were mixed and less consistent than those found for the hamstrings. The 11+ appears to have little benefit on peak torque production at slower concentric speeds.[2, 3, 20] and greater influence on peak torque production at mid and high speeds.[3, 17, 20] It is possible that this

improvement may be related to the squat jump variations included in the warm-up. Improvements in quadriceps and hamstrings isokinetic strength are likely due to the 11+ since isokinetic strength has shown to remain consistent over the course of a football season.[27]

Results from isometric testing report favorable quadriceps and hamstring peak torque production in ranges that put the muscle in mid-range to their most lengthened positions.[18] The degree of improvement in both muscle groups was greater with joint angles that progressively lengthened both muscle groups suggesting that the 11+ has a greater effect on agonist muscle strength in elongated positions. Interestingly, quadriceps peak torque was lower at baseline for each knee angle tested on the non-dominant side and the posttest improvements in peak torque were markedly greater on the same side.[18] The 11+ may have a greater training effect on the weaker side, resulting in more symmetrical quadriceps torque production via isometric testing.

The (H:Q) strength ratio is derived by comparing the concentric peak net torque of the hamstrings to that of the concentric peak net torque of the quadriceps at a matched angular velocity.[21] The two studies measuring H:Q strength ratios reported favorable and significant change in the non-dominant leg at slower speed values, meaning greater post-test improvement in hamstring strength relative to quadriceps strength on the non-dominant side occurred with exposure to the 11+.[17, 21]

The Dynamic Control Ratio (DCR) is calculated by dividing the eccentric peak net torque of the hamstrings by the concentric peak net torque of the quadriceps.[21] Studies measuring DCR yielded conflicting results[17, 21] and are difficult to compare since DCR was measured using different quadriceps and hamstring angular velocity values. A decreased DCR implies the quadriceps isokinetic strength improved more than hamstring isokinetic strength. Although greater quadriceps isokinetic strength has a positive effect on ball kicking speed,[28] a decreased DCR is unlikely to benefit the players health since the hamstrings may not be able to protect against the sheering forces at the joint with forceful knee extension.[29]

Reactive strength index (RSI) and the Bosco Countermovement Jump (BCMJ) are similar in that they both measure explosive strength. RSI is calculated by dividing counter movement jump (CMJ) height that follows a drop jump (DJ) by the contact time on a force platform prior to CMJ take-off[30] while the BCMJ does so through a formula accounting for flight time, force of gravity and number of jumps over a 15 second interval.[23] RSI was measured in one study after subjects completed a single session of the 11+.[7] Posttest RSI values trended negatively

but did not reach statistical significance.[7] It is possible the warm-up induced player fatigue leading to the negative trend in RSI performance. Only one study measured anaerobic power through the BCMJ and it reported a significant improvement following 30 weeks of the 11+.[23] It is plausible that the squat and jumping components of the 11+ contributed to this increased performance.[23]

Three of six articles (50%) reported favorable and statistically significant change in agility following weeks of exposure to the 11+.[14, 19, 23] The final exercise in the 11+ is a high intensity exercise that involves a plant and cut maneuver to change directions quickly without inward buckling of the knee.[1] Of note, one group reporting a nearly 20% improvement in agility times engaged in more than double the 11+ exposures than that of the other groups[14] suggesting a dose-response relationship. A total of four different agility tests were used in the eight studies measuring pre- and posttest agility performance, which limits the generalizations that can be garnered from these results.

Less PM variability existed when examining changes in speed with adoption of the 11+, however some conflicting results were noted in studies that used similar populations and intervention setups.[10, 15] Likewise, in two studies with players of the same sex and skill level,[2, 15] the one study with over twice the 11+ exposures, found non-significant results.[2] Disparity in these findings may be due to differences in the performance capabilities of each athlete. The 11+ may be challenging enough to elicit a training response in some players while inadequate for others regardless of their age and skill level.

The 11+ includes jump squat, lateral jump and box jump exercises.[1] Six of eight (75%) articles measuring change in jump height after several weeks of the 11+ reported favorable, significant improvement.[14-16, 19, 23, 24] The tests used to measure vertical jump height varied across studies. Different jump tests place different physiological demands on the subject. For instance, DVJ and CMJ harness force production via eccentric and concentric load through the lower extremities. The rapid transition from eccentric to concentric load is known as the stretch-shortening cycle and provides elastic energy for use prior to propulsion off the ground.[16] SJ and the Sargent Jump lack countermovement prior to the jump and are therefore more dependent on concentric force production.[16, 23]

Both static and dynamic balance are trained through the use of the 11+ program. Static balance is trained through stationary single-leg exercises and dynamic balance is promoted through emphasizing the intent of sticking the landings from multi-directional movements while maintaining ankle, knee and hip alignment.[1] Four articles

testing static balance yielded mixed results with some studies showing favorable, significant improvement[8, 25] while others did not.[3, 26] Five studies looked at change in dynamic balance after several weeks of the FIFA11+[2, 8, 15, 25, 26] with four studies reporting favorable and substantial change in posttest scores.[8, 15, 25, 26] Population heterogeneity means it is challenging to establish any overarching trends with respect to balance improvements due to adopting the 11+. One study tested females[8] while the other five tested male populations.[2, 3, 15, 25, 26] Skill level ranged from competitive U16 players[8] to professional level players.[25] The single study examining changes in dynamic balance following one 11+ session reported a favorable, statistically significant change in dynamic balance suggesting the 11+ may result in an acute positive neuromuscular response.[6]

The evidence suggesting that the 11+ can improve kicking skill and accuracy is weak relative to other PMs, which is unsurprising given that the 11+ does not include a football-kicking element. However, one study reported a significant improvement in kicking skill and accuracy[19] and two studies reported non-significant change that trended towards improvement.[14, 26] Improvements in balance have been correlated to improvements in kicking accuracy,[31] which could explain this positive trend.

The 11+ manual advises that the warm-up be performed in its entirety a minimum of twice per week, and the running elements of the program be performed prior to every football match.[1] For the studies included in this review, the warm-up was predominantly performed 3 times per week. One study, which had an intervention frequency double that of most other studies, reported sizeable improvements across a number of PMs.[14] This preliminary finding suggests there may be a dose-response relationship for the association between 11+ and PM improvements.

The 11+ manual suggests 10 to 12 weeks are required for the program to have an injury prevention effect.[1] All but 3 studies discontinued the intervention before the 10 week mark,[8, 17, 23] yet many of these reported PM improvements. This trend suggests that improvements in PMs may precede favorable improvements in injury prevention.

Fifteen of the 20 articles (75%) involved adolescent football populations. The remaining 5 articles tested young adult players in the early to mid-20's.[2, 6, 7, 14, 17] No trend appears with respect to a particular age group responding more favorably to the 11+. However, one study postulated that the 11+ may not be rigorous enough to

elicit a training effect in adult populations.[25]As more studies are conducted using comparable intervention frequencies, durations, skill level progressions, age-related PM changes may emerge.

The majority of the studies in this review focus on PM changes in men following 11+ exposure. There are an estimated 40 million female football players worldwide[32] and to the authors knowledge, only one group have studied PM changes in females following the 11+.[8] PM response to the 11+ is largely unknown for female players across all ages and skill levels. More research is needed to examine female players to be able to delineate whether there are any sex-related differences with respect to the PM response to the 11+.

It has been suggested that professional football players may be most likely to see improvements in neuromuscular performance after implementing the FIFA11+.[10] Across most PMs, professional players consistently reported favorable and significant change.[14, 16, 18] However, it should be noted that 5 of the 20 articles included in this review were written by the same authors[18-21, 25] using the same subject pool for all five studies. Improvements in populations of inferior skill levels are less consistent.

Only one study compared and contrasted the performance effects of the 11+ on age-and skill-matched populations based on their adherence to the program, but preliminary research suggests that higher adherence yields more favorable results, at least in static and dynamic balance.[8] More research on 11+ adherence of age- and skill-matched players is warranted as it could provide insight on optimal program dosing from a performance perspective.

4.1. Limitations of included studies

Many articles lack a comparison group making it difficult to determine if PM changes are influenced by subject motivation, expectations, the passage of time or due to other aspects of training. The majority of the articles also have a small sample size with 9 to 15 players in their intervention groups. This makes generalizing the findings of each study difficult, particularly when combined with a broad array of outcome measures and variations in intervention frequency, duration and difficulty level progression. Several studies did not provide MPC values and two studies did not provide pre and post-test data which could subsequently be used to calculate the MPC of various PMs. Future studies should also address factors related to internal validity such as adequate blinding and randomization procedures.

5. LIMITATIONS

Several limitations are noted in the current review. The literature search excluded studies that were not written in English, and this resulted in the exclusion of four studies (**Figure 2**). These papers could possibly provide a greater understanding of the performance effects of the FIFA11+ program. Although the literature searches were performed by two independent reviewers, it is possible that some articles could have been missed through the screening process. The heterogeneous nature of the articles did not allow the authors to perform a meta-analysis. This limitation detracts from the authors ability to extrapolate findings from the included studies.

6. CONCLUSIONS

The most consistent improvements in PMs related to the FIFA11+ are with regards to hamstring strength-related measures. There is also some evidence for the FIFA11+ having a positive long-term effect on H:Q strength ratios, agility, speed, static and dynamic balance and vertical jump height. Improvements in these PMs may serve as an additional motivating factor for program promotion and may help improve coach and player buy-in and program adherence. The evidence for long-term improvement in the remainder of the PMs is limited, insufficient or conflicting and there is limited evidence on the short-term performance effects of the FIFA11+ in all PMs.

Caution should be had when making general inferences based on this systematic review. The FIFA11+ is first and foremost an injury reduction warm-up and more research is strongly warranted to improve our understanding of its short- and long-term effects on various PMs in different populations. Future research should also give consideration to how program dosage, player adherence, and athlete's baseline skill influence the FIFA11+ effect on PMs.

What is already known about this subject?
➢ The FIFA11+ has consistently shown to reduce the incidence of non-contact soccer injuries in various football populations. ➢ For over a decade, researchers have been studying the short- and long-term effects of the FIFA11+ on PMs. ➢ Improving our understanding of the effects of the FIFA11+ on PMs may aid in program promotion and may help with coach and player buy-in and adherence.

What are the new findings?
➢ The most consistent long-term PMs improved with the FIFA11+ are hamstring-related strength measures. ➢ There is some evidence supporting long-term FIFA11+ usage having a favorable effect on agility, static and dynamic balance and vertical jump height. ➢ Evidence for the FIFA11+ having a favorable effect on short-term improvement on PMs is limited, insufficient or conflicting.

Supplementary File 1. Databases Used with Search Strategy

Database	Search Words
MEDLINE	[(football OR soccer).ti,ab. OR Soccer/] AND [(warm-up OR FIFA OR 11+).ti.ab. OR Exercise/ OR warm-up exercise/] AND [(performance OR speed OR agility OR strength OR power OR vertical jump OR balance OR motor control OR kicking skill OR accuracy).ti.ab. OR Exp Athletic Performance/] Limits: English language AND humans AND 2008-current AND (adolescent (13 to 18 years) or young adult and adult (19 to 24 and 19 to 44))
EMBASE	**[(football OR soccer).ti,ab. OR Soccer/] AND [(warm-up OR FIFA OR 11+).ti.ab. OR Exercise/ OR warm-up exercise/] AND [(performance OR speed OR agility OR strength OR power OR vertical jump OR balance OR motor control OR kicking skill OR accuracy).ti.ab. OR Exp Athletic Performance/ OR Exp physical performance/] Limits: English language AND human AND 2008-current AND (adolescent <13 to 17 years> or adult <18 to 64 years>)
CINAHL	***[(Soccer OR Football) OR (MH "Soccer")] AND [(FIFA OR 11+ OR warm-up) OR (MH "Warm-Up Exercise)] AND [(Performance OR speed OR agility OR strength OR power OR vertical jump OR balance OR motor control OR kicking skill OR accuracy) OR (MH "Physical Performance") OR (MH "Physical Fitness+")] Limits: None
SPORTDiscus	(Football OR soccer) AND (FIFA OR 11+) AND (Warm-up) AND (Performance OR speed OR agility OR strength OR power OR vertical jump OR balance OR motor control OR kicking skill OR accuracy) Limits: None

Google Scholar	FIFA 11+ (under section "with all of the words") AND Performance, speed, agility, strength, power, vertical jump, endurance, balance, motor control, range of motion, ROM (under section "with at least one of the words") Limits: 2008-2017

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