

Comparing the acute and short-term effects of FIFA 11+ and total motion release warm-up programs on dynamic balance and physical performance on male football players

Mostafa Barati

Tehran University of Medical Sciences

Kazem Malmir

Tehran University of Medical Sciences

Khadijeh Otadi

k_otadi@sina.tums.ac.ir

Tehran University of Medical Sciences

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Abstract

Background Football demands intense physical and technical effort, so effective warm-up routines are vital for preparing athletes. This study compares the immediate and short-term effects of two different warm-up programs: FIFA 11+, which offers a structured neuromuscular and plyometric approach, and Total Motion Release (TMR), a therapeutic method aimed at correcting movement asymmetries.

Methods Forty-five male football players (15 per group) were randomly assigned to FIFA 11+ (17.60 ± 0.74 years), TMR (17.67 ± 0.90 years), or control (17.73 ± 0.80 years). Y-balance test, vertical jump, sprinting speed, agility, and knee valgus angle were measured before, immediately after, and two hours post-intervention. Statistical analysis was conducted using SPSS 24 and STATA 17 at a 0.05 significance level.

Results FIFA 11+ produced large, sustained reductions in knee valgus angle versus control (mean $\Delta \approx -4.0^\circ$ to -4.7° ; SMD = 1.01–1.05) and improved agility (SMD = -1.20 to -1.63), with acute sprint benefits ($\Delta = -0.31$ s, SMD = -0.96) that diminished by 2h. In Y-balance test posterolateral reach, FIFA showed greater immediate improvement than control ($\Delta = -9.04\%$, SMD = -1.1, $p < 0.001$), while TMR's effects were smaller but more retained at 2h ($\Delta = -7.50\%$, $p = 0.05$). Both interventions modestly improved anterior reach (SMD ≈ -0.63 , $p = 0.05$). TMR showed no superiority over FIFA in any outcome.

Conclusion Both FIFA 11+ and TMR improve balance and physical performance, but through different mechanisms. FIFA 11+ shows acute improvements in agility, jumping, and knee valgus control that persist for up to two hours, making it potentially suitable as a pre-match warm-up. TMR appears to provide more sustained balance support, which may help manage fatigue during prolonged activity. When applied together, these programs may offer complementary benefits for short-term performance preparation.

Level of evidence: 1b

Trial registration IRCT20240616062147N1, registered on 22/06/ 2024.

Introduction

Football, the world's most popular sport, involves 400 million players across 208 countries and generates an annual revenue of one trillion dollars (1). Characterized by frequent running, speed changes, directional shifts, and collisions (2), it demands exceptional physical capabilities and high-intensity performance (3). During matches, players typically perform 100–150 speed changes, covering 170–260 meters at speeds over 25.2 km/h, and 680–1050 meters at intensities exceeding 14 km/h (4). Athletic performance depends on factors such as anaerobic power, sprinting, agility, balance, aerobic capacity, and technical and tactical skills (2). Interestingly, 45% of goals result from linear speed, and 16% from vertical jumps (5).

To meet these demands, coaches emphasize structured warm-up programs that prepare athletes both physiologically and mechanically for performance. Although these routines represent only one part of broader strength and conditioning programs, active warm-up routines, such as low-intensity aerobic exercises, dynamic drills, and sport-specific tasks, aim to improve strength, speed, agility, and neuromuscular control (6, 7). These programs elevate heart rate and tissue temperature, enhance range of motion, and stimulate nerve conduction. Physiological benefits include improved oxygen delivery, accelerated oxidative reactions, and enhanced biomechanical performance (8, 9). Moreover, they influence the neuromuscular and fascial systems, improving movement patterns and lowering injury risk (10). Such warm-ups have been shown to improve anaerobic power, sprinting ability, balance, and agility (11, 12), while also addressing biomechanical risk factors, such as dynamic knee valgus, associated with non-contact anterior cruciate ligament (ACL) injuries and patellofemoral disorders (13, 14). Therefore, warm-up protocols are integral to injury prevention and performance enhancement in competitive sports (7, 15), working through neuromuscular activation and technical integration via strength and plyometric drills (16).

One widely studied program is the FIFA 11+, a 20–25-minute warm-up designed by FIFA for injury prevention. It incorporates running, strength, balance, and advanced agility exercises (17). Its foundation lies in improving neuromuscular coordination, joint control, and proprioceptive feedback, all of which are essential for influencing dynamic stability, jump performance, and directional changes, which are key skills in football. While some studies report improvements in speed, agility, jumping, and stability (18, 19), others have noted inconsistent or limited effects on balance and agility, especially when comparing immediate post-implementation with delayed effects (20).

Total Motion Release (TMR) is a more recent, patient-centered warm-up approach designed to improve both the quantity and quality of movement (21). Its mechanisms are thought to involve central and peripheral nervous system adaptations, particularly through nervous system stimulation driven by interactive movements (22). The TMR protocol focuses on global stability and balance through six bilateral movements targeting limbs and core. It is practical, requiring minimal space, no partner, and short durations, making it easily accessible (23). Evidence indicates that TMR may enhance range of motion, performance readiness, and injury prevention (21, 24). A recent study by Safapoor et al. (2025) reported that TMR also improves cognitive function, anaerobic capacity, and neuromuscular control in sprinters (25).

Although many TMR movements are static or seated, the protocol involves contralateral patterning and asymmetry correction, which are believed to stimulate motor planning, sensorimotor integration, and postural control. These mechanisms may have downstream effects on balance and neuromuscular efficiency even in dynamic tasks. Furthermore, some of the bilateral movements in TMR indirectly activate trunk and lower limb musculature through kinetic chain recruitment. Thus, it is hypothesized that TMR may influence physical performance outcomes traditionally associated with dynamic warm-ups (22, 23). Unlike conventional warm-ups, TMR aims to rebalance asymmetries and optimize

functional alignment via sensorimotor integration, potentially benefiting balance and coordination in ways distinct from FIFA 11+ (23).

Despite the recognized benefits of both programs, no studies to date have directly compared the acute and short-term effects of TMR and FIFA 11 + on physical performance indicators such as balance, sprint speed, vertical jump, and agility. Since competitive matches and training sessions—including warm-up, play, stoppages, and extra time—can extend up to two hours, it is important to understand how long the effects of a warm-up persist. Measuring performance up to 120 minutes helps determine whether improvements are short-lived or maintained throughout a typical football scenario. However, the duration of these effects beyond the immediate post-warm-up phase remains unclear. This study addresses this gap by evaluating the immediate and two-hour post-intervention outcomes of the FIFA 11 + and TMR programs, separately and in combination, in trained football players. To our knowledge, this is the first investigation to compare the acute and short-term effects of TMR versus FIFA 11 + on physical performance outcomes in athletes.

Method

Study design

This parallel, single-blind randomized clinical trial aimed to evaluate the immediate and two-hour effects of the FIFA 11 + and TMR warm-up programs, individually and combined, on physical performance in male football players. The study followed CONSORT guidelines, with a completed CONSORT checklist included as Supplementary material 1, received ethical approval from the Ethics Committee of Tehran University of Medical Sciences (IR.TUMS.FNM.REC.07/05/2024), and was registered in the Iranian Clinical Trials Registry (IRCT20240616062147N1).

Participants

Forty-five semi-professional male football players participated in this study. We estimated the required sample size using G*Power for repeated-measures ANOVA (within-between interaction), with $\alpha = 0.05$ and power = 0.95. Effect sizes were drawn from Aktaz et al. (2022) (19) for agility ($f = 0.283$) and Ayala et al. (2017) (26) for sprint and vertical jump performance ($f = 0.276$ and 0.40 , respectively). The corresponding required total sample sizes were 42 for agility, 12 for vertical jump, and 45 for sprint, with actual powers of 0.954, 0.971, and 0.959. To ensure sufficient power across all outcomes, we adopted the largest requirement and recruited 45 participants (15 per group). Participants, aged 17 to 23, with at least one year of football experience, no musculoskeletal injuries or pain in the lower limbs or back in the past six months, and no neurological conditions affecting performance or balance, were eligible. Exclusion criteria included unwillingness to continue participation, use of medications affecting balance, fatigue or engaged in intense sports activity. Participants provided informed consent and were blinded to group allocation, with only the examiner aware of assignments. Prior to participation, all individuals

provided written informed consent. The research adhered to the ethical principles outlined in the World Medical Association's Declaration of Helsinki for studies involving human participants.

Procedures

Eligible participants were informed about the study's objectives, interventions, and assessments before providing written informed consent. Randomization was conducted using sealed, opaque envelopes to allocate participants to one of three groups: FIFA 11+, TMR, or control. Allocation concealment was ensured by using a third person not involved in the study to prepare and distribute the envelopes. To minimize order effects, the sequence of assessments (Y-balance test, agility, vertical jump, 20m linear sprint, and valgus angle) was randomized for each participant prior to testing. This was achieved using a separate set of sealed envelopes labeled "A" through "E." All assessments were conducted in a single testing session, and the randomized order was applied consistently across all three time points (pre-intervention, immediately post-intervention, and two hours post-intervention). Testing and interventions were conducted at least 48 hours after the participants' last match to guarantee sufficient recovery. The study took place over a period of two months, from April to June 2024. All players were tested or vaccinated against COVID-19 virus, and their healthy condition was monitored by medical professional. All sessions were held consistently between 9 AM and 2 PM to control for diurnal variation and under standardized temperature conditions. Dependent variables were measured by the examiner before the interventions. Subsequently, participants underwent their assigned intervention, after which measurements were taken immediately and two hours post-intervention. During the two-hour interval between the second and third measurements, participants engaged in team-based group activities simulating a football match, achieving realistic conditions for the study while avoiding any undue fatigue (Fig. 1). There were no harms associated with assessments or interventions.

Interventions

a) Total motion release

The TMR protocol included six bilateral movements (Fig. 2) and lasted approximately 20 minutes. Participants performed each movement once and rated its difficulty on a scale from 0 (easiest) to 100 (hardest). The movements were then ordered from highest to lowest difficulty score, with participants completing two sets of 15 repetitions on the non-dominant side first, followed by the dominant side, with a 15-second rest between sets. The six movements were: *Standing Straight Arm Raise*, where participants raised one arm straight up as high as possible, alternating arms; *Standing Trunk Twist*, where participants crossed their arms over their chest and rotated their torso side to side; *Standing 1-Arm Wall Press*, involving raising one shoulder to 90 degrees, pressing against a wall, and moving the torso forward and backward, alternating arms; *Bent Knee Toe Reach*, a single-leg squat to 60 degrees with the opposite foot extended forward, alternating legs; *Sit to Stand*, transitioning from a seated position to

standing with arms crossed over the chest, alternating sides; and *Seated Straight Leg Raise*, raising one leg from a bent to fully extended position while seated, alternating legs.

b) FIFA 11+

The FIFA 11 + program consists of three parts, starting with running exercises, followed by six exercises to improve strength, balance, muscle control, and core stability, and concluding with advanced running exercises. The total duration is about 20 to 25 minutes (27).

The stages of the FIFA 11 + program are shown in Table 1 and Fig. 3.

Table 1 Components of the FIFA 11 + program

Part	Exercise	Level/Variation	Protocol
Part I: Running Exercise (8 min)	Running straight ahead	-	2 sets
	Running hip out	-	2 sets
	Running hip in	-	2 sets
	Running circling partner	-	2 sets
	Running shoulder contact	-	2 sets
	Running quick forwards and backwards	-	2 sets
Part II: Strength, Plyometrics, Balance (10 min)	The Bench	Level 1: Static	3 sets, each takes 20-30 sec
		Level 2: Alternate legs	3 sets, each takes 20-30 sec
		Level 3: One leg lift and hold	3 sets, each takes 20-30 sec
	Sideways Bench	Level 1: Static	3 sets, each takes 20-30 sec for each side
		Level 2: Raise and lower hip	3 sets, each takes 20-30 sec for each side
		Level 3: With leg lift	3 sets, each takes 20-30 sec for each side
	Hamstrings	Level 1: Beginner	3-5X, 1 set
		Level 2: Intermediate	7-10X, 1 set
		Level 3: Advanced	12-15X, 1 set
	Single-leg Stance	Level 1: Hold the ball	2 sets, each takes 30 sec
		Level 2: Throwing ball with partner	2 sets, each takes 30 sec
		Level 3: Test your partner	2 sets, each takes 30 sec
	Squats	Level 1: With toe raise	2 sets, each takes 30 sec

		Level 2: Walking lunges	2 sets, each takes 30 sec
		Level 3: One-leg squats	3 sets, each takes 20-30 sec for each side
	Jumping	Level 1: Vertical jumps	2 sets, each takes 30 sec
		Level 2: Lateral jumps	2 sets, each takes 30 sec
		Level 3: Box jumps	2 sets, each takes 30 sec
Part III: Running Exercises (2 min)	Running across the pitch	-	2 sets
	Running bounding	-	2 sets
	Running plant and cut	-	2 sets

c) Control group

The control group did not undergo any intervention. Assessments were conducted at three time points: baseline, 20 minutes later (matching the duration of the intervention for other groups), and 2 hours after the initial assessment. During the 20-minute interval between the first and second measurements, participants remained seated on a bench without engaging in any physical activity. Following the second measurement, they joined their co-players for regular training, and the final assessment was performed two hours later.

Outcomes assessment

a) Dynamic Balance

Dynamic balance was measured using the Y-balance test with three directions: anterior, posteromedial, and posterolateral, to assess lower limb dynamic balance and neuromuscular control (28). Participants practiced six times prior to the main test to minimize learning effects. Standing on the dominant leg (kicking foot), they reached with the free leg to the indicator box in each direction. Three attempts were made per direction. If the participant lost balance or couldn't control their free leg, the test was failed (29). The maximum distance reached (D) was recorded and normalized to the participant's lower limb length (L), calculated as: $(D/L) \times 100$, with the result expressed as a percentage of limb length.

b) Sprinting

The 20m Linear Sprint Test was conducted to assess sprinting speed (30). Participants ran from a standing start to a finish line 20 meters away. Standardized athletic shoes were worn. The test was performed on a flat, straight surface with markings. Participants began each trial from a split-stance position approximately 50 cm behind a marked starting line, and were requested to sprint maximally through the 20 m distance, with cones placed at 22 m to encourage full-speed completion. Each participant completed three maximal effort trials, with 2 minutes of passive recovery between attempts. Sprint times were recorded manually using stopwatches operated by a trained tester, with strong verbal encouragement provided during each trial. The best result was used for analysis.

c) Vertical Jump

The Countermovement Jump test was used to measure vertical jump height (Fig. 4). This simple, reliable, and valid test assesses lower limb power, with or without arm movement. Arm movement can increase performance by 10% or more. The test began with the participant standing on a mat with hands on their hips, avoiding any force on the hips. Participants then performed a squat and jumped vertically with maximum effort, keeping their hands on their hips throughout the movement. Landing at the same spot was required for a valid test. The test was performed twice, and the best result was recorded (31). Jump height was measured using Kinovea software (32). The measurement was performed manually using Kinovea's track path tool, and no physical markers were placed on the body. The anatomical landmark of the medial malleolus was selected as the reference point for determining jump height due to its high visibility in video recordings, proximity to the ground, and ease of tracking across frames. The vertical distance between two frames was measured: the moment just before take-off and the moment at the peak of the jump. The displacement of the medial malleolus between these two frames represented the jump height in centimeters.

d) Agility

The Illinois Agility Test was used to measure agility, assessing acceleration, deceleration, directional changes, and running at various angles. Four cones were placed 10 meters apart in length and 5 meters in width, with four more cones positioned 3.3 meters apart in the center. The test began with the participant running 10 meters, turning to the center, weaving through the middle cones in a zigzag pattern, and then heading to the finish line (33). The time to cross the finish line was recorded. The test was performed twice, and the best time was used for analysis.

e) Knee Valgus Angle

The assessment was performed during a double-leg landing from a 30 cm height (34). A smartphone camera (Apple iPhone 13) with a resolution of 1080p HD at 30 frames per second was used to record the test. The camera was placed 3 meters in front of the participant at a height of 90 cm from the ground, perpendicular to the frontal plane. Five visible anatomical landmarks were marked on the dominant leg: anterior superior iliac spine (ASIS), internal and external femoral condyles, and internal and external malleoli. Two axes were defined: the first extended from the ASIS to the midpoint between the femoral

condyles, and the second from that midpoint to the midpoint between the malleoli. The knee valgus angle was measured at the point of maximum knee flexion during landing using Kinovea's angle tool, which is a reliable and valid tool for assessment of distance and angle (32). The average of the two trials was considered for analysis (Fig. 5) .

Statistical Analysis

Data were analyzed using SPSS (version 24), with a significance level set at 0.05. Descriptive statistics for demographic and quantitative dependent variables were presented as mean and standard deviation. Normality was checked using both the Kolmogorov-Smirnov and Shapiro-Wilk tests, which generally agreed across outcomes, except for the Y-balance test in the anterior and posterolateral directions after the intervention. For within-group comparisons, the main effect of time (pre-intervention, immediately after intervention, and 2 hours post-intervention) and the interaction effect of group (FIFA, TMR, and control) and time were evaluated using ANCOVA or repeated measures ANOVA. ANCOVA was applied where appropriate to control for baseline (pre-intervention) values of the outcome measures, in order to account for potential initial differences between groups and increase the precision of post-intervention group comparisons. Effect sizes (η^2p) were reported for time and group-time interactions: 0.01–0.06 (small), 0.06–0.14 (medium), and > 0.14 (large) (35). Between-group comparisons focused on the main effect of group on the dependent variable, analyzed through ANOVA or ANCOVA. In ANCOVA models, pre-intervention scores were included as covariates. Effect sizes were reported as adjusted mean differences and standardized mean differences (SMD, Cohen's d), with confidence intervals (CIs) indicating result precision. SMD values of 0.2–0.5, 0.5–0.8, and > 0.8 indicated small, medium, and large effects, respectively (35).

Results

There were 15 participants in each group. The mean age for the FIFA group was 17.60 (0.74) years, for the TMR group was 17.67 (0.90) years, and for the control group was 17.73 (0.80) years, with no significant differences ($p = 0.905$). The FIFA group had a mean weight of 65.67 (6.76) kg, the TMR group had 73.53 (7.77) kg, and the control group had 74.13 (7.30) kg, showing a significant difference ($p = 0.004$). For height, the FIFA group had a mean height of 178.47 (6.24) cm, the TMR group had 181.60 (7.33) cm, and the control group had 181.80 (5.16) cm, with no significant differences ($p = 0.278$).

The analyses showed significant improvements over time across most outcomes, all showing moderate to large effect sizes and significant interaction effects that reflect group-specific patterns of change. Both posteromedial and posterolateral reach distances increased significantly ($p = 0.001$), with their interactions also significant ($p = 0.017$ and $p = 0.001$); all remained significant after Bonferroni correction. The composite Y-balance score improved significantly ($p = 0.001$), accompanied by a significant interaction ($p = 0.003$), both retained after correction. Sprint times decreased significantly ($p < 0.001$) with a meaningful interaction ($p = 0.002$), while agility performance also improved significantly ($p < 0.001$) with a significant interaction ($p = 0.003$); these results remained robust following correction. Vertical jump height showed a significant main effect of time ($p = 0.040$), indicating overall improvement post-intervention across groups. Scores increased from baseline to post-intervention in all groups but

partially declined by the 2-hour follow-up. Although the knee valgus angle showed a moderate improvement over time ($p = 0.024$), this did not withstand Bonferroni correction; however, its significant interaction ($p < 0.001$) suggests that groups responded differently—underscoring distinct intervention effects (Table 2).

Table 2

Main effect of time and the interaction effect of group and time on outcome measures (n = 15 per group)

Variable	Time	FIFA X (SD)	TMR X (SD)	Control X (SD)	Main effect of time [F, P value, Partial η^2]	Interaction effect [F, P value, Partial η^2]
YBT (Ant) (%)	Baseline	76.53 (6.87)	77.07 (13.34)	75.47 (5.95)	6.5, 0.002†, 0.13	0.78, 0.52, 0.36
	After intervention	83.80 (5.77)	83.93 (8.93)	77.33 (7.01)		
	2 Hours later	79.53 (7.59)	78.53 (5.60)	76.60 (5.67)		
YBT (PM) (%)	Baseline	94.07 (8.22)	95.80 (11.99)	100.40 (7.01)	16.51, 0.001†, 0.28	3.12, 0.017†, 0.13
	After intervention	103.40 (9.51)	99.27 (7.70)	100.73 (4.65)		
	2 Hours later	102.73 (11.42)	108.00 (9.30)	104.40 (5.40)		
YBT (PL) (%)	Baseline	94.07 (6.52)	92.87 (7.86)	96.53 (6.56)	20.7, 0.001†, 0.33	5.51, 0.001†, 0.21
	After intervention	104.87 (5.42)	101.47 (6.81)	96.53 (5.57)		
	2 Hours later	101.27 (9.01)	106.60 (8.68)	99.13 (5.62)		
YBT (composite score) (%)	Baseline	88.22 (4.58)	88.58 (8.88)	90.80 (5.15)	22.89, 0.001†, 0.35	4.46, 0.003†, 17
	After intervention	97.36 (4.32)	94.89 (5.64)	91.53 (4.41)		
	2 Hours later	94.51 (6.22)	97.71 (6.10)	93.38 (3.38)		
Sprint (s)	Baseline	3.61 (0.30)	3.43 (0.25)	3.69 (0.45)	16.7, < 0.001†, 0.3	5.34, 0.002†, 0.2
	After intervention	3.29 (0.26)	3.25 (0.19)	3.64 (0.40)		
	2 Hours later	3.66 (0.23)	3.65 (0.25)	3.61 (0.30)		
Vertical jump (cm)	Baseline	39.35 (7.07)	41.45 (7.53)	40.77 (8.27)	3.63, 0.040*, 0.08	0.9, 0.46, 0.04

Variable	Time	FIFA X (SD)	TMR X (SD)	Control X (SD)	Main effect of time [F, P value, Partial η^2]	Interaction effect [F, P value, Partial η^2]
	After intervention	42.86 (6.98)	42.35 (5.05)	41.95 (8.34)		
	2 Hours later	41.03 (7.83)	39.32 (7.50)	40.20 (8.53)		
Agility (s)	Baseline	15.17 (0.85)	15.04 (0.92)	15.93 (0.84)	55.12, < 0.001†, 0.57	4.3, 0.003†, 0.17
	After intervention	13.88 (0.49)	14.07 (0.74)	15.77 (1.03)		
	2 Hours later	13.64 (0.52)	13.81 (0.83)	15.09 (0.74)		
Knee valgus (°)	Baseline	12.11 (6.15)	10.71 (5.27)	12.79 (4.77)	3.88, 0.024*, 0.08	8.04, < 0.001†, 0.28
	After intervention	8.96 (6.56)	11.27 (5.42)	13.57 (4.28)		
	2 Hours later	9.31 (7.10)	13.69 (5.97)	14.66 (4.32)		

Notes: †Significant after Bonferroni correction for multiple comparisons ($p < 0.017$); significant uncorrected ($p^* < 0.05$). **Abbreviations:** Ant, anterior; PL, posterolateral; PM, posteromedial. TMR, total motion release; FIFA, Fédération International de Football Association.

Table 3 summarizes the between-group comparisons. Post-intervention, FIFA showed greater improvements than control across several outcomes, many retained after Bonferroni correction. For the Y-balance composite score, FIFA outperformed control by 6.84 cm (95% CI: 3.02 to 10.67; SMD 1.63); the CI is moderately wide, indicating a robust but somewhat variable estimate. TMR also exceeded control (mean difference = 4.24 cm, 95% CI: 0.43 to 8.05; SMD 1.01), with a wide CI, though this did not remain significant after correction. For posterolateral reach, FIFA improved 9.04 cm over control (95% CI: 3.8 to 14.3; SMD 1.10), showing a wide CI; TMR improved by 6.00 cm (95% CI: 0.7 to 11.3; SMD 0.71), also wide. Only FIFA's result remained significant post-correction. Sprint time decreased more in FIFA than control (mean difference = 0.31 s; 95% CI: 0.11 to 0.51; SMD 0.96), with a relatively narrow CI, retained after correction. TMR also reduced sprint time by 0.24 s compared to control (95% CI: 0.03 to 0.45; SMD 0.70), but this did not survive correction, and the CI was wide. Agility improved significantly in both FIFA (mean difference = 1.41 s; 95% CI: 0.90 to 1.75; SMD 1.63) and TMR (1.13 s; 95% CI: 0.60 to 1.70; SMD 1.30) versus control; both had moderately narrow CIs and remained significant after correction. Knee valgus was reduced significantly more by FIFA compared to both TMR (3.60°; 95% CI: 1.20 to 5.97; SMD 0.93) and control (4.00°; 95% CI: 1.61 to 6.40; SMD 1.05), with both CIs moderately wide and corrected

for multiple comparisons. At 2-hour follow-up, only agility and knee valgus improvements persisted. FIFA showed sustained knee valgus reduction versus TMR (5.70°; 95% CI: 2.70 to 8.70; SMD 1.20) and control (4.73°; 95% CI: 1.80 to 7.70; SMD 1.01), both with wide CIs and significant after correction. For agility, FIFA (mean difference = 1.20 s; SMD 1.20; CI: 0.55 to 1.80) and TMR (0.97 s; SMD 0.94; CI: 0.32 to 1.62) remained faster than control, with moderately wide CIs and both differences corrected. In contrast, no significant between-group differences in balance or sprint remained at the 2-hour mark, and the wide CIs for these outcomes reflect lower certainty.

Table 3
Main effect of group at two time points (after intervention and 2 hours later) on various outcome measures.

Variable	Time	Group pairs	Mean difference (adjusted) (95% CI)	SMD (adjusted) (95% CI)	P value
Y-balance test (Ant)	After intervention	TMR vs FIFA	-0.05 (-6.15 to 6.05)	-0.01 (-7.0 to 7.0)	1.00
		Control vs FIFA	-6.1 (-12.21 to 0.01)	-0.63 (-1.34 to 0.09)	0.05
		Control vs TMR	-6.05 (-12.20 to 0.10)	-0.62 (-1.33 to 0.1)	0.05
	2 Hours later	TMR vs FIFA	-0.94 (-6.71 to 4.84)	-0.10 (-0.80 to 0.60)	1.00
		Control vs FIFA	-3.1 (-8.84 to 2.72)	-0.33 (-1.03 to 0.40)	0.60
		Control vs TMR	-2.12 (-7.91 to 3.70)	-0.23 (-0.93 to 0.47)	1.00
Y-balance test (PM)	After intervention	TMR vs FIFA	-4.7 (-11.14 to 2.70)	-0.43 (-1.13 to 0.30)	0.30
		Control vs FIFA	-4.24 (-11.14 to 2.70)	-0.40 (-1.10 to 0.32)	0.40
		Control vs TMR	0.33 (-6.50 to 7.11)	0.03 (-0.70 to 0.73)	1.00
	2 Hours later	TMR vs FIFA	4.42 (-2.83 to 11.70)	0.38 (-0.32 to 1.10)	0.41
		Control vs FIFA	-1.42 (-8.94 to 6.11)	-0.12 (-0.81 to 0.60)	1.00
		Control vs TMR	-5.84 (-13.23 to 1.60)	-0.50 (-1.20 to 0.23)	0.17
Y-balance test (PL)	After intervention	TMR vs FIFA	-3.10 (-8.25 to 2.14)	-0.40 (-1.10 to 0.34)	0.50
		Control vs FIFA	-9.04 (-14.3 to -3.8)	-1.1 (-1.82 to -0.32)	< 0.001†

Notes: The adjusted mean difference effect size reflects the adjustment for the variable of interest in each group at the pre-intervention time point. †Significant after Bonferroni correction for multiple comparisons ($p < 0.017$); significant uncorrected ($p^* < 0.05$). **Abbreviations:** Ant, anterior; PM, posteromedial; PL, posterolateral. TMR, total motion release; FIFA, Fédération International de Football Association.

Variable	Time	Group pairs	Mean difference (adjusted) (95% CI)	SMD (adjusted) (95% CI)	P value
	2 Hours later	Control vs TMR	-6.00 (-11.3 to -0.7)	-0.71 (-1.42 to 0.02)	0.02*
		TMR vs FIFA	5.34 (-2.00 to 12.70)	0.50 (-0.25 to 1.20)	0.23
		Control vs FIFA	-2.14 (-9.53 to 5.24)	-0.19 (-0.90 to 0.52)	1.00
		Control vs TMR	-7.50 (-15.0 to -0.001)	-0.63 (-1.34 to 0.10)	0.05
Y-balance test (composite score)	After intervention	TMR vs FIFA	-2.61 (-6.38 to 1.16)	-0.62 (-1.52 to 0.28)	0.28
		Control vs FIFA	-6.84 (-10.67 to -3.02)	-1.63 (-2.43 to -0.80)	0.001†
		Control vs TMR	-4.24 (-8.05 to -0.43)	-1.01 (-1.91 to -0.10)	0.02*
	2 Hours later	TMR vs FIFA	-3.20 (-8.11 to 1.71)	-0.59 (-1.51 to 0.32)	0.34
		Control vs FIFA	1.13 (-3.78 to 6.05)	0.20 (-0.66 to 1.06)	1.00
		Control vs TMR	-4.33 (-9.25 to 0.58)	-0.79 (-1.68 to 0.11)	0.10
Vertical jump	After intervention	TMR vs FIFA	-1.72 (-6.70 to 3.30)	-0.22 (-0.91 to 0.50)	1.00
		Control vs FIFA	-1.73 (-6.70 to 3.24)	-0.22 (-0.94 to 0.50)	1.00
		Control vs TMR	-0.01 (-5.00 to 4.94)	-0.001 (-0.70 to 0.70)	1.00
	2 Hours later	TMR vs FIFA	-3.10 (-8.83 to 2.62)	-0.34 (-1.04 to 0.37)	0.60
		Control vs FIFA	-1.80 (-7.50 to 3.93)	-0.20 (-0.90 to 0.51)	1.00
		Control vs TMR	1.33 (-4.36 to 7.02)	0.15 (-0.55 to 0.84)	1.00

Notes: The adjusted mean difference effect size reflects the adjustment for the variable of interest in each group at the pre-intervention time point. †Significant after Bonferroni correction for multiple comparisons ($p < 0.017$); significant uncorrected ($p^* < 0.05$). **Abbreviations:** Ant, anterior; PM, posteromedial; PL, posterolateral. TMR, total motion release; FIFA, Fédération International de Football Association.

Variable	Time	Group pairs	Mean difference (adjusted) (95% CI)	SMD (adjusted) (95% CI)	P value
Sprint	After intervention	TMR vs FIFA	0.10 (-0.13 to 0.30)	0.22 (-0.50 to 0.92)	1.00
		Control vs FIFA	0.31 (0.11 to 0.51)	0.96 (0.21 to 1.70)	0.001†
		Control vs TMR	0.24 (0.03 to 0.45)	0.70 (-0.02 to 1.42)	0.02*
	2 Hours later	TMR vs FIFA	0.03 (-0.20 to 0.30)	0.10 (-0.61 to 0.80)	1.00
		Control vs FIFA	-0.01 (-0.30 to 0.17)	-0.20 (-0.96 to 0.54)	1.00
		Control vs TMR	-0.10 (-0.34 to 0.15)	-0.30 (-0.96 to 0.44)	0.98
Agility	After intervention	TMR vs FIFA	0.30 (-0.23 to 0.80)	0.34 (-0.40 to 1.04)	0.54
		Control vs FIFA	1.41 (0.90 to 1.75)	1.63 (0.80 to 2.43)	< 0.001†
		Control vs TMR	1.13 (0.60 to 1.70)	1.30 (0.50 to 2.04)	< 0.001†
	2 Hours later	TMR vs FIFA	0.21 (-0.40 to 0.81)	0.22 (-0.50 to 0.92)	1.00
		Control vs FIFA	1.20 (0.55 to 1.80)	1.20 (0.40 to 1.92)	< 0.001†
		Control vs TMR	0.97 (0.32 to 1.62)	0.94 (0.20 to 1.70)	0.002†
Knee valgus	After intervention	TMR vs FIFA	3.60 (1.20 to 5.97)	0.93 (0.19 to 1.70)	0.002†
		Control vs FIFA	4.00 (1.61 to 6.40)	1.05 (0.30 to 1.40)	< 0.001†
		Control vs TMR	0.43 (-1.99 to 2.90)	0.11 (-0.60 to 0.81)	1.00
	2 Hours later	TMR vs FIFA	5.70 (2.70 to 8.70)	1.20 (0.41 to 1.94)	< 0.001†

Notes: The adjusted mean difference effect size reflects the adjustment for the variable of interest in each group at the pre-intervention time point. †Significant after Bonferroni correction for multiple comparisons ($p < 0.017$); significant uncorrected ($p^* < 0.05$). **Abbreviations:** Ant, anterior; PM, posteromedial; PL, posterolateral. TMR, total motion release; FIFA, Fédération International de Football Association.

Variable	Time	Group pairs	Mean difference (adjusted) (95% CI)	SMD (adjusted) (95% CI)	P value
		Control vs FIFA	4.73 (1.80 to 7.70)	1.01 (0.26 to 1.75)	0.001†
		Control vs TMR	-0.94 (-3.96 to 2.10)	-0.20 (-0.90 to 0.51)	1.00
Notes: The adjusted mean difference effect size reflects the adjustment for the variable of interest in each group at the pre-intervention time point. †Significant after Bonferroni correction for multiple comparisons ($p < 0.017$); significant uncorrected ($p^* < 0.05$). Abbreviations: Ant, anterior; PM, posteromedial; PL, posterolateral. TMR, total motion release; FIFA, Fédération International de Football Association.					

Discussion

This study aimed to investigate and compare the immediate and short-term effects of the TMR and FIFA 11 + warm-up programs on dynamic balance, physical performance, and knee valgus angle in male football players. The findings showed that both TMR and FIFA 11 + improved dynamic balance and physical performance, but only FIFA 11 + significantly reduced the knee valgus angle.

Dynamic Balance

Our findings indicate that both the FIFA 11 + and TMR programs enhance dynamic balance, although their effectiveness and duration vary depending on direction and type of movement. In the anterior reach, all groups improved over time without significant differences between interventions, suggesting general warm-up effects rather than specific program advantages. This aligns with previous research reporting broad anterior reach improvements following warm-up routines (26). While moderate effect sizes were seen for both interventions compared to control ($SMD \approx -0.62$), neither clearly surpassed the other.

In the posterolateral direction, FIFA 11 + and TMR both outperformed the control group immediately post-intervention, with FIFA showing a more robust and statistically significant effect (mean difference = -9.04%), supporting by a narrow CI. These results may indicate a short-term advantage of FIFA 11 + in boosting lateral stability, likely due to its plyometric and balance components that target proprioceptive control and multidirectional movement (18). Although TMR appeared to maintain this benefit better at the two-hour follow-up, the difference was not statistically significant, and the confidence interval was wide.

For posteromedial reach, both interventions showed improvements over time, but without significant differences between them. While FIFA 11 + again showed a tendency toward greater immediate gains

and TMR appeared to sustain them slightly longer, neither trend reached statistical significance and should be interpreted with caution.

Composite balance scores also improved immediately after both programs. FIFA 11 + showed significant acute gains with large effect sizes, while TMR's improvement was more modest and not significant after correction. These acute effects were not sustained at the two-hour follow-up, suggesting that repeated application may be needed for longer-term benefits—consistent with previous research on neuromuscular training and balance retention (26).

These directional patterns likely reflect the distinct neuromuscular emphases of each protocol. FIFA 11+, with its dynamic progression, appears particularly effective for rapid activation and agility-based movements. TMR's approach, emphasizing neuromuscular symmetry and postural control, may contribute to sustained motor control, even though retention was not confirmed statistically in this study. This may hold relevance in fatigued conditions such as late-match performance (36).

Our results are consistent with Ayala et al. (26), who found similar benefits with FIFA 11 + on dynamic balance. In summary, both programs positively influence dynamic balance, with FIFA 11 + possibly offering greater immediate activation and TMR supporting underlying control mechanisms that merit further investigation over longer time frames.

Physical Performance

Both the FIFA 11 + and TMR programs produced immediate improvements in sprint and agility, with FIFA 11 + showing consistently greater and more sustained effects. For agility, FIFA 11 + led to a large immediate improvement (-1.41 seconds vs. control; $SMD = -1.63$) and retained a substantial effect at two hours (-1.2 seconds; $SMD = -1.20$). These sustained gains hold clinical significance given the demanding agility requirements in football, where rapid changes of direction contribute to 60–70% of non-contact ACL injuries (37). In contrast, TMR showed moderate short-term benefits but was consistently outperformed by FIFA 11+, suggesting that its neuromuscular activation may be less effective in enhancing rapid or explosive performance.

Sprint performance improved moderately to largely with FIFA 11+ (-0.31 seconds vs. control; $SMD = -0.96$), likely due to neural potentiation from plyometric elements (38). However, this speed advantage diminished within two hours, suggesting that the physiological benefits may be transient. This decline suggests that additional activation drills may be necessary during halftime or pre-second-half routines to maintain optimal sprint capacity throughout a full match. TMR also yielded a smaller sprint improvement ($SMD = -0.70$), but differences between FIFA and TMR remained minimal (mean diff = -0.14 sec; $SMD = -0.22$), limiting its practical relevance.

While all groups had modest vertical jump gains post-intervention (2–3.5 cm), the absence of significant between-group differences suggests a general warm-up effect or neuromuscular activation. Since gains diminished within two hours, their effectiveness in scenarios requiring prolonged maximal power output may be limited thus repeated sessions or additional training may be needed for sustained improvements

The lasting agility effects of FIFA 11 + may stem from its focus on dynamic control and plyometrics, supporting its use as a pre-match routine in sports involving frequent directional changes. These findings align with prior work by Aktas et al. (19), and Ayala et al. (26), who reported similar acute improvements following FIFA 11 + in athletic populations. Proposed underlying mechanisms include increased core temperature, improved oxygen delivery, increased neural conduction (8), and greater efficiency of the stretch-shortening cycle through exercises such as the Nordic hamstring (38).

Our comparison of FIFA 11 + and TMR highlights their distinct performance benefits as practical warm-up options. FIFA 11 + demonstrated more robust and longer-lasting effects than TMR, particularly in agility, underscoring its utility for performance enhancement. While TMR may offer mild neuromotor benefits with less physical demand, its smaller effect size and reduced retention suggest a need for program refinement or supplementary interventions. The absence of sustained sprint improvements following either intervention also indicates an area for future warm-up development, emphasizing the inclusion of repeated activation efforts or halftime re-warm-up protocols to better preserve high-intensity performance. These conclusions extend prior evidence from Bizzini et al. (18), reinforcing the overall functional superiority of FIFA 11 + relative to alternative protocols. However, it is worth noting that the FIFA group had a lower baseline body weight, which may have contributed to some of the observed performance advantages.

Knee Valgus Angle

As shown in Fig. 6, the FIFA group demonstrated a significant reduction in knee valgus angle after the intervention, which remained stable two hours later, unlike the control and TMR groups. The FIFA group also showed strong effect sizes compared to TMR at both time points (ES = 0.93 and 1.2).

Ankle and knee injuries are prevalent among football players, accounting for about 40% of all cases (39). Research suggests that hip muscle strength plays a critical role in stabilizing the knee. Specifically, weak hip abductors relative to adductors can increase foot pronation and elevate the risk of lower limb injuries such as ACL tears. Proximal instability—especially around the hip—and inadequate core stability are both strongly linked to knee injuries. Core strength provides a stable base for lower limb function, supporting controlled movement and force absorption. Deficits in hip and trunk control—e.g., trunk flexion, hip adduction/internal rotation, knee valgus, and tibial external rotation—contribute to the "non-returning position," a biomechanical profile associated with high injury risk (40, 41).

The observed decrease in knee valgus angle in the FIFA group likely reflects the benefits of its integrated strength, balance, and core stability components. The FIFA 11 + program integrates running drills, balance challenges, lower limb strengthening, core stability, and plyometric exercises that collectively support neuromuscular control and injury prevention (42, 43). Strengthening hip abductors helps correct internal hip rotation and adduction, thereby reducing knee valgus (44). By contrast, TMR lacks such targeted balance, strength, and plyometric elements, which may explain its limited influence.

Our results align with findings by Seyedi et al. (2023), who reported that FIFA 11 + improved knee valgus and balance in young footballers. Although they used single-leg tasks and we used double-leg landing, both showed comparable positive outcomes. FIFA 11 + reduced the knee valgus angle by approximately 4° compared to control, supporting its ability to acutely improve knee alignment and stability. Relevance to our findings, clinical data show that increases of 4.6° at initial contact and 6.3° at peak knee valgus relate to higher ACL reinjury risk (45). Importantly, this improvement was sustained for two hours, covering the duration of a playoff match and mitigating fatigue-related neuromuscular decline, a key risk factor in late-game injuries. Overall, FIFA 11 + appears to be a practical, effective intervention to acutely improve knee mechanics via targeted neuromuscular training. Even a single session may offer meaningful injury-prevention effects. However, the wide confidence intervals in some comparisons suggest caution and emphasize the need for further trials with larger samples.

These findings offer practical guidance for those working with football players, including coaches, physiotherapists, and sports trainers. Implementing the FIFA 11 + as a primary warm-up appears to be a suitable strategy for improving immediate performance outcomes, particularly reduced knee valgus and improved agility, that are likely to carry over through the duration of a match. In contrast, the TMR program may be more appropriate during training or lower-intensity sessions, where its more sustained effects could help counter fatigue-related impairments. A periodized strategy that combines both approaches may be ideal: FIFA 11 + can support explosive performance during high-intensity competition, while TMR-inspired drills could be introduced during halftime or recovery phases. Together, these programs may offer a comprehensive and adaptable framework for optimizing performance across various phases of competitive play.

Limitations

This study had a few methodological limitations. First, because five different outcomes were assessed in each session, it was not feasible to evaluate every variable immediately after the intervention, which may have limited our ability to fully capture acute neuromuscular effects. Second, due to practical constraints, the same researcher conducted both the interventions and the immediate post-tests. While this ensured consistency, it may have introduced some measurement bias. Third, sprint and agility were measured using a stopwatch rather than more precise automated systems such as photoelectric timing gates. Although we used multiple trials and an experienced assessor to improve accuracy, employing high-precision tools in future studies is recommended. Fourth, performance outcomes were only measured at three time points, which limited our ability to detect subtle or delayed neuromuscular adaptations; more frequent testing intervals could help track performance trends and recovery profiles more precisely. Finally, although participants were randomly assigned, the FIFA 11 + group had significantly lower body weight at baseline than the other groups. This difference may have influenced the results.

Conclusions

Both the TMR and FIFA 11 + programs immediately improve dynamic balance and physical performance. While the FIFA 11 + program led to greater improvement in some parameters of dynamic balance immediately after intervention, the TMR program showed better retention of balance improvements at two hours post-intervention, despite some statistically modest findings. These sustained effects may make TMR more suitable for sports like football that require prolonged neuromuscular control or delayed match entry. The FIFA 11 + program appeared to improve physical performance slightly more than TMR, with somewhat greater lasting effects on agility, reflecting its potential suitability for sports involving frequent directional changes. Additionally, a significant reduction in knee valgus angle during landing was observed immediately after the intervention in the FIFA 11 + group, and this effect persisted up to two hours. Although this study did not assess injury outcomes, this finding may be relevant given that excessive knee valgus during landing is considered a biomechanical risk factor for ACL injuries. From a practical standpoint, the FIFA 11 + program may be more suitable for on-pitch sessions or pre-match warm-ups among older youth and senior athletes, especially when immediate improvements in performance and movement mechanics are needed. In contrast, the TMR protocol may be better implemented during gym-based sessions, recovery periods, or submaximal training phases, where sustained neuromuscular stability is a priority. Based on the current findings, TMR may offer more sustained effects, while FIFA 11 + may provide greater immediate benefits in dynamic balance, agility, and knee alignment during landing tasks.

Declarations

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Author Contribution

Conceptualization: [K.O, K.M, M.B]; Methodology: [K.O, K.M, M.B]; Sampling: [M.B]; Formal analysis and investigation: [M.B, K.M, K.O]; Writing-original draft preparation: [M.B]; Writing-review and editing: [K.O, K.M]; Supervision: [K.O, K.M].

Data Availability

The data that support the findings of this study are available on request from the corresponding author.

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Figures

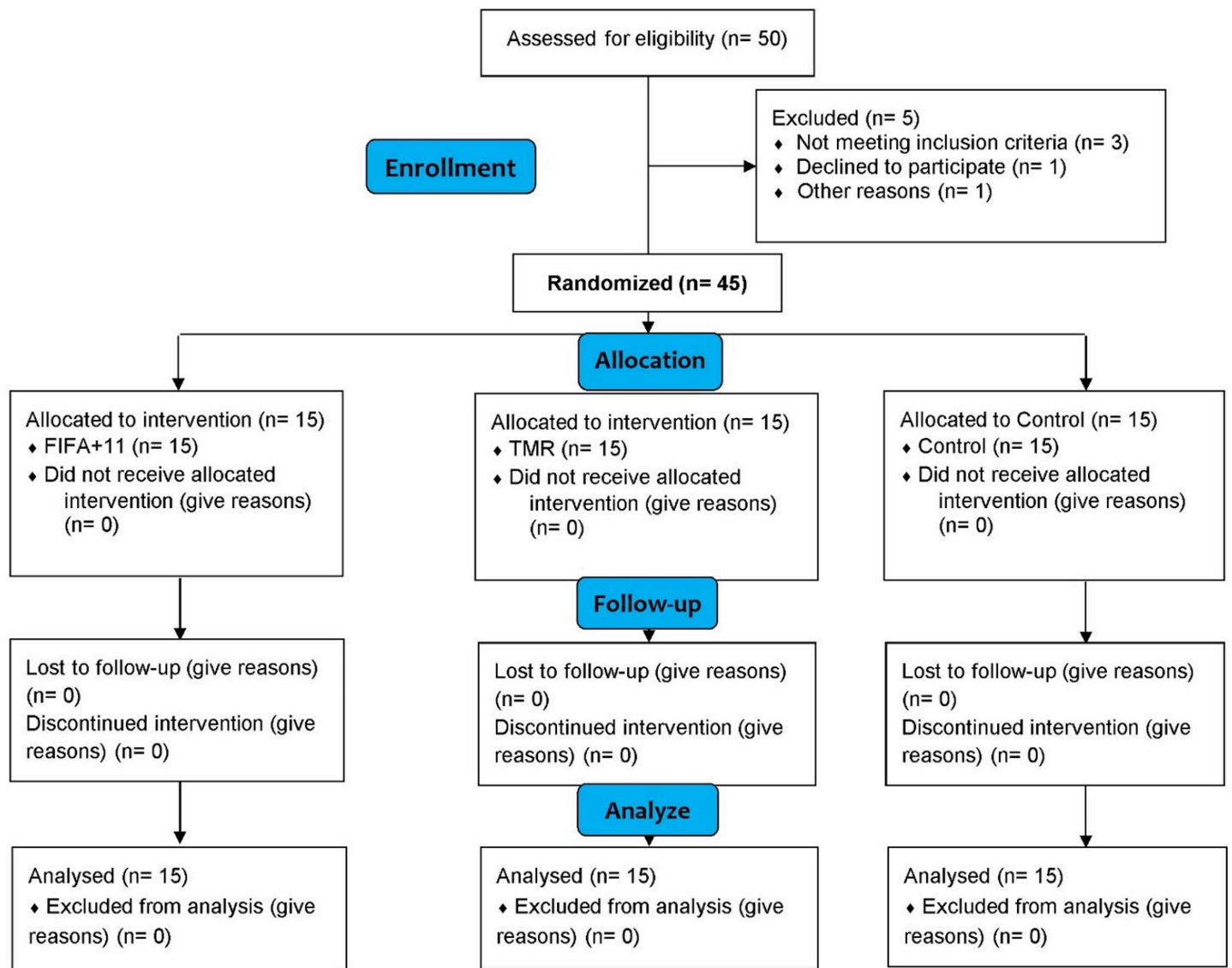


Figure 1

Consort Flow Diagram



Figure 2

Total Motion Release



Figure 3

The FIFA 11+ program



Figure 4

Vertical jump height measurement sequence. Left: Subject position immediately prior to take-off; Right: Subject at peak jump height



Figure 5

Knee valgus measurement. The complementary angle is shown for clarity; valgus angle = $180^\circ - \text{displayed angle}$.

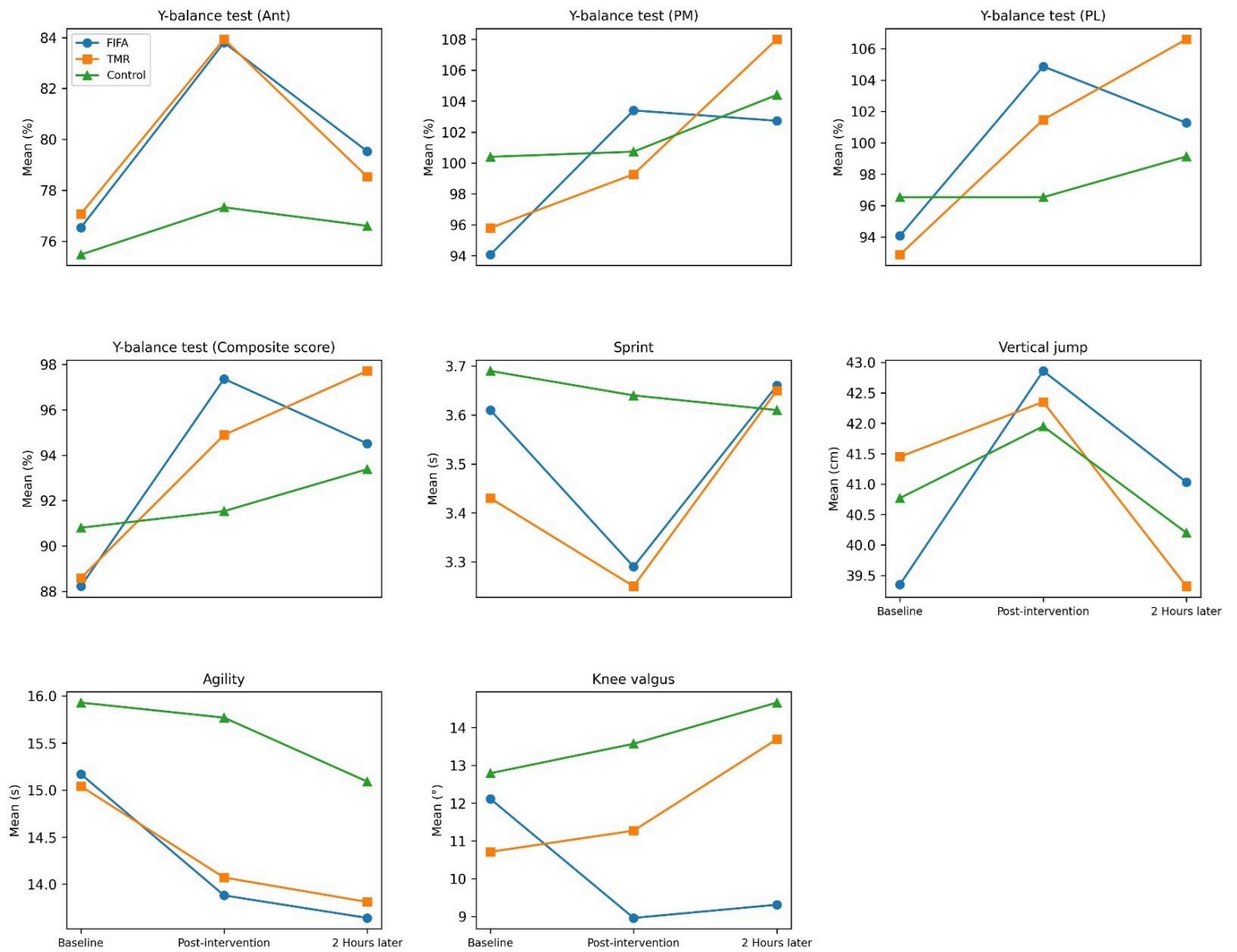


Figure 6

Trends in outcome measures at baseline, immediately after intervention, and 2 hours post-intervention for FIFA, TMR, and control groups. Abbreviations: YBT, Y-balance test; Ant, anterior; PM, posteromedial; PL, posterolateral. TMR, total motion release; FIFA, Fédération International de Football Association.