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Research article

Enhancing Physical Fitness in Elite Field Hockey Players with A Twelve-Week Functional Training Program: A Cluster Randomized Control Trial

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Abstract
This study aimed to explore the impact of functional training on the physical fitness of young elite field hockey players. The study comprised 40 young elite male field hockey players with the following characteristics (mean ± SD age: 21.5 ± 0.8 years; height: 176.9 ± 2.6 cm; weight: 68.4 ± 5.1 kg; BMI: 21.8 ± 1.3; training experience: 51.2 ± 5.4 months). Twenty participants were allocated to two groups: the functional training group (FTG) and the control training group (CG). Each group received 60-minute training sessions three times per week for 12 weeks. Generalized estimating equation analysis and a Bonferroni test for pairwise comparisons were used to assess the intervention's efficacy. Before the start of the exercise program, no statistically significant differences were observed in physical fitness measures between the FTG and CG ($p > 0.05$). However, by the sixth week, a significant difference appeared in both the T-Agility test ($p < 0.001$) and endurance ($p = 0.024$) between the two groups, while no notable distinctions were detected in other fitness parameters ($p > 0.05$). After a 12-week training program, the FTG demonstrated improvements in all physical fitness measures [flexibility ($p < 0.001$); Illinois agility test ($p < 0.001$); T-agility test ($p = 0.020$); endurance ($p < 0.001$)] except speed, which exhibited no significant impact ($p = 0.175$). Notable enhancements in T-agility and endurance were evident after just six weeks of functional training, and a 12-week functional training regimen showed superiority over standard training approaches in young elite male field hockey players. These findings encourage the efficacy of functional training exercises over traditional methods in enhancing athletes' fitness parameters.

Key words: Functional training, fitness parameters, athletes.

Introduction

Field hockey is a multifaceted Olympic sport enjoyed by both men and women, both casually and professionally, with global popularity, boasting over a million players annually from 138 countries (Nassif and Raspaud, 2023). Elite success in this sport demands various physical attributes such as strength, speed, and skill (Burr et al., 2008; Noblett et al., 2023; Azam et al., 2021). Athletes' physical fitness levels heavily influence the athletic prowess required (Wang et al., 2024; Deng et al., 2024). Hockey is renowned for its pace, demanding high conditioning levels during competitions. A robust aerobic capacity ensures sustainability during sprint efforts (Akbar et al., 2022). However, like other team sports, attributes like quick power, speed, consistent strength, and coordination take precedence (Şahin and Coskun, 2020). Sebastian (2018) found that functional training significantly improved players' fitness levels. This training regimen consists of brief bursts of intense exercise followed by rest intervals or recovery exercises at a lower intensity. However, athletes have been using this type of training since the latter half of the 20th century (Feito et al., 2018). It has recently gained popularity among fitness enthusiasts, and Thompson (2017) listed it as one of the top ten fitness trends for 2018. One of the fastest-growing fitness trends today is functional training.

According to Feito et al. (2018) and Wang et al. (2023) studies, functional training has emerged as a popular method for enhancing athletes' performance. This approach focuses on developing muscle strength through coordinated movements across various planes, engaging multiple joints, dynamic activities, and consistent changes in support. Consequently, it enhances athletes' postural control, reduces energy consumption during movement, and improves the effectiveness of power transmission after each movement (Cook et al., 2010; Boyle, 2016). Extensive research on functional training for athletes has consistently demonstrated its positive impact on physical fitness. A thorough examination of functional training programs reveals their significant influence on various physical fitness traits, as evidenced by multiple studies (Bodden et al., 2015; Kamal, 2016; Sebastian, 2018; Yildiz et al., 2019).

Xiao et al. (2021) and Bashir et al. (2022) conducted comprehensive systematic reviews that present contrasting views on how functional training programs influence physical fitness. Several studies have enriched this body of knowledge (Bodden et al., 2015; Kamal, 2016; Sebastian, 2018; Yildiz et al., 2019). While various studies have highlighted the benefits of functional training in enhancing the fitness levels of athletes in sports such as handball, football, and martial arts (Xiao et al., 2021; Bashir et al., 2022), there is a notable gap in research regarding its effects on the fitness of field hockey players. The absence of studies examining functional training's impact on hockey players underscores the need for further investigation. The study hypothesizes that functional training will enhance the fitness performance of elite field hockey players. Given the critical role of skills in player performance, especially among elite young players, understanding how functional training influences their physical fitness is imperative.

Methods

Design
This study was conducted as a Cluster Randomized Controlled Trial (CRCT) in the Faisalabad region of Pakistan, focusing on four central districts for cluster selection. Two districts, Faisalabad and Toba Tek Singh, were randomly

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chosen, and the fishbowl method was employed to select participants for the Functional Training Group (FTG) and Control Group (CG). The FTG received a functional training intervention, while the CG underwent routine hockey training three days a week for 12 weeks. Both groups underwent physical fitness tests before the intervention and at the end of the sixth and twelfth weeks of training. These tests were conducted three times: pretest before intervention, posttest one after 6 weeks, and posttest two after 12 weeks, to compare the differences between FTG and CG throughout the analysis. Additionally, the functional training intervention protocol was registered and approved by ClinicalTrials.gov (ID: NCT05657509).

Randomization and sample size calculation

The study was designed and reported in accordance with the CONSORT declaration (Moher et al., 2010) and used a cluster-randomized technique. The sample size was determined using G*Power 3.1, with an effect size of 0.24 derived from prior studies. Based on an alpha level of 0.05 and a power of 0.80, the initial sample size was calculated to be 30 participants, with 15 in each group. This number was adjusted for the design effect to ensure adequate statistical power in cluster randomized trials (Donner et al., 1981). Considering a potential % dropout rate of 20% (Cramer et al., 2016), the final sample size was determined to be 42.75, then rounded to 44 field hockey players.

Participants

Following the recruitment phase, 80 participants were found (Figure 1). After applying the eligibility criteria, 40 participants were selected for the final analysis (Figure 1). A total of 40 healthy male young elite field hockey players (mean ± SD; age: 21.5 ± 0.8 years; height: 176.9 ± 2.6 cm; weight: 68.4 ± 5.1 kg; BMI: 21.8 ± 1.3; training experience: 51.2 ± 5.4 months). The study's target population comprises elite male field hockey players who have competed at the national level in Pakistan. Field hockey players from the Hockey Training Centre in Faisalabad, Punjab province, were recruited. If a participant fulfilled any of the following requirements, they were disqualified from the final list: a history of rheumatoid illness or current therapy for neurological damage; a history of shoulder, knee, or elbow injury that occurred recently (i.e., less than a year ago). There were no statistically significant differences between the two groups regarding age, height, weight, BMI, and training experience. Subjects gave written informed consent in accordance with the established rules and procedures after being advised of the possible risks and advantages of participating in the study. They were told not to exercise the day before an exam and to eat their last (caffeine-free) meal at least three hours before the test. Approval for the study was secured from the Human Research Ethics Committee of Government College University (GCU-IIB-2186).

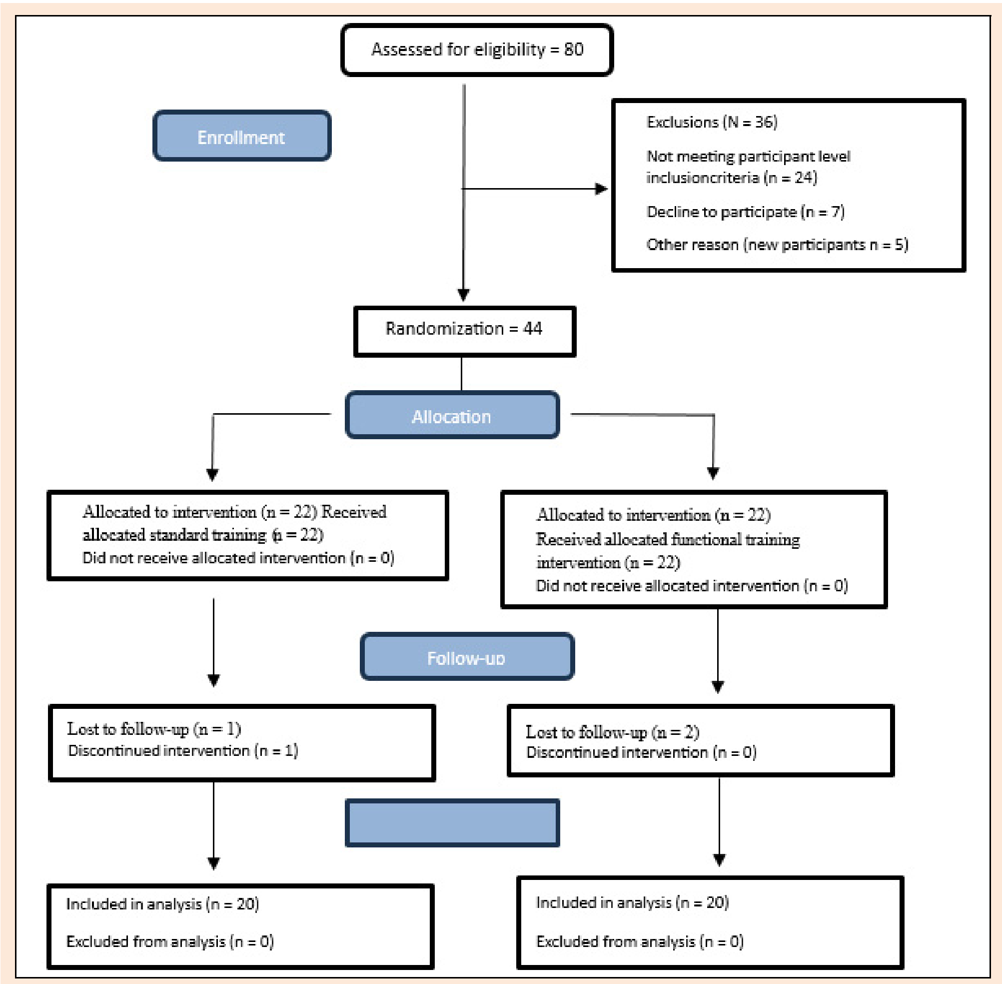

Figure 1. Participants' flow diagram (Source: Moher et al., 2012).

Procedures

The 12-week intervention was conducted. The two weeks before the start of the intervention was used to educate and guide participants to know the intervention process and exercise movement, as well as explain that during the training duration of this study, the participants were not to participate in any exercise training (i.e., resistance training). Otherwise, they need to report to the principal investigator for documentation. Additionally, both groups performed thrice weekly on Monday, Wednesday, and Friday, 4 - 5 pm, and every training day. Two qualified functional training trainers trained the FTG, while two hockey coaches did the CG with previous training experience.

Three phases consisted of the training procedures in the study: (a) the warm-up phase that included 10 minutes of running and stretches, (b) the 60-minute primary exercise session, and (c) a period of cooling down, which comprised 10 minutes of stretching exercises. The exercises for warming up and cooling down were done in accordance with Gelen's (2010) recommendations. During the research time, all players were in the off-season, and no events were scheduled.

Three experts with training experience in field hockey assessed the training intervention's content validity and outcome assessment during the study's planning stage. There is no uniform acceptance guide for the number of experts on content validity, and the number of experts ranges from 3 to more than 10 (Lynn, 1986). In this study, the contents validity of the intervention and instruments evaluated was by six experts in the field through a questionnaire adopts a 5-point Likert scale (1 = strongly disagree; 2 = Disagree; 3 = Not necessarily; 4 = agree; 5 = strongly agree). An open-ended questionnaire was also sent out to get expert input for improving the training intervention.

Functional training program

The framework for this 12-week functional training program was developed from the previous literature (Yildiz et al., 2019; Santana, 2015; Elvin et al., 2022). This functional training program consisted of a systematic progression of exercises to improve fitness and performance.

The content of the experimental group mainly includes warm-up, main content, and cool-down. For FTG, the functional training program had three phases: the first phase was conditioning (4 weeks), the second phase was athletic performance (4 weeks), and the final phase was power endurance (4 weeks). Exercises were offered each week, and participants had to attend 60-minute workouts per week during the 12-week training program. This training volume corresponds to most other functional training studies and represents an appropriate training time to see adjustments in both aptitude and performance. Throughout the functional training program, the exercises have consistently progressed to reflect the improvement in the performance of the phases. The full description of the functional training program can be found in Table 1.

Training program for the control group

The routine training program followed by each group commenced with a 10-minute warm-up. A 10-minute warm-up followed the main phase of each group's structured training program, which included field hockey standard exercises. The program ended with a 10-minute cool-down. Athletes were told to perform at 60 - 100% intensity, with instructors assuring attendance for the 12 weeks (see Table 2). Targeting local muscle groups uniaxially, the Control Group (CG) training regimen comprised single-joint exercises. The main exercise period they consisted of 2 - 4 sets of 10 - 20 repetitions with breaks for relaxation. The main period they lasted 60 minutes throughout the 12-week duration (refer to Table 2).

Measurement procedure

Before commencing the fitness tests, the dominance level of field hockey players was determined using a lateralization questionnaire. Subsequently, the speed (30-m sprint), agility (T-test and Illinois Agility Test [IAT]), flexibility (sit and reach), and endurance (push-ups [PU]) test batteries were employed for assessing athletic performance. In the 6 and 12 weeks of the training program, these fitness test batteries were used again. In accordance with Gelen and Research's (2010) suggestions, subjects performed a dynamic warm-up exercise before the measurements.

The 30-m sprint test evaluated maximum speed capabilities (Sener et al., 2021; Lombard et al., 2021). Agility performance was assessed using the T-test, which includes forward, lateral, and backward running (Negra et al., 2017). The IAT measured subjects' agility performance (Sener et al., 2021). The sit-and-reach test was used to assess the flexibility of the lower extremities (Ellis, 2000). Push-ups assessed upper-body muscular endurance (Miller, 2012; Cordingley et al., 2019).

All participants attended an orientation session with their coaches one week before the baseline evaluation. They were advised to stick to their regular eating routines and not drink alcohol. In addition, they had to spend the day before each examination consuming only food from the training base dining hall. Test batteries were also given to participants for familiarization during the orientation session. Coaches were encouraged not to assign intense workouts 24 hours before each evaluation to ensure optimal recuperation.

Based on the expert's evaluation, the content validity was satisfactory (intervention: I-CVI = 0.833 - 1.000, Kappa = 0.816 - 1.000; physical fitness variables: I-CVI = 0.851 - 1.000, Kappa = 0.816 - 1.000) and met the acceptable thresholds.

Statistical analyses

The data were analyzed using IBM SPSS version 25. The homogeneity of each group concerning demographics and baseline outcome variables was assessed using a two-tailed t-test. A generalized estimating equation analysis and a Bonferroni test for pairwise comparisons were used to determine the intervention's efficacy. Faber et al. (2016) evaluated Cohen's d effect size as (trivial = 0.35; small = 0.35 - 0.80; moderate = 0.80 - 1.50; and big = >1.50) based on the sample's average training experience of less than five years. Intraclass correlation coefficient (ICCR) results were computed to ascertain the test-retest reliability of all measurements. The significance level for the entire procedure was set at $p \leq 0.05$.

Table 1. Detailed description of the Functional Training program.

Type of exercise	Conditioning (1-4 weeks) Week 1	Week 2	Week 3	Week 4
Push up with stability ball, Hamstring curl with stability ball	2 sets×10 reps	2 sets×12 reps	3 sets×10 reps	3 sets×12 reps
Multi-directional lunge with weights(2kg+2kg), step up with heel raise	2 sets×10 reps	2 sets×12 reps	3 sets×12 reps	3 sets×12 reps
Dumbbell step-ups, Step up with heel raise	2 sets×10 reps	2 sets×12 reps	3 sets×12 reps	3 sets×12 reps
One leg bench squat, Split squat jump	2 sets×10 reps	2 sets×12 reps	3 sets×12 reps	3 sets×12 reps
Oblique bridge, Planks, Side planks	2 sets×30 sec	2 sets×30 sec	3 sets×30 sec	3 sets×30 sec
	Athletic performance (5-8 weeks)			
Type of Exercises	**Week 1**	**Week 2**	**Week 3**	**Week 4**
Squats S. leg with Swiss ball Single leg hop S. leg on balance pad	2 sets× 10 reps	3 sets×10 reps	3 sets×12 reps	4 sets×10 reps
Planks One lower limb up and side plank Cross limbs up and one leg up Cross limbs up and one leg upside plank	2 sets× 10 reps	3 sets×10 reps	3 sets×12 reps	4 sets×10 reps
Chop Chop with squat pos. with plantar flex	2 sets× 10 reps	3 sets×10 reps	3 sets×12 reps	4 sets×10 reps
Push up Feet on chair One leg up and extended Feet on Swiss ball	2 sets× 10 reps	3 sets×10 reps	3 sets×12 reps	4 sets×10 reps
Med. ball throw To wall with squat pos. FH-BH side	2 sets× 10 reps	3 sets×10 reps	3 sets×12 reps	4 sets×10 reps
	Power Endurance (9-12weeks)			
Type of exercises	**Week 1**	**Week 2**	**Week 3**	**Week 4**
Biplex 1 KB single-arm swing Squat jump	2 sets×5+5	3 sets×5+5	3 sets×5+5	4 sets×5+5
Biplex 2 BP staggered stance press Explosive push-up	2 sets×5+5	3 sets×5+5	3 sets×5+5	4 sets×5+5
Biplex 3 BP row MB overhead slam	2 sets×5+5	3 sets×5+5	3 sets×5+5	4 sets×5+5
Biplex 4 BP short rotation (10 to 2 o'clock) MB rotational throw: perpendicular	2 sets×5+5	3 sets×5+5	3 sets×5+5	4 sets×5+5
Slide running	2 sets ×10-20 reps per side	2 sets ×10-20 reps per side	3 sets ×10-20 reps per side	3 sets ×10-20 reps per side

MB: Medicine balls; SKB: kettlebells; Reps: repetition; 5+5 indicates 60 seconds of rest between the first and second exercise for power. For power endurance, go straight from the first exercise to the second without resting.

Table 2. Standard Training for control group.

Day	Exercise	Intensity	Time	Recovery Time
3 days/week	Warming Up		10 minutes	
	Main part			
	Chest Press, shoulder Press, lateral pull down, biceps curl, triceps push down, seated leg extension, leg curl, standing calf-rise, modified Push-up and sit up.	60-95%	60 minutes	30-120s
	Cooling Down		10 minutes	

Results

The following tables show the data collected for this study. Furthermore, the obtained data test-retest reliability falls between 0.886 and 0.943, which is the permissible range for all metrics.

To evaluate the differences in physical fitness parameters among young hockey players at three different times for each group, the post-hoc test (Bonferroni) was applied, as shown in Table 3. Descriptive statistics (mean ± SD) information is presented in Table 3. Evaluation of the groups' baseline, week-6, and week-12 test values was conducted. Based on the result, the differences in 30m sprint, IAT, TAT, SAR, and PU between baseline and week 6 ($p < 0.001$), between baseline and week 12 ($p < 0.001$), and between week six and week 12 ($p < 0.001$)

were statistically significant in FTG. The results showed that in CG, there were no significant differences between baseline and week 6 in flexibility ($p = 0.051$), TAT ($p = 1.000$), and push-ups ($p = 0.083$), while IAT ($p < 0.005$) and 30m sprint ($p = 0.001$). Between baseline and week 12, physical fitness measures [flexibility ($p < 0.001$); T-agility test ($p = 0.031$); Illinois agility test ($p < 0.005$); 30m sprint ($p < 0.001$); and push-ups ($p < 0.001$)] showed significant results. While between weeks 6 and 12, the fitness variables [flexibility ($p < 0.001$), T-agility test ($p = 0.031$), Illinois agility test ($p = 0.037$), 30m sprint ($p < 0.001$), and push-ups ($p < 0.001$)] also showed a positive result.

To compare the fitness variables between the two groups across time (baseline, week 6, and week 12), a post hoc test (Bonferroni) was applied, as shown in Table 4. The analysis revealed that the adjusted physical fitness variables between the Functional Training Group (FTG) and Control Group (CG) at baseline showed no significant differences in physical fitness variables ($p > 0.05$). At week 6, the T-agility test exhibited statistically significant results ($p < 0.001$), while push-ups showed significant results as well ($p = 0.024$). However, no significant changes were observed in other parameters, including flexibility ($p = 0.567$), the Illinois agility test ($p = 1.000$), and the 30m sprint ($p = 1.000$). At week 12, statistically significant differences were observed between FTG and CG in flexibility ($p < 0.001$), the T-agility test ($p < 0.001$), the Illinois agility test ($p = 0.020$), and push-ups ($p < 0.001$), except for the 30m sprint ($p = 0.175$), which showed no significant results.

At week 12, within-group comparisons indicated a substantial effect of time on push-up performance in the FTG group ($d = 2.41$). In contrast, the CG group exhibited a moderate impact on flexibility ($d = 0.33$), and a small effect on the Illinois agility test ($d = 0.12$) (Table 3). Effect size analyses between FTG and CG across three-time points demonstrated a small effect size on the Illinois agility test at baseline ($d = 0.03$), and at week 6, speed had a small effect size ($p = 0.06$) while push-ups had a large effect size ($d = 1.09$). At week 12, large effects were observed for flexibility ($d = 1.53$), T-agility ($d = 1.01$), Illinois agility ($d = 0.93$), and push-ups ($d = 1.29$), while the 30m sprint showed a moderate effect of time ($d = 0.67$) (Table 4). Figure 2 shows the mean fitness scores across the time for both groups.

Discussion

The flexibility data showed that the comparison between groups was not statistically significant at baseline and week 6 ($p > 0.05$), while they showed statistical significance for sit and reach (SAR) at week 12 ($p < 0.05$).

Table 3. Groups baseline, Week-6, and Week-12 values with Post Hoc test (Bonferroni)*

	Flexibility (inch)	Agility (s)		30m sprint (s)	Push-ups (#)
		TAT	IAT		
FTG					
Baseline	13.97 ± 1.21	11.10 ± 0.53	17.23 ± 0.73	4.49 ± 0.06	39.40 ± 3.60
Week-6	14.85 ± 1.27	10.67 ± 0.51	17.02 ± 0.68	4.46 ± 0.06	43.50 ± 3.55
Week-12	16.27 ± 1.06	10.15 ± 0.54	16.54 ± 0.49	4.39 ± 0.06	47.35 ± 2.96
p	<0.001	<0.001	0.001	<0.001	<0.001
d (baseline vs week-12)	2.02 (L)	1.77 (L)	1.10 (L)	1.49 (L)	2.41 (L)
CG					
Baseline	14.04 ± 1.34	11.02 ± 0.60	17.20 ± 0.74	4.48 ± 0.06	38.65 ± 4.89
Week-6	14.21 ± 1.49	10.89 ± 0.58	17.17 ± 0.74	4.46 ± 0.64	39.50 ± 4.91
Week-12	14.48 ± 1.26	10.72 ± 0.59	17.11 ± 0.71	4.44 ± 0.66	41.95 ± 5.13
p	<0.001	0.031	0.005	<0.001	<0.001
d (baseline vs week-12)	0.33 (M)	0.51 (M)	0.12 (S)	0.53 (M)	0.66 (M)

TAT = T-agility test; IAT = Illinois agility test; S = seconds; S = small; L = large; M = medium; inch = inches; FTG = functional training group; CG = control group; d = effect size. *p < 0.05 level of significance.

Table 4. Pairwise comparison of between group on physical fitness parameters with Post Hoc test (Bonferroni)*

	Flexibility (inch)	Agility (s)		30m sprint (s)	Push-up (#)
		TAT	IAT		
Baseline					
FTG	13.97 ± 1.21	11.10 ± 0.53	17.23 ± 0.73	4.49 ± 0.06	39.40 ± 3.60
CG	14.04 ± 1.34	11.02 ± 0.60	17.20 ± 0.74	4.48 ± 0.06	38.65 ± 4.89
p	1.000	0.407	1.000	1.000	1.000
d	0.05 (S)	0.14 (S)	0.03 (S)	0.27 (S)	0.17 (S)
Week-6					
FTG	14.85 ± 1.27	10.67 ± 0.51	17.02 ± 0.68	4.46 ± 0.06	43.50 ± 3.55
CG	14.21 ± 1.49	10.89 ± 0.58	17.17 ± 0.74	4.46 ± 0.64	39.50 ± 4.91
p	0.567	<0.001	1.000	1.000	0.024
d	0.48 (M)	0.43 (M)	0.21 (S)	0.06 (S)	1.09 (L)
Week-12					
FTG	16.27 ± 1.06	10.15 ± 0.54	16.54 ± 0.49	4.39 ± 0.06	47.35 ± 2.96
CG	14.48 ± 1.26	10.72 ± 0.59	17.11 ± 0.71	4.44 ± 0.66	41.95 ± 5.13
p	<0.001	<0.001	0.020	0.175	<0.001
d	1.53 (L)	1.01 (L)	0.93 (L)	0.67 (M)	1.29 (L)

TAT = T-agility test; IAT = Illinois agility test; S = seconds; S = small; L = large; M = medium; inch = inches; FTG = functional training group; CG = control group; d = effect size. *p < 0.05 level of significance.

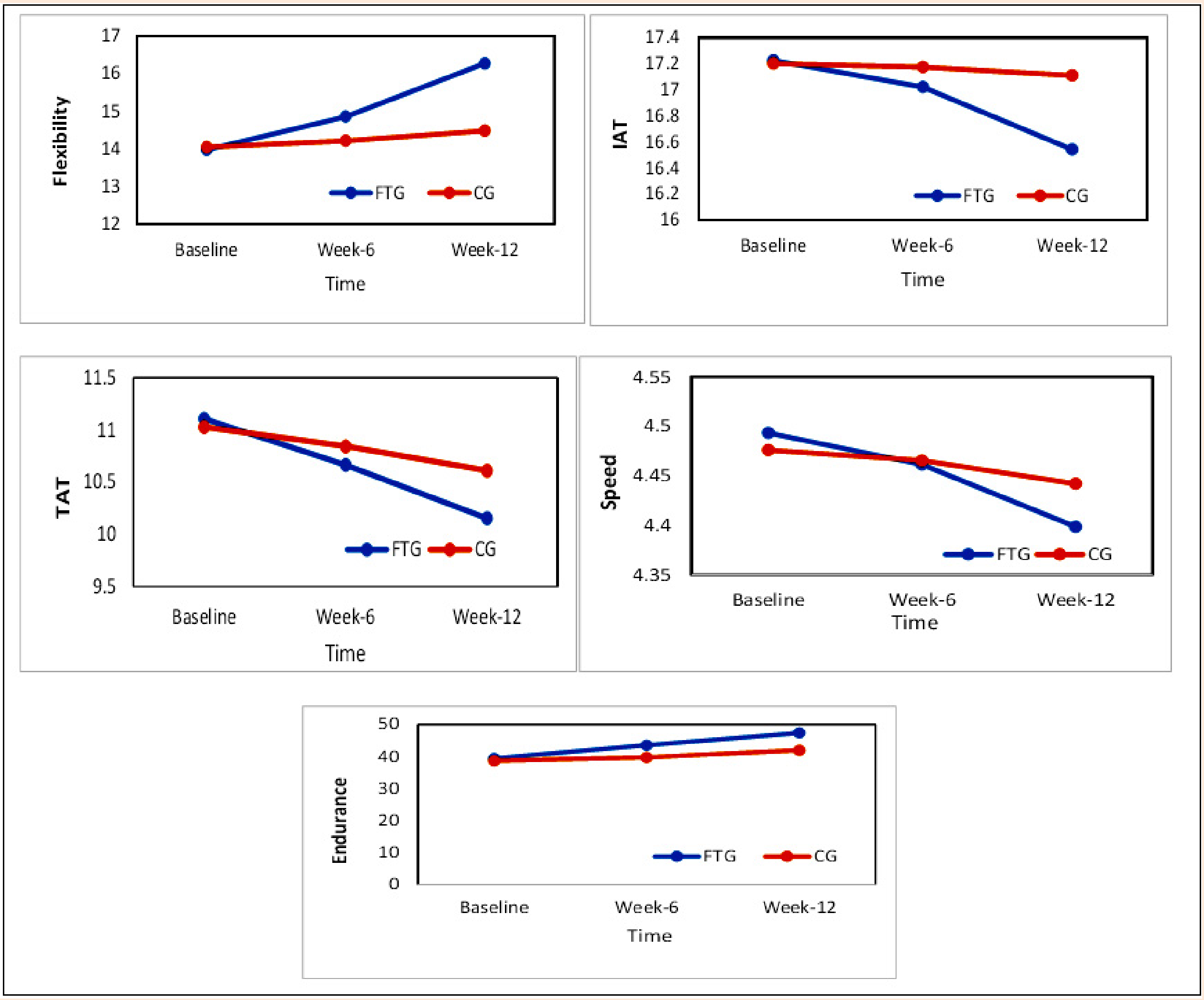

Figure 2. The Mean Scores Changes of physical fitness measure across the times for FTG and CG. Abbreviation: TAT = T-agility test; IAT = Illinois agility test; FTG = functional training group; CG = control group.

In addition, the FTG and CG within groups showed statistically significant differences ($p < 0.05$). This improvement suggests that 12 weeks of functional training should be undertaken to improve flexibility performance in elite male field hockey players. Since the joint range of motion is proportional to its frequency, participation in standardized exercise training programs can improve joint flexibility and range of motion (Robertson et al., 2003; Martin et al., 2009). Meanwhile, the results of this study showed that six weeks of functional training intervention affected flexibility performance in elite male field hockey players. The findings are the first to show that a one-month exercise training program effectively develops players (Yildiz et al., 2019), supporting our results. It is essential to note that participants who have participated in exercise training for a long time may require longer exercise training interventions (Weiss et al., 2010; Xinhui, 2019). Additionally, only one study, conducted by Yildiz et al. (2019), stated that an eight-week FT intervention indicated improvements in flexibility performance among the players. Weiss et al. (2010) reported that seven weeks of functional training programs significantly improved flexibility performance in college students (non-athletes). Notably, most of these studies were conducted three times per week (Yildiz et al., 2019; Weiss et al., 2010). Therefore, the results of this study suggest that a 12-week, three-times/week functional training method can positively enhance the flexibility performance of elite male field hockey players.

The Illinois agility test (IAT) data showed that comparisons between groups were not statistically significant at baseline and week-6 ($p > 0.05$). However, only the adjusted T agility test (TAT) at week-6 showed a statistically significant difference ($p < 0.05$). At the conclusion of the 12-week period, a notable difference was observed between the Functional Training Group (FTG) and the Control Training Group (CG). In the current study, the minimum experimental period required to observe significant differences in the agility performance of athletes after functional training was four weeks. Analysis of agility data collected over four weeks revealed significant differences (Yildiz et al., 2019). However, contradictory findings suggest that a five-week functional training intervention improves the power ability and postural control of male moderately trained athletes' led agility performance (THT), but there was no discernible variation in the quality of their speed-led agility performance, as measured by the 5 – 10 - 5 agility test, between the groups (Tomljanović et al., 2011). However, researchers need to be aware that this functional training program consists of primarily unstable resistance upper-body exercises (Tomljanović et al., 2011), whereas our intervention program consists of whole-body exercises. Thus, improvements in agility performance after six weeks of functional training intervention were somewhat unlikely. To better explain the lack of positive changes after six weeks of functional training intervention aimed at significantly improving agility performance in elite male hockey players, this may be primarily due to the failure of the intervention. Six weeks of functional training did not directly stimulate the proprioceptive properties of the knees, hips, and trunk to improve posture control and agility performance in players (Marković et al., 2007).

Additionally, only one study stated that an eight-week functional training program could increase the agility performance of athletes (Yildiz et al., 2019). However, it is worth noting that other functional training studies have shown that non-athlete agility performance is enhanced by more than six weeks of functional training intervention (Weiss et al., 2010; Shaikh and Mondal, 2012; Haddock et al., 2016). According to Weiss et al. (2010), a study investigating the advantages of a seven-week functional training intervention demonstrated statistically significant enhancements in agility performance among participants of mixed sexes. Shaikh et al. (2012) reported that eight weeks of functional training intervention could statistically improve the agility performance of male college students. Haddock et al. (2016) conducted a study about 12 weeks of functional training intervention and found that it statistically improved the agility of military personnel. Notably, most of these studies were conducted three times per week (Tomljanović et al., 2011; Weiss et al., 2010; Shaikh and Mondal 2012; Yildiz et al., 2019; Haddock et al., 2016). Therefore, based on the findings of previous studies, which primarily focused on non-athletes, there is a notable gap in the research. It is necessary to conduct additional studies on athletes to assess the impact of functional training on agility.

The speed (30m) data showed that there was no statistically significant difference between groups ($p > 0.05$) at three-time tests. However, a statistically significant difference ($p < 0.05$) was observed within the group. According to the findings of this study, there were no statistically significant differences in speed following a functional training intervention for elite male hockey players over a 6- to 12-week period. This result indicated that functional training had no additional benefit to improving the speed performance of elite male hockey players compared with standard training.

However, in the literature, it can be found that the trial period was six weeks among the studies on the significant difference in athletes' speed performance. That is, in the study by Baron et al. (2020), the analysis of 30m data revealed significant differences following six weeks of functional training intervention in football players. This improvement can be attributed to the enhanced movement patterns associated with functional training. At the same time, Turna and Alp, (2020) and Tomljanović et al. (2011) described no significant difference in speed performance in male professional and moderately trained athletes after 4 to 5 weeks of functional training intervention. These studies did not support our results because the study's intervention analysis was resolute that this result was primarily due to the researchers' attempt to simulate the real world of competitive sports (Tomljanović et al., 2011). Studies have shown that training programs for lower limbs can effectively improve athletes' speed (Fischetti et al., 2018). Notably, in our study, functional training intervention consisted of full-body training, and the results indicated that a six-week functional training intervention did not lead to a significant improvement in speed performance among elite young male field hockey players. However, data from this study showed that week 12 of functional training intervention did not positively enhance speed performance in elite male field hockey players. This result may be due to the lack of acceleration-stimulating exercises in the training program, which would benefit speed performance most (Gaudino et al., 2014). Additionally, other mechanisms that did not improve speed performance in this study, such as stride length and frequency changes, could potentially impact speed performance. Previous research has indicated a strong relationship between these two variables and speed performance (Salo et al., 2011). However, this study has not been supported by more literature, so future studies can strengthen this aspect to explain whether twelve weeks of functional training, conducted three times a week, could significantly enhance the speed performance of athletes in other sports and populations.

Furthermore, endurance levels are expected to increase in elite male field hockey players following standard training, as standard training programs can also significantly improve endurance levels (Tajudin et al., 2022). However, the baseline was not significantly different between groups ($p > 0.05$), both participants in FTG and CG received the exact duration of intervention, and the functional training group's mean endurance levels were significantly higher at week-6 and 12 than the CG group. Notably, other studies have demonstrated the effect of six weeks of functional training on endurance levels in non-athlete populations. For example, Wibowo et al. (2021) observed significant improvement in recreational runner endurance after 6 weeks of training intervention. Fathir et al. (2021) stated that six weeks of FTG significantly improved recreational runners' endurance. Studies that focus on rectus abdominal endurance are worthless. However, measuring the endurance performance of elite male field hockey players in this study was a push-up test based on an expert questionnaire. The general trend is that male youth players' endurance capacity increases with age. However, elite youth players improve more over time than sub-elite youth players (Faber et al., 2016). Therefore, in future research, greater attention should be paid to the effect of functional training on the endurance performance of field hockey players, as well as athletes in other sports and populations.

Conclusion

The current study examined the effects of a functional training program on physical fitness in elite male field hockey players. The results showed that functional training is more effective than standard training in improving the physical fitness of elite male field hockey players. In addition, six weeks of functional training was also found to have a more significant effect on T-agility test and endurance variables than standard training. Furthermore, the findings indicate that functional training provides adequate stimulation for improving physical fitness parameters but not speed in male field hockey players.

Practical implications

Based on the results of this study, functional training is a superior method and may be beneficial for elite young players to improve fitness more efficiently compared with standard training during and after 12 weeks of functional training. However, although functional training is a hot research topic in exercise training, studies have yet to be published on the effect of functional training on the physical fitness of elite male field hockey players. Nonetheless, this study's findings can assist hockey players, coaches, researchers, and managers implement the most effective exercise training methods for improving fitness. This study demonstrates that Santana's field-based functional training programs can improve elite male field hockey players' physical fitness. As a result, coaches, researchers, and managers can apply the 12-week functional training programs to other field hockey youth athletes, mainly to improve physical fitness parameters in field hockey sports. Furthermore, functional training provides more exercise prescription options for strength and conditioning practitioners.

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The authors declare that there are no conflicts of interest. The experiments comply with the current laws of the country where they were performed. The data that support the findings of this study are available on request from the corresponding author.

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Key points

- Based on Santana's functional training exercises specific for field hockey, the results were comparable to those of traditional training methods, which involved higher volume condensed into fewer sessions, in terms of enhancing fitness parameters.
- Coaches have the opportunity to enhance the physical fitness of young male field hockey players by implementing 12-week functional training. This approach incorporates field hockey-specific protocols within the functional training sessions, thereby reducing the risk of fatigue accumulation and maintaining the players' physical readiness.

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