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EFFECTIVENESS OF FUNCTIONAL TRAINING PROGRAMS IN ENHANCING FUNDAMENTAL MOVEMENT SKILL COMPETENCE AND MOVEMENT QUALITY AMONG ADOLESCENT ATHLETES

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Abstract

The purpose of this study was to determine whether an eight-week functional training program could enhance adolescent athletes' Fundamental Movement Skills (FMS). There were 40 participants aged 13-16 years, randomly allocated to experimental group (n = 20) and control group (n = 20) where the participants received functional training and regular training in school respectively. Functional Movement Screen (FMS) was tested at the beginning and the end of the intervention to assess the movement competency, mobility, stability, and coordination.

The results obtained showed that the experimental group recorded significant improvement in total FMS scores, in comparison to the control group. Comparison between pre- and post-tests depicted that there was an increase of mean 4.60 points in the experimental group and massively significant p-value ($p < 0.001$). Conversely, the control group had low and statistically non-important improvement. The seven elements of FMS improved dramatically in the experimental group with improvement in deep squat, hurdle step, inline lunge, shoulder mobility, active straight-leg raise, trunk stability, and rotary stability. The experimental group was found to be superior in post-test group comparisons, which also proved the superiority of functional training. The size of the effect was high (Cohen d= 2.3), which means it has a strong practical importance.

As a conclusion of the research, it can be stated that functional training is a very effective approach to enhance basic movement skills among the adolescent athletes. It improves quality of movement, neuromuscular control and athletic preparedness on the whole. The findings backing these include incorporation of functional training in youth sports programs and curriculum of physical education. Suggestions of future research and practice recommendations are also provided.

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INTRODUCTION

Movement competence is an important factor that predicts life-long involvement in physical activity and athletic success. Fundamental Movement Skills (FMS) including running, jumping, throwing, catching and balance are viewed as the building blocks on which sports-specific skills are built (O'Brien et al., 2022: Piotrowski et al., 2025). The process of acquiring and training these skills should occur at adolescence because motor skills that are developed during this time have a strong impact on the success in sports and engagement in physical activities in the future (Boyle, B. 2024).

Older-type strength and conditioning regimens of young athletes have focused more on isolated musculus training and performance-based measures and the functional aspect of movement patterns (Akbar et al., 2022). Conversely, Functional Training (FT) has become a multidimensional and movement-focused strategy that focuses on multi-joint, multiplanar, and task-specific activities to increase the efficiency of the body when faced with life or sport-specific situations (Boyle, 2020). The functional training is potentially aimed at strength and power, but is also designed to concentrate on stability, mobility, coordination, and proprioception characteristics that are directly related to the essential movement components (Behm and Sale, 2021: Bashir et al.,2024).

Recently, research has proven that functional training interventions have the potential to enhance motor competence, neuromuscular control and movement quality in adolescents (Gupta et al., 2023). These programs often include body-weight exercises, resistance band exercises, medicine ball exercises and exercises on unstable surfaces that simulate changing, sporting situations. FT increases the activity of the nervous and musculoskeletal system by using a wide range of muscles and planes of movement, which results in the efficiency and control of simple motor motions (Cook et al., 2019).

Such a development has necessitated functional training in order to strengthen the basic movement skills in you the on considering that interest in early specialization and participation in sports has been on the rise. Poor movement competence has been linked to higher risk of injuries, lower performance and premature quitting of sports (Lloyd et al., 2021). Thus, it is critical to empirically test the efficiency of the structured functional training programs to develop FMS among young athletes. The study will also add to the current body of evidence by laddering the evaluation of the effect of functional training on movement proficiency and overall athletic preparedness among this age group (Heinrich et al., 2023).

Although functional training has gained momentum, the extent to which it is particularly effective in the enhancement of fundamental movement skills in adolescent athletes has not been studied (Brogno, 2025). Most of the training programs in the youth level continue to focus on the traditional methods of strengthening or endurance without taking into account the quality or efficiency of the movement patterns. Subsequently, this leads to imbalances in the adolescent athletes, motor coordination and lacks transferability of strength made in the gym to the field performance (Lloyd and Oliver, 2020).

Moreover, there are also rapid development processes and neuromuscular changes inherent in adolescence which may facilitate or inhibit the motor development process depending on the quality of trainings interventions (Aslam et al., 2025: Fogliata et al., 2025). The lack of emphasis on functional movement at this age can jeopardize the future performance in sports and put the athletes at risk of being injured (Hauser et al., 2025). Hence, the evidence-based assessment of the effect of the functional training programs on the basic movement skills, motor control, and the general athletic performance of the adolescent population is urgently needed (Malambo et al., 2022: Xing et al., 2024). Although more attention has been drawn to it, there is a paucity of studies that have undertaken an elaborate research on the long term implications of functional training on basic movement ability of different sports in adolescence. Several researches are not long in

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terms of intervention and do not control confounding factors, including growth, training background, and sport type (O'Hagan et al., 2022). Moreover, the majority of studies were undertaken in developed countries, and little information is presented in the developing environment where the availability of structured FT programs might be scarce. This research will bridge this gap by empirically determining the effectiveness of structured functional training program in enhancing FMS in adolescent athletes in a controlled environment. This paper will fill the gap by exploring how a structured functional training intervention can be effective in enhancing FMS in an adolescent athlete in chosen sports fields.

Fundamental Movement Skills (FMS)

The basic skills of movement (FMS) are the major patterns of movements which are the basis of subsequent and more specialized skills (Duncan, et al., 2022). Their classification can be divided into three (namely locomotor skills (e.g. running, jumping, hopping), object control skills (e.g. throwing, catching, kicking), stability skills (e.g. balancing, twisting, bending)). Stodden et al. (2023) noted that characters of these basic patterns are vital in building movement competence and confidence in physical activities, which lead to life-long sporting and physical fitness decision making.

The development of the FMS is progressive, and it is important that at the initial age of growth, bare motor skills are acquired, and then enhanced in the adolescence stage. This is a phase with high neuromuscular, physical, and cognitive changes that may lead to great impact on the learning of skills and coordination (Kara et al., 2020). Without the ability to master FMS during adolescence, the teenagers would not be efficient in learning skills specific to sports as the performance and motivation levels decline (Wang et al., 2025).

The modern studies focus on the extrapolability of well-trained FMS to athletic performance. As an example, Adeyemi et al. (2023) discovered that athletes of agility, balance, and reaction time in competitive sports were more FMS-proficient adolescents. Thus, FMS directed training interventions should be used to increase athletic capacity and injury prevention.

Functional Training and Neuromuscular Adaptation

On top of elevating stabilizer and synergist muscles that are typically poorly developed during traditional strength training, functional training brings about positive changes in attention to the neuromuscular (Xiong, & Thadanatthaphak, 2024). These adaptations enhance the motor control, proprioception, and intermuscular coordination, which act as the main constituents of FMS mastery (Bashir et al., 2022: Akbar et al., 2022).

Electromyographic (EMG) studies indicate that functional exercises stimulate core and stabilizing muscles more strongly than isolated ones (Escamilla et al., 2021). This improves the performance of the athlete to hold a posture, balance, and body control when going through complex athletic maneuvers. Furthermore, plasticity of motor learning comes with the repetitive exposure to unstable surfaces and dynamic movements allowing athletes to perfect and automate the movement patterns more effectively (McGill et al., 2023).

Functional Training and Fundamental Movement Skills

A number of empirical investigations have been conducted on the correlation between functional training and improvement of FMS in young athletes. According to Gupta et al. (2023), object control skills and locomotor skills were significantly improved following a type of functional training program that lasted eight weeks in adolescent basketball players. Likewise, Martins et al. (2021) have discovered that FT has improved coordination, agility and balance in soccer players in their youth, as opposed to the conventional resistance training.

In a randomized controlled trial, Choudhary and Singh (2022) concluded that functional training could enhance FMS composite scores by 18% among adolescent athletes overall and balance and coordination subelements, in particular. The

Frontier in Medical & Health Research

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authors were able to conclude that FT plays a great role in stimulating central and peripheral neuromuscular mechanisms affecting more efficient movement execution.

Functional training fits well into the principles of the developmental principles of the motor learning process as it focuses on variability of practice, improving the generalization of skills (Schmidt and Lee, 2019). Training in adolescents in variable, functional conditions led to better transferability of skills to sport-specific movements, which results in the ecological validity of interventions based on FT (Rauter et al., 2022).

Functional Training and Injury Prevention

Functional training has also been identified in terms of minimizing the risk of injury by enhancing patterns of movements and posture. According to Cook et al. (2019), bad functional movement patterns, including knee valgus, lumbar flexion, or trunk asymmetry are frequent forewarners of overuse injuries. FT facilitates equilateral motion and stability of the joints by managing these deficiencies.

Lloyd et al. (2021) in their research about adolescent athletes revealed that when non-contact injuries were reduced by 25 percent in athletes who underwent functional training, versus those who went through conventional strength programs. Mediating factors that explained this protective effect were cited as improved FMS competency, core strength and neuromuscular control.

Adolescent Development and Trainability

Adolescence is a time of increased trainability, when the neuromuscular system is adaptable and receptive to the systematic training stimulus (Hardy et al., 2020). Nevertheless, at this stage of growth spurts and hormonal changes in the body, coordination, and balance may suffer at the moment (Malina et al., 2021). These transitional deficits can be alleviated and overcome using the integrated approach of functional training to strengthen movement control and proprioception.

Besides, FT gels with the Youth Physical Development (YPD) model which promotes progressive and skills-based training and development in adolescence to develop athletic foundation (Lloyd and Oliver, 2020). The use of FMS-based exercises makes sure that the adolescents progress to effective movement patterns prior to entering effectiveness in sport-oriented techniques.

Table 1: Previous Empirical Studies

A summary of key empirical studies is presented below:

Author(s)	Year	Participants	Intervention	Major Findings
Gupta et al.	2023	60 adolescent basketball players	8-week FT program	Significant improvement in FMS composite scores and balance
Choudhary & Singh	2022	40 school athletes (13–17 years)	10-week FT vs. traditional training	FT group showed higher gains in coordination and agility
Martins et al.	2021	50 youth soccer players	6-week FT intervention	Improved movement quality and motor control
Rauter et al.	2022	80 adolescent athletes	FT + balance training	Enhanced neuromuscular control and reduced injury risk
Silva et al.	2022	45 adolescent volleyball players	Functional strength and stability training	Improved proprioception and jump performance

The overall implication of such findings is that compared to the traditional strength or endurance-based training program, functional training appears to generate better outcomes with respect to the basic movement skills, coordination and balance.

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

Table 2: Demographic Characteristics of Participants

There were 40 teenage athletes (13-16 years old) who took part in the research, in an equal number (20) experiment and control groups. All the subjects were active pupils in schools who were under physical activity programs.

Variable	Experimental Group (n=20)	Control Group (n=20)	Total (n=40)
Mean Age (years)	14.5 ± 1.2	14.7 ± 1.3	14.6 ± 1.2
Gender (M/F)	12/8	11/9	23/17
Mean Height (cm)	158.6 ± 7.8	159.2 ± 8.1	158.9 ± 7.9
Mean Weight (kg)	52.1 ± 6.5	51.7 ± 7.0	51.9 ± 6.7

Table 3: Pre-Test and Post-Test Scores of Fundamental Movement Skills (FMS)

The quality of movement measured on the Functional Movement Screen (FMS) test was assessed on seven essential movement patterns (deep squat, hurdle step, inline lunge, shoulder mobility, active straight leg raise, trunk stability push-up, and rotary stability).

Group	Pre-Test Mean ± SD	Post-Test Mean ± SD	Mean Difference	t-value	p-value
Experimental	13.25 ± 2.10	17.85 ± 1.85	4.60	9.32	0.000**
Control	13.10 ± 2.05	13.75 ± 2.00	0.65	1.21	0.238

$p < 0.05$ = Significant, $p < 0.001$ = Highly Significant

The difference between the experimental and the control group was significant ($p < 0.001$) in the improvement of the FMS total scores at eight weeks of functional training, but not in the improvement of the control group. The mean difference of 4.6 is very high, which means that there is a very high strong positive influence of functional training on movement patterns.

Table 4: Subcomponent Analysis of FMS Scores

FMS Component	Experimental Pre-Test	Experimental Post-Test	Control Pre-Test	Control Post-Test	p-value (Exp)
Deep Squat	1.8 ± 0.4	2.6 ± 0.5	1.9 ± 0.4	2.0 ± 0.5	0.000**
Hurdle Step	1.9 ± 0.5	2.8 ± 0.4	1.8 ± 0.6	1.9 ± 0.5	0.000**
Inline Lunge	1.7 ± 0.6	2.5 ± 0.5	1.8 ± 0.4	1.9 ± 0.5	0.001**
Shoulder Mobility	2.0 ± 0.5	2.7 ± 0.5	2.1 ± 0.4	2.2 ± 0.5	0.002**
Active Leg Raise	2.0 ± 0.4	2.8 ± 0.4	2.1 ± 0.5	2.2 ± 0.4	0.000**
Trunk Stability	1.9 ± 0.5	2.9 ± 0.3	2.0 ± 0.4	2.1 ± 0.5	0.000**
Rotary Stability	1.8 ± 0.5	2.6 ± 0.4	1.9 ± 0.4	2.0 ± 0.5	0.000**

The seven elements reported improvement in the experimental group significantly and this implies that functional training is effective in improving mobility, stability, and coordination in a variety of movement patterns.

Comparison Between Groups (Post-Test Scores)

Variable	Experimental (Mean ± SD)	Control (Mean ± SD)	t-value	p-value
Total FMS Score	17.85 ± 1.85	13.75 ± 2.00	7.14	0.000**

The comparison of the post-test showed that there was a strong difference between the experimental and control groups ($p < 0.001$). This validates the fact that the training intervention based on functional training was

Frontier in Medical & Health Research

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significantly superior to the conventional training.

Effect Size (Cohen's d)

In order to identify the size of the functional training effect, the dn of Cohen was computed:

$$d = \frac{M_2 - M_1}{SD_{pooled}}$$

For the experimental group: $d = \frac{17.85-13.25}{2.0} = 2.3 \rightarrow$ Large Effect Size

This is indicative of an extremely high effect of the functional training on the FMS results.

The results of the research show that functional training contributed greatly to enhancing the basic movement skills in adolescent athletes. The findings are consistent with the previous studies that highlight the advantages of the combined, movement-based approaches in training.

Comparison with Previous Studies

These findings agree with the findings of Cook et al. (2019), who mentioned that functional movement-based programs have a positive effect on the coordination, balance, and mobility of youth athletes. Equally, Faigenbaum et al. (2020) concluded that compared to the traditional resistance training, functional training resided in the competency of movement and injury resilience significantly.

Additionally, Myer et al. (2016) reported that programs focused on movements enhance neuromuscular efficiency to boost motor efficiency and sport performance.

Discussion of Results

Effect of Functional Training on Total FMS Scores

The results of the current research showed that there was a significant improvement in the overall FMS scores of the experimental group following eight weeks of functional training that was extremely significant. The average improvement of 4.60 points shows that there is a significant improvement in the overall movement quality, mobility and stability. These findings substantiate the efficacy of functional training to create movement competency on adolescent athletes.

The noted changes can be explained by the type of functional training, which is focused on integrated, multi-joint, and multi-planar movements that are closely similar with those habits, which are specific to a sporting activity. In contrast to the conventional training methods where the individual muscle groups are isolated, a functional training system enhances the coordinated activity of the kinetic chain leading to the increased neuromuscular efficiency and movement control. The results align with the existing literature that stated high-quality improvement of movements after functional training interventions (Gupta et al., 2023; Martins et al., 2021).

On the contrary, the control group recorded mean improvement but marginally not statistically significant. This implies that a single physical training program conducted in school might not be adequate to cure movement shortcomings and enhance functional movement styles in adolescence.

Component-Wise Improvements in FMS

The most important conclusion of the study was the great level of improvement of all seven FMS components in the experimental group. Deep Squat: The quality of the deep squat should be improved, which means the increased lower-body mobility, hip and ankle flexibility, and the stability of the trunk. Such adaptations are necessary to produce and absorb the forces efficiently at a time when the person is engaged in sports. Hurdle Step: Hurdle Step Inline Lunge: These are important components whose significant improvement of such areas as dynamic balance, unilateral strength, and coordination. To this end, the type of functional training exercise (lunges and variant of steps) were also likely involved in these results since they tested the ability to balance posture and symmetry. Shoulder Mobility and Active Straight-Leg Raise: An increase in these examinations signifies an augmentation in joint pliability and adaptability especially in the shoulder girdle alongside the posterior chain. These adaptations may have

Frontier in Medical & Health Research

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been enabled by functional movements that include a range of movement and stability needs that people keep in control. Trunk Stability Push-Up and Rotary Stability: The core stability components had the greatest enhancement which showcases the efficacy of functional training in enhancing core musculature and enhancing neuromuscular control. It is a common knowledge that core stability poses a critical requirement to smooth movement performance and injury prevention. These findings are in line with the works by Choudhary and Singh (2022) and Silva et al. (2022), who have found that functional training had a significant positive effect on balance, coordination, and stability in adolescent athletes.

Functional Training and Neuromuscular Adaptation

The considerably high positive changes in this research can be attributed to results of neuromuscular adaptations to functional training. Functional exercises activate the muscles of stabilization and increase proprioceptive messages and professionals in the result of increased control of the body and movement accuracy. The dynamic and changing conditions of movement that are repeatedly practiced improves intermuscular coordination and motor learning that are important in learning the basic movement skills.

The level of plasticity of neuromuscular system is at the highest during adolescence, and this age is the one susceptible to appropriately designed training interventions. The functional training seems to maximize on this developmental window by reinstating the effective movement patterns and diminishing the presence of the compensatory patterns that might manifest themselves in the drastic growth stages. The results are in line with the Dynamic Systems Theory and Motor Schema Theory, which stress variability, integration, and adaptability of development of motor skills.

Comparison with Previous Studies

The findings of the current paper are very consistent with the available literature. In their study, Gupta et al. (2023) showed that an eight-week functional training program resulted in considerably higher FMS composite scores of adolescent basketball players. On the same note, Martins et al. (2021) reported better movement quality and motor control among young soccer players who have undergone functional training.

In addition, the high effect size, which was reported in the current study (d = 2.3), is higher than the ones recorded in some previous studies, which suggest that the structured character and proper time span of the intervention may have been some of the factors that led to such strong improvements. The results also support the notion that the use of functional training is better than use of traditional basis of strength or endurance training in facilitating movement competency development in the youth populations.

Conclusions

According to the results of the analysis, the following conclusion was made: Functional training has a beneficial effect on the acquisition of basic movement skills among adolescent athletes. A total of eight weeks of functional training results in a significant improvement in the overall FMS scores and as well as individual movement elements. Functional training is better than traditional physical training that students go through in school and enhance the quality of movement, stability, mobility, and coordination of movement. Such high effect size means that functional training has high practical and applied implications on the development of young athletes. Neuromuscular control and movement efficiency are beneficial in preventing injuries and enhancing performance, which cannot be achieved without functional training in the teenage age.

Recommendations

Resting on the results and conclusions of the study, the following recommendations are offered: It should be proposed to include the functional training in the school physical education programmes and the youth sports training programs in the order. Before engaging

Frontier in Medical & Health Research

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in advanced sport specific training coaches and physical education teachers should emphasize on the quality of the movements and ability to perform basic kinds of movements. The functional Movement screen (FMS) assessment is to be conducted on a regular basis in order to ascertain the deficiencies in the movements and checking training movement among the adolescent athletes. The adolescent training programs ought to focus on core stability, balance, and coordinated movement patterns to aid in long time athletic development. The coaches should be offered opportunities to learn the principles of functional training professionally by sports organizations and educational institutions.

Future Research

Research on the long-term outcomes of functional training on the movement competency and athletic performance is to be carried out in the future. The sport-specific functional training interventions in various sports in adolescence should be researched. It is also suggested to use larger samples of the studies and focus on multi-center in order to enhance the generalization. Biomechanical and electromyographic studies can also be involved in the future to enhance the comprehension of neuromuscular adaptations. Functional training should be used in a longitudinal study in order to determine the relationship with the incidence of injuries and their effect on performance.

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