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The Effect of Life Kinetic Exercises on Mental Toughness and Basic Motor Skills in Young Male Football Players

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ORIGINAL ARTICLE

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Abstract

This study aimed to investigate the effects of Life Kinetik exercises, applied in addition to regular football training, on athletes' mental toughness and basic motor skills. Life Kinetik exercises have recently gained attention for their positive influence on performance, skill acquisition speed, and the development of coordinative abilities. The study included 20 licensed male football players aged 10 to 14. Participants engaged in a training program that incorporated Life Kinetik exercises three times per week alongside their regular football training for a period of eight weeks. Assessments of basic motor skills and mental training levels were conducted before and after the intervention using the Mental Training Inventory in Sports (MTIS) developed by Yarayan and İlhan (2018). Data were analyzed using SPSS software, with the significance level set at $p < 0.05$. Analysis revealed statistically significant improvements in flexibility, skill coordination, shuttle run, dominant hand grip strength, and 30-meter sprint performance between pre-test and post-test measurements ($p < 0.05$). No significant changes were observed in body weight ($p > 0.05$). Concerning mental toughness, a significant improvement was detected in the mental visualization sub-dimension ($p < 0.05$), whereas no significant changes occurred in the total mental training score or in the sub-dimensions of basic mental skills, mental performance skills, interpersonal skills, and self-talk ($p > 0.05$). In conclusion, the addition of Life Kinetik exercises to regular football training enhanced basic motor skills and certain aspects of mental training in young male football players aged 10–14.

Keywords: Football, Life Kinetic, Mental Training, Basic Motor Skills .

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Life Kinetik Egzersizlerinin Genç Erkek Futbolcularda Zihinsel Dayanıklılık ve Temel Motorik Özellikleri Üzerine Etkisi

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Öz

Sportif performans açısından iyi planlanmış ve bilimsel temellere dayanan antrenman programlarının önemi bilinmektedir. Son yıllarda, life kinetik egzersizlerinin performansa, beceri öğrenme hızına ve koordinatif yeteneklerin gelişimine olan olumlu etkileri dikkat çekmektedir. Bu araştırmanın amacı, futbol antrenmanlarına ek olarak uygulanan life kinetik egzersizlerinin sporcuların zihinsel dayanıklılık ve temel motorsal özelliklerine etkisini incelemektir. Araştırma grubunu, 10-14 yaş aralığında lisanslı 20 erkek futbolcu oluşturmuştur. Sporculara, sekiz hafta boyunca haftada üç gün olmak üzere, futbol antrenmanlarına ek olarak life kinetik egzersizlerini içeren bir program uygulanmıştır. Antrenman öncesi ve sonrası, temel motorsal özelliklerin belirlenmesine yönelik ölçümler ile sporcuların zihinsel antrenman düzeylerini değerlendirmek amacıyla Yarayan ve İlhan (2018) tarafından geliştirilen "Sporda Zihinsel Antrenman Envanteri (SZAE)" kullanılmıştır. Veriler SPSS istatistik programı ile analiz edilmiştir ve anlamlılık seviyesi $p < 0,05$ olarak kabul edilmiştir. Analiz sonuçları, esneklik, beceri koordinasyonu, mekik koşusu, dominant el kavrama kuvveti ve 30 metre sürat performanslarında antrenman öncesi ve sonrası arasında istatistiksel olarak anlamlı gelişmeler olduğunu göstermiştir ($p < 0,05$). Ancak, sporcuların vücut ağırlığında anlamlı bir değişiklik gözlenmemiştir ($p > 0,05$). Zihinsel dayanıklılık açısından, mental canlandırma alt boyutunda anlamlı bir iyileşme saptanırken ($p < 0,05$), zihinsel antrenman ölçeği toplam puanı ile zihinsel temel beceriler, zihinsel performans becerileri, kişilerarası beceriler ve kendinle konuşma alt boyutlarında anlamlı değişiklikler görülmemiştir ($p > 0,05$). Sonuç olarak, 10-14 yaş grubundaki genç erkek futbolcuların antrenmanlarına ek olarak uygulanan life kinetik egzersizlerinin, sporcuların temel motorsal özelliklerini ve bazı zihinsel antrenman boyutlarını geliştirdiği belirlenmiştir.

Anahtar kelimeler: Futbol, Life Kinetik, Zihinsel Antrenman, Temel Motorsal Özellikler.

Introduction

Developed in Germany, kinetic brain exercises are currently utilized worldwide as an educational and training program designed to revitalize neuronal learning processes, restructure brain networks, alleviate neurological symptoms, and enhance concentration and visual system performance. These exercises employ activities with varying difficulty levels tailored to individual abilities; as a person's capacity improves, the exercises progressively become more challenging to further stimulate the brain.

Today, it is widely accepted that peak athletic performance results from meticulously planned and scientifically validated training systems. Achieving high-level performance requires training that integrates technical and tactical skills, physical conditioning, psychological qualities, and coordination. The speed and repetition of skill acquisition depend largely on coordinative abilities. Coordination is essential for the effective use of talent, technique, and tactics at an advanced level. Kinetic brain training fosters active cognitive engagement in athletes (Lutz, 2017). Components of Life Kinetik training include movement science, functional anatomy, modern brain research, and functional optometry (measurement of visual acuity and field). This training combines sport-specific technical or motor movements with mental content, creating new neural connections in the brain (Peker, 2014).

Such integrated training is thought to rapidly enhance cognitive functions such as perception, concentration, and decision-making, while simultaneously improving coordination and athletic performance (Lutz, 2010). In football, quickness in both offensive and defensive plays, especially in open play and goal-scoring areas, is crucial. Players must develop versatile strength, and spinal mobility plays a critical role in executing technical and tactical skills. Full-body coordination is vital during gameplay (Senemoğlu, 2007; Arslan and Ermiş, 2023). Speed, a fundamental motor skill, strongly influences football performance and requires structured training for optimal development. Improvements in speed, combined with dynamic and efficient training methods, positively impact performance and success (Günay, 2005). Understanding key motor characteristics specific to different sports is crucial for achieving targeted outcomes. In football player selection, evaluating candidates solely on ball-handling skills is insufficient; knowledge of motor abilities and the development of sport-specific athlete profiles are essential (Akçakaya, 2009). The development of skills necessitates a harmonious equilibrium of endurance, agility, and strength training. Basic strength and endurance are fundamental prerequisites for successful coordination skills. Robust coordination is imperative for the effective management of motor commands. Achieving success in this domain necessitates movement variation, with the incorporation of additional movements or an augmentation in intensity

serving as a catalyst for skill development (Morrison and Newell, 2023). Within this framework, integrating mental and Life Kinetik exercises into football training from an early age is crucial for fostering both basic motor skills and mental abilities. This study aims to examine the effects of Life Kinetik exercises added to football training on athletes' basic motor skills and mental resilience levels.

Materials and Methods

Research Method/Model

The present study was conducted using an experimental research design based on pre-test and post-test measurements. The research method aims to examine the cause-and-effect relationships of changes in intra-group mental resilience and basic motor skills. In this context, 20 volunteer footballers underwent Life Kinetik exercises in addition to their regular football training, and the effect of these exercises on the athletes' performance and skill levels was evaluated comparatively. The study was conducted in accordance with the principles outlined in the Declaration of Helsinki, and all participants provided informed voluntary consent. Ethical approval was obtained from the Dicle University Social and Human Sciences Ethics Committee prior to the commencement of the study (Approval No: 2023/166).

Universe and Sample of the Research

The study population comprised 20 volunteer athletes aged between 10 and 14 years who were training at the Genç Murat Spor football school in the Genç district of Bingöl province and had held a sports licence for a minimum of two years. The inclusion criteria for the study were as follows: participants had to be within the specified age range, have held a sports licence for a minimum of two years, participate in regular training, and consent to voluntary participation in the study. Exclusion criteria encompassed athletes who sustained significant injuries during the study period and were unable to continue training, those who did not adhere to the study protocol, or those whose sports licence period was less than two years. Before and after the life kinetic training intervention, pre-test and post-test measurements were conducted to assess flexibility, strength, skill coordination, shuttle run performance, dominant hand grip strength, and 30-meter sprint speed. Additionally, the Mental Training Inventory in Sports (MTI) was administered to evaluate the athletes' mental training levels.

Applied Tests and Measurements

Speed Test

For the speed test, a 30-meter track was set up within the football field. The test required athletes to run the 30-meter distance at their maximum speed. The athletes' performance was recorded from start to finish using a digital stopwatch during both pre-test and post-test sessions. Prior to the test, the 30-meter track was introduced and necessary instructions were provided, followed by one or

two practice attempts. Athletes began from a stationary starting position at the designated test area, prepared to start upon the signal. The test was conducted twice, and the fastest finishing time was recorded in seconds (Mutlu Bozkurt et al., 2021).

Endurance Test

This test was designed to measure aerobic endurance. The endurance running test required participants to run a total distance of 20 repetitions of 4 meters (20 × 4 m), serving as an indicator of maximal aerobic capacity and endurance. The measurements were conducted on a quiet, well-lit outdoor football field. The objective was for athletes to maintain a consistent running rhythm throughout the test until completion of the total distance. The test setup included four cones arranged facing each other to mark the running course. The test concluded when the participant crossed the final cone, and performance time was recorded in seconds (Poul and Kulkarni, 2025).

Coordination Test

Coordination levels were assessed alongside the participation in Life Kinetik exercises. The coordination test administered to participants measured their ability to perform various motor movements quickly, smoothly, and with control. The test was conducted on a quiet, well-lit outdoor football field. The course incorporated equipment such as cones, slalom sticks, a Life Kinetik exercise ball, a badminton racket, and a pool ball. The test concluded when athletes crossed the final cone, and their completion time was recorded in seconds (Morawietz et al., 2024).

Strength Test

Athletes' handgrip strength was measured using a Takkei brand handgrip dynamometer with a sensitivity of 0.100 kg. Measurements were taken while the athletes stood with their arms bent and hands not touching the body. Each hand was tested twice, and the highest value recorded, expressed in kilograms, was used for analysis (Sezer et al., 2017).

Flexibility Test

The flexibility of the study group was assessed using the sit-and-reach test. For this test, athletes sat on the floor with bare feet placed flat against a bench. They were instructed to reach forward as far as possible with their torso facing forward and knees fully extended, holding the position for one to two seconds. Each participant performed the test twice, and the best measurement, recorded in centimeters, was used for analysis (Erdoğan et al., 2020).

Mental Training Inventory in Sports (MTIS)

The "Mental Training Inventory in Sports" (MTIS), used as a data collection tool in this study, is a 5-point Likert-type scale comprising 20 items across five sub-dimensions: Basic Mental Skills,

Mental Performance Skills, Interpersonal Skills, Self-Talk, and Mental Visualization. The scale's total scores range from 20 to 100, with interpretative categories as follows: Very Inadequate (0–29), Inadequate (30–49), Average (50–69), Good (70–89), and Very Good (90–100). The validity and reliability of the MTIS were established by Yarayan and İlhan (2018), with a Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy of 0.899, Bartlett's test of sphericity value of 3247.940, and a Cronbach's alpha coefficient of 0.91, indicating high internal consistency.

Training Program

The present study implemented an 8-week training programme with the objective of developing footballers' coordination, attention, ball control and dual-task skills. The programme comprised stages that occurred in two-week periods. In weeks 1–2, following a series of warm-up exercises designed to enhance agility, coordination, and balance, the footballers transitioned to a series of throwing and catching exercises. These exercises involved the use of a pool ball, which the players were required to throw and catch while simultaneously dribbling a football. The development of attention and coordination skills was facilitated by the utilisation of balls of varying colours and the execution of hand-switching commands. In weeks 3–4, players were instructed in double-handed ball bouncing, ball exchanges with a partner, and passing drills based on the coach's colour commands. This stage of the experiment focused on the players' reaction speeds and paired coordination. In weeks 5 and 6, players were instructed to engage in individual training, which involved dribbling a football while simultaneously throwing and catching a pool ball. They were also instructed to reach cones of the opposite colour to the one indicated. The present section is concerned with the development of individual ball control, attention span, and decision-making skills. In weeks 7 and 8, the exercises commenced with slaloms devoid of a ball and progressed to more intricate tasks incorporating both the football and pool ball, encompassing passing and altering direction. The level of difficulty was increased by the introduction of mixed commands from the coach, thereby developing the players' multitasking skills. Throughout all stages, participants were instructed to maintain visual contact with the coach while manipulating the ball, in accordance with the programme's overarching emphasis on integrating the development of both physical and cognitive abilities.

Life Kinetic Training Program

Figure 1. Warm-up Exercise

In Figure 1, the player is shown performing warm-up exercises involving the soccer ball placed in front of him. These exercises include stepping on the ball alternately with the right and left foot, circling around the ball forwards and backwards, approaching and retreating from the ball, and running towards the ball on command while raising the knee in place. These warm-up activities, conducted prior to training sessions, aim to enhance the effectiveness of subsequent training and drills.

Figure 2. Week 1-2 Training

In Figure 2, players begin by switching places with their partners while walking and controlling the soccer ball. Upon command, they toss and catch a ball approximately 30 cm high using pool balls, all while continuing to dribble. When the ball is in the right hand, players switch it to their left hand; when it is in the left hand, they switch it to the right hand, maintaining the dribble. The exercise is made more challenging by introducing different colored balls. On the command "right," the ball must be held in the left hand; on "left," in the right hand; and on "double," the ball is bounced alternately in both hands as dribbling continues. Throughout the drill, players must maintain focus on the coach while controlling the ball in motion.

Figure 3. Week 3-4 Training

In Figure 3, players begin by approaching and moving away from the soccer ball alongside their partners, bouncing the ball with both hands. Next, they walk toward a central soccer ball while continuing to bounce their balls with both hands, and partners alternate throwing pool balls to each other using both hands. As the drill progresses, the difficulty increases: upon command, partners holding the red ball perform a double bounce, approach the central ball, and pass it to their partner using the inside of the foot. In the final stage, partners incorporate their own balls while continuing the drill. Throughout the exercise, players must maintain their focus on the coach while moving the ball with their feet.

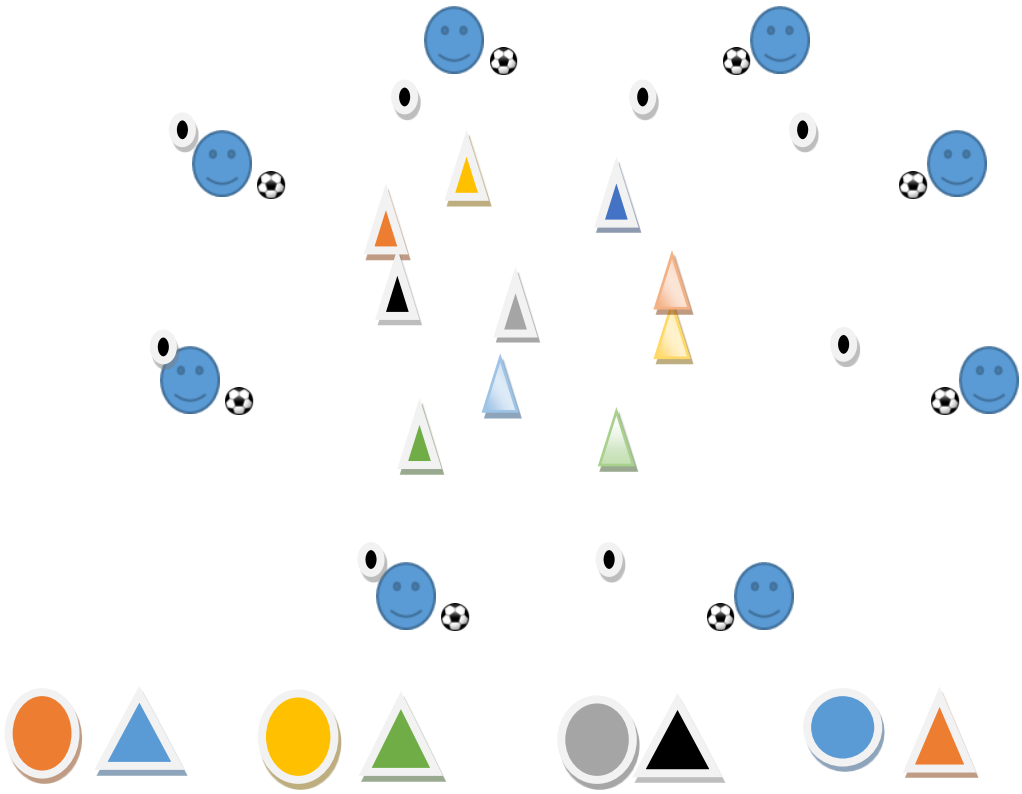

Figure 4. Week 5-6 Training

In Figure 4, players first practice individually by tossing and catching the soccer ball, each using a ball of a different color. Upon command, the player dribbles the ball while tossing and catching it, aiming to reach the funnel marked with the opposite color. The training progresses through stages, increasing in difficulty based on the player's performance. Throughout the exercise, the player must maintain focus on the coach while controlling the ball in motion.

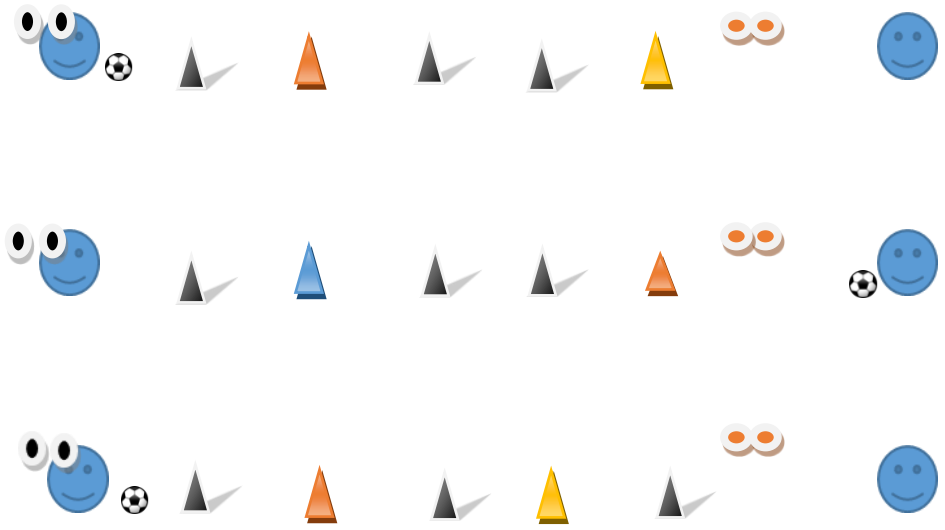

Figure 5. Week 7-8 Training

In Figure 5, players initially perform a slalom by throwing and catching a ball with both hands while weaving between cones, without using the soccer ball, before swapping places with their partner. In the second phase, players use a single pool ball to navigate the slalom while dribbling the soccer ball, then swap places. In the third phase, upon reaching cones of different colors, players transfer the pool ball from their right hand to their left hand and vice versa. In the final phase, players pass the ball to the opposite side, perform the slalom with the pool balls, and after passing the last cone, receive the soccer ball from their partner via a through-foot pass to complete the slalom once again. This training progresses through four stages with mixed commands and varying difficulty levels. Throughout the exercise, players must maintain focus on the coach while controlling the ball in motion.

Data Analysis

The data were analysed using the SPSS statistical programme. The normality of the distribution of the data was ascertained through an examination of the skewness and kurtosis values. Data exhibiting skewness and kurtosis values within the ±2 range were deemed to be normally distributed (George and Mallery, 2010). The application of parametric tests to data exhibiting a normal distribution is a well-established statistical technique. The demographic information of the

participants was presented in the form of frequency percentages and arithmetic means, in order to provide a comprehensive overview of the sample. The Paired Samples t-test was utilised to compare the pre-test and post-test measurements of the research group, with a statistical significance level set at $p < 0.05$. The analyses demonstrated that the incorporation of Life Kinetik exercises into a football training regimen resulted in substantial enhancements in flexibility, skill coordination, shuttle run, dominant hand grip strength, and 30-metre sprint performance (Cohen's d = 0.59–0.82, 95% CI [0.12–1.30], $p < 0.05$). Furthermore, substantial enhancements were identified in the mental visualisation sub-dimension. However, no significant changes were detected in body weight or other mental training sub-dimensions.

Table 1

Mean, Standard Deviation, Skewness, and Kurtosis Values for the Sports Mental Training Inventory and its Subscales

Sub-Dimensions	Mean	sd	Skewness	Kurtosis
Basic Mental Skills (1)	17,88	0,88	,607	-,246
Mental Performance Skills (1)	26,44	2,25	-,609	-,645
Interpersonal Skills (1)	17,11	1,63	-,168	-1,201
Self-Talk (1)	13,11	1,50	-,403	-,669
Mental Visualization (1)	12,22	1,71	,127	-1,315
Mental Training Inventory in Sports (1)	86,61	5,09	,062	-,682
Basic Mental Skills (2)	17,55	1,14	-,930	0,602
Mental Performance Skills (2)	25,77	2,12	-,253	0,262
Interpersonal Skills (2)	16,66	1,46	-,553	0,294
Self-Talk (2)	12,33	1,62	-,296	-,654
Mental Visualization (2)	13,33	0,81	0,541	0,190
Mental Training Inventory in Sports (2)	85,33	3,83	,177	-,782

Findings

Table 2

Pre- and Post-Training Comparison Analyses of Athletes' Physical Measurements

Measurements	Pre-test		Post-test			
	$\overline{X}$	ss	$\overline{X}$	sd	t	p
Body Weight	48,99	7,81	4956	7.99	-0.798	0.43
Flexibility	27,75	2,83	29.85	3.99	-4.291	0.00*
Skill Coordination	36,29	5,40	33.73	5.04	2.640	0.01*
Shuttle	30,26	2,76	27.42	2.61	4.891	0.00*
Strength	27,25	8,60	31.05	10.78	-4.254	0.00*

Speed	5,53	0,43	5.35	0.59	2.986	0.00*

*p< 0.05

As shown in Table 2, there was a statistically significant difference between the pre-test and post-test values for athletes' flexibility, skill coordination, shuttle run, dominant hand grip strength, and 30-meter speed ($p < 0.05$). However, no statistically significant difference was found in body weight between the pre-test and post-test measurements ($p > 0.05$).

Table 3

Pre- and Post-Training Comparison Analyses of Athletes' Mental Measurements

Variables	**Pre-test**		**Post-test**			
	$\overline{X}$	**ss**	$\overline{X}$	**ss**	**t**	**p**
Basic Mental Skills	161.70	1.14	17.95	0.88	1.280	0.21
Mental Performance Skills	25.70	2.12	26.35	1.14	1.395	0.17
Interpersonal Skills	16.05	1.98	17.05	1.63	2.055	0.05
Self-Talk	12.30	1.62	13.05	1.50	1.561	0.13
Mental Visualization	13.35	0.81	12.25	1.71	-2.604	0.01*
Mental Training Inventory in Sports	84.90	4.08	86.65	5.09	1.804	0.08

*p< 0.05

When examining Table 3, a statistically significant difference was observed between the pre-test and post-test scores in the mental visualization sub-dimension of the athletes ($p < 0.05$). However, no statistically significant differences were found between pre-test and post-test scores for the total mental training scale, basic mental skills, mental performance skills, interpersonal skills, and self-talk sub-dimensions ($p > 0.05$).

Discussion and Conclusion, Recommendations

This study aimed to examine the relationship between body weight, strength, speed, flexibility, endurance, skill coordination, and soccer skills in children aged 10 to 14 who actively play soccer. The results revealed that incorporating an 8-week Life Kinetics training program alongside regular soccer training positively influenced athletes' flexibility, skill coordination, sit-up performance, strength, and speed, leading to significant improvements. Supporting these findings, Kurt and Çolak (2022) reported that although 8 weeks of Life Kinetics training applied to badminton players did not produce statistically significant changes in agility, balance, speed, and reaction time, a positive and significant difference was observed in orientation ability between the control and experimental groups. Similarly, Aycan (2022) examined the effects of Life Kinetics training on

football players at Samsun Spor Football Club's youth academy over 12 weeks, finding statistically significant improvements in agility and Life Kinetics track test results in the experimental group compared to the control group. In volleyball, Kocaoğlu et al. (2022) investigated the impact of Life Kinetics exercises on female players' reaction time and skills, concluding that while there were no significant differences in hand pass, reaction, and spike performance between the Life Kinetics and routine training groups, the exercises contributed to improvements in serving and finger passing techniques. Pietsch et al. (2017) applied a mental rotation test alongside Life Kinetics exercises for primary school students twice weekly over five weeks, noting a 49.94% improvement in the experimental group compared to 7.6% in the control group. Conversely, Buraczewski et al. (2016) found no statistically significant effects of Life Kinetics exercises on kinesthetic perception and rhythm skills in female football players. Faris et al. (2022) observed positive improvements in forehand strokes among table tennis players following Life Kinetics training. Cakir et al. (2020) reported no significant effects of a 6-week Life Kinetics program on speed jump and agility performance in football players. Komarudin et al. (2019) also found no significant differences between routine football training and Life Kinetics training in enhancing football performance. More recent research by Korkmaz et al. (2023) demonstrated significant improvements in technique (stationary and moving ball), reaction time, and balance in 12–13-year-old male and female football players following Life Kinetics training compared to controls. Mulyadi et al. (2021) further reported that a 7-week Life Kinetics training program positively affected concentration levels in football players.

The findings of this study suggest that Life Kinetics (LK) training may contribute to the development of certain physical and cognitive skills related to athletic performance. However, the effectiveness of this training may vary depending on the sport, the skill being measured, and the duration of the intervention. The research results indicate a significant difference between the pre-test and post-test scores of athletes in the mental imagery sub-dimension. However, no statistically significant difference was found in the total mental training scale and the basic mental skills, mental performance skills, interpersonal skills, and self-talk sub-dimensions ($p > 0.05$). Furthermore, it was determined that the application of LK exercises in conjunction with football training positively affected the athletes' overall mental training levels. However, in the present study, while the effect of LK training on mental performance was discussed, only examples from the literature were provided, and no explanations were given as to why the results were as they were. It is noteworthy that the observed enhancement was predominantly confined to the domain of mental imagery. This finding can be attributed to the direct impact of the exercises on attention, perception, and visualisation processes. The absence of significant variance in other sub-dimensions may be ascribed to the brief duration of the programme, inadequate training intensity, or the existence of alternative methods for

developing these skills. Examining related research, Kumar et al. (2016) compared mental toughness between male and female volleyball players at the South Asian Games and found no significant gender differences in mental toughness test results. Crust and Azadi (2010) reported a positive and significant relationship between athletes' emotional control, relaxation, self-talk strategies, and mental toughness. Al Jubouri et al. (2016) demonstrated that a mental training program implemented alongside routine volleyball training effectively increased athletes' mental toughness despite psychological pressures. Aksoy (2021) compared mental training skills between football and taekwondo athletes, finding significant differences in interpersonal skills and mental performance skills but not in self-talk, basic mental skills, or mental visualization. Newland (2009) examined mental toughness and performance in university basketball players, reporting no significant correlation between mental toughness and performance, though male athletes exhibited higher mental toughness levels than females. In youth soccer, Kulak et al. (2011) found that combining mental and physical training improved flexibility, balance, and speed in 10- to 12-year-old players, whereas physical training alone produced no such improvements. Dehghani and Ebrahimi (2017) showed that psychological skills training significantly enhanced mental toughness in talented female volleyball players. Nicholls et al. (2015) further highlighted a positive association between mental toughness, emotional intelligence, and flexibility in athletes, suggesting a mediating role of mental toughness in sports performance.

The present study is not without its limitations. Firstly, the sample size is limited to only 20 athletes, which restricts the generalisability of the results. Given that the study was conducted at a single football academy and within a specific age range (10-14 years), the external validity of the findings may be limited when applied to different age groups or athletes of different levels. Moreover, due to the temporal constraints imposed by the research period, the investigation did not permit the examination of the long-term effects of Life Kinetik exercises. The outcomes may also be influenced by uncontrollable individual factors, including the intensity of the athletes' training, their nutritional intake, and their sleep patterns. It is important to note that the study's scope was limited to football players; consequently, its generalisability to athletes in other sports remains to be investigated.

In conclusion, it has been determined that Life Kinetik exercises, in addition to regular football training, have a positive effect on athletes' fundamental motor skills. Moreover, the training programme in question has been designed to support athletes' mental training levels, thereby contributing to the development of cognitive processes such as attention, concentration and visualisation. This finding indicates that Life Kinetik exercises represent a comprehensive approach to developing both physical and mental performance.

Suggestions

- The effects of Life Kinetik exercises on athletic performance can be further investigated by applying them to different age groups within football.
- The impact of Life Kinetik exercises on athletic performance across various sports disciplines can be explored.
- Life Kinetik exercises can be introduced to athletes at an early age, and their effects on both mental and physical development can be systematically examined.

Author's note

This study is derived from the Master's thesis of Hakan ŞİRİN.

Ethical Approval Information

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Author Contribution Statement

Both authors contributed equally to all stages of the research

Conflict of Interest Statement

The authors declare that they have no conflicts of interest in relation to this research.

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