Exercise-Based Rehabilitation for Injured Football Players: A Systematic Review and Meta-Analysis

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ABSTRACT

This study aimed to investigate the effects of exercise programmes on pain, muscle strength, range of motion, functional performance, and balance in injured football players using a meta-analysis. A systematic review of twenty-four papers published from the 2000s to the present, from Korea and other countries, was conducted. The meta-analysis results indicated that exercise programmes were generally effective for football players recovering from injuries. Specifically, exercise programmes led to statistically significant improvements in muscle strength, range of motion, and functional performance. However, they did not significantly alleviate pain or enhance balance. First, the hypothesis that exercise programmes would reduce pain in injured football players was not supported, indicating that exercise is not effective for pain relief. Second, the hypothesis that exercise programmes would improve muscle strength was confirmed, showing that exercise is effective in enhancing muscle strength. Third, the hypothesis that exercise programmes would increase the range of motion was upheld, demonstrating the effectiveness of exercise in improving flexibility. Fourth, the hypothesis that exercise programmes would boost functional performance was supported, indicating that exercise enhances performance ability. Finally, the hypothesis that exercise programmes would improve balance was not significant, showing no effectiveness in balance improvement.

Keywords: Exercise programs, Injured football players, Pain relief, Muscle strength

INTRODUCTION

Football is the world's most popular sport, with approximately 270 million active players, according to the International Football Federation. However, football also has a high incidence of injuries, with re-injuries being common. For instance, there is a significant likelihood of ankle re-injury within a year following an initial injury. After treatment, injured football players engage in rehabilitation exercise programs to restore their functions and resume sporting activities. The average recovery time is 61 days for severe ankle injuries and 28 days for moderate injuries. Various studies have investigated the effects of exercise programs on injured football players, with some reporting unfavourable outcomes.

Injuries lead to increased pain and decreased muscle strength, range of motion, functional performance, and balance in football players. Consequently, research has evaluated the impact of post-injury exercise programs on these parameters by measuring effect sizes before and after the program. Studies also examine how exercise programs specifically affect pain in injured areas, providing insights into the impact on each damaged area and variable. However, a comprehensive analysis synthesizing these findings is essential for determining more effective exercise programs. This study aims to analyse the effects of exercise programs on professional and youth football players across various countries following injuries. It assesses the impact of rehabilitation intervention programs on different effect variables, injured domains, and specific programs. By verifying the effect of interventions on each variable and damaged area, and analysing the overall impact of each program, this study provides fundamental data on effective athletic programs.

The study employs a meta-research methodology to synthesize and analyse existing studies rather than conducting new experimental research. Given the heterogeneity in sample sizes and exercise programs, this study calculates a single, quantified effect size while addressing potential uncertainties. The research questions guiding this study are: Do exercise programs yield significant results in terms of pain, muscle strength, range of motion, functional performance, and balance? Do they produce significant outcomes for specific injured areas and overall recovery? By synthesizing results and providing a single effect size for each variable, this study aims to help implement more validated intervention programs, promoting recovery and functional performance in injured football players.

MATERIALS AND METHODS

This study analyzed academic journal articles published between 2000 and 2020 from various countries, including Korea. The literature review followed the guidelines in the systematic literature review handbook of the Cochrane Collaboration and adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) procedure. This review was approved by the Gachon University Ethics Committee (1044396-202203-HR-049-01).

A comprehensive literature search was conducted using several databases, including the Korean Studies Information Service System (KISS), KoreaMed, DBpia, Korea Education & Research Information Service (KERIS), and Korean Studies Information (KSI). These databases contain literature written in Korean. Additionally, foreign literature searches were performed using PubMed, MEDLINE, ClinicalKey, ScienceDirect, and Web of Science, focusing on academic journals published within the last 20 years and domestic doctoral research papers. The search terms used included “Football,” “Rehabilitation,” “Injury,” and “Exercise.” The final search was conducted on September 1, 2020, covering studies published between January 2000 and August 2020. The search yielded 34,456 studies, including 175 from DBpia, 63 from KoreMed, 16

Table 1. Data sets examined

Kinds of Effect	Number Studies	Point estimate	Standard error	Variance	Lower limit	Upper limit	Z-value Upper limit	P-value
Pain	29	-0.20647	0.577993	0.334075	-1.33931	0.926375	-0.35722	0.720928
Muscle strength	101	0.465814	0.110819	1.23E-02	0.248613	0.683015	4.203386	2.63E-05
Functional performance	116	0.635294	5.60E-02	3.14E-03	0.525488	0.745	11.33956	0
balance	8	-0.81064	0.341837	0.116852	-1.48063	-0.14065	-2.37142	1.77E-02
ROM	26	0.783897	9.91E-02	9.82E-03	0.589654	0.97814	7.90973	2.66E-15
Total	304	0.608873	4.41E-02	1.95E-03	0.522371	0.695375	13.79592	0

from Korean Academic Information, 101 from the Korea Education and Research Information Service, 9,116 from PubMed, 8,250 from MEDLINE Complete, 726 from Clinical Key, 1,744 from ScienceDirect, and 14,265 from the Web of Science. During the initial screening, 34,219 studies were excluded based on titles and abstracts, and 35 studies were identified as duplicates.

SELECTION OF STUDY CATEGORIES

Following a systematic literature review, it was determined that exercise programs applied to football players significantly impact pain, muscle strength, range of motion (ROM), functional performance, and balance. This study conducted a meta-analysis of 21 previous studies to assess these variables as dependent variables. The primary objective is to investigate the effect size of exercise programs on these aspects among football players recovering from injuries. The analysis categorizes effects by variables (Pain, Muscle strength, ROM, Functional performance, Balance), damaged areas (Muscle, Knee, Ankle), age groups (Youth, Adults), and types of exercise programs, including muscle strengthening, plyometric exercises, electrotherapy for pain relief, and other comprehensive programs.

RESULTS AND DISCUSSION

A funnel plot was utilized to visualize the distribution of effect sizes (x-axis) and standard errors (y-axis) from the 21 studies included in this meta-analysis (Figure 1). Approximately one-third of the results clustered around the average effect size, with others dispersed to the left and right. The asymmetrical distribution suggests potential publication bias, where studies with significant findings may be more likely to be published than those with null results. This skew indicates a tendency for effect sizes to be slightly overestimated, influencing the overall interpretation of the meta-analysis.

The quality of the 21 selected studies was assessed using the Cochrane Risk of Bias (RoB) tool. Approximately 52.4% of studies had uncertainties regarding random allocation order generation, and 57.2% lacked clear allocation order concealment. Implementation bias was uncertain in 62.0% of studies, while confirmation bias was uncertain in 19.1%. Dropout bias was uncertain in 14.3% of studies, and reporting bias was uncertain in 19.1%. Other biases were uncertain in 28.6% of studies. Overall, most studies demonstrated a low risk of bias, particularly in confirmation, dropout, reporting, and other biases, although uncertainties existed in randomization and allocation concealment methods.

For the second selection phase, focusing on the effectiveness of exercise programs, additional criteria were applied. Studies were excluded if they lacked the original text, did not employ a randomized clinical trial design, or involved interventions other than prescribed exercise programs. Additionally, studies were excluded if they involved non-elite football players, lacked appropriate medical results, or were doctoral dissertations. Ultimately, 26 studies without the original text, 38 studies without randomized clinical trial designs, 23 studies on other interventions, 18 studies on non-elite football players, 58 studies without appropriate medical results, and 15 other studies were excluded. Finally, 6 Korean studies and 15 overseas studies, totaling 21 studies, were included for analysis. The exclusion criteria are summarized as follows: duplicated articles, articles without full text, studies not focusing on the effectiveness of exercise programs, studies with interventions other than the prescribed exercise program, studies involving non-elite soccer players, studies lacking appropriate medical results, articles with insufficient details, and articles with limited rigor.

EFFECT SIZE OF THE RESEARCH RESULTS

Category	N	The mean effect size (D)	95% CI	P
Kind of effect				
Pain	29	-0.19	-1.36 ~ 0.99	.752
Muscle strength	101	0.68	0.57 ~ 0.79	.000***
ROM	26	0.77	0.60 ~ 0.95	.0000***
Functional performance	116	0.58	0.36 ~ 0.81	.0000***
Damaged area				
Muscle	33	0.26	-0.01 ~ 0.52	0.055
Knee	70	-0.05	-0.30 ~ 0.19	0.654
Ankle	37	0.93	0.84 ~ 1.03	0.000***
Complex	140	0.95	0.66 ~ 1.25	0.000***
Type of exercise program				
Physical exercise	111	0.57	0.43 ~ 0.72	0.000***
Electrotherapy	2	-0.46	-0.97 ~ 0.06	0.085
Plyometric exercise	13	0.42	0.07 ~ 0.77	0.019*
Others	154	0.70	0.42 ~ 0.97	0.000***
Age group				
Adult	211	0.59	0.42 ~ 0.78	0.000***
Youth	69	0.61	0.47 ~ 0.75	0.000***

*** P < .001, * P < .05

EFFECT SIZE OF EXERCISE PROGRAM IN FOOTBALL PLAYERS

The homogeneity analysis indicated heterogeneous results among the 21 selected studies, leading to the use of a random-effects model for effect size analysis. The average effect size across 280 measurements was 0.57, with a 95% confidence interval of 0.43-0 (p<.001), indicating statistical significance (Table 3). The meta-analysis supported the hypothesis that exercise programs significantly improve the conditions of football players (p<.001). While some studies reported ineffectiveness, synthesizing previous research through meta-analysis showed a high degree of evidence supporting the benefits of exercise programs. Overall, the findings suggest that exercise programs effectively enhance the condition of football players.

RESULTS AND CONCLUSIONS

This study investigated the impact of exercise programs on football players across several key outcome measures: pain, muscle strength, range of motion (ROM), functional performance, balance, as well as various injured areas, types of exercise programs, and age groups.

Pain: The effect size for pain reduction was -0.19, indicating a minimal and statistically nonsignificant improvement (95% CI: -1.36 to 0.99). Notably, some studies reported significant reductions in pain scores, emphasizing the role of tailored rehabilitation programs in pain management.

Muscle Strength: Exercise programs led to a significant improvement in muscle strength, with an effect size of 0.68. Various interventions such as aerobic exercises, neuromuscular electrical stimulation (NMES), and isokinetic exercises demonstrated substantial gains in muscle strength. However, interventions like Kinesio taping showed mixed results, suggesting the need for individualized approaches.

Range of Motion (ROM):Overall, exercise programs improved ROM, particularly in studies focusing on physical exercises. However, auxiliary programs like fascial manipulation and Kinesio taping did not significantly enhance ROM, highlighting the efficacy of structured physical exercises in improving joint flexibility.

Functional Performance: Significant enhancements in functional performance were observed across studies employing different exercise modalities. Programs emphasizing plyometric training and change of direction (COD) exercises consistently improved agility and strength-related metrics. However, conflicting results indicate the need for further investigation into optimal training protocols.

Balance: Exercise programs showed varied impacts on balance, with some studies reporting positive outcomes while others found no significant improvements, especially in ankle-injured players. This suggests that balance recovery may require comprehensive strategies beyond exercise alone.

Injured Areas: Interventions targeting ankle injuries showed significant improvements, including the use of ankle protectors and specific exercise regimens. In contrast, studies focusing on knee injuries did not consistently demonstrate significant gains in muscle strength and functional outcomes post-rehabilitation.

Types of Exercise Programs: Plyometric exercises consistently yielded significant improvements across different functional metrics and age groups. Other interventions like aerobic exercises and NMES also showed promise in enhancing specific parameters such as muscle strength.

Age Groups: Adolescents (ages 14-19) generally exhibited larger effect sizes compared to adults across various outcome variables, indicating potentially greater benefits from exercise programs during developmental stages. However, both age groups showed overall positive effects, supporting the utility of tailored exercise interventions in rehabilitation.

Limitations: This study encountered limitations such as data heterogeneity and variability in intervention protocols and participant demographics. Future research should address these gaps through more focused meta-analyses and long-term studies to better understand the sustained effects of exercise programs on injury recovery and performance.

In conclusion, while exercise programs significantly enhance muscle strength, ROM, and functional performance in football players post-injury, improvements in pain relief and balance remain challenging. Tailored interventions, especially those involving plyometric exercises and targeted rehabilitation strategies, show promise in optimizing recovery outcomes across various injury types and age groups. These findings underscore the importance of evidence-based rehabilitation practices in sports medicine and highlight the need for further research to refine and customize exercise programs for optimal therapeutic benefits.

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