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Detraining and Re-Training Effect on Cardiovascular Fitness on Elite Soccer Players

Nor Ikhmar Madarsa[1,2], Nor Fazila Abd Malek[1], Nor Haizan Mohd Rodzi[3], Amir Hafizuddin Ismail[3], Amirulnizar Zulkefli[2,4], Mohd Hafizuddin Baki[1,5], Nur Ikhwan Mohamad[1]

[1]Coaching Science Department, Faculty of Sports Science and Coaching, Sultan Idris Education University, Tanjung Malim 35900, Malaysia, [2]Negeri Sembilan Football Club, Seremban 70100, Malaysia, [3]Sports Performance & Medical Unit, Perak State Sports Council, Ipoh 31400, Malaysia, [4]Faculty of Sports Science and Recreation, Universiti Teknologi MARA, Shah Alam 40450, MALAYSIA, [5]Education Secretariat of Anti-Doping Agency of Malaysia, Putrajaya 62570, Malaysia

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Abstract

This study aims to investigate the effect of detraining and subsequent re-training on the cardiovascular fitness of elite male soccer players. This study recruited twenty-two elite male soccer players (n = 22, mean age: 23.29 ± 2.89 years). Pre-season training, detraining, and re-training phases were incorporated in the experiments' pre-post design, and Yoyo Intermittent Recovery Level 2 (YYIR2) assessed participants' cardiovascular fitness levels. The pairwise comparison result suggests that the eight weeks pre-season training program significantly improves the players' VO2 max by 17.95% (baseline=57.81 ± 3.23, post pre-season=68.19 ± 4.32, p=.000 < .05). Following fourteen weeks of the detraining phase, the VO2 max significantly drops 21.83% to 53.30 ± 0.66, p=.000 < .05. By using the same eight weeks of pre-season training programs in the re-training phase, players' VO2 max show a significant rebuild by 14.20% to 60.87 ± 3.12, p=.000 < .05. The repeated-measures analysis of variance (ANOVA) revealed a significant main impact of phase on VO2 max (F(3,63)=102.878, p=.000), which suggests that the various stages of training brought on the variations in VO2 max. In conclusion, this study found that elite soccer players' cardiovascular fitness decreased after detraining but improved again with re-training. Proper year-round periodized training and conditioning is highlighted, as the study was based on an actual elite players program.

Keywords: Detraining, Re-training, Pre-season, Cardiovascular Fitness, Elite Soccer Player

Introduction

A periodized physical conditioning program for soccer players may include a period of detraining, especially during and immediately after the COVID-19 pandemic, with match

schedules changed and rescheduled for various reasons. Several studies have indicated significant global match planning changes during and after COVID-19 (Alvurdu et al., 2022; Drewes et al., 2021; Nassar et al., 2021). In certain ways, these changes produced a league gap period, which may or may not produce a period of detraining, depending on how the team training program was programmed and implemented.

While skill retention may not be much of a problem during a certain gap of the training period, physical fitness components, especially cardiovascular endurance and speed endurance, usually will be affected once the detraining period starts. Cardiovascular fitness is an essential component of elite soccer performance, with players primarily reliant on their aerobic capacity to sustain high-intensity efforts throughout a match. Athletes may undergo detraining due to scheduling, injuries, or maintenance periods, during which their fitness levels fall (Rampinini et al., 2021). Detraining can result in lower cardiovascular fitness, injury risk, and diminished performance. Conversely, re-training sessions are required to rebuild fitness levels and enhance performance (Angoorani et al., 2021; Fisher et al., 2022).

According to a scientific study on the influence of detraining and re-training on the cardiovascular fitness of trained football players, as few as two weeks of detraining can reduce exercise performance and physiological indicators such as maximal oxygen consumption (VO2 max). The scientific literature shows that detraining for 6 to 12 weeks may result in significant losses in muscular strength, power, and sports-specific abilities. Re-training, conversely, can have a favourable impact on physiological and athletic factors. It appears that re-training can swiftly restore muscle mass and improve performance much more than detraining could. The specifics of each case determine the amount to which this is achievable (Marques et al., 2022; O'Connor et al., 2020; J. R. Silva et al., 2015).

Previous research has conducted several investigations to determine how detraining affects soccer players' cardiovascular fitness. For instance, some discovered that elite soccer players suffered significant decreases in their maximal oxygen consumption (VO2 max) and running distance after only two weeks of detraining (Marques et al., 2022). According to another finding, elite female soccer players saw declines in their VO2 max and aerobic power after detraining for six weeks, and even brief intervals of not training might have significant detrimental impacts on the cardiovascular fitness of soccer players (Clemente et al., 2022; Hostrup & Bangsbo, 2023).

Re-training has also been proven in studies to increase cardiovascular fitness after inactivity. After a two-week hiatus from training, professional soccer players regained their VO2 max and running speed with a four-week re-training schedule. Another study found that a four-week re-training regimen helped top male soccer players restore their aerobic power and enhanced sprinting performance following a four-week layoff from training. Re-training appears to be an excellent approach to mitigate the negative consequences of not exercising on cardiovascular fitness (A. F. Silva et al., 2022; Thomakos et al., 2023).

A literature finding mentioned various re-training programs to enhance cardiovascular fitness performance. A study found that high-intensity interval training outperforms endurance training in boosting VO2 max and running performance in professional soccer players. At the same time, further research has revealed that HIIT and endurance training similarly improve cardiovascular fitness in soccer players. Individualization principles such as age, fitness level, and history can all impact the ideal training strategy (Alvurdu et al., 2022; Ávila-Gandía et al., 2023).

The physiological processes that underlie the effects of detraining and re-training on cardiovascular fitness are not well known. Detraining and re-training both improve

cardiovascular fitness. On the other hand, some research has linked detraining to losses in mitochondrial density, capillary density, or muscle fibre type, which may contribute to reductions in VO2 max and other cardiovascular fitness metrics. On the other hand, engaging in re-training could result in increases in these characteristics as well as improvements in muscular strength and endurance (Burtscher et al., 2022; Ferguson et al., 2021).

This study was an experimental case study on professional soccer players of a team competing in a national level league during the data collection period. The training program presented was the actual training program utilized by the team. This study investigates the detraining and re-training effect on cardiovascular fitness performance among elite soccer players. Outcomes are expected to provide valuable insights into the effects of detraining and re-training, especially for teams competing in local Malaysian soccer leagues.

Material And Methods

Experimental Approach to the Problem

Table 1
Research timeframe

TIMEFRAME: DETRAINING AND RE-TRAINING PHASES			
Baseline (Prior to pre-season)	Pre-season (8 weeks)	Detraining (14 weeks)	Re-training (8 weeks)

Table 2
Pre-season training plan

Pre-Season Focus/Week	**Week 1&2**	**Week 3&4**	**Week 5&6**	**Week 7&8**
Aerobic	Endurance, moderate intensity	Endurance, high intensity	Endurance, high intensity	Combination
Anaerobic	Speed endurance maintenance	Speed endurance production	Speed	Combination & SAQ
Resistance Training	Basic strength	Transference power	Football power	Football power
Technical/Tactical	11 vs. 11 - 8 vs8	7 vs. 7 - 4V4	3 vs. 3 - 1 vs. 1	11 vs. 11 - 1vs.1 - Set Play

Using VO2 max to measure cardiovascular fitness, this study investigated the effects of detraining and re-training on cardiovascular fitness in male elite soccer players. This investigation used quantitative methodologies to determine VO2 max. This research utilized a pre-post design, which included three stages: the pre-season phase, the detraining phase, and the re-training phase. As mentioned in Table 1, during the pre-season phase, which lasted eight weeks, participants followed a standardized training program to increase their cardiovascular fitness, as illustrated in Table 2. During the detraining phase, which lasted for fourteen weeks, individuals were given the directive to engage in significantly less strenuous physical exercise. The re-training phase lasted eight weeks and followed the same training program as the pre-season phase. VO2 max was determined by the Yoyo Intermittent Recovery Level 2 test.

Participants

Participants were selected for the study based on the inclusion criteria, which required them to be elite male soccer players with more than two years of playing experience. Participants were not allowed to participate in the research if they met the exclusion criteria, which stated that they must not have any medical or orthopaedic disorders that would prevent them from finishing the study. Twenty-two participants were recruited for this study, and throughout the data collection period, all participants were professional soccer players. The participants in the study were briefed on the procedures to be followed, and they signed a consent form.

Instruments and Procedures

The participant's body mass was measured with an OMRON digital weight scale HN-289 (Kyoto, Japan), and their height was determined using a Seca steady stadiometer (Hamburg, Germany). The participants were briefed on the study's methodology and well-informed of its potential outcomes. However, the duration of each phase was initially uncertain. The data were acquired in the actual setting of team preparation in a COVID-19 pandemic, and the researcher could not predict the duration of each phase. The regular eight-week pre-season training program, as per Figure 2, has been laid out, and the baseline and post-test dates have been scheduled. The cardiovascular fitness performance was assessed using the Yoyo Intermittent Recovery Level 2 (YYIR2) test procedure. The test was done on a turf pitch, and the subjects needed to run back and forth between two cones 20 metres apart for 10 seconds at a time. VO2 max was determined based on the distance covered during the test, which was performed until exhaustion.

Data collection and statistical analysis

The YYIR2 test was used to evaluate VO2 max at each trial phase, consisting of the baseline, pre-season, detraining, and after-re-training phases. During the detraining phase, participants were told not to engage in any additional physical activity to verify that any changes in VO2 max were related to detraining and not to changes in exercise habits. Participants received the same pre-season cardiovascular fitness training programme during the re-training phase. Means and standard deviations were used to describe the sample characteristics of the individuals using descriptive statistics. The variations in VO2 max over the three phases of the trial were examined using repeated-measures analysis of variance (ANOVA). Pairwise comparison was used to compare the VO2 max difference within every phase. All statistical analyses were performed with the SPSS program.

Results

The descriptive statistics analysis derived the demographic data's mean and standard deviation (SD). All statistical analyses were run on version 22 of the Statistical Package for Social Science (SPSS) software (IBM, USA).

Table 3
Descriptive Statistic of Demographic Data

	N	Minimum	Maximum	Mean	Std. Deviation
Age (years)	22	19	28	23.29	2.89
Body mass (kg)		58	88	71.04	8.40
Body height (cm)		165	193	176.96	7.22

The descriptive data for the demographic characteristics of the participants are presented in Table 3. The age range of the twenty-two participants was 19 to 28 years, with a mean age of 23.29 ± 2.89 years. The average body mass was 71.04 ± 8.40 kilogrammes, and the average body height was 176.96 ± 7.22 centimetres. All participants had more than two years of professional soccer playing experience.

Table 4
Repeated measure ANOVA of cardiovascular performance within phase

Variable	Phase	Mean ± SD	Sig.
YYIR2 (VO_2max, ml•kg-1•min)	Baseline	57.81 ± 3.23	.001
	Pre-season	68.19 ± 4.32	
	Post detraining	53.30 ± 0.66	
	Post re-training	60.87 ± 3.12	

Significant is set at 0.05 level

The descriptive statistics for VO2 max at each research phase are presented in Table 4. The mean baseline VO2 max was 57.81 ± 3.23 ml•kg-1•min, which significantly increased to 57.81 ± 3.23 ml•kg-1•min following the pre-season phase. Following the detraining phase, VO2 max drastically fell to 53.30 ± 0.66 ml•kg-1•min. VO2 max increased significantly to 60.87 ± 3.12 ml•kg-1•min following the re-training phase. The repeated-measures ANOVA demonstrated there was a significant difference ($p<0.05$) for VO2 max performance within phase $F(3,63)=102.878$, $p=.000$.

Table 5
Pairwise comparison of cardiovascular performance within phase

Phase	Phase	Sig.
Baseline	Post-pre-season	0.000
Baseline	Post detraining	0.000
Baseline	Post re-training	0.004
Post-pre-season	Post detraining	0.000
Post-pre-season	Post re-training	0.000
Post detraining	Post re-training	0.000

The result of the pairwise comparison in Table 5 shows there was a significant difference ($p=0.00$) in VO2 max performance between baseline (57.81 ± 3.23 mL/kg/min) with post-pre-season (68.19 ± 4.32 mL/kg/min), post-detraining (53.30 ± 0.66 mL/kg/min) and post-re-training (60.87 ± 3.12 mL/kg/min). VO2 max performance during the post-pre-season and

post-re-training phases was significantly higher than the baseline. However, VO2 max performance during post-detraining was significantly (p=0.004) reduced compared to the baseline phase.

Other than that, the result of pairwise comparison also showed there was a significant difference (p=0.00) in VO2 max performance between the post-pre-season phase (68.19 ± 4.32 mL/kg/min) with post-detraining phase (53.30 ± 0.66 mL/kg/min) and post-re-training phase (60.87 ± 3.12 mL/kg/min), which is VO2 max performance during post-pre-season phase was significantly higher than post detraining and post-re-training phase. Lastly, the pairwise comparison showed there was a significant difference (p=0.00) between post-detraining (53.30 ± 0.66 mL/kg/min) and post-re-training (60.87 ± 3.12 mL/kg/min). VO2 max performance during post-detraining was lower compared to the post-re-training phase.

This study revealed that detraining significantly dropped VO2 max among elite male soccer players following pre-season training. However, after the re-training phase, the VO2 max returned to its levels before detraining. These data imply that detraining can harm elite soccer players' cardiovascular fitness, whereas re-training can help restore cardiovascular fitness.

Discussion

This study examines the effect of detraining and re-training on elite male soccer players' cardiovascular fitness. The study's results indicated that detraining caused a significant drop in VO2 max among elite male soccer players following the pre-season. This finding is consistent with prior research demonstrating a reduction in VO2 max after detraining phases. Reduced mitochondrial density, oxidative enzyme activity, or capillary density could cause a drop in VO2 max. Nevertheless, after the re-training phase, the VO2 max returned to its levels before detraining. Previous studies also have indicated that re-training can restore cardiovascular fitness following detraining phases (Angoorani et al., 2021; Ávila-Gandía et al., 2023; Ferguson et al., 2021).

The outcomes of this study have significant implication for elite soccer players' training and recovery techniques. Coaches of soccer and fitness should be aware of the detrimental effects of detraining on cardiovascular fitness and stress the significance of maintaining activity levels during decreased training sessions. A good maintenance program during any short-term break between league schedules is essential. In addition, the findings imply that re-training can be an effective technique for regaining cardiovascular fitness during detraining phases. However, re-training will be much easier if the previous effect of training is retained during the break, thus allowing a much shorter re-training period. This will assist the players to move on to the next fitness goal of the training much faster.

Apart from that, an assessment of what was done during this study should be performed periodically. While the effect presented in this study indicates improvement, periodical assessment over several phases and seasons will provide a much better insight into how much improvement can be seen, especially with different training programs. Not many studies have examined the effect in much more extended periods and seasons. This is the data that every fitness coach should have as part of their monitoring program.

The small sample size and lack of a control group were limitations of this study. Future research should include a bigger sample size and a control group to study further the impact of detraining and re-training on elite soccer players' cardiovascular fitness. Also, future studies should address the mechanisms underlying the observed improvements in VO2 max.

Conclusion

This study provided insight into how detraining and re-training impact the cardiovascular fitness of elite male soccer players. Detraining during pre-season significantly decreased VO2 max, but subsequent re-training restored the values to pre-season levels. These findings suggest prospective future research avenues and have significant implications for elite soccer players' training and recovery practises. This study provides insight into the effect of detraining and subsequent rehabilitation on the cardiovascular fitness of elite male football players. In addition, the work demonstrates a comprehensive comprehension of various approaches to training and recovery, as well as novel suggestions for future research in this area.

Practical Implications

The findings from this study contribute to the current literature on the detrimental effect on cardiovascular fitness after a certain period of training ceased. It also shows that regaining cardiovascular fitness in the retraining process can be significantly impactful with the same training session conducted before the detraining period. The outcomes from this study can also be a guideline for the practitioners to critically design their training program with a specific objective and time frame to ensure the program's effectiveness and the periodical plan can be monitored appropriately. Since the researcher conducted the training intervention and fitness testing process as a strength and conditioning coach, the actual practice and hands-on experience that are academically documented should be highly reliable to be adopted and adapt in a real practice by the other researcher or practitioner.

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