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Short Title: Isolated training effects on fitness in soccer

Viswanath B. Unnithan[1], Barry Drust[2], Colin Brow[1], Andisheh Bakhshi[3], Liam Mason[4] and Matthew Weston[5]

[1] Institute of Clinical Exercise and Health Science, Division of Sport and Exercise, School of Health and Life Sciences, University of the West of Scotland, Hamilton, Scotland, UK, [2] School of Sport, Exercise and Rehabilitation Sciences, University of Birmingham, Birmingham, UK, [3]Phastar, Glasgow, Scotland, UK, [4]Head of Athletic Performance, Blackburn Rovers FC, Blackburn, UK and [5]Institute for Sport, Physical Education and Health Sciences, University of Edinburgh, Edinburgh, Scotland, UK,

Address for correspondence:

Professor V.B. Unnithan, Ph.D., FACSM

Division of Sport and Exercise

Institute of Clinical Exercise and Health Science

School of Health and Life Sciences

University of the West of Scotland

Hamilton

Scotland, UK

Tel: 01698 894413

E-mail: vish.unnithan@uws.ac.uk

Abstract

BACKGROUND: The SARS-COV2 agent initiated a global pandemic. The initial response to the pandemic was severe disruption to the public and private sector including sports. The resultant was that soccer clubs had to prescribe that the players trained in isolation for a prolonged period of time in an attempt to maintain fitness. The aim of the present study was to evaluate the impact of a 10-week period of training in isolation on aerobic fitness, body composition and injury incidence on the return to pre-season team-training in a group of elite, male soccer players. **METHODS:** Twenty-two professional soccer players (age: 25.2 ± 4.4 years) who played for an English Championship first team participated in this study. A weekly training programme was sent to each player at the start of each week. Prior to the start of the isolated training period, all players underwent a maximal aerobic speed test (MAS) and body mass index data (BMI) were obtained. These measurements were repeated on the return to team training. **RESULTS:** There was a significant ($p<0.05$) increase in MAS pre-post isolated training (Pre: 4.71 ± 0.15 vs Post: 4.92 ± 0.17 m/s), no change in BMI (Pre: 24.3 ± 1.3 vs Post: 24.1 ± 1.1 kg/m^2) and a low non-contact, soft tissue muscle incidence on the return to team training. **CONCLUSIONS:** The evidence from this study suggests that a more prolonged pre-season schedule can enhance aerobic conditioning and mitigate the injury risk on the return to competitive match-play in elite soccer players.

Keywords: Covid 19, Maximal Aerobic Speed, Elite Soccer

Introduction

In late 2019 and early 2020, the SARS-COV2 agent initiated a global pandemic, which is still on-going and is likely to be part of our lives for the foreseeable future. The initial response to the pandemic was severe disruption to the public and private sector including sports[1,2]. The SARS-COV2 virus is primarily spread by respiratory droplets and direct contact; consequently, for a sport such as soccer, it was impossible to maintain safe distancing to prevent transmission of the virus. This was particularly pertinent, as the transmission mechanism of the virus is facilitated by the high depth and frequency of breathing seen in soccer. The resultant was that soccer clubs had no choice, but to prescribe that the players trained in isolation for a prolonged period of time in an attempt to maintain fitness[3].

The concern with this approach is that an insufficient training stimulus can result in a reduction in player fitness. Evidence exists to support the theory that short-term detraining (greater than 4 weeks) can lead to a rapid decline in VO_2max[4], which is one of the most important physical determinants of soccer performance[5,6] . The establishment of high levels of this attribute in elite

soccer provides the bases for creating resilience to the repeated high-intensity actions that characterise elite soccer match-play[7]. The limited soccer research that exists with regard to the influence of pandemic-initiated, prolonged isolated soccer training on aerobic fitness demonstrated that it resulted in maintaining aerobic fitness measured via the Yo-Yo IR1[8] and Magnoni submaximal test[9] in elite male soccer players.

The only equivalent research model to the pandemic-initiated time spent away from team pre-season training seen in elite soccer was seen in 2011 in the National Football League (NFL). Due to a collective bargaining dispute between owners and players, NFL players were unable to take part in team training for 18 weeks. The consequence of this was a rapid increase in Achilles injuries during the subsequent NFL season[10]. Other injury-related consequences for a prolonged period away from team training lay in the reversing of training-induced muscle cross-sectional area increases with a subsequent potential for an increase in injury risk[11].

The evidence from the extant literature is clear; pre-season is a short (4-6 weeks), but crucial period in a soccer season where training load and intensity is increased to build resilience for the competitive season[12,13,14,15]. The national lockdown in the UK resulted in the disruption of the 2019-2020 English Championship soccer season in March 2020 with a subsequent 10-week break from team-training prior to the resumption of team- training in June 2020. This created the scenario of a second, more prolonged pre-season, with the challenge of a complete lack of team training.

Consequently, the aim of the present study was to evaluate the impact of this 10-week period of training in isolation on aerobic fitness, body composition changes and injury incidence on the return to pre-season team-training in a group of elite, male soccer players. It is hypothesised that as a result of the lack of team training during the lockdown, aerobic fitness would be maintained or decline, body composition would be negatively affected and there would be a high rate of injury incidence on the return to team-training.

Materials and Methods

Participants

Twenty-two professional soccer players (age: 25.2 ± 4.4 years, stature: 1.82 ± 0.12 m, mass: 79.8 ± 7.3 kg) who played for an English Championship first team participated in this study. This was a convenience sample and limited by the players that were available for participation at the club during the English football lockdown period in 2020. The statistical power for this study was determined using G*Power (version 3.1.9.7, Heinrich Heine University Düsseldorf, Germany). A sample size of 15 participants was determined to have sufficient power (> 0.80) based on an alpha of 0.05 and a *moderate* effect size (d = 0.8.). All training and testing was assessed by a member of the research team (LM) and club staff. All players had been screened by the club's medical team and were deemed fit to participate. Participants were included in the study if they undertook more than 90% of the programme and were able to perform both the pre- and post-training programme testing protocols. The study was approved by the institutional research ethics committee at the University of the West of Scotland under the auspice of the Chair: Dr Gary Boyd and was conducted in accordance with the principles set forth in the Declaration of Helsinki.

Lockdown Training Programme

The Lockdown period began in March 2020, eight months into the English Championship season. As such, the first week of the lockdown period was set as a rest week with no training prescribed by the performance staff. A weekly training programme was sent to each player at the start of each week. During the first 4 weeks, there was no indication on how long the lockdown period would last, or when the players would be allowed back into training. During week 4 it became apparent that the lockdown period would be prolonged and would likely see a congested fixture period commence shortly after. Therefore, following week 1, the remaining 9 weeks of the lockdown period was broken down into 3x3 week blocks, weeks 2-4, weeks 5-7, and weeks 8-10. All players were required to track their conditioning sessions using the Strava (CA, USA) software app to enable the sports science team to

monitor each players' adherence to the training programme. The players were given the autonomy to decide if they felt they needed a break from on-feet conditioning, and if so, were allowed to substitute a running session for a bike ride of the same session duration. The sports science team then calculated each player's weekly running and cycling distances and produced a league table style feedback document. Each player was also required to complete a weekly monitoring questionnaire on google forms. This provided the sports science department with information on bodyweight, number of completed strength and power sessions, and details of any potential coronavirus symptoms. Sports science and nutrition support was available remotely to all players throughout the entire 10-week period.

Weeks 2-4

Weeks 2 and 4 contained four conditioning sessions (Supplementary Digital Material: Supplementary Text File online content only) and three strength sessions (Supplementary Digital Material: Supplementary Text File online content only) per week. Within the conditioning programme, there were two isolated aerobic conditioning sessions without the use of a football. The other two sessions were more football-specific and broken down into intensive (short distance drills with the football), and extensive (longer distance drills done with the football). Each session lasted between 30-45 minutes in duration (including warm up-period). During week 3 there was one less isolated aerobic conditioning session prescribed by the sports science staff, with the fourth conditioning session in that week left optional, and allowed for self-prescription from the players.

Weeks 5-7

These middle 3-weeks were an 'off-season' period where no training programme was prescribed by the sports science staff. All players were advised to rest and recover for the entire 3-week period.

Weeks 8-10

Weeks 8-10 all contained five conditioning sessions, and three strength sessions per week. Week 8 contained two aerobic endurance sessions and one anaerobic endurance session, which were both isolated conditioning sessions without the use of a football. The other two sessions that week were more football-specific, and broken down into intensive (short distance drills with the football), and extensive (longer distance drills done with the football). Weeks 9-10 contained one isolated aerobic conditioning session without the use of a football per week. With the other four sessions in each week being the more football specific intensive (twice weekly), and extensive (twice weekly) sessions, each of which utilised a football. Each session lasted between 30-45 minutes in duration (including warm up-period), with the intensity of the sessions similar to those sessions in weeks 2-4 (Supplementary Digital Material: Supplementary Text File online content only).

Fitness Testing

On the first day of the return to team training, all players had their body mass recorded and performed the maximal aerobic speed (MAS) fitness test[16]. Body mass was determined to the nearest 0.1kg using the same calibrated electronic Seca 813 weighing scale (Hamburg, Germany) which was used for pre-lockdown measurement. The MAS test was a 1500m time trial consisting of 15x100m pitch lengths performed in as fast a time as possible. Each of the players were familiar with the MAS testing procedure, having performed it previously as part of the club's performance testing battery. The pre-lockdown MAS test took place during the November 2019 international break. Before pre-and post-lockdown testing sessions, players were instructed to arrive at the training ground having undertaken their usual sleeping habits. All tests were performed at the clubs training facility. On each testing occasion the same observer undertook each assessment both pre-and post.

Injury Recording

The football clubs head of medical services recorded all injuries that occurred during the investigation using the Benchmark54 injury analytics system (Harrogate, England).

Statistical Methods

A Shapiro-Wilk test was conducted to evaluate the normality of the data. Normality was confirmed and consequently descriptive statistics in the form of mean, standard deviation and 95% confidence intervals were generated for all pre-post comparisons. All pre-to-post evaluations were conducted using a paired t-test with an alpha level set at 0.05. Cohen's d effect sizes were also calculated for all pre-post comparisons. All statistical analyses were performed using SPSS version 25 (Armonk, NY, USA).

Results

Evaluation of Lockdown Training Load (n=22)

With the exception of week 3 when the players covered 122% more than the prescribed training volume the players ran close to the prescribed training load designed by the sports science staff (Table I). Table II outlines the weekly cycling distances during the 2020 lockdown. The actual running training load achieved was substantially higher per week during the lockdown (2020) compared to the normal 6-week off-season training prescription in 2019 (Table III). Furthermore, the prescribed running training load during the lockdown was substantially greater than that designated during the traditional 6-week off-season conditioning programme in 2019 (Table III).

There were no significant differences in body mass or body composition based on BMI following the 10 -week lockdown period. MAS was significantly faster following the 10-week lockdown with respect to both the personal best MAS obtained during the 2019-2020 season and the MAS value obtained just prior to the 10-week lockdown. There were concomitant large effect sizes for both MAS comparisons. There was, however, no significant difference in MAS from the end of season 2018-2019 and the start of pre-season for season 2019-2020 (Table IV).

Injury Incidence Data

There was no significant difference between the accumulated home-based strength sessions (Appendix I) per player in weeks 2-4 (7.9 ± 3.9) vs weeks 8-10 (9.6 ± 2.8). Table V highlights the injury incidence, mechanism of injury and days lost to injury on the return to training and match-play.

Discussion

The major findings from the study were that there was a significant improvement in MAS following the period of isolated training due to the CV 19-induced national lockdown with no concomitant change in body composition, and injury incidence was low on the return to training. These outcomes contradicted our original hypothesis which anticipated either maintenance or deleterious responses for all three parameters in the absence of team training.

The improvements seen in MAS, pre-and post-lockdown were not noted regarding the end of the 2018-19 season and the start of the 2019-20 season. Scrutiny of the off-season prescribed running training load highlights some significant differences to the pattern of training prescribed by the sports science team during the lockdown. Firstly, the duration of prescribed training was shorter, 4 weeks during a normal off-season versus 8 weeks during the lockdown. Secondly, the volume of running training prescribed during the lockdown was significantly greater than that seen in a traditional off-season training programme. During the lockdown, the running training was augmented on a volitional, individual player-level by cycling, this resulted in accumulative combined cycling and running training loads of between 80 km (weeks 2-4) to 125 km (weeks 8-10). The players' engagement in the cycling activity was optional and evidence exists in the medical literature[17] to support the efficacy of volitional based approaches in maintaining compliance in physical activity programmes compared to a more intervention-based approach. It is possible to speculate that this high volume cross-training model used during lockdown was the primary reason for the significant increase in MAS[18] and the subsequent resilience to injury noted on the return to individual and then team training.

Evidence to support the efficacy of a home-based training programme during the Covid initiated lockdown on maintaining aerobic fitness was also demonstrated by Rampinini et al[9] and Albuquerque Fiere[8]. One other potential benefit of the lockdown in enhancing aerobic fitness was the change in the actual content of the training microcycles that the players were exposed to. It was impossible during the lockdown for the players to engage in tactical and technical sessions that would normally be seen during any given on-pitch training microcycle. While this may have had deleterious effect on the development of these constructs, these sessions are not always efficient in achieving the volume and intensity required to stimulate adaptive aerobic change. Consequently, the absence of these sessions and the focus on purely physical conditioning provided a stimulus for aerobic adaptation in the players in the current study[19].

The efficacy of a more prolonged pre-season training exposure on aerobic fitness as seen in the present investigation can also be seen in the approach adopted in Rugby Union for the pre-season preparation of their players. Pre-season is commonly between 8- 12 weeks, with average distances covered per player of between 10 and 12km per week. This type of training stimulus has been effective in increasing shuttle run distances (3 x 60m) irrespective of position[20]. The paradox of this scenario is that greater workloads (10 week pre-season in the present study) are normally associated with greater rates of injury[21,22], but also more beneficial for aerobic adaptations[23,]

There was no negative influence of isolated-training on the players' body composition. This suggested that the players maintained good discipline with their caloric intake and this was complimented by the significant increase in training volume during the lockdown. The product of both was an optimal energy balance was obtained and body composition was maintained. The lack of change in BMI pre-post lockdown in the present study is supported by the absence of differences in body mass of Brazilian soccer players during a similar Covid-induced 40 day quarantine period[8]. There is limited evidence in the extant literature to suggest that a prolonged pre-season will

stimulate significant increases in lean body mass[20] in elite athletes that have already been exposed to resistance training over many years.

The calendar periods of June and July are conventionally associated with pre-season in English professional football. This phase is customarily devoted towards rest followed by physical training; thus, injuries of insidious onset and no known trauma (overuse injury) are commonly concomitant with this stage of the season[24,25]. The first team player(s) injuries sustained during this period – May until the end of July 2020- highlighted that five non-contact and four contact injuries occurred during this juncture. The 5 non-contact injuries were all muscle related injuries with three associated with the anatomical thigh area – Rectus Femoris (1) and Hamstrings (2) with one Obturator Externus muscle and one Gastrocnemius/ Soleus structural area of injury. These regions and types of injuries are comparable to other research conducted within English professional football[26,25] and first team players with top professional clubs within Union of European Football Associations[24]. However, interestingly during this Covid-19 enforced non-traditional break and with an extended pre-season training period there were no first team professional players with any overuse injuries evident during the months of May, June, and July. Evidence exists in Rugby League to support the approach adopted within the present study, that greater distance covered at lower intensities has been associated with a reduction in the injury risk for the player[27]. This greater accumulated load can only be derived via the participation in a greater number of sessions. Therefore, it is unsurprising that there is evidence of an inverse relationship between the greater number of sessions completed and the number of competitive in-season games missed during the prolonged pre-season (18 weeks) seen in Rugby League[28]. The evidence exists to support a prolonged pre-season, a proportion of which is spent exercising at moderate to low intensities will allow a greater number of players to participate in more sessions and act as an injury resilience mechanism for team sport players. It may be that Soccer needs to be more reflective in its approach to the preparatory phase for the season (pre-season), as it may pre-dispose players for subsequent injury, when the competitive matches start[29].

The authors acknowledge that there were some limitations to this study, this was not a randomised controlled study and the adherence to the prescribed weekly training programme for the players could not be strictly controlled. Furthermore, the intensity of these sessions could not be monitored. These limitations, however, have to be contextualised within the environment that existed at the time in professional sport, where contact with the players was minimised due to government guidelines.

Conclusions

We remain in a pandemic and while the hope is that we never have to go back into a national lockdown scenario, the evidence from this study provides some clear insights as to how this could be managed in elite soccer, should it occur again. Furthermore, the evidence from this retrospective study has provided some valuable insights on the potential of a more prolonged off-season/pre-season in enhancing aerobic conditioning and mitigating the injury risk on the return to competitive match-play in a non-Covid environment.

Conflicts of Interest

The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript

Authors' Contribution

Viswanath Unnithan conceived the study, analysed and interpreted the data, drafted the manuscript, gave final approval for this version to be published and is accountable for all aspects of the work. Barry Drust helped with the design of the study, interpreted the data, revised drafts of the manuscript, gave final approval for this version to be published and is accountable for all aspects of the work. Andisheh Bakhshi analysed and interpreted the data, revised the manuscript, gave final approval for this version to be published and is accountable for all aspects of the work. Colin Brow

interpreted the data, revised drafts of the manuscript, gave final approval for this version to be published and is accountable for all aspects of the work. Liam Mason acquired the data, interpreted the data, revised drafts of the manuscript, gave final approval for this version to be published and is accountable for all aspects of the work. Matthew Weston interpreted the data, revised drafts of the manuscript, gave final approval for this version to be published and is accountable for all aspects of the work. All authors read and approved the final version of the manuscript.

Data Availability

The data associated with the paper are not publicly available but are available from the corresponding author on reasonable request.

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Tables

Table I: Weekly Running Distances during the 2020 lockdown

Week	**Actual Running Distance (km)**	**Running Distance Prescribed by Training Staff**
Week 2	17.2 ± 11.1	14.6
Week 3	18.6 ± 12.7	8.37
Week 4	14.1 ± 10.6	14.1
Week 8	22.4 ± 11.3	29.0
Week 9	27.1 ± 12.1	31.5
Week 10	29.6 ± 10.4	30.5

All values are mean ± SD.

Table II: Weekly Cycling Distances during the 2020 lockdown

Week	**Cycling Distance (km)**
Week 3	13.6 ± 32.1
Week 4	12.9 ± 26.0
Week 8	22.3 ± 34.3

Week 9	13.0 ± 23.9
Week 10	10.7 ± 20.2

All values are mean ± SD.

Table III: A comparison of prescribed training load for the 2019 off-season vs 2020 lockdown

Week	**Actual Running Distance Per Week during the 2020 Lockdown (km)**	**Running Distance Prescribed by Training Staff during the 2020 Lockdown (km)**	**Average Running Distance Prescribed per week by Training Staff during the 2019 Off-Season (km)**
Week 2	17.2 ± 11.1	14.6	13.0
Week 3	18.6 ± 12.7	8.37	13.0
Week 4	14.1 ± 10.6	14.1	18.4
Week 8	22.4 ± 11.3	29.0	16.7
Week 9	27.1 ± 12.1	31.5	15.9
Week 10	29.6 ± 10.4	30.5	10.4

All values are mean ± SD.

Table IV: Body Composition Changes Pre-and Post-Lockdown, Maximal Aerobic Speed (MAS) Changes Pre-and Post-Lockdown and with respect to Personal Best Time and Maximal Aerobic Speed (MAS) Changes at End of Season 2018-19 and Pre-Season Start 2019-20

	Pre-Lockdown (n=21)	**Post-Lockdown (n=21)**	**Effect Size**
Body Mass (kg)	79.8 ± 7.3 [76.5-83.1]	79.5 ± 7.8 [75.9-83.0]	0.04
BMI (kg/m^2)	24.3 ± 1.3 [23.7-24.8]	24.1 ± 1.1 [23.6-24.7]	0.17
MAS Personal Best (m/s)	4.74 ± 0.16 [4.67-4.81]	4.92 ± 0.17 [4.84-4.99]*	-1.09
MAS-Pre-Post (m/s)	4.71 ± 0.15 [4.64-4.77]	4.92 ± 0.17 [4.84-4.99]*	-1.31
	End of Season: 2018-19 (n=9)	**Pre-Season Start: 2019-2020 (n=9)**	

MAS-Pre-Post (m/s)	4.59 ± 0.19 [4.44-4.74]	4.62 ± 0.17 [4.49-4.76]	-0.17

*p<0.05. All values are mean ± SD. [95%CI]

Table V: Injury incidence profile on the return to training

Name	Season	Date of Injury	Age at injury	Reported Injury	Body Area	Body Side	Dominant Side?	Mechanism	Contact Type	Severity	Total Days Missed	Training Days Missed	Match Days Missed
Player 16	2019/20	30/05/2020	32.2	Obturator Externus Grade 1B	Groin / Hip Muscle Strain	Right	Yes	Training - Kicking	Non-Contact	Moderate	4	4	0
Player 5	2019/20	06/06/2020	19.6	Calf Strain Soleus 2B	Calf Strain	Left	Yes	Training - Running	Non-Contact	Mild	46	37	9
Player 18	2019/20	10/06/2020	27.0	Thigh Strain - Rectus Femoris 3B	Thigh Strain	Left	Yes	Training - Deceleration	Non-Contact	Mild	35	28	7
Player 1	2019/20	17/06/2020	23.4	Calf Haematoma	Calf Strain	Right	Yes	Training - Tackle	Contact	Mild	7	6	1
Player 3	2019/20	20/06/2020	25.2	Foot Big Toe Proximal Phalanx Fracture	Foot	Right	Yes	Match - Tackle	Contact	Mild	32	24	8
Player 19	2019/20	20/06/2020	23.6	Hamstring Strain Grade 2B	Hamstring Strain	Right	Yes	Match - Running	Non-Contact	Mild	15	12	3
Player 2	2019/20	27/06/2020	23.4	Knee Medial Collateral Ligament Sprain	Knee	Right	Yes	Match - Tackle	Contact	Severe	6	5	1
Player 9	2019/20	30/06/2020	19.7	Foot Cuboid Bruising	Foot	Right	Yes	Match - Tackle	Contact	Mild	2	2	0
Player 22	2019/20	18/07/2020	22.3	Hamstring Tightness	Hamstring Strain	Right	Yes	Unsure	Non-Contact	Mild	5	3	2