Analysis of exercise training programmes on developing strength and flexibility in recreational athletes

Introduction

Understanding the most effective training approaches to enhance specific abilities such as strength and flexibility are essential to ensure that athletes can develop their abilities effectively. As such, previous studies have noted that a variety of training approaches may be employed to support such improvements, including the use of focused approaches and the use of a combination approach to training. The use of combination training sees the use of multiple components of fitness such as strength, agility and endurance, which can be seen in training such as high-intensity interval training (HIIT) and plyometrics.

Simao et al. (2011) investigated the influence of strength, flexibility and simultaneous training on strength and flexibility gains in eighty sedentary females. The study found that following 16 weeks of training, strength training enhanced both flexibility and strength, and the use of simultaneous training can lead to further enhancements of flexibility. Such findings have been replicated in the literature (see. Morton et al., 2011; Kim et al., 2011); however, some studies suggest that the use of simultaneous training may lead to reductions in strength development (Leite et al., 2015). Therefore, this has led to some debate arising and a lack of clarity on the potential impact of simultaneous training on strength and flexibility gains.

The current report is interested in understanding the most effective approach to improving both strength and flexibility abilities in recreational team sport athletes. Therefore, the current study aims to identify the most effective training method to support strength and flexibility developments in recreational team sport athletes. The report initially hypothesises that there will be significant differences in strength gains between the training groups. Secondly, the study hypotheses that there will be a significant difference in flexibility gains between the training groups. Both null hypotheses suggest that there will be no significant differences in flexibility or strength gains between the groups.

Methods

Participants

The study recruited 52 participants who provided informed consent to participate. The participants were separated into four groups: placebo, strength training, flexibility training or a combination of the training types. Each training programme consisted of three sessions each week for sixty minutes per session, over six weeks. All collected data was held in accordance with the Data Protection Act (2018), and all subjects were assigned a pseudonym to preserve the identity of the participants.

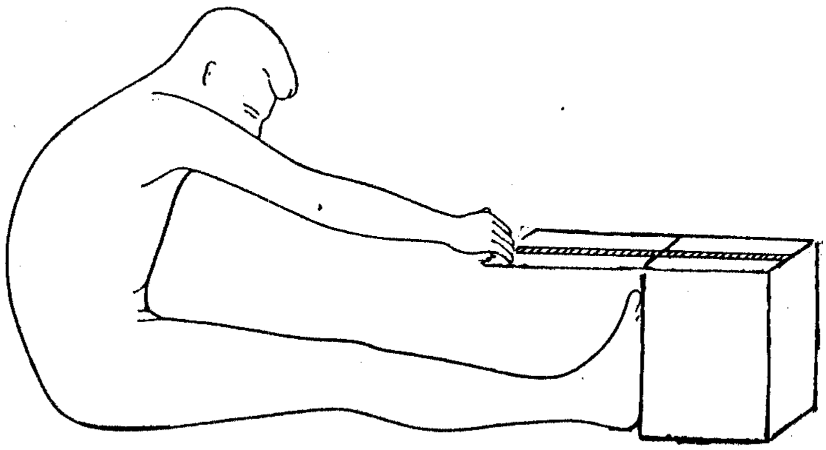
Materials and Procedure

Prior to the testing commencing, all participants underwent a structured warm-up for 10 minutes followed by a further 10 minutes of upper and lower body stretching. The warm-up was led by an exercise professional, and all subjects were provided with a further 5 to 10 minutes to complete additional exercises or stretch to ensure they were sufficiently prepared for the testing. All subjects were provided with written instructions and relevant information on how to perform all tests, including a physical demonstration of the tests.

All participants were required to complete three attempts of the sit and reach test to assess flexibility, with an average score utilised for the pre-and post-test score. All participants were required to sit on the floor with their legs stretched out straight ahead to complete the movement, as demonstrated in figure 1. The participants placed the soles of their feet against the box with both knees locked and pressed flat to the floor. Each participant then reaches forward along the measuring line and reach as far as possible. Each hand was required to reach the same line for the score to count. The scores were recorded in centimetres (cm), and all participants received three practice attempts before the start of testing. The sit and reach test has previously been encouraged due to its ability to provide a reliable and valid measure of subjects linear flexibility and is therefore justified for inclusion.

To assess strength, all participants were required to complete the push-up test, which requires subjects to complete as many full push-ups as they can in one minute. To complete the movement, all participants start in a push-up position with their hands and toes touching the floor, their body and legs in a straight line with their feet slightly apart and their arms at shoulder-width. Subjects are required to keep the back and knees straight and must lower their body to a predetermined point, specifically a tennis ball in the current study, before returning to the original starting position. The subject must repeat this movement until either failure or until sixty seconds pass. An illustration of the appropriate position can be seen in figure 2.

Figure 1. *An illustration of the appropriate position to complete the sit and reach test.*



As the current study was interested in understanding different forms of exercise interventions on strength and flexibility outcomes in recreational athletes, the intervention effect sizes were calculated using Cohen's *d* (Cohen, 1977), which was calculated using the formulae;

$$d = \frac{M_1 - M_2}{s_{Dp}}$$

In the formulae, M_1 refers to the mean of the experimental group while M_2 refers to the control group's mean, with SDP referring to the pooled standard deviations for each group. SDP was calculated using the formulae;

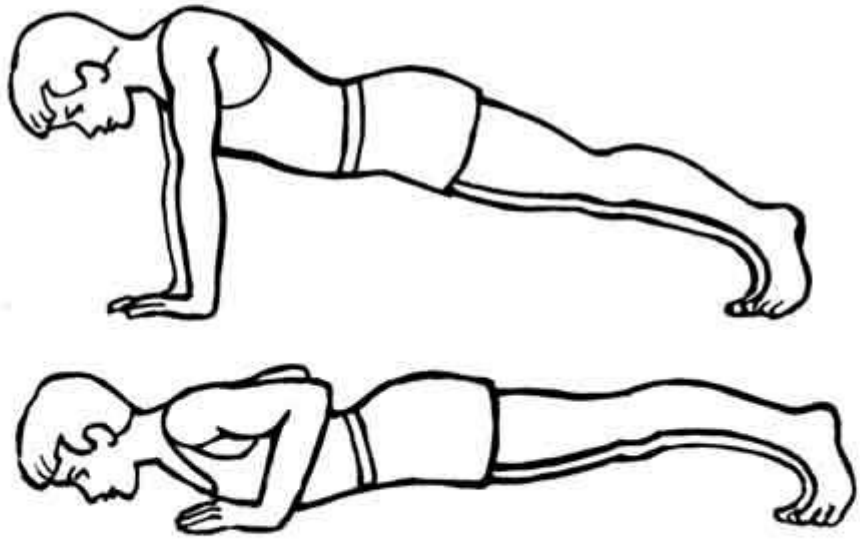
$$\sqrt{\frac{(s_1^2 + s_2^2)}{2}}$$

S_1^2 refers to the standard deviation of the experimental group and S_2^2 the control group's standard deviation. As it is predicted that sample sizes will differ greatly, a correction factor was implemented for samples of 49 subjects or less. This correction factor allows the prevention of over-inflation as previous studies have noted that Cohen's is typically more effective in samples of 50 subjects or greater. Therefore, the correction factor was calculated using the formulae;

$$d = \frac{M_1 - M_2}{SDp} \times \left(\frac{N-3}{n-2.25}\right) \times \sqrt{\frac{N-2}{N}}$$

Effect size calculations were deemed appropriate for use in the current study due to their ability to provide further insight into each intervention in addition to the basis of significant differences. This provides a greater value to understanding the trends relating to the exercise intervention and supports the determination of the most appropriate training programmes to initially support improved flexibility and, secondly, improved strength amongst recreational athletes.

Figure 2. *An illustration of the position for the push-up test.*



Analysis

The current study used SPSS v.25 software (IBM Inc, Chicago, IL) to analyse the participant's data. To investigate the impact of the training programmes on strength and flexibility, the study conducted a one-way ANOVA with the conduction of a Tukey post-hoc test to identify where any significant differences may lie. All data were presented as (M±SD), with the alpha set at α = 0.05.

Results

Descriptives

The study consisted of 52 participants aged 18 to 35 years (24.40±4.50yrs) with an average height of 173.44cm (±13.00cm) and weighing 72.87kg (±12.75kg). The sample had a slightly larger proportion of females (n = 29, 55.8%) with the majority of athletes being involved in Basketball (n = 15, 28.8%), Handball (n = 10, 19.2%) and Football (soccer) (n = 9, 17.3%). The majority of participants were from the USA (n = 27, 51.9%) and Germany (n = 12, 23.1%). Each group consisted of 13 subjects. An overview of the demographics can be seen in table 1.

Table 1. *Subject demographics*

Gender	**n**	**%**
Male	23	44.2
Female	29	55.8
Nationality		
American	27	51.9
German	12	23.1
Spanish	9	17.3
Romanian	3	5.8
French	1	1.9
Sport		
Football	9	17.3
Basketball	15	28.8
Handball	10	19.2
Softball	8	15.4
Volleyball	6	11.5
Rugby	4	7.7

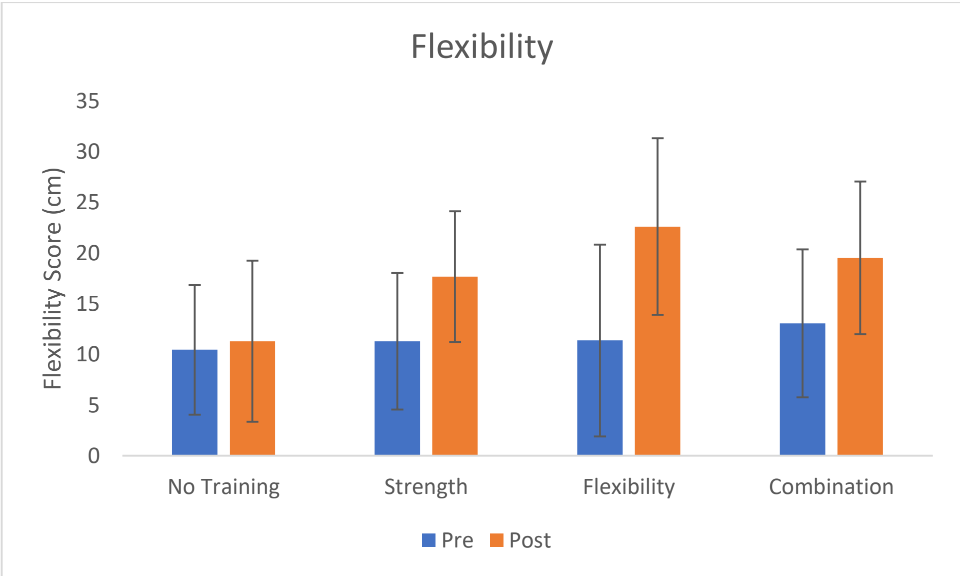
The pre scores demonstrated an average flexibility score of 11.56cm (±7.41cm) and a average strength score of 25.08 (±12.276). Following the training programmes, the average flexibility score increased to 17.79cm (±8.56cm) which was also seen in the strength post scores which increased to 29.00 (±11.74).

Flexibility

Firstly, normality tests were conducted using the Shapiro-Wilk tests demonstrated a non significant departure from a normal distribution for the pre-intervention scores, W(52) = 0.928, p = 0.132 for the pre-score as well as the post-intervention scores, W(52) = 0.974, p = 0.299). Therefore, the study progressed with a parametric test, namely the one-way ANOVA.

Initially, each of the training groups had similar scores on the sit and reach test, with the no training group (10.46cm±6.41cm), strength (11.31cm±6.74cm), flexibility (11.38cm±9.47cm) and the combination group (13.08cm±7.30cm) all being deemed to have an average flexibility score. Following the completion of the training programmes, each group recorded increases in flexibility, namely the no training group (11.31cm±7.94cm), strength (17.69cm±6.45cm), flexibility (22.62cm±8.71cm) and combination training (19.54cm±7.55cm). An overview of the change in scores can be seen in figure 3.

Figure 3. The changes in flexibility score from pre to post-intervention in each training group



The results from a one-way ANOVA demonstrate a significant between-groups difference in post-test scores for flexibility (F(3, 48) = 4.990, p = 0.004). A Tukey post hoc test revealed that the significant differences between the no training group and flexibility group (-11.31±3.02, p = 0.016) only. This suggests that the flexibility intervention was the lone intervention which allowed significant improvements to be made. Based on such findings, the flexibility hypothesis can be accepted.

To determine the effect size of the interventions, Cohen's d calculation was implemented for the intervention groups. Firstly, the strength intervention was found to have a large effect (*d* = 0.97) as was found with the combination training group (*d* = 0.87). The greatest effect was found in the flexibility group which found a very large effect (*d* = 1.24).

Strength

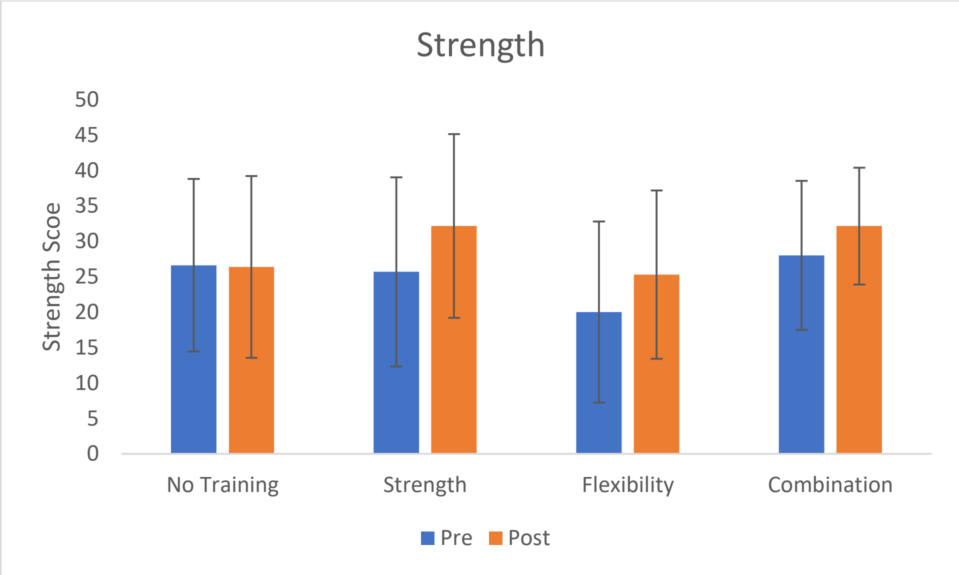
Firstly, normality tests were conducted utilising the Shapiro-Wilk test which demonstrated a statistically significant departure from a normal distribution for the pre-intervention scores, W(52) = 0.948, $p = 0.027$). However, the post-intervention scores were found to not be statistically significant from a normal distribution, W(52) = 0.959, $p = 0.073$). As the post-intervention scores were normally distributed, the study progressed with parametric testing through the conduction of a one-way ANOVA.

Initially, the participants in the combination training group (28.00±10.53) had the highest strength score, followed by the no training (26.62±12.18), strength (25.69±13.34) and flexibility group (20.00±12.78). The post scores demonstrated improvements for the strength (32.15±12.97), flexibility (25.31±11.88) and combination training groups (32.15±8.24), while the no training group (26.38±12.84) had a slight decline in score. An overview of the score changes can be seen in figure 4.

The results from the one-way ANOVA demonstrated no significant difference between the groups ($F(3,48) = 1.291$, $p = 0.288$). Based on the findings, the strength hypothesis is rejected, and the null hypothesis is accepted.

To determine the effect of the training programmes, Cohen's *d* was implemented. Firstly, strength training was found to have a medium effect (*d* = 0.49) which was also found for flexibility training (*d* = 0.43) and combination training (*d* = 0.44).

Figure 4. *The changes in strength score from pre- to post-intervention score.*



Discussion

The current report investigated the impact of specific training techniques on improving strength and flexibility in recreational team sport athletes. The findings demonstrated that each of the groups were able to support improvements in both strength and flexibility compared to no training group. However, the effectiveness of the interventions did reap differing benefits.

Firstly when considering flexibility, the study found that flexibility training was the most beneficial, as was initially anticipated. However, the study found that while not statistically significant, the use of strength and combination training did lead to improvements in flexibility with the effect of the interventions being large. This would suggest that the use of flexibility as well as strength training can lead to improvements in recreational team sport athletes flexibility.

Secondly when focusing on strength gains, the results further demonstrate the benefit of both strength and flexibility training, but utilising direct strength was found to be the most beneficial. As expected, the use of strength training was found to lead to the greatest improvements in strength which is likely due to its direct focus on increasing the subject’s strength. However, the study supports findings from previous studies that have noted the beneficial impact of flexibility training on improving strength in recreational athletes. As such, this report provide support and further evidence of different training approaches to enhance strength.

Conclusion

The results from the study highlight the benefits of specific exercise training to support improvements in flexibility and strength performance in recreational team sport athletes. Following the data, the report recommends the use of specific training methods to improve such components of fitness, although the study further notes the benefit of utilising a combined approach. However, it is key to note that while significant differences were not identified in terms of strength developments, it is key to understand that each of the training programmes did lead to enhancements as outlined by the effect size calculations. Therefore, it can be noted that each of the training programmes can lead to enhanced strength as well as flexibility.

References

Kim, E., Dear, A., Ferguson, S. L., Seo, D., & Bemben, M. G. (2011). Effects of 4 weeks of traditional resistance training vs. superslow strength training on early phase adaptations in strength, flexibility, and aerobic capacity in college-aged women. *The Journal of Strength & Conditioning Research*, *25*(11), 3006-3013.

Leite, T., de Souza Teixeira, A., Saavedra, F., Leite, R. D., Rhea, M. R., & Simão, R. (2015). Influence of strength and flexibility training, combined or isolated, on strength and flexibility gains. *The Journal of Strength & Conditioning Research*, *29*(4), 1083-1088.

Morton, S. K., Whitehead, J. R., Brinkert, R. H., & Caine, D. J. (2011). Resistance training vs. static stretching: effects on flexibility and strength. *The Journal of Strength & Conditioning Research*, *25*(12), 3391-3398.

Simão, R., Lemos, A., Salles, B., Leite, T., Oliveira, É., Rhea, M., & Reis, V. M. (2011). The influence of strength, flexibility, and simultaneous training on flexibility and strength gains. *The Journal of Strength & Conditioning Research*, *25*(5), 1333-1338.