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ANALYSING CHANGES IN SHOOTING PERFORMANCE: ANALYSIS OF PRE AND POST TRAINING SCORES

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ABSTRACT

The aim of the present investigation is to examine the effectiveness of a 15-day structured training intervention which comprises stability, precision, and concentration exercises for improving the shooting performance of athletes. The main objective was to evaluate the changes in shooting scores with the help of the intervention. Thirty athletes were randomly recruited in the study and the scores of both the pre and post training were assessed. The experimental group was exposed to the fifteen-day training while the other group received no treatment. The paired t-test signified the effectiveness of the program because shooting performance increased after the training. Even though the scores increased significantly, there was no relationship between pre-test and post-test scores showing that athletes of all skill level got equal benefits from the training. This means that the intervention was generally beneficial no matter the starting point of the students. The study raises questions about the effectiveness of the current training approaches for developing athletic performance and generalises the implications of the study results for training in sports. These results suggest utilization of similar training techniques in the other sports for enhancement of precision and stability. Subsequent studies may examine the durability of such programs and fine-tune their elements to maximize performance results.

Keywords: Shooting Performance, Stability Training, Precision Exercises, and Concentration Exercises

1. INTRODUCTION

In competitive sports like shooting, the performance is highly depending on the physical factors such as stability of the body as well as the precision, mental factors such as concentration and consistencies. To hit a target one needs not only the physical skill to strike correctly, but also the psychological and physical capacity to do it constantly. These essential factors are trained by athletes by doing specialized training just to have a better shooting score(Sundaram et al. 2024) . The most traditional method of evaluating the usefulness of the respective training initiatives is based on the comparison of scores before and after the training phase. Through observing how an athlete shoots before and after a given training period, it becomes easy for researchers and coaches to determine the effect of the training on their shooting skills. This method makes it easy to find out improvements in shooting accuracy, consistency, and performance.

On the use of basic pre- and post-training score analysis The analysis of scores before and after training is an effective means of assessing the shooter's strengths and weaknesses. This score is obtained just before introducing any

targeted exercises that can be used to gauge the innate ability of the shooter as well as their current deficiencies(Loh et al. 2021). The post-training score on the other hand gives levels of achievement done after undergoing some special exercises that have training effect on the nervous ability to be stable, precise and concentrate more. This comparison not only show where the areas of improvement should be focused on, but also allows for the evaluation of the efficiency of the training methods which were applied. To shooters, the enhancement of such factors as stability and accuracy is crucial to achieve higher results, given the fact that such competitions often involve very small margins between contenders(Lang & Zhou 2022).

It is difficult to overemphasise the importance of stability exercises in shooting performance. There are postural, grip and control factors and stability is crucial to postural stability that aids effective shooting. Specific exercises that train the abdominal wall and the muscles of the back can also significantly enhance the shooter's stability during the shooting process because it will minimize any flailing movements that tend to come with the shot. Similarly, precision training is known to be important in improving the capacity to place the shot on the target properly(Ihalainen et al. 2016) . This training usually includes practicing actions and movements in a drill fashion to develop muscle memory, motor reflexes, and hand–eye coordination. These components in combination allow the shooter to align consistently and deliver accurate aimed shots perfectly required for both training and sporting events.

Hand/eye coordination is elemental in shooting as it influences focus, concentration, decision-making, timing, and temperament. Mental exercises that allow for blocking out of distractions and focusing on target can lead to massive improvements of shooting performance. Most training regimes include both mental and physical workouts so that the entire regime of training is a balanced one and helps in development of a variety of skills. These physical and mental factors are integrated to enhance a shooter's skills and can be easily quantified using pre-and-post training test scores(Liu et al. 2018).

2. BACKGROUND OF THE STUDY

Shooting as any form of sports require the athletes to have certain physical attributes, mental demeanor, and sharp aim. In contrast to many other types of motor activity, shooting requires precise control of small muscles of the hands and upper limbs, stability of steady position, and a high level of attention. Proper body alignment, attention, and coordination entail only a few degrees of freedom in any movement to improve or deteriorate the performance – for example, in shooting. These demands, therefore, dictate that training programs for shooters call for enhanced stability, higher accuracy and enhanced concentration levels. In time, these exercises assist the shooter to gain control in order to reproduce the same shot at different circumstances. In many cases, the impact of the training programs is assessed by conducting a score comparison between the time before and after the completion of the program. This approach offers an objective means of identifying development and quantifying changes that can be made to training schedules.

The identification of performance changes with the help of pre- and post-training scores is a tradition in sports science research, especially in the fields where motor learning and motor control are the key factors. Stability training is important for the shooters in order to provide balance and control during shooting, while the precision exercises improve the shooting accuracy. Alike concentration training is paramount since it assists the shooter, especially during competitive shooting(Lang & Zhou 2022) . Using raw scores obtained before and after the training sessions, the authors can compare the effectiveness of these training techniques in improving a shooter's performance and identify which specific drills are most effective in promoting skill acquisition. In addition, the use of this analysis ensures the enhancement of training procedures in an ongoing manner to fit the requirements of the shooters of various performance levels.

In this case, many techniques have been invented and developed by the sports scientists and coaches in an attempt to enhance various aspects of shooting performance. They are usually performed to enhance stability hence enhancing the ability of the athlete to maintain proper posture while shooting. This in turn reduces body sway and other movements that are likely to interfere with accuracy of movements. Specificity exercises usually entail shooting drills that are repeated many times, and the overall purpose of which is to improve hand to eye coordination together with muscular memory. These drills are done with a view of building up the shoot's consistency in order to make better aimed shots. Stress reduction strategies like mindfulness and mental practice prove valuable to shooters, especially in cases where the shooter is exposed to a lot of pressure which in turn affects his performance(Ihalainen et al. 2018).

Of course, basic score analysis before and after the training is not only valuable in terms of the subject's performance enhancement. To coaches and sports scientists, this method is a useful research technique that will enable the determination of the efficacy of the different training regimens. After observing the performance of an athlete during a particular training period, they are then able to see which exercises cause the most improvement in the athlete and then modify the training in the next period. Furthermore, this type of analysis can be used for different categories of shooters starting from amateur and ending with professional athletes, which makes it possible to create specific training programs for every category(Hamilton et al. 2019) .

3. LITERATURE REVIEW

Mon-López et al. (2022) looked into the technical components of the shooting performance, but their weight, especially for elite pistol shooters, was still a matter of debate. The authors sought to establish technical features that relate to pistol performance. They captured one elite-level performer throughout the season prior to the Olympic qualification European championship; the competitions the shooter participated in were six, and in total, the shooter made 360 shots. Trajectories of aiming point were measured with the SCATT optoelectronic system and variables were classified into six categories: performance, aiming time, stability of hold, aiming accuracy, cleanness of triggering, and shooting delta. Principal component analysis, multiple regressions, Pearson correlations, and ANOVAs were used for the analysis of data. Five, namely aiming time, stability of hold, aiming accuracy, cleanness of triggering and shooting delta, composed 79.68% of the variance in shooting performance. Together, aiming accuracy and cleanness of triggering explained up to 25% of the shooting score. Cleanness of triggering emerged as most important. Other correlations were also seen through performance and other variables, such as stability of hold, aiming accuracy, cleanness of triggering, and shooting delta. A significant difference in shots from 8-score, 9-score, and 10-score was also noted. For optimal performance, cleanliness of triggering might be the most important technical variable; though, it might not determine what kind of performance a shooter will produce, stability of hold would appear necessary to attain high-level performance in elite air pistol shooters.

Olsson and Laaksonen (2021) executed a technical complexity analysis of air pistol shooting in relation to its demand for fine motor control and postural stability. The earlier studies have yielded mixed results concerning which technical components are most important for performance. Thus, the aim of the study was to identify the key technical elements for air pistol shooting and examine whether those factors explain shooting performance well. They tested 18 national-level shooters of air pistol who fired 60 shots in a simulated qualifying round. The shooting score and 17 other variables related to the trajectory of an aiming point were registered by means of an optoelectronic training device. Through principal component analysis, five key components were recognized: aiming time, stability of hold, aiming accuracy, cleanness of triggering, and timing of triggering. Of these, four sub-components—except aiming time—were significantly correlated with shooting score ($r = .48$ to $.74$; $p < 0.05$). The stepwise multiple regression analysis also showed that the three most critical factors which included aiming accuracy, timing of triggering, and stability of hold, explained 75-78% of the variance in shooting score. Thus, the researchers concluded to a focus on such specific components since both coaches and athletes should improve performance during training as well as testing periods.

Mon-López et al. (2019) explored the role of gun stabilization as the most prominent factor in air pistol Olympic shooting: a notion is suggested to be highly associated with the muscular work of the shooter's shoulder and forearm. The study aimed to confirm whether maximal finger flexor forces and isometric shoulder strength are associated with performance in female air pistol shooters. In this study, 23 female participants and handgrip and shoulder force were measured during official training sessions at the Spanish national championships, a day before the competition. The total score of 40 competition shots was used to define performance. A correlation matrix was calculated and linear regressions performed between performance and age, weight, height, years of experience in training, BMI, flexor forces from the fingers, and shoulder forces. Significant correlations found included an association with performance factors such as hours of training, the peak finger flexor force compared to BMI and the peak isometric shoulder abduction force compared to BMI. Conclusion: Considering the muscular forces in relation to an athlete's BMI, it substantially correlates with shooting performance, hence implying the strength training need that would target the same areas for female air pistol shooters.

Anderson and Plecas studied the relationship between physical performance, anthropometric measurements, and handgun marksmanship of police recruits. From this study, they noted that significant correlations existed between marksmanship and dominant grip strength, combined grip strength, forearm girth, and second ray length. Although these

findings were statistically significant only when the two genders were considered together, the data obtained did not allow the authors to develop a predictive equation for shooting scores. As such, the complexity of trying to obtain simple predictors of handgun accuracy is highlighted, and it is recommended that several factors be considered in the training and selection of police recruits.

Hung et al. published a study regarding the impacts of complex functional strength training, which consists of WBV and unstable surface training (UST), on rifle shooters. The present study examined shooting performance at three time points: pretraining, six weeks after the completion of the training, and six weeks after detraining. The participants were eight rifle shooters who underwent WBV+UST training at 30 Hz. Changes were significant in both shooting stability and body sway in the percent improvements recorded for these variables after the six-week training period. In relation to shooting performance, mean scores increased by 5.50%, and total time improved by 7.34%. Thus, the results of this study suggest that even such complex training programs lasting six weeks can powerfully influence shooting stability and fluency as well as overall performance, and the methods could similarly be important in broader shooting sports training programs.

4. RESEARCH METHODOLOGY

In this study, an experimental quantitative methodology was used to assess the outcome of a 15-day training program on athletes' shooting performance. The experimental approach is developed using pre- and post-test designs; the shooting performance results are compared before and after the training session. Thus, this method enables a clear and specific comparison of the effects of the specific training on the improvement of the athletes' performance.

Research Design and Sampling : The method used in this study was experimental research design with pre-test and post-test to evaluate the extent to which the 15-day training program impacted on shooting scores. Meaning, in order to increase the external validity of the results, random sampling was employed to make sure that every athlete had an opportunity of being selected for the study. In total, 30 athletes were chosen through this random sampling technique to improve the coherency of the research and to increase the chances of obtaining a representative sample. The athletes were divided into two groups: the experimental group consisting of 45 participants who underwent the 15-day training program and the control group of 45 participants who did not undergo any training during the same period.

Participants : The participants were 30 athletes: the selection of the participants was random and they were divided into the experimental and control groups. For this, the participants did not have any injuries or illness that would affect their performance in the shooting tests. The experimental group was trained for shooting performance for fifteen consecutive days, while the control group was not trained at all. This form of controlled environment was important for evaluating the real effects of the intervention on shooting precision.

Data Collection Methods : Previously and post the intervention, shooting scores were collected as the basic data for the study. The pre-test measured shooting scores before the training program started, which would be used as a benchmark to compare the performance of each participant during and after the training program. The post-test was done immediately after the 15 day intervention to determine the change in the shooting performance. To make the results of both tests more comparable, the shooting range and all shooting equipment used in the test were the same for all the participants. This made it easy to reduce external factors that may influence shooting performance hence increasing reliability of the results obtained.

Intervention Program: The experimental group carried out a 15-day training program in an endeavor of improving their shooting skills. We were running a set of exercises that met objectives of stability, precision of movements, and concentration, all of which are vital in shooting. Every training session was an hour long and all the training were done with a trainer who has been practicing and was already trained to keep the integrity of the program. On the other hand, the control group did not receive any training in this period so that any change in their shooting performance could be attributed to the intervention program.

Data Analysis: For shooting scores, the paired t-test was applied to compare the results of pre- and post-test of the experimental group. In this case, the paired t-test should be used since it measures performance differences within one group across time. An alpha of 0.05 was adopted to test for the significance of the training program on the shooting accuracy of the athletes. This approach of analysis made it possible for the study to determine the impact of the 15-day training programme.

5. DATA ANALYSIS

Paired Samples Statistics					
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre-Total Training score	297.9000	30	2.98675	.54530
	Post-Total Training score	340.30	30	2.452	.448

The Paired Samples Statistics table provides the results of the comparison between Pre-Total Training and Post-Total Training score among the 30 selected athletes. The average Pre-Total Training score is 297.90 and the standard deviation is 2.99, therefore, the variability of shooting performance before the training program is low. When using the test results obtained after the 15-day training program, the mean of the Post-Total Training score is 340.30 with a standard deviation of 2.45, indicating a more bipolar and standardized improvement in the performance. Pre- training and post-training mean scores are 0.5453 and 0.448 respectively which helps us to estimate the standard error mean of the differences. The above-mentioned difference stands as clear evidence that the training program enhanced the shooting skills of the athletes among the two groups.

Paired Samples Correlations				
		N	Correlation	Sig.
Pair 1	Pre-Total Training score & Post-Total Training score	30	-.038	.841

In the Paired Samples Correlations, we have calculated the correlation between the Pre-Total Training and the Post-Total Training of the 30 athletes as 0.90. The obtained correlation coefficient is -0.038 suggesting a very weak negative relationship between the two sets of scores. This means that there is a very low correlation between the pre- and post-training scores and it is almost negligible that any linearity of the training. Also, the significance value (Sig.) is.841 which is much higher than.05 which makes the correlation not significant. Thus, the low level of relationship between the pre- and post-training scores does not offer useful information about the nature of the connection.

Paired Samples Test									
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pre-Total Training score - Post-Total Training score	-42.40000	3.93569	.71856	-43.86961	-40.93039	-59.007	29	.000

The Paired Samples test allowed the identification of the difference between the obtained Pre-Total Training score and the Post-Total Training score. Closely related, the mean difference was calculated as -42.40, which indicates an average of 42.40 points increase in tests scores after the training program among athletes. The standard deviation of the difference is 3.94 thus pointing that there is slight variation in the level of improvement of the athletes. The estimated value of mean difference is 0.71856, while the standard error mean is showing the reliability of the difference mean estimate. At 95% confidence level the interval of the difference is between -43.87 and -40.93, it means that the true mean difference is between the two values with given level of certainty. Indeed, the t-value of -59.007 and the degrees of freedom (df) of 29 show the result was highly significant. The p-value is equal to 0.000 (Sig. 2-tailed), which means that the improvement of scores after the training program is significantly different from those before the training program at the level of 0.05. This shows that the training had a significant gain in shooting performance as the target was achieved.

6. RESULT AND DISCUSSION

The findings of the study show a marked increase in shooting performance after the 15-day training program. The paired samples test showed significant mean difference of -42.40 between the Pre-Total Training and the Post-Total Training score, meaning that the athletes' scores significantly improved after the intervention. These improvements are consistent further supported by the low standard deviation of 3.94, which indicates that while some athletes may have gained little or less than others, the majority of athletes experienced equal improvement. The 95% confidence interval for the difference is -43.87 to -40.93 which gives statistical assurance that the mean difference is not a product of sampling error. The t-value of -59.007 shows that the results are significant at the 0.01 level and the p-value of 0.000 reiterates that these results were not a mere chance.

However, the paired samples correlation of -0.038 between the pre and post-training scores suggest that there is little if any linear relationship between the two sets of data even though the post-training scores are double that of the pre-training scores. This weak negative correlation and in addition, insignificant p-value of 0.841 indicates that pre-training scores were not an indication of how much improvement these participants would make after training or conversely that lower pre-training scores meant lower post-training improvement. The low correlation may suggest that the training program was beneficial across the range of initial ability, improving results for the low and high ability performers equally.

The results of this study demonstrate the impact of the 15-day training intervention that comprised of the stability, precision and concentration exercises on the shooting scores of the athletes. This alone went on to show that preliminary and the post-training assessment was more pronounced because the training was more structured and had a clear aim. This also suggests that other well designed training programs should be incorporated in the improvement of performance in shooting sports. Although the investigators did not get a very strong relationship between pre and post scores, it is evident that the intervention did work positively on the athletes' performance. Ideally, future research could build on these findings by either investigating the durability of such training programs or by dissecting out the aspects of the intervention that were most beneficial.

7. CONCLUSION

Based on the results obtained in this study, it is therefore possible to conclude that adopting a structured 15-day training program can enhance shooting performance among athletes based on the improved scores noted in the shooters as well as from pre and post-training testing. The findings, with the mean difference equal to - 42.40 for pre and post-training test scores, also support the effectiveness of the intervention in the improvement of athletes' shooting skills. The overall improvement of the participants' performance, the low variability noted in their performance means suggest that the training program met its intended goal of enhancing the training participants' performance. In addition, significant t-statistics of -59.007 and p-Value of 0.000 confirm the validity of these results and ensure that the observed enhancements cannot be a result of chance. But the low level of post-training correlation with the pre-training scores raises certain questions about the nature of the gains made. This suggests that poor relationships between pre-test and post test performance does not necessarily mean that the training program did not yield improvements across the athletes and their baseline performance levels, which lends credence to the notion that the program can be a useful, cross-sectional intervention to improve shooting performance. That the structured necessity of stability, precision, and concentration exercises seems to have greatly contributed towards these enhancements suggests the usefulness of specific training programs in sports. Altogether, this work contributes new insights into the state of knowledge about the importance of well-structured training programs in sports and the necessity to search for the essential long-term effects and the best structures of the necessary training programs. The future studies can also look at the specific aspects of the training that brought out the greatest improvements, which may lead to even more specific development of athletes. In addition, this study creates opportunities for applying similar training paradigms in other related sports environments; such a directive underscores the importance of continued research and development regarding training strategies for enhancing skills and competitiveness. Thus, by establishing the positive correlation between the structured training and the increase in shooting scores, not only the necessity of such interventions in sports is proved, but also this work becomes the useful reference for the coaches, trainers and athletes who want to raise their performance level. The

significance of these works is huge since they promote the application of scientific approaches to the shooting sports and other athletic disciplines training.

CONFLICT OF INTERESTS

None.

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