CULTURA, CIENCIA Y DEPORTE

Competitive anxiety and trigger timing in female sport pistol shooters

Ansiedad en competición y tiempo de disparo en tiradoras de pistola deportiva

Daniel Mon-López[1*], Eva M. Olivares[2], María S. Zakynthinaki[3], Arturo Díaz[4]

[1] Facultad de Ciencias de la Actividad Física y del Deporte (INEF-Sports Department), Universidad Politécnica de Madrid, 28040 Madrid, Spain

[2] Universidad de Murcia. Facultad de Psicología

[3] Hellenic Mediterranean University, Department of Electronical Engineering

[4] Universidad de Murcia. Facultad de Ciencias del Deporte
* Autor para la correspondencia: Daniel.mon@upm.es Teléfono: 910678023

Received: 25 January 2021 / Accepted: 22 June 2021

Cómo citar el artículo:
Mon-López, D., Olivares, E., Zakynthinaki, M., & Díaz, A. (2022). Competitive anxiety and trigger timing in female sport pistol shooters. *Cultura, Ciencia y Deporte*, *17*(51), 23-29. http://dx.doi.org/10.12800/ccd.v17i51.1685

Abstract

Olympic shooting is a precision sport, influenced by both physical and psychological parameters. The main objective of the study was to analyze the effects of competitive anxiety in female sport pistol shooting during the qualification and the final rounds. Twenty-three women, including 5 elite shooters, who competed at a national Spanish Olympic shooting championship, participated in the study. All shooters completed a socio-demographic and a Competitive State Anxiety Inventory-2 (CSAI-2) questionnaire 10 minutes before each competition round. Performance was measured at competition by use of electronic targets Sius Ascor D941. Demographic and anxiety variables were registered using a questionnaire and the CSAI-2, respectively. Wilcoxon signed-rank, U *Mann-Whitney* tests, *linear regressions* and Pearson correlations were used for the data analysis. Our results showed that pre-competition anxiety impairs performance and increases trigger time. In addition, there are a strong relation between the physical condition and the psychological variables of somatic anxiety and self-confidence for the finalist shooters. We conclude that anxiety modified trigger time and that shooters' physical condition is inversely related to anxiety and positively related with performance and self-confidence. For this reasons, physical condition programs could be recommended for Olympic shooting.

Keywords: Olympic shooting, stress, performance, self-confidence, gun.

Resumen

El tiro olímpico es un deporte de precisión, influenciado por factores físicos y psicológicos. El principal objetivo del estudio fue analizar los efectos de la ansiedad precompetitiva y competitiva en mujeres de la modalidad de pistola deportiva durante la clasificación y la final olímpica. Veintitrés mujeres, incluyendo cinco tiradoras de élite, que compitieron en un Campeonato de España participaron en el estudio. Todas las deportistas completaron un cuestionario sociodemográfico y el CSAI-2 10 minutos antes de cada ronda de competición. El rendimiento fue medido mediante blancos electrónicos Sius Ascor D941 durante la competición. Para el análisis de datos se usaron las pruebas de Wilcoxon, U Mann–Whitney, regresiones lineales y correlaciones de Pearson. Los resultados mostraron que la ansiedad precompetitiva afecta al rendimiento y aumenta el tiempo de disparo. Además, existe una fuerte correlación entre la percepción de la condición física y las variables psicológicas de ansiedad somática y autoconfianza para las atletas finalistas. Nosotros concluimos que la ansiedad modifica el tiempo de disparo y que la condición física de las tiradoras se relaciona de forma inversa con la ansiedad y de forma positiva con la autoconfianza y el rendimiento. Por estas razones, programas de actividad física podrían ser recomendables en tiro olímpico.

Palabras clave: Tiro olímpico, stress, rendimiento, autoconfianza, arma.

Olympic shooting includes several disciplines, such as pistol, rifle and shotgun. The female Olympic pistol category consists of two modalities: a) air pistol (caliber 4.5), with a single shooting precision component and b) sport pistol (caliber 22), which includes a shooting precision stage, similar to air pistol in its technique and execution, and a rapid fire phase with a clear temporal limitation in the execution of the shot, where five shots per set are performed with 3 second (shoot) and 7 second (rest) intervals between shots (RFEDETO, 2014).

Due to the high precision requirements (Mon-López, Tejero-González, et al., 2019), performance in shooting can be influenced by many parameters, both physical and psychological (Reinkemeier et al., 2006). Among the physical-physiological parameters, the ability to stabilize the weapon seems to play a very important role (Hawkins, 2011). This ability is determined by the shooters' postural stability (Pellegrini & Schena, 2005), their physical condition (Gulbinskienė & Skarbalius, 2009) ,as well as their ability to reduce muscular tremor which may in turn be the result of various other factors (Lakie, 2010). Mental preparation plays also a very important role: shooters must remain calm and completely focused on the target under psychological pressure during competition. Anxiety has been identified as a very important psychological parameter that influences performance in sport in general (Ortega et al., 2017) and in Olympic shooting in particular (Causer et al., 2011; Kayihan et al., 2013; Nieuwenhuys & Oudejans, 2010, 2011).

Various anxiety levels can be defined, corresponding to different situations during which stress levels can vary, such as training or actual shooting conditions (Kayihan et al., 2013). In addition, the shooters' level influences anxiety. Thus, higher anxiety values having been reported in lower level shooters (Kayihan et al., 2013). Furthermore, decreases in performance have been reported under high anxiety, when compared with low anxiety conditions (Nieuwenhuys & Oudejans, 2010, 2011). Specifically, state anxiety can lead to a significant impairment in performance in Olympic shooting, as it influences the goal-directed attention of the shooters (Causer et al., 2011) and could be a differential element of the sport level (Spancken et al., 2021). Evidence suggests that anxiety caused by highly stressful conditions (competition) can cause differences in trigger times between novice and experienced athletes (Vickers & Lewinski, 2012). Anxiety can also importantly reduce the action time in police pistol shooting from the first shot. However, other studies report that an increase in the anxiety levels could increase the execution time in precision tasks (Nibbeling et al., 2014).

The activation level (defined as the change in the basal arousal level while performing a task) which is related to anxiety, was also found to be inversely correlated with performance in pistol shooting, as it decreases the total execution time, as well as the time intervals between shots (Vaez et al., 2011). High pressure-stress conditions have been also found to impair performance in police officers, causing changes in body position, in visual attention and in movement (trigger pulling) times (Nieuwenhuys & Oudejans, 2010, 2011). Also in skeet shooting, performance has been found to be influenced by anxiety, as changes have been detected in the movements of the shotgun, combined with increases in the amplitude/speed of the gun barrel displacements (Causer et al., 2011). On the other hand, training programs specially designed to minimize the effect of anxiety on parameters such as the ones mentioned above should be implemented to improve performance (Nieuwenhuys & Oudejans, 2011).

Additionally, physical condition has been related to shooting performance. Factors like the finger flexor or shoulder isometric abduction forces have been related directly to performance (Mon-López, Zakynthinaki, et al., 2019). However physical condition also seems to affect shooters psychologically. Thus, physical training could improve the mental wellness of the shooters and specifically their self-confidence depending on the experiences of each athlete (Mon-López, Moreira da Silva, et al., 2019).

Although it has been previously proved that anxiety affects shooting performance, there is controversy regarding the effect of this psychological variable on trigger time. Moreover, the number of studies that examine the effects of anxiety in female shooting is very limited. Consequently, the aim of this study was to analyze the effects of pre-competition anxiety on trigger time and performance in female pistol shooting at two different competition stages: the qualifying low-stress round and the highly stressful final competition.

Materials and Methods

Participants

Twenty-three female shooters aged 38.30 ± 12.40 years with an experience of 10.76 ± 8.18 years and 8.59 ± 7.67 hours of weekly training participated in this study. Data were collected during the sport pistol Spanish Olympic championship, which took place in Granada (Spain). As inclusion criteria, shooters must have had accredited a minimum score of 500 points in previous shooting sport pistol competitions (RFEDETO, 2014). From the total number of participants five belonged to the elite Spanish group and have scored 581 points once or 577 points two times in national/international events previously (RFEDETO, 2014). Participants who had suffered injuries during the last year and with less than one year of experience in the sport pistol modality were excluded from the study.

The possibility to voluntary participate in this study was offered to all competitors. The participation percentage was 95.83% (only one shooter denied). An informed consent was signed by all the participants before data collection. This study was approved by the ethics committee of the Polytechnic University of Madrid.

Materials and variables

The demographic and training questionnaire design was carried out by two professional coaches with more than five years of international experience independently. Later, both questionnaires were discussed by the two researchers until an agreement was reached. In case of discrepancy in any of the questions, one of the researchers acted as judge.

The final demographic and training questionnaire included the following variables: age (years), weekly training (hours), experience (years), injuries suffered during the last year, elite (yes or no) and self-perception of the competition importance (according to the athlete's annual competition program), performance level and physical condition (all in a Likert scale 1-10). Electronic targets (model Sius Ascor D941) were used to measure performance. The following performance variables were analysed during the qualification round: Precision stage score, rapid fire stage score, total performance (qualification total score, sum of the score obtained during the precision and the rapid-fire stage), triggering time (hundredths of a second), points average per shot. In addition, during the

final round only triggering time (hundredths of a second) and points average per shot were used due to the specific characteristics of the final shooting system.

Pre-competitive and competitive anxiety were evaluated using the Competitive State Anxiety Inventory-2 (CSAI-2) questionnaire in its Spanish version of Márquez (1992). This questionnaire was previously validated by Fernández et al. (2007) and used in different sports (Cervantes et al., 2009; Prados et al., 2011). CSAI-2 consists of 27 items with a Likert type scale from 1 (nothing) to 4 (a lot) and three subscales: somatic anxiety, cognitive anxiety and self-confidence. The reliability of the CSAI-2 questionnaire in our study was: somatic anxiety α = .705; cognitive anxiety α = .871 and self-confidence α = .913.

Procedure

The Spanish rules and regulations were followed throughout the entire competition (RFEDETO, 2014). All athletes were allowed to train in the official stand and targets, the day before the competition. All shooters competed with their own pistols, sportswear and supplementary material. The full questionnaire was given to all shooters ten minutes before the qualification rounds, starting close to their shooting stands. During the second phase of the study (the final round), only the eight athletes who were classified were asked to fill in the same questionnaire, again ten minutes before the competition start.

The competition consisted of: (1) qualification round, in which all participants took part, consisting of 60 shots divided in two stages (precision and rapid-fire shooting). This round begun with 6 series of five shots, where each series had to be fired in 5 minutes (precision shooting). Another 6 series of five shots followed, during which each shot had to be fired in 3 (up to 3.2) seconds (rapid fire), with a 7 (up to 7.1) seconds resting time between shots (the athletes had to lower their arm down at a 45° angle before firing each shot). Prior to each series the athletes were allowed to perform one series of five test shots (ISSF, 2020). (2) An Olympic rapid-fire final round where only 8 athletes participated (time allowed to shoot was equal as in the qualifying round), consisting of two stages: one semi-final and two finals (one for the gold medal and one for the bronze). The semi-final begun with 5 series of 5 shots. The top two athletes after the semi-final advanced to the gold medal match, while the 3rd and the 4th ranked athletes went to the bronze medal match. The principle adopted to assign points during the medal matches was hit or miss: a shot of 10.2 points or more counted as a hit, while a shot lower than 10.2 points counted as a miss. The competitors' performance was validated after the finals by the Spanish national committee of referees. Both points and trigger times were given by the electronic targets model Sius Ascor D941.

Statistical Analysis

The normal distribution of the variables was tested using the Shapiro-Wilk test. Since the variables did not fit the normal distribution, nonparametric tests were used. Wilcoxon signed-rank test were used to compare anxiety values and trigger times in the qualification and final rounds. In addition, according to (Rosenthal et al., 1994) , effect size was calculated for those comparison with statistical differences using $r = (Z/\sqrt{N})$ and with the following effect size ranges: small r = .10 to < .30; medium r = .30 to < .50 and large r = ≥ .50. Mann–Whitney U test was used to compare finalist and non-finalist shooters. The shooters' performance was calculated using linear regressions. The relations between somatic anxiety, cognitive anxiety and self-confidence and the rest of the variables were calculated using Pearson correlations. IBM SPSS Statistics software (Version 25.0. IBM Cor) was used to make the mathematical calculations. The level of significance was set to 0.05.

Additionally, in order to compare performance between the qualifying and the final rounds, only the score of the rapid-fire stage was taken into account (to avoid comparison of performance between events of unlike shots). Lastly, the statistical analysis of the present study included only the scores up to the semi-finals. Due to the small number of athletes that participated in the medal rounds (only four), these data were excluded from the analysis.

Results

Factors Affecting Performance depending on the stage.

The statistical analysis revealed that the qualification performance for all shooters was positively affected by the number of training hours, $F_{(1,21)}$= 5.28, p = .032, and that the age and performance were inversely correlated, $F_{(1,21)}$ = 12.35, p= .002. No statistically significant correlations were found between overall performance and the rest of the variables (p > .05). On the other hand, performance during the qualification rapid-fire stage was positively affected by the athletes' physical condition, $F_{(1,21)}$ = 4.80, p = .039, but not by any of the rest of the variables (p > .05). The performance of the precision stage was not found to be affected by any of the variables (p < .05).

Regarding the final (only the eight athletes classified), performance was found to be positively related to the perceived shooting status $F_{(1,6)}$ = 8.33, p = .028, the physical condition $F_{(1,6)}$ = 9.09, p = .024, as well as with training hours $F_{(1,6)}$ = 9.33, p = .022 and inversely related to age $F_{(1,6)}$ = 6.03, p = .049, and somatic anxiety $F_{(1,6)}$ = 8.93, p = .024.

Differences between finalists and non-Finalists

Total, precision stage and rapid-fire stage performances of the non-finalists during the qualifications round were not affected by any variable (p > .05). However, a tendency of negative correlation was found between performance and cognitive and somatic anxiety. Contrary, the finalists' total performance during the qualifications round was found to be affected by their perceived shooting status, $F_{(1,6)}$ = 7.89, p = .031, as well as the physical condition, $F_{(1,6)}$ = 6.40, p = .045. During the precision stage, finalists' performance were affected by shooting status, $F_{(1,6)}$ = 16.9, p = .006, while during the rapid fire stage performance was not affected by any variables (p > .05).

Differences were found between finalists and non-finalists in their total performance Z = -3.78, p < .001, their performance during the precision, Z = -3.10, p = .002, and the rapid-fire round, Z = -3.72, p < .001. Differences were also found regarding their age, Z = -2.66, p = .007. No differences were found between finalists and non-finalists regarding the rest of the variables (p > .05).

Differences Between Final and Qualification Rounds

For the 8 finalists, performance during rapid fire shooting as well as self-confidence was significantly lower in the final round than in the qualification round (Z = -1.97, p = .049).

Trigger times and cognitive anxiety were on the contrary increased during the final round (Z = 2.17, p = .030 and Z = 2.37, p = .018, respectively). No significant differences were found in somatic anxiety before entering the finals (p > .05) Table 1.

Table 1. Cognitive anxiety somatic anxiety selfconfidence trigger time and performance during qualifying and final rounds

	Qualifying		Final				Effect size
Variable	*M*	*SD*	*M*	*SD*	*z*	*p*	*r*
Cognitive anxiety	27.99	18.22	42.55	26.53	2.37	.018	.83
Somatic anxiety	43.92	12.88	51.34	15.63	1.63	.102	
Self-confidence	59.84	18.29	49.95	26.09	-1.97	.049	.69
Trigger time	2.74	0.12	2.84	0.07	2.17	.030	.76
Performance	9.42	0.19	9.29	0.21	-1.97	.049	.69

Notes. M = mean; SD = standard deviation Z = z-score; p = level of significance r = effect size

Correlations between cognitive anxiety, somatic anxiety, self-confidence and the rest of the variables

During the qualifications round, self-confidence was found to be positively related to physical condition (r^2 = .17, p = .025). Score and somatic anxiety were negatively related to precision stage performance (r^2 = .13, p = .047) for the whole group of athletes. In addition, negative relations were found for the non-finalists between cognitive anxiety and perceived competition (r^2 = .23, p = .036) and precision stage performance with both cognitive (r^2 = .24, p = .031) and somatic anxiety (r^2 = .24, p = .031). No statistically significant correlations were found between anxiety or self-confidence and the rest of the variables (p > .05) (see Table 2).

Table 2. Correlations between cognitive anxiety, somatic anxiety, self-confidence and the rest of the variables during the qualifications round.

	All shooters			Non-finalists			Finalists		
Variable	CA	SA	SC	CA	SA	SC	CA	SA	SC
Age	.07	.14	.00	.22	.11	.08	-.05	-.19	-.11
Competition Importance	-.06	.02	.18	-.48*	-.27	.25	.34	.36	.11
Shooting status	-.05	.04	.27	-.29	.08	.20	.16	.14	.38
Physical condition	-.02	.09	.41*	.07	.31	.35	-.13	-.11	.61
Experience	-.08	-.10	-.01	-.25	-.20	-.03	.20	.02	.05
Training hours	-.14	-.13	.23	-.36	-.24	.10	-.06	.08	.34
Score in precision stage	-.12	-.36*	.18	-.49*	-.49*	.30	.26	.24	.06
Score in rapid-fire stage	.01	-.13	.00	.02	.10	-.17	.09	.12	.31
Total performance	-.06	-.27	.10	-.36	-.30	.10	.21	.21	.20

CA = cognitive anxiety; SA = somatic anxiety; SC = self-confidence * p < .05

Concerning the final round, the statistical analysis of the 8 finalists (see Table 3) revealed a negative correlation between somatic anxiety and perceived shooting status (r^2 = .50, p = .025), physical condition (r^2 = .71, p = .004), number of training hours (r^2 = .53, p = .020) and average score during the finals (r^2 = .59, p = .012). However, self-confidence was found to be positively related to perceived shooting status (r^2 = .56, p = .017), physical condition (r^2 = .64, p = .009) and average score during the finals (r^2 = .49, p = .027).

Table 3. Correlations between anxiety, self-confidence and the rest of the variables during the finals

Variable	Cognitive anxiety	Somatic anxiety	Self-confidence
Age	.20	.52	-.29
Competition Importance	-.19	-.47	.44
Shooting perceived status	-.36	-.71*	.75*
Percieved physical condition	-.55	-.84**	.80**
Experience	.17	.27	.02
Training	-.43	-.73*	.47
Average Score	-.32	-.77*	.70*

* p < .05; ** p < .01

Discussion

The results showed that, during the qualifications round, the shooters' performance was not affected by pre-competitive anxiety, although a tendency of inverse correlation could be observed between performance and somatic/cognitive anxiety, which is in accordance with the existing literature (Bueno et al., 2002; Kais & Raudsepp, 2005; Mullen et al., 2005). However, this inverse correlation between performance and anxiety became statistically significant during the final stages of the competition.

It was also observed that the participating female shooters had medium to high levels of cognitive/somatic anxiety and self-confidence. Interestingly, the high anxiety values were not registered, as is usually the case in other types of sports (Cervantes et al., 2009). Despite the high levels of anxiety, the self-confidence of the athletes was high, and this could explain the high-performance levels of these female shooters. Similar results were also reported in the study of Prados et al. (2011) where high-level gymnasts showed higher levels of anxiety than lower levels gymnasts, but also higher levels of self-confidence.

Our results also showed an increase in the cognitive anxiety levels and a decrease in self-confidence for the shooters qualified for the final round. This is a fact that could be related to the importance of the forthcoming final round. Shooting-specific studies refer to the possibility of activation-anxiety bands that could determine performance. It has been suggested that the theory of Individual Zones of Optimal Functioning (IZOF) is also valid in Olympic shooting (Bertollo et al., 2012). Furthermore, these psychological changes will depend on how the shooter interprets its (like something positive or negative) (Moreira da Silva et al., 2021), which can be different between athletes (Athan & Sampson, 2013). Additionally, the state anxiety could be a differential element between the sport level of the athletes (Spancken et al., 2021)

The results of the present study also revealed that the trigger time was also influenced by anxiety, in accordance with other studies where differences in trigger time related to the athletes' experience were observed under anxiety conditions (Vickers & Lewinski, 2012). However, in the study of Vickers and Lewinski (2012) the actions were reported to be accelerated, thus leaving the trigger time unchanged; also in the studies of (Nieuwenhuys & Oudejans, 2010, 2011) the trigger times were found to be reduced under high stress conditions.

Our results are in accordance with the study of Nibbeling et al. (2014) where a delay in the trigger pull was also reported. These differences could be due to the differences in the way points were assigned during the qualifications round (sum of series of shots without decimal points) as well as during the finals (hit of 10.2 points or miss), which could be pressing the athletes to work outside their individual trigger time, decreasing their performance. Similarly the changes in anxiety levels between the different competition stages could be the reason for the slowing down of the action; the study of Causer et al. (2011) also reports that anxiety situations decrease the ability to fix attention on a goal, thus decreasing performance. Additionally, the perceived state of self-control is reduced with the number of shots performed (final stage is after the qualifying round) and this lower perceived state self-control could explain partly the decrease in shooting performance (Englert et al., 2021). Consequently, to reduce the negative effects of anxiety, coaches should implement coping interventions (Kent et al., 2018), specific training programs (Nieuwenhuys & Oudejans, 2011) and the use of professional psychological support (Moreira da Silva et al., 2021). In this line, mindfulness techniques could improve shooting performance (Josefsson et al., 2020).

Regarding the importance of the athletes' physical condition, the results of the present study are in accordance with other studies (Gulbinskienė & Skarbalius, 2009; Mon et al., 2015). In this line, the perceived physical condition has been found to be positively correlated with somatic anxiety as well as self-confidence. Accordingly, existing studies have pointed out that physical condition (Mon-López, Moreira da Silva, et al., 2019) and shooting perceived status (Hanton et al., 2008) could influence the self-confidence for the finalist

shooters. For this reason, it seems logical to recommend physical condition programs (Krasilshchikov et al., 2007).

The present study is based on data recorded during a very important shooting competition (a Spanish championship qualifying for international competitions), a fact that highlights the importance of the results. In addition, it should be mentioned that the number of studies in Olympic shooting that are based on data recorded under real competition conditions is very limited (Ihalainen et al., 2017; Mon, Zakynthinaki, Cordente, Barriopedro, et al., 2014; Mon, Zakynthinaki, Cordente, Monroy Antón, et al., 2014). However, even though the 95% of the shooters participated in the study, the sample is very limited, especially concerning the final data (registered from only eight shooters). This imposes limitations on the statistical power of our results and futures studies should be contacted using larger samples. In addition, due the controversy regarding the trigger time, future studies should confirm the anxiety effect on the rapid-fire stage in female sport pistol, or even in other shooting modalities where there is a time limitation to shoot.

Conclusions

The results of the present study revealed that high levels of pre-competition anxiety can cause a decrease in performance in female sport pistol, as well as changes in the shooting time. In addition, performance and self-confidence was found to decrease, while cognitive anxiety and trigger time was found to increase during the final round when compared to the qualifying round. As a practical application, coaches should apply appropriate programs to reduce anxiety levels and to improve the shooting time during the different parts of the competition. Therefore, programs of activation control techniques (Bueno et al., 2002; Kais & Raudsepp, 2005; Mullen et al., 2005), coping interventions (Kent et al., 2018), specific training programs (Nieuwenhuys & Oudejans, 2011) and professional psychological support (Moreira da Silva et al., 2021) should be included in Olympic shooting.

References

Athan, A., & Sampson, U. (2013). Coping with pre-competitive anxiety in sports competition. *European Journal of Natural and Applied Sciences*, *1*(1), 1-9.

Bertollo, M., Robazza, C., Falasca, W. N., Stocchi, M., Babiloni, C., Del Percio, C., Marzano, N., Iacoboni, M., Infarinato, F., & Vecchio, F. (2012). Temporal pattern of pre-shooting psycho-physiological states in elite athletes: A probabilistic approach. *Psycholoy of Sport and Exercise*, *13*(2), 91-98. 10.1016/j.psychsport.2011.09.005

Bueno, J., Capdevila, L., & Fernández-Castro, J. (2002). Sufrimiento competitivo y rendimiento en deportes de resistencia. *Revista de Psicología del Deporte*, *11*(2), 209-226.

Causer, J., Holmes, P. S., Smith, N. C., & Williams, A. M. (2011). Anxiety, movement kinematics, and visual attention in elite-level performers. *Emotion*, *11*(3), 595-602. https://doi.org/10.1037/a0023225

Cervantes, J. C., Rodas, G., & Capdevila, L. (2009). Perfil psicofisiológico de rendimiento en nadadores basado en la variabilidad de la frecuencia cardíaca y en estados de ansiedad precompetitiva. *Revista de Psicología del Deporte*, *18*, 0037-0052.

Englert, C., Dziuba, A., Wolff, W., & Giboin, L.-s. (2021). An investigation of the effects of self-reported self-control strength on shooting performance. *Psychology of Sport and Exercise*, *52*, 101839. https://doi.org/10.1016/j.psychsport.2020.101839

Fernández, E. M. A., Río, G. L., & Fernández, C. A. (2007). Propiedades psicométricas de la versión española del Inventario de Ansiedad Competitiva CSAI-2R en deportistas. *Psicothema*, *19*(1), 150-155.

Gulbinskienė, V., & Skarbalius, A. (2009). Peculiarities of investigated characteristics of lithuanian pistol and rifle shooters´ training and sport performance. *UGDYMAS KÛNO KULTÛRA*, *73*(2), 21-27. https://doi.org/10.33607/bjshs.v2i73.433

Hanton, S., Neil, R., Mellalieu, S. D., & Fletcher, D. (2008). Competitive experience and performance status: An investigation into multidimensional anxiety and coping. *European journal of sport science*, *8*(3), 143-152. https://doi.org/10.1080/17461390801987984

Hawkins, R. (2011). Identifying mechanic measures that best predict air-pistol shooting performance. *International Journal of Performance Analysis in Sport*, *11*(3), 499-509. https://doi.org/10.1080/24748668.2011.11868568

Ihalainen, S., Mononen, K., Linnamo, V., & Kuitunen, S. (2017). Which technical factors explain competition performance in air rifle shooting? *International Journal of Sports Science & Coaching*, *13*(1), 78-85. https://doi.org/10.1177/1747954117707481

ISSF. (2020). General Technical Rules. ISSF.

Josefsson, T., Gustafsson, H., Rostad, T. I., Gardner, F. L., & Ivarsson, A. (2020). Mindfulness and shooting performance in biathlon. A prospective study. *European journal of sport science*, 1-20. https://doi.org/10.1080/17461391.2020.1821787

Kais, K., & Raudsepp, L. (2005). Intensity and direction of competitive state anxiety, self-confidence and athletic performance. *Kinesiology*, *37*(1), 13-20.

Kayihan, G., Ersoz, G., Özkan, A., & Mitat, K. (2013). Relationship between efficiency of pistol shooting and selected physical-physiological parameters of police. *Policing*, *36*(4), 819-832. 10.1108/PIJPSM-03-2013-0034

Kent, S., Devonport, T. J., Lane, A. M., Nicholls, W., & Friesen, A. P. (2018). The effects of coping interventions on ability to perform under pressure. *Journal of sports science & medicine*, *17*(1), 40.

Krasilshchikov, O., Zuraidee, E., & Singh, R. (2007). Effect of general and auxiliary conditioning on specific fitness of young pistol and rifle shooters. *Asian Journal of Exercise & Sports Science*, *4*, 01-06.

Lakie, M. (2010). The influence of muscle tremor on shooting performance. *Experimental Physiology*, *95*(3), 441-450.

Márquez, S. (1992). Adaptación española de los cuestionarios de antecedentes, manifestaciones y consecuencias de la ansiedad ante la competición deportiva. I. Estructura factorial. *Revista de Psicología del Deporte*,

Mon-López, D., Moreira da Silva, F., Calero Morales, S., López-Torres, O., & Lorenzo Calvo, J. (2019). What Do Olympic Shooters Think about Physical Training Factors and Their Performance? *International journal of environmental research and public health*, *16*(23), 4629. 10.3390/ijerph16234629

Mon-López, D., Tejero-González, C., & Calero, S. (2019). Recent changes in women's Olympic shooting and effects in

performance. *PLoS ONE*, *14*(5), e0216390. https://doi.org/10.1371/journal.pone.0216390

Mon-López, D., Zakynthinaki, M. S., Cordente, C. A., & García-González, J. (2019). The relationship between pistol Olympic shooting performance, handgrip and shoulder abduction strength. *Journal of Human Kinetics*, *69*, 7. https://doi.org/10.2478/hukin#2019#0009.

Mon, D., Zakynthinaki, M. S., Cordente, C. A., Antón, A. J. M., Rodríguez, B. R., & Jiménez, D. L. (2015). Finger Flexor Force Influences Performance in Senior Male Air Pistol Olympic Shooting. *PLoS ONE*, *10*(6), e0129862. https://doi.org/10.1371/journal.pone.0129862

Mon, D., Zakynthinaki, M. S., Cordente, C. A., Barriopedro, M. I., & Sampedro, J. (2014). Body sway and performance at competition in male pistol and rifle Olympic shooters. *Bio Hum Kinetics*, *6*, 56-62. https://doi.org/10.2478/bhk-2014-0010

Mon, D., Zakynthinaki, M. S., Cordente, C. A., Monroy Antón, A., & López Jiménez, D. (2014). Validation of a Dumbbell Body Sway Test in Olympic Air Pistol Shooting. *PLoS ONE*, *9*(4), e96106. https://doi.org/10.1371/journal.pone.0096106

Moreira da Silva, F., Malico Sousa, P., Pinheiro, V. B., López-Torres, O., Refoyo Roman, I., & Mon-López, D. (2021). Which Are the Most Determinant Psychological Factors in Olympic Shooting Performance? A Self-Perspective from Elite Shooters. *International journal of environmental research and public health*, *18*(9), 4637. https://doi.org/10.3390/ijerph18094637

Mullen, R., Hardy, L., & Tattersall, A. (2005). Sport psychology. *Journal of Sport Exercise & Psychology*, *27*, 212-225.

Nibbeling, N., Oudejans, R. R., Ubink, E. M., & Daanen, H. A. (2014). The effects of anxiety and exercise-induced fatigue on shooting accuracy and cognitive performance in infantry soldiers.*Ergonomics*, *57*(9), 1366-1379. 10.1080/00140139.2014.924572

Nieuwenhuys, A., & Oudejans, R. R. (2010). Effects of anxiety on handgun shooting behavior of police officers: a pilot study. *Anxiety Stress Coping*, *23*(2), 225-233. 10.1080/10615800902977494

Nieuwenhuys, A., & Oudejans, R. R. (2011). Training with anxiety: short-and long-term effects on police officers' shooting behavior under pressure. *Cognitive Processing*, *12*(3), 277-288. 10.1007/s10339-011-0396-x

Ortega, F. Z., Fernández, S. R., Extremera, M. O., Sánchez, M. C., Cuberos, R. C., & González, M. d. M. C. (2017). Análisis de la resiliencia, ansiedad y lesión deportiva en fútbol según el nivel competitivo. *Cultura, ciencia y deporte*, *12*(35), 135-142. http://dx.doi.org/10.12800/ccd.v12i35.885

Pellegrini, B., & Schena, F. (2005). Characterization of arm-gun movement during air pistol aiming phase. *J Sport Med Phys Fit*, *45*(4), 467-475.

Prados, J. A. L., García, I. F., & Lluch, Á. C. (2011). Ansiedad estado y autoconfianza precompetitiva en gimnastas. *Rev Int Cienc Deporte*, *7*(23), 76-91. 10.5232/ricyde2011.02301

Reinkemeier, H., Bühlmann, G., & Konietzny, A. (2006). Tiro olímpico con pistola: Técnica · Entrenamiento · Táctica · Preparación Psicológica · Armas. MEC High Tech Shooting Equipment. http://books.google.es/books?id=ohAWMwAACAAJ

RFEDETO. (2014). Reglamento Técnico General para todas las Modalidades de Tiro. Real Federación Española de Tiro Olímpico. http://www.tirolimpico.org/apps/displayFile/es/RFEDETO/public/pages/normativas-y-reglamentos.cms_xhtml

Rosenthal, R., Cooper, H., & Hedges, L. (1994). Parametric measures of effect size. The handbook of research synthesis, 621(2), 231-244.

Spancken, S., Steingrebe, H., & Stein, T. (2021). Factors that influence performance in Olympic air-rifle and small-bore shooting: A systematic review. *PLoS ONE*, *16*(3), e0247353. https://doi.org/10.1371/journal.pone.0247353

Vaez, S., Naji, M., Hassanzadeh, N., & Esmaeilpour Marandi, H. (2011). Arousal and activation in a pistol shooting task. *Mil Med*, *12*(4), 185-190.

Vickers, J. N., & Lewinski, W. (2012). Performing under pressure: Gaze control, decision making and shooting performance of elite and rookie police officers. *Hum Mov Sci*, *31*(1), 101-117. 10.1016/j.humov.2011.04.004