EFFECT OF PILATES BASED EXERCISE ON BODY SWAY AND SHOOTING PERFORMANCE OF BRAZILIANS POLICE.

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This study investigated the effect of a 10-week Pilates practice on core stability, shooting performance and body sway in fifteen policemen (25.3 ± 3 years; 171 ± 9 cm; 71.6 ± 12.1 kg). The policeman performed 10 pistol shots and had the three dimensional ground reaction forces data (AMTI-OR-06, USA and gun target fluctuation point (SCATT USB Professional Trainer) registered during 5s prior shooting. Shooting score was also determined. Core stability was accessed by the double lowering limb (DLL) test. Although the Mann- Whitney U test showed that the Pilates practice significantly improve the core stability, no changes was observed on body sway or shooting performance. Ten weeks of Pilates practice was effective to improve core stability in policemen, but it was not able to decrease body sway during shooting or the ability of the shooter hit the target.

KEYWORDS: Pilates, core stability, balance, pistol shooting.

INTRODUCTION: Shooting is an Olympic sport and is used by policeman and military for self-defense. In both cases the main goal is to hit a target accurately. Precision and accuracy determine the performance of the shooter and can be influence by the control of the posture (Ball, Best, & Wrigley, 2003; Mononen, Konttinen, Viitasalo, & Era, 2007). It has been showed that highly skilled shooters present smaller body sway amplitudes during bipedal standing when compared to non-shooters (Aalto, Pyykkö, Ilmarinen, Kähkönen, & Starck, 1990) or less experienced shooters (Era, Konttinen, Mehto, Saarela, & Lyytinen, 1996). The maintenance of an up-right standing position is deemed as a demanding task (Woollacott, 1993), in which the body moves backwards, forwards and side-to-side as an inverted pendulum. These movements depend on the synergy of several muscle contractions to maintain the center-of-mass inside the base of support (Winter, Patla, & Frank, 1990). The deep muscles of the trunk (core muscles) are described as fundamental while stabilizing the spine during a quiet standing position or when lower and/or upper segments are moved (Miyake, Kobayashi, Kelepecz, & Nakajima, 2012). It was demonstrated that the Pilates method improves functional autonomy, static and dynamic balance (English & Howe, 2007; Johnson, Larsen, Ozawa, Wilson, & Kennedy, 2007; Siqueira Rodrigues, Ali Cader, Bento Torres, Oliveira, & Martin Dantas, 2010). Therefore, increasing the ability of the core muscles to provide stability may reduce body sway and increase shooting performance. Thus, the purpose of this study was to verify the effects of Pilates practice on body sway and shooting performance in policemen pistol shooters.

METHODS: Fifteen policemen, eleven male and four female (25.3 ± 3 years, 171 ± 9 cm, 71.6 ± 12.1 kg), regularly attending a Military Police Academy volunteered to the study. All participants were informed about the methods and provided written informed consent. The protocol was approved by the local Research Ethics Committee. The effects of the Pilates practice on body sway and shooting performance were assessed during two testing sessions. The first session was conducted one week before the intervention protocol, while the second session was performed on week after the end of the practice period. Two force plates (AMTI-OR-06, USA) mounted side-by-side (figure 1) provided center of pressure data. Data was collected during 10 shots with 5s interval between each other. Shot were performed using a pistol (Taurus PT840 .40). The ground reaction forces data were collected using a sampling frequency of 100 Hz, over 5s prior shooting. Forces and moments data were filtered (4^{nd} order Butterworth low pass filter, cut off frequency 15Hz) and used to

calculate the distance of the COP sway in the anterior-posterior (DAP) and medial-lateral directions (DML). An optical laser System (SCATT USB Professional Trainer) was used to measure shooting performance (Score) and aim point fluctuation. From the aim point fluctuation point the following variables were calculated: Total length of aim point trace (LT); length of aim point trace in the horizontal axis (LH) and the length of aim point trace in the vertical axis (LV). The median value of 10 shots was considered for analysis purposes. The effectiveness of the Pilates practice to increase core muscles stability was assessed by the double limb lowering test (DLL) (Prentice & Voight, 2001). The test was performed with the participants resting in a supine posture (hip flexed - 90º and knees extended – 0º). A sphygmomanometer was placed between the lumbar spine and the supporting base. The policemen were encouraged to activate the core muscles, while maintaining the back in a neutral position (abdominal hollowing maneuver). Then they were requested to lower both legs towards the floor until the pressure dropped below 40mm Hg. The hip flexion angle was recorded when the pressure under the lumbar spine (40mm Hg) was no longer sustained.
The Pilates practice was performed during 10 weeks with two sessions per week and conducted by a qualified instructor. Mean attendance at the exercise program was 70%. The exercise was performed included mat and swiss ball exercises. The session was divided into 10 min warming up, 40 min of core activation and balance exercise and 10 min of relaxing.
The Shapiro-Wilk test revealed that parametric assumptions were not met and the Mann-Whitney U test was performed to test the practice effect on core stability, body sway and shooting performance.

RESULTS: At baseline, core stability in the group was 118.5º ±13.1º. After 10 weeks exercising there was a significantly increased in core stability (139.1º ±11.3º, $p<0.001$). However as show in table 1, the intervention program showed no influence ($p>0.05$) on shooting performance score, aim point fluctuation (LT; LH and LV) or body sway parameters (DPA and DML).

Table1. Shooting performance variables before (PRE) and after (POST) 10 weeks of Pilates training.

	Pre-training	Post-training	P
Score	5.7±1.52	6.5±1.08	0.229
LT (mm)	1558±479	1837±630	0.29
LV (mm)	912±207	1090±308	0.085
LH (mm)	1075±421	1261±531	0.191
COP length ML (mm)	17.8±9	15.2±8.26	0.395
COP length AP (mm)	43.8±10.8	44.8±14.6	0.917

Score; LT – Total length of aim point trace; LH - length of aim point trace in the horizontal axis and LV- length of aim point trace in the vertical axis. Postural control variables – distance of the COP sway in anterior-posterior direction (DAP) and in medial-lateral direction (DML).

DISCUSSION: This study was innovative by applying a controlled Pilates training aiming to improve core stability, postural control and shooting performance in a group of policemen. Although the effectiveness of the Pilates increased core stability, no shooting performance or body sway improvements were observed.
The COP oscillation in the DAP (3.0 mm) and DML (2.3 mm) was greater than the one reported by Ball and colleagues (2003). The type of shot and the position assumed during shooting may explain the 2.5 times larger displacement in the anterior-posterior direction. The posture used during shooting (standing with both feet parallel to aim and with arms raised forward at shoulder level) may have limited the displacements in the medial-lateral direction. In addition, the fluctuation in the anterior-posterior direction is naturally larger due to the joint configuration that provides a greater degree of freedom of movement in the

anterior-posterior direction. (Balasubramaniam, Riley, & Turvey, 2000). These mechanisms may explain the asymmetry between DAP and DML in pre and post-practice period.
The distance between the shooter and the target may have also influenced the stability of the shooter. In long distance shooting the postural control cannot rely on visual system as it is required while aiming. Therefore, a more effective contribution of the vestibular and proprioceptive systems are expected (Balasubramaniam et al., 2000; Era et al., 1996; Herpin et al., 2010).
It may be argued that the postures in which the Pilates exercises are performed (i.e., in a lying position) contribute to improve the stability oft he core muscles (DLL test), but do not coincide with the task demands required during shooting. So, is possible that the participants were unable to transfer such gains to shooting performance. In addition, the physical fitness of the participants was high and the intervention program may have little influence on their ability to control the centre of pressure during the shooting.
In addition it can be considered that the shot is a task that requires a specific skill training (Silva et al., 2009) and not just physical condition. If Pilates practice was associated with specific shooting drills, perhaps core stabilization improvement would have helped to give better condition for specific shooting training.

CONCLUSION: Ten weeks of Pilates practice was effective to improve core stability in policemen, but was unable not decrease body sway during shooting or to improve the shooter´s ability to hit the target. The relatively small sample size and the lack of inter-subject analysis warrant future analysis.

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