

# Comparisons of Leg Joint Angles-Shooting Shoes vs Jogging Shoes

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**ABSTRACT-** The main factor in maintaining good performance for air pistol athletes is to keep a stable posture without physical change. In addition, the athletes are ought to implement various approaches to enhance their shooting performance. The athletes have attempted to use different shoes to keep their balance intact. The present study evaluated effects of different shoes on kinematics (leg joint angles) of 8 elite shooters while performing air gun shooting. The results suggested that there were no statistical differences in either leg angles. The results suggested that the shoes in the present study did not influence kinematic changes of a body while performing air gun shooting.

**KEYWORDS-** Air gun, Shoes, Joint Angles, Stability

## I. INTRODUCTION

Currently, the tradition of shooting as a sport started in Europe, and shooting as an official sport was adopted from the 1st Athens Olympic Games and has been adopted and played in the Olympic Games until now. Shooting is a static sport with a constant line of sight. The aiming task is one of the goal-oriented tasks that have been studied for a long time to solve the complex human freedom problem along with reaching and grasping tasks in the field of motion control [1,2].

Athletes have been maintaining the same posture for a long time on the firing line for 1 to 2 hours or more. One of the important factors in shooting performance is to focus on the mind, to be consistent and not to disturb the balance, and to maintain a stable posture without changing the body is one of the important performance factors in shooting [3,4].

A typical example of an aiming task in a sports situation is shooting and archery. In order to get the highest score through the best performance in a match situation, it is necessary to create an optimized coordination pattern by effectively controlling the movements of joints, muscles, and motor units that make up the complex human system and their interactions [5,6].

As such, shooting is a skill-intensive exercise that requires more scientific training techniques than any other sports field. In order to improve performance, efforts to solve problems such as physical, mental and technical training

and mastery of the muscles and motor nerves necessary to maintain a shooting posture and skills connected to shooting behavior are required [7,8]. In particular, the shooting posture of the air pistol is one of the most unstable among shooting sports because of the high center of gravity and the narrow support surface due to the standing shooting posture. At a range of 10m, the athletes will fire 60 shots out of 600 points for 1 hour and 15 minutes against the target of the air pistol.

For effective shooting of such an air pistol, the ability to consistently and continuously maintain the shooter's readiness posture, gun speed, muzzle trajectory and sway width, percussion action, breathing rhythm, and timing is the main task factor [7,8].

Air Pistol athletes use an air pistol, a machine that incorporates several comprehensive techniques. To that extent, players use various methods to advance to the top ranks, to raise their performance. In the technical part, it is important to examine how weightlifting shoes contribute to postural stability. The study measured the angles of the joints around the lower extremities, and COM to evaluate shooting performance.

## II. METHOD

### A. Participants

Eight air gun athletes from local universities were recruited. They were high-level shooters who, at least, have won 3rd place or higher in the national competition and have more than 6 years of shooting experience. They had no history of musculoskeletal injuries in the previous 6 months prior to the examinations. Their characteristics are followed (Table 1).

Table 1: Age and Experience

Subject	Age	Experience
1	27	12
2	24	10
3	23	9
4	20	6
5	21	7
6	22	7
7	22	7
8	24	10

### B. Procedure

The air gun (mrini CM162 EI) was used for shooting. The shot 60 shots for each trial. The participants wore either weightlifting shoes or their jogging shoes in random orders. They performed shootings twice (one wearing weightlifting shoes and the other wearing their jogging shoes). Thirteen infrared cameras were used to collect motion data. Markers were placed on left and right hips, waist, left and right knee, and left and right ankle to compute joint angles. Total of 37 markers were placed on a full body to compute center of mass of a participant.

### III. RESULTS

One-way repeated measured ANOVA results suggested that there was no significant difference in all joint angles of lower extremity during air gun shooting.

Table 2: Data and ANOVA Summary in Joint Angles (unit: radian, N=8)

		WS	JS	P
<b>Hip</b>	L Ext(-)	- 0.13±0.13	- 0.14±0.26	0.95
	R Ext(-)	- 0.06±0.15	- 0.08±0.28	0.83
<b>Knee</b>	L Flex(+)	0.10±0.07	0.16±0.11	0.14
	R Flex(+)	0.09±0.09	0.13±0.10	0.74
<b>Ankle</b>	L PI Flex(+)	1.15±0.09	1.14±0.12	0.40
	R PI Flex(+)	1.08±0.10	1.06±0.12	0.74

WS: weightlifting shoes, JS: jogging shoes, R: right, L: left, Ext: extension, Flex: flexion, PI: Plantar. P>0.05 indicates no significant difference.

### IV. DISCUSSION

The study objective was to compare leg joint angles to evaluate whether weightlifting shoes had effects on shooting postures compared to jogging shoes.

Hip joint extension angles and knee joint flexion angles while wearing weightlifting shoes showed decreases in comparison to wearing jogging shoes although it was not statistically significant. This may suggest that weightlifting shoes could affect their shooting posture especially in the lower extremity [9, 10].

The shooting posture is a posture in which the body is moved backwards with the hip joint and lower back in extensions. During hip extension, the erector spinae, gluteus maximus, and hamstrings, including semitendinous muscles, are used [11]. These extensor problems create semitendinous dominance and gluteus medius muscle weakness, resulting in back pain and knee-related pain and diseases due to strain of the semitendinous and improper hip joint movement function (dysfunction).

However, the high heel height of the heel, a characteristic of shooting shoes, creates flexion, which makes the posture

closer to the line of gravity and reduces the load on the erector spinae muscle. In addition, it makes it possible to maintain a stable posture, which is the main task of shooting, and it can be said that the standard deviation of the angle of the lower extremity joint is small by wearing shooting shoes, and it can be said to be stable. It has been shown that wearing shooting shoes contributes to the angle of the joints of the lower extremities (hip joint, waist, knee, and ankle), and can reduce the load on the lower back through angle adjustment [11].

### V. CONCLUSION

In conclusion, wearing shooting shoes should contribute to the angle of the lower extremity joint creating a posture should be able to relieve the load on the lower back.

### VI. RESEARCH QUESTION

- What will be other factors influencing shooting performance besides shoes?
- What will happen to shooting scores if different shoes were provided?
- Will fatigue decrease if weightlifting shoes would be worn?

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