JOURNAL OF NUTRITION FASTING AND HEALTH

The Effect of Carbohydrate Supplementation on the Pistol Shooting Performance of Police Officers after Exhaustive Acute Exercise

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ARTICLEINFO

Article type:
Research Paper

Article History:
Received: 10 Jun 2020
Accepted: 11 Jul 2020
Published: 01 Jan 2021

Keywords:
Carbohydrates
Exercise
Performance
Police

ABSTRACT

Introduction: Pistol shooting performance in police officers is paramount while chasing suspects. The present study aimed to investigate the effects of carbohydrate supplementation on the pistol shooting performance, pulse rate (PR), systolic blood pressure (SBP), and diastolic blood pressure (DBP) of police officers after exhaustive acute exercise.

Methods: This quasi-experimental study was conducted on 40 male officers with the mean age of 30.12±2.21 years and more than eight years of police work experience. The subjects were divided into five groups of eight, including control, placebo consumption before exercise (PBE), placebo consumption during exercise (PDE), carbohydrate consumption before exercise (CBE), and carbohydrate consumption during exercise (CDE). The subjects performed an exhaustive acute exercise on the treadmill between two shooting trails in accordance with the protocol and consumed carbohydrates and placebo supplementation. Pistol shooting performance, PR, SBP, and DBP were measured before and after the exercise.

Results: The pistol shooting performance in the PBE and PDE groups significantly decreased after the exercise ($P \leq 0.05$), while it significantly increased in the CDE group ($P \leq 0.05$). In addition, the PR and SBP of the PBE, PDE, CBE, and CDE groups significantly increased after the exercise ($P \leq 0.05$).

Conclusion: According to the results, carbohydrates supplementation during exhaustive acute exercise could enhance the pistol shooting performance of the police officers.

► Please cite this paper as:
Fathi I, Ghanbari Y, Hosseini SA, Mohammad Hosseini Servak R, Dolati S. The Effect of Carbohydrate Supplementation on the Pistol Shooting Performance of Police Officers after Exhaustive Acute Exercise. J Nutr Fast Health. 2021; 9(1): 50-56. DOI: 10.22038/jnfh.2020.49456.1271

Introduction

Police officers are often engaged in two types of conflicting activities, which are sedentary official works and those that require physical activity and fitness (1). Evidently, police officers must chase to arrest suspects, and in some cases, it is essential to use a weapon to stop the suspect or shoot them in the leg. One of the most important priorities of officers is to be careful in firing weapons so as to minimize possible danger to other officers and protect the safety of innocent civilians. In such cases, the readiness of officers is considered to be a potential risk factor (2), and performance optimization becomes a priority. Readiness also largely affects the efficient and safe performance of the police duties (3), and the officers who are not physically prepared may be at the greater risk of injuries and illnesses (4). Undeniably, police forces are required to undergo initial physical trainings (5), and the emphasis is placed on the readiness of police officers to perform the most necessary physical tasks (4, 6). Nevertheless, the physical fitness of police officers has recently been reported to decline significantly, which in turn adversely affects their job performance over time (7). Studies have shown that reduced physical fitness in police officers may be due to factors such as aging (8) and the sedentary nature of the job (e.g., shift work, sedentary work) (5). Therefore, the level of physical fitness may vary greatly in police officers and be

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influenced by factors such as education level, training, work experience, age, and gender (9).

Research in this regard has been focused on the accuracy and shooting performance of police officers in stressful situations. For instance, Giessing et al. (2019) evaluated the psychological stress responses of shooting in police recruits by reality-based scenarios (10). In the mentioned study, 19 police officers were examined under a fact-based shooting scenario in two experimental conditions of low-stress (against a non-threatening mannequin) and high-stress. The scenarios encompassed a physical threat from an opponent, and the subjects observed a decrease in their performance under stress, generally reporting increased anxiety and mental effort in response to a reality-based shooting scenario in the high-stress compared to the low-stress condition. However, the shooting accuracy in both scenarios was relatively low, and no significant difference was denoted between the low-stress and high-stress scenarios in this regard.

Considering the critical, perilous, and unpredictable events in the police work that may lead to stress, the physical reactions to these factors activate the sympathetic adrenomedullary system (11) and reduce the hypothalamic-pituitary-adrenal axis (HPA) (12), which in turn cause severe and immediate metabolic changes in the body. For instance, increased hepatic gluconeogenesis and increased glucose uptake by the muscles occur as a result of physical stress, which is mainly due to the activation of the sympathetic nervous system (SNS) (13). In fact, the SNS is an integrated system that responds to dangerous stimuli, and SNS activation is integral to the classic response of "fight and flight". Not only the SNS is active in such critical situations, but also the HPA, sensory nervous system, and vaginal nervous system play a key role in this regard (13). Within the context of physical and mental stress, chasing disrupts hemostasis and blood glucose maintenance (main fuel for the brain and muscle activation under stress), which is considered to be a potentially negative factor.

Previous findings have indicated that carbohydrate consumption may delay fatigue by maintaining the plasma glucose concentrations, increasing carbohydrate oxidation, and performance improvement (14). Given the importance of shooting in the armed forces, the present study aimed to investigate the effects of carbohydrate supplementation before and during exhaustive acute exercise on the shooting performance of police officers.

Materials and Methods

This quasi-experimental study was conducted on 40 male police officers of Yasouj police office, Iran. The mean age of the subjects was 30.12±2.21 years, and their demographic characteristics were measured initially.

Grouping

Due to the adverse effects of anxiety on muscle tremor and shooting performance, the anxiety level of the subjects was measured using the sports competition anxiety test, and the individuals with high sports competition anxiety were excluded from the study. Subsequently, the subjects were divided into five groups of eight, including control, placebo consumption before exercise (PBE), placebo consumption during exercise (PDE), carbohydrate consumption before exercise (CBE), and carbohydrate consumption during exercise (CDE). The inclusion criteria were the minimum work experience of eight years as a police officer and working with a pistol weapon. The exclusion criterion was a high level of sports competition anxiety.

Research Protocol

The subjects initiated the research protocol in a sitting position. After 10 minutes of rest, pulse rate (PA), diastolic blood pressure (DBP), and systolic blood pressure (SBP) were measured, and the test was started in the pretest phase by the referee's command. Each police officer was allowed to shoot 10 targeting shots, and the score was not recorded. Afterwards, the police officers had to shoot 20 shots within a maximum of 25 minutes, followed by the exhaustive Bruce protocol, which was performed by the subjects in groups 2-5 on a treadmill. The next stage was similar to the pretest phase, and the test was started on the posttest by the referee's command, with each police officer allowed to shoot 10 targeting shots without recording the score. Following that, the police officers had to shoot 20 shots within a maximum of 25 minutes. Notably, carbohydrate supplements were consumed by the CBE and CDE groups before and during the exercise, while groups two and three consumed placebo before and during the exercise. The carbohydrate supplements were consumed as 200 cc of 7% liquid (Merck Company, Germany), and aspartame was used as the placebo.

On the day of the test and after preparing the shooting conditions and exercise testing, the research plan was implemented, with the control group participating in a shooting activity and repeating the same activity after 27 minutes of rest. In addition, the PBE group participated in a shooting activity, followed by placebo supplementation, the exhaustive Bruce protocol, and repeating the shooting activity. The PDE group participated in a shooting activity, performed the exhaustive Bruce protocol, and simultaneously consumed the carbohydrate supplements while running on a treadmill; following the Bruce protocol, these subjects performed the shooting activity again. These stages were also implemented by the CBE and CDE groups, which received the carbohydrate supplements instead of the placebo.

Data were recorded on the PR, DBP, and SBP of the study groups (Glamor TMB-1112 Blood Pressure Monitor) before and after the exhaustive acute exercise. Notably, the submaximal Bruce test was used as the exhaustive acute exercise, which consists of nine three-minute steps; in the first stage, the gradient and speed were 0% and 1.7 miles per hour, respectively and increased to 22% and six miles per hour, respectively in the final stage.

Statistical Analysis

Data analysis was performed using the Kolmogorov-Smirnov test to investigate the normal distribution of the data. In addition, paired sample t-test, one-way ANOVA, and Tukey's post-hoc test were used to analyze the findings ($P \leq 0.05$).

Results

Figures 1-4 depict the pistol shooting performance, PR, DBP, and SBP of the five study groups, respectively. The results of one-way ANOVA indicated significant differences in the pistol shooting performance (P=0.007), PR (P=0.001), and SBP (P=0.001) between the five study groups, while no significant difference was observed in DBP between the groups (P=0.06).

The results of Tukey's post-hoc test showed that the pistol shooting performance of the CDE group was significantly higher compared to the PDE group (P=0.01) (Figure 1). Furthermore, the PR (Figure 2) and SBP (Figure 4) of the PBE, PDE, CBE, and CDE groups were significantly higher compared to the control group (P=0.001). In the control group, the results of paired sample t- test demonstrated no significant differences in the pistol shooting performance (P=0.22), PR (P=0.07), DBP (P=0.67), and SBP (P=0.71) between the pretest and posttest (Figures 1-4).

In the PBE group, the pistol shooting performance at the posttest significantly decreased compared to the pretest (P=0.03), while the PR and SBP significantly increased (P=0.001), and no significant difference was observed between the pretest and posttest in terms of DBP (P=0.07) (Figures 1-4). In the PDE group, the pistol shooting performance at the posttest significantly decreased compared to the pretest (P=0.04), while the PR and SBP significantly increased (P=0.001), and no significant difference was denoted between the pretest and posttest in the DBP levels (P=0.87) (Figures 1-4).

In the CBE group, the PR and SBP at the posttest significantly increased compared to the pretest (P=0.001), while no significant differences were observed between the pretest and posttest in the pistol shooting performance (P=0.36) and DBP (P=0.48) (Figures 1-4). In the CDE group, the pistol shooting performance (P=0.04), PR (P=0.001), and SBP (P=0.001) at the posttest significantly increased compared to the pretest, while no significant difference was denoted between the pretest and posttest in the levels of DBP (P=0.06) (Figures 1-4).

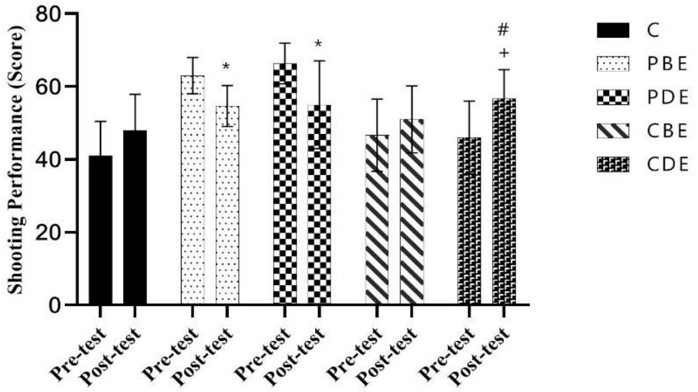

Figure 1. Pistol shooting performance in five groups of research
Statistical analyses were performed using paired sample t-test, one-way ANOVA with Tukey's *post- hoc* tests
* P<0.05 Significant decrease compare to pre- test
+ P<0.05 Significant increase compare to pre- test
# P<0.05 Significant increase compare to PDE group

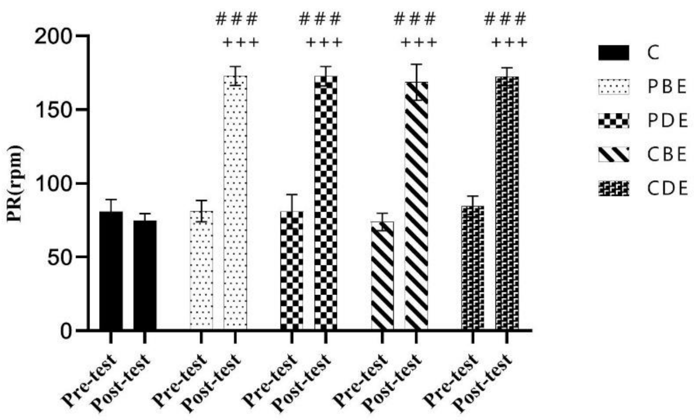

Figure 2. PR in five groups of research
Statistical analyses were performed using paired sample t-test, one-way ANOVA with Tukey's *post- hoc* tests
+++ P<0.001 Significant increase compare to pre- test
P<0.001 Significant increase compare to C group

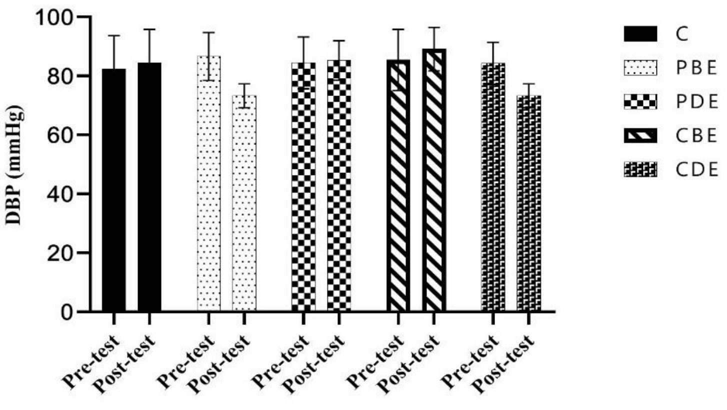

Figure 3. DBP in five groups of research

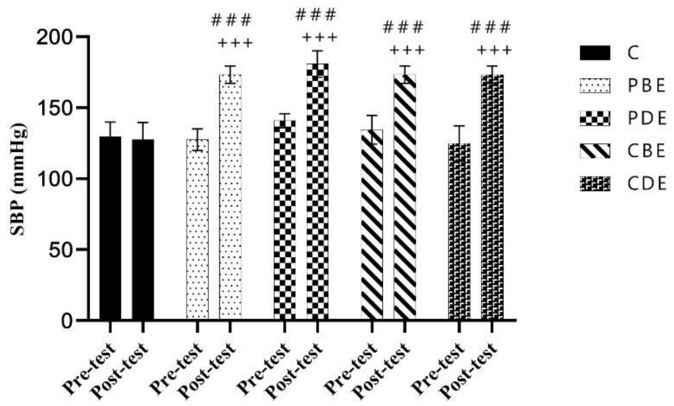

Figure 4. SBP in five groups of research
Statistical analyses were performed using paired sample t-test, one-way ANOVA with Tukey's *post- hoc* tests
+++ P<0.001 Significant increase compare to pre- test
P<0.001 Significant increase compare to C group

Discussion

The present study aimed to evaluate the pistol shooting performance, PR, SBP, and DBP of police officers following physical exercise and carbohydrate supplementation. According to the obtained results, the PR and SBP increased significantly after the exercise without affecting the shooting performance. On the other hand, carbohydrate consumption during exercise could enhance the pistol shooting performance of the police officers.

Shooting is a popular sport, and for police officers, shooting is a form of sports activity regardless of the chasing aspect. Several studies have investigated the effects of carbohydrate consumption on performance in various, proposing different results. For instance, some studies have not revealed a clear association between hypoglycemia and performance and the nutritional effects of carbohydrates on the perceived excretion and overall physical fatigue (15-18), which is inconsistent with the results of the present study. On the other hand, the results of some studies are in line with our findings (19-22). In fact, several studies have confirmed the ergogenic effects of carbohydrate consumption during exercise, which is a common approach in numerous sports, especially endurance training (23). According to the statements of the American College of Sports Medicine (ACSM), the American Dietetic Association (ADA), and the Canadian Dietetic Association (CDA) on the nutritional status of athletes, carbohydrates play a key role in athletic performance, and particular recommendations have been dedicated to carbohydrate consumption (23).

In a study in this regard, Angus et al. (2000) investigated the effects of glucose and fructose consumption on endurance performance. In the mentioned study, the subjects received 60 grams of carbohydrate supplementation (6%) per hour, and the exercise protocol included cycling on an ergometer bike. The obtained results indicated increased athletic performance and delayed fatigue (19). Despite the general acceptance of the ergogenic effects of carbohydrate supplementation during exercise, more accurate assessments are required as some findings may have been exaggerated due to the selection of specific experimental protocols, which may not be comparable to competitive areas (23). The discrepancy in the findings in this regard could be attributed to several factors, such as the intensity, duration, and type of performance, as well as the type and concentration of carbohydrate supplementations (23).

Similar to the current research, some studies have measured performance as a short-term test or a fast activity after 3-4 hours of continuous exercise, while others have measured the effects of carbohydrate consumption on endurance capacity and fatigue time. The repeatability of these protocols clearly differs as some variables and physical fitness factors may be more sensitive to carbohydrate consumption. Therefore, it is essential to control the effects of external variables (e.g., diet, test conditions, motivation, and feedback) to obtain more accurate results.

Some researchers have suggested that the non-ergogenic effects of carbohydrate consumption on performance could be due to the very short time of the exercise test. In the present study, carbohydrate supplementation had no ergogenic effects on the pistol shooting performance of the CBE group, which could be due to the short time of the shooting test. However, the balance of the studies in this regard is convincingly in favor of those confirming the ergogenic effects of carbohydrate consumption during exercise, which is incidentally consistent with the present study.

One of the limitations of the current research was our inability to perform an ECG measurement. It is recommended that the further investigations assess the molecular markers of fatigue along with the variables of the present study.

Conclusion

According to the results, carbohydrate supplementation during exhaustive acute exercise could enhance the pistol shooting performance of the police officers. Therefore, it is recommended that police officers use appropriate carbohydrate supplementation during martial activities.

Conflicts of Interest

None declared.

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