The Impact of Carbonated Sodium Bicarbonate Drinks on Physical Fitness in Adolescents

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ABSTRACT
Background*: Physical fitness is a crucial factor for individuals to support their daily physical activities. Soda beverages have gained popularity among adolescents and are believed to affect physical fitness.* ***Objective****: This study investigated the influence of soda consumption on the physical fitness of adolescents.* ***Methods****: The study included 30 male participants with 18-25 years old who voluntarily participated and willingly provided informed consent. Physical fitness was measured before and after carbonated sodium bicarbonate drinks consumption using the Harvard Step Test. Participants orally consumed $NaHCO_3$ at a dose of 0.3 gr/kg of body weight in carbonated water at a dose of 0.4 ml/kg of body weight. The employed statistical test was the T-test.* ***Results****: The average physical fitness score of the participants before soda consumption was 34.37 ± 13.465, while the average score after soda consumption was 51.57 ± 20.100. The T-test yielded a score of 0.001.* ***Conclusion****: Based on the statistical analysis, it can be concluded that carbonated sodium bicarbonate drinks can enhance physical fitness in adolescents.*
Keywords*: carbonated drinks; harvard step test; physical fitness*

INTRODUCTION

Physical fitness is the ability to carry out daily physical activities and tasks without experiencing significant signs of exhaustion. Significant signs of exhaustion imply that after completing an activity, an individual still possesses sufficient ability and energy to enjoy leisure time or engage in additional activities (Wiarto, 2013; WHO, 2011).

Health-related fitness encompasses several components, such as muscle strength, cardiorespiratory endurance, muscle endurance, flexibility, and body composition (Muhtar, 2021). Meanwhile, skill-related fitness includes elements like speed, coordination, power, and agility (Sudiana, 2020).

Carbonated soft drinks are beverages that provide an extra effervescence characterized by a soda-like mouthfeel and a distinct tingling sensation on the tongue (referred to as "bite") (Astuti, 2018). The production of carbonated beverages involves various methods, including the addition of sodium bicarbonate. When sodium bicarbonate is added to carbonated water, it is referred to as soda water (Viejo, 2019). Sodium bicarbonate has garnered the attention of numerous scientists, as it has been proven to significantly enhance performance, up to 3%, in athletes such as swimmers and cyclists (Hadzic, 2019). Presently, there is a proliferation of beverages containing

sodium bicarbonate available directly to the public, and these beverages are also believed to alleviate fatigue (Putri, 2013).

The Harvard Step Test is a fitness assessment tool employed to measure physical fitness. It evaluates an individual's physical performance by monitoring their heart rate during the test. Additionally, it serves as one of several cardiac stress tests designed to detect and/or diagnose cardiovascular abnormalities. The faster an individual's heart rate returns to a normal level, the fitter their body is (Santoso, 2020; Salikunna et al. 2021). Young age is a period in which body organs are in their prime optimum condition to perform physical activities, and the body organs have not had any decline in function. For these reasons, this study aimed to investigate the impact of soda consumption on physical fitness in adolescents using the Harvard Step Test.

METHODS

Subjects

A total of 30 male adolescents, aged 18-23 years, voluntarily participated in the study and provided informed consent. The research obtained ethical clearance approval from the Faculty of Medicine, Tadulako University, with the reference number: 11083/UN.28.1.30/2022.

Procedures

Physical fitness index was assessed both before and after soda consumption using the Harvard Step Test. Harvard Step Test used platform Harvard with height 48 cm for males, subjects were step up and down by metronome for 5 mins or until exhaustion. After 5 mins or exhaustion, subject should immediately sit down and be relaxed. After 1 min of rest, the subjects should measure his heart beat for 30 seconds (Buanasita, 2022). Physical fitness index was calculated using the following formula: PFI = total duration of exercise in seconds x (5.5 x post exercise 30-sec pulse count) $^{-1}$ x 100 (Sharma et al., 2014). The research participants orally consumed $NaHCO_3$ at a dose of 0.3 gr/kg BW in 0.4 ml/kg BW of carbonated water (Figure1).

Statistical Analyses

All the data are presented as mean ± SD. The Shapiro-Wilk test was used to evaluate the normality of the subject population. The employed statistical analysis was the T-test.

RESULTS

The research findings are presented in Table 1.

DISCUSSION

This study aimed to investigate the impact of soda consumption on the physical fitness of adolescent students in the Faculty of Medicine at Tadulako University. Primary data were collected by measuring physical fitness levels using the Harvard Step Test. Physical fitness was assessed twice: before the soda intervention (pre-test) and after the soda intervention (post-test). The samples consisted of 34 male students from the Faculty of Medicine at Tadulako University, although 4 were dropouts because they were challenging to reach during the post-test data collection.

The study commenced with an

explanation of the research phases and the process of obtaining informed consent, signifying the respondents' agreement to participate as research subjects. After securing informed consent, initial data, including the respondents' body weights, were recorded. Subsequently, physical fitness measurements were conducted before soda consumption (pre-test) using the Harvard Step Test. After a one-day interval, physical fitness measurements were repeated following soda consumption (post-test). The soda used was a brand known as "*Air Zoda*," containing water and CO_2 carbonation agents, necessitating the addition of sodium bicarbonate. The sodium bicarbonate used in this study was of the brand "*Nonik*." The prepared soda water was then consumed 60 minutes before the physical fitness measurements.

Physical fitness represents an individual's ability to engage in physical activities, and it can be measured using various methods, including exercise tests, such as the Harvard Step Test. The Harvard Step Test employs heart rate as a unit for determining the level of physical fitness (Maulina, 2017). The results are subsequently categorized into fitness levels: < 50 = poor, 50-80 = moderate, and > 80 = good (Buanasita, 2022).

A study by Grgic *et al*. (2021) revealed that sodium bicarbonate supplementation at doses ranging from 0.2 to 0.5 g/kg BW can enhance muscle endurance and ergogenic effects. This improvement extends to various physically demanding activities, such as boxing, judo, karate, taekwondo, wrestling, high-intensity cycling, running, swimming, and rowing. Both men and women experience enhanced performance. The minimum effective dose of sodium bicarbonate for ergogenic effects is 0.2 g/kg BW (Grgic, 2021).

In this study, we measured physical fitness using the Harvard Step Test and obtained an average physical fitness score before soda consumption (pre-test) of 34.37 and after soda consumption (post-test) of 51.57. Based on the data obtained, it is evident that the physical fitness levels of the students from the Faculty of Medicine at Tadulako University significantly improved. This is reflected in the increase in the average pre-test score from 34.37 to the post-test score of 51.57.

We employed a Paired T-test in the bivariate analysis to ascertain the impact of soda consumption on the physical fitness of the students from the Faculty of Medicine at Tadulako University. The resulting *p*-value was < 0.05, specifically 0.001, leading to the conclusion that soda consumption can indeed enhance the physical fitness of students in the Faculty of Medicine at Tadulako University.

Our research findings are consistent with a study conducted by Liu (2015), which involved volunteers, including both active athletes and non-athletes of the same age. This study yielded statistically significant results ($p < 0.05$), indicating a significant difference in the effect of $NaHCO_3$ administration on volunteers during the shuttle run test. Another study by Fahma (2019) focused on 20 respondents, who were students from the Faculty of Medicine at the University of Jember. It

demonstrated a reduction in muscle soreness after the consumption of 0.3 g/kg BW of sodium bicarbonate, with a significance value of $p< 0.05$, specifically 0.024. Similarly, research by Gurton *et al*. revealed an improvement in cycling exercise performance following the consumption of 0.2 and 0.3 g/kg BW of sodium bicarbonate. These studies collectively support the conclusion that soda consumption can enhance physical fitness.

The administration of sodium bicarbonate at an effective dose of 0.3 g/kg BW, taken 1-2 hours before exercise, has demonstrated performance improvements. The safe dosage for sodium bicarbonate consumption is 0.311 g/kg BW. This is crucial to note as exceeding the safe limit of sodium bicarbonate usage can potentially lead to issues such as alkalosis. In this study, a sodium bicarbonate dosage of 0.3 g/kg BW was employed, falling within the safe range. However, some respondents experienced complaints after consuming soda, such as nausea, dizziness, and gastrointestinal disturbances. These symptoms are also explained in Liu's study (2015) as side effects of sodium bicarbonate. Importantly, although respondents experienced these symptoms, there were no serious effects or long-term detrimental consequences. According to Budiman (2005), the administration of sodium bicarbonate increases pH and HCO_3^- concentration in body fluids. Consequently, HCO_3^- accelerates the removal of H^+ ions from muscle cells, helping maintain optimal muscle pH, and ultimately facilitating optimal muscle contraction.

Based on the research data, the physical fitness scores of students from the Faculty of Medicine at Tadulako University exhibited significant improvement after soda consumption compared to their scores before soda consumption. However, the majority of the respondents' physical fitness levels remained categorized as "poor" (< 50), both before and after soda consumption. Several factors may influence this, including the level of physical activity, anxiety levels, and sleep duration.

Physical activity can be defined as any movement generated by the body as a result of skeletal muscle contractions. Planned, repetitive, and structured physical activities can help maintain or improve physical fitness. One form of such physical activity is sports. Increased physical activity is characterized by an increase in the rate of oxygen consumption. Nevertheless, individual oxygen consumption varies significantly due to the frequency of training (Sudiana, 2014). This aligns with the data indicating low physical fitness levels among students from the Faculty of Medicine at Tadulako University, who tend to engage less in physical activity due to high academic demands. Consequently, their physical activity tends to be more sedentary. This observation is also supported by a study conducted by Riskawati (2018), which found that medical students at Brawijaya University in Malang had low activity levels, with a percentage of 60%.

According to Sudiana (2014), physical fitness is also characterized by other aspects of life, such as determination, responsibility, enthusiasm, and happiness, even though these components are difficult to

measure precisely. Meanwhile, Alamsyah (2017) explains that one emotional disturbance is anxiety. Anxiety is a response to conflicting or stressful conditions. In terms of age, during adolescence, individuals undergo a transition from one stage to another. Consequently, adolescents become highly susceptible to mental health issues. This applies to the respondents in this study, who are in the late adolescent age group. Furthermore, the majority of them are new college students, which constitutes a significant change from their previous lives. This aligns with Ilsya's (2019) research, which found a significant impact of anxiety on the performance of basketball athletes, while Setiawan's (2022) study discovered a significant influence of anxiety variables on the performance of canoeing athletes with a significance value of 0.002.

Sleep is a crucial aspect of life. It is a normal, human activity performed by every individual. According to Gunarsa (2021), poor sleep quality can affect an individual's physical fitness. Adolescents, who are mostly engaged in education, are not immune to disruptions in their sleep quality. The abundance of academic and non-academic tasks, as well as responsibilities, affects their sleep quality because it often necessitates staying active late into the night. Essentially, the positive impact that can be derived from good sleep quality includes energy recovery as body cells are repaired, and it results in a refreshed mind due to the brain's integration of new associations upon waking from sleep. This is an influential factor indicating that sleep duration affects the physical activity of the respondents. This aligns with Egi's (2017) research on 30 female adolescents, which found a significant relationship between sleep disturbances and physical fitness levels at SMK Kertha Wisata in Tlogomas, Lowokwaru, Malang, with a *p*-value of 0.00 ($p < 0.05$). This research has shown that sleep disturbance is one of the factors that can influence physical fitness in adolescents.

CONCLUSION

Carbonated sodium bicarbonate drinks consumption can improve physical fitness. Therefore, carbonated sodium bicarbonate drinks can be considered one of the beverages for individuals engaged in physical activities, especially during adolescence.

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Table 1. Results of Physical Fitness Examination

Data Score	Fitness	N	Mean	*p*-Value
	Pre-test	30	34.37	0.001*
	Post-test	30	51.57	

*p-value < 0,05

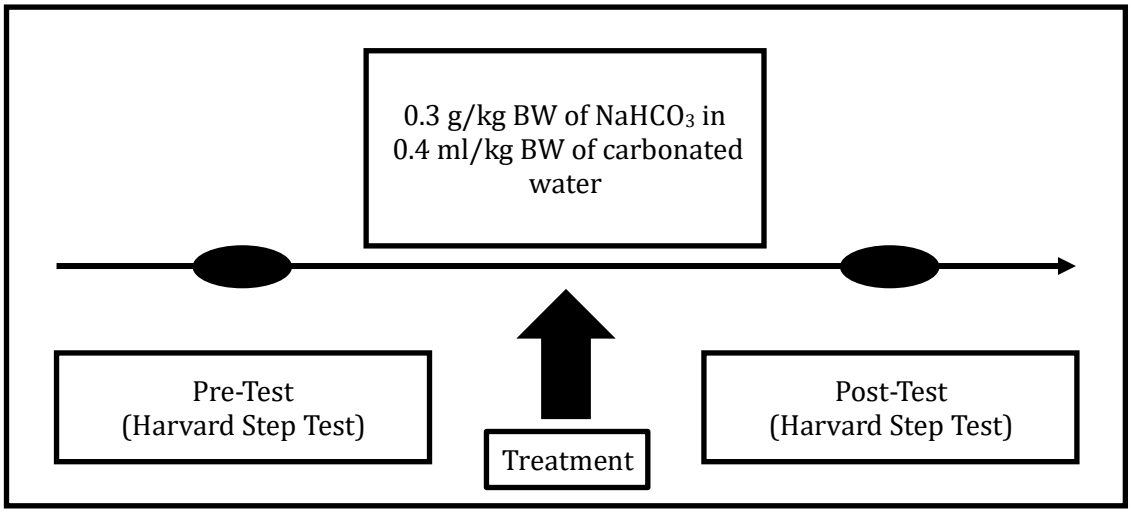

Figure 1. Research Scheme