

## Enhancing high school students' physical fitness via Crossfit: a study on 15-16-year-olds

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### Abstract

**Background and Study Aim** CrossFit represents a high-intensity functional training that has recently gained popularity among the youth. At the same time, restrictions imposed by military actions require different approaches to organizing CrossFit sessions. The most acceptable solution in such a situation is online education and training. The purpose of this study was to investigate the impact of CrossFit sessions within the framework of remote physical education on the physical fitness indicators of high school students.

**Material and Methods** The study involved 27 students (aged 15-16 years) from a 10th-grade class at a school located in a war conflict zone (Kharkiv, Ukraine). The group consisted of 11 boys and 16 girls. Due to the military conflict and corresponding restrictions, physical education was conducted remotely. Physical education classes were held three times a week, lasting 45 minutes each. The structure of the lesson included 30 minutes of synchronous online work with the teacher and 15 minutes for independent task completion. Tests aimed at measuring strength, endurance, flexibility, and speed were used to assess the impact of CrossFit programs on physical fitness. Data were collected at the beginning and end of the experiment. The experiment was conducted over 8 weeks. Testing was carried out at home by students under the control and guidance of the teacher via video link during the first three lessons.

**Results** The test results confirm improvement in all indicators. The boys increased their plank hold duration from 48 seconds to 53 seconds, and the girls from 46 seconds to 52 seconds. In the squat series, an increase in indicators was noted: for boys from 21 to 25 in the third series. Girls also showed significant improvement across all squat series. The boys' speed-strength indicators improved from 43 cm to 46 cm. Girls demonstrated improvement in performing "Burpees" within 60 seconds, increasing the number of repetitions from 8 to 12.

**Conclusions** The study results indicate that CrossFit effectively enhances the physical fitness of high school students. However, the improvement in girls occurs to a slightly lesser extent compared to boys. This may be due to the initial level of physical fitness and individual physiological characteristics.

**Keywords:** strength, endurance, speed, boys, girls, CrossFit, school

### Introduction

The relevance of incorporating CrossFit into the educational process for high school students is particularly important in the current context of globalization and changes in teenagers' lifestyles. CrossFit has already been introduced as an elective module in the curriculum for students in grades 6-9. However, this module is not included in the physical education program for students in grades 10-11, despite many studies highlighting its benefits [1, 2, 3, 4, 5]. Additionally, living in conditions of military conflict in Ukraine forces schools to switch to online learning [6, 7, 8]. This opens a discussion on the need to research the effectiveness of CrossFit as a means to improve the physical fitness of high school students and to develop a quality physical education program.

Research indicates significant benefits of performing CrossFit exercises, particularly "Burpees," which contribute to improving physical endurance and attention span in teenagers aged 15-16 [9, 10]. Additionally, an 8-week CrossFit program demonstrates a positive impact on overall physical well-being and emotional perception of self-efficacy, highlighting the importance of this program for adolescent health [11].

A key aspect of CrossFit is its ability not only to enhance physical fitness but also to foster the development of social connections and motivation for regular physical exercise sessions [12, 13]. This is especially important in the context of online training, where community interaction and support play a critical role in maintaining activity [14]. The relationship between social networks, self-efficacy, and participation in CrossFit training underscores the significance of this approach in forming a sustainable motivation for sports activities [11, 15, 16, 17].

Thus, integrating CrossFit into the physical education curriculum represents a promising direction for enhancing the physical fitness and psychological well-being of high school students. This not only contributes to improving physical health indicators but also creates conditions for forming a healthy lifestyle, motivation, and social integration among teenagers. In this context, the importance of research and practical application of CrossFit in the school program is evident.

The aim of this study was to investigate the impact of CrossFit sessions within the framework of remote physical education on the physical fitness indicators of high school students.

## Materials and Methods

### Participants

The study involved 27 students from a 10th-grade class at a school located in a war conflict zone (Kharkiv, Ukraine). The group consisted of 11 boys and 16 girls. Parents gave their consent for their children's participation in the experiment.

### Ethical Aspect of the Research

The study received approval from the University's Ethical Committee and was conducted in accordance with the Principles of the Declaration of Helsinki. Detailed information about the study was provided to the parents of the children involved, and their written consent was obtained.

### Research Design

Due to the military conflict and corresponding restrictions, physical education was conducted remotely, aiming to preserve and develop the students' physical fitness. Physical education classes were held three times a week, each lasting 45 minutes. The lesson structure included 30 minutes of synchronous online work with the teacher and 15 minutes for independent task completion.

To assess physical fitness, a battery of tests consisting of the following exercises was used (fig. 1):

1. Three series of squats with a wide stance and 15-second breaks between series (fig. 1a);
2. Holding the "Plank" position for the maximum possible time (fig. 1b);
3. Vertical jump from a standstill, measuring the height of the jump in centimeters (fig. 1c);
4. Jumping over a line with hands in a push-up position, counting the number of times in 5 seconds (fig. 1d);
5. Maximum number of push-ups (bending and straightening of arms) in a prone position in 40 seconds (fig. 1e);
6. Performing the "Burpee" exercise for 60 seconds, counting the number of repetitions (fig. 1f).

Testing was conducted at home by students under the control and guidance of the teacher via video link during the first three lessons. This approach allowed the physical education process to be adapted to the conditions of remote learning. It ensures an



**Figure 1.** Battery of Tests (image: VectorStock)

objective assessment of students' physical fitness and the effectiveness of the implemented training program.

#### Statistical Analysis

For data processing and analysis, the statistical software SPSS (Statistical Package for the Social Sciences) version 25 was used. During the statistical processing, the mean value ( $\bar{X}$ ) and standard deviation (SD) were determined. The t-test for dependent samples was used to compare results before and after the experimental intervention within groups. To assess differences between groups (boys and girls), the t-test for independent samples was applied. The significance level for all statistical tests was set at  $p < 0.05$ .

### Results

This study compared the test results between groups of boys and girls at the beginning of the study (Figure 2).

The results in Figure 2 suggest that:

- The Plank hold, vertical jumps, line jumping in push-up position, and push-ups in 40 seconds showed statistically significant differences in favor of the boys' group.
- In the three series of squats for 45 seconds with a 15-second break, statistically significant differences were observed only in the third series, also in favor of the boys.
- In the Burpees exercise for 60 seconds, no statistically significant differences were found between the groups, indicating similar

performance results for this exercise between boys and girls.

Figure 3 demonstrates changes in the physical fitness of 10th-grade male/female students during the study.

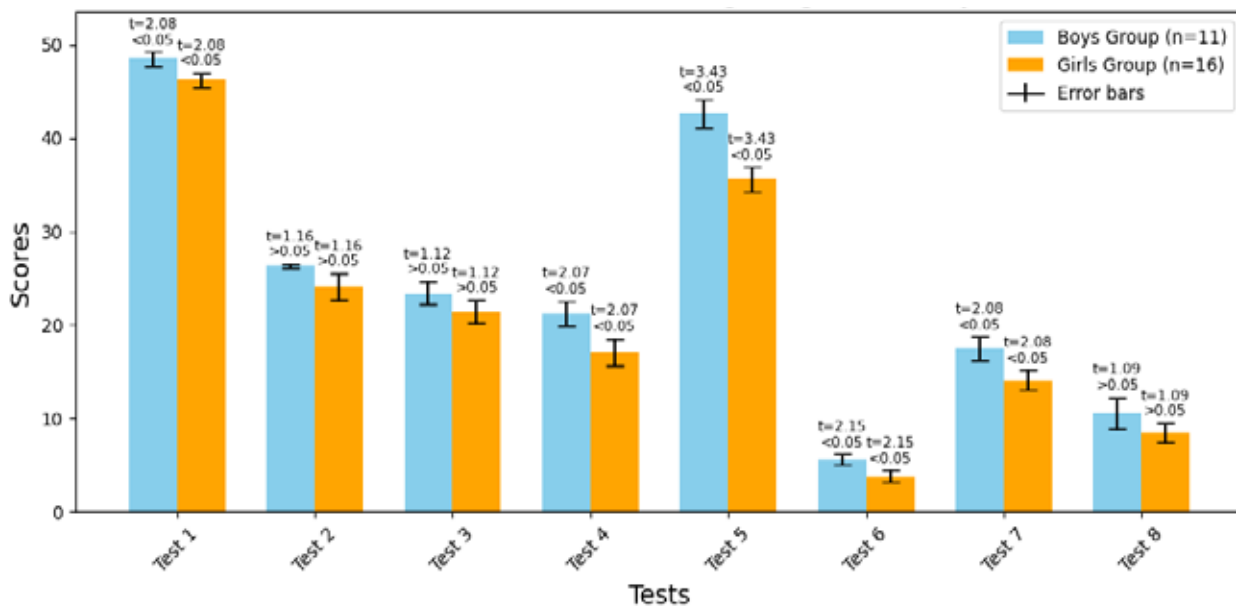
A noticeable improvement in most test exercises is observed by the end of the study compared to its beginning (fig. 3):

Statistically significant improvement is observed in exercises for holding the Plank position, the third series of squats, vertical jumps, line jumping in push-up position, push-ups in 40 seconds, and performing Burpees for 60 seconds.

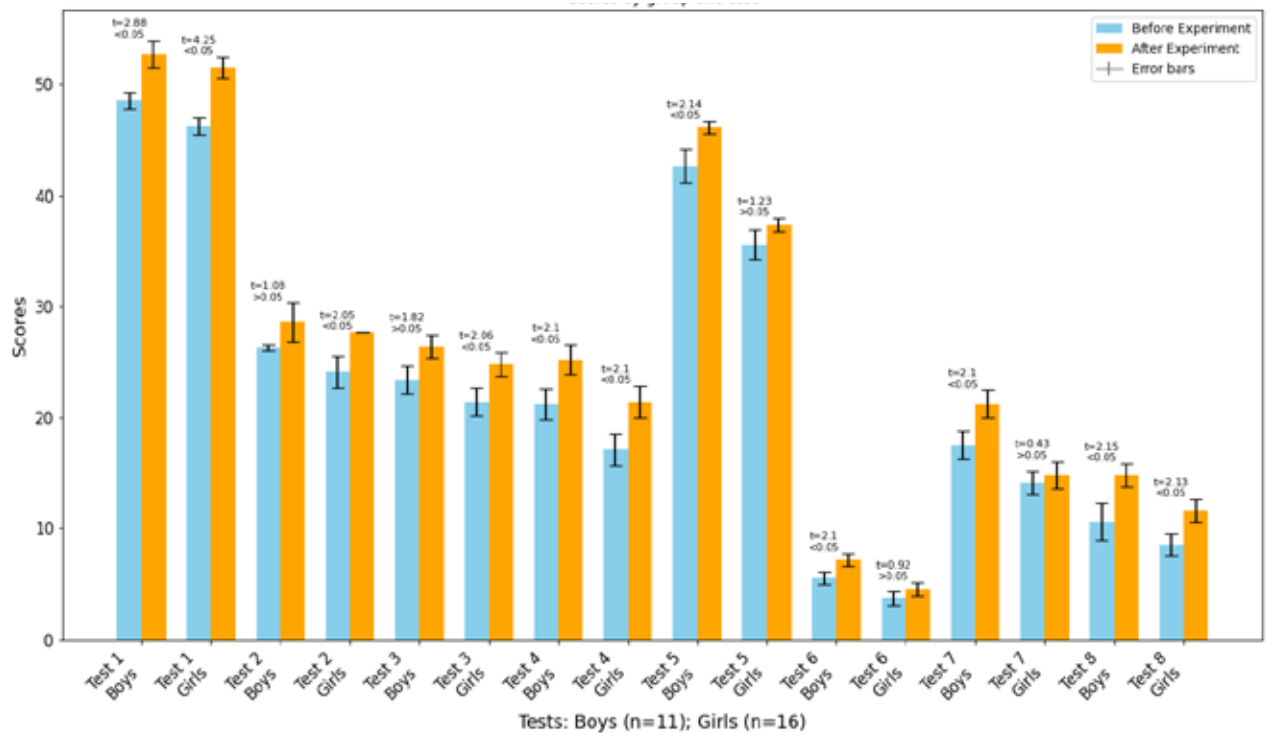
Although improvements in the first and second series of squats are also observed, they are not statistically significant, indicating the need for further efforts to improve results in these exercises.

Overall, the results indicate the effectiveness of the training program for 10th-grade boys, contributing to their physical development and improvement of results.

As seen in Figure 3, 10th-grade female students showed significant improvement in the plank hold exercises, in all three series of squats for 45 seconds with a 15-second break, and in the Burpee exercise for 60 seconds, as confirmed by statistical significance ( $p < 0.05$ ). However, in exercises such as the vertical jump from a standstill, line jumping in push-up position, and push-ups in 40 seconds, no statistically significant improvement was observed ( $p > 0.05$ ), indicating the need for further specialized training in these aspects of physical fitness.



**Figure 2.** Test exercise results at the beginning of the study (Mean  $\pm$  SD). Test 1 - Plank Hold, sec; Test 2 - 1st series of squats for 45 seconds with a 15-second break, reps; Test 3 - 2nd series of squats for 45 seconds with a 15-second break, reps; Test 4 - 3rd series of squats for 45 seconds with a 15-second break, reps; Test 5 - Vertical jump from a standstill, cm; Test 6 - Line jumping in push-up position, reps; Test 7 - Push-ups in 40 seconds, reps; Test 8 - Burpees in 60 seconds, reps.



**Figure 3.** Results of test exercises for boys (n=11) and girls (n=16) at various stages of the study (Mean  $\pm$  SD). Test 1 - Plank Hold, sec; Test 2 - 1st series of squats for 45 seconds with a 15-second break, reps; Test 3 - 2nd series of squats for 45 seconds with a 15-second break, reps; Test 4 - 3rd series of squats for 45 seconds with a 15-second break, reps; Test 5 - Vertical jump from a standstill, cm; Test 6 - Line jumping in push-up position, reps; Test 7 - Push-ups in 40 seconds, reps; Test 8 - Burpees in 60 seconds, reps.

## Discussion

The aim of this study was to assess the impact of CrossFit sessions within the framework of remote learning on the physical fitness indicators of high school students. The obtained results confirm the positive effect of CrossFit training on improving endurance, strength endurance in both boys and girls, as well as speed-strength and strength indicators in boys. In this regard, our results align well with the conclusions of previous studies [9, 10, 11]. In our view, the lack of statistical significance in the change of results for girls in these tests may be related to the need for more time and motivation for girls at this age to engage in exercises that carry strength and speed-strength loads. It may also be due to girls' lesser interest in strength exercises aimed at the upper shoulder girdle muscles.

Introducing CrossFit into the curriculum for senior students is particularly relevant in today's context, considering globalization and changes in teenagers' lifestyles [5]. Despite its absence in the official physical education program for grades 10-11, existing research [1, 2, 3, 4] emphasizes the need to incorporate CrossFit as a means to enhance physical fitness.

The results of our study resonate with works demonstrating the importance of physical activity, particularly CrossFit exercises, in improving not only the physical but also the psychological aspects

of adolescent health [11]. CrossFit contributes not only to physical development but also to strengthening social connections and motivation for regular physical education sessions, which is especially valuable in conditions of limited physical interaction [12, 13].

An interesting observation of our study is that, although improvements in physical fitness indicators were observed in both groups of students, boys showed more pronounced improvements in speed-strength indicators. This may be related to differences in physiological and biomechanical characteristics between genders, which requires further study and could be the subject of future research [16, 17].

It's also important to note the significance of the social aspect of CrossFit training. The relationship between social networks, self-efficacy, and participation in training underscores the need for community support for successful adaptation and maintaining motivation for sports activities [14, 15]. This is particularly relevant in the context of remote learning, where the loss of customary forms of social interaction can impact the overall well-being of students.

In conclusion, our results confirm the need to integrate CrossFit into the physical education curriculum for high school students. Such an approach will not only improve the physical health

indicators of students but also contribute to the formation of a healthy lifestyle, motivation, and social integration of teenagers. However, further research in this area is necessary for a deeper understanding of all aspects of CrossFit's impact on the physical and psychological components of students' health.

## Conclusions

The key aspect of successful integration of CrossFit into the educational process is its ability not only to improve physical fitness but also to foster the development of social connections and motivation for physical education. This is especially

important in conditions of limited physical interaction, characteristic of remote learning.

Integrating CrossFit into the physical education program for senior students represents a promising direction for the development of physical culture in schools. It not only contributes to improving physical health indicators but also creates conditions for forming a healthy lifestyle and social integration among teenagers.

Thus, the results of this study confirm the significance and potential of CrossFit as a means to enhance physical fitness and overall well-being of high school students, highlighting the importance of its further study and integration into the educational system.

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