

## Original Article

### Functional state of cardiovascular system of 10–16-year old teenagers under the influence of cheerleading classes

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#### Abstract:

**Purpose:** to determine extent of influence of cheerleading classes on functioning of cardiovascular system of girls of 10-16 years old. **Material:** Researches were conducted on the basis of educational institutions of Kharkov. 640 girls of 10-16 years old took part in them, of whom 7 main and 7 control groups were made. **Results:** functional state of cardiovascular system of girls of 10-16 years old is investigated; differences in age aspect of indicators of systolic and diastolic arterial blood pressure, heart rate in rest and after the dosed physical activity are considered; positive influence of exercises of cheerleading on functioning of cardiovascular system is revealed. **Conclusions:** 1) "Average" level of regulation of cardiovascular system of girls of 10-16 years old is established as a result of the initial research. 2) Application of exercises of cheerleading in the course of physical education positively influenced functioning of cardiovascular system of the studied contingent.

**Key words:** physical education, schoolgirls, physical development, lesson, exercise.

#### Introduction

Modern living conditions cause essential increase in incidence among various segments of the population. The special concern causes state of health of children and teenagers, at whom sharp deterioration in physical development and motive preparedness is noted, according to a number of scientists (Wellard & Sekker, 2017; Pomeshchikova, Iermakov et al., 2016; Mameshina, 2016; Podrigalo et al., 2016; Keyl & Harris, 2013; Kuzmenko & Shesterova, 2009) for the last decade. One of criteria of level of physical development are indicators of functioning of cardiovascular system which indicators depend on heredity, anthropometrical data, stages of puberty, extent of development of skeletal muscles, psychological climate in family and also on academic, workload and physical activities (Antropova, Paranicheva et al., 2009; Maslyak & Krivoruchko, 2016; Mameshina, 2016; Podrigalo, Iermakov et al., 2015).

A number of researches showed that intensification of educational process, wide use of various pedagogical innovations, lead to discrepancy of an academic load to functionality of an organism and decrease in adaptable mechanisms (Pavlenko, 2014; Maslyak, Mameshina & Zhuk, 2014; Vrublevskiy et al., 2014). Therefore, the search of solutions of this problem is extremely necessary.

One of conditions of increase in level of physical development and motive preparedness of pupils is modernization of physical education (Aghyppo, Tkachov & Orlenko, 2016). A number of authors dealt with an issue of optimization of process of physical education of pupils by introduction of various innovative means, methods and approaches to the organization of physical education of children and teenagers. So, Maslyak, Shesterova, Kuzmenko et al., 2016, suggest to use the special exercises, which are directed to improvement of functional state of vestibular analyzer; Pomeshchikova, Shevchenko et al., 2016 – exercises and ball games; Loshenko & Nazarenko, 2007; Stepanova, 2009 – aerobics; Artem'yeva & Nechytailo, 2014; Skurikhina, Kudryavtsev et al., 2016 – kinds of fitness; Mulyk & Grynova, 2015 – tourism; Filenko et al., 2013 – rugby-5 Loquet, 2011 – rhythmic gymnastics.

In our opinion, cheerleading is an effective remedy of physical education. It unites in itself elements of choreography, acrobatics, gymnastics, sports and national dances (Bala & Maslyak, 2014; Carrier & McKay, 2006; Chappell, 2005). A number of works is devoted to studying of efficiency of application of cheerleading. Authors investigated impact of cheerleading on the level of development of various physical qualities (Bala, 2015; Kryvoruchko, Masliak, Zhuravlyova, 2013, 2015; Lutsenko & Bodrenkova, 2013; Pyatnickaya, 2015); physical working capacity (Kryvoruchko & Masliak, 2015); physical health (Bala & Maslyak, 2011, 2012). At the same time the question of influence of means of cheerleading for state of cardiovascular system of girls of 10-16 years old is studied insufficiently.

The purpose of the research: to determine extent of influence of cheerleading classes on functioning of cardiovascular system of girls of 10-16 years old.

### Material & methods

The researches were conducted on the basis of educational institutions of Kharkov. 640 girls of 10-16 years old took part in them, of whom 7 main and 7 control groups were made. All children, who participated in the research, were assigned to main and preparatory medical group. Exercises of cheerleading (basic movements, hopping elements, stunts, pyramids, etc.) were included in the educational process on physical education of girls of the main groups during the experiment.

Research methods: theoretical analysis and synthesis of data of scientific and methodical literature, pedagogical experiment, medico-biological methods, methods of mathematical statistics. Functional state of cardiovascular system was determined by indicators of regulation level of cardiovascular system (Robinson's index) and extent of reaction of cardiovascular system on standard physical activity (Ruffie index).

Indicators of arterial blood pressure at rest, heart rate at rest and after the dosed physical activity were studied (30 squats for 45 seconds).

### Results

Considering the received results, the lack of reliable differences in indicators of the studying control and main groups on all studied parameters is revealed ( $p > 0,05$ ).

The analysis of the results, reflecting state of cardiovascular system (Robinson's index) in age aspect, showed the insignificant increase in indicators of arterial blood pressure with age ( $p > 0,05$ ). Indicators of systolic pressure of girls of 12 years old make an exception, which results are lower, than girls of 10-11 years old and also indicators of diastolic pressure of schoolgirls of 10 years old which are higher, than girls of 11-12 years old have and schoolgirls of 16 years old, which indicators authentically prevail over indicators of schoolgirls of 15 years old ( $p < 0,05$ ) (Figure 1-2).

Considering the received results of heart rate, the lack of reliable differences in indicators ( $p > 0,05$ ) with the general tendency to decrease in results with age is revealed generally (Figure 1-2). Indicators of girls of 10-11 years old of control group make an exception, which data are reliable above, than schoolgirls of 14 years old ( $p < 0,01$ ) and the data of girls of 15-16 years old of main group which are authentically prevailing over data of girls of 14 years old ( $p < 0,05$ ).

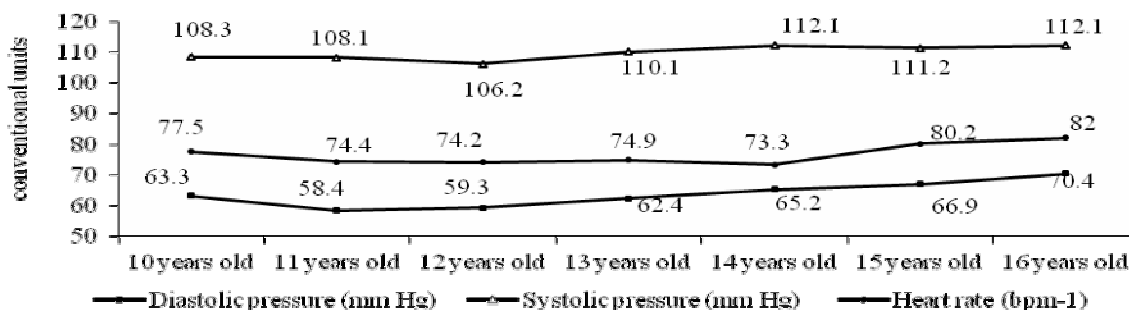


Fig. 1. Age comparisons of average values of cardiovascular system of schoolgirls of main groups of 10-16 years old before the experiment

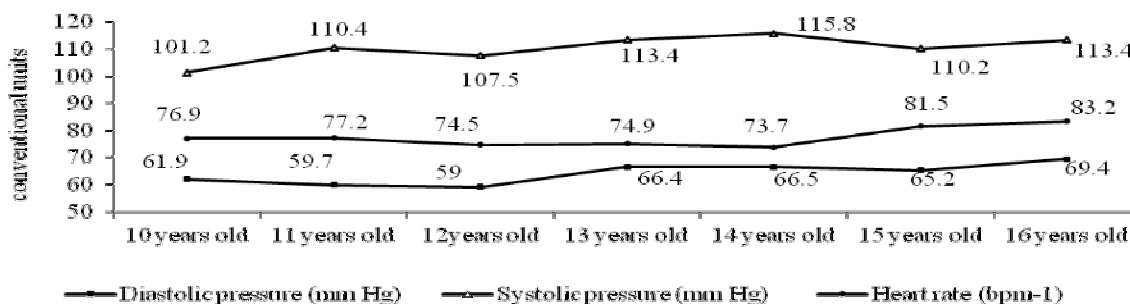


Fig. 2. Age comparisons of average values of cardiovascular system of schoolgirls of control groups of 10-16 years old before the experiment

Comparing the received results of Robinson's index with the rating scale, which is presented by Polyakov et al., 2006, it is defined that they correspond to the assessment 3 points – "average" level of regulation of cardiovascular system at girls of 10-16 years old.

At the research of the received indicators, reflecting the extent of reaction of cardiovascular system to standard physical activity (Ruffle index), multidirectional non-system character of change of results with age is revealed (Figure 3).

When comparing indicators of Ruffle index to the rating scale, which is presented by Polyakov et al., 2006, it is revealed that results of the studied 11, 13–14 years old correspond to the assessment 3 points, 10 and 12 years old – the assessment 4 points, 15-16 years old – the assessment 1 point. Thus, "average" level of reaction of cardiovascular system on standard physical activity at girls of 11, 13–14 years old, at the studied 10 and 12 years old – "above the average" is observed, and at girls of 15-16 years old – "low" level.

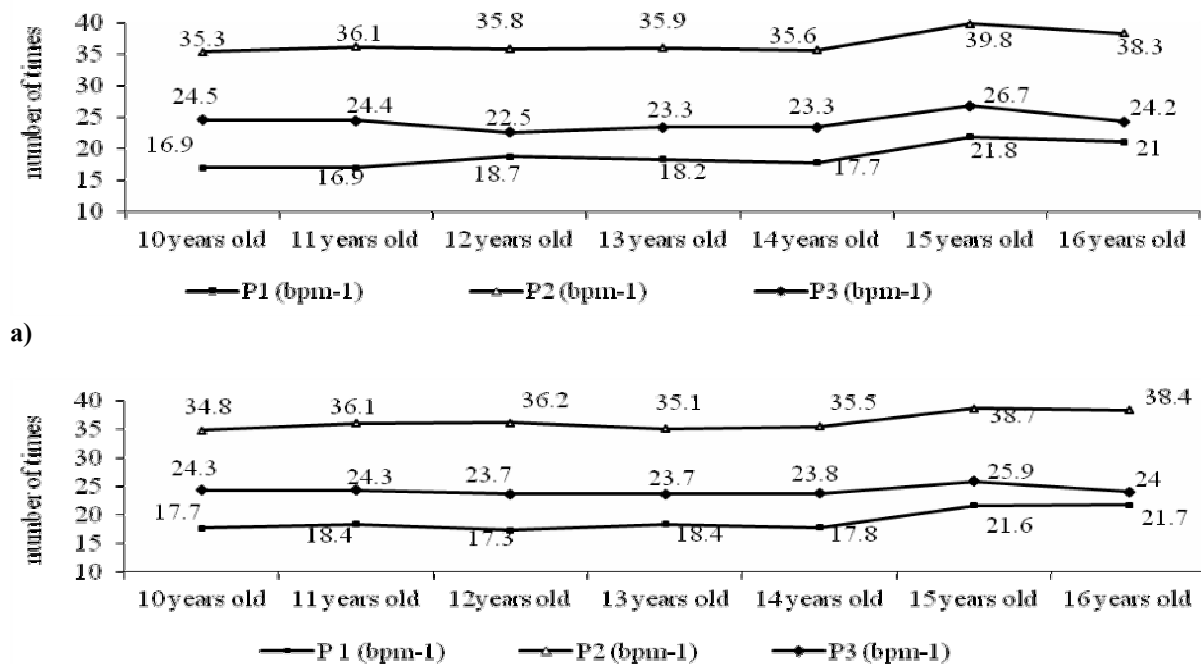


Fig. 3. Age comparisons of average values of reaction of cardiovascular system to standard physical activity before the experiment ( $P_1$  – heart rate for 15" at rest;  $P_2$  – heart rate for the first 15" of the first minute of recovery;  $P_3$  – heart rate for the last 15" of the first minute of recovery) a) schoolgirls of main groups; b) schoolgirls of control groups

The analysis of the results, reflecting state of cardiovascular system (Robinson's index), received after application of exercises of cheerleading (Table 1), revealed unreliable decrease in results of arterial blood pressure at schoolgirls of 10-16 years old of main groups ( $p < 0,05$ ). Indicators of girls of 10 years old make an exception, where decrease in results, has a reliable character ( $p > 0,001$ ).

The analysis of results of the studied control groups, which were received after the experiment, revealed changes similar to experimental groups ( $p < 0,05$ ).

In age aspect the dynamics of distinctions significantly didn't change in comparison with the initial researches.

Considering the data of heart rate, which were received after the experiment, revealed that results of schoolgirls as main, and control groups significantly didn't change, in comparison with basic data (Table 1). Indicators of girls of 16 years old make an exception, where changes are reliable ( $p < 0,001$ ). The nature of differences in age aspect remained invariable.

Comparing the repeated indicators of Robinson's index to the rating scale, it is defined that results improved a little at girls of 10-16 years old after the experiment and began to correspond to the assessment 4 points at the studied of 11–13 and 15-16 years old. The improvement of results wasn't reflected on the rating scale at schoolgirls of 10 and 14 years old, and they also as well correspond to the assessment 3 points before the experiment. Thus, the level of regulation of cardiovascular system of girls of main groups increased from "average" to "above the average" after application of exercises of cheerleading.

Table 1. Comparison of average values of state of cardiovascular system of girls of main groups before and after the experiment

| Age          | Groups                | n   | Indicators $\bar{X} \pm m$ |                            |  |                                      |                |                |
|--------------|-----------------------|-----|----------------------------|----------------------------|--|--------------------------------------|----------------|----------------|
|              |                       |     | Systolic pressure (mm Hg)  | Diastolic pressure (mm Hg) | Heart rate for 1' (bpm <sup>-1</sup> ) | Heart rate for 15" (number of times) |                |                |
|              |                       |     |                            |                            |  | P <sub>1</sub>                       | P <sub>2</sub> | P <sub>3</sub> |
| 10 years old | Before the experiment | 15  | 108,27 ± 1,90              | 63,33 ± 1,89               | 77,5 ± 1,29                            | 16,9 ± 0,28                          | 35,3 ± 0,28    | 24,5 ± 0,41    |
|              | After the experiment  |     | 103,00 ± 1,81              | 55,33 ± 1,18               | 75,9 ± 0,88                            | 17,1 ± 0,26                          | 33,3 ± 0,41    | 22,2 ± 0,50    |
|              | t                     |     | 2,01                       | 3,59                       | 1,02                                   | 0,52                                 | 4,01           | 3,60           |
|              | p                     |     | >0,05                      | <0,001                     | >0,05                                  | >0,05                                | <0,001         | <0,001         |
| 11 years old | Before the experiment | 14  | 108,14 ± 2,80              | 58,43 ± 0,97               | 74,4 ± 1,20                            | 16,9 ± 0,26                          | 36,1 ± 0,28    | 24,4 ± 0,34    |
|              | After the experiment  |     | 104,50 ± 1,73              | 57,50 ± 1,19               | 75,4 ± 0,97                            | 17,1 ± 0,24                          | 34,4 ± 0,44    | 20,9 ± 0,59    |
|              | t                     |     | 1,11                       | 0,61                       | 0,65                                   | 0,80                                 | 3,14           | 5,04           |
|              | p                     |     | >0,05                      | >0,05                      | >0,05                                  | >0,05                                | <0,01          | <0,001         |
| 12 years old | Before the experiment | 6   | 106,17 ± 3,78              | 59,33 ± 3,82               | 74,2 ± 1,68                            | 18,7 ± 0,83                          | 35,8 ± 0,66    | 22,5 ± 1,16    |
|              | After the experiment  |     | 100,00 ± 5,29              | 55,83 ± 2,20               | 75,2 ± 0,91                            | 18,3 ± 0,46                          | 35,0 ± 0,63    | 21,3 ± 0,61    |
|              | t                     |     | 0,95                       | 0,79                       | 0,52                                   | 0,35                                 | 0,91           | 0,89           |
|              | p                     |     | >0,05                      | >0,05                      | >0,05                                  | >0,05                                | >0,05          | >0,05          |
| 13 years old | Before the experiment | 14  | 110,14 ± 1,64              | 62,43 ± 1,51               | 74,9 ± 0,75                            | 18,2 ± 0,29                          | 35,9 ± 0,33    | 23,3 ± 0,33    |
|              | After the experiment  |     | 107,14 ± 1,51              | 60,71 ± 0,74               | 74,7 ± 0,63                            | 18,1 ± 0,30                          | 34,4 ± 0,34    | 21,1 ± 0,38    |
|              | t                     |     | 1,35                       | 1,02                       | 0,22                                   | 0,34                                 | 3,15           | 4,35           |
|              | p                     |     | >0,05                      | >0,05                      | >0,05                                  | >0,05                                | <0,001         | <0,001         |
| 14 years old | Before the experiment | 16  | 112,13 ± 1,55              | 65,19 ± 1,23               | 73,3 ± 1,33                            | 17,7 ± 0,24                          | 35,6 ± 0,34    | 23,3 ± 0,31    |
|              | After the experiment  |     | 111,56 ± 1,47              | 63,75 ± 1,11               | 73,2 ± 1,10                            | 18,1 ± 0,25                          | 33,3 ± 0,51    | 21,3 ± 0,42    |
|              | t                     |     | 0,26                       | 0,87                       | 0,07                                   | 0,26                                 | 3,80           | 3,85           |
|              | p                     |     | >0,05                      | >0,05                      | >0,05                                  | >0,05                                | <0,001         | <0,001         |
| 15 years old | Before the experiment | 75  | 111,2 ± 0,94               | 66,93 ± 0,58               | 80,28 ± 1,21                           | 21,8 ± 1,17                          | 39,8 ± 1,46    | 26,7 ± 1,13    |
|              | After the experiment  |     | 110,5 ± 0,88               | 66,53 ± 0,49               | 77,27 ± 1,01                           | 21,1 ± 0,28                          | 37,5 ± 0,48    | 24,2 ± 0,51    |
|              | t                     |     | 0,52                       | 0,53                       | 1,91                                   | 0,83                                 | 3,04           | 2,28           |
|              | p                     |     | >0,05                      | >0,05                      | >0,05                                  | >0,05                                | <0,01          | <0,01          |
| 16 years old | Before the experiment | 108 | 112,1 ± 0,95               | 70,46 ± 0,71               | 82,06 ± 0,94                           | 21,0 ± 0,70                          | 38,3 ± 1,06    | 24,2 ± 0,72    |
|              | After the experiment  |     | 112,4 ± 0,72               | 70,42 ± 0,53               | 77,72 ± 0,80                           | 20,8 ± 0,37                          | 37,2 ± 0,67    | 22,8 ± 0,58    |
|              | t                     |     | 0,27                       | 0,05                       | 3,51                                   | 0,42                                 | 2,51           | 2,64           |
|              | p                     |     | >0,05                      | >0,05                      | <0,001                                 | >0,05                                | <0,01          | <0,01          |

Comparing data of the repeated researches reflecting the extent of reaction of cardiovascular system to standard physical activity (Ruffle index), it is revealed that indicators of heart rate at rest for 15 seconds significantly didn't change at schoolgirls of main groups ( $p > 0,05$ ), (Table 1). Generally reliable decrease in results is revealed ( $p < 0,01$ ;  $0,001$ ) in the analysis of the specified indicators for the first and last 15 seconds of the first minute of recovery. Indicators of heart rate for the first and last 15 seconds of the first minute of recovery of the studied of 12 years old make an exception, where decrease in results isn't reliable ( $p > 0,05$ ). The analysis of these pupils of control groups, which were received after the experiment, showed minor changes of results ( $p > 0,05$ ). When studying these indicators depending on age, the lack of considerable differences in comparison with the initial research is revealed.

Comparing Ruffle index indicators to the rating scale, it is revealed that results of schoolgirls of the main groups increased by 1 point and began to correspond to 4 points at the studied 11, 13–14 years old, to 5 points – girls of 10 years old, to 2 points - girls of 15 years old. The assessment increased by 2 points and began to answer 3 points at the studied 16 years old. It wasn't reflected in the rating scale in any way at schoolgirls of 12 years old in spite of the fact that results improved, and they as well as before the experiment correspond to the assessment 4 points. Thus, level "below the average" of reaction of cardiovascular system to standard physical activity is observed at schoolgirls of main groups of 15 years old, schoolgirls of 16 years old – "average", girls of 11–14 years old – "above the average", and at the studied 10 years old – "high" level that demonstrates positive influence of exercises of cheerleading on adaptation opportunities of cardiovascular system.

It follows from the above that application of specially selected exercises of cheerleading in the course of physical education positively affected functional state of cardiovascular system of girls of 10-16 years old. The most considerable improvement of results is noted at schoolgirls of 12 and 16 years old.

### Discussion

The theoretical analysis and generalization of literature showed the existence of insignificant number of the works, which are devoted to studying of influence of cheerleading on functioning of various systems of an organism of youth. So, influence of cheerleading on physical health of pupils of middle school (Bala, Maslyak, 2011; 2012), physical fitness, working capacity and physical development of girls of teacher training college (Kryvoruchko, Masliak, Zhuravlyova, 2013; 2015; 2016), physical fitness of students-cheerleaders of higher educational institutions (Lutsenko, Bodrenkova, 2013; Pyatnickaya, 2015) was investigated.

As a result of the conducted researches, it is revealed that inclusion of cheerleading in the process of physical education of schoolgirls of 10-16 years old exerts positive impact on their cardiovascular system. So, considering changes in the indicators of arterial blood pressure, which were received after application of cheerleading, insignificant increase in indicators of arterial blood pressure is revealed at girls of the studied groups ( $p>0,05$ ). The above is confirmed by the data, which are submitted by Solodkov & Sologub, 2001, according to which arterial blood pressure increases with age. In our opinion, the specified changes are explained by increase in volume of blood, which is thrown out by heart for one reduction with age.

Considering the data of heart rate, which are received after the experiment, the lack of reliable differences in indicators ( $p>0,05$ ) is revealed generally both at pupils of the experimental, and control groups with the general tendency to decrease in heart rate. In our opinion, these changes demonstrate profitability of functions of heart and will be coordinated with the main regularities of age development of teenagers during this period (Vahitov & Martyanov, 2009, 2010). The reliable nature of changes is observed only in data of heart rate of the studied 16 years old ( $p<0,05$ ). The above is confirmed by data of Zemtsova, 2008 according to which systematic classes by physical exercises of long moderate intensity influence decrease in indicators of heart rate. Comparing data of the repeated researches, reflecting extent of reaction of cardiovascular system to standard physical activity (Ruffle index), it is revealed that indicators of heart rate at rest significantly didn't change in comparison with basic data at pupils of main groups. Generally reliable decrease in results is revealed at schoolgirls of 10-16 years old ( $p<0,01$ ;  $0,001$ ) at the analysis of indicators of heart rate for the first and last 15 seconds of the first minute of restoration. The exception is made by data of girls of 12 years old, where decrease in results has not reliable character ( $p>0,05$ ). The received results will be coordinated with the data, which are submitted by Sedyih, 2002; Spirin, 2004 according to which, improvement of reaction of cardiovascular system to standard load is observed as a result of application of various outdoor games, sports pauses, heterotraining, extension exercises. This results from the fact that systematic muscular activities stimulate processes of morphological formation and functional maturing therefore there is a considerable reduction of heart rate in a growing organism, contractive power of cardiac muscle increases, duration of the recovery period after physical activity decreases. The analysis of these pupils of control groups, which were received after the experiment, showed minor changes of results ( $p>0,05$ ). Data of Zinchenko, 2013; Bykov, Tyanyugina & Galimzyanova, 2014; Pyatnickaya, 2015; Lutsenko & Bodrenkova, 2016 about positive influence of cheerleading on various spheres of activity of engaged are expanded in the course of the research. Data of Bala, Maslyak & Krivoruchko, 2011; 2012; 2015; 2016 about positive impact of cheerleading on parameters of physical development of engaged are added. Influence of exercises of cheerleading on functional state of cardiovascular system of girls of 10-16 years old is defined for the first time. The optimum age periods of increase in level of activity of cardiovascular system are also found by means of cheerleading.

### Conclusions

Results of the initial research testify to "average" level of regulation of cardiovascular system of girls of 10-16 years old. Application of exercises of cheerleading in the course of physical education positively influenced functioning of cardiovascular system of the studied contingent.

*Further researches in this direction can be conducted by definition of influence of exercises of cheerleading on functional state of respiratory system of girls of 10-16 years old.*

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**Conflicts of interest.** The authors note that there is no conflict of interests.

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