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## Original article

### Association between changes in physical activity levels and depressive symptoms in high school students during the COVID-19 pandemic

Asociación entre cambios en los niveles de actividad física y síntomas depresivos en estudiantes de secundaria durante la pandemia de COVID-19

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#### Abstract

**Objective:** The study examined the association between depressive symptoms (DS) and perceptions of changes in the physical activity (PA) levels in high school students during the COVID-19 pandemic. **Methods:** 186 students of a federal education institution from southern Brazil participated in the study. Perception of changes in the PA levels during the pandemic and the DS were collected through questionnaires in an electronic form. DS was scored and classified in low or increased depressive symptoms. **Results:** 60.8% of students showed increased depressive symptoms, being more frequent (75.6%) among girls ( $p<0.05$ ). Regarding the PA levels during the COVID-19 pandemic, 70.4% of students reported a reduction in general PA, 54.3% to light PA, 67.2% to moderate PA, and 72.0% to vigorous PA, being the decrease in light and moderate PA more frequent among girls ( $p<0.05$ ). Students who reported unfavorable changes in PA during the COVID-19 pandemic are about three times more likely to present increased depressive symptoms ( $p<0.05$ ). **Conclusion:** Therefore, this result indicates that PA reduction levels during the pandemic are associated with higher DS among high school students at a federal educational institution in southern Brazil.

**Keywords:** depressive symptoms; students; COVID-19; physical activity.

#### Resumen

**Objetivo:** El estudio examinó la asociación entre los síntomas depresivos (SD) y las percepciones de los cambios en los niveles de actividad física (AF) en estudiantes de secundaria durante el período de la pandemia COVID-19. **Métodos:** En el estudio participaron 186 estudiantes de una institución educativa federal del sur de Brasil. La percepción de cambios en los niveles de AF durante la pandemia y el SD se recogieron a través de cuestionarios en formato electrónico. Las puntuaciones de SD se clasificaron en síntomas depresivos bajos o altos. **Resultados:** El 60.8% de los estudiantes mostró síntomas depresivos altos, siendo más frecuente (75.6%) entre las chicas ( $p<0.05$ ). En cuanto a los niveles de AF durante la pandemia de COVID-19, el 70.4% de los estudiantes refirió disminución en AF general, 54.3% en AF ligera, 67.2% en AF moderada y 72.0% en AF vigorosa, siendo más frecuente la disminución de AF ligera y moderada entre las chicas ( $p<0.05$ ). Los estudiantes que informaron cambios desfavorables en la AF durante la pandemia de COVID-19 tienen aproximadamente tres veces más probabilidades de presentar síntomas depresivos altos. **Conclusión:** Por lo tanto, estos resultados indican que las reducciones en los niveles de AF durante la pandemia están asociadas con los SD más altos en estudiantes de secundaria de una institución educativa federal en el sur de Brasil.

**Palabras clave:** síntomas depresivos; estudiantes; COVID-19; actividad física.

## Key Points

- There was an association between increased depressive symptoms and unfavorable perceptions of changes in PA levels of students during social distancing.
- Almost 2/3 of adolescents showed increased depressive symptoms, most of them were girls.
- Seven out of ten students reported a reduction in PA levels during social distancing.
- Students who perceived a reduction in PA levels were three times more likely to present increased depressive symptoms.

## Introduction

Depression is a serious illness that affects more than 300 million people worldwide, with a 3% to 6% prevalence among young people<sup>1</sup>. Since adolescence is a biological, psychological, and social changes period, which can facilitate depressive disorders to arise<sup>2</sup>, the worsening of the illness may cause complications such as a reduced performance in school, drug abuse, and, as a more severe consequence, suicide<sup>3</sup>, which is the third leading cause of death among adolescents in the Americas<sup>4</sup>.

Consistent evidence has shown the benefits of physical activity (PA) to treat depressive symptoms (DS)<sup>5-8</sup>. It may be an effective tool for preventing and treating the illness since using only the medication can be inefficient in some cases, not treating all the symptoms and causing relapses<sup>9</sup>.

With the emergence of the pandemic caused by the novel coronavirus and the consequent absence of efficient treatment for its disease<sup>2</sup>, social distancing policies became essential to contain the virus dissemination. Thus, daily routine changes caused by social distancing, such as working from home, suspension of face-to-face classes, and the significant reduction of social relations, mainly with relatives and friends, are causing negative effects on the population's physical and mental health<sup>10-12</sup>.

According to a recent Chinese study<sup>13</sup>, 40% to 50% of adolescents are more likely to have mental disorders due to the pandemic, with DS being one of the most prevalent psychological problems. The authors reported that young people's mental health deterioration might be associated with the absence of outdoor activities and social interaction.

As a consequence of such context, the restrictions imposed to control the virus dissemination modify people's behavior regarding the PA practice. Concerning this, scientific literature points to an increase in sedentary behavior and a significant reduction of PA levels<sup>14,15</sup>.

The school closures contributed to a social relation reduction, making the PA practice infeasible during break time and physical education classes<sup>16</sup>. Such a combination of unfavorable behaviors can become relevant to the increase of DS among adolescents. Therefore, daily routine and PA practices maintenance can be crucial factors to diminish mental health problems<sup>13</sup> since high PA levels during the pandemic have been associated with fewer humor variations among young people<sup>17</sup>.

Based on the described scenario, in order to reflect on the social distancing side effects in young people's mental health, this study aims to analyze the association between DS and perceptions modifications in PA levels among high school students during the COVID-19 pandemic.

## Methods

### *Design and Participants*

This cross-sectional descriptive study was conducted on students enrolled in secondary education with a technical specialization at Federal Institute Sul-rio-grandense (IFSUL), Campus Bagé, Brazil. The study was approved by the Research Ethics Committee, under protocol n. 4.240.741. The 212 students enrolled at IFSUL in 2020 who were attending Physical Education (students from 3rd to 8th semester)

until the academic activities were suspended due to the pandemic were invited to participate in the study. From those, 186 consented to cooperate. Due to the social distancing recommendations required because of the COVID-19 pandemic, the information gathering procedure was performed through a standardized online form sent to the students via e-mail or instant message apps, used in previously published study<sup>15</sup>. The instrument was adapted to the adolescent population, where self-reported information was collected about the perceptions of changes in the PA level of students during the COVID-19 pandemic. The students who were enrolled in the 1st and 2nd semesters did not participate in the study because of the contact impossibility resulting from social distancing policies and the absence of Physical Education classes in the curriculum.

A text describing the goals, justification, and risks/benefits of participating in the study was presented when accessing the form. It was followed by a question asking for the students' consent to take part in the research. All sample members agreed to participate in the study through the free and informed assent term that appeared at the beginning of the instrument. The consent term regarding the underage students was sent to their parents or guardians as an online form through e-mail or instant message apps. After they were permitted to participate in the study, the form used to collect information was sent to the underage students, where the first part had the minor's consent form, in which students agreed or not to participate in the study.

The students answered questions regarding any alterations in the PA levels and DS during the social distancing period, always comparing it to the face-to-face classes period. Besides information related to PA levels and DS alterations, sociodemographic information was also collected (such as sex, age, and socioeconomic status). Data were collected five months after adopting social distancing as a restrictive measure, between August and September 2020. During this period, schools closed for approximately five months, and government guidelines were to maintain social distance, leaving home only to perform essential tasks.

### *Variables and Procedures of the Study*

#### *Physical activity*

To elucidate the general concepts about PA, the following definition was included before the questions: "PA is every and any activity in which there is body movement, such as displacements, housework, personal hygiene, games, sports, dancing, exercises, etc." It was also explained that PA can be performed in different intensities: "Light Physical Activity (LPA) refers to those movements performed without much effort, causing no change in breathing"; Moderate Physical Activity (MPA) are those which requires some physical effort and change breathing, making it slightly stronger than usual; "Vigorous Physical Activity (VPA) is those which require a substantial physical effort, making breathing much stronger than normal." The perceptions about the possible modifications in the PA levels during the social distancing period were evaluated through four questions: "When compared to the face-to-face classes period, do you think that your involvement level with PA during this social distancing period is in general: a) much lower b) lower c) the same d) higher e) much higher." The three last questions were identical to the first. However, they referred to the PA's alteration perceptions concerning different intensities (light, moderate, and vigorous) and not to the General Physical Activity (AFG). To analyze the perception of modification in the PA levels of students, the instrument by Bergmann et al. (2020)<sup>15</sup> was adapted to the standard electronic form.

#### *Depressive Symptoms*

This variable was evaluated through the Center for Epidemiological Studies – Depression (CES - D)<sup>18</sup>, an easy-to-understand and self-applicable tool validated for the Brazilian youth population<sup>19</sup>. Besides

measuring the number of DS, CES-D also evaluates its severity, which is indicated by the number of symptoms and the frequency they manifested during the previous week. The tool offers 20 questions, and its score varies from 0 to 3 points for each question, depending on the frequency the symptoms manifest. The final punctuation is the sum of all other items, and it can vary from 0 to 60 points. The adopted cut-off point was a score of 16 points<sup>20</sup>, indicating that the students who obtained this or a higher score were classified as having "increased depressive symptoms." Students who obtained a lower score than 16 points were classified as having "low depressive symptoms." It is essential to highlight that CES-D does not present a Depression diagnosis but evaluates its number of symptoms.

### *Sociodemographic information*

Aiming at characterizing the participants and adjusting the multivariable analyzes, information regarding the sex (boys and girls), age (completed years), and socioeconomic status was collected. The socioeconomic status was considered from the students' report regarding the family income in minimum wage numbers. Important to note, during 2020, the minimum wage in Brazil is R\$ 1.045.00 per month. The family income mentioned in this study is based on this value.

### *Statistical analysis*

Initially, the normality of the distributions of age and DS score were tested. These analyses indicated a non-parametric distribution for DS score. Thus, age was described by mean ( $\bar{x}$ ) and standard deviation (SD), DS score was described by median (M) and interquartile range (IQR), and categories variables were described by absolute and relative frequencies. To analyze the modifications in PA levels reported by the participants, the categories "much lower" and "lower" were grouped as "reduction of PA levels." The categories "higher" and "much higher" were grouped as "Increase of PA levels." The category "the same" was described in the analysis as "maintenance of PA levels." To compare variables between sexes, the Mann-Whitney's U test and the Chi-Square test were used. For the association between changes in PA indicators and DS classification, the Chi-square test was used. For analyzing the adjusted association between the perceived changes in PA indicators and the SD classification, binary logistic regression was used, and the Odds Ratio (OR) and their respective 95% confidence intervals (95% CI) were calculated. The variable outcome was the DS classification ("increased depressive symptoms" and "low depressive symptoms"), the PA indicators changes were inserted as exposures, and the sex, age, and socioeconomic level were used as adjustment variables. For all analyzes, a significance level of 5% was used. The analyses were conducted using the SPSS version 20.0 statistical package.

## **Results**

A total of 186 adolescents with an average age of 18 ( $\pm 1.2$ ) participated in the study, most of them were boys ( $n = 96$ ). When considering the DS score, girls had a significantly higher value than boys ( $p < 0.05$ ). In the DS classification, this difference remains ( $p < 0.05$ ), with 75.6% of the girls being classified as having increased depressive symptoms. Regarding changes in PA levels, most participants reported its reduction, with VPA being the one with the largest number of participants reporting involvement reduction. Moreover, the PA levels reduction were greater among the girls, being statistically significant for LPA and MPA ( $p < 0.01$ ).

**Table 1.** Descriptive characteristics of the participants.

Participants	All (n=186)	Boys (n=96)	Girls (n=90)	p-value
<b>Age (years) (<math>\bar{x}</math>; SD)</b>	18 (1.2)	18 (1.2)	18 (1.2)	0.808
<b>Family income (n; %)</b>				0.736
Less than 3 minimum wages	135 (72.6)	68 (70.9)	67 (74.4)	
Between 3 and 6 minimum wages	38 (20.4)	20 (20.8)	18 (20.0)	
Bigger than 6 minimum wages	13 (7.0)	8 (8.3)	5 (5.6)	
<b>Depressive Symptoms score (M; IQR)</b>	18 (18.25)	15 (17)	23.5 (16.5)	<0.001
<b>Depressive Symptoms classification</b>				<0.001
Low depressive symptoms (n;%)	73 (39.2)	51 (53.1)	22 (24.4)	
Increased depressive symptoms (n;%)	113 (60.8)	45 (46.9)	68 (75.6)	
<b>Changes in PA Levels</b>				
General PA levels reduction (n; %)	131 (70.4)	62 (64.6)	69 (76.7)	0.179
Light PA levels reduction (n; %)	101 (54.3)	44 (45.8)	57 (63.3)	< 0.01
Moderate PA levels reduction (n; %)	125 (67.2)	57 (59.4)	68 (75.6)	< 0.01
Vigorous PA levels reduction (n; %)	134 (72.0)	62 (64.6)	72 (80.0)	0.064

*n*: participants;  $\bar{x}$ : mean; SD: standard deviation; %: relative frequency; M: Median; IQR: interquartile range; BMI: body mass index.

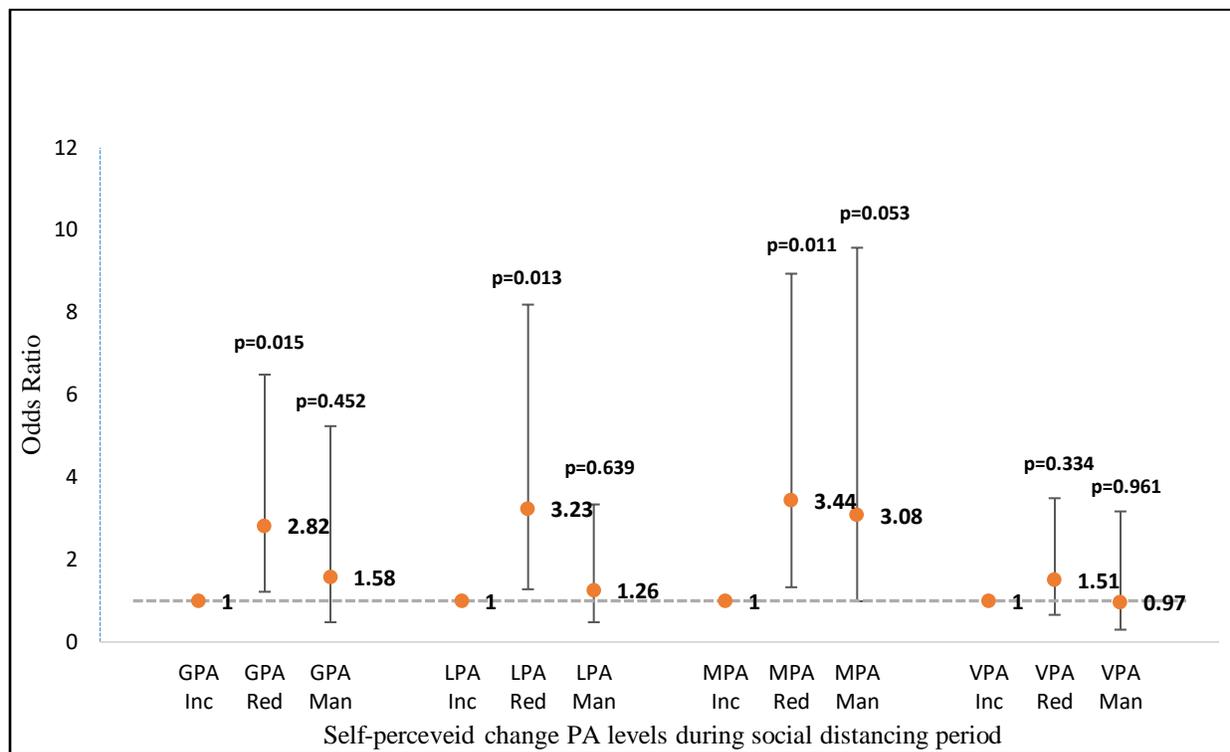
Table 2 presents that, except for VPA, in all other PA intensities, the proportion of participants classified as having increased depressive symptoms was greater ( $p < 0.05$ ) among those that noticed a PA levels reduction.

**Table 2.** Association between adolescents' self-perceived changes in the physical activity levels during the social distancing period and the classification of depressive symptoms.

Variables	LDS	IDS	p-value
<b>General PA</b>			0.004*
GPA Reduction (n; %)	43 (32.8)	88 (67.2)	
GPA Maintenance (n; %)	09 (47.4)	10 (52.6)	
GPA Increase (n; %)	21 (58.3)	15 (41.7)	
<b>Light PA</b>			0.002*
LPA Reduction (n; %)	28 (27.8)	73 (72.2)	
LPA Maintenance (n; %)	30 (53.5)	26 (46.5)	
LPA Increase (n; %)	15 (51.7)	14 (48.3)	
<b>Moderate PA</b>			0.011*
MPA Reduction (n; %)	42 (33.6)	83 (66.4)	
MPA Maintenance (n; %)	16 (44.5)	20 (55.5)	
MPA Increase (n; %)	15 (60.0)	10 (40.0)	
<b>Vigorous PA</b>			0.079*
VPA Reduction (n; %)	47 (35.1)	87 (64.9)	
VPA Maintenance (n; %)	10 (50.0)	10 (50.0)	
VPA Increase (n; %)	16 (50.0)	16 (50.0)	

*n*: participants; %: relative frequency; LDS: low depressive symptoms; IDS: increased depressive symptoms; GPA: general physical activity; LPA: light physical activity; MPA: moderate physical activity; VPA: vigorous physical activity. \*Chi-square test for linear trend.

According to Figure 1, the adjusted analyses indicated that, regardless of sex, age, and socioeconomic status, adolescents who reported a reduction in PA levels, except for VPA, presented approximately three times more chance (GPA OR:2.82; LPA OR:3.23; and MPA OR:3.44) of being classified as having increased depressive symptoms when compared to those who noticed an increase in the PA levels.



**Figure 1.** Adjusted odds ratios for increased depressive symptoms according to the adolescents' self-perceived changes in the physical activity levels during the social distancing period. GPA: General Physical Activity; LPA: Light Physical Activity; MPA: Moderate Physical Activity; VPA: Vigorous Physical Activity; Inc: Increased; Red: Reduction; Man: Maintenance.

## Discussion

This study analyzed the association between the PA's self-referred modifications during the COVID-19 pandemic and the DS in adolescent students. The results indicated that the perception of unfavorable changes regarding PA is associated with increased depressive symptoms, revealing a tendency: as PA's perceived levels decrease, DS's perception increases. After performing the adjusted analysis, adolescents who noticed a reduction in the PA levels were about three times more likely to be classified as having increased depressive symptoms.

The high percentage of adolescents who reported a reduction in VPA levels may stand as a warning to the relevance of Physical Education classes at school. Perhaps what explains such a high percentage is the students' social distancing, due to face-to-face classes suspension, with the school often being the reference environment for PA practice and, on many occasions, the most favorable and unique place where VPA is provided. The effects of the PA reduction practice, associated with the negative psychological effects occasioned by social distancing measures, may generate severe complications for young people's physical and mental health<sup>10</sup>.

In this sense, this study revealed data regarding the DS classifications among adolescents during the social distancing period, mainly among girl students. More elevated DS indicators among girls adolescents were also found in some previous studies<sup>3,17,21</sup>. However, it is important to highlight that the average scores found in this study were practically twice as high as those reported by Salle et al. (2012)<sup>22</sup>, which were also measured using the CES-D scale. Therefore, it seems that one of the social distancing effects influenced by the COVID-19 pandemic is the increase of DS among adolescents<sup>13</sup>. The decrease of the possibilities of moving freely in common areas of the city, the social interaction reduction, the

substitution of school time by idle time, and the feeling of insecurity, aroused by a global health problem, might be contributing to the increasing number of adolescents with DS.

Although current literature presents a limited number of studies that analyzed social distancing effects in PA and DS levels in the adolescent population, some pieces of research seem to corroborate the findings in this study. An Australian cohort that analyzed the changes in health and welfare of 582 adolescents observed during 22 weeks, including the pre-pandemic and pandemic periods<sup>22</sup>, presented important data. After implementing social distancing policies, there was a significant reduction in PA levels among adolescents and a reduction in happiness levels, which was assessed through questions sent monthly to the study participants' smartphones. After social distancing measures, it was found that adolescents were 38% more likely to feel unhappy. Moreover, there was an increased feeling of loneliness among young people after the pandemic, which can affect the perception of well-being and be associated with the emergence of chronic diseases<sup>22</sup>.

Although there is not yet a significant number of studies, the association between PA level reduction and worse perceptions regarding mental health during the COVID-19 pandemic seems well established. A Chinese study<sup>17</sup>, carried out with 4,898 adolescents, analyzed the PA level, sedentary behavior time, and humor changes during the COVID-19 pandemic. The results indicated that Chinese adolescents do an average of 23.4 minutes of daily MPA or VPA and spend approximately six hours a day in sedentary activities during the social distancing period. Higher levels of PA were significantly associated with fewer humor changes. Besides, according to the authors, maintaining an active lifestyle can produce positive emotional changes and contribute to fewer levels of depression in adolescents.

Corroborating with the results mentioned above, a Canadian study<sup>23</sup> that examined the impact of COVID-19 in the behavior change of 1,472 children and adolescents presented important findings regarding increased physical inactivity. Among adolescents, only 0.6% met the recommendations of PA during the isolation period. Scaling up the pandemic's effects, 2016 data by World Health Organization indicated that 23.7% of Canadian adolescents met the recommendations<sup>24</sup>. This is crucial, as the data before the pandemic related to PA's practice already concerns since most adolescents did not meet the recommendations for PA practice<sup>24</sup>. Thus, even though the present study did not analyze the students' PA level before the pandemic, from the adolescents' reports, it is possible to realize that they are less active during the social distancing period, which makes the results extremely relevant.

Moreover, the results in the current study indicated a significant reduction of all PA intensities among girls students, although it was not statistically significant for VPA. In a Brazilian study, which verified the influence of social distancing in adult PA levels during the pandemic<sup>25</sup>, the findings regarding PA's general levels corroborate this study's results. About 60% of the subjects showed a reduction in the PA level during the pandemic. Additionally, the practice of physical activity before the pandemic was strongly associated with keeping active during the social distancing period. Approximately 60% of the subjects showed a reduction in PA level during the pandemic. Besides, being physically active before the pandemic was strongly associated with staying active during the period of social distancing.

Based on this study's findings, it may be noticed how social distancing measures seem to affect adolescents' mental health. Distancing from friends and family, online studying, increased hours exposed to screens, reduced overall quality of sleep, and decreased PA levels are essential components that might directly affect this population's welfare perception and quality of life. These factors evaluation becomes relevant so that the authorities adopt measures to alleviate these issues during the upcoming months, especially in Brazil, where the expectation of having the entire population vaccinated in a short period of time is low. In addition, the post-pandemic demand increase for health services would already justify the adoption of prophylactic measures to improve adolescents' mental health.

### Strengths and limitations

Although this study presents important results regarding modifications in adolescents' PA levels and their association with DS, it is vital to point out some limitations. The first refers to the study's outline, which, because it is a cross-sectional study, does not allow establishing the temporal relations of the facts. A second limitation was the use of standardized online form, as well as a possible memory bias, due to perception information prior to the pandemic. Furthermore, the results must be analyzed with caution, as it is impossible to generalize them to the rest of the population. However, considering the reality of the pandemic and the need to respect social distancing policies, this was the most viable alternative for collecting information, reinforced by previously published studies that used similar collection strategies<sup>26</sup>.

Although many of such limitations exist because of the pandemic situation, the study also presented highly relevant data. Different studies have observed significant changes that examine PA's adolescent behavior in adolescents' lives during the social isolation period. Information such as those is crucial for developing public policies that meet the young people's needs, both during social distancing and in a future post-pandemic scenario. Moreover, this study's results may help schools and teachers outline an action plan to prepare them to welcome these adolescents that might be emotionally sensitized and in need of interventions that improve their mental health. In this sense, PA and the Physical Education teachers have a relevant role in promoting strategies that aim to improve young students' health and quality of life.

### Conclusion

Based on this study's findings, the perception of PA reduction during the COVID-19 pandemic is associated with increased depressive symptoms among adolescent students. The promotion of PA and the orientation of physical practices in alternative and safe environments are essential to minimize the physical and psychological damage caused by the pandemic.

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### Authorship Contributions

GOKC wrote the methods, discussion, and conclusion. GBC performed statistical analysis and wrote results. TWH coordinated data collection, designed the Project, and wrote introduction. GGB performed the review of the manuscript.

### Declaration of conflict of interest

The authors declare no conflict of interest.



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