Brief Report

Predictors of stress in college students during the COVID-19 pandemic

Mírian Celly Medeiros Miranda David [a,b], Gilberto Ramos Vieira [c], Lívia Maria de Lima Leôncio [c], Letycia dos Santos Neves [d], Clécia Gabriela Bezerra [c], Marina Souza Barbosa de Mattos [e], Nataly Ferreira dos Santos [b], Flávio Henrique de Santana [c], Rodolfo Barbosa Antunes [f], John Fontenele Araújo [g], Rhowena Jane Barbosa de Matos [a,b,h,*]

[a] Posgraduate Program in Neuropsychiatry and Behavioral Sciences, Health Sciences Center, Federal University of Pernambuco, Recife, Brazil
[b] Neural Plasticity, Environment and Behavior Research Group, Federal University of Recôncavo of Bahia, Santo Antônio de Jesus, Brazil
[c] Physical Education and Sports Science Nucleus, Academic Center of Vitória, Federal University of Pernambuco, Vitória de Santo Antão, Brazil
[d] Nutrition Nucleus, Academic Center of Vitória, Federal University of Pernambuco, Vitória de Santo Antão, Brazil
[e] Department of Physiotherapy, State University of Paraíba, Campina Grande, Brazil
[f] Department of Mathematics, Center of Exact and Natural Sciences, Federal University of Pernambuco, Recife, Brazil
[g] Department of Physiology, Federal University of Rio Grande do Norte, Natal, Brazil
[h] Health Sciences Center, Federal University of Recôncavo of Bahia, Avenida Carlos Amaral, 1015, Cajueiro, Santo Antônio de Jesus, Bahia 44574-490, Brazil

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ABSTRACT

Background: College students experience high stress levels during emergency remote classes in the COVID-19 pandemic. However, it is not clear whether this is due to the summation effect of both stressors (classes and pandemic). Therefore, the aim of this study was to investigate predictors of stress in college students before and during remote classes five months after the beginning of the COVID-19 pandemic.
Methods: The study was conducted before (BRC, July-August 2020) and during remote classes (DRC, October-November 2020). The sample consisted of 177 individuals (80 in BRC, 97 in DRC). Students were asked to self-collect saliva for cortisol analysis at each moment of the study, and to fill out a form to characterize the individual and assess the chronotype (Morningness-Eveningness Questionnaire), sleep quality (Pittsburgh Sleep Quality Index) and the stress (Perceived Stress Scale–10).
Results: There was no difference between the evaluated periods for cortisol, perceived stress or sleep quality. Predictors for cortisol levels were gender, academic semester, chronotype, sleep quality and sadness due to pandemic ($p < 0.001$).
Limitations: Short interval between BRC and DRC assessments of perceived stress and salivary cortisol.
Conclusions: Age, sex, income, academic semester, chronotype, and the impact of the pandemic on mood are predictors of stress among college students. In addition, emergency remote classes and sleep quality contribute to less perceived stress.

1. Introduction

The transmission of coronavirus disease 2019 began in the city of Wuhan in China at the end of 2019. With the rapid expansion of the virus around the world, the World Health Organization declared it to be a pandemic, which took place throughout 2020 and continues to the present day, adding up to millions of deaths (WHO, 2021). In the midst of this scenario, countries differed in terms of strategies to combat the virus, as well as in the speed and effectiveness of implementing these strategies. Brazil has adopted partial social distancing measures since March 2020 (although it was not homogeneous among the states), one of which was the substitution of presential classes to remote classes (Brazilian Ministry of Health, 2021). This led to the need for sudden changes in the organization of schools and universities, in the teaching patterns, as well as in students' study habits.

In this scenario, college students are suffering the most among students, as they generally need practical classes (Wilcha, 2020). In addition, there is the fear of impairment in learning, guilt/embarrassment of

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not being able to follow remote classes with quality equipment, the uncertainty of when the situation will normalize and insecurity about when they will enter the job market (Rizvi and Nabi, 2021). Such factors end up making college students more susceptible to emotional and affective disorders, which in turn can also compromise learning, as well as the perception of stress (Batra et al., 2021).

Several studies have pointed to stress among college students, however, the studies available in the literature have cross-sectional designs (Fawaz and Samaha, 2021; Mridul et al., 2021), showing only the punctual impact of remote classes. In addition to remote learning, factors such as sleep (Ulrich et al., 2021), sedentary lifestyle (Alzahrani et al., 2021), social distancing (Marroquín et al., 2020) and other individual characteristics such as age, gender and economic status (Xiong et al., 2020; Fu et al., 2021) may contribute to stress in college students.

Therefore, there is a need to understand whether social distancing, sleep, sedentary lifestyle, emergency remote classes, and socioeconomic characteristics have had additional effects on stress levels during the pandemic moment. In addition, if there is a change in hormonal stress indicators in college students. This type of analysis has already been carried out with frontline health professionals (Çalık et al., 2020), residents in anesthesiology (Kurniawan and Utariani, 2021) and young adults in general (Baliyan et al., 2021). Therefore, we aimed to investigate predictors of stress in college students before and during remote classes five months after the beginning of the COVID-19 pandemic.

2. Methods

This is an analytical and cross-sectional study carried out in two moments: before remote classes (BRC, July to August 2020) and during the implementation of remote classes (DRC, October to November 2020). The sample consisted of college students from public institutions (State University of Paraíba and Federal University of Pernambuco). It included college students of both genders aged between 18 and 30 years old, living in the cities of Campina Grande in Paraíba; Recife, Surubim and Vitória de Santo Antão in Pernambuco. To better understand the impact of the abrupt change to remote learning, the students included in BRC had their classes interrupted for almost five months due to the pandemic. On the other hand, college students included in DRC were in the first semester of implementing remote classes. Individuals from the last year of the undergraduate course were excluded (to eliminate specific stressors from the last year, avoiding biases in the results), as well as individuals with presential or night work, dysfunctions or substance ingestion which would interfere in the evaluated measures or diagnosis of psychiatric disorders. The study was approved by the Ethics and Research Committee of the Federal University of Pernambuco (protocol: 32360720.4.0000.5208). Students were recruited through digital media at each research moment and participated in the study at both times, if they were interested. They were asked to self-collect saliva and fill out a Google form to characterize the individual, trace the chronotype, sleep quality, impact of the pandemic on mood and assess the perceived stress level according to the following instruments:

Horne & Ostberg Morningness-Eveningness Questionnaire - it was used to assess the individual's chronotype based on 19 questions about the moments of preference for sleeping and for performing common activities (Horne and OStberg, 1976). As the chronotype is a genotypic characteristic of the individual, this evaluation was performed only once.

Pittsburgh Sleep Quality Index (IQSP) – it assesses sleep quality through 19 questions. The higher the score, the worse the sleep quality, with results >5 points indicating poor sleep quality (Buysse et al., 1989).

Impact of pandemic on mood – two statements were selected from the Fear of Progression Questionnaire (Herschbach et al., 2005) and adapted to the pandemic context: 1. "I get anxious if I think the COVID-19 pandemic could get worse"; 2. "The concerns about the COVID-19 pandemic took the joy out of my life". The responses were grouped into two categories: "never to sometimes" and "often to very often".

Perceived Stress Scale - 10 (PSS-10) - it measures the perceived stress by individuals (Dias et al., 2015). It consists of 10 items related to the last 30 days in which the higher the score, the greater the stress. This evaluation was carried out at both times of the study.

Salivary cortisol analysis - a saliva collection tube containing sterilized cotton was delivered to each individual in their residence so they could self-collect the next day. Participants were instructed to perform the collection 30 min after waking up, being encouraged to wake up at 8am to perform the collection at 8:30 am; despite this, a tolerance interval for collection between 5am and 9am was accepted (Pruessner et al., 2003). For the collection, the individuals were instructed to chew the cotton roll of the collection tube for two minutes in order to completely soak it with saliva. Then, they launched the cotton roll directly into the collection tube, without manipulating the material to avoid contamination. The samples were frozen until the ELISA (enzyme-linked immunosorbent assay), which was performed according to the manufacturer's instructions (IBL International, Hamburg, Germany). This measure was collected in the two study moments.

The results are expressed as mean, standard deviation, percentage and/or absolute numbers. The Kolmogorov-Smirnov normality test was applied. The Student's *t*-test was used for paired and unpaired analysis of two groups when the data were parametric. One-way ANOVA with Tukey's post hoc was applied in the analysis of more than two groups. Furthermore, the Wilcoxon and Mann-Whitney tests were used for paired and unpaired analysis of two groups for non-parametric data, respectively. The Kruskal-Wallis test with Dunn's post hoc was applied to non-parametric data with more than two groups. The significance level was set at $p < 0.05$.

Generalized linear models were used, as an explorative analyses, to determine an equation for the prediction of cortisol values and perceived stress (PSS-10) considering the time of assessment (BRC and DRC), as well as regarding age, gender, monthly income, academic semester, physical exercise, social distancing, chronotype, sleep quality and state of anxiety and sadness in relation to the pandemic. To validate the variables in the model, the Wald Chi-Square test was used, using a p value < 0.05 as the minimum statistical significance value. Statistical analysis was performed using the Statistical Package for Social Science (SPSS) v.20.

3. Results

The sample initially consisted of 203 college students (95 in BRC, 108 in DRC), but three individuals were excluded in BRC for incorrectly collecting the saliva sample, as well as 12 in BRC and 10 in DRC for reporting a diagnosis of anxiety or depression. Another individual was excluded from the analyzes for not answering all the research tests. Therefore, the sample culminated in 177 individuals (BRC, $n = 80$; DRC, $n = 97$), with 56 individuals participating in the two study moments. There was an age of 21.5 ± 2.3 years in BRC and 22.0 ± 2.2 years in DRC and a predominance of females (73.7% in BRC, 76.3% in DRC). For undergraduate courses, 95.0% were students in the health area in BRC and 92.8% in DRC. In BRC, 62.5% of individuals were enrolled between the first and fourth academic semesters, while this percentage decreased to 57.7% in DRC.

Individuals of the intermediate chronotype were predominant in both study moments (48.7% in BRC, 41.8% in DRC). In BRC, 43.7% said they practice physical exercise regularly; this percentage increased to 87.6% in DRC. In contrast, 98.7% reported practicing social distancing (only leaving home for essential activities) in BRC, but there was a reduction in DRC to 39.2%. The median value of the number of people they lived with was 3 people at both moments (ranging from zero to nine individuals). Regarding income, 60% had more than 2090.00 Brazilian reais per month in BRC and 50.5% in DRC.

There was no statistical difference in the levels of cortisol (Paired *t*-test, $n = 56$), perceived stress and quality of sleep (Wilcoxon test, $n = 56$) between BRC and DRC ($p > 0.05$). Furthermore, there was no difference

between cities for the variables of salivary cortisol and perceived stress (Kruskal-Wallis test with Dunn's post hoc; BRC, $n = 80$; DRC, $n = 97$; $p>0.05$). In addition, there was no difference in cortisol levels regarding the salivary collection time (Kruskal-Wallis test with Dunn's post hoc; BRC, $n = 80$; DRC, $n = 97$; $p>0.05$). As for the impact of the pandemic on mood, 47.5% presented an anxious state due to the pandemic often to very often in BRC, while this percentage decreased to 8.3% in DRC. Regarding the sadness state due to the pandemic, only 10% were often to very often sad in BRC, and 7.2% in DRC.

When evaluating the predictive factors for cortisol levels (through generalized linear model; BRC, $n = 80$; DRC, $n = 97$), being male (Beta=−0.144, Wald Chi-Square=6.090, $p<0.05$) and earlier academic semesters (Beta=−0.030, Wald Chi-Square=4.014, $p<0.05$) were associated with higher cortisol levels. Being of the morning chronotype was also associated with higher cortisol levels (Beta=0.005, Wald Chi-Square=5.944, $p<0.05$). On the other hand, it was found that decreasing sleep quality (Beta=−0.018, Wald Chi-Square=4.990, $p<0.05$) and the sadness state due to pandemic (Beta=−0.200, Wald Chi-Square=5.170, $p<0.05$) were predictors of lower cortisol levels. The remote classes, in turn, did not influence the cortisol levels ($p<0.05$) (Table 1).

As for the predictors of perceived stress (analyzed through generalized linear model; BRC, $n = 80$; DRC, $n = 97$; Table 2), attending remote classes (DRC, Beta=−3.959, Wald Chi-Square=17.671, $p<0.001$) and being older (Beta=−0.677, Wald Chi-Square=10.526, $p<0.01$) were associated with less stress. Contrary to what was verified in terms of cortisol, reduced sleep quality was associated with greater perceived stress (Beta=1.013, Wald Chi-Square=40.761, $p<0.001$). Less frequent anxious state due to pandemic (Beta=−3.520, Wald Chi-Square=12.280, $p<0.001$) and being male (Beta=−6.768, Wald Chi-Square=34.399, $p<0.001$) were predictors of higher perceived stress.

On the other hand, having lower income was a predictor of lower perceived stress (Beta=2.031, Wald Chi-Square= 4.336, $p<0.05$).

The other variables: number of people they live with, social distancing and physical exercise were not associated with cortisol levels or perceived stress ($p>0.05$).

4. Discussion

Based on the results obtained, emergency remote teaching was not associated with cortisol levels, but it contributed to a lower perceived stress among college students during the pandemic. Chronotype, academic semester and sadness state due to pandemic were associated with cortisol levels but not with perceived stress. On the other hand, age, income and anxious state due to pandemic were predictors of perceived stress but not for cortisol levels. Sleep quality and gender, in turn, were associated with both cortisol levels and perceived stress.

Prior to the pandemic, studies already pointed to stress among college students, since it is a population with a high study load, lots of responsibilities and important decisions to be made that will have repercussions throughout their lives (Saleh et al., 2017). Some factors were associated with stress in college students before the pandemic, such as self-esteem (Saleh et al., 2017), self-efficacy (Han, 2005), neuroticism (Vollrath, 2000), life satisfaction, gender (Karaman et al., 2019), problem-focused coping, anxiety, and support (Renk and Smith, 2007). It had also been found that cortisol levels vary according to coping strategies (Sladek et al., 2016), sleep quality (Suh, 2018) and college year (Manigault et al., 2018). However, the present study contributes to the literature, bringing data related to a particular stressful moment in history and of great repercussion, which is the COVID-19 pandemic.

Table 1

Linear regression analysis for predictors of stress in college students during the COVID-19 pandemic according to cortisol levels.

Parameter	Beta	Std. Error	95% Wald Confidence Interval		Hypothesis Test		
			Lower	Upper	Wald Chi-Square	Sig.	
(Intercept)	.631	.2724	.097	1.165	5.361	.021	
Age	.006	.0106	−0.015	.026	.295	.587	
Gender							
Male#	−0.144	.0584	−0.259	−0.030	6.090	.014*	
Female§							
Income							
< 2090.00 Brazilian reais/month#	−0.007	.0494	−0.103	.090	.018	.893	
> 2090.00 Brazilian reais/month§							
Number of people they live with	.010	.0180	−0.025	.046	.333	.564	
Academic semester	−0.030	.0152	−0.060	−0.001	4.014	.045	
Social distancing							
No#	−0.060	.0871	−0.230	.111	.469	.494	
Yes§							
Physical exercise							
No#	−0.027	.0479	−0.121	.067	.310	.578	
Yes§							
Chronotype (HO-MEQ)	.005	.0023	.001	.010	5.944	.015	
Sleep quality (PSQI)	−0.018	.0080	−0.034	−0.002	4.990	.025	
Anxious state due to pandemic							
Never to sometimes#	−0.012	.0509	−0.112	.088	.054	.816	
Often to very often§							
Sadness state due to pandemic							
Never to sometimes#	−0.200	.0879	−0.372	−0.028	5.170	.023*	
Often to very often§							
Study moment							
Before remote classes#	.010	.0477	−0.084	.103	.043	.835	
During remote classes§							
(Scale)	.091	.0096	.074	.112			

$N = 177$. Std.= Standard; df= degree of freedom; Sig.= significance; #= dichotomous covariate analyzed as 0; §= dichotomous covariate analyzed as 1; HO-MEQ= Horne & Ostberg Morningness-Eveningness Questionnaire (higher scores of this instrument indicate more morning chronotype, while lower scores indicate more evening chronotype); PSQI= Pittsburgh Sleep Quality Index (higher scores of this instrument indicate lower sleep quality). The analysis was performed using generalized linear models.

  * $p<0.05$.

Table 2
Linear regression analysis for predictors of stress in college students during the COVID-19 pandemic according to perceived stress.

Parameter	Beta	Std. Error	95% Wald Confidence Interval		Hypothesis Test		
			Lower	Upper	Wald Chi-Square	Sig.	
(Intercept)	34.157	5.3813	23.610	44.705	40.290	.000	
Age	−0.677	.2086	−1.086	−0.268	10.526	.001**	
Gender							
Male#	−6.768	1.1540	−9.030	−4.506	34.399	.000***	
Female§							
Income							
< 2090.00 Brazilian reais/month#	2.031	.9755	.119	3.943	4.336	.037*	
> 2090.00 Brazilian reais/month§							
Number of people they live with	.318	.3560	−0.380	1.016	.797	.372	
Academic semester	−0.521	.3001	−1.110	.067	3.017	.082	
Social distancing							
No#	−0.557	1.7211	−3.930	2.816	.105	.746	
Yes§							
Physical exercise							
No#	.270	.9460	−1.585	2.124	.081	.776	
Yes§							
Chronotype (HO-MEQ)	−0.002	.0445	−0.090	.085	.003	.956	
Sleep quality (PSQI)	1.013	.1586	.702	1.324	40.761	.000	
Anxious state due to pandemic							
Never to sometimes#	−3.520	1.0045	−5.489	−1.551	12.280	.000***	
Often to very often§							
Sadness state due to pandemic							
Never to sometimes#	.154	1.7361	−3.249	3.556	.008	.929	
Often to very often§							
Study moment							
Before remote classes#	−3.959	.9419	−5.806	−2.113	17.671	.000***	
During remote classes§							
(Scale)	35.329	3.7554	28.685	43.513			

$N = 177$. Std.= Standard; df= degree of freedom; Sig.= significance; #= dichotomous covariate analyzed as 0; §= dichotomous covariate analyzed as 1; HO-MEQ= Horne & Ostberg Morningness-Eveningness Questionnaire (higher scores of this instrument indicate more morning chronotype, while lower scores indicate more evening chronotype); PSQI= Pittsburgh Sleep Quality Index (higher scores of this instrument indicate lower sleep quality). The analysis was performed using generalized linear models.

* $p<0.05$,.
** $p<0.01$,.
*** $p<0.001$.

The association verified between chronotype and salivary cortisol was not observed for perceived stress. Chronotype is a relatively stable characteristic of individuals and is influenced by genetic factors (Jones et al., 1999). Previous studies corroborate our findings of higher cortisol levels near awakening among morning individuals when compared to evening ones (Kudielka et al., 2006; Griefahn and Robens, 2008; Randler and Schaal, 2010). Several circadian rhythms peak earlier in morning than in evening individuals, as occurs with melatonin secretion (Henry-Benítez et al., 2013), body temperature (Bailey and Heitkemper, 2001) and blood pressure (Nebel et al., 1996). The low release of cortisol when waking up would probably be involved with the difficulty of evening individuals to perform their activities in the early hours of the day. With this, it can be assumed that students with an evening chronotype would be waking up before the ideal time for their organism, which could impair their academic performance (Montaruli et al., 2019).

Contrary to expectations, worse sleep quality and more frequent sadness state due to pandemic were predictors of lower cortisol levels. One of the possibilities would be the homeostatic adaptation to stress (Hannibal and Bishop, 2014). Furthermore, adapted cortisol levels may indicate a state of resilience of the participants (García-León et al., 2019). On the other hand, students from earlier academic semesters had higher levels of cortisol, probably because they were more uncertain about when they would graduate and enter the job market (Manigault et al., 2018; Rizvi and Nabi, 2021).

On the other hand, when analyzing the predictors for perceived stress, there was no association with the sadness state, but the anxious state due to pandemic was a predictor. Therefore, the higher frequency of anxious state due to pandemic was one of the predictors for lower perceived stress in individuals. Probably, individuals with greater concerns about the pandemic could reframe other stressful situations they go through on a daily basis. This suggests that other factors could be interfering with the perception of stress among college students, such as the adoption of coping strategies (Rotas and Cahapay, 2021).

Sleep quality was also a predictor of perceived stress, but with a response inversely proportional to that observed in the cortisol data. Better sleep quality was a predictor of lower perceived stress. Therefore, the present study corroborates Stanton et al. (2020) and Benham (2020) who found that poorer sleep quality is associated with worse symptoms of perceived stress and other mood alterations in college students and the general population. Thus, sleep hygiene strategies could benefit college students (Enright and Refinetti, 2017).

Regarding socioeconomic variables, these were also predictors of the perceived stress of college students. Being younger was a predictor of greater perceived stress, corroborating findings by Xiong et al. (2020). It shows that they are more sensitive to changes in the environmental context. Regarding gender, females had lower levels of perceived stress and cortisol levels, contrary to what was found in previous studies (Xiong et al., 2020; Fawaz and Samaha, 2021). In addition, lower income was not expected to be a predictor of less perceived stress, because the need for technological adaptation for remote classes is an additional worrying factor (Wilcha, 2020; Rizvi and Nabi, 2021). These unexpected results could have been due to more effective coping strategies applied by women and lower income students after the start of the pandemic, such as problem focused coping, emotion focused coping, avoidant coping and socially supported coping (Fluharty and Fancourt, 2021). These points are important to be observed since individuals with high resilience can resist the psychosocial influences of major events, using

coping strategies (Southwick et al., 2015

Finally, another predictor of perceived stress was the second study moment (during remote classes). Aguilera-Hermida (2020) had found that college students preferred face-to-face learning over online learning. Other studies also found challenges of emergency remote classes for college students such as technical challenges, inadequate home environment and excessive screen-time (Wilcha, 2020; Rizvi and Nabi, 2021). However, the present study suggests that there was a contribution to the reduction of perceived stress. We hypothesize that the remote classes would provide the achievement of a routine, which could have favored a regular sleep-wake cycle, times for meals, and the students' social interaction. In addition, remote classes could have reduced the insecurity of college students about their professional future, due to the resumption of regular daily studies, even during the pandemic.

Through the obtained results, we were able to analyze predictors for the stress of college students in relation to the stress perception and cortisol levels. Although there have been studies prior to the pandemic in this area (Vollrath, 2000; Han, 2005; Renk and Smith, 2007; Sladek et al., 2016; Saleh et al., 2017; Suh, 2018; Manigault et al., 2018; Karaman et al., 2019), the present study investigated stress predictors at an atypical time, but one of great challenge for society. The pandemic was and is a factor that has changed the habits of our society and caused several behavioral changes such as less social interaction (Marroquín et al., 2020), economic difficulties (Xiong et al., 2020; Fu et al., 2021), unpredictability of the future (Rizvi and Nabi, 2021), and insecurity about our own health and the health of our family and friends (Yang et al., 2021). College students are an investment of society for the future (Saleh et al., 2017), thus knowing the predictors of their stress at a time like the COVID-19 pandemic helps to prevent or reduce the stress of college students in similar situations in the future.

5. Limitations

As study limitations, we can point to the short interval between the assessments in BRC and DRC of perceived stress and salivary cortisol. Perhaps a longer period between evaluations would demonstrate the cumulative effect of stress on cortisol levels and even on perceived stress. The fact that physical exercise was analyzed as a dichotomous variable could have superficialized the findings, requiring more in-depth questions such as the intensity and frequency of physical exercise. Another limitation of the study is that salivary collection was only performed at one time of the day, requiring further studies with systematic collections at various times throughout the day and on more days of the week to deepen knowledge about this variable. Despite these limitations, the present study points out some predictors of cortisol levels (chronotype, sleep quality, sadness due to pandemic, gender and academic semester) and perceived stress (remote classes, sleep quality, anxious state due to pandemic, age, gender, and monthly income). This encourages the development of new studies to deepen knowledge about the mechanisms behind these associations, and to develop strategies to prevent mood and sleep disorders in college students during remote classes due to the pandemic and in similar situations in the future.

6. Conclusion

The results suggest that the analyzed college students adapted to emergency remote classes, so that such stimulus was not enough to change their cortisol levels. However, there are predictors of stress, such as age, gender, income, chronotype and the impact of the pandemic on mood. In addition, emergency remote classes and sleep quality contribute to less perceived stress among college students.

Declaration of Competing Interest

The authors declare no conflict of interests related to this study.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jadr.2022.100377.

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