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RESEARCH ARTICLE

Impact of the COVID-19 Lockdown on Food Habits, Body Weight, and Physical Activity in School-Aged Students

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Abstract
The COVID-19 pandemic, caused by the SARS-CoV-2 virus, represents a significant health crisis, particularly affecting individuals' physical and mental well-being across all ages, especially students. This study seeks to assess how the COVID-19 lockdown affected food consumption, body weight, physical activity, and sleep patterns among Algerian students. A cross-sectional survey was conducted with 128 students, averaging 17.99 years old, featuring questions on demographics, body measurements, food habits, and lifestyle changes during the lockdown. Data analysis was performed using SPSS version 23, employing methods such as the Student's t-test, Spearman's correlation, and the Chi-square test to describe the results. Findings revealed a notable disparity in overweight rates ($p<0.001$), with females at 25.93% and males at 10.64%. Furthermore, 29.63% of females reduced their food intake, while 34.04% of males increased theirs ($p=0.003$). During the lockdown, 23.46% of females gained weight, contrasting with 35.8% who lost weight. There were notable and statistically significant differences between the sexes, with $p<0.001$. Physical activity levels were 17.19% higher on school days compared to during the lockdown. Sports activity and walking durations were significantly greater for males than females ($p<0.001$). Conversely, the mean sleep duration of students during the COVID-19 lockdown was 7.33±1.16 hours, with significant differences observed between sexes ($p<0.001$) These findings provide a valuable foundation for future research exploring the impact of COVID-19 on populations. They offer insights that may inform policy-making, public health strategies, and further academic studies.

Keywords
COVID-19, Food Intake, Sports Activities, Students, Body Weight, Sleep Duration

INTRODUCTION

The first detection of COVID-19 was in Wuhan, China, at the end of December 2019. This virus was quickly spread and exported to the globe in March 2020, and it was declared a pandemic by the World Health Organization (Villani et al., 2021: Dolaş & Toptaş Demirci, 2023). Algeria was the most severely impacted country in Africa, following South Africa, Egypt, and Morocco. On March 23rd, 2020, according to the Algerian health minister's declaration, phase 3 was started with 2718 cases and 384 deaths (Lounis, 2021). During this period, the daily life and education sectors were disturbed by the COVID-19 pandemic (Schröpfer et al., 2021). To ensure the smooth running of studies, teachers and students have used social platform sites (such as Facebook, Instagram, YouTube,

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WhatsApp, and Twitter) and educational online platforms (Ghounane, 2020). However, the online teaching methodology used to ensure physical distancing and stop the spread of the virus can result in depression and anxiety (Schröpfer et al., 2021).

Stress can be caused by a variety of factors, including the environment or a person's internal perception. It can produce anxiety with or without other negative emotions and feelings, like depression, sadness, and pain, with the development of potential psychological disorders (Shahsavarani et al., 2015). Stress can be classified into two types: episodic acute stress and chronic acute stress. The first one is a recurring type of stress that happens over and over. The second can be thought of as never-ending stress that relentlessly wears on you. It can appear due to situational responses and circumstances beyond your control, such as poverty or a toxic job. Persons feeling chronic acute stress require help because it can affect human health, causing heart problems, strokes, or even cancer (Hena et al., 2020).

Students lives are accompanied by stress, which can affect their lives and also their academic performance (Edjah et al., 2020; Kaya & Demirci, 2024). Sometimes, minimal stress can generate positive student results; however, uncontrolled stress can induce a negative effect on health. A previous study reported that female students were more influenced by academic stress than male students (Rana et al., 2019). Furthermore, stress can increase appetite and craving, disturb sleep, and decrease physical activity. The presence of these factors plays a key role in weight gain and obesity (Geiker et al., 2018). It was reported that the increase or decrease in energy intake was related to the severity of stressors, sex, and other factors.

Physical activity can be very beneficial in the event of a pandemic and in the prevention of infectious diseases (Chastin et al., 2021). Sport or exercise can have a positive or negative impact on the immune system, depending on the type of workout, intensity, and duration. Moderate exercise seems to help compensate for the negative effects that aging has on the immune system (Forte et al., group, and by twenty-five students from the same school before the inclusion phase. In addition, face-to-face interviews were conducted by members of research groups highly experienced in conducting interviews (Figure 1). The survey was distributed to all students present at the high school (128 students). The designers of this questionnaire 2022). It is suggested that physical activity can improve vaccine response; therefore, acquired immunity may be higher in an active population (Chastin et al., 2021). Recently, it has been demonstrated that COVID-19 can decrease mobility, walking, and physical activity, and increase sedentary behavior (Park et al., 2022). Thus, this study aimed to explore how the COVID-19 lockdown influenced food intake, body weight, physical activity, and changes in sleeping habits among high school students preparing for the baccalaureate exam.

MATERIALS AND METHODS

Participants

This survey was done at the high school of Colonel Ali Tounsi in the center of Relizane (Northwest Algeria) between April, 8th to 15th, 2021 during the COVID-19 lockdown period. The study included only students in the third year (preparing for the baccalaureate exam) from both sexes (Male and Female) with a mean of age 17.99±0.89 years old. A total of 128 students, comprising 81 females and 47 males, participated in this study, accounting for 92% of the 139 students subscribed to the third year.

Study Design

In this cross-sectional study, a survey questionnaire was prepared to collect information about students. Subjects were voluntarily enrolled and had given their consent to participate. The data was collected through face-to-face interviews with students. It was divided into four parts; part 1: demographic and general information (age, sex); part 2: anthropometry parameters (body weight, height, waist, and hip); part 3: food intake (food intake frequency, effects of COVID-19 lockdown, and stress baccalaureate on food intake); and part 4: physical activity (sports activity, number of sessions per week, walking daily duration, and number of sessions per week.) and sleeping (sleep duration). The developed questionnaire was checked for comprehension, validity, and reliability, pre-tested by all members of the research (Authors) excluded from this study, students with: i). eating disorders (Inherited obesity, Anorexia nervosa, Bulimia Nervosa, etc.), ii). physical restrictions and iii). other pathologies treated with medications that could interfere with eating or physical activity. The study team coded the data, added it to the database, and then verified, updated,

and validated it. The use of all information was used anonymously, and all data was kept private.

Research Procedure

The preparation phase includes securing research permits from the Department of Education and the school, along with organizing essential tools and equipment like digital scales and a stadiometer. Following this, a briefing is held for the research assistants responsible for data collection. The data collection process involves measuring and recording each student's weight, height, waist circumference, and hip circumference in rotation. Furthermore, the assistants document details about students' food intake, body weight, physical activity, and sleep patterns.

Collection of Data Anthropometry

A calibrated balance was used to measure body weight to the nearest 100 g (Terraillon, Croissy-sur-Seine, France). Standing height was measured in centimeters using a studio meter positioned on a wall. The circumferences of the waist and hips were measured to the nearest 1 mm using a 0-220 cm measuring tape. The circumference of the waist was measured at mid-height between the lower rib and the iliac crest, while the circumference of the hip was measured at the highest circumference around the buttocks. Body mass index (BMI) was calculated by dividing the weight (in kilograms) by the height squared (in meters squared) (Hadri et al., 2024; WHO, 2024; Yusuf et al., 2024). Corpulence was defined as underweight (BMI < 18.0 kg/m2), normal (BMI = 18.5-24.9 kg/m2), overweight (BMI = 25.0-29.9 kg/m2), and obese (BMI ≥ 30.0 kg/m2), according to the BMI values.

Food Intake And Body Weight Data

As shown in Figure 1, food intake was evaluated by the student's declaration of normal, an increase or a decrease under COVID-19 lockdown and baccalaureate stress. Students were asked to report any changes in their food intake compared to their usual dietary habits before the COVID-19 lockdown and during the period of baccalaureate. The body weight evolution during the COVID-19 lockdown was also recorded using three situations: lost weight, gained weight, and no change (or stable body weight). Participants were asked to select the situation that best represented them before and during the stage of confinement and during the period of baccalaureate. Students were able to discern any changes in their body weight before and after the confinement period by participating in physical activity sessions, during which they had several opportunities throughout the school year to measure their weight.

Physical Activity and Sleeping Data

Physical activity during lockdown (sports activity, number of sessions per week, walking daily duration, and number of sessions per week) was evaluated by the student's self-declaration using modified (Hadri et al., 2022; Romero-Blanco et al., 2020). Furthermore, we assessed sleep quality and duration using specific questions selected from the Pittsburgh Sleep Quality Index Questionnaire (Luciano et al., 2021).

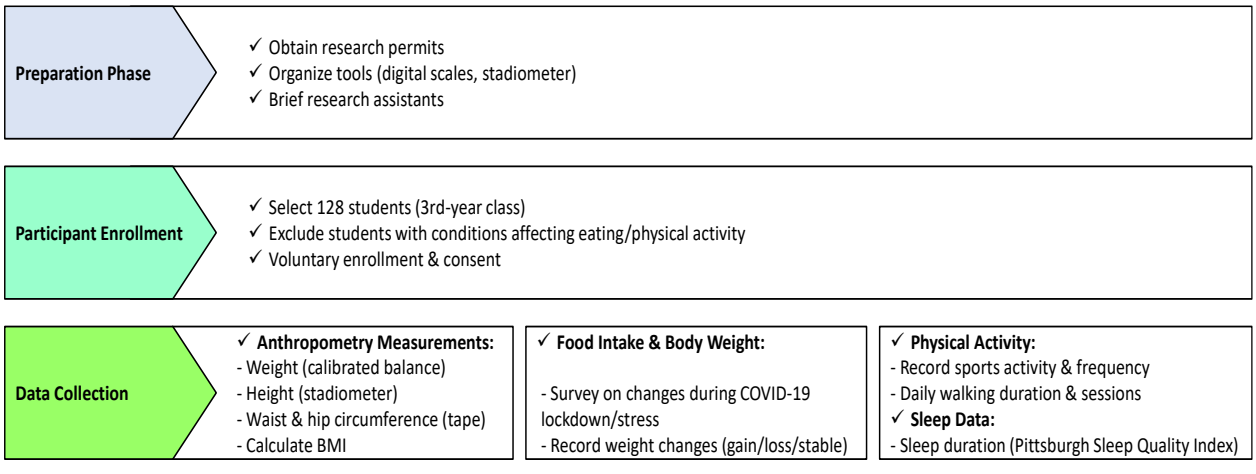

Figure 1. Research procedure flowchart: assessing the impact of COVID-19 on student health and behavior

Statistical Analysis

The data were represented by mean ± SD (standard deviation), percentage, and frequency. When the conditions of normality and homogeneity of the variances were observed using Shapiro-Wilk's test, means were compared between males

and females using a student's t-test for anthropometry indicators (weight, height, BMI (total and for the four categories separately: underweight, normal weight, overweight, and obese), waist and hip circumferences), physical activity (sports activity, walking daily duration), and sleeping (sleep duration). Relationships between body weight and physical activities were evaluated by the calculation of Spearman's correlation coefficient. The chi-square test was used to compare between percent and frequency (food intake, body weight variation, and physical activity). All data analyses were carried out using SPSS software (IBM SPSS Statistics, Version 23.0. Armonk, NY, USA). The level of significance was fixed at $p<0.05$.

RESULTS

Table 1: Anthropometry of students by sex during the pandemic

Parameters	Total (N=128)	Female (N=81)	Male (N=47)	p-value
Anthropometry (Mean ± SD)				
Weight (kg)	60.05 ± 10.19	58.43 ± 9.72	62.84 ± 10.48#	<0.001
Height (m)	1.67 ± 0.09	1.62 ± 0.06	1.75 ± 0.08#	<0.001
BMI (kg/m²)	21.64 ± 3.43	22.28 ± 3.42	20.55 ± 3.19#	<0.001
Waist circumference (cm)	76.88 ± 8.56	75.94 ± 8.81	78.5 ± 7.94#	<0.001
Hip circumference (cm)	94.51 ± 7.72	94.29 ± 6.98	94.88 ± 8.92#	<0.001

N: sample size; SD: Standard Deviation; BMI: Body mass index; # indicates a significant difference between males and females (Students t-test, $p<0.05$).

Table 2: BMI weight status categories of students during the pandemic

BMI weight status categories	Total (%)	Female (%)	Male (%)	p-value
Underweight : <18.5 kg/m²	18.75	13.58	27.66#	<0.001
Normal weight : 18.5-24.9 kg/m²	60.16	59.26	61.7#	<0.001
Overweight : 25-29.9 kg/m²	20.31	25.93	10.64#	<0.001
Obese : ≥ 30 kg/m²	0.78	1.23	0	/

BMI: Body mass index; # indicates a significant difference between males and females (Students t-test, $p<0.05$).

COVID-19 Lockdown Stress Period and Food Intake

According to the data provided by the questionnaire, the daily number of students' meals during the COVID-19 lockdown was 1.89±1.2 meals. The mean number of meals consumed by males was higher than for females ($p<0.001$), which represented 2.15±1.4 and 1.74±1.1 meals per day, respectively. During the COVID-19 lockout, 26 (20.31%) out of the total students included (128 students) claimed a reduction in their food intake, and the number of students who declared an increase in their food intake was 35 (27.34%), while 67 students (52.34%) had a stable food intake. According to statistical analysis, the impact of COVID-19 stress on food intake varied by sex ($p=0.003$, table 3). Female students decreased their food intake more than males students, which is represented by the rates of 29.63% vs. 4.26%, respectively. A higher rate of increase in food intake was observed in males compared to females (34.04% vs. 23.46%, respectively).

Impact of COVID-19 Lockdown on Body Weight

An important change in body weight showed during the COVID-19 lockdown compared to the period before the COVID-19 lockdown ($p<0.001$, table 4). Female students were more affected by the change in their body weight. The weight gain was reported at a rate of 35.8%. However, 23.46% of females had lost weight, while 40.74% of females had a stable weight. Except for one male student who declared weight loss, the body weight of males seems not to have been affected by the COVID-19 lockdown.

Table 3: Effect of the COVID-19 lockdown and baccalaureate stress on food intake

	Food intake during COVID-19 lockdown N (%)			
	Decrease	**Increase**	**No change**	**p-value**
Female	24 (29.63%)	19 (23.46%)	38 (46.91%)	0.003*
Male	2 (4.26%)	16 (34.04%)	29 (61.7%)	
Total	26 (20.31%)	35 (27.34%)	67 (52.34%)	

N: Sample size; *: Indicate a significant difference between males and females (Chi-square test, p<0.05).

Table 4: Body weight variation during COVID-19

	Lost weight	**Gained weight**	**No change**	**p-value**
Female N (%)	19 (23.46%)	29 (35.8%)	33 (40.74%)	<0.001*
Male N (%)	1 (2.13%)	0	46 (97.87%)	
Total N (%)	20 (15.63%)	29 (22.66%)	79 (61.72%)	

N: sample size; *: Indicate a significant difference between males and females (Chi-square test, p<0.05).

Table 5: Physical activity and sleeping duration during COVID-19 lockdown

	Total	**Female**	**Male**	**p-value**
Duration of sports activity (hour)*	1.01±0.64	0.64±0.29	1.36±0.69#	<0.001
Duration of walking (hour/day)**	0.47±0.29	0.46±0.24	0.5±0.36#	<0.001
Frequency of sports activity (Session/week)				
	1 session	**2 sessions**	**3 sessions**	**More**	**p-value**
Female	22	8	2	1	<0.001##
Male	7	12	9	6	
Total	29	20	11	7	
Physical activity under the COVID-19 lockdownN (%)**				
	Increase	**Decrease or no change**		
Female	40 (49.38%)	41 (50.62%)		
Male	26 (55.32%)	21 (44.68%)		
Total	66 (51.56%)	62 (48.44%)		
Physical activity during the school yearN (%)**				
	Increase	**Decrease or no change**		
Female	52 (64.2%)	29 (35.8%)		
Male	36 (76.6%)	11 (23.4%)		
Total	88 (68.75%)	40 (31.25%)		

N: sample size. * Data of the athletic students. ** Data of all students. # Indicate values that are significantly different between males and females (Student t-test, p<0.05).##: Indicate a significant difference between males and females (Chi-square test, p<0.05).

Physical Activity and Sleeping During the COVID-19 Lockdown

In this study, physical activity was defined as an indoor and outdoor sports activity, or walking during the COVID-19 lockdown. The number of athletic students was 67 (52.34%), while 61 (47.66%) students did not practice any sports activity. The frequency of sports activity was significantly higher in males than in females (Table 5). The majority of female students practiced one session of sport per week. According to table 5, the duration of the sports per session in males was higher than in females (1.36 hours vs. 0.64 hours, respectively; p<0.001). The mean time of walking was also higher in males than in females, which was represented respectively by 0.5±0.36 hour/day and 0.46±0.24 hour/day. During the school year (from September 2020 to April 2021), students increased their physical activity by 17.19% compared to the total COVID-19 lockdown (From March 2020 to August). Moreover, a positive correlation was recorded between body weight and physical activity (r=0.304; p= 0.013).

In addition, the sleep patterns of the students varied between 6 hours or less and 9 hours or more (Table 6). It was found that 33.59% had 6 hours or

less of sleep, 22.66% had 7 hours, 21.09% had 8 hours, and 22.66% had 9 hours or more throughout the day. The sleep pattern for females and males is more clearly illustrated in table 6. The daily sleeping time of females (7.45±1.12 hours) was significantly higher than that for males (7.26±1.18 hours).

DISCUSSION

This study aimed to evaluate the effect of the stress due to COVID-19 lockdown and baccalaureate exams on food intake and body weight variation. During the COVID-19 lockdown, results from this study showed that 1/5 (20.31%) of students were underweight, while obesity was represented by a rate of 0.78%. Moreover, the analyses of the collected data indicated that a quarter of females were underweight, while 1/10 of males were underweight. In contrast, 27.66% of males and 13.58% of females were underweight. Females were more affected by the body weight variation than males. Weight gain for females was perceived at 35.8%, and weight loss was perceived at 23.46%. In a recent study, it was shown that weight gain was reported in 38% and weight loss was reported in 22.8% among included Peruvian adults during the COVID-19 lockdown (Rojas Huayta et al., 2022). In Saudi Arabia, the COVID-19 quarantine was implicated in the weight gain of 38% and the weight loss of 26% among subject participants using an online questionnaire (Bakhsh et al., 2021). In the same country, students' BMI showed that 32% increased their weight, 22% lost weight, and 46% maintained the same weight during the COVID-19 crisis (Jalal et al., 2021). In Bangladesh, the prevalence of overweight for adult participants was 30.5% before the COVID-19 pandemic, and it increased to 34.9% during the pandemic (Akter et al., 2022). Morocco, like other countries, was affected by COVID-19, and according to Boukrim et al., more than a quarter of the students with a high education were overweight or obese during lockdown (Boukrim et al., 2021), while the same rate was observed for females in this study. Furthermore, three months of COVID-19 lockdown increased the number of overweight and obese Lebanese students by 5.2% (Zoghbi et al., 2022).

In this study, a positive correlation was reported between body weight and sports activity but not with walking, which can be explained by the importance of sports activity to increase the lean mass of the human body. In 2016, Klemmer et al. observed an increase in the lean body mass of participants due to sports activity (Kemmler et al., 2016). The type of effort or exercise was implicated in lean body mass construction. The measurement of the lean mass using dual-energy X-ray absorptiometry (DXA) showed that the handball players had the highest values in lean mass in comparison to the swimmers and football players (Ubago-Guisado et al., 2017).

In these findings, the stress of COVID-19 and the baccalaureate exam can affect the food intake behavior of high school students. More than half of the female students increased or decreased their food intake under the COVID-19 lockdown. On the one hand, males were the most affected by the increase in food intake, and they had a higher number of meals than females. On the other hand, the stress of the baccalaureate changed the food intake of all students (67.19% of the students decreased their food intake and 32.81% of students increased it). In line with the findings of Demirci et al., food consumption was disturbed in Turkish high school students during COVID-19 compared to the period before COVID-19, and more meals were cocked at home (Demirci et al., 2021). According to an Italian investigation, eating habits were recorded for 1841 participants out of 3533 participants during the COVID-19 pandemic.

The perception of hunger and satiety was affected by more than half of the participants: 17.7% had less appetite, while 34.4% had more appetite (Di Renzo et al., 2020). In 2019, a study was conducted by Bhavani and Prabhavathy Devi to investigate the impact of stress on the food intake of Indian college students. It was found that 47% and 29.9% of subjects consumed more and less food at stressful times, respectively, and that around 37.5% consumed more food in sight of their favorite foods (Bhavani & Prabhavathy Devi, 2019). Students who had perceived high levels of stress increased unhealthy eating behaviors, such as eating prepared meals and snacking (Caso et al., 2020; Choi, 2020; Oh et al., 2023).

In addition, our data showed that the athletic students were represented at a rate of 52.34% (67 students out of 128 students). Physical activity levels during the social distancing period were lower than those during the pre-pandemic period (Puccinelli et al., 2021). Our finding showed that there was no gender effect on physical activity,

which was in concordance with the results reported by Mohd Hakim et al. (Mohd Hakim et al., 2021). We also investigated the number and duration of the sports sessions and observed that males had more sports sessions and longer sessions than females. In addition, walking time was higher for males than for females. The low physical activity of females explains the most important part of the weight gain and the high BMI of females. From a previous study, moderate to intense daily physical activity can be decreased by 42.5%, from an average preschool duration of 80.18 minutes per week to a post-secondary duration average of 46.13 minutes per week (Grimes et al., 2022; Grimes et al., 2022). Recently, Bielec and Omelan reported a vigorous physical activity decrease in female students following an online survey (Bielec & Omelan, 2022), and inactivity affected males more negatively than females during lockdown (Atiković et al., 2020).

Results from this questionnaire reported that the females sleeping time was higher than that of the males, and the general mean sleep duration was 7.33±1.16 hours/day. An on-line survey conducted over six months showed that 36.5% of Nigerian students changed their sleep patterns during COVID-19 (Ellakany et al., 2022). In our findings, the sleep pattern during quarantine varied from 6 hours or less to 9 hours or more. The sleep pattern of the Iranian students during the school closure following the COVID-19 pandemic varied from 5 hours to 12 hours. It was reported that 13.4% of students had 5 or fewer hours of sleep, 13% had 6 to 8 hours, 12.8% had 9 to 10 hours, 7.3% had 11 to 12 hours, and 53.5% had above 12 hours of sleep per day (Ranjbar et al., 2021). In southern England, students' bedtime and waking time were later, and sleep duration was longer in 2020 than in the 2019 survey (Illingworth et al., 2022). On the other hand, a longer sleep period was significantly associated with better health characteristics, although this has been balanced by a combination of depressive symptoms with poorer health-related features and increased caffeine intake (Albrecht et al., 2022).

Limitations of this study include that research has been conducted with participants living in the city center; consequently, it is necessary to interpret its results carefully, and the generalization of these results to all Algerian high school students should be more cautious. The majority of Relizane's regions were under lockdown, which limited our travel to develop this survey. Relizane is a rural city, and the access of the students to the internet was almost very difficult, which prevented us from putting the questionnaire online. In this study, the impact of stress during school on body weight and sleeping was not evaluated due to the short duration of the questionnaire. Objective measurements were not available, such as changes in the levels of body hormones under stress.

Conclusion

Our findings indicated that high school students' food intake was influenced by the stress associated with the COVID-19 pandemic and the baccalaureate exams. This stress affected eating habits in both genders. Additionally, the weight of female students was impacted by pandemic-related stress. Males were generally more active than females, participating in more sports sessions and spending longer durations on physical activities, including walking. The lockdown created a unique situation where boredom and stress could disrupt athletes' routines and lead to unhealthy eating habits.

To mitigate the negative health effects of stress, various strategies can support students, such as balancing study and leisure time, improving time management, engaging in regular exercise, and practicing relaxation techniques like meditation and yoga. The limited access to sports activities during the lockdown should be supplemented with home-based physical activities.

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Conflict of interest

We affirm that the article we have authored does not involve any conflict of interest.

Ethics Statement

This research ethical approval was obtained Research from The Local Ethics Committee and the Data Protection Board (DPB) of the University of Relizane on January 18th, 2021 under the project code D04N01UN480120230001.

Author Contributions

Study design, HZ and BM; Data collection, HZ and BM; Statistical analysis, HZ, BS, BM, BB, KR and SSH; Data interpretation, HZ, BS, BM, BB, KR and SSH; Literature search, HZ, BS, BM, BB, KR and SSH. All authors have read and approved the published version of the manuscript.

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