

Joint associations of sports participation and smartphone screen time with anxiety among school adolescents

Asociaciones conjuntas de la participación en deportes y el tiempo de pantalla de smartphone con la ansiedad entre adolescentes escolares

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Abstract. To investigate the joint association of sports participation and smartphone screen time (ST) with anxiety symptoms in school adolescents. This cross-sectional study included 142 Brazilian high school adolescents from a federal public school. Anxiety symptoms were assessed using the Screen for Child Anxiety Related Disorders, with a cutoff point of ≥ 30 . Sports participation was measured using the Habitual Physical Activity Questionnaire for Adolescents, classifying participants as sports participation or non-sports participation. ST was measured using the digital well-being function of the smartphone, categorizing participants into low ST and high ST based on the median. Participants were distributed into four groups: sports participation + low ST, sports participation + high ST, non-sports participation + low ST, and non-sports participation + high ST (reference group). Analysis was performed using Poisson regression with robust variance to calculate prevalence ratio (PR) and 95% confidence intervals (CI) for anxiety among groups. The prevalence of anxiety was 41.5% (95% CI 33.6, 50.0). The sports participation + low ST group exhibited a lower prevalence of anxiety compared to the reference group (PR 0.52; 95% CI 0.28, 0.94; $p = 0.031$). The other groups showed no significant association with the reference group ($p > 0.05$). In conclusion, sports participation associated with low smartphone ST is related to a lower prevalence of anxiety symptoms in school adolescents.

Keywords: Sports. Exercise. Sedentary time. Mental health. Adolescence.

Resumen. Investigar la asociación conjunta de la participación en deportes y el tiempo de pantalla de smartphone (TP) con los síntomas de ansiedad en adolescentes escolares. Este estudio transversal incluyó a 142 adolescentes de secundaria brasileños de una escuela pública federal. Los síntomas de ansiedad se evaluaron utilizando la Escala de Ansiedad para Niños, con un punto de corte de ≥ 30 . La participación en deportes se midió utilizando el Cuestionario de Actividad Física Habitual para Adolescentes, clasificando a los participantes en participación deportiva o no participación deportiva. El TP se midió utilizando la función de bienestar digital del smartphone, categorizando a los participantes en TP bajo y TP alto basado en la mediana. Los participantes se distribuyeron en cuatro grupos: participación deportiva + TP bajo, participación deportiva + TP alto, no participación deportiva + TP bajo, y no participación deportiva + TP alto (grupo de referencia). El análisis se realizó utilizando la regresión de Poisson con varianza robusta para calcular la razón de prevalencia (RP) y los intervalos de confianza (IC) del 95% para la ansiedad entre los grupos. La prevalencia de ansiedad fue del 41,5% (IC del 95%: 33,6; 50,0). El grupo de participación deportiva + TP bajo mostró una menor prevalencia de ansiedad en comparación con el grupo de referencia (RP 0,52; IC del 95%: 0,28; 0,94; $p = 0,031$). Los otros grupos no mostraron una asociación significativa con el grupo de referencia ($p > 0,05$). En conclusión, la participación en deportes asociada con un TP bajo en smartphones está relacionada con una menor prevalencia de síntomas de ansiedad en adolescentes escolares.

Palabras clave: Deportes. Ejercicio. Tiempo sedentario. Salud mental. Adolescencia.

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Introduction

Adolescence is a transitional stage in human development between childhood and adulthood. It is characterized by significant changes in the body, including physical, neurobiological, and hormonal changes (Best & Ban, 2021). Additionally, adolescents experience modifications in social relationships and self-discovery, questioning their identity and their role in society (Sawyer et al., 2018; Steinberg & Morris, 2001). During this stage, appropriate or inappropriate lifestyle behaviors are established, which can determine the development of health-related problems, particularly in mental health (Blakemore, 2019). Regarding mental health, the prevalence of anxiety symptoms is quite high in the adolescent population (Tiirikainen et al., 2019), and this number has increased significantly due to the COVID-19 pandemic (Ahsan & Abualait, 2024). Anxiety symptoms

are characterized by feelings of apprehension, tension, and excessive fear of future events or unexpected situations (American Psychiatric Association, 2013). In addition, factors such as low self-esteem, life dissatisfaction, and suicidal thoughts, alongside familial influences like mental illness, substance abuse, and domestic violence, may contribute to the emergence of anxiety symptoms (Blanco et al., 2014; Sá et al., 2010). While anxiety disorders may affect individuals of all ages, they are more likely to development in young people (Shim et al., 2022).

A robust body of evidence has shown that certain behaviors, such as reducing screen time and increasing levels of physical activity, including participation in sports, are associated to higher self-esteem and a reduced risk of anxiety, depression symptoms, and socio-behavioral inhibition (Amú-Ruiz et al., 2024; Bélair et al., 2018; Guddal et al., 2019; Kjellenberg et al., 2022; Kremer et al., 2014;

Oberle et al., 2020; Taheri et al., 2019; Wen et al., 2022). Therefore, engaging in sport offers a significant mental health benefits through the experienced social support (Tahira, 2022). Beyond the well-known physical and social advantages, sports activities may provide considerable psychological benefits for young people (Broglio et al., 2021). Consequently, engaging in sports and physical activity during adolescence is associated with sustained physical activity throughout life (Bélanger et al., 2015; Kjønnsniksen et al., 2009). However, during this transition phase from primary to secondary school (e.g., between the ages of 15 and 16), there is a significant decrease in PA level amongst, resulting in a decline in physical and mental health (Dumith et al., 2011; Guddal et al., 2019; Marques & Gaspar de Matos, 2014).

On the other hand, high levels of sedentary behavior, particularly screen time (ST) spent on smartphones, emerge as an additional concern in the lives of adolescents. ST is even more associated with anxiety than total sedentary time among college students (Huang et al., 2022). Consequently, facilitated access to technology has increased sedentary behavior and reduced physical activity levels among young people (Leitzmann et al., 2018; Woessner et al., 2021). Interestingly, the World Health Organization recommends limiting ST, as prolonged periods are associated with adverse health effects (World Health Organization, 2020), including heightened levels of anxiety and depression symptoms (Taheri et al., 2019).

Previous studies have explored the relationship between sports participation, physical activity, ST, and mental health in adolescents (Bélair et al., 2018; Guddal et al., 2019; Kjellenberg et al., 2022; Kremer et al., 2014; Oberle et al., 2020; Taheri et al., 2019; Wen et al., 2022). For example, Kjellenberg et al. (2022) observed that boys who participated in sports experienced lower anxiety symptoms compared to those who did not, while girls who spent more than five hours a day on ST showed higher anxiety symptoms. In addition, studies have reported that physically inactive adolescents with high ST are more likely to have anxiety and depression symptoms (Bélair et al., 2018).

Despite the growing number of studies linking physical activity, sports participation, ST, and anxiety in adolescents (Bélair et al., 2018; Guddal et al., 2019; Kjellenberg et al., 2022; Kremer et al., 2014; Oberle et al., 2020; Taheri et al., 2019; Wen et al., 2022). However, there is still a gap in research. For instance, there is a lack of investigation into the joint associations of sports participation and smartphone ST with anxiety symptoms in school adolescents. Therefore, this study aims to understand how these factors interact and affect the prevalence of anxiety symptoms in school adolescents. This understanding is crucial for the developing of effective strategies to promote mental health and well-being during this critical stage of development.

Methods

Study design

This is an observational study with a cross-sectional design. The study followed the criteria established by STROBE for observational studies (Von Elm et al., 2007). Data collection occurred between June and October 2023 at the Sousa campus of the Federal Institute of Education, Science, and Technology of Paraíba (IFPB) in the city of Sousa, Paraíba, Brazil. Sousa is a municipality in the interior of the state of Paraíba, with approximately 70,000 inhabitants, situated in the semi-arid region of the northeastern hinterland. The study adhered to the principles outlined in the Declaration of Helsinki and Resolution No. 466/2012 of the National Health Council of Brazil, following approval by the Research Ethics Committee (CAAE No. 49857421.0.0000.5184).

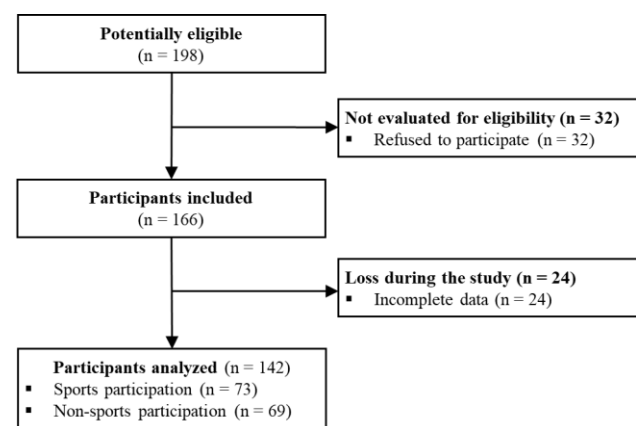


Figure 1. Flowchart of the study sample

Participants

The study participants were recruited from the high school courses at IFPB, Sousa campus. This institution is a federal public school that offers integrated high school education with technical courses, including agroindustry, agriculture, environment, and informatics, all on a full-time basis (morning and afternoon). Sousa campus attracts students from various cities and neighboring states due to its federal school status. Recruitment was conducted by advertising the research in classrooms and on social networks (Instagram and WhatsApp). The following inclusion criteria were followed: aged between 14 and 19 years; having participated in some form of sport for at least three months (at least 2 sessions per week); not having performed physical exercise programs in the last three months (control group); having a personal smartphone of any model, line of manufacture or operating model that contains any of the following features activated in the system: “digital well-being” or similar; no diagnosis of psychological or psychiatric diseases and/or disorders; and not using medication for these conditions. Exclusion criteria included: voluntary withdrawal by the participant; and failure to perform any of the proposed measures and assessments. A total of 142 students were included in the final analysis of the study, 73 of whom

participated in sports activities (“sports participation”) and 69 of whom did not participate in regular physical activity (“non-sports participation”) (Figure 1). All participants and their respective parents and caregivers provided informed consent.

Procedures

Data were collected face-to-face by qualified evaluators in the Department of Physical Education of the IFPB Sousa campus. All the procedures of the study, including risks and benefits, were explained. Once the consent of the volunteer and their legal representative and/or parents had been obtained, a questionnaire was administered to collect personal information such as age, sex, ethnicity, and level of education. Afterward, the ST of the smartphone used by the participant in the last week was recorded. Were performed the Habitual Physical Activity Questionnaire for Adolescents (Florindo et al., 2006) and the Screen for Child Anxiety Related Disorders (SCARED) (Birmaher et al., 1997; Isolan et al., 2011). Lastly, each participant's height and weight were measured.

Sports participation

Sports participation was analyzed using the Habitual Physical Activity Questionnaire for Adolescents (Florindo et al., 2006). This instrument is validated and reliable among Brazilian adolescents (Florindo et al., 2006). The questionnaire consists of 17 questions divided into two blocks: (a) fifteen questions about sports and physical exercises; (b) two questions regarding physical activity related to commuting to school. The first block measures weekly and yearly physical activity (time, frequency, and duration). The second block measures weekly commuting physical activity. Results were obtained in minutes per week and minutes per year, as well as weekly frequency. Participants were categorized as “sports participation” if they engaged in any sports modality, individual and/or collective, at least twice a week for a minimum period of three months. Participants who did not engage in sports modalities were categorized as “non-sports participation”.

Smartphone screen time

ST was assessed using the participant's own smartphone, accessing the function available on all models and operating systems, typically referred to as “digital well-being”, “parental control”, or “usage time”. ST is frequently spent in a seated or lying position, and it is commonly linked with sedentary behavior (Lourenço et al., 2019; Xiang et al., 2020). The recorded data included the device's operating time per day (h/day), collected over the entire previous week (from Monday to Sunday), starting from the date of questionnaire administration. During data collection, participants were instructed to access the app on their own devices and provide the necessary data to the researcher, without the need for direct manipulation of the device by the researcher. The average ST over the seven days was calculated. Considering that there is not a well-established cut-

off to define smartphone ST categories, the median value of smartphone ST from this cohort was adopted to define low (<6.6 h/day) and high ST (6.6+ h/day).

Joint associations of sports participation and smartphone screen time

Participants were allocated into four groups according to the categories of sports participation and smartphone ST: “sports participation + low ST”, “sports participation + high ST”, “non-sports participation + low ST”, and “non-sports participation + high ST” (reference group).

Anxiety symptoms

Anxiety symptoms were assessed using the SCARED, which was originally developed as a screening tool for anxiety disorders in children (Birmaher et al., 1997). The SCARED is validated and reliable among Brazilian children and adolescents (Isolan et al., 2011). The scale consists of forty-one items grouped into five anxiety symptom factors: panic, generalized anxiety, separation anxiety, social phobia, and school phobia. Within each item, participants had to select the response that best represented how they felt in the last three months. The items are scored on a three-point Likert scale: 0= “not true or rarely true”; 1= “sometimes true”; 2= “true or often true”. Scores range from 0 to 82, with higher scores reflecting higher levels of anxiety. The presence of clinically significant anxiety was considered as a score ≥ 30 points (Birmaher et al., 1997).

Other variables

The variables such as age, sex, education, ethnicity, alcohol consumption, and sleep quality used to characterize the sample or as confounding variables (covariates) were obtained through the Global School-based Student Health Survey (World Health Organization, 2021) questionnaire and standardized measures. Height and weight were measured using a digital scale (model W200, Welmy, Brazil) and a portable stadiometer (model ES2060, Sanny, Brazil), respectively. Body mass index (BMI) was calculated as the ratio of weight to height squared (kg/m^2). The BMI of each participant was classified according to sex and age by z-score (WHO Multicentre Growth Reference Study Group, 2006), and grouped into normal, overweight, and obesity.

Statistical Analysis

Continuous and categorical data characterizing the sample were reported as mean \pm standard deviation and absolute frequencies and relative frequencies, respectively. The prevalence of anxiety symptoms was calculated using the observed relative frequency and 95% percentile bootstrap confidence intervals (CI). Poisson regression with robust variance was used to analyze the prevalence ratio (PR) and 95% CI for anxiety symptoms between groups (“non-sports participation + high ST” as the reference group). All assumptions of Poisson regression were assessed, including multicollinearity. These analyses were adjusted for potential confounding factors: age, BMI categories, sleep quality,

and alcohol consumption. Except sex exhibited multicollinearity among the main variables. The model fit quality was assessed by the Omnibus test. All analyses were performed using SPSS version 27 software (IBM Corp., Armonk, NY), and a significance level of $p < 0.05$ was adopted as a statistically significant criterion for all analyses.

Results

The sample described is presented in Table 1. The majority of participants are female (63%), and 55% identify as brown or black. In the group, 28% are excess weight (overweight + obesity), while 61% have sleep quality classified as good to excellent. Sports participation is adopted by approximately 51% of participants, while 49% are non-sports participation. The average and median daily ST spent on smartphones by participants are 6.7 hours and 6.6 hours, respectively.

Table 1.
Participant characteristics (n = 142)

Variables	Mean \pm SD or n (%)
Age, years	16.0 \pm 1.3
Girls	90 (63.4)
Boys	52 (36.6)
Brown/Black	78 (54.9)
White/Yellow	64 (45.1)
Good/Excellent sleep	87 (61.3)
Poor/Regular sleep	55 (38.7)
Height, m	1.66 \pm 0.09
Weight, kg	60.3 \pm 13.5
BMI, kg/m ²	21.8 \pm 4.2
Ideal weight	102 (71.8)
Overweight	31 (21.8)
Obesity	9 (6.3)
Alcohol consumption	71 (50.0)
Non-alcohol consumption	71 (50.0)
Sports participation	73 (51.4)
Non-sports participation	69 (48.6)
Screen time, h/day	6.7 \pm 2.0
Low smartphone screen time	70 (49.3)
High smartphone screen time	72 (50.7)

Continuous data are presented as mean \pm standard deviation (SD), while categorical data are expressed as absolute frequencies (n) and relative frequencies (%). BMI, body mass index

Figure 2 presents the prevalence of anxiety symptoms among participants, considering the groups of sports participation and smartphone ST. A high prevalence of anxiety symptoms was observed among total participants (41.5%; 95% CI: 33.6, 50.0). However, a higher prevalence of anxiety symptoms was observed in the non-sports participation + high ST group (52.8%; 95% CI: 36.1, 69.4) and non-sports participation + low ST group (45.5%; 95% CI: 30.3, 60.6). The sports participation + high ST group had a prevalence of 38.9% (95% CI: 22.2, 54.3), while the sports participation + low ST group recorded a prevalence of 29.7% (95% CI: 15.8, 45.9).

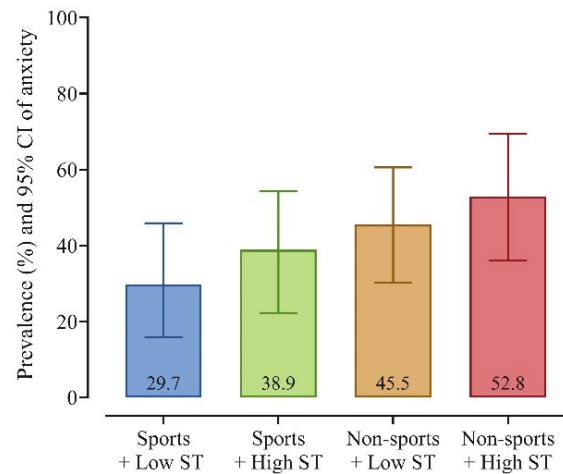


Figure 2. Prevalence of anxiety symptoms according to joint associations of sports participation and smartphone screen time (ST) in school adolescents (n = 142). Data are presented as relative observed frequency (%) and 95% percentile bootstrap confidence intervals (CI)

Figure 3 presents the results of the association between sports participation, smartphone ST, and anxiety symptoms. Participants in the sports participation + low ST group showed a lower prevalence of anxiety symptoms compared to the non-sports participation + high ST group (PR 0.52; 95% CI: 0.28, 0.94; $p = 0.031$). The sports participation + high ST (PR 0.70; 95% CI: 0.42, 1.17; $p = 0.172$) and non-sports participation + low ST (PR 0.78; 95% CI: 0.49, 1.26; $p = 0.310$) groups were not associated with the reference group.

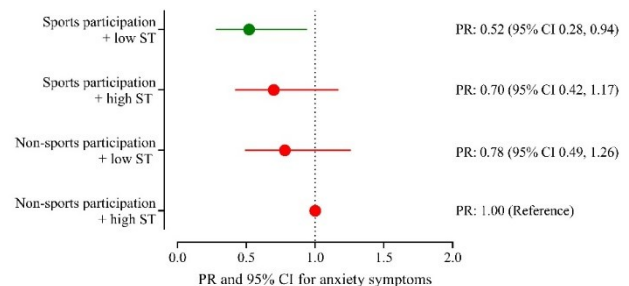


Figure 3. Joint associations of sports participation and smartphone screen time with anxiety symptoms in school adolescents (n = 142). The data are presented with adjusted prevalence ratio (PR) and 95% confidence intervals (CI). The model was adjusted for age, body mass index, sleep quality, and alcohol consumption.

Discussion

This is the first study to evaluate the joint associations of sports participation and smartphone ST with anxiety symptoms in school adolescents. The main results highlight that: a) school adolescents who engage in sports activities and maintain low smartphone ST exhibit a lower prevalence of anxiety compared to their non-sports practitioners with high ST; b) groups of school adolescents who participate in sports and have high ST, as well as those who are non-sports practitioners with low ST, did not demonstrate a lower

prevalence of anxiety symptoms compared to school adolescents in the reference group. These findings suggest that sports participation when associated with low ST, may play a protective role against anxiety symptoms in school adolescents.

Our results indicate that adolescents engaged in any sports activity combined with low smartphone ST have a lower prevalence of anxiety symptoms compared to the reference group. Previous studies conducting this combined analysis are scarce. However, from a similar perspective, it is possible to observe that both high ST and non-engagement in sports participation may be negatively associated with anxiety symptoms (Boers et al., 2019; Maras et al., 2015). On the other hand, participation in sports is associated with greater mental health among adolescents (Guddal et al., 2019). During sports participation, adolescents often experience a positive distraction and a focus on the present moment, moving away from worries and negative thoughts that can contribute to anxiety symptoms. In addition, engagement in sporting activities may increase self-esteem and self-efficacy, promoting a sense of competence that may reduce anxiety symptoms (Guddal et al., 2019; Wright et al., 2023). Furthermore, there are several mechanisms associated with the effects of sports participation, as it involves physical activity. For example, the release of endorphins, neurotransmitters associated with mood regulation, reduces pain perception (Matta Mello Portugal et al., 2013). Moreover, engaging in physical activity reduces cortisol levels, the stress hormone, which may contribute to the reduction of anxiety in school adolescents (Matta Mello Portugal et al., 2013). Thus, our study suggests that school adolescents should engage in sports activities and reduce the time spent using smartphones, consequently reducing the prevalence of anxiety symptoms.

Regarding the impacts of smartphone ST, excessive time spent on mobile device screens can be exposed to potentially stressful environments, such as negative news, violent images, or conflicting social interactions on social media platforms (Twenge & Campbell, 2018). This constant exposure can increase the activation of the sympathetic nervous system, triggering stress responses that contribute to the development and maintenance of anxiety symptoms (Twenge & Campbell, 2018). From a psychological perspective, it may promote sedentary behaviors and social isolation, reducing opportunities for engagement in physical activities and meaningful social interactions (Tana & Amâncio, 2023). In the same way, from a social perspective, excessive ST can impair adolescents' communication skills and interpersonal interactions, leading to a greater sense of isolation and loneliness. Therefore, strategies to reduce ST should be developed to contribute to better mental health among school adolescents.

Additionally, our results indicate that both the "sports participation + high ST" and the "non-sports participation + low ST" groups did not exhibit a lower prevalence of anxiety symptoms compared to the "non-sports participation + high ST" groups. This suggests that reducing smartphone ST

or engaging in sports in isolation may not be sufficient to mitigate anxiety symptoms in school adolescents, indicating the influence of both behaviors from a biopsychological level. In addition, these results make us consider the practical implications of these findings in the real world. This might be explained by several factors, including the content type consumed and the impact of excessive screen use on social isolation. In fact, the COVID-19 pandemic has changed movement behavior, reducing physical activity levels and increasing sedentary time and mobile device use, affecting adolescents' mental health (Cao et al., 2023; Marconcin et al., 2022).

In the educational environment, schools should play an important role in encouraging student participation in physical activities and promoting diverse and inclusive sports programs (Sierra-Díaz et al., 2019). Additionally, the implementation of school policies that limit mobile device usage during school hours can encourage students to engage more in physical activities and face-to-face social interactions. Workshops and lectures on the importance of balancing physical exercise and electronic device usage can also be beneficial. In the sports realm, clubs and gyms need to offer programs tailored to adolescents, focusing not only on the physical aspect but also on the development of social skills and resilience. On the other hand, at home, parents or caregivers may establish healthy standards for electronic device usage and promote family activities involving physical activities, including walking, cycling, or team sports, strengthening family bonds while promoting physical and mental health (Rainham et al., 2022). Additionally, public policies should promote environments helpful to outdoor physical activities and limit the advertising of electronic devices targeting children and adolescents. Considering the limitations of this study, it opens pathways for future investigations. Temporality and causality may be limiting factors. This study's results are cross-sectional and, therefore, do not allow causal inferences. Longitudinal studies would be necessary to better understand how changes in behavior over time, both in terms of sports participation and smartphone ST, affect the mental health of school adolescents. Additionally, there may have been a selection bias since the sample was recruited exclusively from a federal public school. This institution is known for selecting students with superior academic performance, which may not be representative of the general student population. Therefore, when interpreting the results, it's necessary to consider that they may not directly apply to students from state public schools, which may have different socioeconomic and educational profiles. This suggests the need for caution when generalizing conclusions to broader educational contexts. Furthermore, exploring intermediate variables, such as the type of sports participation, the content consumed during smartphone use, and the quality of social interactions, may provide more in-depth information on how these factors affect mental health. It's equally important to investigate the complex interactions between multiple factors, including sociodemographic aspects, family

environment, and genetics, to better understand the dynamics of these relationships.

Conclusion

Findings indicate that sports practice combined with low smartphone ST (<6.6 h/day) is positively associated with a lower prevalence of anxiety among school adolescents. This relationship suggests that strategies promoting sports activity and reducing the use of electronic devices may be considered effective interventions in the context of emotional health for school adolescents.

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Conflict of interest

The authors declare that there are no conflicts of interest.

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