ORIGINAL ARTICLE

# Relationship between sleep patterns, bedtime and recurrent aphthous stomatitis (RAS) during the COVID-19 pandemic: analytical observational research

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## ABSTRACT

**Introduction:** Recurrent Aphthous Stomatitis (RAS) is an inflammation on the oral mucosa, presenting as recurrent, round, single, or multiple ulcers with well-defined boundaries. Although the exact etiology of RAS remains unknown, several factors are known to contribute to its development. During the COVID-19 pandemic, various problems have arisen, especially among adolescents, including senior high school students, whose sleep patterns-specifically their sleep time, duration, and quality-have been disrupted. These disruptions may weaken their immune system, making them more susceptible to RAS disease. The objective of this study is to analyze the relationship between sleep patterns, bedtime, and the occurrence of RAS during the COVID-19 pandemic. **Method:** The research design employed was an analytical observational study, with a cross-sectional approach. Purposive sampling was used to select all class XI students of SMA 6 Yogyakarta, based on inclusion and exclusion criteria. The research instruments included the PSQI questionnaire (used to measure sleep patterns, sleep time, sleep duration, and sleep quality) and the RASDX questionnaire (a diagnostic tool for measuring the prevalence of RAS lesions) both administered via Google Forms. Statistical analysis was conducted using the Chi-square test. **Results:** A total of 58 students (55.8%) experienced RAS, with a higher prevalence among female students. Regarding age, 16-year-old students had the highest incidence of RAS, with 79 students (64.4%) affected. Most respondents, 79 respondents (76%), were reported to have good sleep patterns. The results of the bivariate analysis also revealed a significant relationship between sleep patterns, bedtime, and the occurrence of RAS ($p=0.043<0.05$). **Conclusion:** Sleep patterns, bedtime, and the occurrence of RAS were found to be interrelated during the COVID-19 pandemic.

## KEYWORDS

Sleep patterns, bedtime, recurrent aphthous stomatitis (RAS), COVID-19, pandemic

## INTRODUCTION

Recurrent Aphthous Stomatitis (RAS) is a condition characterized by recurring inflammation on the oral mucosa, presenting as single or multiple ulcers that are round or oval in shape and have well-defined boundaries with a yellow-gray necrotic center and reddish edges. Typically, RAS symptoms appear with pain and burning for 1-2 days and sores in the form of ulcers in the oral cavity. These lesions can recur and heal within 3-4 days, but they often cause discomfort, especially during eating, due to the associated pain and burning sensation.[1,2]

The exact etiology of Recurrent Aphthous Stomatitis (RAS) remains uncertain; however, several factors are believed to contribute to its development. These predisposing factors include trauma, stress, microorganisms, hematinic deficiency, systemic conditions, food allergies, immune dysregulation, hormonal factors, and genetics.[3]

The prevalence of RAS ranges from 2% to 66% in populations throughout the world each year.[4] In a national scope, the prevalence of RAS was 8%, while in the Yogyakarta Special Region (DIY) Province, it was 8.7%. The school category for students with RAS prevalence was in third place at 8.8%, and the age category was in first place, ranging from 15–24 years at 9.6%.[2]

In this case, the second decade of a person's life (aged 20–24 years), is the period with the highest prevalence of RAS, at 54%. Notably, 70% of RAS cases occur in adolescent girls, while 30% occur in adolescent boys.[5] Previous research has consistently shown that the adolescent are the most affected group by RAS. Therefore, it is crucial to carry out a study on RAS in adolescents.[6]

Furthermore, the COVID-19 pandemic was first reported to occur at the end of December 2019 in Wuhan, Hubei Province, China.[7] The pandemic has been associated with sleep problems in many individuals, and worsen symptoms in people who already have sleep problems.[8] Approximately, 20-66% of teenagers experienced sleep disturbances during the COVID-19 pandemic. Various factors, such as low social support, academic problems, mental health, physical health, knowledge, and sleep hygiene, contribute to sleep problems in adolescents.[9]

Individuals with demanding lifestyles and limited rest often experience sleep disturbances. Heavy workloads and high-stress levels can negatively impact psychological well-being and disrupt sleep patterns. [10] Sleep disorders, including reduced sleep quality, sleep duration, and sleep time, can be induced by various factors, such as work shifts, work periods, caffeine consumption, sleeping pills, smoking, psychological stress, and diet.[11]

Reduced sleep quality, duration, and timing often result from late-night studying before exam, excessive internet use, and a lack of health knowledge, so late bedtimes become a major habit among adolescents. Sleep disturbances, such as sleeping late at night, can weaken the immune system, resulting in a higher susceptibility to RAS.[12] In other words, disrupted sleep patterns, can impair immune and hormonal function, potentially affecting the body and manifest in the oral cavity as RAS.

Some predisposing factors for RAS are hematinic deficiencies (iron, folate, and vitamin B12), menstruation, stress, allergies, and AIDS. RAS is also common in individuals with severe stress, likely due to the suppression of the immune system and resulting tissue destruction.[13] Stress is a complex biological reaction with mechanisms that are not yet fully understood. Although stress may play an important role in causing recurrent aphthous stomatitis, the exact relationship between stress and the development of oral pathology remains unclear.[14]

High cortisol levels are immunosuppressive, interfering with the phagocytic system and immune response. The phagocytic and inflammatory systems play a role in the mechanism of the disease. RAS typically manifests through both acute and chronic inflammation, which can potentially damage the oral mucosa.

Additionally, acute inflammation often leads to pain and discomfort in RAS lesions.[15,16]

Stress factors and psychological imbalance have been associated with the development of RAS. Patients who frequently experience increased heightened stress are more likely to be in an early stage of RAS. Higher levels of anxiety may lead to transient or episodic stressful situations that are associated with RAS, potentially triggering certain mechanisms, such as increased leukocyte count at the site of inflammation.[17]

Several previous studies have not explained the relationship between sleep patterns and the occurrence of RAS during the COVID-19 pandemic among senior high school students in Yogyakarta. During the pandemic, various factors, such as stress and anxiety, have contributed to sleep pattern disturbance, which in turn may lead to the development of RAS in students. Therefore, a study is necessary to investigate the relationship between sleep patterns during the COVID-19 pandemic and the occurrence of RAS among students in Yogyakarta.

This study is novel since it was conducted during the COVID-19 pandemic, a period that may have influenced the emergence of RAS due to disrupted sleep patterns and altered bedtime. Therefore, the objective of this study is to examine the relationship between sleep patterns, bedtime, and the occurrence of Recurrent Aphthous Stomatitis (RAS) among senior high school students during the COVID-19 pandemic.

The findings will provide valuable information to help schools understand the stress-related sleep patterns and bedtime habits that may contribute to RAS among their students. This knowledge will enable schools to plan and provide treatment for RAS during the COVID-19 pandemic. The objective of this study is to analyze the relationship between sleep patterns, bedtime, and the occurrence of RAS during the COVID-19 pandemic.

## METHODS

This research used an analytical observational method with a cross-sectional research design. This research was conducted online in Yogyakarta due to the COVID-19 pandemic. Schools were selected randomly using a lottery system from state schools in the city of Yogyakarta. The population in this study included all eleventh-grade students from 11 senior high schools. The school only allowed the research to be conducted with grade XI students because grade XII students were preparing for exams, and grade X students were still adjusting to their new school environment.

The method used for sample selection was purposive sampling. The inclusion criteria for this research were eleventh-grade senior high school students in Yogyakarta, male or female, who were willing to provide an informed consent by signing the consent form and agreeing to take part in the research.

In contrast, the exclusion criteria included eleventh-grade senior high school students who a history of systemic diseases that could cause sleep disorders, such as lupus erythematosus, asthma, and multiple sclerosis. Other excluded groups were students using orthodontics and prosthodontics, students without a history of RAS as indicated by the questionnaire results, and students diagnosed by a doctor with systemic disease (HIV, anemia, diabetes mellitus, or gastrointestinal disease). The total number of subjects in this research was 104 students. Although the minimum sample size required for this study, based on calculations, was only 72 students, 104 students participated in the study.

The measuring instruments utilized in this study were the Pittsburgh Sleep Quality Index (PSQI)[18] and Recurrent Aphthous Stomatitis Diagnosis (RASDX)[19] questionnaires. Sleep patterns, including sleep quality, sleep time, and sleep duration over the past month, were assessed using the l Pittsburgh Sleep Quality Index (PSQI)[18] questionnaire. The PSQI questionnaire is a measurement tool containing nine questions with responses that generate scores covering various

aspects of sleep patterns, such as sleep time, duration, and quality. The final assessment was based on the total accumulated scores and conclusions derived from the respondents' completed questionnaire.

The validity of the questionnaire was tested in previous studies, yielding results > 0.4, indicating that the PSQI questionnaire is valid. The reliability testing was conducted using the Cronbach Alpha analysis method, with a result of 0.753. This result demonstrates that the PSQI questionnaire is deemed reliable, as it obtained a value exceeded the threshold 0.6, with values closer to 1 indicating a better the measuring instrument.

Bedtime was classified into two categories: before 11 PM and after 11 PM. Sleep duration was scored as follows: 0 for sleeping 7 hours or more, 1 for 6-7 hours, 2 for 5-6 hours, and 3 less than 5 hours. Sleep quality was scored 0 for very good, 1 for fairly good, 2 for fairly bad, and 3 for very bad). Based on the three factors- bedtime, sleep duration, and sleep quality-it was determined whether the sleep pattern was good or bad. A sleep pattern was categorized as good if the total score was less than 5 and bad if the total score was 5 or higher.

Meanwhile, a person can be diagnosed with RAS when they have a history of recurrent ulcers at least 3-4 times a year that cause pain. RAS incidence was measured using the Recurrent Aphthous Stomatitis Diagnosis (RASDX) questionnaire.[19] The RASDX questionnaire is a standard tool designed to identify RAS based on patients' medical history. It is also used to measure the prevalence of RAS lesions, as direct clinical observation of RAS lesions was not possible in this study. The questionnaire consists of 21 yes/no questions regarding the history of RAS. A diagnosis of RAS is considered positive if at least 7 out of the 12 minor criteria are met, and the respondent recognizes the RAS description provided as an experience they have had.

The data analysis for this research was conducted using the Chi-square test to determine whether there was a relationship between the independent and dependent variables. The data were analyzed using SPSS version 20 software.

## RESULTS

The study findings revealed that senior high school students had relatively good sleep patterns during the COVID-19 pandemic, as presented in Table 1 below.

**Table 1. Characteristics of respondents based on age, gender, and sleep patterns**

| Characteristic | | Sleep Pattern | | | | Total | |
|---|---|---|---|---|---|---|---|
| | | Good | | Poor | | | |
| | | n | % | n | % | n | % |
| Age | 14 years old | 0 | 0 | 1 | 1 | 1 | 1 |
| | 15 years old | 14 | 13.5 | 2 | 1.9 | 16 | 15.4 |
| | 16 years old | 53 | 51 | 19 | 18.3 | 72 | 69.2 |
| | 17 years old | 12 | 11.5 | 3 | 2.9 | 15 | 14.4 |
| Gender | Male | 36 | 34.6 | 6 | 5.8 | 42 | 40.4 |
| | Female | 43 | 41.3 | 19 | 18.3 | 62 | 59.6 |

Respondents who had poor sleep patterns were aged 16 – 17 years, with 19 respondents (18.3%) for 16-year-olds and three respondents (2.9%) for 17-year-olds. In comparison, good sleep patterns were found in individuals aged 15-16 years, with 14 respondents (13.5%) aged 15 years and 53 respondents (51%) aged 16 years. Based on gender category, the female respondents had higher poor sleep patterns than male respondent, at 19 respondents (18.3%).

Meanwhile, an analysis of the characteristics of respondents based on their age, gender, and bedtime is presented in the following Table 2.

**Table 2. Characteristics of respondents based on age, gender, and bedtime**

| Characteristic | | Bedtime | | | | Total | |
|---|---|---|---|---|---|---|---|
| | | < 11 PM | | > 11 PM | | | |
| | | n | % | n | % | n | % |
| Age | 14 years old | 1 | 1 | 0 | 0 | 1 | 1 |
| | 15 years old | 14 | 13.5 | 2 | 1.9 | 16 | 15.4 |
| | 16 years old | 57 | 54.8 | 15 | 14.4 | 72 | 69.2 |
| | 17 years old | 11 | 10.6 | 4 | 3.8 | 15 | 14.4 |
| Gender | Male | 34 | 32.7 | 8 | 7.7 | 42 | 40.4 |
| | Female | 49 | 47.1 | 13 | 12.5 | 62 | 59.6 |

Based on Table 2 the respondents who reported a bedtime after 23:00 were between the ages of 15 and 17. Out of these respondents, 15 individuals (14.4%) were 16 years old, while two individuals (1.9%) were 15 years old, and four individuals (3.8%) were 17 years old. Among respondents with a bedtime before 23;00, 14 respondents (13.5%) were 15 years old, and 57 individuals (54.8%) were 16 years old. The research findings revealed that female participants had a sleep duration exceeding 23.00, which was higher compared to male participants. This accounted for a total of 13 respondents (12.5% of the sample), compared to 8 male respondents (7.7% of the total sample).

**Table 3. Characteristics of respondents based on age, gender, and sleep duration**

| Characteristic | | Sleep Duration | | | | Total | |
|---|---|---|---|---|---|---|---|
| | | ≥ 6 hours | | < 6 hours | | | |
| | | n | % | n | % | n | % |
| Age | 14 years old | 0 | 0 | 1 | 1 | 1 | 1 |
| | 15 years old | 11 | 10.6 | 5 | 4.8 | 16 | 15.4 |
| | 16 years old | 44 | 42.3 | 28 | 26.9 | 72 | 69.2 |
| | 17 years old | 10 | 9.6 | 5 | 4.8 | 15 | 14.4 |
| Gender | Male | 31 | 29.8 | 11 | 10.6 | 42 | 40.4 |
| | Female | 34 | 32.7 | 28 | 26.9 | 62 | 59.6 |

According to Table 3, the majority of respondents who reported a sleep duration of less than 6 hours were 16 years old, comprising 28 respondents (26.9%). Similarly, the majority of respondents who reported a sleep duration of 6 hours or more were also 16 years old, with 44 respondents (42.3%). Female respondents were more likely to have a sleep duration of less than 6 hours, which was greater than that of male respondents, with, 28 respondents (26.9%) and 10 males (10.6%) reporting this sleep duration.

**Table 4. Characteristics of respondents based on age, gender, and sleep quality**

| Characteristic | | Sleep quality | | | | Total | |
|---|---|---|---|---|---|---|---|
| | | Good | | Poor | | | |
| | | n | % | n | % | n | % |
| Age | 14 years old | 1 | 1 | 0 | 0 | 1 | 1 |
| | 15 years old | 13 | 12.5 | 3 | 2.9 | 16 | 15.4 |
| | 16 years old | 46 | 44.2 | 26 | 25 | 72 | 69.2 |
| | 17 years old | 11 | 10.6 | 4 | 3.8 | 15 | 14.4 |
| Gender | Male | 31 | 29.8 | 11 | 10.6 | 42 | 40.4 |
| | Female | 40 | 38.5 | 22 | 21.2 | 62 | 59.6 |

Statistical tests examining the relationship between sleep quality and the occurrence of RAS disclosed no significant association, with a significant value ($p = 0.192 > 0.05$).

## DISCUSSION

The study's findings demonstrated that the frequency and prevalence of RAS incidence during senior high school were primarily observed in individuals aged 15 and 16. These findings of this investigation are corroborated by Riskesdas[2], which reports that the frequency of RAS occurrence in the 15-24 age group (15.24%) is higher than that in other age groups. Additionally, WHO data in Riskesdas highlights that the 15-year-old age group has the highest frequency (15.19%). The study also found that the female respondents (62 individuals, 59.6%) had a higher prevalence of RAS compared to male respondents.

This study's results are consistent with gender-based research, which has shown that the prevalence of RAS is higher in women, with 28 individuals (59.57%) compared to men, with 19 individuals (40.42%).[20] The higher prevalence of RAS in women is associated with one of the predisposing factors for its development in the oral cavity: hormonal factors. Specifically, hormonal imbalances during the luteal phase of the menstrual cycle, involving progesterone and estrogen hormones, have been linked to the occurrence of RAS.[17]

Hormonal imbalance, characterized by low progesterone levels and normal estrogen levels, can reduce anti-inflammatory and chemotactic functions, thereby initiating the development of RAS. This mechanism also explains why RAS does not occur during pregnancy, a period when estrogen and progesterone levels are elevated.[21] The regulation of these two hormones is controlled by follicle-stimulating hormone (FSH) and luteinizing hormone (LH). The role of female reproductive hormones in the development of RAS may be attributed to the influence of progesterone and estrogen, which disrupt innate and cell-mediated immunity.

The production of large quantities of the hormone cortisol and stress responses in women can be induced by hormonal changes during the menstrual cycle.[22] An increase in cortisol levels often occurs as a result from physiologically stress within the body. This hormone can accelerate the process of protein catabolism, resulting in the easy disintegration of tissue in the oral mucosa, thus ultimately triggers the occurrence of RAS in the oral cavity.[23]

In this study, the occurrence of RAS among the 104 respondents showed that the majority, totaling 94 individuals (90.4%), were positive for RAS, including both male and female (90.4%) senior high school students. Previous research, Recurrent Aphthous Stomatitis (RAS) can manifest in all age groups, with approximately 80% of RAS cases occurring in adolescents between the ages of 10 and 19.[24] In comparison, the age group in this research encompassed eleventh-grade senior high school students, who are classified as either adolescents or individuals between the ages of 14 and 17.

Adolescence may be linked to the emergence of more intricate cognitive processes in students. Adolescents exhibit a more robust response to stress than middle-aged children (7-12 years). Students may experience shock when they are subjected to pressure from both their minds and the external environment, including numerous academic obligations, such as final semester exams, answering class questions, and demonstrating course progress. Prolonged tension is a risk factor for Recurrent Aphthous Stomatitis and can lead to health issues.[25]

The table shows that positive RAS was found to be higher in good sleep patterns (71.2%) than in bad sleep patterns (19.2%), and based on the Chi-square statistical test, the results of the study showed a significant relationship between the two variables, with a p-value of 0.043. These findings contradict previous research[26], which demonstrated that 65.9% of RAS patients in their study encountered poor sleep patterns, with a statistically significant correlation.

Various immunocompetent cells can increase an individual's risk of developing diseases, including RAS, as a consequence of changes at the molecular level resulting from irregular sleep patterns. While previous study have reported

the relationship between sleep patterns and RAS, the correlation was weak and not statistically significant.[27] This research suggests that the predisposing factors for RAS in students are not limited to a single cause but are activated by a combination of factors. Stress is one of the multifactorial contributors to RAS. Additional research has demonstrated that a healthy lifestyle contributes to the development of RAS.[28] It is important to prioritize good sleep habits as a part of a healthy lifestyle.

In this study, RAS was most frequently observed in the group of students who had a bedtime before 11 p.m., as indicated by the sleep duration of those with RAS. This group comprised 78 students who tested positive for RAS. The statistical tests revealed a correlation between the incidence of RAS and bedtime, with a p value of 0.014. These findings contrast with those of previous research [12], which identified late bedtime as a substantial independent risk factor for RAS, with cumulative bedtimes after 11 p.m., exacerbating the severity of RAS. The control of RAS may be accomplished through the implementation of earlier bedtimes, increasing sleep duration or both. Previous studies suggest that the majority of individuals with positive RAS had a late bedtime, typically after than 11 p.m. which is in contrary to the results of the research. This suggests that a late bedtime had a significant impact on the incidence of RAS, as discussed in prior research.[29]

Variations in sleep duration can influence the secretion of growth hormones, cortisol and ACTH. Growth hormones play a key role in fibroblast proliferation, keratinocyte migration, and T-cell differentiation. Their secretion reaches its maximum during the night and persists for several hours. However, delayed nighttime sleep reduces the secretion of growth hormone levels, leading to increased inflammation, heightened allergic reactions, and delayed healing process.

Similarly, the release of inflammatory substances can be inhibited by normal levels of cortisol and ACTH. These hormone levels are typically low during the early hours of sleep; however, a late bedtime can lead to their elevation. These elevated hormone levels, along with increased growth hormone levels, can exacerbated inflammation, allergic reactions, and delayed healing., These combined mechanisms can further aggravate inflammation, contributing to the development of RAS.

Furthermore, the research results reported that the majority of RAS patients, 35 (33.7%) students, had a sleep duration of less than 6 hours, while 53 (56.7%) students had a sleep duration of 6 hours or more. However, statistical tests conducted in this study indicated no significant relationship between the incidence of RAS and sleep duration, with a p value of 0.864. In contrast, previous research demonstrated that 30% of individuals with RAS experienced sleep duration deficiencies.[30]

Sleep disorders cannot always be directly linked to sleep duration. In this study, the sleep duration of RAS patients did not exhibit any significant differences between the groups. Nevertheless, most RAS patients had a sleep duration of less than 6-7 hours, followed by those with a sleep duration of 5-6 hours. The number of hours of sleep required by each individual is highly variable; however, the majority of young adults require approximately 7-8 hours of sleep for optimal health.

Patients with RAS experienced insufficient sleep duration, either due to prolonged wakefulness or consistently reduced daily sleep. The transcription of interleukin-6 (IL-6) messenger ribonucleic acid (mRNA) was induced by sleep loss, resulting in a more than threefold increase, as well as a twofold increase in tumor necrosis factor-alpha (TNF α) mRNA levels. The effects of alterations in the immune system, triggered by these changes, can result in an increase in the severity of sleep deprivation and a delay in ulcer healing, as supported by evidence of the excessive production of pro-inflammatory cytokines and IgM in a study.[31]

The results of this study revealed that the majority of individuals with RAS experienced either fairly good or relatively poor sleep quality. The statistical test analysis yielded a p-value of 0.192, suggesting no significant relationship between sleep quality and RAS. The frequency distribution of sleep quality variables observed in this study are inconsistent with the findings of previous research,[26] which found that the majority of respondents with relatively poor sleep quality were more likely to develop of RAS. Additionally, prior research[32] reported that high school students aged 15–17 exhibited poor sleep quality more frequently than excellent sleep quality. This may trigger the inhibition of the hormone melatonin release, resulting in sleep disorders often caused by a variety of external factors.

During the COVID-19 pandemic, the time students spend in front of screens has increased significantly, potentially negatively affecting their sleep health. These adverse effects can be mitigated by incorporating rest into the nighttime routine, provided that the duration and frequency of the naps are appropriately limited. Online learning methods emerged as the most convenient and secure approach during the pandemic. However, in the future, authorities and decision-makers should consider factors such as the unavailability of smartphones or computers among students, poor network connectivity in remote areas, and an unreliable power supply when planning for the implementation of online teaching.

Prolonged exposure to artificial screens can have a detrimental effect on an individual's sleep health, particularly as students spend extended hours in front of laptop screens for online learning. This exposure is also linked to prolonged sitting, which may cause physical discomfort, such as soreness and fatigue, further leading to sleep disturbances.[33]

The hypothesis of this study has been validated by the results and discussion, which indicate a correlation between the incidence of Recurrent Aphthous Stomatitis (RAS) in senior high school students during the COVID-19 pandemic and their sleep patterns and bedtime.

A limitation of this study is that it was conducted during the COVID-19 pandemic, which necessitates further exploration of other predisposing factors of RAS. Suggestions for further research include conducting direct examinations of respondents and measuring their level of stress and anxiety.

It is also recommended that future studies involve face-to-face interactions with respondents by distributing questionnaires in person and conducting direct oral cavity examinations. This approach would enhance engagement with respondents, increase the number of respondents for greater accuracy and minimize potential bias.

## CONCLUSION

There is a relationship between sleep patterns, bedtime, and the incidence of RAS during the COVID-19 pandemic. The implication of these findings suggest that students should regulate their sleep patterns to ensure optimal sleep duration, thereby minimizing the risk of RAS in an effort to improve quality of life.

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**Informed Consent Statement:** Informed consent was obtained from all subjects involved in the study.
**Data Availability Statement:** Data supporting reported results can be found, including links to publicly archived datasets analyzed or generated during the study.
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