

Original Article

Factors influencing the nutritional status of adolescents during the COVID-19 pandemic: A cross-sectional study

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Abstract

Background: The COVID-19 pandemic substantially altered adolescents' daily routines, including eating habits, physical activity, and sleep patterns, all of which may influence nutritional status. Evidence from Indonesia remains limited, particularly regarding the simultaneous contribution of these behavioral factors during periods of prolonged social restriction.

Objective: This study aimed to examine the associations between dietary patterns, physical activity, sleep quality, and nutritional status among adolescents in Pekanbaru, Indonesia, during the COVID-19 pandemic.

Methods: A cross-sectional study was conducted from June to November 2021 among 75 adolescents aged 15–18 years in Pekanbaru, Riau Province, Indonesia. Participants were recruited through convenience sampling using school and alumni WhatsApp groups. Data were collected online using a structured self-administered questionnaire that included a Food Frequency Questionnaire for dietary patterns, the Indonesian version of the Physical Activity Questionnaire for Adolescents (PAQ-A), and the Pediatric Daytime Sleepiness Scale (PDSS) for sleep-related problems. Nutritional status was assessed using self-reported weight and height to calculate body mass index (BMI), which was then classified into underweight, normal, and overweight categories. Descriptive statistics and chi-square tests were used for data analysis, with statistical significance set at $p < 0.05$.

Results: Of the 75 participants, most were 17 years old (40.0%) and female (70.7%). Overall, 68.0% had normal nutritional status, 18.7% were overweight, and 13.3% were underweight. Chi-square analysis showed significant associations between dietary patterns and nutritional status ($p = 0.001$), sleep quality and nutritional status ($p = 0.001$), and physical activity and nutritional status ($p = 0.001$). These findings indicate that unhealthy dietary patterns, poor sleep-related functioning, and lower physical activity were associated with abnormal BMI categories among adolescents.

Conclusion: Dietary patterns, physical activity, and sleep quality were significantly associated with adolescent nutritional status during the COVID-19 pandemic. These findings highlight the importance of integrated behavioral screening and adolescent health interventions targeting diet, movement, and sleep to support optimal nutritional outcomes.

Background

The Coronavirus Disease 2019 (COVID-19) pandemic, declared in early 2020, has profoundly disrupted social systems worldwide, including education, mobility, and health-related behaviors. Because transmission occurs primarily through respiratory droplets and close interpersonal contact, governments implemented large-scale non-pharmaceutical interventions such as physical distancing, isolation, and restrictions on population movement to mitigate viral spread (Kemenkes, 2020). One of the most consequential measures for adolescents was the prolonged closure of schools, environments characterized by dense social interaction and therefore considered potential transmission hotspots. In Indonesia, nationwide learning-from-home policies were implemented beginning in March 2020 and

continued in various forms for more than a year, substantially altering adolescents' daily routines and behavioral environments (Anderson et al., 2020).

From a public health perspective, these structural disruptions may contribute to the development of obesogenic environments, in which environmental constraints shape behaviors that promote positive energy balance (Nugroho, 2025). Pandemic related restrictions can influence adolescent nutritional outcomes through several interrelated behavioral pathways, particularly dietary intake, physical activity, and sleep patterns. Under normal circumstances, schools provide structured opportunities for daily movement through walking between classes, organized sports, and physical education activities, while also supporting regular eating schedules and stable

sleep or wake routines (Gunawan & Sekartini, 2024). When these institutional structures are disrupted, adolescents may experience reductions in energy expenditure, irregular eating behaviors, and disturbances in circadian rhythms that collectively influence body composition and metabolic health (Feiz et al., 2020).

Empirical evidence accumulated during the COVID-19 pandemic indicates substantial behavioral shifts among children and adolescents. Lockdown conditions have been associated with reductions in moderate to vigorous physical activity, prolonged sedentary behavior, and increased screen exposure. Increased screen engagement may indirectly contribute to excessive caloric intake through mindless snacking and exposure to digital food marketing, while extended time spent at home may also increase reliance on highly processed, energy dense foods rich in sugar, saturated fat, and sodium (Dunton et al., 2020; Storz, 2020). In parallel, sleep disturbances, including delayed sleep onset, shortened sleep duration, and irregular sleep timing, have been widely reported during the pandemic. It may further exacerbate metabolic dysregulation through hormonal mechanisms affecting appetite and satiety (Micklesfield et al., 2021).

Adolescent nutritional problems have consequently been widely documented during the COVID-19 period. Many studies conducted in high income countries report accelerated increases in body mass index (BMI) and a growing prevalence of overweight and obesity among children and adolescents during periods of school closure and restricted mobility (Chang et al., 2021). Meta-analytic evidence suggests that lockdowns were associated with significant weight gain and higher obesity risk in this age group, largely mediated by reduced physical activity, increased sedentary behavior, and disruptions in dietary patterns (Woolford et al., 2021). At the regional level, Southeast Asia has also experienced a growing burden of adolescent overweight and obesity, with recent estimates indicating that approximately 5% of boys and 3% of girls aged 5-19 years were classified as obese in 2020, particularly in urban settings (Tee & Voon, 2024).

However, emerging evidence suggests that the Indonesian context may exhibit nutritional trajectories that differ from patterns observed

in many Western countries. School based surveys conducted in urban areas of Java during the pandemic have documented the coexistence of underweight and overweight among adolescents, accompanied by generally poor dietary quality during the COVID-19 period (Kemenkes, 2022). In addition, a longitudinal study involving Indonesian adolescents reported a slight decline in mean BMI-for-age z-scores (zBMI) over one year of the pandemic, particularly among girls and individuals with higher baseline zBMI (Sarintohe et al., 2025). These findings contrast with international reports describing consistently increasing BMI trends during lockdown periods. Such inconsistencies in epidemiological patterns across settings and timelines highlight the importance of generating context specific evidence on the determinants of adolescent nutritional status in Indonesia during the COVID-19 pandemic.

Conceptually, adolescent BMI during the pandemic can be understood as the product of interacting behavioral determinants influencing overall energy balance. Dietary patterns determine caloric intake and nutrient composition, physical activity regulates energy expenditure and body fat accumulation, and sleep quality influences metabolic regulation through hormonal pathways affecting appetite, satiety, and circadian rhythm (Mecheva et al., 2023). Disruptions in any of these domains may independently contribute to unfavorable nutritional outcomes; however, their combined influence may be particularly important in shaping adolescent weight trajectories during periods of prolonged environmental disruption (Dasdemir et al., 2020).

Despite increasing attention to the health consequences of the COVID-19 pandemic, empirical research examining the simultaneous contribution of dietary patterns, physical activity, and sleep quality to adolescent nutritional status in Indonesia remains limited. Existing studies frequently examine these behavioral domains separately or focus primarily on younger children, leaving an important gap in understanding how these interrelated lifestyle factors collectively influence BMI among adolescents.

Therefore, this study aims to examine the associations between dietary patterns, physical activity, sleep quality, and nutritional status

(BMI) among adolescents in Pekanbaru, Riau, during the COVID-19 pandemic period. By integrating multiple behavioral determinants of energy balance within a single analytical framework, this study seeks to generate context specific evidence that may inform adolescent nutrition interventions and health promotion strategies in Indonesia.

Methods

Study Design

This research used a cross-sectional study design to examine the associations between dietary patterns, physical activity, sleep-related functioning, and nutritional status among adolescents in Pekanbaru, Riau Province, Indonesia. The cross-sectional approach allowed all variables to be measured simultaneously during a single period of data collection from June to November 2021, providing an overview of adolescent health behaviors and nutritional status during the COVID-19 restriction period.

Sampling

Participants were recruited using convenience sampling through school and alumni WhatsApp groups. This study may have been affected by self-selection bias because data were collected online through school and alumni WhatsApp groups; however, invitations were disseminated across multiple groups to improve reach.

Instruments

A structured, self-administered questionnaire comprising validated behavioral and anthropometric measures was used to collect data on dietary patterns, physical activity, sleep-related problem, and nutritional status. Dietary patterns were assessed using a Food Frequency Questionnaire (FFQ) adapted from a previously validated food-frequency instrument for Indonesian adolescents. Dietary patterns were classified as good or poor based on FFQ responses, with good dietary patterns indicating more regular meal frequency and healthier food choices, and poor dietary patterns indicating irregular meals and frequent consumption of energy dense food. Physical activity was measured using the Indonesian

version of the Physical Activity Questionnaire for Adolescents (PAQ-A), which has demonstrated acceptable validity and reliability in Indonesian adolescent samples. Physical activity was categorized as high or low based on the PAQ-A score, with higher scores indicating greater participation in moderate to vigorous physical activity during the previous seven days. Sleep-related problems were evaluated using the Pediatric Daytime Sleepiness Scale (PDSS), which is widely used instrument for assessing daytime sleepiness in adolescents with established psychometric properties internationally. Although local validation evidence in Indonesian populations remains limited, PPDS was retained for consistency with the study's focus on adolescent sleep disturbances. Sleep quality was categorized as having good or poor based on the total score, with higher scores indicating greater daytime sleepiness and poorer sleep related functioning. Nutritional status was determined using body mass index (BMI), calculated from self-reported weight and height, which may introduce measurement bias due to possible underreporting or overreporting of anthropometric data. This limitation was accepted because face to face measurement was not feasible during the pandemic.

Data Collection

Data were collected online using Zoho Forms after informed consent was obtained. The questionnaire collected sociodemographic characteristics, dietary patterns, physical activity, sleep-related problems, and anthropometric data.

Data Analysis

Descriptive statistics were used to summarize demographic characteristics and behavioral variables. Chi-square (χ^2) tests were employed to examine associations between dietary patterns, physical activity, sleep-related functioning, and nutritional status. A significance level of $p < 0.05$ was applied. Statistical analyses were performed using SPSS (version 26).

Ethical Consideration

This study received ethical approval from the Research Ethics Committee for Nursing and Health, Faculty of Nursing, Universitas Riau (Approval No: 312/UN.19.51.8/KEPK.FKp/2021). All participants provided electronic informed consent prior to data collection. Confidentiality and anonymity were ensured, participation was voluntary, and respondents retained the right to withdraw at any time without consequences.

Results

The study sample comprised 75 adolescents aged 15–18 years residing in Pekanbaru. The characteristics of the participants in this study are presented in Table 1.

Table 1. Respondent Characteristics

Characteristics	n (%)
Age Group	
15 years old	14 (18.7)
16 years old	14 (18.7)
17 years old	30 (40.0)
18 years old	17 (22.7)
Gender	
Male	22 (29.3)
Female	53 (70.7)
Birth Order	
Firstborn	38 (50.7)
Second-born	15 (20.0)
Third-born	13 (17.3)
Fourth-born or later	9 (12.0)
Living Arrangement	
With parents	64 (85.30)
With family	6 (8.0)
Dormitory	2 (2.7)
Other	3 (4.0)
Parental Income (IDR/Month)	
<3 million	17 (22.7)
3-6 million	36 (48.0)
6-12 million	2 (2.7)
>12 million	3 (4.0)
Nutritional Status	
Underweight	10 (13.3)
Normal	51 (68.0)
Overweight	14 (18.7)

Based on respondent characteristics in Table 1, the majority were aged 17 years, predominantly female, and primarily resided with their parents. Most respondents originated from modest family backgrounds, with parental income most frequently falling within the 3-6

million IDR range, exceeding the regional minimum wage (UMK). However, these characteristics do not fully represent the general adolescent population. This limitation likely stems from online sampling via WhatsApp, favoring participants with smartphone access and sufficient internet data. Alternative sampling methods may yield differing results. For the nutritional status of adolescents, we assessed using self-reported weight and height data from the questionnaire. These measurements were converted to body mass index (BMI) values, with classification performed according to Z-scores. As shown in Table 1, 18,7% of adolescents were categorized as overweight, while 13,3% were underweight.

Table 2 presents the associations between dietary pattern, sleep quality, physical activity, and body mass index (BMI) categories among adolescents during the COVID-19 pandemic. Overall, the findings indicate that all examined behavioral factors were significantly associated with nutritional status.

Among adolescents with a good dietary pattern, 60.5% had normal BMI, 23.7% were overweight, and 15.8% were underweight. In contrast, among those with a poor dietary pattern, a greater proportion were classified as normal weight (75.7%), while 13.5% were overweight and 10.8% were underweight. The chi-square test demonstrated a statistically significant association between dietary pattern and BMI category ($p = 0.001$), indicating that dietary behavior was related to adolescents' nutritional status.

Regarding sleep quality, 69.7% of adolescents with good sleep quality had normal BMI, whereas 18.2% were overweight and 12.1% were underweight. Among those with poor sleep quality, 66.7% had normal BMI, 19.0% were overweight, and 13.3% were underweight. The association between sleep quality and BMI category was also statistically significant ($p = 0.001$), suggesting that sleep-related functioning may contribute to variations in nutritional status.

For physical activity, adolescents with high physical activity showed a lower proportion of normal BMI (55.3%) and relatively higher

proportions of underweight (21.1%) and overweight (23.7%). By comparison, those with low physical activity were predominantly in the normal BMI category (81.1%), while 13.5%

were overweight and 5.4% were underweight. The chi-square analysis confirmed a statistically significant association between physical activity and BMI category ($p = 0.001$).

Table 2. Factors Influencing Nutritional Status

Variables	BMI Category						p-value
	Underweight		Normal		Overweight		
	n	%	n	%	n	%	
Dietary Pattern							
Good	6	15.8	23	60.5	9	23.7	0.001
Poor	4	10.8	28	75.7	5	13.5	
Sleep Quality							
Good	4	12.1	23	69.7	6	18.2	0.001
Poor	6	13.3	28	66.7	8	19.0	
Physical Activity							
High	8	21.1	21	55.3	9	23.7	0.001
Low	2	5.4	30	81.1	5	13.5	

Discussion

This study identified significant associations between adolescent nutritional status and three behavioral factors during the COVID-19 pandemic in Pekanbaru, specifically dietary patterns ($p < 0.001$), physical activity levels ($p < 0.001$), and sleep quality or daytime sleepiness ($p < 0.001$), among 75 adolescents aged 15–18 years. Of all participants, 68% had normal BMI, while 18.7% were classified as overweight and 13.3% as underweight. Furthermore, poor dietary patterns, low levels of physical activity, and inadequate sleep quality were each independently associated with higher odds of both overweight and underweight, indicating a bidirectional vulnerability in adolescent nutritional outcomes.

COVID-19 lockdowns substantially exacerbated Indonesia's adolescent dual burden of malnutrition. National estimates show that the prevalence of overweight among adolescents rose to 18.7%, exceeding the 13.5% reported in Riskesdas (2018), while the proportion classified as underweight reached 13.3%, surpassing the previous thinness prevalence of 8.1%. Similar trajectories were observed among adolescents in urban Surabaya during the period of online learning, where 13.2% were underweight and 18.4% were overweight or obese. These patterns were accompanied by universally poor dietary behaviors, largely driven by the loss of structured school

environments and limited access to healthier cafeteria meals, which led many adolescents to rely more heavily on processed, energy dense foods at home (Jannah et al., 2025). Jannah et al. (2025) on their evidence showing that pandemic related obesogenic environments (restricted mobility, increased screen time, and shifts toward processed food consumption) were strongly associated with rising urban adolescent overweight rates.

Poor dietary patterns were strongly associated with abnormal BMI, reflecting similar trends observed during COVID-19 lockdowns in Indonesia. During lockdowns, most respondents consumed snacks more frequently than pre-pandemic levels. Adolescents exhibited elevated intake of high-calorie processed foods, potentially contributing to excess weight gain (Skolmowska et al., 2021). Ashar et al. (2025) reported a 42% increase in snack consumption and a 67% decrease in vegetable intake during mobility restrictions. An Indonesian school-based study reported that during COVID-19 restrictions, adolescents experienced a coexistence of underweight and overweight, alongside universally poor dietary quality, suggesting that unstructured snacking and reduced access to school meals may contribute to both energy excess and micronutrient deficiencies. School closures also shifted adolescents from structured meal routines to unstructured snacking, may have contributed to

sustained positive energy imbalances and disrupted nutritional status home (Jannah et al., 2025).

Beyond dietary behaviors, the findings also indicate that physical activity played a critical role in shaping adolescents' nutritional status during the pandemic. The observed associations between low physical activity and abnormal BMI in this study are consistent with broader national evidence on adolescent behavioral shifts during COVID-19. Low PAQ-A scores were significantly linked to abnormal BMI, aligning with findings from Mutia et al. (2022) which reported strong associations between reduced physical activity and overweight status ($p < 0.01$) amid nationwide learning from home. Evidence from Rahayu et al. (2025) further demonstrated a marked shift toward sedentary behaviors following the removal of physical education classes and school recess. Collectively, pandemic related confinement was likely associated with active school environments into sedentary home settings, substantially reducing adolescents' energy expenditure and contributing to BMI deviations across weight categories.

In addition to diet and physical activity, sleep-related functioning also emerged as an important behavioral determinant of adolescents' nutritional status in this study. Elevated daytime sleepiness (PDSS) was correlated with abnormal BMI, consistent with Indonesian evidence showing substantial sleep disturbances among adolescents during COVID-19 restrictions. Suja'l et al. (2022) reported that although 65,9% of adolescents slept at least eight hours, their circadian rhythms remained disrupted, demonstrating that sufficient sleep duration did not necessarily translate into optimal sleep quality during the pandemic. Similarly, a study among Laeto et al. (2022) found that 77,82% experienced poor sleep quality accompanied by low physical activity, reflecting the compounded behavioral effects of prolonged home confinement.

While the results offer important evidence on adolescent behaviors during COVID-19, the following limitations should be recognized in interpreting the magnitude and direction of the

observed associations. The cross-sectional design limits the ability to draw causal inferences despite the significant statistical relationships identified. Online convenience sampling during the pandemic may have disproportionately captured digitally connected adolescents, particularly females (70,7%), thereby reducing the generalizability of the findings. Future research should incorporate mixed-methods approaches to better capture contextual determinants of adolescent behavior; conduct local validation studies for behavioral instruments to ensure cultural relevance, and include longitudinal follow-up to observe temporal changes in dietary patterns, physical activity, sleep, and BMI beyond pandemic conditions.

Conclusion and Recommendation

This study involved 75 respondents, predominantly female and aged 17 years. BMI calculations indicated that 68% fell within the normal category, followed by 18% overweight. Chi-square analysis revealed significant associations between dietary patterns, physical activity, sleep quality, and adolescent nutritional status. Future research should explore adolescent dietary patterns in greater detail, particularly caloric quantity, employing alternative sampling methods. This study demonstrated significant associations between dietary patterns, physical activity, sleep quality, and nutritional status among predominantly female adolescents in urban Pekanbaru during the COVID-19 restriction period. Although most participants exhibited normal BMI, the proportions of underweight and overweight exceeded national Riskesdas 2018 estimates, indicating that pandemic-related behavioral disruptions may have exacerbated Pekanbaru's existing triple burden of malnutrition. These findings underscore the importance of integrating behavioral screening encompassing diet, physical activity, and sleep into post-pandemic school health assessments, particularly for digitally connected female adolescents who are more reachable through online platforms. Practical nursing interventions should emphasize regular meal timing rather than calorie counting and encourage brief, scheduled physical activity breaks throughout the day to mitigate the dual

risks of undernutrition and overweight observed in this cohort.

In light of the methodological constraints, including convenience sampling and the single-city setting, the findings cannot be generalized nationally but provide valuable preliminary evidence for informing adolescent health strategies. To advance this line of inquiry, future research should adopt probability-based sampling frames, employ prospective cohort designs to establish temporal relationships between behavioral factors and BMI changes, and utilize objective anthropometric measurements to minimize self-report bias. The use of locally validated sleep assessment instruments, such as the Indonesian PSQI, is also recommended to enhance measurement accuracy. Additionally, multi-city comparative studies involving both urban and rural regions are needed to evaluate contextual differences and strengthen generalizability across diverse Indonesian adolescent populations.

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Declaration of conflict of interest

The authors declare no competing interests.

Declaration on the Use of AI

No AI tools were used in the preparation of this manuscript.

References

- Akbar, M. A. (2024). The important role of community nurses post pandemic covid-19. *Journal of Community Nursing and Primary Care*, 1(1), 26-28. <https://doi.org/10.63202/jcnpc.v1i1.26>
- Amalia, F., & Siahaan, J. (2025). Relationship of parenting patterns in children aged 2-5 years with attitudes preventing stunting: A cross-sectional study. *Indonesian Journal of Health Services*, 2(1), 1-10. <https://doi.org/10.63202/ijhs.v2i1.32>
- Amaliyah, M., Soeyono, R. D., Nurlaela, L., & Kritiastuti, D. (2021). Pola konsumsi makan remaja di masa pandemi Covid-19. *Jurnal Tata Boga*, 10(1), 129-137.
- Amita, D. F., Siti Yuyun Rahayu Fitri, & Wiwi Mardiah. (2024). Intervensi Digital Untuk Meningkatkan Perilaku Makan Buah Dan Sayur Pada Remaja : Systematic Review. *Lentera Perawat*, 5(1), 156-165. <https://doi.org/10.52235/lp.v5i1.294>
- Anderson, R. M., Heesterbeek, H., Klinkenberg, D., & Hollingsworth, T. D. (2020). How will country-based mitigation measures influence the course of the COVID-19 epidemic? *The Lancet*, 395(10228), 931-934. [https://doi.org/10.1016/S0140-6736\(20\)30567-5](https://doi.org/10.1016/S0140-6736(20)30567-5)
- Ashar, A. M., Yusuf, R. A., & B, N. H. (2025). Hubungan perilaku gizi seimbang aktivitas fisik dan perilaku sedentari dengan status gizi pada remaja. *Window of Public Health Journal*, 6(2), 342-353.
- Bastian, A. D., Budianto, Y., & Zulkifli, A. F. B. (2024). Implementation of red rice consumption education for diabetes mellitus patients: A case study. *Indonesian Journal of Health Services*, 1(2), 56-66. <https://doi.org/10.63202/ijhs.v1i2.6>
- Berasategi Santxo, N., Idoiaga Mondragon, N., Ozamiz-Etxebarria, N., & Dosil-Santamaria, M. (2021). Well-Being of adolescents in de-escalation situation: Physical, emotional, social, and academic impact. *Frontiers in Psychology*, 12(August), 1-10. <https://doi.org/10.3389/fpsyg.2021.646027>
- Brand, S., & Kirov, R. (2011). Sleep and its importance in adolescence and in common adolescent somatic and psychiatric conditions. *International Journal of General Medicine*, 425. <https://doi.org/10.2147/ijgm.s11557>
- Brazendale, K., Beets, M. W., Weaver, R. G., Pate, R. R., Turner-McGrievy, G. M., Kaczynski, A. T., Chandler, J. L., Bohnert, A., & von Hippel, P. T. (2017). Understanding differences between summer vs. school obesogenic behaviors of children: The structured days hypothesis. *International Journal of Behavioral Nutrition and Physical Activity*, 14(1). <https://doi.org/10.1186/s12966-017-0555-2>
- Chaabane, S., Doraiswamy, S., Chaabna, K., Mamtani, R., & Cheema, S. (2021). The impact of covid-19 school closure on child and adolescent health: A rapid systematic review. *Children*, 8(5). <https://doi.org/10.3390/children8050415>
- Chang, T., Chen, Y., Chen, W., Chen, C., Hsu, W., & Chou, Y. (2021). Weight gain associated with COVID-19 lockdown in children and adolescents: A systematic review and meta-analysis. *Nutrients*, 13(3668), 1-10.
- Clarke, J., Kipping, R., Chambers, S., Willis, K., Taylor, H., Brophy, R., Hannam, K., Simpson, S. A., & Langford, R. (2021). Impact of COVID-19 restrictions on preschool children's eating, activity and sleep behaviours: A qualitative study. *BMJ Open*, 11(10),

- e051497. <https://doi.org/10.1136/bmjopen-2021-051497>
- Dasdemir, F., Orbatu, D., Bekta, M., & Özkan, B. (2020). Impact of the coronavirus disease 2019 pandemic on obesity, internet addiction, and sleep quality in adolescents. *Journal of Pediatric Nursing*, 66(January), 196–201.
- Destiana, C., Harokan, A., & Zaman, C. (2025). Analysis of factors associated with the incidence of anemia in adolescent girls at the Muara Enim Health Center: A cross-sectional study. *Lentera Perawat*, 6(3), 504–512. <https://doi.org/10.52235/lp.v6i3.491>
- Dunton, G. F., Do, B., & Wang, S. D. (2020). Early effects of the COVID-19 pandemic on physical activity and sedentary behavior in children living in the U.S. *BMC Public Health*, 20(1), 1–13. <https://doi.org/10.1186/s12889-020-09429-3>
- Feiz Arefi, M., Babaei-Pouya, A., & Poursadeqiyani, M. (2020). The health effects of quarantine during the COVID-19 pandemic. *Work*, 67(3), 523–527. <https://doi.org/10.3233/wor-203306>
- Gunawan, T. D., & Sekartini, R. (2024). Physical activity levels and sleep disturbances in Indonesian primary school students during the COVID-19 pandemic. *Paediatrica Indonesiana*, 64(2), 106–112. <https://doi.org/10.14238/pi64.2.2024.106-12>
- Jannah, N. M., Taufiqurrahman, Christyaningsih, J., & Shofiya, D. (2025). Overview of adolescent diet and nutritional status during the covid-19 pandemic at SMAN 17 Surabaya. *Journal of Nutrition Explorations*, 3(4), 263–271. <https://doi.org/10.36568/jone.v3i4.166>
- Laeto, A. Bin, Putri, S. S. F., Zulissetiana, E. F., & Swanny. (2022). Hubungan kualitas tidur remaja selama pandemi COVID-19 dengan aktivitas fisik serta screen time. *Jurnal Kesehatan Islam*, 11(2), 61–66.
- Mecheva, M. D. V., Rieger, M., Sparrow, R., Prafiantini, E., & Agustina, R. (2023). Behavioural and environmental risk factors associated with primary schoolchildren's overweight and obesity in urban Indonesia. *Public Health Nutrition*, 26(8), 1562–1575. <https://doi.org/10.1017/S1368980023000897>
- Meyer, C., Ferrari Junior, G. J., Barbosa, D. G., Andrade, R. D., Pelegrini, A., & Felden, É. P. G. (2017). Análise da sonolência diurna em adolescentes por meio da pediatric daytime sleepiness scale: Revisão sistemática. *Revista Paulista de Pediatria*, 35(3), 351–360. <https://doi.org/10.1590/1984-0462/2017;35;3;00015>
- Micklesfield, L. K., Hanson, S. K., Lobelo, F., Cunningham, S. A., Hartman, T. J., Norris, S. A., & Stein, A. D. (2021). Adolescent physical activity, sedentary behavior and sleep in relation to body composition at age 18 years in urban South Africa. *BMC Pediatrics*, 21(1), 30. <https://doi.org/10.1186/s12887-020-02451-9>
- Mokoginta, F. S., & Manampiring, A. E. (2016). Gambaran pola asupan makanan pada remaja di kabupaten bolaang mongondow utara kandidat skripsi fakultas kedokteran Universitas Sam Ratulangi Manado. *Jurnal E-Biomedik*, 4(2), 1–10.
- Mutia, A., Jumiyati, & Kusdalinah. (2022). Pola makan dan aktivitas fisik terhadap kejadian obesitas remaja pada masa pandemi COVID-19. *Journal of Nutrition College*, 11(1), 26–34.
- Nagata, J. M., Cortez, C. A., Cattle, C. J., Ganson, K. T., Iyer, P., Bibbins-Domingo, K., & Baker, F. C. (2021). Screen time use among US adolescents during the COVID-19 pandemic. *JAMA Pediatrics*, May 2020, 2020–2022. <https://doi.org/10.1001/jamapediatrics.2021.4334>
- Nugroho, A. (2025). Low economic level and the risk of overweight among Indonesian junior and senior high school students. *Jurnal Kesehatan Masyarakat Nasional*, 20(3), 222–229. <https://doi.org/10.7454/kesmas.v20i3.2391>
- Owens, J. A., Babcock, D., & Weiss, M. (2020). Evaluation and treatment of children and adolescents with excessive daytime sleepiness. *Clinical Pediatrics*, 59(4–5), 340–351. <https://doi.org/10.1177/0009922820903434>
- Parekh, Z., & Suryawanshi, Y. (2025). Innovations in Indian healthcare: Unlocking the benefits of telehealth and telemedicine. *Journal of Community Nursing and Primary Care*, 2(1), 9–16. <https://doi.org/10.63202/jcnpvc.v2i1.61>
- Puspitasari, E., Zaman, C., Harokan, A., & Suryani, D. (2025). Analysis of factors affecting the incidence of anemia in adolescent girls at Nawangsasi Health Center: A cross-sectional study. *Lentera Perawat*, 6(3), 411–418. <https://doi.org/10.52235/lp.v6i3.485>
- Rahayu, D., Idayanti, I., Paramita, I. S. (2025). Adolescent education for weight monitoring, nutritional status, and physical activity. *Jurnal Abmas Negeri*, 6(2), 259–269.
- Risikesdas. (2018). Laporan nasional riset kesehatan dasar taun 2018. Badan Penelitian dan Pengembangan Kementerian Kesehatan RI.
- Sarintohe, E., Burk, J., Vink, J. M., & Larsen, K. (2025). Changes in body mass index during the COVID-19 pandemic among Indonesian adolescents: The role of sex, urban area, baseline BMI, and appetitive traits. *Obesity Facts*, 18, 169–177. <https://doi.org/10.1159/000543078>
- Skolmowska, D.; Głabska, D.; Guzek, D. (2021). Differences in adolescents' Food Habits Checklist (AFHC)

Scores before and during pandemic in a population-based sample: Polish adolescents' COVID-19 experience (PLACE-19) study. *Nutrients*, 13(1663).

<https://doi.org/https://doi.org/10.3390/nu13051663>

Storz, M. A. (2020). The COVID-19 pandemic: An unprecedented tragedy in the battle against childhood obesity. *Korean Journal of Pediatrics*, 63(12), 477–482.
<https://doi.org/10.3345/cep.2020.01081>

Suja'l, M. N. M., Noviasty, R., Kurniawati, E. R., & Ratih, W. (2022). The association between sleep duration, breakfast routine and nutritional status in Indonesian adolescents during COVID-19 pandemic. *Jurnal Gizi Indonesia*, 10(2), 168–180.

Tee, E. S., & Voon, S. H. (2024). Combating obesity in Southeast Asia countries: Current status and the way forward. *Global Health Journal*, 8(3), 147–151.
<https://doi.org/10.1016/j.glohj.2024.08.006>

Woolford, S. J., Sidell, M., Li, X., Else, V., Young, D. R., Resnicow, K., & Koebnick, C. (2021). Changes in body mass index among children and adolescents during the COVID-19 pandemic. *JAMA - Journal of the American Medical Association*, 326(14), 1434–1436. <https://doi.org/10.1001/jama.2021.15036>