

Long covid syndrome experienced by children in West Sumatra, Indonesia

Mega Utami Basra, Defriman Djafri, Anggela Pradiva Putri

Department of Public Health, Faculty of Public Health, Universitas Andalas, Padang, Indonesia

Article Info

Article history:

Received Dec 11, 2022

Revised Aug 15, 2023

Accepted Sep 13, 2023

Keywords:

Children
COVID-19
Fatigue
Pediatrics
Respiratory disorders
Sleep disorders

ABSTRACT

In several countries, it has been found that people experienced symptoms of COVID-19 even after several weeks or months since they were declared cured or tested negative. This symptom is known as the long COVID-19 syndrome. This study aimed to get an overview of the long COVID-19 syndrome experienced by children. This study was a cross-sectional study conducted in West Sumatra, Indonesia in August-October 2021. The sample was 214 children younger than 18 years old. The results showed that after more than four weeks tested positive for COVID-19, 28.5% of children still have respiratory disorders, 26.2% experienced symptoms of sleep disorders, 23.4% of children experienced fatigue, 11.2% of children experienced symptoms of memory disorders, and 8.42% experienced symptoms of digestive disorders. Although not as much as in adults, this study shows that long COVID-19 syndrome can also occur in children. The clinical manifestations of long COVID-19 were varied in symptoms and can occur alone or in combination simultaneously. Parents should continue to optimize their child's time to rest even though they have declared negative for COVID-19 and keep an eye on the symptoms that still appear.

This is an open access article under the [CC BY-SA](#) license.



Corresponding Author:

Mega Utami Basra

Department of Public Health, Faculty of Public Health, Universitas Andalas

Limau Manis, Pauh, Padang 25163, West Sumatra, Indonesia

Email: megautamibasra@ph.unand.ac.id

1. INTRODUCTION

The number of confirmed positive COVID-19 cases worldwide has surpassed 247,472,724 people as of November 3, 2021, with 5,012,337 death tolls [1]. Some sick people with COVID-19 are asymptomatic or recover quickly, but some have persistent symptoms even weeks or months afterward. This phenomenon is known as the long COVID syndrome. The long COVID syndrome can proceed for 12 weeks or more and cannot be clarified by alternative diagnoses, including ongoing COVID-19 symptoms (from 4 to 12 weeks) and post-COVID syndrome (12 weeks or more) [2]–[4].

The wide range of persistent or recurrent symptoms reported by people after COVID-19 infection includes: shortness of breath, chest pain, fever, cognitive impairment, severe fatigue, headache, skin rash, joint pain, and swelling. This syndrome is frequently accompanied by anxiety and depression, related with extended and erratic symptoms. Typical symptoms vary widely in one person from day to day [5]–[8]. According to the High Health Authority estimates in France, the long COVID syndrome affects 50% of patients one month after recovery, and 10% at six months, even in mildly symptomatic COVID patients [9].

In the United Kingdom (UK), 1,200 children from 890 families experience symptoms of long COVID syndrome. Based on the data of long COVID-19 kids organization, the number of long COVID-19 syndrome is increasing rapidly, and no one has returned to their previous health condition. A statistical report

from the UK office for national calculated that 12.9% of children aged 2 to 11 years, and 14.5% of children aged 12 to 16 years, still have side effects within five weeks of their first infection. It usually takes a few days or weeks to recover from COVID-19, and most need to recover within 12 weeks [10].

The number of children reported to have COVID-19 is not as many as adults. But, findings showed that the new variant of COVID-19 causes more children to be infected with COVID-19 than the previous variant [11]. Until now, the focus of handling the COVID-19 pandemic is still on preventing and overcoming severe symptoms and death in the adults and elderly. However, the real focus of attention also needs to shift to the children especially for long COVID-19 cases. It is imperative to classify groups based on the age variable to create way better choices about disease prevention and management so that future healthcare providers, researchers, and educators recognize the age-related impacts of long COVID syndrome [10], [12], [13].

As of March 28, 2021, as many as 31,455 people were confirmed positive for COVID-19 in West Sumatra, Indonesia. 13.9% of them are children, which is around 4,372 children [14]. With the possibility of developing variations of the COVID-19 virus and the potential for long COVID-19 syndrome, it is also necessary to research the long COVID-19 syndrome in children considering that there is not much information and research about it in Indonesia, especially in West Sumatra Province. Therefore, this study aimed to identify the symptoms of long COVID-19 syndrome experienced by children in West Sumatra.

2. RESEARCH METHOD

This study was quantitative research using descriptive cross-sectional approach to see the distribution of long COVID-19 syndrome symptoms in children, such as memory disorders, sleep disorders, body temperature disorders, cardiovascular disorders, respiratory disorders, digestive disorders, and fatigue, after more than four weeks of being confirmed positive for COVID-19. The research was carried out in West Sumatra Province, with the research time started from August to October 2021. The study population was children younger than 18 years old in West Sumatra Province confirmed positive for COVID-19. The research samples were 214 children that were part of the population.

The primary data were collected from respondents who joined the research voluntarily by filling in an online questionnaire. A questionnaire by University College London regarding long COVID-19 syndrome was modified so it would be suitable for children research subjects [15]. The parents or guardians of the children filled out the questionnaire considering that the children could not do it by themselves. This study obtained ethics approval from the Faculty of Public Health, Universitas Andalas research ethics committee, with registered number 5/UN16.12/KEP-FKM/2021.

3. RESULTS AND DISCUSSION

3.1. Long COVID-19 symptoms category

Table 1 shows 121 children, or more than half of the respondents (56.5%), experienced long COVID-19 syndrome. This is in line with a cross-sectional study involving 129 children ≤ 18 years old diagnosed with COVID-19 in Rome, Italy, from March to November 2020. It showed that 52.7% of children had at least one symptom for 120 days after diagnosis [16]. In England and Wales, a research study conducted on 174 children affected by COVID-19 revealed that 4.6% of them reported experiencing symptoms that persisted for a duration of more than four weeks [17]. An online platform created by a parent association called long COVID-19 kids was used to collect data from 510 children residing in the UK and the United States. Only children who had COVID-19 symptoms lasting for more than four weeks were included in the study. The findings indicated that the median duration of symptoms was 8.2 months. Among the participants, 25.3% experienced persistent long-COVID symptoms, 49.4% had symptoms that varied over time, and 19% dealt with recurring symptoms after a period of wellness [18].

A cross-sectional study conducted nationwide, which involved children between the ages of 0 and 14 with a confirmed positive polymerase chain reaction (PCR) test for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (cases), along with matched controls, revealed that children who had contracted a SARS-CoV-2 infection had a higher occurrence of persistent symptoms compared to the control group [19]. Patients affected by COVID-19 face the potential risk of organ deterioration, which may necessitate an extended recovery period and result in long-term consequences. The SARS-CoV-2 virus has the ability to impact various organs, including the heart, lungs, nervous system, and other bodily systems, leading to potential harm [20].

Children can have several symptoms of long COVID-19 at the same time. Based on our result in Table 1, some children simultaneously experienced two long COVID syndrome symptoms (20.1%) and more than two symptom categories (12.1%). This finding is supported by some studies that long COVID-19 shows very varied clinical manifestations. Buonsenso *et al.* [16] found that 20 out of 30 children (66.6%) evaluated

between 60 and 120 days after initial COVID-19 had at least one persisting side effect (13 had one or two symptoms, seven had three or more). A recent study conducted at the Children's Clinical University Hospital in Latvia focused on long-COVID-19 and involved 236 pediatric patients who had contracted COVID-19, along with a comparison group of 142 patients. Following a median follow-up period of 73.5 days, the study revealed that nearly 70% of the participants experienced at least one persistent symptom, while more than 50% reported two or more persistent symptoms [21]. Mechanically, diverse patient symptoms may stem from direct damage from a viral disease, impaired immune reaction, opportunistic bacterial contaminations, and mental health indications that are connected with physiological symptoms in complex ways [22]. Long COVID-19 contributes to the possibility of persistent viral infections and interferes with immune responses. It may include a few conditions with distinctive etiologies and more than one mechanism, even within the same patient.

Table 1. Distribution of long COVID-19 syndrome experienced by children

Long COVID-19 syndrome	f	%
Yes	121	56.5
1 symptom category	52	24.3
2 symptom categories	43	20.1
>2 symptom categories	26	12.1
No	93	43.5
Total	214	100.0

3.2. Characteristics of respondents

Most respondents were 10-18 years old (49.5%), with half experiencing long COVID-19 symptoms. More than half of each age group experienced long COVID-19 symptoms, as shown in Table 2. It is in line with research by Ludvigsson [12] who found that children with the potential for long COVID-19 had an average age of 12 years (range 9-15). They experience symptoms until eight months after being diagnosed with COVID-19. Meanwhile, our research found that the number of female respondents (59.3%) was more than male respondents (40.7%). Girls may be more susceptible to this than boys [12]. For the sake of making the right decisions regarding the prevention and management of long COVID-19 syndrome in children, it is essential to do grouping based on age and gender variables.

Table 2. Distribution of children's characteristics

Characteristics	Long COVID-19 symptoms				Total	
	Yes		No			
	f	%	f	%	f	%
Age (years old)						
0-5	30	14.0	25	11.7	55	25.7
6-9	33	15.4	20	8.3	53	24.8
10-18	58	27.1	48	22.4	106	49.5
Total	121	56.5	93	43.5	214	100.0
Sex						
Male	51	23.8	36	16.8	87	40.7
Female	70	32.7	57	26.6	127	59.3
Total	121	56.5	93	43.5	214	100.0

3.3. Symptoms of long COVID-19 syndrome on children

3.3.1. Respiratory disorders

Table 3 shows the symptoms category of long COVID-19 syndrome that happened to children. For respiratory disorders (28.5%), some children experienced dry cough (53 cases), sore throat (31 cases), cough with phlegm production (18 cases), runny-nosed (16 cases), and shortness of breath (8 cases). This is in line with research by Buonsenso *et al.* [16] that long COVID-19 symptoms such as breathing problems (14.7%) and nasal congestion (12.4%) were the most reported effects. These symptoms happen in children with symptomatic and asymptomatic acute COVID-19. Research by Ludvigsson [12] found that children with long COVID-19 had dyspnea and sore throats. Another study also shows that children within five weeks of a positive COVID-19 test result had one of the following symptoms: sore throat, shortness of breath, and cough [23]. A clinical trial that characterized both morphologic and functional changes of lung parenchyma at low-field-strength magnetic resonance imaging (MRI) showed persistent pulmonary dysfunction in children and adolescents who recovered from COVID-19 and those with long COVID-19 compared with healthy controls [24]. COVID-19 can produce ongoing lung problems, both serious or mild infections can cause persistent shortness of breath. Lung recuperation after COVID-19 is possible but takes time. Specialists said it could take months for a person's lung function to return to normal [25].

Table 3. Symptoms of long COVID-19 syndrome on children

Symptoms category		f	%
Respiratory disorder			
Yes		61	28.5
	Dry cough.	53	
	Cough with phlegm production.	18	
	Shortness of breath.	8	
	Sore throat.	31	
	Runny-nosed.	16	
	Breath shaking/rattling.	4	
No		153	71.5
Memory disorder			
Yes		24	11.2
	Not being able to remember/concentrate on new things, such as the name of a new person/assignment.	18	
	Short-term memory loss (memory that lasts only a few hours/minutes/seconds).	2	
	Long-term memory loss (forgetting yesterday or so).	4	
No		190	88.8
Sleep disorder			
Yes		56	26.2
	Difficulty of sleeping/insomnia/waking up several times while sleeping.	54	
	Night sweats.	16	
	Frequent awakenings due to shortness of breath/difficulty breathing.	2	
No		158	73.8
Body temperature disorder			
Yes		14	6.5
	Frequent fever (38 degrees celsius or more).	7	
	Sloping body temperature (37.1-37.9 degrees celsius).	6	
	Cold/not feeling well/easy to sweat.	6	
No		200	93.5
Cardiovascular disorder			
Yes		7	3.3
	Increased heart rate of more than 90 bpm (tachycardia).	5	
	Weak heart rate, less than 60 bpm (bradycardia).	1	
	Abnormally low blood pressure.	1	
No		207	96.7
Digestive disorder			
Yes		18	8.4
	Constipation.	5	
	Nauseous.	5	
	Loss of appetite.	15	
	Abdominal pain.	5	
	Diarrhea.	6	
No		196	91.6
Fatigue			
Yes		50	23.4
	It appears after physical or mental activity.	43	
	No physical or mental activity.	7	
No		164	76.6

3.3.2. Memory disorders

There were 11.2% of children experienced symptoms of memory disorders, mainly not remembering or concentrating on new things, such as the name of a new person or assignment (18 cases). Our research is in line with a study by Ludvigsson [12] that found children with long COVID-19 had difficulty concentrating. Research by Buonsenso *et al.* [16] also found that long COVID-19 symptoms such as concentration difficulties (10.1%), were the most frequently reported symptoms. Neurologists found that some people develop medium to long-term side effects after COVID-19 infection, including brain fog and tipsiness. The cause of these symptoms is unclear but is in a dynamic range of examination [25]. A paediatric case series showed possible long COVID-19 symptoms in children, with a similar functional brain involvement to those found in adults, regardless of initial severity [26].

3.3.3. Sleep disorders

Our study found that 26.2% of children experienced sleep disorders, as shown in Table 3. Children have difficulty sleeping, insomnia, waking up several times while sleeping (54 cases), and night sweats (16 cases). Buonsenso *et al.* [16] found that long COVID-19 symptoms such as insomnia (18.6%) happened to children with symptomatic and asymptomatic acute COVID-19. A doctor from John Hopkins found that people who survived COVID-19 are more susceptible to postural orthostatic tachycardia syndrome (POTS). Difficulties sleeping or insomnia are part of the symptoms [25].

3.3.4. Body temperature disorders

This study showed that 6.5% of children experienced symptoms of body temperature disorders, such as seven cases of frequent fever (38 degrees celsius or more), six cases of sloping body temperature (37.1-37.90°), six cases of cold, not feeling well, or easy to sweat. This finding was in accordance with a study about persistent symptoms in Swedish children after hospitalization because of COVID-19. It also shows intermittent increases in children's body temperature [27]. There is also a study shows that 12.9% of primary school-aged children and 15% of secondary school-aged children had a fever within five weeks of a positive COVID-19 test result [23]. According to a meta-analysis conducted by Lopez-Leon *et al.* [28] children who were infected with SARS-CoV-2 had a higher likelihood of experiencing persistent fever (OR=1.87). This symptom, along with other long-COVID-related symptoms, such as body temperature dysregulation, is commonly observed in dysautonomia. Dysautonomia refers to a dysfunction in the autonomic nervous system, specifically the sympathetic and parasympathetic branches. However, it remains uncertain whether dysautonomia directly arises from SARS-CoV-2, interacts with other viruses, or is a result of immune-mediated processes, such as cytokines, which play a role in the inflammatory response.

3.3.5. Cardiovascular disorders

Our study shows that as much as 3.3% of children experienced symptoms of cardiovascular disorders such as increased heart rate of more than 90 bpm (tachycardia), weak heart rate, heart rate less than 60 bpm (bradycardia), and abnormally low blood pressure. Research by Ludvigsson [12] also found that children with long COVID-19 had palpitations, chest pain, headaches, and dizziness. This condition showed up even in those who had mild symptoms of COVID-19 and had no medical issues before they got sick. Kids who have experienced the uncommon but severe complication of COVID-19 can be left with heart damage and should be taken after by a pediatric cardiologist [25].

3.3.6. Digestive disorders

Eight point forty-two percent of children experienced the symptoms of digestive disorders in our result, mainly loss of appetite (15 cases) followed by constipation, nauseous, abdominal pain, and diarrhea (5 cases). A study also shows that 12.9% of primary school-aged children and 15% of secondary school-aged children within five weeks of a positive COVID-19 test result had one of the following symptoms: nausea, vomiting, diarrhea, or stomach pain [23]. Angiotensin converting enzyme 2 (ACE2), the cellular receptor for SARS-CoV-2, is profoundly expressed within the digestive system. Direct harm to the gastrointestinal tract by viral interaction with the squamous and columnar epithelium interceded by the ACE2 receptor can happen and clarify the esophagitis caused by SARS-CoV-2 and diarrhea [29].

3.3.7. Fatigue

Based on Table 3, 23.4% of children experienced symptoms of fatigue. It generally appears after physical or mental activity (43 cases). Buonsenso *et al.* study shows that although the symptoms in children are milder, a survey conducted on 510 children shows that fatigue symptoms are still felt about eight months after being infected and recovering from COVID-19 [18]. Ludvigsson [12] found that some children with long COVID-19 had improved after 6-8 months, but they all suffered from fatigue, and none completely returned to school. The most likely hypothesis includes the simultaneous presence of central, peripheral, and mental health factors. Chronic neuroinflammation and neuromuscular problems cause by COVID-19 also may result in long-term fatigue [30].

Long COVID-19 patients require quick multidimensional diagnostic investigation and treatment to rule out potentially life-threatening developments [22]. All the severe long COVID-19 symptoms cases significantly affected children's daily activities, including decreased school attendance and leisure activities [16], [27]. Children recovering from COVID-19 also need more attention, including further consultations with pediatricians, mental health specialists, and policymakers to implement measures to diminish the impact on children's wellbeing. This study has some limitations. The generalizability of the findings is limited as the study population might not be representative of the general COVID-19 children patients in West Sumatra. Only a limited number of symptoms were included because this study was based on parent-reported symptoms without an objective clinical examination.

4. CONCLUSION

Based on our study results, it can be concluded that long COVID-19 syndrome can also occur in children. The symptoms can occur both alone and in combination at the same time. The most considerable percentages of the symptoms are respiratory disorders, sleep disorders, fatigue, memory disorders, and digestive disorders. Further research is needed to know why and how these symptoms still happen in COVID-19 survivors. Parents need to continue to optimize their child's time to rest even though they have

declared negative for COVID-19 and keep an eye on the symptoms that still appear. Information from the results of this study can be used to prevent problems that arise in children's health due to COVID-19 symptoms in the long term. Policymakers also need to make Long Covid Guidelines for children.

ACKNOWLEDGEMENTS

The author would like to thank all parents who were willing to take the time to participate in this research. The author is also very grateful to the Faculty of Public Health, Universitas Andalas, for financially supporting this research by contract number: 001/BPPT/SPK/PNP/FKM/Unand-2021.





REFERENCES

- [1] World Health Organization, "WHO coronavirus (COVID-19) dashboard," *who.int*, 2021. <https://covid19.who.int/> (accessed Nov. 03, 2021).
- [2] S. Rajan *et al.*, *In the wake of the pandemic: preparing for long COVID*. Copenhagen: European Observatory on Health Systems and Policies, 2021.
- [3] NICE Guidelines, *COVID-19 rapid guideline: managing the long-term effects of COVID-19*. London: National Institute for Health and Care Excellence (NICE), 2020.
- [4] Centers for Disease Control and Prevention, "Long COVID or post-COVID conditions," *cdc.gov*, 2021. <https://www.cdc.gov/coronavirus/2019-ncov/long-term-effects/index.html> (accessed Dec. 17, 2020).
- [5] The Royal Society, "Long COVID: what is it, and what is needed?," *The Royal Society*. pp. 1–5, 2020.
- [6] C. J. Iwua, C. D. Iwu, and C. S. Wiysonge, "The occurrence of long COVID: a rapid review," *Pan African Medical Journal*, vol. 38, pp. 1–12, 2021, doi: 10.11604/pamj.2021.38.65.27366.
- [7] T. D. Vannorsdall *et al.*, "Cognitive dysfunction, psychiatric distress, and functional decline after COVID-19," *Journal of the Academy of Consultation-Liaison Psychiatry*, vol. 63, no. 2, pp. 133–143, Mar. 2022, doi: 10.1016/j.jaclp.2021.10.006.
- [8] J. R. Chevinsky *et al.*, "Late conditions diagnosed 1–4 months following an initial coronavirus disease 2019 (COVID-19) encounter: a matched-cohort study using inpatient and outpatient administrative data—United States, 1 March–30 June 2020," *Clinical Infectious Diseases*, vol. 73, no. Supplement_1, pp. 5–16, Jul. 2021, doi: 10.1093/cid/ciab338.
- [9] Y.-M. Dalmat, "Covid long ou syndrome post-guérison," *Option/Bio*, vol. 32, no. 629–630, pp. 10–11, Mar. 2021, doi: 10.1016/S0992-5945(21)00040-4.
- [10] H. Thomson, "Children with long covid," *New Scientist*, vol. 249, no. 3323, pp. 10–11, Feb. 2021, doi: 10.1016/S0262-4079(21)00303-1.
- [11] N. G. Davies *et al.*, "Estimated transmissibility and impact of SARS-CoV-2 lineage B.1.1.7 in England," *Science*, vol. 372, no. 6538, pp. 1–9, Apr. 2021, doi: 10.1126/science.abg3055.
- [12] J. F. Ludvigsson, "Case report and systematic review suggest that children may experience similar long-term effects to adults after clinical COVID-19," *Acta Paediatrica*, vol. 110, no. 3, pp. 914–921, Mar. 2021, doi: 10.1111/apa.15673.
- [13] S. Lopez-Leon *et al.*, "More than 50 long-term effects of COVID-19: a systematic review and meta-analysis," *Scientific Reports*, vol. 11, no. 1, p. 16144, Aug. 2021, doi: 10.1038/s41598-021-95565-8.
- [14] COVID-19 Handling Task Force, "COVID-19 situation in Indonesia (in Indonesian: *Situasi COVID-19 di Indonesia*)," *covid19.go.id*, 2021. <https://covid19.go.id/situasi#> (accessed Nov. 03, 2021).
- [15] A. Akrami, "Online survey on recovery from COVID-19," *qualtrics.com*, 2021. <https://uclcovid19.fra1.qualtrics.com/jfe/form/SVcZ9liD5VzHqkhZb?source> (accessed Nov. 03, 2021).
- [16] D. Buonsenso *et al.*, "Preliminary evidence on long COVID in children," *Acta Paediatrica*, vol. 110, no. 7, pp. 2208–2211, Jul. 2021, doi: 10.1111/apa.15870.
- [17] F. Miller *et al.*, "Prevalence and characteristics of persistent symptoms in children during the COVID-19 pandemic: evidence from a household cohort study in England and Wales," *Pediatric Infectious Disease Journal*, vol. 41, no. 12, pp. 979–984, Dec. 2022, doi: 10.1097/INF.0000000000003715.
- [18] D. Buonsenso, F. E. Pujol, D. Munblit, D. Pata, S. McFarland, and F. K. Simpson, "Clinical characteristics, activity levels and mental health problems in children with long coronavirus disease: a survey of 510 children," *Future Microbiology*, vol. 17, no. 8, pp. 577–588, May 2022, doi: 10.2217/fmb-2021-0285.
- [19] S. K. Berg *et al.*, "Long COVID symptoms in SARS-CoV-2-positive children aged 0–14 years and matched controls in Denmark (LongCOVIDKidsDK): a national, cross-sectional study," *The Lancet Child & Adolescent Health*, vol. 6, no. 9, pp. 614–623, Sep. 2022, doi: 10.1016/S2352-4642(22)00154-7.
- [20] M. Zhou *et al.*, "Inflammatory profiles and clinical features of Coronavirus 2019 survivors 3 months after discharge in Wuhan, China," *The Journal of Infectious Diseases*, vol. 224, no. 9, pp. 1473–1488, Nov. 2021, doi: 10.1093/infdis/jiab181.
- [21] I. Roge *et al.*, "Comparison of persistent symptoms after COVID-19 and other non-SARS-CoV-2 infections in children," *Frontiers in Pediatrics*, vol. 9, pp. 1–13, Oct. 2021, doi: 10.3389/fped.2021.752385.
- [22] E. Perego, F. Callard, L. Stras, B. Melville-Jóhannesson, R. Pope, and N. A. Alwan, "Why the patient-made term 'long covid' is needed," *Wellcome Open Research*, vol. 5, no. 224, pp. 1–12, Sep. 2020, doi: 10.12688/wellcomeopenres.16307.1.
- [23] Office for National Statistics, "Updated estimates of the prevalence of long COVID symptoms," *ons.gov.uk*, 2021. <https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/healthandlifeexpectancies/adhocs/12788updatedestimatesoftheprevalenceoflongcovidssymptoms> (accessed Jun. 29, 2022).
- [24] R. Heiss *et al.*, "Pulmonary dysfunction after pediatric COVID-19," *Radiology*, vol. 306, no. 3, pp. 1–9, Mar. 2023, doi: 10.1148/radiol.221250.
- [25] T. Chung, A. K. Morrow, A. Parker, M. H. Mastalerz, and A. Venkatesan, "Long COVID: long-term effects of COVID-19," *Johns Hopkins Medicine*, 2022. <https://www.hopkinsmedicine.org/health/conditions-and-diseases/coronavirus/covid-long-haulers-long-term-effects-of-covid19> (accessed Oct. 25, 2022).
- [26] A. Morand *et al.*, "Similar patterns of [18F]-FDG brain PET hypometabolism in paediatric and adult patients with long COVID: a paediatric case series," *European Journal of Nuclear Medicine and Molecular Imaging*, vol. 49, no. 3, pp. 913–920, Feb. 2022, doi: 10.1007/s00259-021-05528-4.
- [27] E. Sterky *et al.*, "Persistent symptoms in Swedish children after hospitalisation due to COVID-19," *Acta Paediatrica*, vol. 110,





- no. 9, pp. 2578–2580, Sep. 2021, doi: 10.1111/apa.15999.
- [28] S. Lopez-Leon *et al.*, “Long-COVID in children and adolescents: a systematic review and meta-analyses,” *Scientific Reports*, vol. 12, no. 1, pp. 1–12, Jun. 2022, doi: 10.1038/s41598-022-13495-5.
- [29] A. M. Bogariu and D. L. Dumitrascu, “Digestive involvement in long- COVID syndrome,” *Medicine and Pharmacy Reports*, vol. 95, no. 1, pp. 5–10, Dec. 2021, doi: 10.15386/mpr-2340.
- [30] V. Fainardi *et al.*, “Long COVID in children and adolescents,” *Life*, vol. 12, no. 2, pp. 1–13, Feb. 2022, doi: 10.3390/life12020285.

BIOGRAPHIES OF AUTHORS







Mega Utami Basra     is a lecturer of Epidemiology and Biostatistics from the Faculty of Public Health, Universitas Andalas, Padang. She mainly working on projects in the field of public health, especially about air borne diseases. She can be contacted at email: megautamibasra@ph.unand.ac.id.



Defriman Djafri     is a researcher and lecturer of Epidemiology and Biostatistics, Faculty of Public Health, Universitas Andalas. He won the Korean Baccalaureate Award, which he received in October 2011, as well as the Young Investigator Award presented to him by the 43rd Asia Pacific Academy Consortium for Public Health (APACPH). His areas of expertise include epidemiology, biostatistics, environmental health, and environmental epidemiology. He can be contacted at email: defrimandjafri@ph.unand.ac.id.



Anggela Pradiva Putri     is a lecturer at Faculty of Public Health, Universitas Andalas, majoring in Reproductive Health. She got a master degree in Public Health at the Universitas Indonesia. She has an interest in research and preventive-promotive community activities. She can be contacted at email: anggelapradivaputri@ph.unand.ac.id.