

ARTICLE INFORMATION

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The association of age, sex, residence, and parental occupation with acute lymphoblastic leukemia in children

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Abstract

Background: The Association of Age, Sex, Place of Residence, and Parental Occupation with Acute Lymphoblastic Leukemia in Children at Dr. H. Abdul Moeloek Regional General Hospital, Bandar Lampung. Acute lymphoblastic leukemia (ALL) represents the predominant hematologic malignancy affecting the pediatric population, with its development believed to be associated with both demographic and environmental determinants.

Purpose: To examine the associations of age, sex, place of residence, and parental occupation (mother) with ALL among pediatric leukemia patients.

Method: This analytical observational study used a cross-sectional design and secondary data from the medical records of 123 pediatric patients with leukemia at Dr. H. Abdul Moeloek Regional Hospital, Bandar Lampung, Indonesia, from January 2024 to December 2025. Total sampling was used. Data were analyzed using the Chi-square test or Fisher's exact test.

Results: Among 123 pediatric leukemia patients, 104 (84.6%) were diagnosed with ALL. Most patients were aged 1–5 years (44.7%), male (71.5%), lived in regency areas (81.3%), and had parents working as farmers/laborers (47.2%). Sex was significantly associated with ALL ($p = 0.011$; OR = 3.511; 95% CI: 1.283–9.607). Parental occupation was also significantly associated with ALL ($p = 0.001$). Age ($p = 0.059$) and place of residence ($p = 0.196$) were not significantly associated with ALL.

Conclusion: Sex and parental occupation were significantly associated with ALL among pediatric leukemia patients, whereas age and place of residence were not. Further studies should assess specific occupational and environmental exposures to clarify potential risk factors for childhood ALL.

Keywords: Acute Lymphoblastic Leukemia; Age; Children; Parental Occupation; Sex.

INTRODUCTION

Acute lymphoblastic leukemia (ALL) is a hematological malignancy characterized by the uncontrolled proliferation of immature lymphoid cells in the bone marrow, which disrupts the production of normal blood cells and ultimately leads to anemia, thrombocytopenia, and an increased risk of infection (Hoffbrand & Steensma, 2019). ALL is the most common type of leukemia in children, accounting for approximately 75% of all pediatric leukemia cases, with a global incidence of approximately 3–4 cases per 100,000 children per year (Escherich et al., 2023;

World Health Organization, 2023). The five-year survival rate in developed countries exceeds 85%; however, treatment outcomes in developing countries, including Indonesia, remain relatively poor due to delayed diagnosis, limited access to treatment facilities, and families' socioeconomic conditions (World Health Organization, 2022; Ward et al., 2014).

In Indonesia, childhood leukemia is one of the major causes of morbidity and mortality among pediatric cancer patients, with an estimated 2,000–2,500 new cases reported annually (Ministry of Health

of the Republic of Indonesia, 2025). Meanwhile, the 2018 Basic Health Research reported an estimated prevalence of childhood leukemia of approximately 2–3 cases per 100,000 children, with an increasing trend in urban areas (Ministry of Health of the Republic of Indonesia, 2019). Demographic factors such as age and sex are known to contribute to variations in ALL incidence, with the highest incidence occurring among children aged 2–5 years and a higher incidence observed in boys (Inaba & Mullighan, 2020). Socioeconomic conditions and parental occupation may also influence environmental exposure and access to healthcare services, potentially affecting disease risk and outcomes (Deschler et al., 2023).

The Lampung Provincial Health Office (2023) reported approximately 120 cases of childhood leukemia treated at healthcare facilities, with Dr. H. Abdul Moeloek Regional Hospital serving as the primary referral hospital for pediatric hematology-oncology services in Lampung Province. Most patients reportedly presented at an advanced stage with severe hematological conditions, which may have been influenced by delayed diagnosis and family sociodemographic factors, such as place of residence and parental occupation (Rahmawati et al., 2024).

However, research examining the relationships between age, sex, place of residence, and parental occupation simultaneously and the occurrence of ALL among children at the referral healthcare level in Lampung Province remains limited. This study provides a comprehensive description of the sociodemographic characteristics of pediatric patients with ALL at Dr. H. Abdul Moeloek Regional Hospital. The findings are expected to serve as a

basis for identifying high-risk groups, promoting early detection, and supporting the planning of pediatric leukemia healthcare policies at the provincial level (Ministry of Health of the Republic of Indonesia, 2025; World Health Organization, 2022).

RESEARCH METHOD

This analytical observational study used a cross-sectional design and secondary data obtained from the medical records of pediatric patients diagnosed with leukemia at Dr. H. Abdul Moeloek Regional Hospital, Bandar Lampung, Indonesia, from January 2024 to December 2025. The study population consisted of 123 pediatric leukemia patients, and all eligible patients were included using total sampling.

The inclusion criteria were patients aged <18 years who had a documented diagnosis of leukemia and complete information regarding age, sex, place of residence, and parental occupation. Patients with incomplete medical records or other comorbidities were excluded.

The independent variables were age (1–5, 6–11, and 12–17 years), sex (male and female), place of residence (Bandar Lampung/Metro and regencies), and parental occupation (civil servant/military/police personnel, private-sector employee, entrepreneur, farmer/laborer, and unemployed/housewife). The dependent variable was leukemia type, categorized as ALL or other leukemia.

Univariate analysis was performed to describe the distribution of each study variable. Bivariate analysis was conducted using the Chi-square test or Fisher's exact test when the expected cell count was <5. Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated where applicable. A p-value <0.05 was considered statistically significant.

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RESEARCH RESULTS

Table Characteristics of Respondent (N=123)

Variable	Results	ALL (+)	Other Leukemia	p-value	OR (95% CI)
Age (Mean±SD) (Years) (Range)	(6.87 ± 4.00)				-
1–5	55/44.7	49/89.1	6/10.9	0.059	
6–11	51/41.5	44/86.3	7/13.7		
12–17	17/13.8	11/64.7	6/35.3		
Gender (n/%)					3.511 (1.283-9.607)
Male	88/71.5	79/89.8	9/10.2	0.011	
Female	35/28.5	25/71.4	10/28.6		
Parental Occupation (n/%)				0.001	-
Civil servant/Military/Police	2/1.6	1/50.0	1/50.0		
Private-sector employee	19/15.4	15/78.9	4/21.1		
Entrepreneur	14/11.4	8/57.1	6/42.9		
Farmer/Laborer	58/47.2	50/86.2	8/13.8		
Unemployed/Housewife	30/24.4	30/100.0	0/0.0		
Place of Residence (n/%)					0.423 (0.141–1.269)
Bandar Lampung/Metro City	23/18.7	17/73.9	6/26.1	0.196	
Regency	100/81.3	87/87.0	13/13.0		

Table presents the characteristics of the 123 pediatric leukemia patients. The mean age was 6.87 ± 4.00 years. The largest age group was 1–5 years (44.7%), followed by 6–11 years (41.5%) and 12–17 years (13.8%). Most patients were male (71.5%) and lived in regency areas (81.3%). The most common parental occupation was farmer/laborer (47.2%).

Of the 123 patients, 104 (84.6%) had ALL and 19 (15.4%) had other types of leukemia. Sex was significantly associated with ALL status ($p = 0.011$). Male patients had higher odds of having ALL than female patients (OR = 3.511; 95% CI: 1.283–9.607). Parental occupation was also significantly associated with ALL status ($p = 0.001$). In contrast, age was not significantly associated with ALL status ($p = 0.059$), and no significant association was observed between place of residence and ALL status ($p = 0.196$).

DISCUSSION

The findings of this study indicate that sex and parental (maternal) occupation were significantly

associated with the occurrence of acute lymphoblastic leukemia (ALL) among pediatric leukemia patients, whereas age and place of residence were not significantly associated with ALL. The peak incidence of ALL among children aged 1–5 years can be explained by the two-hit model of leukemia development, in which an initial genetic mutation (first hit) occurs during the prenatal period and generates a preleukemic cell clone, followed by additional mutations (second hit) influenced by immune responses and exposure to infections that trigger transformation into clinically apparent ALL (de Smith et al., 2025). High-hyperdiploidy, the largest genetic subtype of pediatric ALL, has also been reported to peak at 3–5 years of age (Haas & Borkhardt, 2022). This classical age pattern is supported by an Indonesian meta-analysis and a population-based study in Mexico City, both of which reported a predominance of ALL cases among younger children. However, unlike these studies, the present study found no significant association between age and the occurrence of ALL ($p = 0.059$),

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possibly because the sample sizes in those studies were substantially larger (Garniasih et al., 2022; Duarte-Rodríguez et al., 2024). Conversely, the present findings are consistent with previous studies that found no significant association between age and ALL occurrence or outcomes ($p = 0.664$ and $p = 0.463$, respectively), particularly in studies with limited samples and relatively small numbers of patients aged 12–17 years (Juniasari et al., 2020; Dwiarta et al., 2025).

The significant association between sex and ALL occurrence ($OR = 3.511$) is consistent with global epidemiological evidence showing a male-to-female incidence ratio of approximately 1.2–1.3:1. Genetic factors associated with the X chromosome may contribute to this difference. Females have two X chromosomes, potentially providing genetic redundancy when one allele is mutated, whereas males are hemizygous and lack a second copy of the X chromosome (Idriansari et al., 2025). Hormonal differences may also contribute, with estrogen exerting immunomodulatory and antiproliferative effects on lymphoid cells, whereas androgen has been associated with increased proliferation of hematopoietic progenitor cells (Ginanjar et al., 2025). These findings are consistent with previous studies reporting a higher proportion of male patients with ALL (Aulia et al., 2025; den Boer et al., 2021).

Parental occupation should not be interpreted as a direct cause of ALL but rather as an indirect indicator of occupational environmental exposure and socioeconomic conditions. In the present study, mothers working as farmers or laborers may have been exposed to pesticides, herbicides, and chemical fertilizers, while laborers may have been exposed to organic solvents, benzene, heavy metals, and silica dust (Mahdalena et al., 2024). Biologically, parental exposure to chemicals before conception or during pregnancy may induce oxidative stress and DNA damage in germ cells, potentially resulting in heritable effects in offspring (Wang et al., 2023; Park et al., 2020). This finding is consistent with a previous meta-analysis reporting an increased risk of acute leukemia associated with parental pesticide exposure ($OR = 1.75$) (Karalexi et al., 2021). Another study also found that paternal occupational exposure to silica was associated with an increased risk of ALL ($OR = 2.20$) (Onyije et al., 2022). However, these findings are inconsistent with a study conducted in Sweden, which found no significant association between parental

occupational exposure and childhood leukemia. This discrepancy may be attributable to differences in occupational classification, as the present study used broad occupational categories, whereas the Swedish study assessed specific exposures such as pesticides and silica (Rossides et al., 2022).

The absence of a significant association between place of residence and ALL occurrence ($p = 0.196$) does not indicate that the residential environment has no role in ALL risk. General residential categories may be insufficient to capture specific environmental exposures, such as pesticide concentrations, air pollution, or proximity to industrial areas (Onyije et al., 2022). This finding is consistent with previous studies that also found no significant association between residential proximity and specific environmental exposure sources and childhood leukemia (Bamouni et al., 2022; Mazzei et al., 2022). However, it differs from a study conducted in Tehran, which found that living closer to major roads was associated with an increased risk of leukemia. This discrepancy may be related to differences in exposure assessment, as the present study used broad residential categories, whereas the other study used geographical coordinates or specific distances from pollution sources (Norzaee et al., 2024).

This study has several limitations. First, it was conducted at a single hospital and relied on secondary data from medical records. Second, the comparison group consisted of patients with other types of leukemia rather than children without leukemia. Third, parental occupation and place of residence were categorized broadly, without assessing the specific type, duration, or intensity of environmental or occupational exposures.

CONCLUSION

Among pediatric leukemia patients at Dr. H. Abdul Moeloek Regional Hospital, sex and parental occupation were significantly associated with ALL status, whereas age and place of residence were not. Male patients had higher odds of having ALL than female patients. Because parental occupation was assessed using broad categories without specific exposure measurements, further studies should investigate occupational and environmental exposures in greater detail.

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