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RECURRENT RESPIRATORY INFECTIONS AND THE INCIDENCE OF STUNTING AMONG UNDER-FIVE CHILDREN

Adinda Elsyira Qurroty A'yuny[1], Atriany Nilam Sari[2*], Rufidah Maulina[3], Evi Rokhayati[4], Iffah Indri Kusmawati[5]

[1,2,3,5]Department of Midwifery Study Program' Faculty of Medicine, Universitas Sebelas Maret, Surakarta, Indonesia

[4]Department of Pediatrics' Faculty of Medicine, Universitas Sebelas Maret-Dr. Moewardi Regional General Hospital, Surakarta, Indonesia

**Corresponding Author*: atriany.ns@staff.uns.ac.id.

ABSTRACT

Background: Children who are stunted in the first five years of life have lower learning capacity and productivity, and are at risk of not reaching their full physical and cognitive potential, resulting in poor school performance and low economic productivity as adults. Infectious diseases are a direct causative factor for stunting depending on the frequency of recurrence. Acute respiratory infections is the most common infectious diseases affecting under-five children with an estimated recurrence of 3-6 episodes annually. This study aims to examine the association between recurrent respiratory infections and the incidence of stunting among children aged 24-59 months. **Methods:** An analytic observational study with a cross-sectional design in 88 mothers of children aged 24-59 months who were diagnosed with acute respiratory infections at Sibela Public Health Center selected by purposive sampling, data collection was carried out in June 2023. The mother was interviewed using questionnaire and the children was measured for their height and weight, the immunization status was obtained from maternal and child health book. **Results:** Underweight contributed to the incidence of stunting (p-value=0,001), while mother's occupation status (p-value=0,015) and incomplete immunization status (p-value=0,005) contributed to recurrent respiratory infections. The chi-square test showed that recurrent respiratory infections significantly associated with the incidence of stunting (p-value=0.001). **Conclusion:** There was a significant association between recurrent respiratory infections and stunting, and it was found that enderweight contributed to the incidence of stunting, while having a working mother and incomplete immunization status contributed to recurrent respiratory infections in children.

Keywords: Stunting., Acute Respiratory Infections., Recurrent Respiratory Infections., Under-five

INTRODUCTION

Stunting is the chronic malnutrition indicated by anthropometric index weight-for-age less than -2SD based on WHO child growth standards. Children who experience stunting in the first five years of life have a low learning capacity and productivity, and are at risk of not reaching their full physical and cognitive potential, which results in poor performance at school and low economic productivity as adults . Another impact on children with stunting is a higher risk of developing acute and chronic diseases. More than a million child mortality can be attributed to stunting[2,3].

Stunting was included in the 2nd Sustainable Development Goals (SDGs) target with the global prevalence of stunting at 22% in 2020, while in Indonesia at 24.4% in 2021[4], which is categorized as a chronic health problems by WHO, because the prevalence of stunting exceeds 20%. World Health organization (WHO) states that infectious diseases are a direct causative factor for stunting depending on the frequency of recurrence[1,5].

Acute respiratory infection (ARI) is the most common infectious diseases affecting children under five years of age, with an average of 3-6 episodes annually regardless of their country of residence or socio-economic situation[4,5]. Recurrent respiratory infections (RRIs) is a condition in which children aged 24-35 months experience ≥6 ARI episodes (1 of which may be pneumonia) or ≥2 pneumonia in 1 year and children aged 36-59 months experience ≥5 ARI episodes (1 of which may be pneumonia) or ≥2 pneumonia in 1 year[6]. ARI involves the upper respiratory tract from nasal cavity to larynx, including paranasal sinuses and middle ear, such as sinusitis, otitis media, common cold, tonsilitis, pharyngitis, epiglotitis dan

lower respiratory tract includes the continuation of the respiratory tract from trachea and bronchi to the bronchioles and alveoli, such as bronchitis, bronchiolitis, pneumonia[7]. symptoms are characterized by coughing, difficulty breathing, sore throat, runny nose, earache, and fever, which can interfere with the children's appetite[8]. Infectious diseases even with mild symptoms or during the subclinical phase (asymptomatic) can increase the level of nutrients lost as a metabolic response of the child's body against infection[9]. If this conditions occurs repeatedly, it will have a long-term consequences on the child's linear growth, leading to stunting[10].

Based on preliminary studies, 391 children aged 24-59 months were diagnosed with ARI at Sibela Public Health Center, and 239 children experienced ARI recurrence of 2-18 episodes with a total of 1056 visits in the last 1 year (March 2022 - March 2023). Despite the importance of this issue, there is limited research on it, therefore, this study aims to examine the association between RRIs and the incidence of stunting in under-five children.

2. MATERIALS AND METHODS

This study is an observational analytic with a cross-sectional design. Subjects were mothers of under-five children who were diagnosed with ARI during the last 1 year at Sibela Public Health Center that had fulfilled the inclusion criteria: [1] Mothers of children aged 24-59 months who are willing to take part in the study. [2] Registered at the integrated healthcare center (Posyandu) of the Sibela Public Health Center Working Area [3] Children have experienced ARI at least 1 episode in the last 1 year seen from the Sibela Public Health Center Information and Management System (SIMPUS). The exclusion criteria were: [1] ARI symptoms experienced by children lasting more than 14 days. [2] The presence of congenital abnormalities [3] Has a history of chronic lung disease. [4] Having a history of immunodeficiency disease.

88 from 391 under-five children were selected by purposive sampling, data collection was carried out in June 2023. This study was conducted after obtaining ethical eligibility by The Health Research Ethics Committee of Dr. Moewardi General Hospital Surakarta (1.105/V/HREC/2023).

This study was conducted by measuring children weight using digital weight scale, interviewing mothers using a sociodemographic questionnaire and immunization status from Maternal and Child Health (KIA) book to obtain subject characteristics. RRIs was measured by interviewing mothers using questionnaire that has been tested for validity and reliability, regarding the number recurrency of ARI symptomps including cough, runny nose/nasal congestion, sore throat, earache or discharge, pneumonia diagnosed by doctor or other health workers with children aged 24-35 months experiencing ≥6 ARI episode (1 of which may be pneumonia) or ≥2 pneumonia in 1 year and children aged 36-59 months experiencing ≥5 ARI episode (1 of which may be pneumonia) or ≥2 pneumonia in 1 year were categorized as having. RRIs (chiappini, 2021). The children are measured for height using wireless height meter and then categorized stunting (>-2SD) and non-stunting (≥-2SD) by height-for-age anthropometric index based on WHO child growth standards.

Univariate analysis was performed to describe characteristic of the subjects using frequency distribution and cross-tabulation. Bivariate analysis was performed using the chi-square test to examine the association between RRIs and stunting and spearman rho to examine the characteristics contributes to RRIs and Incidents of stunting. Data were processed using Microsoft Excel and IBM SPSS 26.

3. RESULTS

[Table 1] The distribution characteristics of subjects aged 36-59 months were higher than those aged 24-35 months. The majority of the children were female (53.4%) and had normal weight for their age (64.8%). Most of the children were born with normal birth weight (87.5%) and had complete immunization status (93.2%). Most children were exclusively breastfed without formula or complementary foods until 6 months of age (68.2%). Half of the children were exposed to cigarette smoke at home, while the other half were not. In addition, more than half of the children had working mothers (51.1%), and most mothers had secondary education or graduated from high school (64.8%).

Table 1. Characteristics of Respodents

Characteristic	Frequency (n=88)	Percentage (%)
Age		
24-35 months	28	31.8
36-59 months	60	68.2
Gender		
Male	41	46.6
Female	47	53.4
Weight		
Underweight	27	30.7
Normal	57	64.8
Risk of overweight	4	4.5
Birth weight		
<2500 gram	10	11.4
≥2500-≤4000 gram	77	87.5
>4000 gram	1	1.1
Immunization Status		
Complete	82	93.2
Incomplete	6	6.8
Breastfeeding history		
Exclusive	60	68.2
Non-exclusive	28	31.8
Cigarette smoke exposure		
Yes	44	50
No	44	50
Mother's occupation status		
Worker	45	51.1
Housewife	43	48.9
Mother's education		
Higher Education	15	17
High School	57	64.8
Junior High School	14	15.9
Elementary	2	2.3

The characteristics of the subjects showed that the children with underweight was likely found in stunted children (59,3%) and children with RRIs (42,9%), children with the history of low birth weight (LBW) are more likely to be stunted (12,5%), children with incomplete imunization status were found more in stunted children (66,7%) and children with RRIs (83,3%), the majority of the stunted children were exclusively brestfed (71,8%) and exposed to cigarette smoke (62,5%), the stunted children have more of mothers with primary education (18,8%) and less of higher education (6,3%) than the non-stunted children, and the majority of both stunted children and children with RRIs had non-working mothers (56,3% and 44,2%). However, after performing statistical tests, only underweight contributed to the incidence of stunting [Table 2], while immunization and maternal occupation status significantly contributed to RRIs in children [Table 3].

The majority of the non-stunting children (75%) experienced non-recurrent ARI, while the majority of the stunted children (68,6%) experienced RRIs. The chi-square test shows the association between RRIs and the incidence of stunting were statisically significant [table 4].

Table 2. Subjects Characteristics on The Incident of Stunting

Characteristic	Incidence of Stunting				Spearman's rho	p-value
	Non-stunting (n=56)		Stunting (n=32)			
	n	%	n	%		
Age						
24-35	17	60.7	11	39.2	-0,041	0.701
36-59	39	65	21	35		
Gender						
Male	29	70.8	12	29.2	0,138	0.201
Female	27	57.5	20	42.5		
Weight						
Underweight	11	40.7	16	59.3		
Normal	41	71.9	16	28.1	-0,338	0.001*
Risk of overweight	4	100	0	0		
Birth weight						
<2500 gram	6	60	4	40		
≥2500-≤4000 gram	49	63.6	28	36.4	-0,049	0.653
>4000 gram	1	100	0	0		
Immunization status						
Complete	54	65.9	28	34.1	0,170	0.112
Incomplete	2	33.3	4	66.7		
Breastfeeding history						
Exclusive	37	61.7	23	38.3	-0,069	0.523
Non-exclusive	19	67.9	9	32.1		
Cigarette smoke exposure						
Yes	32	72.8	12	27.2	0,189	0.078
No	24	54.5	20	45.5		
Mother's occupation status						
Worker	31	68.9	14	31.1	0,112	0.300
Housewife	25	58.1	18	41.9		
Mother's education						
Higher Education	13	86.7	2	13.3		
High School	33	57.9	24	42.1	0,146	0.175
Junior High School	9	64.3	5	35.7		
Elementary	1	50	1	50		

Notes:

1. *p-value < 0,05 or <0,01 obtained by spearman's-rho test
2. A positive Spearman correlation indicates that high ratings of the one variable (characteristic) tend to occur with high ratings of the incidence of stunting.
3. A negative correlation indicates that a high rating of the one variable (characteristic) occurs with a low rating of the incidence of stunting.

Table 3. Subjects characteristics on recurrent respiratory infections

Characteristic	ARI				Spearman's rho	*p*-value
	Non-RRIs (n=60)		RRIs (n=28)			
	n	%	N	%		
Age						
24-35	18	64.2	10	35.7	-0,057	0.597
36-59	42	70	18	30		
Gender						
Male	28	68.3	13	31.7	0,002	0.984
Female	32	67.1	15	32.9		
Weight						
Underweight	15	55.6	12	44.4		
Normal	42	48.2	15	17.2	-0,174	0.105
Risk of overweight	3	75	1	25		
Birth weight						
<2500 gram	5	50	5	50		
≥2500-≤4000 gram	54	70.1	23	29.9	-0,153	0.154
>4000 gram	1	100	0	0		
Immunization Status						
Complete	59	72	23	28		
Incomplete	1	16.7	5	83.3	0,299	0.005*
Breastfeeding history						
Exclusive	41	68.3	19	31.7		
Non-exclusive	19	67.9	9	32.1	-0,005	0.961
Cigarette smoke exposure						
Yes	34	77.2	10	22.7		
No	26	59.1	18	40.9	0,195	0.068
Mother's occupation status						
Working	36	80	9	20		
Not Working	24	55.8	19	44.2	0,260	0.015*
Mother's education						
Higher Education	12	80	3	20		
High School	38	66,7	19	33.3	0,121	0.261
Junior High School	10	71.4	4	28.6		
Elementary	0	0	2	100		

Notes:

1. *p-value < 0,05 or <0,01 obtained by spearman's-rho test
2. A positive Spearman correlation indicates that high ratings of one variable (characteristic) tend to occur with high ratings of RRIs.
3. A negative correlation indicates that a high rating of one variable (characteristic) occurs with a low rating of RRIs.

Tabel 4. Association between RRIs and Incidence of Stunting Among Under-five Children

ARI	Incidence of stunting				Total (n)	Percentage (%)	*p*-value
	Non-stunting		Stunting				
	n	%	n	%			
Non-RRIs	45	75	15	25	60	68,2	
RRIs	11	39,3	17	60,7	28	31,8	0,001*
Total	56	63,6	32	36,4	88	100	

Notes: **p*-value < 0,05 obtained by chi-square test

DISCUSSION

A large number of stunted children appear to be underweight [Table 2]. WHO categorizes 3 main factors that cause stunting, including inadequate nutrition, infection, and family and household factors. Undernutrition indicators can also contribute to stunting. This study shows that children who are stunted are more likely to have underweight, this condition is determined because underweight children can experience stunting, wasting, or both[11]. Being underweight indicates that the children lacks the energy and nutrients needed according to his age, if this undernutrition condition lasts long / chronically it can inhibit the children's linear growth (height-for-age)[11]. Previous research examining the correlation between indicators of undernutrition in toddlers found that there was a significant relationship between stunting and underweight[12].

The passive immunity provided by the mother during breastfeeding diminishes after weaning, making children aged 24-59 months more vulnerable to infections even they had more matore and adaptive immune system[13]. Immunization is an intervention to boost children' immune response, and this study shows incomplete immunization status is linked to RRIs [Table 3]. Previous studies have shown that immunizations has been shown to reduce ARI cases[14,15]. It was also found that working mothers statistically contributed to the incidence of RRIs in children, this result is in line with previous research that children with working mothers have a 1.46 risk of children experiencing ARI[16].

The chi-square test confirmed that there is a significant relationship between RRIs and the incidence of stunting in children 24-59 months [Table 5]. When a children's body is exposed to infectious pathogenes, the innate immune system initiates a defense reaction to prevent the infection from spreading. This innate immune system works within the first 0-12 hours after the pathogen enters the body. However, if the ARI-causing agents manage to overcome the innate immune system, the adaptive immune system comes into into its role 12 hours - 5 days after pathogen entry which have specific substances to the antigens produced by the microbes[17]. This immune response is what results in symptoms of fever as a sign of the body's defense against the pathogens, other symptoms such as coughing, and runny nose is an attempt to eliminate the microbes from the body[18]. Fever also increase energy expenditure for each temperature increase (°C) in children by ~7-11% in children[19,20].

The body's immune response requires proper metabolism to function optimally. The body's metabolic response to infection and the demands of the immune system is hypermetabolism, which increases the energy requirements to convert anabolic processes to catabolic and increases waste that will be eliminated through urinary excretion. This hypermetabolism occurs resulting in increased gluconeogenesis, fat acid oxidation, and negative nitrogen balance, leading to protein loss increases the demand for energy and nutrients in the body. The mean protein loss during infections was calculated to be 0.6 g/kg body weight per day, and can reach 1.14 g./kg. body weight per day during the peak of the febrile response[20.]

The results of this study interviews showed 71.6% children experienced appetite disorders during ARI episode. Previous study discovered that the children's calorie intake decreases between 8%-22% during ARI[20]. The severity of the condition when this infection occurs is combined with the impaired appetite that toddlers tend to experience due to the symptoms of ARI leads to an imbalance between nutrient intake and loss in children, which when it occurring repeatedly, can lead to malnutrition and stunting in children[10]. Previous study in Kolkata found that 36.99% of children were stunted due to ARI comorbid factors[21]. Research conducted in various regions of Indonesia has shown a significant relationship between stunting and the frequency of ARI in children. A study in Banyumas, it was observed that stunted children experienced more frequent and prolonged ARI compared to normal children[22]. Another study conducted in Surabaya found a significant relationship between frequency and duracy of ARI and the incidence of stunting in toddlers[23]. However, malnutrition, specifically stunting, was identified as a contributing factor to increased susceptibility to ARI by compromising the immune system, which means children with undernourishment are more likely to experience repeated infections. A study conducted in Bangladesh also identified stunting as a potential risk factor for ARI[24]. Taken together, these findings highlight the importance of integrated interventions to improve nutritional status and reduce the burden of disease, particularly in developing countries.

In conclusion, the study confirms a significant relationship between RRIs and stunting in children. The immune response to ARI, the increased metabolic demand, apetite disorders during infections and the resulting imbalance between nutrient intake and usage contribute to the frequent occurrence of malnutrition and has long-term consequences for the linear growth of children, leading to stunting. It was found that underweight contributed to the incidence of stunting, while having a working mother and incomplete immunization status also contributed to the condition of children experiencing RRIs.

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CONFLICT OF INTEREST

The authors have no conflicts of interest to declare. All co-authors have seen and agree with the contents of the manuscript and there is no financial interest to report.

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