

JMHSJ | Jambura Medical and Health Science Journal

Analysis of Nutritional Intake Determinants and Anemia Incidence in Adolescent Girls in Senior High Schools in Bone Bolango Regency

Amanda Iin Melisa PH Harun, Sunarto Kadir, Vivien Novarina A Kasim

Effectiveness of a Digital Flipbook Intervention on Health Cadres' Knowledge Regarding Child Growth and Development Detection and Stimulation

Putri Rhadiyah, Annisa Sali Pineramas, Akhiat

Effect of an Interactive Educational Intervention on Knowledge and Attitudes toward Cervical Cancer and Its Prevention among Adolescent Girls

Gaipyana Sembriring, Lestarida Nainggolan, Ayi Diah Damayani, et al.

Incision-Site Descemet Membrane Detachment After Femtosecond Laser-Created Versus Manual Clear Corneal Incisions in Cataract Surgery: A Systematic Review

Baiq Nova Fajriyatun, Aloysius Angga Wibowo

Outcome of Triplet Pregnancy with Concurrent Uterine Myoma: Successful Management of a Rare Case

Mirza Aditya Hakim, Syahrul Rauf, Iin Fadhilah Utami Tamasse

Reconstruction at The Edge of Oncologic Safety: Immediate Latissimus Dorsi Flap After Neoadjuvant Chemotherapy in Locally Advanced Triple Negative Breast Cancer

Aldhi Tri Budhi, Taufiq Qurrohman, Annisa Verawati et al.

Vol. 5 No. 2
August 2026



JMHSJ

Jambura Medical and
Health Science Journal

Publish by Faculty of Medicine

Universitas Negeri Gorontalo

Jend. Sudirman St. No. 6, Gorontalo City. Postal Code 96128

<https://ejurnal.ung.ac.id/index.php/JMHSJ/index>



EDITORIAL PREFACE



Dear Readers,

Alhamdulillah, we are pleased to announce the publication of the second edition of the fifth volume of the Jambura Medical and Health Science Journal (JMHSJ), a peer-reviewed journal published by Faculty of Medicine Universitas Negeri Gorontalo. This edition features seven original research articles, one review article, and two case reports contributed by esteemed researchers from various institutions, including Citylife Sehat Jakarta, Pangkalpinang Health Polytechnic of Ministry of Health, Manambai Abdulkadir Hospital Sumbawa, Hasanuddin University, and Universitas Negeri Gorontalo. The diversity of submissions showcases the growing interest in JMHSJ among academics, researchers, and practitioners across Indonesia.

This issue presents a collection of original research articles covering a broad spectrum of public health, clinical, and educational challenges relevant to Indonesian healthcare settings, with a strong emphasis on maternal and child health, nutritional epidemiology, and community-based interventions. The original articles investigate determinants of anemia and stunting among adolescents and toddlers, examine the link between hygiene and nutritional status in children, and evaluate the effectiveness of various health education tools—ranging from animated videos and digital flipbooks to interactive sessions—on knowledge and attitudes regarding scoliosis, child growth monitoring, and cervical cancer prevention, alongside exploring pedagogical strategies like problem-based learning in midwifery education. Complementing these community-focused studies, the issue also includes a systematic review on ophthalmological surgical outcomes and two clinical case reports detailing the successful management of a complex triplet pregnancy with uterine myoma and oncoplastic breast reconstruction after neoadjuvant chemotherapy, thereby bridging the gap between frontline public health research and specialized clinical practice.

We anticipate that future editions will continue to attract a diverse range of articles from various medical fields, reflecting our commitment to advancing knowledge and enhancing the quality of our journal, which has recently achieved accreditation from SINTA 3. We extend our heartfelt gratitude to

all contributors and reviewers for their dedication and support. We wish you an insightful reading experience.

Gorontalo, August 2026

Dr. dr. Muhammad Isman Jusuf, Sp.N



TABLE OF CONTENT

Editorial Board

Chief Editor :

Dr. dr. Muhammad Isman
Jusuf, Sp.N

Managing Editor:

dr. Abdi Dzul Ikram
Hasanuddin, M.Biomed.
Novia Martin, M.Keb.

Section Editor:

dr. Sri Manovita Pateda,
M.Kes, Ph.D
Dr. dr. Vivien Novarina A.
Kasim, M.Kes
Dr. dr. Zuhriana K. Yusuf,
M.Kes
Dr. dr. Edwina R. Monayo,
M.Biomed
Dr. dr. Sri A. Ibrahim, M.Kes
Dr. dr. Andi Sitti Rahma,
M.Kes
Dr. dr. Syatirah Jalaluddin,
Sp.A
dr. Nur Upik En Masrika,
M.Biomed.
dr. Makhyan Jibril Alfarabi,
M.Biomed., M.Sc., Sp.JP,
FIHA
dr. Yanuar Rahmat Fauzi,
Ph.D
dr. Rahmawati Samad, Sp.GK
dr. Muchtar Nora Ismail,
Sp.JP, FIHA
dr. Pascal Adventra
Tandiabang, M.Biomed.

IT Administration :

Ahmad Azhar Kadim, S.Kom,
M.Kom

General Adminisitation :

Sri Wahyuningsih, STr.Keb.

- 1. Analysis of Nutritional Intake Determinants and Anemia Incidence in Adolescent Girls in Senior High Schools in Bone Bolango Regency** **95-115**
Amanda Iin Melisa P.H. Harun, Sunarto Kadir, Vivien Novarina A. Kasim
- 2. Analysis of Determinants Related to Stunting in Toddlers in the Working Area of the Buntulia Community Health Center, Pohuwato Regency** **116-133**
Nur Istiqoma Suja, Sunarto Kadir, Vivien Novarina A. Kasim
- 3. Outcome of Triplet Pregnancy with Concurrent Uterine Myoma: Successful Management of a Rare Case** **134-144**
Mirza Aditya Hakim, Syahrul Rauf, Iin Fadhillah Utami Tamasse
- 4. Incision-Site Descemet Membrane Detachment After Femtosecond Laser-Created Versus Manual Clear Corneal Incisions in Cataract Surgery: A Systematic Review** **145-167**
Baiq Nova Fajriyatun, Aloysius Angga Wibowo
- 5. Analysis of the Relationship between Hygiene Level and Nutritional Status among Children in Wonosari Vilage, Boalemo, Gorontalo** **168-177**
Siti Rakhmatia Paramita Th. Kum, Pascal Adventra Tandiabang, Dewi Nurindah Panai, Astri Anita



TABLE OF CONTENT

Editorial Board

Chief Editor :

Dr. dr. Muhammad Isman
Jusuf, Sp.N

Managing Editor:

dr. Abdi Dzul Ikram
Hasanuddin, M.Biomed.
Novia Martin, M.Keb.

Section Editor:

dr. Sri Manovita Pateda,
M.Kes, Ph.D
Dr. dr. Vivien Novarina A.
Kasim, M.Kes
Dr. dr. Zuhriana K. Yusuf,
M.Kes
Dr. dr. Edwina R. Monayo,
M.Biomed
Dr. dr. Sri A. Ibrahim, M.Kes
Dr. dr. Andi Sitti Rahma,
M.Kes
Dr. dr. Syatirah Jalaluddin,
Sp.A
dr. Nur Upik En Masrika,
M.Biomed.
dr. Makhyan Jibril Alfarabi,
M.Biomed., M.Sc., Sp.JP,
FIHA
dr. Yanuar Rahmat Fauzi,
Ph.D
dr. Rahmawati Samad, Sp.GK
dr. Muchtar Nora Ismail,
Sp.JP, FIHA
dr. Pascal Adventra
Tandiabang, M.Biomed.

IT Administration :

Ahmad Azhar Kadim, S.Kom,
M.Kom

General Adminisitation :

Sri Wahyuningsih, STr.Keb.

- 6. Animated Video-Based Health Education on Primary School Students' Knowledge of Scoliosis: One Group Pretest-Posttest Study** **178-184**
Tinah Tan, Serly Daud, Jesica Mulyadi
- 7. Effectiveness of a Digital Flipbook Intervention on Health Cadres' Knowledge Regarding Child Growth and Development Detection and Stimulation** **185-193**
Putri Rhadiyah, Annisa Sali Pineramas, Akhiat
- 8. Problem-Based Learning as a Strategy to Enhance Metacognitive Skills in Midwifery Education** **194-204**
Annisa Sali Pineramas, Putri Rhadiyah, Rohmatun Karimah
- 9. Effect of an Interactive Educational Intervention on Knowledge and Attitudes toward Cervical Cancer and Its Prevention among Adolescent Girls** **205-220**
Gaipyana Sembiring, Lestarida Nainggolan, Ayi Diah Damayani, Astri Yulia Sari Lubis, Arica, Akhiat
- 10. Reconstruction at The Edge of Oncologic Safety: Immediate Latissimus Dorsi Flap After Neoadjuvant Chemotherapy in Locally Advanced Triple Negative Breast Cancer** **221-233**
Aldhi Tri Budhi, Taufiq Qurrohman, Annisa Verawati, Indra

Analysis of Nutritional Intake Determinants and Anemia Incidence in Adolescent Girls in Senior High Schools in Bone Bolango Regency

Amanda Iin Melisa P.H. Harun^{1,*}, Sunarto Kadir², Vivien Novarina A. Kasim³

¹Master of Public Health, Postgraduate Program, Gorontalo State University, Gorontalo, Indonesia

²Department of Public Health, Faculty of Sports and Health, Gorontalo State University, Gorontalo, Indonesia

³Department of Nutrition, Faculty of Medicine, Gorontalo State University, Gorontalo, Indonesia

*Corresponding Author. Email: amandaharun66@gmail.com, Telp: +6285399816017

ABSTRACT

Introduction: Anemia is a pathological state defined by a reduction in red blood cell mass, evidenced by decreased hemoglobin concentrations (<11 g/dL), hematocrit values, and erythrocyte counts. Preliminary data indicate that out of 3,073 adolescents screened for hemoglobin levels in Bone Bolango Regency, 225 were identified as anemic. This study aims to investigate the factors contributing to the prevalence of anemia among female high school students in this regency.

Method: This study was carried out in three schools in Tapa District, using a quantitative research design. The sample comprised 225 adolescent girls of reproductive age. Logistic regression analysis was used to examine the relationships between anemia incidence and several independent variables, including iron tablet consumption, iron intake, protein intake, vitamin C intake, vitamin B12 intake, zinc intake, meal frequency, and dietary diversity.

Results: The findings indicated that among the adolescent female population in Bone Bolango Regency, 77 individuals were anemic, whereas the remaining 148 presented with normal hemoglobin levels. Bivariate analysis revealed that iron intake was the only variable significantly associated with the occurrence of anemia, with no other factors demonstrating a statistically significant relationship.

Conclusion: This study demonstrates that iron intake is the primary determinant significantly associated with anemia among adolescent girls, showing a stronger influence than other nutritional factors and variables examined in the study.

Keywords: Adolescent girls, anemia, dietary diversity, iron intake, meal frequency



Published by:
Universitas Negeri Gorontalo

Mobile number:
+62852 3321 5280

Address:
Jend. Sudirman St. No.6, Gorontalo
City, Gorontalo, Indonesia

Email:
jmhsj@ung.ac.id

Article History:
Received 23 October 2025
Accepted 16 March 2026
Published 4 April 2026

DOI:
<https://doi.org/10.37905/jmhsj.v5i2.34999>

Introduction

Anemia is defined as a reduction in red blood cell parameters, marked by hemoglobin levels below 11 g/dL.¹ Iron Deficiency Anemia (IDA) remains a global public health challenge, affecting approximately two billion individuals, 80% of whom reside in developing nations. Among pediatric populations, IDA impacts roughly 300 million children aged 6–59 months,² while anemia affects an estimated 600 million preschool and school-aged children globally. Although the prevalence among school-aged children declined from 18.8% in 1995 to 9.9% in 2010, the burden persists.³

Anemia remains a significant public health issue in Indonesia, particularly among young women. According to the 2023 National Health Survey (Survey Kesehatan Indonesia, SKI), the prevalence among adolescents aged 15–24 years stands at 14.6%, compared to 27.7% in pregnant women.⁴ This burden is further emphasized by Riskesdas data, which reports that 30.2% of women of reproductive age experience anemia, with the prevalence peaking at 32% among adolescents aged 15–24 years.⁵

The prevalence of anemia among adolescent girls is 26.50%, while among women of reproductive age (WRA) it reaches 26.9%, indicating that anemia remains a significant public health issue in Indonesia.⁶ Current prevention and control efforts are largely directed toward pregnant women, whereas early preventive measures targeting adolescent girls, who represent future mothers, have received relatively limited attention. Prioritizing preventive strategies among adolescents before they enter marriage may enhance the effectiveness and efficiency of anemia prevention programs.⁷

The high prevalence of anemia is predominantly attributed to inadequate intake of iron tablets and essential nutrients, including protein, vitamin C, vitamin B12, and zinc, relative to daily requirements. This nutritional deficit can be mitigated through dietary incorporation of iron-rich animal and plant-based foods.⁸ Preliminary data from the Bone Bolango Regency Central Bureau of Statistics (BPS) for 2023 indicate that among 3,073 adolescents screened between January and September 2023, 224 were identified as anemic. Accordingly, this study aims to examine factors influencing anemia incidence among female high school students in the regency.

Methods

This quantitative cross-sectional study was conducted from January to May 2025 at three educational institutions in Tapa District: SMK Negeri 1 Bulango Selatan, SMA Negeri 1 Tapa, and Madrasah Aliyah Hubulo. All procedures of this research have been approved by the supervisor and comply with health research ethics which consist of respondent consent,

confidentiality, not harming respondents and fairness.

The target population consisted of 515 female students, from which the sample size was determined using the Slovin formula:⁹

$$n = \frac{N}{1 + N(e)^2}$$

$$n = \frac{515}{1 + 515 (5\%)^2}$$

$$n = \frac{515}{1 + 515 \times 0,0025}$$

$$n = \frac{515}{2,2875} = 225 \text{ Respondents}$$

Based on this formula, a sample size of 225 was obtained. Proportional stratified random sampling was also used to determine the sample size from each school.

$$\frac{\text{Number of Teenagers in Each School}}{\text{Total Population}} \times \text{Number of Sample}$$

Thus, the sample determination can be described as follows:

1) SMK Negeri 1 Bulango Selatan

$$n_1 = \frac{216}{515} \times 225 = 94 \text{ Samples}$$

2) SMA Negeri 1 Tapa

$$n_2 = \frac{256}{515} \times 225 = 112 \text{ Samples}$$

3) Madrasah Aliyah Hubulo

$$n_3 = \frac{43}{515} \times 225 = 19 \text{ Samples}$$

This study used both primary and secondary data sources. Primary data was obtained from observations, interviews, and questionnaires filled out by respondents, while secondary data was obtained from anemia case data in Bone Bolango Regency.

To ensure methodological transparency, the metrics and objective criteria used to measure the research variables are summarized in Table 1.

Data analysis proceeded in three stages. Univariate analysis was employed to describe participant characteristics, including age, class, school, anemia status, compliance with iron supplementation, nutrient intake (iron, protein, vitamin C, vitamin B12, zinc), eating frequency, and dietary diversity. Bivariate analysis using the chi-square test ($\alpha = 0.05$) examined associations between anemia incidence and each independent variable.

Subsequently, multivariate analysis was conducted to identify the factors most strongly associated with anemia.

Table 1. Operational definition and criteria of variables

No	Variable	Definition	Measuring Instrument	Criteria	Scale
1	Dependent Variable Anemia incident	A condition where the hemoglobin level in the blood is <12 mg/dl based on a blood test	Direct examination using the Finger Prick Method using a Hemoglobin measuring tool, the Easy Touch brand.	1. Anemia (If Hb Level < 12. mg/dL). ¹⁰	Nominal
2	Independent Variable Consuming Iron Tablet	Taking supplemental iron tablets consisting of 60 mg of elemental iron and 0.400 mg of folic acid. Each adolescent is given four iron tablets per month, with the dosage being one tablet per week. ¹¹	questionnaires	1. Taking Iron Tablets, if the student is compliant with taking 4 Iron tablets per month. 2. Not taking Iron Tablets, if the student is compliant with taking ≥ 4 Iron tablets per month. ¹²	Nominal
3	Fe Intake	The amount of iron in food consumed in 1 day is obtained from the results of a 24-	Food recall 1 x 24 Hour	1. Sufficient ($\geq 80\%$ RDA). 2. Insufficient ($< 80\%$ RDA). ¹⁴	Ordinal

		hour recall and then compared with the RDA. ¹³			
4	Protein Intake	The amount of protein in food consumed in 1 day is obtained from the results of a 24-hour recall and then compared with the RDA. ¹⁵	Food recall 1 x 24 Hour	1.Sufficient ($\geq 80\%$ RDA). 2.Insufficient ($< 80\%$ RDA). ¹⁴	Ordinal
5	Vitamin C Intake	The amount of vitamin C in food consumed in 1 day is obtained from the results of a 24-hour recall and then compared with the RDA. ¹⁶	Food recall 1 x 24 Hour	1.Sufficient ($\geq 80\%$ RDA). 2.Insufficient ($< 80\%$ RDA). ¹⁴	Ordinal
6	Vitamin B12 Intake	The amount of vitamin B12 in food consumed in one day is obtained from a 24-hour recall and then compared with the RDA. ¹³	Food recall 1 x 24 Hour	1.Sufficient ($\geq 50\%$ RDA). 2.Insufficient ($< 50\%$ RDA). ¹⁴	Ordinal
7	Zinc Intake	The amount of zinc in food consumed in one day is obtained from a 24-hour recall and then	Food recall 1 x 24 hour	1.Sufficient ($\geq 80\%$ RDA). 2.Insufficient ($< 80\%$ RDA). ¹⁴	Ordinal

		compared with the RDA. ¹⁷			
8	Meal Frequency	Daily eating frequency seen based on breakfast, lunch and dinner times. ¹⁸	Food Frequency Questionnaire (FFQ)	1.Frequently ≥ 3 time per day. 2.Rarely < 3 time per day. ¹⁸	Ordinal
9	Food Diversity	Dietary diversity is the number of different types of food consumed in a day. ¹⁹	Food recall 1 x 24 hour	1.Diverse : ≥ 4 types. 2.Not Diverse : $<$ 4 types. ¹⁹	Ordinal

RDA: Recommende dietary allowance

Result

The respondents in this study were characterized by three variables: age, grade level, and school of origin, with a total of 225 female students. As shown in Table 2, the largest proportion of respondents was aged 17 years, with 82 individuals (36.4%), while the smallest proportion was in the 15-year-old age group, with 6 individuals (2.6%). Most participants were in grade XI, with 129 students (57.3%), and no respondents were from grade XII. In terms of school distribution, most respondents were from SMA Negeri 1 Tapa, with 112 students (50.2%), followed by 94 students from SMK Negeri 1 Bulango Selatan and 19 students from Madrasah Aliyah Hubulo.

Distribution of factors influencing anemia incidence among adolescent female students

Frequency distribution analysis was conducted on the questionnaire data to describe the distribution of respondents based on the variables under study (Table 3). The findings revealed that the sample provided information related to the incidence of anemia, iron tablet consumption, dietary intake of iron, protein, vitamin C, vitamin B12, and zinc, as well as meal frequency and dietary diversity. As presented in Table 3, among the 225 respondents, 148 individuals (65.8%) were classified as non-anemic, while the remaining 77 respondents (34.2%) were identified as anemic. Regarding iron tablet consumption, the majority of respondents ($n = 196$; 87.1%) reported not consuming iron supplements, whereas 29 respondents (12.9%) reported regular consumption. In terms of iron intake, 161 respondents (71.6%) were found to have inadequate iron consumption, while 64 respondents (28.4%) met

the recommended intake. Protein intake was adequate among 145 respondents (64.4%), while the remaining 80 respondents (35.6%) had insufficient protein intake. Regarding vitamin C, only 71 respondents (31.6%) demonstrated adequate intake, whereas 154 respondents (68.4%) were categorized as insufficient. Vitamin B12 intake was sufficient in the majority of respondents (n = 160; 71.1%), with the remaining 65 respondents (28.9%) categorized as insufficient. Zinc, an essential micronutrient, was inadequately consumed by 154 respondents (68.4%), while 71 respondents (31.6%) achieved adequate zinc intake. In terms of eating frequency, 144 respondents (64.0%) reported regular meal patterns, while the remaining 81 respondents (36.0%) were categorized as having infrequent meals. Dietary diversity was observed in 98 respondents (43.6%), whereas the majority (n = 127; 56.4%) had a less diverse dietary pattern.

Table 2. Baseline characteristics of respondents

Aspect	Frequency (N=225)	Percentage (%)
Age		
15	6	2.6
16	56	24.8
17	82	36.4
18	66	29.3
19	15	6.67
Grade		
X	96	42.6
XI	129	57.3
XII	0	0
School of Origin		
SMA Negeri 1 Tapa	112	50.2
SMK Negeri 1 Bulango Selatan	94	41.3
Madrasah Aliyah Hubulo	19	8.4

Relationship between iron tablet consumption and anemia incidence among female adolescents in senior high schools in Bone Bolango Regency

Based on Table 4, among the 29 respondents who consumed iron tablets, 20 individuals (13.51%) were not anemic. Among the 196 respondents who did not consume iron tablets, 128

individuals (86.49%) were also not anemic. The results of the Chi-square test produced a *p-value* of 0.698, which is greater than the significance level ($\alpha = 0.05$). Therefore, H_a was rejected, and H_0 was accepted, indicating that iron tablet consumption had no statistically significant association with the incidence of anemia among adolescent girls in senior high schools in Bone Bolango Regency.

Relationship between iron intake and anemia in female adolescents in senior high schools in Bone Bolango Regency

Table 5 indicates that among the 64 respondents with adequate iron intake, 49 individuals (33.11%) were not anemic. In contrast, among the 161 respondents with inadequate iron intake, 99 individuals (66.89%) were not anemic. The Chi-square test results showed a *p-value* of 0.032, which is lower than the significance level ($\alpha = 0.05$). Therefore, H_a was accepted, and H_0 was rejected, indicating a significant relationship between iron intake and the incidence of anemia among adolescent girls in senior high schools in Bone Bolango Regency.

Relationship between protein intake and anemia incidence among female adolescents in senior high schools in Bone Bolango Regency

Table 6 shows that among the 145 respondents with adequate protein intake, 97 individuals (65.54%) were not anemic. Meanwhile, among the 80 respondents with inadequate protein intake, 51 individuals (34.46%) did not experience anemia. The results of the Chi-square test produced a *p-value* of 0.634, which is greater than the significance level ($\alpha = 0.05$). Therefore, H_a was rejected, and H_0 was accepted, indicating that protein intake had no significant association with the incidence of anemia among adolescent girls in senior high schools in Bone Bolango Regency.

Relationship between vitamin C intake and anemia in female adolescents in senior high schools in Bone Bolango Regency

Table 7 indicates that among the 71 respondents with adequate vitamin C intake, 51 individuals (34.46%) were not anemic. Among the 154 respondents with inadequate vitamin C intake, 97 individuals (65.46%) also did not experience anemia. The Chi-square test results produced a *p-value* of 0.194, which is greater than the significance level ($\alpha = 0.05$). Therefore, H_a was rejected, and H_0 was accepted, indicating that vitamin C intake had no significant association with the incidence of anemia among adolescent girls in senior high schools in Bone Bolango Regency.

Table 3. Descriptive factors influencing anemia incidence among adolescent female students

Variable	Frequency (N=225)	Percentage
Incidence of Anemia		
Anemic	77	34.2
Non-Anemic	148	65.7
Iron Tablet Consumption		
Consumed	29	12.8
Not consumed	196	87.1
Iron Intake		
Adequate	64	28.4
Inadequate	161	71.5
Protein Intake		
Adequate	145	64.4
Inadequate	80	35.5
Vitamin C Intake		
Adequate	71	31.5
Inadequate	154	68.4
Vitamin B12 Intake		
Adequate	160	71.1
Inadequate	65	28.8
Zinc Intake		
Adequate	71	31.5
Inadequate	154	68.4
Eating Frequency		
Frequent	144	64
Infrequent	81	36
Food Diversity		
Diverse	98	43.5
Less Diverse	127	56.4

Table 4. Relationship between iron tablet consumption and the incidence of anemia (N=225)

Iron Tablet Consumption	Anemia Incidence				N	%	P-value
	Non-Anemic		Anemic				
	n	%	n	%			
Not consumed	128	86.49	68	88.31	196	87.11	0.698 ^{NS}
Consumed	20	13.51	9	11.69	29	12.89	
Total	148	100	77	100	225	100	

Chi-square test. NS: Not significant

Table 5. Relationship between iron intake and the incidence of anemia (N=225)

Iron Intake	Anemia Incidence				N	%	P-value
	Non-Anemic		Anemic				
	n	%	n	%			
Inadequate	99	66.89	62	80.52	161	71.56	0.032*
Adequate	49	33.11	15	19.48	64	28.44	
Total	148	100	77	100	225	100	

Chi-square test. *significant at $P < 0.05$

Table 6. Relationship between protein intake and the incidence of anemia (N=225)

Protein Intake	Anemia Incidence				N	%	P-value
	Non-Anemic		Anemic				
	n	%	n	%			
Inadequate	51	34.46	29	37.66	80	35.56	0.634 ^{NS}
Adequate	97	65.54	48	62.34	145	64.44	
Total	148	100	77	100	225	100	

Chi-square test. NS: Not significant

Table 7. Relationship between vitamin C intake and the incidence of anemia (N=225)

Vitamin C Intake	Anemia Incidence				N	%	P-value
	Non-Anemic		Anemic				
	n	%	n	%			
Inadequate	97	65.54	57	74.03	154	68.44	0.194 ^{NS}
Adequate	51	34.46	20	25.97	71	31.56	
Total	148	100	77	100	225	100	

Chi-square test. NS: Not significant

Relationship between vitamin B12 intake and anemia incidence among female adolescents in senior high schools in Bone Bolango Regency

Table 8 shows that among the 160 respondents with adequate vitamin B12 intake, 100 individuals (67.57%) were not anemic. Meanwhile, among the 65 respondents with inadequate vitamin B12 intake, 48 individuals (32.43%) did not experience anemia. The Chi-square test results produced a *p-value* of 0.104, which is greater than the significance level ($\alpha = 0.05$). Therefore, H_a was rejected, and H_0 was accepted, indicating that vitamin B12 intake had no significant association with the incidence of anemia among adolescent girls in senior high schools in Bone Bolango Regency.

Table 8. Relationship between vitamin B12 intake and the incidence of anemia (N=225)

Vitamin B12 Intake	Anemia Incidence				N	%	P-value
	Non-Anemic		Anemic				
	n	%	n	%			
Inadequate	48	32.43	17	22.08	65	28.89	0.104 ^{NS}
Adequate	100	67.57	60	77.92	160	71.11	
Total	148	100	77	100	225	100	

Chi-square test. NS: Not significant

Relationship between zinc intake and anemia incidence among female adolescents in senior high schools in Bone Bolango Regency

Table 9 indicates that among the 71 respondents with adequate zinc intake, 48 individuals (32.43%) were not anemic. Meanwhile, among the 154 respondents with inadequate zinc intake, 100 individuals (67.57%) did not experience anemia. The Chi-square test results produced a *p-value* of 0.695, which is greater than the significance level ($\alpha = 0.05$). Therefore, H_a was rejected, and H_0 was accepted, indicating that zinc intake had no significant association with the incidence of anemia among adolescent girls in senior high schools in Bone Bolango Regency.

The relationship between eating frequency and anemia incidence among female adolescents in senior high schools in Bone Bolango Regency

Table 10 shows that among the 144 respondents who reported frequent meal consumption, 97 individuals (65.54%) were not anemic. Meanwhile, among the 81 respondents who reported infrequent meal consumption, 51 individuals (34.46%) did not experience anemia. The Chi-square test results produced a *p-value* of 0.504, which is greater than the significance level ($\alpha = 0.05$). Therefore, H_a was rejected, and H_0 was accepted, indicating that

meal frequency had no significant association with the incidence of anemia among adolescent girls in senior high schools in Bone Bolango Regency.

Table 9. Relationship between zinc intake and the incidence of anemia (N=225)

Zinc Intake	Anemia Incidence				N	%	P-value
	Non-anemic		Anemic				
	n	%	n	%			
Inadequate	100	67.57	54	70.13	154	68.44	0.695 ^{NS}
Adequate	48	32.43	23	29.87	71	31.56	
Total	148	100	77	100	225	100	

Chi-square test. NS: Not significant

Table 10. Relationship between meal frequency and the incidence of anemia (N=225)

Meal Frequency	Anemia Incidence				N	%	P-value
	Non-Anemic		Anemic				
	n	%	n	%			
Inadequate	51	34.46	30	38.96	81	36.00	0.504 ^{NS}
Adequate	97	65.54	47	61.04	144	64.00	
Total	148	100	77	100	225	100	

Chi-square test. NS: Not significant

Relationship between food diversity and the incidence of anemia in female adolescents in senior high schools in Bone Bolango Regency

Table 11 indicates that among the 98 respondents who consumed a varied diet, 59 individuals (39.86%) were not anemic. Meanwhile, among the 127 respondents who consumed a less varied diet, 89 individuals (60.14%) did not experience anemia. The Chi-square test results produced a *p-value* of 0.122, which is greater than the significance level ($\alpha = 0.05$). Therefore, H_a was rejected, and H_0 was accepted, indicating that dietary diversity had no significant association with the incidence of anemia among adolescent girls in senior high schools in Bone Bolango Regency.

Correlation between iron intake and incidence of anemia

Table 12 presents the results of a multivariate analysis using logistic regression to examine the association between iron intake and the incidence of anemia among adolescent girls in senior high schools in Bone Bolango Regency. Logistic regression analysis revealed that iron intake was significantly associated with the incidence of anemia ($P = 0.033$). The

negative coefficient ($B = -0.716$) indicates that higher iron intake is associated with a reduced likelihood of anemia. Specifically, the odds ratio ($\text{Exp}(B) = 0.489$) suggests that individuals with higher iron intake have a 51.1% lower risk of developing anemia compared to those with lower intake, after controlling for other variables in the model.

Table 11. Relationship between food diversity and the incidence of anemia (N=225)

Food Diversity	Incidence of Anemia				N	%	P-value
	Non-Anemic		Anemic				
	n	%	n	%			
Less diverse	89	60.14	38	49.35	127	56.44	0.122 ^{NS}
Diverse	59	39.86	39	50.65	98	43.56	
Total	148	100	77	100	225	100	

Chi-square test. NS: Not significant

Table 12. Logistic regression equation results

	B	S.E.	Wald	df	Sig.	Exp(B)
Step 1a X ₂	-.716	.337	4.522	1	.033	.489
Constant	.248	.438	.320	1	.572	1,281

a. Variable(s) entered on step 1: X₂.

B: Regression coefficient, Df :Degrees of freedom of the test (1), Exp(B):Odds ratio (OR) value, S.E: Standard error of B, Sig.: P-value, Wald :Statistical test to test the significance of coefficient B

Discussion

Anemia incidence

Based on the findings, the majority of respondents were classified as non-anemic ($n = 148$; 65.8%), whereas 77 respondents (34.2%) were identified as anemic. Anemia among adolescent girls is often attributed to inadequate attention to iron intake, a daily diet lacking in iron-rich food sources, and a tendency to consume fast food or nutritionally poor foods. These observations align with the study by Akib and Sumarmi,²⁰ which reported that anemic adolescent girls commonly exhibit dietary habits characterized by low iron consumption.

Anemia remains one of the most prevalent nutritional disorders affecting adolescent girls. The condition, marked by reduced hemoglobin levels, manifests through symptoms such as fatigue, pallor, and diminished concentration. The substantial prevalence of anemia underscores the necessity of addressing dietary patterns, optimizing nutrient intake, and strengthening health education initiatives.²¹

The relationship between iron tablet consumption and anemia incidence

The analysis revealed no significant association between iron tablet consumption and anemia incidence. This finding may be attributed to suboptimal adherence among adolescent girls, who typically consume only two iron tablets per month rather than the recommended frequency of four times monthly. Furthermore, female students often refrain from taking iron supplements due to their unpalatable taste and perceived side effects, particularly nausea. Overall, compliance with iron supplementation remains markedly low among this population, influenced by multiple factors including boredom, laziness, and forgetfulness.

These findings are consistent with previous research by previous studies,²² which reported that 82.2% of adolescent girls demonstrated non-compliance with iron tablet regimens prescribed by health professionals. Compliance, in this context, refers to the behavioral shift from non-adherence to adherence in accordance with established guidelines or instructions. Blood Supplement Tablets (Tablet Tambah Darah, TTD) are oral nutritional supplements formulated to enhance hematopoiesis and circulatory function. These supplements are available in tablet, caplet, or capsule form and may be obtained through two primary channels: government-managed programs or independent acquisition. The government-subsidized TTD Program distributes supplements to targeted populations via public health facilities. Conversely, independently obtained TTDs may be acquired with professional prescription or guidance from private healthcare facilities, pharmacies, or drug stores, or alternatively received as gifts from family members or other individuals.²³

The relationship between iron intake and anemia incidence

The results demonstrated a statistically significant relationship between iron intake and anemia incidence. This association is supported by the finding that certain adolescents avoided vegetable consumption and exhibited irregular adherence to iron supplementation provided by health centers. This behavioral pattern may reflect a lack of perceived importance attributed to iron intake, potentially stemming from inadequate knowledge regarding anemia risks and preventive strategies. Additionally, approximately 35% of the study population resided independently in boarding facilities, which was associated with irregular dietary patterns.

The biological plausibility of this association can be justified where inadequate iron intake directly precipitates a decline in hemoglobin levels, thereby elevating an individual's susceptibility to anemia. These results are consistent with the findings of Warda and Fayasari, who reported that adolescent girls with poor iron intake faced a 35.283-fold higher risk of developing anemia compared to those with adequate iron consumption.²⁴

The relationship between protein intake and anemia incidence

The analysis revealed no statistically significant relationship between protein intake and the incidence of anemia among adolescent girls. Several factors may contribute to inadequate protein consumption in this population. During early adolescence, females experience an accelerated growth phase that results in higher protein requirements compared to their male counterparts. However, findings from this study indicate that the types and quantities of food consumed by adolescent girls are often inconsistent with their age-specific nutritional needs. Dietary patterns observed among respondents included frequent consumption of tea or coffee, which is known to inhibit iron absorption and may indirectly affect hematological status. Additionally, some participants reported limited food availability at home, characterized by insufficient portions of staple foods and side dishes, or meals consisting predominantly of rice and vegetables. Protein-rich foods such as tempeh and tofu were typically consumed only during main meals, with larger quantities of carbohydrates and protein sources ingested just once daily. However, individuals with low protein intake but adequate consumption of iron and vitamin C were still able to maintain normal hemoglobin levels, suggesting that protein may not be a limiting factor for anemia in the presence of sufficient micronutrient intake. These findings are consistent with the research conducted by Fithria et al., which also reported no significant correlation between protein consumption and the occurrence of anemia in adolescent populations.²⁵

The relationship between vitamin C intake and the anemia incidence

The analysis showed that vitamin C intake was not significantly associated with the incidence of anemia among adolescent girls. Vitamin C is known to enhance iron absorption by up to fourfold, as it forms soluble iron–ascorbate complexes that are more easily absorbed in the gastrointestinal tract. Therefore, the consumption of fresh fruits and vegetables rich in vitamin C is generally considered beneficial for the prevention of anemia.

The lack of a significant relationship between vitamin C intake and anemia in this study may be explained by the timing of consumption. The effectiveness of vitamin C in enhancing iron absorption largely depends on its simultaneous intake with iron-containing foods. When vitamin C is consumed separately from iron sources, such as several hours after meals, its role in facilitating iron absorption becomes minimal, thereby exerting little influence on anemia status.

These findings are consistent with the study by Ningsih,²⁶ which reported no significant association between vitamin C intake and anemia prevalence among adolescents at SMA Negeri 9 Padang. Physiologically, vitamin C acts as a catalyst in the conversion of ferric iron

(Fe³⁺) to ferrous iron (Fe²⁺), thereby facilitating its absorption in the alkaline environment of the duodenum and small intestine. The absorption of non-heme iron can increase up to four times when consumed together with vitamin C. In addition, vitamin C supports the mobilization of iron from transferrin in plasma to ferritin, which ultimately contributes to increased hemoglobin (Hb) levels.¹⁴

The relationship between vitamin B12 intake and anemia incidence

The findings of this study indicate that vitamin B12 intake was not significantly associated with the incidence of anemia. Many respondents reported frequent consumption of fast food and instant processed products, which generally contain low levels of vitamin B12. Limited nutritional knowledge may also contribute to respondents' lack of awareness regarding the importance of consuming foods rich in vitamin B12. The absence of a significant relationship between vitamin B12 intake and anemia may also be explained by other contributing factors. For instance, blood loss during menstruation often plays a more prominent role in the development of anemia among adolescent girls than vitamin B12 deficiency. Consequently, menstrual blood loss may have a greater influence on anemia incidence in this population.

The findings of the present study are consistent with those reported by Supriyadi et al., who investigated the relationship between vitamin B12 consumption and anemia incidence among schoolchildren at MI PUI Kota Cimahi and obtained a *P*-value of 0.329, indicating no statistically significant association between the two variables.²⁷ Vitamin B12 contributes to red blood cell formation and plays a role in facilitating the metabolic processes involved in iron absorption during hemoglobin synthesis. Its primary dietary sources are animal-based foods, which provide the vitamin in a form that is more readily absorbed compared to plant-derived sources.¹⁴

The relationship between zinc intake and anemia incidence

The analysis showed that zinc intake was not significantly associated with the incidence of anemia. This finding may be explained by the fact that although zinc plays a role in metabolic processes in the body, it is not a primary determinant of anemia. The most common form of anemia, particularly among adolescents, is iron deficiency anemia. Therefore, inadequate zinc intake does not necessarily lead to anemia if iron intake remains sufficient. These findings are consistent with the study by Abby et al.,²⁸ which reported no significant association between zinc intake and the incidence of anemia among adolescent girls at SMPN 8 Konawe Selatan.

Zinc functions as an antioxidant that protects red blood cells from oxidative damage caused by free radicals. It also contributes to the activity of enzymes involved in intestinal iron

absorption and the transport of iron within the body. When zinc levels are inadequate, the body's ability to utilize iron efficiently may decline. In addition, zinc supports enzymatic processes related to hemoglobin synthesis, the protein responsible for oxygen transport in red blood cells. Therefore, zinc deficiency can worsen anemia by impairing the production of healthy erythrocytes.²⁹

The relationship between eating frequency and anemia incidence

The analysis results indicate that meal frequency was not significantly associated with the incidence of anemia. During adolescence, dietary patterns often shift toward increased consumption of fast food, which is typically high in fat, calories, and sodium but low in essential nutrients such as folic acid, fiber, and vitamin A. Although inadequate nutritional intake may contribute to the development of anemia, the consumption of nutritionally balanced foods in appropriate quantities plays a crucial role in maintaining overall physical health.

According to a study by Putera et al.,³⁰ anemia may arise from multiple factors. Other determinants that can contribute to the occurrence of anemia include parasitic infections, genetic conditions, and menstrual disorders. In particular, irregular menstrual patterns have been associated with a higher risk of anemia compared with regular menstrual cycles.

The relationship between dietary diversity and anemia incidence

The analysis results indicate that dietary diversity was not significantly associated with the incidence of anemia. Achieving balanced nutrition requires the consumption of a variety of foods, as no single food item contains all essential nutrients in adequate proportions. Therefore, dietary variety is important to help ensure that the body receives sufficient essential nutrients and to prevent nutritional deficiencies.²³ In principle, food consumption aims to supply the body with the necessary nutrients to replace those depleted through physical activity and other physiological processes. While dietary diversity influences the variety and quality of food intake, it does not necessarily determine the quantity of food consumed.³¹ Therefore, maintaining a balance between diverse food choices and appropriate portion sizes is important for achieving adequate nutritional intake.

Variables most related to anemia incidence

Based on the results of the logistic regression analysis, a significance value of 0.033 (< 0.05) was obtained, indicating that iron intake is the variable most significantly associated with the incidence of anemia among adolescent girls in senior high schools in Bone Bolango Regency. Statistically, this variable often demonstrates a significant relationship because the biological mechanism is direct, as iron deficiency is a primary cause of anemia in adolescent girls who experience regular menstruation and therefore have higher iron requirements.

These findings are consistent with a previous study,³² which reported a significant association between iron intake and the incidence of anemia among adolescent girls, most of whom had insufficient iron intake (<70% of the Recommended Dietary Allowance). Iron plays a crucial role in hemoglobin synthesis, and inadequate iron intake can impair the production of red blood cells. Adolescent girls frequently experience low iron intake due to restrictive dieting practices, limited consumption of iron-rich foods such as meat, or dietary patterns dominated by fast food.

Limitation

This study focuses on the incidence of anemia among female senior high school students in Bone Bolango Regency and examines a selected set of variables, including iron tablet consumption, iron intake, protein intake, vitamin C intake, vitamin B12 intake, zinc intake, meal frequency, and dietary diversity. While these variables represent key nutritional factors related to anemia, other biological, behavioral, or environmental factors may also contribute to anemia risk and were beyond the scope of the present analysis. Future studies may expand the range of variables to provide a more comprehensive understanding of anemia determinants in this population.

Conclusion

The prevalence of anemia among adolescent girls in senior high schools in Bone Bolango Regency is 34.2%, while 65.7% of respondents are not affected by anemia. The analysis further indicates that iron intake is significantly associated with the incidence of anemia among adolescent girls. In contrast, other variables examined in this study, namely iron tablet consumption, protein intake, vitamin C intake, vitamin B12 intake, zinc intake, meal frequency, and dietary diversity, do not demonstrate a significant association with anemia incidence. Among all variables analyzed, iron intake emerges as the factor most significantly related to the occurrence of anemia in adolescent girls attending senior high schools in Bone Bolango Regency.

Conflicts of Interest

Nothing to declare.

Funding sources

Nothing to declare.

Acknowledgment

Nothing to declare.

References

1. Warlenda SV, Widodo MD, Candra L, Rialita F. Determinants of Anemia in Adolescent Girls at SMA Negeri 1 Reteh, Reteh District, Indragiri Hilir Regency, 2019. *Phot J Nat Sci Technol.* 2019;9(2):88–98.
2. Youssef MAM, Hassan ES, Yasien DG. Effect of Iron Deficiency Anemia on Language Development in Preschool Egyptian Children. *Int J Pediatr Otorhinolaryngol.* 2020;135:110114.
3. Zhang Y-X, Chen J, Liu X-H. Profiles of Anemia Among School-Aged Children Categorized by Body Mass Index and Waist Circumference in Shandong, China. *Pediatr Neonatol.* 2021;62(2):165–71.
4. Ministry of Health of the Republic of Indonesia. Indonesian Health Survey: Prevalence of Anemia According to Characteristics. Jakarta; 2023.
5. Ministry of Health of the Republic of Indonesia. Basic Health Research Report. Jakarta: Ministry of Health of the Republic of Indonesia; 2018.
6. Elias SO, Ajayi RE. Effect of Sympathetic Stress From the Cold Pressor Test on Left Ventricular Function in Young Healthy Adults. *Physiol Rep.* 2019;7(2):e13985.
7. Fitria L, U.B AR. Effectiveness of the Youth Family Development Program (BKR) in Minimizing Early Marriage in Sidoarjo District. *Ranah Res J Multidiscip Res Dev.* 2024;6(5):1684–97.
8. Sugartini NKA, Wikayanti NPR. Adolescent Girls' Knowledge about Iron Tablets to Overcome Anemia. *J Midwifery Ziiгот.* 2019;2(2):44–7.
9. Fauzy A. Sampling Methods. 2nd ed. South Tangerang: Open University; 2020. 410 p.
10. World Health Organization. Nutritional Anemias. Geneva; 1968.
11. Milah AS. Hubungan Konsumsi Tablet Fe dengan Kejadian Anemia Pada Ibu Hamil di Desa Baregbeg Wilayah Kerja PUSKESMAS Baregbeg Kabupaten Ciamis Tahun 2018. *J Keperawat Galuh.* 2019;1(1):12–36.
12. Lindawati R. Analisis Faktor Yang Berhubungan Dengan Kepatuhan Konsumsi Tablet Fe Pada Remaja Putri di SMA Negeri 3 Kota Serang Provinsi Banten Tahun 2022. *Detector: J Inov Ris Ilm Kesehat.* 2023;1(1):239–55.
13. Dieny FF, Ayuningtyas IN, Tsani AFA, Candra A. Analisis Asupan Zat Besi Heme dan Non Heme, Vitamin B12 dan Asam Fola Serta Asupan Enhancer dan Inhibitor Zat Besi Berdasarkan Status Anemia Pada Santriwati. *J Nutr Coll.* 2022;11(2):171–81.
14. Lewa AF. Hubungan Asupan Protein, Zat Besi Dan Vitamin C Dengan Kejadian Anemia

- Pada Remaja Putri di MAN 2 Model Palu. *J Publ Kesehat Masy Indones*. 2016;3(1):26–31.
15. Safitri IM, Rakhma LR, Mardiyati NL. Hubungan Asupan Energi dan Asupan Protein dengan Kebugaran Jasmani pada Mahasiswa Pendidikan Jasmani Universitas Muhammadiyah Surakarta. *Ranah Res: J Multidisciplin Res Dev*. 2024;7(1):184-96.
 16. Lisa M, Sopiandi, Sulistyaningsih I. Perbedaan Tingkat Konsumsi Sayur dan Buah, Serat, Vitamin C dan Zat Besi Pada Mahasiswi Gizi dan Non Gizi di Asrama Politeknik Kesehatan Pontianak. *Media Gizi Khatulistiwa*. 2025;2(1):50–3.
 17. Fitriyah N, Setyaningtyas SW. Hubungan Asupan Energi, Makronutrien, Zink dan Fe dengan Underweight pada Ibu dan Balita di Desa Suwari Bawean, Gresik. *Media Gizi Kesmas*. 2021;10(1):56–62.
 18. Permata II, Achyar K, Kusuma IR. Faktor-Faktor yang Mempengaruhi Anemia. *J Ris Kesehat Masy*. 2023;3(3):135–42.
 19. Indrawatiningsih Y, Hamid SA, Sari EP, Listiono H. Faktor-Faktor yang Mempengaruhi Terjadinya Anemia pada Remaja Putri. *JlUBJ: J Ilm Univ Batanghari Jambi*. 2021;21(1):331–7.
 20. Akib A, Sumarni S. Kebiasaan Makan Remaja Putri yang Berhubungan dengan Anemia : Kajian Positive Deviance. *Amerta Nutr*. 2017;1(2):105–16.
 21. Gumilang L, Dj RT, Dhamayanti M, Handono B. Layanan Kesehatan Anemia Remaja Putri. Sleman: Deepublish; 2024. 67 p.
 22. Thirtawati S, Rosidi A, Sulistyowati E, Ayuningtyas RA. Knowledge, Attitudes of Adolescent Girls and Support from Health Workers towards Iron-Folic Acid Tablet Consumption at SMKN 1 Bangsri Jepara: A Cross-Sectional Study. *J Gizi Unimus*. 2020;9(2):201-14.
 23. Ministry of Health RI. Pedoman Pencegahan dan Penanggulangan Anemia Pada Remaja Putri dan Wanita Usia Suber (WUS). Jakarta: Kementerian Kesehatan RI; 2018. 1–92 p.
 24. Warda Y, Fayasari A. Food consumption and iron bioavailability are associated with anemia status in adolescent girls in East Jakarta. *Ilmu Gizi Indones*. 2021;4(2):135-46.
 25. Fithria F, Junaid J, Sarmin WOS. Hubungan antara Asupan Zat Gizi dengan Kejadian Anemia pada Remaja Putri SMA Negeri 1 Barangka Tahun 2019. *J Ilm Mahasiswa Kesehat Masy*. 2021;6(1).
 26. Hamidah W, Pitriyani R, Febrina F. Dampak Kebijakan Sekolah terhadap Pencegahan Anemia pada Siswa dan Tingkat Pengetahuan Remaja Putri Kelas X Tentang Anemia SMK Negeri 9 Kota Padang. *J Siti Rufaidah*. 2025;3(3):15-28.

27. Supriadi D, Budiana T Ak, Jantika G. Incidence of Anemia Based on Energy Intake, Vitamin B6, Vitamin B12, Vitamin C, and Food Diversity in Elementary School Children at Mi Pui, Cimahi City. *JIKBHK J Ilmu Kesehat Bhakti Husada*. 2022;13(1):103–15.
28. Abby SO, Arini FA, Sufyan DL, Ilmi IMB. The Relationship between TTD Consumption Compliance, Nutrient Intake, and Nutritional Status on the Incidence of Anemia in Adolescent Girls at SMPN 1 Gunungsari. *Amerta Nutr*. 2023;7(2):213–23.
29. Yunita VS, Maigoda TC. The Roles of Micronutrients (Folic Acid, Vitamin C, Zinc) on the Incidence of Anemia in Adolescent Girls. *J Prot Kesehat*. 2023;12(2):169–76.
30. Putera KSK, Noor MS, Heriyani F. The Relationship Between Dietary Patterns and the Incidence of Anemia at SMP Negeri 18 Banjarmasin 2019/2020. *Hemostatis*. 2020;3(3):217–22.
31. Qurbani NM, Santanu AM, Astuti W, Kumalasari I. Relationship between Food Diversity, Food Consumption, and Family Economic Status on the Nutritional Status of Students at SMP XYZ. *J Ilmu Kedokt dan Kesehat Indones*. 2025;5(3):302–13.
32. Junengsih J, Yuliasari Y. The Relationship Between Iron Intake and Anemia Incidence in Female High School Students at SMU 98 in East Jakarta. *J Health Sci Technol*. 2017;5(1):55-65.

Analysis of Determinants Related to Stunting in Toddlers in the Working Area of the Buntulia Community Health Center, Pohuwato Regency

Nur Istiqoma Suja^{1,*}, Sunarto Kadir², Vivien Novarina A. Kasim³

¹Master of Public Health, Postgraduate Program, Gorontalo State University, Gorontalo, Indonesia

²Department of Public Health, Faculty of Sports and Health, Gorontalo State University, Gorontalo, Indonesia

³Department of Nutrition, Faculty of Medicine, Gorontalo State University, Gorontalo, Indonesia

*Corresponding Author. Email: nuristiqomahsuja@gmail.com, Telp: +6282396747498

ABSTRACT

Introduction: Stunting is a health problem and associated with the risk of illness and death, suboptimal brain development, resulting in impaired motor and mental growth. Gorontalo Province ranks 12th out of 38 provinces, where Pohuwato District has a stunting prevalence of 18.4% among toddlers. Several variables can influence the incidence of stunting in children, including nutritional intake, infectious diseases, food availability, feeding patterns, and environmental sanitation. This study aims to assess the relationship between nutritional intake, infectious diseases, food availability, feeding patterns, and environmental sanitation with the incidence of stunting in Buntulia Community Health Center working area.

Method: The study was conducted at the Buntulia Community Health Center using quantitative methods with cross sectional approach. A sample of 272 toddlers was obtained using the Slovin formula. The data analysis used logistic regression consisting of univariate, bivariate and multivariate method.

Results: 91.2% of the toddlers did not experience stunting. Regarding individual determinants, 81.1% of the subjects had insufficient nutritional intake, while 89.3% had no history of infectious diseases. Household food security was observed in 57.4% of cases, yet 87.1% of toddlers exhibited inadequate dietary patterns. Additionally, 93.8% of respondents maintained good environmental sanitation. The results of the multivariate model revealed that nutritional intake (95% CI: 0.00) and dietary pattern (95% CI: 0.00) were significant predictors, while food availability (95% CI: 0.15) showed a broader confidence interval in relation to the incidence of stunting.

Conclusion: Only food availability are associated with stunting in the Buntulia Community Health Center working area.

Keywords: Environmental sanitation, feeding patterns, food availability, nutritional intake, stunting



Published by:
Universitas Negeri Gorontalo

Mobile number:
+62852 3321 5280

Address:
Jend. Sudirman St. No.6, Gorontalo
City, Gorontalo, Indonesia

Email:
jmhsj@ung.ac.id

Article History:
Received 28 September 2025
Accepted 24 March 2026
Published 11 April 2026

DOI:
<https://doi.org/10.37905/jmhsj.v5i2.34584>

Introduction

The 2023 Indonesian Health Survey (Survey Kesehatan Indonesia, SKI) ranked Gorontalo Province 12th out of 38 provinces in terms of stunting percentage, with a rate of 26.9%, an increase from 23.8% in the previous year. In Pohuwato District, the prevalence of stunting in toddlers also showed a significant increase, from 6.4% in 2022 to 18.4% in 2023. Children who experience stunting are generally caused by malnutrition, especially during the first 1000 days of life.¹ The factors causing stunting include direct and indirect factors, including toddler nutrition intake, infectious diseases, food availability, parenting patterns, feeding, environmental health, as well as socioeconomic factors, maternal education levels, maternal nutrition knowledge, and the environment.² In addition, child growth is also influenced by biological factors such as growth hormone or *human growth hormone* (HGH).³

Good nutritional intake can reduce the incidence of stunting in toddlers, where a diet high in animal protein is more recommended than plant protein because animal protein has better digestibility and a more complete content of essential amino acids.⁴ Therefore, most of the protein consumed by toddlers should come from animal sources to support optimal growth. This is in line with previous research which concluded that energy and protein intake affect the incidence of stunting in children aged 12–36 months at the Tilango Community Health Center, Tilango District, Gorontalo Regency.⁵

Infectious diseases are a direct cause of stunting, thus proper treatment of children suffering from infectious diseases needs to take into account nutritional intake according to their needs in order to help improve their nutrition.⁶ Data from the Indonesian Health Survey shows that the national prevalence of Acute Respiratory Tract Infetion (ARI) is 23.5%, with the highest rates in Papua Pegunungan (41.7%), Central Papua (39.4%), and East Nusa Tenggara (36.3%), while in Gorontalo Province the rate is 15.8%. The prevalence of ARI among toddlers has increased nearly threefold compared to the 2018 Riskesdas results, from 12.8% to 34.2%. Meanwhile, the national prevalence of diarrhea was 4.3%, with the highest rates in Central Papua (16.1%) and Papua Pegunungan (14.6%), and the lowest in Riau Islands (2.1%). The prevalence of diarrhea in children under five decreased from 12.3% to 7.4%, with Gorontalo at 9.2%. Infectious diseases are one of the risk factors for stunting (OR 9.375; 95% CI: 1.748–50.286).¹ In addition, the proportion of toddlers with a history of infectious diseases (62.9%) was higher than those without a history of infectious diseases (30.4%), indicating a significant relationship between a history of infectious diseases and stunting.⁷

Based on the previous study on household food security of stunted children aged 6–23 months in Wilangan, Nganjuk Regency, it is known that most non-stunted toddlers are in food-

secure households (75.0%), while stunted toddlers are more likely to be in food-insecure households (41.7%). This shows that food-insecure households have a higher risk of stunting than food-secure households. In addition, feeding practices were also found to have a significant relationship within stunting, where toddlers with inappropriate feeding practices were 4.61 times more likely to experience stunting than toddlers with appropriate feeding practices.⁸ The study of Widyaningsih et al. and Rahim et al. also shows that most stunted toddlers (85.4%) have an unbalanced diet, dominated by energy-rich foods such as rice, noodles, and corn, with low consumption of vegetables, fruits, and milk.^{7,9}

Environmental factors also contribute to stunting prevalence. Data from The Effect of Water and Sanitation on Child Health International of Epidemiology in 2007 study states that good sanitation access can reduce the prevalence of stunting by 27%.^{10,11} For this reason, the government is implementing the Community-Based Total Sanitation (Sanitasi Total Berbasis Masyarakat, STBM) program, starting with the first pillar, which is to stop open defecation. Several researches proves that the implementation of STBM pillar I is associated with a decrease in stunting rates in toddlers, in line with the findings.¹²⁻¹⁴

Based on direct observations of anthropometric measurements of weight and height in November 2024, out of 1,068 toddlers weighed in Buntulia Subdistrict, 28 toddlers were found to be stunted (2.6%). Although the prevalence of stunting in the Buntulia Health Center working area is still below the national target of 14%, the issue of stunting in toddlers remains a focus of the Buntulia District government in Pohuwato Regency. This article aims to analyze the determinants associated with the incidence of stunting among toddlers in the service area of the Buntulia Community Health Center, Pohuwato Regency.

Methods

This study was conducted in the working area of the Buntulia Community Health Center, Buntulia District, Pohuwato Regency. All procedures of this research have been approved by the supervisor and comply with health research ethics which consist of respondent consent, confidentiality, not harming respondents and fairness. To ensure methodological transparency, the metrics and objective criteria used to measure the research variables are summarized in Table 1.

The population in this study were mothers who had children aged 6-59 months. This study used accidental sampling of mothers of toddlers at the Buntulia Community Health Center's health post, with a representative sample size calculated using the Slovin formula.¹⁵ Regarding to the number of total population (N=850) and e value of 5%, the number of samples taken was 272 respondents.

This study employed three data analysis methods: univariate analysis, which described the incident of stunting, nutritional intake, infectious disease, food security, feeding pattern and environmental sanitation. Bivariate analysis employed the chi-square test with a 95% confidence level to ascertain the association between the incidence of stunting nutritional intake, infectious disease, food security, feeding pattern and environmental sanitation. Multivariate analysis was used to determine which factors were most strongly associated with the incidence of stunting.

Result

Table 2 shows the characteristics of respondents in this study, including demographic characteristics, namely gender and age, with 272 respondents. The majority of respondents were female, with 140 respondents (51.5%), and the minority were male, with 132 respondents (48.5%). The age group of 6-11 months had the highest number of respondents at 119 (43.8%), followed by the age group of 24-59 months with 86 respondents (31.63%), and the age group of 12-23 months had the lowest number of respondents at 67 (24.6%). The highest number of respondents who came and were weighed at the health post was in Hulawa village with 50 respondents (18.4%), while the lowest number of respondents who came and were weighed at the health post was in Karya Indah village with 27 respondents (9.9%).

Univariate analysis

Univariate analysis was conducted to determine the distribution and frequency of each variable studied, including stunting, nutritional intake, infectious diseases, food availability, feeding patterns, and sanitation, as presented in the Table 3. There were 248 toddler respondents who did not experience stunting (91.2%) and 24 toddler respondents who experienced stunting (8.8%). Furthermore, in terms of nutritional intake, 218 toddlers or 80.1% had insufficient nutritional intake and only 19.9% or 54 toddlers had adequate nutritional intake. Of the 272 respondents, 243 or 89.3% of toddlers did not have infectious diseases and only 10.7% or 29 toddlers had infectious diseases. A total of 156 toddlers (57.4%) were classified as food secure, while the remaining 116 (42.6%) were classified as food insecure. In the dietary patterns variable, 237 respondents (87.1%) had inadequate dietary patterns, while only 35 respondents (12.9%) had adequate dietary patterns. There were 255 respondents (87.1%) with good environmental sanitation (open defecation behavior), while 17 respondents (63%) had poor environmental sanitation (open defecation behavior).

Table 1. Operational definition and criteria of variables

No	Variable	Definition	Measuring Instrument	Criteria	Scale
1	Stunting	The percentage of children aged 6 to 59 months in Buntulia Subdistrict whose nutritional status, as determined by the length-for-age (LFA) or height-for-age (HFA) index, has a Z-score of less than -2 SD. ¹⁶	a. Microtois weighing (children over 2 years old) Lengthboard (children under 2 years old) ¹⁷ b. Nutritional Status in the e-PPGBM (Community-Based Nutrition Recording and Reporting) Application. ¹⁸	a. Stunting (2 SD to - 3 sd) b. Normal (2 SD to + 3 SD). ¹⁹	Ordinal
2	Nutrinional Intake	All types of nutrients from the food and beverages consumed daily. The nutrients measured include: energy, carbohydrates, and fat, which are then compared to the recommended dietary allowances. ²⁰	Interviews using a 24-hour food recall form, which was then analyzed using Nutrisurvey 2007. ²¹	a. Inadequate = <80 % of the RDA b. Adequate = 80 % - 110 % of the RDA. ²²	Ordinal
3	Infectious Diseases in Toddlers	Infectious diseases that the toddler has had in	Medical Record	a. Never: if the toddler has never	Nominal

	the past 6 months (respiratory infections and diarrhea). ²³		had an infectious disease in the past 6 months	
			b. History: if the toddler has had an infectious disease within the past 6 months	
4	Food Availability	Food security refers to the condition in which the food needs of every family member have been met over the past 12 months. ²⁴	US Household Food Security Survey Module (USHFSSM) Questionnaire	Ordinal
			a. Food Secure :0-2	
			b. Food Insecure :3-18. ²⁵	
5	Feeding Pattern	The actions taken by parents to ensure adequate nutrition from the food consumed by their children, appropriate for their age, based on the types of food consumed, the amount of	Child feeding Questionnaire (CFQ)	Ordinal
			1= Incorrect category, if the answer score is <55%	
			2 = Correct category, if the answer score is 55-100%. ²⁷	

		food consumed, and the children's meal schedule. ²⁶			
6	Environmental sanitation: Open defecation	Living conditions that include The practice of open defecation in open areas due to a lack of a toilet or having a toilet but not using it. ²⁸	Questionnaire	a. Poor (Open defecation, defecation in public restrooms even though there is a toilet at home) b. Good (Defecating in a toilet equipped with a septic tank and enclosed, using the toilet regularly). ²⁹	Nominal

RDA: Recommende dietary allowance, SD: Standard deviation

Bivariate analysis

Table 4 indicates the bivariate analysis results. Among the 248 non stunted toddlers, the majority (71.3%; n=194) had poor nutritional intake, while only 19.9% (n=54) maintained good nutrition. Notably, all stunted toddlers (100%; n=24) were characterized by poor nutritional intake. Statistical analysis using the Chi-Square test yielded a p-value of 0.011 ($\alpha < 0.05$), leading to the rejection of the null hypothesis H0. This demonstrates a significant relationship between nutritional intake and the incidence of stunting within the Buntulia

Community Health Center working area.

Table 2. Characteristics of respondents

Variable	Frequency (N=272)	Percentage (%)
Gender		
Male	132	48.5
Female	140	51.5
Age		
6-11 months	119	43.8
12-23 Months	67	24.6
24-59 Months	86	31.6
Village		
Sipatana	33	12.1
Central Buntulia	48	17.6
North Buntulia	36	13.2
Taluduyunu	45	16.5
North Taluduyunu	33	12.1
Karya Indah	27	9.9
Hulawa	50	18.4

Regarding infectious diseases, the majority of non-stunted children (81.6%; n=222) had no history of infection, compared to 9.6% (n=26) who did. Similarly, most stunted infants (7.7%; n=21) had not experienced infectious diseases, while only 1.1% (n=3) had. The Chi-Square test resulted in a p-value of 0.760 ($P > 0.05$), indicating that H_0 is accepted. Consequently, there is no significant association between the history of infectious diseases and stunting incidence in this population.

Analysis of food security reveals that most non-stunted toddlers fell into the food-secure category (54.4%; n=148), while 36.8% (n=100) were food-insecure. Conversely, stunted toddlers were more prevalent in the food-insecure group (5.9%; n=16) than the food-secure group (2.9%; n=8). With a p-value of 0.013 ($p < 0.05$), the alternative hypothesis (H_0) is accepted, confirming a significant relationship between food security and stunting.

In terms of dietary patterns, the majority of non-stunted toddlers had an inadequate diet (78.3%; n=213), with only 12.9% (n=35) having an adequate diet. All stunted toddlers (8.8%; n=24) were found to have an inadequate dietary pattern. The Chi-Square test produced a p-value of 0.049 ($p < 0.05$), clarifying a significant association between dietary patterns and the

occurrence of stunting in the study area.

Table 3. Univariate analysis results

Variable	Frequency (N=225)	Percentage
Incidence of Stunting		
No Stunting	248	91.2
Stunting	24	8.8
Nutritional Intake		
Good	54	19.9
Poor	218	80.1
Infectious Disease		
Never	243	89.3
Ever	29	10.7
Food Security		
Food Security	156	57.4
Food Vulnerability	116	42.6
Dietary Patterns		
Appropriate	35	12.9
Inadequate	237	87.1
Environmental Sanitation		
Good	255	93.8
Not Good	17	6.3

Finally, the data shows that both non-stunted and stunted toddlers generally had access to good environmental sanitation (85.7% and 8.1%, respectively). Only a small fraction of the total sample exhibited poor sanitation or open defecation behavior. Statistical testing yielded a p-value of 0.659 ($P > 0.05$), suggesting that there is no significant relationship between environmental sanitation (specifically open defecation behavior) and the incidence of stunting in the Buntulia Community Health Center working area.

Multivariate analysis

Multivariate analysis with logistic regression was used to determine the most dominant variable associated with stunting in toddlers in the Buntulia Health Center Working Area, through candidate selection and model creation. Before conducting multivariate analysis, bivariate analysis was first performed on each dependent variable to determine which variables would be used as model candidates to be included in the multivariate analysis (Table 5). If the

bivariate analysis resulted in a P -value < 0.5 , the variable was included in the multivariate analysis. There were three variables with P -values < 0.05 , namely nutritional intake ($P=0.011$), food availability ($P=0.013$), and feeding patterns ($P=0.049$). These variables will be included in the multivariate analysis.

Table 4. Determinants associated with the incidence of stunting among toddlers in the service area of the Buntulia Community Health Center, Pohuwato Regency

Variable	Stunting Incident						P-value	OR	95% CI	
	Stunting		Not Stunting		Total				Lower	Upper
	N	%	N	%	N	%				
1. Nutritional intake										
Good	0	0.00	54	19.9	54	19.9	0.011*	1.27	1.19	1.36
Insufficient	24	8.8	194	71.3	218	80.1				
2. Infectious diseases										
Ever	3	1.1	26	9.6	29	10.7	0.760	0.82	0.22	2.93
Never	21	7.7	222	81.6	243	89.3				
3. Food availability										
Food security	8	2.9	148	54.4	156	57.4	0.013*	0.33	0.13	0.81
Food insecurity	16	5.9	100	36.8	116	42.6				
4. Dietary patterns										
Appropriate	0	0.0	35	12.9	35	12.9	0.049*	1.16	1.10	1.22
Inappropriate	24	8.8	213	78.3	237	87.1				
5. Environmental sanitation (open defecation behaviour)										
Good	22	8.1	233	85.7	255	93.8	0.659	1.41	0.30	6.57
Not Good	2	0.7	15	5.5	17	6.3				

Chi-square test. CI: Confidence interval, OR: Odds ratio. *significant at $P<0.05$

Table 5. Selection of multivariate candidate variables

Variable	P -value	Description
Nutritional intake	0.011	Candidate entry
Food availability	0.013	Candidate entry
Dietary Pattern	0.049	Candidate entry

Simple logistic regression test. *significant at $P<0.05$

Table 6 is the final step of the *logistic regression* analysis and is the final model of the multivariate analysis. The results of the multivariate analysis show that the most closely associated variable to stunting in toddlers is food availability (P -value = 0.036).

Table 6. Results of logistic regression test

No	Variable	B	Sig	Exp (B)	95% CI
1	Nutritional intake	18,756	0.997	139,792,387.808	0.000
2	Food availability	-.964	0.036*	0.381	0.155
3	Dietary Pattern	18,663	0.998	127,437,344.222	0.000

Multiple logistic regression test. B: Regression coefficient, CI: Confidence Interval, Exp(B):Odds ratio (OR) value, Sig.: P -value. *significant at $P<0.05$

Discussion

Based on the analysis, stunting in toddlers in the Buntulia Community Health Center working area is influenced by inadequate nutritional intake, improper and unbalanced eating patterns, and low household food availability. This condition is exacerbated by the low economic status of most respondents, who earn below the minimum wage, resulting in limited food availability and infrequent growth and development monitoring at health posts. Long-term energy and protein deficiencies cause the body to experience nutrient depletion and tissue damage, leading to stunting.³⁰ This study alligns with Sumarti et al.,³¹ which revealed a relationship between macronutrient intake and the incidence of stunting in toddlers.

Analysis using the 24-hour food recall method over three days showed that toddlers consumed carbohydrate sources such as instant porridge, rice, noodles, and bread, with rice as the main food (1–2 times/day). The most consumed animal protein source was chicken eggs (1–2 times/day), while plant-based protein sources included tofu and green beans. Fat intake mainly came from formula milk (4 times/day). Toddlers also often consumed snacks such as biscuits, wafers, and chocolate. For fibre, the dominant fruit was bananas (1–2 times/day), while vegetables were mainly carrots (2–3 times/day) and spinach.

Most respondents had nutrient intake (energy, protein, carbohydrates, and fat) in the poor category (<80% of the RDA) in both the stunted and non-stunted groups. Several factors can influence inadequate intake in toddlers. Toddlers with low nutritional intake were 1.28 times more likely to experience stunting than those with adequate nutrition. This aligns with UNICEF's theoretical framework, which states that insufficient food consumption is one of the contributing factors to stunting. The results of this study are consistent with the theory that inadequate energy intake is associated with the risk of stunting in toddlers. Growth hormone

depletion appears in children who are energy deficient. Therefore, protein plays a major role in the growth of toddlers.^{32,33}

Based on the recent study, it was found that of the 24 toddlers who were stunted, 3 (1.1%) had experienced infectious diseases, while 26 (9.6%) of those who were not stunted had experienced infectious diseases. Mild infections or those that occur for a short period are not long enough or severe enough to significantly affect a child's nutritional status or growth; thus, they cannot be identified, and there are no repeated infections. According to Presidential Regulation No. 72 of 2021, stunting is closely related to repeated infections. Children who receive complete immunisations may be more immune to infections that can cause stunting. Immunisation is an effort to induce and increase immunity to disease in infants, carried out by injection. Incomplete immunisation causes toddlers' immunity to become weak, making them susceptible to infectious diseases.^{34,35}

Regarding household food availability, it was found that families were unable to buy food and eat a balanced diet because they did not have enough money. Mothers of toddlers tended to meet their staple food needs from shops near their homes. A total of 5.9% of mothers in the stunting group reported that they were sometimes only able to buy cheap food for their children because of limited money. The high percentage of food-insecure households in both the stunting and non-stunting groups in this study is related to the low level of family income over the past 12 months, as the majority of people in Buntulia Subdistrict work as miners. The ongoing crackdown and closure of mines in the area has caused some families to lose their jobs, resulting in low household economic access to food and a decrease in household food availability. This is supported by research showing that household food security has a significant impact on the nutritional status of toddlers. If the adequacy and availability of nutritious food is limited or does not meet the needs of toddlers, it will cause food insecurity and disrupt their growth and development.³⁶

A high percentage of inappropriate feeding patterns was observed in both stunted and non-stunted toddlers in the present study. Based on direct interviews with parents, inappropriate feeding patterns were caused by various factors, namely low economic status, inability to provide complete nutritious food, giving snacks too close to main mealtimes, and toddlers often being given snacks high in sugar, salt, or unhealthy fats that are low in nutrients. These foods can make children feel full, causing them to refuse more nutritious main meals. Complementary foods that lack variety, are low in energy (calories), and low in protein are often the main problem. Examples include giving only rice porridge without sufficient side dishes, portions not in accordance with needs (side dishes rarely given and only 1–2 pieces),

irregular meal schedules with only two meals a day, rarely giving snacks, eating at irregular times, and no set meal schedule for children.³⁷

This study shows that 255 respondents (93.8%) already defecate in toilets and only 17 respondents (6.3%) still practise open defecation. This is influenced by the implementation of healthy life behaviour (*perilaku hidup bersih dan sehat*, PHBS), local government policies, the STBM programme, toilet construction assistance, and health education, so that the community understands the dangers of open defecation to health and the environment. Therefore, environmental sanitation factors in this area are not the cause of stunting. However, these results differ from a study by Fitirana et al.,³⁸ which found a significant relationship between environmental sanitation and stunting, where toddlers from households with poor sanitation had a 2.94 times higher risk of stunting compared to those with good sanitation (OR = 2.949; $P = 0.022$).

Regarding household food availability, it was found that families were unable to buy food and eat a balanced diet (staple foods, side dishes, vegetables, and fruit), relying only on a few types of cheap food. Children ate less because parents could not afford to provide enough food, often skipping children's mealtimes and reducing children's meal portions because parents did not have the money to buy and provide more food.

Food availability is a major factor related to stunting because it is the gateway to nutritional fulfilment. If food problems exist from the outset, then children's eating patterns, nutritional intake, and nutritional status will also be affected. Food availability includes the quantity, diversity, and sustainability of food supplies in households. Food shortages or monotonous consumption (e.g., only carbohydrates without protein and micronutrients) can lead to energy and essential nutrient deficits. Food availability affects eating patterns, which in turn determine nutritional intake and ultimately children's growth. Like a warehouse of raw materials, if the warehouse is limited, no matter how good the processing in the kitchen, the results will still be minimal.

This study is in line with the research of Mumtaza,³⁹ which examined the relationship between food security and food diversity with the incidence of stunting in children aged 24–59 months. Statistical tests showed a significant relationship between household food security and the incidence of stunting ($P = 0.001$). Conversely, families in a food-insecure condition have an increased likelihood of stunting in children. Similar to the study by Sihite & Tanziha conducted at the 11 Ilir Palembang Community Health Centre, statistical tests showed a significance of 0.031 ($P < 0.05$), indicating a relationship between household food security and the incidence of stunting.³⁶

The limitations of this study lie in the fact that other variables that may have a significant association with stunting, such as genetic factors, the mother's health history during pregnancy (Chronic Energy Deficiency/CED), and parents' health literacy levels, have not been explored in depth.

Conclusion

The prevalence of stunting among toddlers in the Buntulia Community Health Center working area was recorded at 8.8% (n=24), while the vast majority of the population, comprising 91.2% (n=248) of the sampled toddlers, did not exhibit growth faltering. Although the percentage of stunted children is relatively low compared to some regional averages, the presence of these cases indicates a persistent nutritional challenge within the community that requires targeted intervention. Statistical analysis reveals that the incidence of stunting in this region is significantly influenced by a triad of closely interrelated factors: inadequate nutritional intake, suboptimal feeding patterns, and limited household food security. These variables function as the primary determinants of a child's growth trajectory in Buntulia. The findings suggest that when toddlers are subjected to inconsistent dietary diversity and insufficient caloric or protein intake, the biological risk of stunting increases substantially, regardless of other environmental factors. Of the variables analyzed, household food security emerged as the most critical determinant of stunting in the Buntulia Community Health Center working area. This underscores the fact that economic access to a diverse and stable food supply serves as the foundational gateway for nutritional health. Consequently, addressing stunting in Pohuwato Regency necessitates a multi-sectoral approach that focuses not only on nutritional education but also on strengthening the economic resilience and food availability of local households.

Conflicts of Interest

There is no conflict of interest.

Funding Sources

All funding in this research using authors own money.

Acknowledgments

Nothing to Declare.

References

1. Ministry of Health of the Republic of Indonesia. Indonesian Health Survey (SKI) 2023 in Figures. Jakarta: Ministry of Health of the Republic of Indonesia; 2024.
2. Rusliani N, Hidayani WR, Sulistyoningsih H. Literature Review: Factors Associated with

- Stunting in Toddlers. *J Midwif Nurs*. 2022;1(1):32–40.
3. Sholikhah A, Dewi RK. The Role of Animal Protein in Preventing Stunting in Toddlers. *J Res Sci and Technol*. 2022;6(1):95–110.
 4. Lisdeni R. Environmental Sanitation Risk Factors and Nutritional Intake on the Occurrence of Stunting in Toddlers (6-59 Months) in the Batangkapas District, South Pesisir Regency [Internet]. University of Indonesia; 2024. Available from: <https://lib.fkm.ui.ac.id/detail?id=137085&lokasi=lokal>
 5. Anasiru MA, Domili I. The Effect of Energy and Protein Intake, Parenting Patterns, and Health Status on Stunting Incidence in Children Aged 12-36 Months at the Tilango Community Health Center, Tilango District, Gorontalo Regency. *J Heal Nutr*. 2018;4(1):7-16.
 6. Eldrian F, Karinda M, Setianto R, Dewi BA, Gusmira YH. The Relationship Between a History of Infectious Diseases and the Incidence of Stunting in Toddlers at the Cipadung Community Health Center in Bandung City. *J Manj Kesehat Yayasan RS Dr Soetomo*. 2023;9(1):80–9.
 7. Rahim R. Analysis of Determinants of Increased Stunting Incidence in the Working Area of Cempae Community Health Center, Parepare City, South Sulawesi [Internet]. Hasanudin University Makassar; 2022. Available from: <http://repository.unhas.ac.id:443/id/eprint/12052%0A>
 8. Fadzila DN, Tertiys EP. Food Security of Households with Stunted Children Aged 6–23 Months in Wilangan, Nganjuk District. *Amerta Nutr*. 2019;3(1):18-23.
 9. Widyaningsih CA, Didah D, Sari P, Wijaya M, Rinawan FR. Identification of Factors Contributing to Stunting. *J Kebidanan Malahayati*. 2021;7(2):207-12.
 10. Fink G, Günther I, Hill K. The effect of water and sanitation on child health: evidence from the demographic and health surveys 1986-2007. *Int J Epidemiol*. 2011;40(5):1196–204.
 11. Windi N, Guling SL. The Relationship Between Environmental Sanitation and Stunting in Toddlers in Aralle District, Mamasa Regency. Stella Maris Makassar College of Health Sciences; 2020.
 12. Pateda SM, Ramadhani FN, Yusuf NAR. Prevention of Stunting Through the 5 Pillars of Community-Based Total Sanitation in Ulantha Village. *Pharmacare Soc J Pengambidan Masy Farm*. 2023;2(1):29-35.
 13. Opu S, Hidayat H. The Relationship between Community-Based Total Sanitation (STBM) and Efforts to Reduce Stunting Rates in Toddlers. *Sulolipiu Media Komun Sivitas Akad*

- dan Masy.* 2021;21(1):140–52.
14. Tunyy R, Hatuwe E, Hitiyaut M, Astuti AD. Prevention of Stunting Through Pillar 1: Stop Open Defecation in Waehaong Village, Nusaniwe District, Ambon City. *OBAT J Ris Ilmu Farm dan Kesehat.* 2023;1(6):97–105.
 15. Fauzy A. Metode Sampling. Edisi 2. Tangerang Selatan: Universitas Terbuka; 2020. 410 p.
 16. Rante IH, Rahayu AS, Elieser E, Astawa GAE, Kambu SEB. Gambaran Status Gizi Balita di Puskesmas Kotaraja Jayapura. *J Syntax Admiration.* 2024;5(11):5137–47.
 17. Putri PMS, Humairo MV, Romadlona NA, Puspitaningtyas D, Zarreta AM, Saputri LA, et al. Pelatihan Pengukuran Antropometri Balita Pada Kader Dalam Rangka Pencegahan Dini Stunting Di Posyandu Mawar. *Promot J Pengabd Kpd Masy.* 2024;2(2):136–148.
 18. Syaflly H, Lendrawati L. Analisa Kepuasan Pengguna Aplikasi Elektronik Pencatatan Pelaporan Gizi Berbasis Masyarakat (E-PPGBM) Menggunakan Metode End User Computing Satisfaction (EUCS). *J Inform dan Tek Elektro Terap.* 2024;12(3S1):5503-16.
 19. Ministry of Health of the Republic of Indonesia. Peraturan Menteri Kesehatan Republik Indonesia Nomor 2 Tahun 2020 Tentang Standar Antropometri Anak. Jakarta: Ministry of Health of the Republic of Indonesia;; 2020.
 20. Badi'ah A. Hubungan Kebiasaan Sarapan dan Durasi Tidur Dengan Kegemukan Pada Remaja di SMP Islam Al-Azhar 29 Semarang Universitas Islam Negeri Walisongo Semarang.; 2019.
 21. Hayatunnufus F, Melani V, Ronitawati P, Swamilaksita PD. Asupan Makan Sehari, Status Gizi, dan Produktivitas Kerja Guru SMK Pelita Ciampea Bogor. *J Kesehat Indones.* 2022;13(1):50–6.
 22. Lembaga Ilmu Pengetahuan Indonesia (LIPI). Widyakarya Nasional Pangan dan Gizi X. 1st ed. Fandar, Tantri, Budi, editors. Jakarta: Biro Kerja Sama dan Pemasyarakatan Ilmu Pengetahuan dan Teknologi; 2014.
 23. Sahitarani AS, Paramashanti BA, Sulistiyawati S. Kaitan Stunting Dengan Frekuensi Dan Durasi Penyakit Infeksi Pada Anak Usia 24-59 Bulan di Kecamatan Sedayu, Kabupaten Bantul. *J Nutr Coll.* 2020;9(3):202–7.
 24. Aisyah IS. Ketahanan Pangan Keluarga di Masa Pandemi Covid 19. *J Kesehat Komunitas Indones.* 2020;16(2):179–89.
 25. Aritonang EA, Margawati A, Dieny FF. Analisis Pengeluaran Pangan, Ketahanan Pangan dan Asupan Zat Gizi Anak Bawah Dua Tahun (BADUTA) Sebagai Faktor Risiko Stunting. *J Nutr Coll.* 2020;9(1):71–80.

26. Rizona F, Rahmawati F, Purwanto S, Padiana RAD. Dukungan Orang Tua Dalam Pemenuhan Kebutuhan Gizi Seimbang Pada Anak Usia Sekolah. *Proceeding Semin Nas Keperawatan*. 2024;10(1):118–21.
27. Camcı N, Bas M, Buyukkaragoz AH. The Psychometric Properties of the Child Feeding Questionnaire (CFQ) in Turkey. *Appetite*. 2014;78(1):49–54.
28. Ruwaida R, Is JM, Kiswanto K, Marniati M, Ernawati E. Faktor-Faktor Yang Mempengaruhi Praktik Buang Air Besar Pada Desa ODF dan Non ODF. *JUKEJJ Kesehatan Jompa*. 2025;4(2):613–23.
29. Sukrisdiyanto W, Soedjono ES. Strategi Penanganan BABS Melalui Penyediaan Sanitasi Sehat di Permukiman Semampir. *J Penataan Ruang*. 2023;18(1):53–9.
30. Wati L, Musnadi J. The Relationship Between Nutritional Intake and Stunting in Children in Padang Village, Manggeng District, Southwest Aceh Regency. *J Biol Educ*. 2022;10(1):44–52.
31. Sumarti, Salma WO, Binekada MC. Relationship Between Nutritional Intake and Stunting Incidence in Children in Padang Village, Manggeng District, Southwest Aceh Regency. *J Gizi Ilm*. 2024;11(2):1–8.
32. Indrasari FP, Husna A. Effectiveness of Nutrition Education on Increasing Knowledge of Stunting Prevention Among Mothers with Toddlers at Risk of Stunting. *J Mhs Kesmas*. 2023;3(1):11–9.
33. Ministry of Health of the Republic of Indonesia. Recommended Nutrient Intakes for Children. Jakarta: Ministry of Health of the Republic of Indonesia; 2018.
34. Vasera RA, Kurniawan B. The Relationship Between Immunization and the Incidence of Stunting in Children at the Sungai Aur Pasaman Barat Community Health Center in 2021. *J Kedokt STM*. 2023;6(1):82–90.
35. Aprilia SD, Budiono I. Stunting Incidence in Children Aged 24-59 Months in Farming Families in the Sumbang Community Health Center Working Area. *Jambura J Heal Sci Res*. 2024;6(1):55-70.
36. Sihite NW, Tanziha I. Factors affecting household food security in Medan City. *J AcTion Aceh Nutr J*. 2021;6(1):15–24.
37. Fitriana I, Banudi L, Hikmandayani, Nurlaela E. Relationship Between Diet, Energy Intake, Protein, And Knowledge Of Maternal Nutrition With Nutritional Status (Stunting) In Children Under Five Aged 24-59 Months In The Working Area Of Pajala Public Health Center West Muna Regency. *J Stunting Pesisir Dan Apl*. 2023;2(2):90–103.
38. Wahdaniyah, Ningsih NW, Sari D. The Relationship Between Environmental Sanitation

- and Stunting in Toddlers in Majene Regency. *Bina Gener J Kesehat.* 2022;13(2):39–48.
39. Mumtaza M. The Relationship Between Food Security and Food Diversity with the Incidence of Stunting in Toddlers Aged 24-59 Months. *Media Gizi Kesmas.* 2023;13(1):93–101.

Outcome of Triplet Pregnancy with Concurrent Uterine Myoma: Successful Management of a Rare Case

Mirza Aditya Hakim^{1*}, Syahrul Rauf², Iin Fadhilah Utami Tammasse¹

¹Obstetric and Gynecology Department, Faculty of Medicine, Hasanuddin University, Makassar, Indonesia

²Oncology and Gynecology Division, Obstetric and Gynecology Department, Faculty of Medicine, Hasanuddin University, Makassar, Indonesia

*Corresponding Author. Email: mirzaichot@gmail.com, Telp: +6281354295031

ABSTRACT

The management of a triplet pregnancy complicated by a degenerating fibroid is reported. The patient presented with persistent abdominal pain radiating to the back and a watery vaginal discharge mixed with mucus and blood. She had no relevant medical, family, or medication history and had not received tetanus immunization during pregnancy. Examination revealed stable vital signs, a fundal height of 39 cm, and a monochorionic triamniotic triplet pregnancy with all three fetuses in cephalic presentation and normal heart rates. Vaginal examination showed 1 cm cervical dilation with intact membranes and a bloody vaginal discharge. The patient was diagnosed with a triplet pregnancy in latent labour, complicated by a large fibroid. A caesarean section was performed for delivery, followed by myomectomy and subsequent intrauterine device (IUD) insertion. The removed mass showed necrotic and hemorrhagic tissue. Histopathology confirmed a leiomyoma with cystic and red degeneration. The mother and her three babies were in good health after the operation and at the three-month follow-up. In conclusion, caesarean section combined with myomectomy can be safely performed in selected cases of triplet pregnancy with large fibroids, particularly when the mother and fetus are clinically stable.

Keywords: Cesarean section, high-risk pregnancy, myomectomy, triplet pregnancy, uterine fibroid



Published by:
Universitas Negeri Gorontalo

Mobile number:
+62852 3321 5280

Address:
Jend. Sudirman St. No.6, Gorontalo
City, Gorontalo, Indonesia

Email:
jmhsj@ung.ac.id

Article History:
Received 24 February 2026
Accepted 9 May 2026
Published 8 July 2026

DOI:
<https://doi.org/10.37905/jmhsj.v5i2.37530>

Introduction

Triplet pregnancies impose a substantially greater cardiovascular burden on the mother, resulting in an increased risk of maternal morbidity and mortality compared to singleton pregnancies. Individuals with multiple gestations are at higher risk for complications during pregnancy and the postpartum period, including hemorrhage and postpartum depression. These elevated risks underscore the necessity for intensive prenatal monitoring and a multidisciplinary approach to maternal health management.¹⁻³

The presence of uterine leiomyoma in a triplet pregnancy further increases the complexity of clinical management, particularly due to the potential for complications such as degenerative changes, obstructed labor, and intraoperative bleeding. Uterine fibroids (leiomyomas) occur in up to 10% of pregnancies and may influence pregnancy outcomes based on their size, number, and location. Although fibroids are often asymptomatic, some cases exhibit cystic or red degeneration (carnea), leading to acute pain and complicating management decisions.^{4,5} Literature reviews have emphasized the ongoing debate regarding concurrent myomectomy during caesarean section, as clinicians must balance the benefits of removing large, symptomatic fibroids against the heightened risk of bleeding and prolonged operative time.⁶

Reports of triplet pregnancies complicated by large degenerating uterine leiomyomas are rare. This combination presents distinct clinical challenges related to the timing and mode of delivery, surgical planning, and postoperative recovery. The present case report details the management of a triplet pregnancy complicated by symptomatic degenerating fibroids, successfully treated with caesarean section and myomectomy during late prematurity. The distinctive feature of this case report is the uneventful clinical course of a triplet pregnancy complicated by large fibroids, from initial detection during antenatal care through to elective term caesarean section. This favorable outcome stands in contrast to several previously reported multifetal pregnancies, in which first-trimester surgical removal of fibroid masses led to complications, including fetal loss.^{7,8}

Case

A 30-year-old woman presented to the emergency department with persistent abdominal pain radiating to the back, which had been ongoing for several days. She reported the passage of mucus, blood, and watery discharge per vaginam several days before admission. During that episode, she was hospitalized and received antenatal corticosteroids to promote fetal lung maturation. The patient denied any history of chronic medical conditions, hereditary diseases, or medication use. She is a housewife and has been married for 10 years.

Obstetric history indicated gravida 2, para 0, abortus 1 (G2P0A1). The first pregnancy in 2013 ended in spontaneous abortion without curettage. The current pregnancy, conceived in 2025, had reached 30–31 weeks of gestation based on the last menstrual period dated November 15, 2024, with an estimated due date of August 22, 2025. The patient attended antenatal care more than four times at a primary health center. She had not received tetanus vaccination during the current pregnancy and had never used contraception.

On general examination, the patient was alert and oriented, with a blood pressure of 134/88 mmHg, pulse rate of 98 beats per minute, respiratory rate of 22 breaths per minute, body temperature of 36.2°C, and oxygen saturation of 99% on room air. Abdominal examination revealed a fundal height of 39 cm and an abdominal circumference of 104 cm. The estimated total fetal weight was approximately 4056 grams, consistent with a triplet pregnancy. All three fetuses were in a longitudinal lie in a single chorion and three amniotic sacs, with their backs on the right side; fetal heart rates were within normal limits (Fetus I: 143 bpm, Fetus II: 142 bpm, Fetus III: 140 bpm). Uterine contractions occurred every 10 minutes, each lasting 20–25 seconds. The presenting part was cephalic, and the descent was 5/5. The patient reported fetal movements. Ultrasonography revealed a well-defined, mixed-echoic intrauterine mass measuring $8.24 \times 9.66 \times 10.4$ cm, suggestive of a uterine myoma (Figure 1).

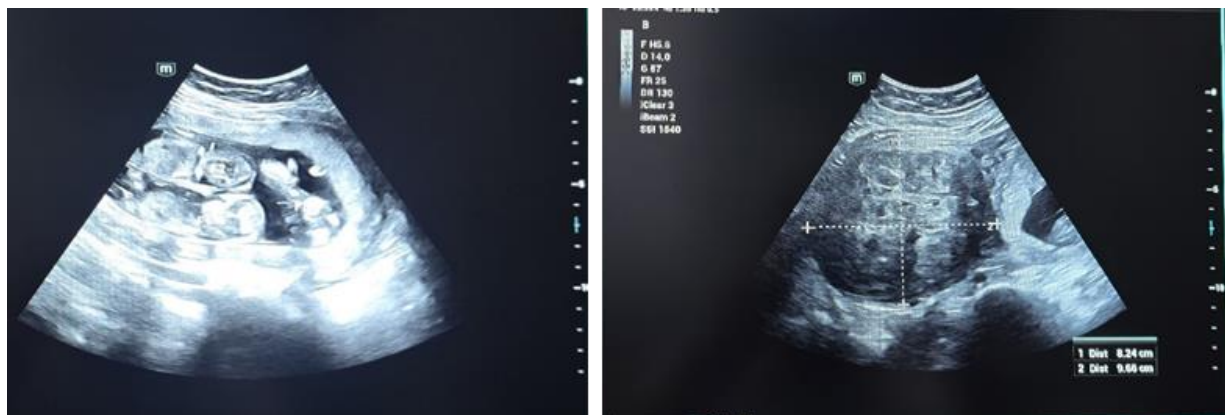


Figure 1. Ultrasonographic findings of the patient

Vaginal examination revealed a normal vulva and vagina. The cervix was thick and dilated to 1 cm. The fetal head was the presenting part, and the membranes were intact, accompanied by mucus, blood, and fluid. The fetal head was positioned at the pelvic inlet, and the pelvis was assessed as clinically adequate. The patient was diagnosed as G2P0A1 at 30–31 weeks of gestation with a triplet pregnancy in the latent phase of the first stage of labor. She was also evaluated as a candidate for postpartum intrauterine device (IUD) insertion.

A cesarean section was performed to deliver the triplets and the concurrent large intrauterine mass (Figures 2(a) and 2(b)). The incision was vertical midline under spinal and general anesthesia. In the abdominal cavity, a large mass measuring approximately $6.5 \times 8.0 \times 4.0$ cm was observed, occupying half of the upper abdominal floor, with no adhesions. Uterine visualization was possible, confirming the fibroid process. The giant myoma had a pedicle measuring approximately 6 cm in length and 8 cm in width, located in the anterior part of the uterine corpus. A uterine incision was then made in the lower uterine segment, followed by delivery of the three babies and subsequent uterine suturing. A myomectomy was performed to excise the mass, and the bleeding area from the myomectomy was sutured with separate stitches, achieving excellent hemostatic control. No intraoperative complications occurred. Blood transfusion was not necessary, given the estimated blood loss of approximately 600 mL and operative duration of 60 minutes.

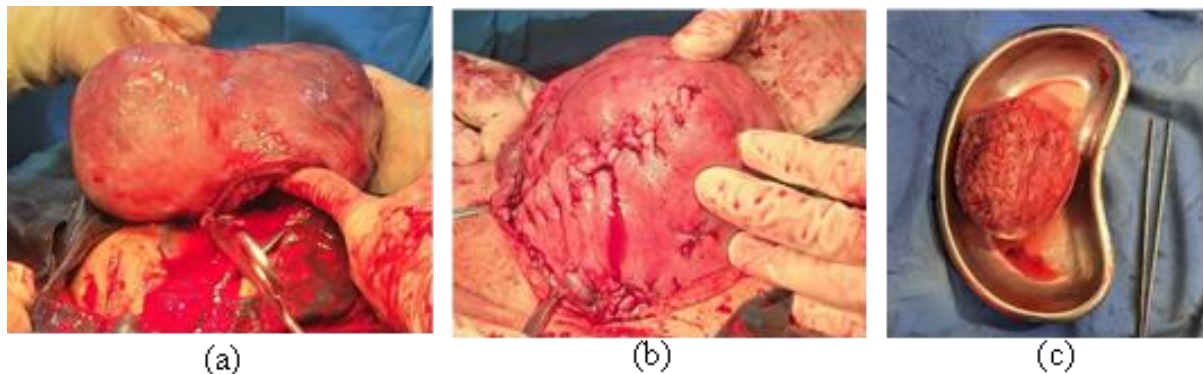


Figure 2. (a) Intraoperative view during myomectomy procedure following cesarean section; (b) Postoperative view following myomectomy procedure; (c) Resected uterine fibroid specimen sent for histopathological examination

The excised tissue was submitted for laboratory evaluation (Figure 2(c)). Cytological analysis identified necrotic and hemorrhagic tissue. Histopathological examination revealed proliferation of smooth muscle cells with elongated, non-atypical spindle nuclei arranged in parallel, with some intersecting. Several foci of cystic degeneration were present, with medium-sized, cystically dilated blood vessels containing erythrocytes. In the luminal portion, there was a necrotic mass, hemorrhagic foci, and numerous hemosiderophages. These findings confirmed a uterine leiomyoma with cystic and red (carneous) degeneration.

Postoperatively, the patient was transferred to the inpatient ward for monitoring and received intravenous injection therapy of ceftriaxone 1 gram/12 hours, ketorolac® 30 mg/8 hours, ranitidine 50 mg/8 hours, and tranexamic acid 500 mg/8 hours. Her vital signs remained

stable, and her overall clinical condition was satisfactory. All three babies were born in stable condition without any special care (Figure 3). The mother and all three babies were healthy at the three-month follow-up after discharge from the hospital.



Figure 3. The triplet newborns delivered via cesarean section, stabilized postnatally

Discussion

The patient was diagnosed with a triplet pregnancy. Spontaneous triplet pregnancies are exceptionally rare, with an incidence of approximately 1 in 8,000 natural conceptions.⁹ Globally, triplet and higher-order multiple pregnancies constitute more than 3% of all live births.¹⁰ The presentation of spontaneous triplet pregnancy is particularly notable in the absence of assisted reproductive technology (ART).

The patient presented with persistent abdominal pain radiating to the back, which histopathology confirmed as a uterine leiomyoma with cystic and red degeneration. Additionally, the patient experienced vaginal discharge consisting of mucus, blood, and watery fluid several days prior to admission at 30–31 weeks' gestation. These findings are indicative of preterm labor. Previous research has shown that up to 29.6% of women with triplet pregnancies deliver before 34 weeks of gestation.¹¹ Triplet pregnancies result in excessive uterine distension, leading to mechanical stretching and activation of the labor cascade, including increased corticotropin-releasing hormone, prostaglandins, and upregulation of oxytocin receptors.¹² This physiological response increases the likelihood of preterm birth before 34 weeks. Administration of corticosteroids during the latency period was initiated to promote fetal lung maturation, a practice demonstrated to reduce neonatal respiratory

morbidity. This intervention stabilized the pregnancy and facilitated optimal planning for neonatal care and delivery. Recent reviews support the use of a single course of antenatal corticosteroids to accelerate fetal lung maturation in women at risk of preterm birth, as this treatment reduces the risk of perinatal and neonatal death.¹³ Some clinicians advocate for prophylactic corticosteroid administration in all women with triplet pregnancies, regardless of preterm labor symptoms; however, current evidence does not support this approach.¹¹ Furthermore, abdominal pain is the most frequent symptom of leiomyoma, and premature labor is a recognized obstetric complication associated with larger fibroids. Degenerating fibroids can cause significant pain during pregnancy.¹⁴ Therefore, premature delivery in this case was attributable to both the triplet pregnancy and complications arising from uterine leiomyoma.

A cesarean section was performed to deliver the triplets, followed by a myomectomy to remove the uterine fibroids. The type of multiple gestation influences the delivery method, timing, and assessment of potential complications for both mother and fetus. No standardized prenatal testing protocol exists for triplet or higher-order pregnancies; instead, monitoring and delivery timing are individualized. Cesarean section is recommended for triplet or higher-order pregnancies due to the increased risk of cord accidents. Patients are instructed to fast for at least six hours prior to cesarean delivery to minimize the risk of aspiration. Intravenous antibiotics are administered within one hour of the procedure to reduce the risk of infection. Cefazolin dosing is weight-based: 1 g for patients weighing less than 80 kg, 2 g for those weighing 80–120 kg, and 3 g for those weighing more than 120 kg.¹⁵ This case was characterized by a relatively stable early labor profile. Admission during the latent phase of labor enabled the clinical team to implement timely interventions, such as administering antenatal corticosteroids to promote fetal lung maturity, coordinating with the neonatal intensive care unit (NICU) team, and developing a comprehensive delivery plan.

Simultaneous myomectomy with cesarean section is considered an effective and safe approach for treating large uterine fibroids during pregnancy. This procedure offers the dual benefit of addressing fibroid pathology while ensuring maternal and neonatal safety during cesarean delivery. The insertion of a Foley catheter to clamp the uterine artery is used to prevent excessive intraoperative bleeding. This technique can be applied to pregnant patients with large uterine fibroids who require cesarean section.¹⁶ Concomitant fibroid removal during cesarean delivery reduces surgical time, minimizes complications, avoids the need for subsequent surgeries, and decreases overall surgical costs associated with fibroid management. This approach is preferable to cesarean section alone, particularly when performed by experienced surgeons employing appropriate hemostatic techniques in a tertiary care setting. Concurrent

myomectomy and cesarean section can alleviate patient symptoms and reduce the likelihood of repeat surgical interventions.¹⁷ In certain cases, this procedure does not increase the risk of hemorrhage, postoperative fever, or prolonged hospital stay if performed with the correct indications and technique.¹⁸ While this operation has been reported as safe for singleton and twin pregnancies,¹⁷ there are no previous reports in triplet pregnancies. In the present case, the operation resulted in favorable maternal and fetal outcomes. Therefore, this report contributes new evidence regarding the safety of concurrent cesarean section and myomectomy in triplet pregnancies complicated by large fibroids.

In this case, the patient with a triplet pregnancy was multigravida and nulliparous and was considered a candidate for postpartum IUD insertion. IUD placement during cesarean section is effective in preventing unintended pregnancy within the first year postpartum, without impacting surgical outcomes.¹⁹ When a cesarean section is combined with myomectomy, the uterus is restored to its original shape following fibroid removal, and an IUD is inserted to prevent intrauterine adhesions. Uterine contractions remain stable following this procedure.²⁰ Among high-risk pregnancy populations, including women with cardiac disease or multifetal gestations, the IUD is recognized as a safe, highly effective, and convenient postpartum contraceptive. Its efficacy in preventing unintended pregnancies is well-established, with minimal failure rates, making it particularly suitable for women who should avoid short interpregnancy intervals. Additionally, the IUD does not interfere with lactation due to the absence of systemic hormonal effects, thereby supporting optimal breastfeeding practices. Immediate postpartum insertion within the first 10 minutes after placental delivery offers significant convenience and eliminates the need for a separate procedure, especially advantageous in settings with limited follow-up access. Therefore, the IUD represents a valuable contraceptive option for women recovering from high-risk pregnancies who require reliable, long-term, and breastfeeding-compatible contraception.²¹

The management of triplet pregnancies complicated by uterine leiomyomas is further challenged by risks such as degenerative changes, obstructed labor, and intraoperative hemorrhage. Uterine fibroids, or leiomyomas, affect up to 10% of pregnancies and can alter gestational outcomes depending on their size, number, and location.²² In several similar cases of multifetal pregnancies, surgical removal of fibroids was performed in the first trimester, but the outcome was not entirely successful. Ribeiro et al. reported the delivery of dichorionic diamniotic twins with giant uterine fundal myomas. Myomectomy was performed at 18 weeks' gestation due to complications of uterine prolapse and decreased gastric capacity. The results showed the death of one fetus two weeks after the myomectomy, and the other fetus was

successfully delivered by cesarean section at term.⁷ Muanda-Mbaki et al. reported a heterotopic triplet pregnancy with one fetus in the fallopian tube that ruptured at 8 weeks' gestation. Laparoscopic salpingectomy was performed immediately, but only one fetus survived and was born healthy at term.⁸ In this case, the absence of acute maternal or fetal emergencies during early hospitalization was unexpected for a high-order multiple pregnancy complicated by fibroids, and underscores the importance of vigilant antenatal surveillance and timely hospitalization. This scenario demonstrates a rare and favorable balance between significant risk and clinical stability. Although the pregnancy was associated with considerable risk due to its triplet status and preterm presentation, the presence of latent labor, reassuring fetal status, and cephalic presentation facilitated an environment conducive to optimizing maternal and neonatal outcomes. Such presentations are uncommon and offer valuable insights into management strategies for triplet pregnancies that do not initially present with emergencies.

This case of triplet pregnancy complicated by uterine fibroids illustrates several important clinical lessons. Early identification and prompt referral of high-risk pregnancies to tertiary care centers are crucial for optimizing maternal and neonatal outcomes. Administration of corticosteroids and vigilant inpatient monitoring were instrumental in reducing severe neonatal morbidity, particularly in the context of anticipated prematurity. In a triplet pregnancy with large fibroids, cesarean myomectomy with hemostatic techniques tends to show low rates of intraoperative hemorrhage, postoperative fever, or prolonged hospital stay. Concurrent myomectomy offers dual benefits: treating fibroids while ensuring maternal and neonatal safety, reducing surgical time, avoiding repeat surgeries, and lowering costs. This case supports safety even in triplets. Furthermore, the case emphasizes the significance of comprehensive family planning, especially for high-parity or high-risk obstetric patients, to mitigate complications in future pregnancies. However, the absence of histopathological images of the excised tissue should be noted as a limitation of this case report. Overall, this case reinforces the necessity of individualized, physiology-based decision-making in rare and complex obstetric situations, where tailored management can achieve favorable outcomes despite substantial risk factors.

Conclusion

This case demonstrates the multifactorial complexity of spontaneous triplet pregnancy complicated by preterm labor at 30 to 31 weeks, primarily influenced by uterine overdistension and potentially aggravated by the presence of a uterine myoma. Although spontaneous triplet gestations are rare and inherently high-risk, early onset of labor often results from mechanical

stretch and hormonal activation pathways that exceed physiological thresholds. The presence of a myoma may further reduce uterine compliance, contribute to fetal malpresentation or placental dysfunction, and elevate the risk of preterm delivery. Decisions regarding the mode of delivery should be individualized, considering fetal positions, labor progression, and maternal factors, while ensuring neonatal intensive care unit preparedness. Cesarean section combined with myomectomy can be safely performed in selected cases of triplet pregnancy with large fibroids, particularly when the mother and fetus are clinically stable. Additionally, immediate postpartum contraception, such as IUD placement, is essential to prevent rapid repeat pregnancy and to support long-term maternal health in high-risk multiparous patients.

Conflict of interest

No potential conflict of interest relevant to this article was reported.

Informed consent

Written consent was obtained from the patient in this report.

Funding source

This report did not receive any source of funding.

Acknowledgments

Nothing to declare.

References

1. Meah VL, Khurana R, Hornberger LK, Steinback CD, Davenport MH. Cardiovascular function during triplet pregnancy. *J Appl Physiol*. 2025;130:1286–92.
2. Ekström M maria, Tiblad E, Norman M, Stephansson O, Granfors M. Maternal, pregnancy and neonatal outcomes in triplet pregnancies in Sweden – a nationwide cohort study. *Uppsala J Med Sci*. 2023;128:1–8.
3. Liu S, Wang C, Chen X, Song B. Pregnancy and Obstetric Outcomes of Dichorionic and Trichorionic Triamniotic Triplet Pregnancy with Multifetal Pregnancy Reduction : A Retrospective Analysis Study. *Res Sq*. 2021;1–19.
4. Gemici A, Tapisiz OL. The meaning and management of uterine fibroids in pregnancy : a narrative review of the literature. *Gynecol Pelvic Med*. 2023;6:1–15.
5. Tîrnovanu MC, Lozneau L, Cojocaru E. Uterine Fibroids and Pregnancy : A Review of the Challenges from a Romanian Tertiary Level Institution. *Healthcare*. 2022;10:1–14.
6. Micic J, Macura M, Andjic M, Ivanovic K, Dotlic J, Micic DD, et al. Currently Available Treatment Modalities for Uterine Fibroids. *Medicina (Mex)*. 2024;60(868):1–16.
7. Ribeiro C, Nakamura A, Franca T, de Azevedo Focchi R, Limone G, Kuster M, et al. Giant

- myoma associated with uterine prolapse during the second trimester of twin pregnancy: case report. *Obstet Gynecol Int J*. 2021; 12(4):249–51.
8. Muanda-Mbaki E, Tshiamu Bakamwenz A, Kusuman A, Odimba Mpoy J, Mamanisini Kiaku-Mbuta D, Lokomba Bolamba V, et al. A Triplet Heterotopic Pregnancy with Favourable Outcome after Laparoscopic Salpingectomy and Loss of One Intrauterine Twin. *The Trocar*. 2025;6(4):73–80.
 9. Hu Q, Zeng Z, Liu H, Liao H, Xu T, Yu H. Perinatal outcomes and growth discordance of triplet pregnancies based on chorionicity: a retrospective cohort study. *BMC Pregn Childbir*. 2024;24(391):1–13.
 10. Lee JY, Lee SM, Jeong M, Choe SA, Jun JK. Short-term and long-term outcomes of trichorionic triplet pregnancies with expectant management. *Acta Obstet Gynecol Scand*. 2022;101:111–8.
 11. van de Mheen L, Ravelli AC, Oudijk MA, Nij Bijvank S, Porath MM, Duvekot JJ, et al. Prediction of Time to Delivery Week-by-Week in Women with a Triplet Pregnancy. *Am J Perinatol*. 2016; 33(14):1394-1400.
 12. Gao T, Zhou J, Yang L, Wang T. Association of multiple pregnancies with risk of preterm birth in the United States: a retrospective cohort study. *Transl Pediatr*. 2025;14(5):915–26.
 13. Mcgoldrick E, Stewart F, Parker R, Dalziel SR. Antenatal corticosteroids for accelerating fetal lung maturation for women at risk of preterm birth (Review). *Cochrane Database Syst Rev*. 2020;12(12):CD004454.
 14. Hui M, Sibai B, Leon MG. Uterine Leiomyomata as a Cause of Abdominal Compartment Syndrome in the Postpartum Period. *Am J Perinatol Rep*. 2024;14(1):74–9.
 15. Root E, Tonismae T. Multiple Birth Delivery. StatPearls Internet Treasure Isl FL StatPearls Publ. 2024.
 16. Baktiar MP, Rauf A. Simultaneous Myomectomy and Cesarean Section: A Dual Surgical Approach Pregnancy with enormous fibroid. *Indones J Perinatol Perinasia*. 2023;4(2):27–31.
 17. Na H, Lee K no, Kim Y, Kim BY, Park M, Song SY, et al. Outcomes of cesarean myomectomy in Singleton compared with twin pregnancies: a 10-year retrospective cohort study. *BMC Surg*. 2025;25:185.
 18. Ercan F, Pekin A, Sarıkaya M, Kılıç F, Balcı O, Gökemli H, et al. A safe procedure for myomectomy during cesarean section. *Clin Exp Obstet Gynecol*. 2019;XLVI(1):72–8.
 19. Garimi G, Seh-shmali K, Zafran N, Erez O, Romano S, Salim R. Efficacy and safety of

- intrauterine device placement during a planned cesarean section. *Heliyon*. 2022;8(November):e12318.
20. Uli PT, Wada Y, Suhartini L. Myomectomy After Cesarean Section : Considerations and Planning. *J Obstet Gynecol Cancer Res*. 2025;10(4):333–8.
 21. Bolling KR, Wahdan Y, Warnock N, Lott J, Schoendorf J, Pisa F, et al. Utilisation, effectiveness, and safety of immediate postpartum intrauterine device insertion : a systematic literature review. *BMJ Sex Reprod Health*. 2023;49(1):1–30.
 22. Sobel M, Hobson S, Chan C. Uterine fibroids in pregnancy. *CMAJ*. 2022;194(22):E775.

Incision-Site Descemet Membrane Detachment After Femtosecond Laser–Created Versus Manual Clear Corneal Incisions in Cataract Surgery: A Systematic Review

Baiq Nova Fajriyatun^{1,2*}, Aloysius Angga Wibowo^{1,2}

¹H.L Manambai Abdulkadir Hospital, Sumbawa, Indonesia

²Abdul Malik Fadjar PKU Muhammadiyah Sumbawa Hospital, Sumbawa, Indonesia

*Corresponding Author. Email: nova.fajriyatun@gmail.com, Telp: +6281239902009

ABSTRACT

Background: Clear corneal incision (CCI) is the standard approach in modern cataract surgery; however, incision-related Descemet membrane detachment (DMD) is increasingly recognized with the widespread use of anterior segment optical coherence tomography. Variations in incision architecture may affect posterior corneal stability and DMD risk.

Content: This systematic review compares the incidence of incision-site DMD following femtosecond laser-created versus manual CCI in adult undergoing cataract surgery. The review was conducted in accordance with PRISMA guidelines. PubMed, Cochrane Library, and ScienceDirect were searched using keywords related to femtosecond lasers, CCI, and cataract surgery. Comparative studies reporting DMD incidence intraoperatively or in the early postoperative period were included. Risk ratios were pooled using a random-effects model. Seven studies met the inclusion criteria. Across studies, femtosecond laser-created CCIs demonstrated a lower incidence of incision-site DMD than manual keratome incisions, particularly during intraoperative and early postoperative assessments using optical coherence tomography. Although not all studies reached statistical significance, the effect direction was consistent. Most DMDs were small, subclinical, and resolved spontaneously. The reduced DMD incidence associated with femtosecond laser-created incisions is biologically plausible and likely reflects improved incision geometry and posterior wound stability. Heterogeneity in study design and imaging protocols limits certainty, and the clinical relevance of subclinical DMD remains modest.

Conclusion: Femtosecond laser-created CCI are associated with a lower early risk of incision-site DMD compared with manual incisions, although most detachments are transient and clinically insignificant.

Keywords: Cataract surgery, clear corneal incision, Descemet membrane detachment, femtosecond laser, optical coherence tomography



Published by:
Universitas Negeri Gorontalo

Mobile number:
+62852 3321 5280

Address:
Jend. Sudirman St. No.6, Gorontalo
City, Gorontalo, Indonesia

Email:
jmhsj@ung.ac.id

Article History:
Received 11 May 2026
Accepted 18 June 2026
Published 28 July 2026

DOI:
<https://doi.org/10.37905/jmhsj.v5i2.38871>

Introduction

Cataract surgery is one of the most frequently performed surgical procedures worldwide and continues to advance alongside developments in microsurgical techniques and imaging technologies. In contemporary practice, a clear corneal incision (CCI) has become the standard approach for anterior chamber access during phacoemulsification, largely due to its self-sealing nature, reduced conjunctival manipulation, and favorable postoperative recovery profile. Nevertheless, the corneal incision is not merely an entry point but a dynamic surgical interface whose architectural integrity has direct implications for intraoperative maneuverability, wound stability, and postoperative corneal health.^{1,2}

Despite the overall safety of modern cataract surgery, incision-related complications remain clinically relevant. Among these, Descemet membrane detachment (DMD) has gained increasing attention over the past decade. DMD is defined as the separation of the Descemet membrane from the posterior corneal stroma and may occur intraoperatively or during the early postoperative period. While large or centrally extending detachments can lead to persistent corneal edema and visual deterioration, most incision-site DMDs are localized and subclinical, detectable primarily through high-resolution anterior segment optical coherence tomography (AS-OCT).^{3,4} The increasing availability and routine use of AS-OCT have revealed that DMD following cataract surgery may be substantially more prevalent than previously recognized based on slit-lamp examination alone.

The development of incision-site DMD is thought to result from multiple contributing factors. Mechanical stress during incision creation, disruption of stromal–Descemet adhesion, endothelial cell trauma, and misdirection of fluid at the internal corneal lip have all been implicated as potential mechanisms.⁵ Manual keratome-created CCIs rely heavily on surgeon experience and tactile feedback, resulting in inherent variability in incision length, depth, tunnel configuration, and internal wound smoothness. Even subtle irregularities at the internal wound margin may serve as focal points for shearing forces during phacoemulsification or irrigation–aspiration, predisposing the Descemet membrane to localized separation.⁶

Femtosecond laser–assisted cataract surgery has introduced an unprecedented level of precision to several surgical steps, including corneal incision formation. Femtosecond laser–generated CCIs are created according to predefined parameters, enabling reproducible control of incision depth, tunnel length, angulation, and multiplanar architecture. This level of precision theoretically minimizes irregular internal wound morphology and reduces unintended trauma to the posterior corneal layers.⁷ Imaging-based comparative studies have demonstrated that femtosecond laser incisions are associated with smoother internal wound surfaces, more

consistent tunnel geometry, and reduced posterior wound gape when compared with manual keratome incisions.⁸

These structural advantages have led to the hypothesis that femtosecond laser–created CCIs may reduce the risk of incision-related complications, including DMD. Several comparative studies employing intraoperative or early postoperative AS-OCT have reported a lower incidence of DMD following femtosecond laser incision creation, particularly during the immediate and early postoperative phases.^{4,9} These findings suggest that improved incision architecture may translate into greater posterior corneal stability at the incision site.

However, the available evidence remains heterogeneous and, in some cases, conflicting. Not all studies have demonstrated statistically significant differences in DMD incidence between femtosecond-laser–created and manually created CCIs. In smaller observational cohorts, although DMD rates were often numerically higher in manual incision groups, limited sample sizes and wide confidence intervals reduced statistical power, resulting in nonsignificant findings.¹⁰ Furthermore, DMD has frequently been reported as a secondary or incidental observation rather than a predefined outcome, leading to variability in detection methods, imaging time points, and reporting standards across studies.

Another important consideration is the clinical relevance of incision-site DMD. Longitudinal imaging studies suggest that most small, localized DMDs resolve spontaneously over time without requiring intervention or affecting final visual outcomes.^{3,5} Nevertheless, the presence of DMD may reflect underlying deficiencies in incision construction and wound integrity, serving as a surrogate marker of surgical quality rather than a benign incidental finding. From this perspective, reducing the incidence of DMD may be relevant not only for preventing rare clinically significant complications but also for optimizing incision architecture and corneal wound healing.

Despite increasing attention to incision morphology and corneal alterations detected by OCT, no previous systematic review has specifically examined incision-site DMD as an outcome in comparisons between femtosecond laser–created and manually constructed CCIs in cataract surgery. Most existing reviews of femtosecond laser–assisted cataract surgery have focused primarily on refractive outcomes, endothelial cell loss, or overall complication rates, without addressing DMD as a distinct and clinically relevant endpoint.¹⁰

Considering the growing recognition of subclinical DMD and its potential impact on corneal wound integrity, a targeted synthesis of the existing evidence is justified. Accordingly, this systematic review aims to compare the incidence of incision-site DMD in adult patients undergoing cataract surgery using femtosecond laser–created versus manually constructed

CCIs. Through a systematic evaluation of comparative studies incorporating intraoperative and postoperative OCT assessment, this review seeks to elucidate the magnitude and consistency of the relationship between incision technique and the risk of DMD.

Methods

Study design and reporting standards

This systematic review was conducted to evaluate the association between corneal incision techniques and the risk of incision-site DMD after cataract surgery. The review was designed and reported in accordance with PRISMA guidelines, using a predefined methodology to guide literature searching, study selection, data extraction, and qualitative synthesis.

Literature search strategy

A comprehensive literature search was conducted in PubMed, Cochrane Library, and ScienceDirect from database inception to April 2026, including all studies published up to the final search date without restriction on publication year to ensure that both earlier and recent comparative evidence on femtosecond laser–created and manual CCIs could be captured. In PubMed, the following search query was used: (“femtosecond laser” OR “femtosecond laser-assisted”) AND (“clear corneal incision” OR “corneal incision”) AND (cataract OR phacoemulsification), while in the Cochrane Library and ScienceDirect, the search was performed using the keywords/query: femtosecond laser AND corneal incision AND cataract. The search strategy was intentionally kept broad, and outcome-specific terms such as Descemet membrane detachment were not mandated at the search stage to avoid excluding relevant studies in which the outcome was reported as a secondary or incidental finding. In addition to electronic database searching, the reference lists of all included studies and relevant review articles were manually screened to identify any additional eligible studies.

Eligibility criteria

Studies were eligible for inclusion if they involved adult patients undergoing cataract surgery with a CCI, in which the intervention involved femtosecond laser–created CCIs and the comparison group included manual keratome-created CCIs. The outcome of interest was incision-site DMD detected intraoperatively or during the early postoperative period using clinical examination or imaging modalities, including anterior segment optical coherence tomography. Eligible study design included randomized controlled trials, as well as prospective or retrospective comparative cohort and observational study designs. Studies were excluded if involved non-cataract anterior segment procedures, absence of a manual incision comparator, lack of DMD outcome reporting, and publication formats such as reviews, editorials, case

reports, conference abstracts without full text, or non-English articles.

Study selection

Records retrieved from the electronic searches were entered into a reference management system, and duplicates were eliminated. Two reviewers independently screened titles and abstracts to identify potentially eligible studies, followed by full-text reviews to confirm eligibility based on predefined criteria. Any disagreements arising during the screening or full-text review stages were resolved through discussion until consensus was reached between the reviewers. The study selection process is summarized in a PRISMA flow diagram.

Data extraction

Two reviewers independently extracted data using a standardized form. Extracted information comprised publication details, study location and setting, study design, sample size, patient characteristics, femtosecond laser platform and incision parameters, manual incision technique, timing and modality of DMD detection, follow-up period, and incidence of incision-site Descemet membrane detachment.

When DMD was reported at multiple time points, data were extracted for each reported assessment, with particular attention to intraoperative and early postoperative findings. Any discrepancies in extracted data were resolved by re-reviewing the original articles.

Risk of bias assessment

An assessment of methodological quality and risk of bias was conducted for each included study. Given that most included studies employed non-randomized designs, domains including selection bias, comparability of intervention and comparator groups, outcome assessment, and completeness of follow-up were evaluated. Based on these domains, studies were categorized as having low, moderate, or high risk of bias. Overall, the risk of bias was judged to be moderate for most included studies, primarily due to observational study designs and limited sample sizes.

Data synthesis

Findings from the included studies were synthesized using a qualitative narrative approach to facilitate comparison. Due to heterogeneity in study design, incision architecture, imaging protocols, timing of DMD assessment, and outcome reporting, quantitative pooling of results was not performed.

Findings were synthesized descriptively, focusing on patterns in DMD incidence between femtosecond laser-created and manual CCIs, as well as the temporal evolution of DMD when longitudinal data were available. Emphasis was placed on consistency in the direction of effect rather than on formal statistical comparison. Clinical and methodological

heterogeneity among studies was explored qualitatively by comparing surgical techniques, laser platforms, imaging modalities, and follow-up durations.

Results

Study selection

The comprehensive database search yielded 647 records across the three selected databases, reflecting a deliberately sensitive search strategy designed to capture a broad spectrum of studies related to femtosecond laser–assisted and manual CCIs in cataract surgery. ScienceDirect contributed the majority of records ($n = 548$), followed by PubMed ($n = 50$) and the Cochrane Library ($n = 49$). This distribution reflects the predominance of surgical technique–focused observational studies indexed in broader biomedical databases rather than trial registries.

After screening titles and abstracts, 637 records were excluded. The primary reasons for exclusion at this stage included studies focusing on femtosecond laser–assisted cataract surgery without specific evaluation of corneal incision characteristics, studies addressing refractive or visual outcomes without reporting incision-related complications, review articles, editorials, and non-comparative case series. Duplicate assessment of the remaining records identified two duplicate publications, leaving eight full-text articles for detailed eligibility assessment.

During full-text review, one study was excluded because it involved an inappropriate population and intervention, specifically refractive surgery without cataract extraction and without reporting incision-site DMD as an outcome. In total, seven studies fulfilled all inclusion criteria and were incorporated into the qualitative synthesis. The study selection process, along with reasons for exclusion, is depicted in the PRISMA flow diagram (**Figure 1**).

Characteristics of included studies

The six included studies were published between 2014 and 2025. As resumed on **Table 1**, these studies reflect over a decade of evolving experience with femtosecond laser technology in anterior segment surgery. Geographically, the studies originated from Asia, North America, and South America, including research conducted in India, China, Brazil, and the United States, thereby encompassing a range of surgical settings and patient populations.

All included studies employed comparative study designs, predominantly prospective non-randomized cohorts and observational comparative studies, with one retrospective comparative case series. Importantly, no randomized controlled trials were identified that were specifically designed to evaluate incision-site DMD as a primary endpoint. Sample sizes varied

widely, from small cohorts involving fewer than 20 eyes per group to larger studies enrolling more than 100 eyes, contributing to variability in statistical power across studies.

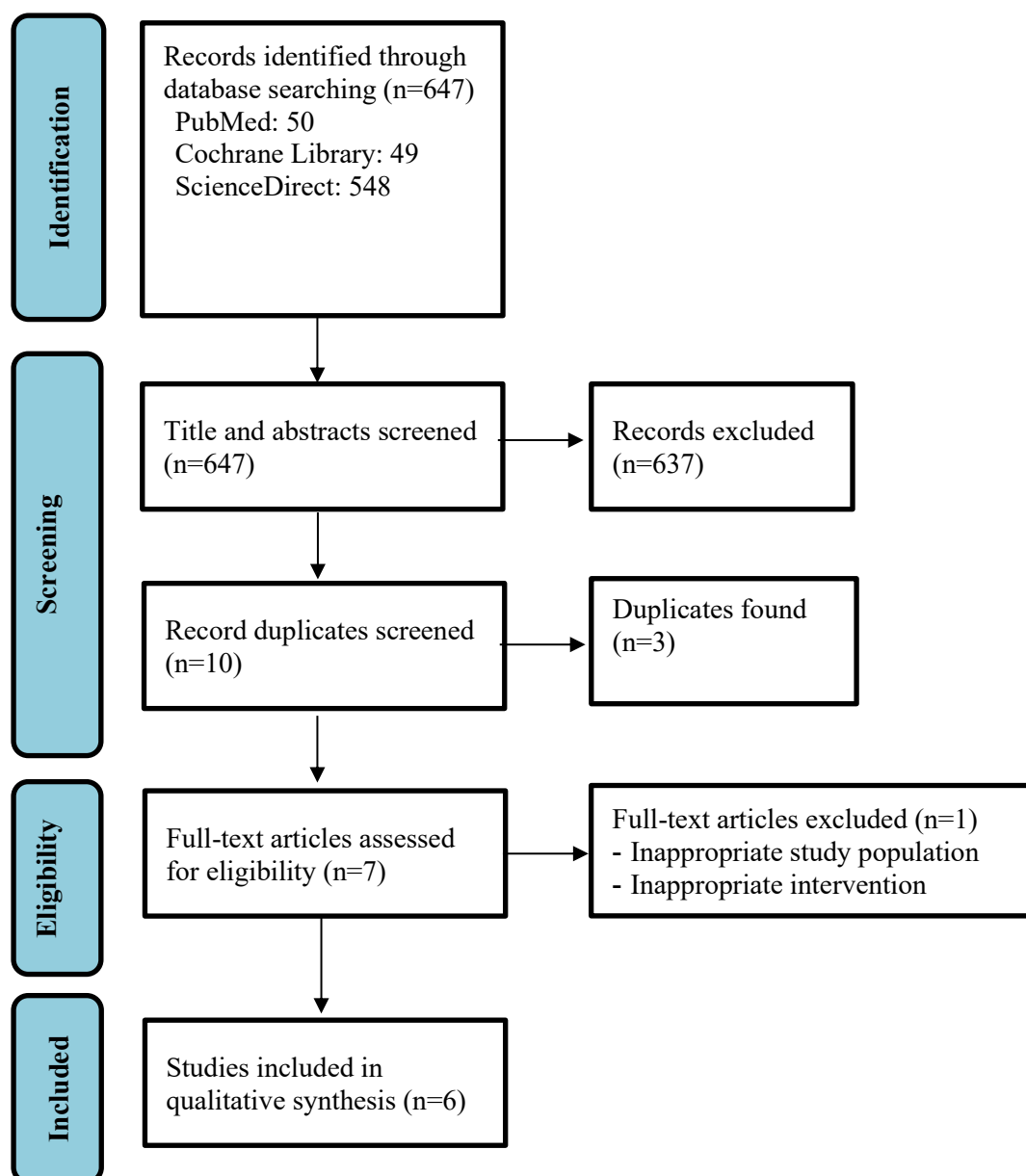


Figure 1. Diagram flow of literature search strategy for this systematic review

The study populations consisted of adult patients undergoing uncomplicated cataract surgery via a CCI. Most studies explicitly excluded eyes with pre-existing corneal pathology, previous ocular surgery, glaucoma, pseudo exfoliation, or intraoperative complications, thereby minimizing confounding factors known to influence corneal wound integrity. Surgical procedures were typically performed by single experienced surgeons, reducing inter-operator variability but potentially limiting generalizability.

Table 1. Summary source

First Author (Year)	Country / Setting	Study Design	Population Characteristics	Sample Size*	Surgical Technique Details	DMD Detection Method	Outcome Assessed	Main Findings	Summary of Findings	Risk of Bias
Titiyal et al. (2017)¹¹	India; tertiary referral ophthalmic center (AIIMS New Delhi)	Prospective comparative cohort (non-randomized)	Adults with senile cataract undergoing uncomplicated phacoemulsification; excluded corneal pathology, glaucoma, pseudo exfoliation, prior ocular surgery	52 / 77	FL group: femtosecond laser–created 2.2-mm biplanar temporal CCI (LenSx); Manual group: 2.2-mm metal keratome biplanar CCI;	Microscope-integrated intra-operative OCT and anterior segment OCT (POD 1 & 30)	Incision-site Descemet membrane detachment (intraoperative and early postoperative)	Intraoperative DMD: 9.6% (FL) vs 49.4% (manual), p < 0.001; POD-1 DMD: 5.8% vs 37.6%; all DMD self-resolving by one month	Femtosecond laser CCI were associated with significantly lower incidence of incision-site DMD compared with manual keratome CCI; ragged incision	Moderate

					single surgeon				morpholog y strongly predicted DMD	
Horta et al. (2025)⁴	Brazil; tertiary ophthalmol ogy centers (Horta Institute & University of São Paulo)	Prospectiv e comparati ve cohort (non- randomize d, investigato r-masked)	Adults with cataract undergoing uncomplicated phacoemulsifica tion; no significant baseline differences in age, sex, or laterality	18 / 19	FL group: femtosec ond laser– created 2.2-mm triplanar clear corneal incision (LensX®, planned length 1.65 mm); Manual group:	Anterior segment OCT (AS- OCT) at 2–4 days and 1– 3 months postoperativ ely	Incidence of incision- site Descemet membrane detachment in early and intermediat e postoperati ve period	Early postoperati ve DMD: 22.2% (FL) vs 63.2% (manual), p = 0.012; late DMD (1–3 months): 0% vs 10.5% (NS)	Femtoseco nd laser– created CCIs showed significant- ly lower early postoperati ve DMD compared with manual keratome CCIs; most DMD resolved	Moder ate

					2.2-mm keratome biplanar clear corneal incision				spontaneou sly over time	
Wang et al. (2018)⁹	China; Shanxi Eye Hospital	Prospectiv e comparati ve cohort	Adults with senile cataract; LOCS III grade 3; pupil ≥ 8 mm; endothelial cell count $>1,200/\text{mm}^2$; no prior ocular surgery or corneal pathology	58 / 34	FL group: LenSx femtosec ond laser– created 2.2-mm two-plane primary CCI; Manual group: 2.2-mm single- plane	Spectral- domain anterior segment OCT at POD-1, week-1, month-1, month-3	Incidence of incision- site Descemet membrane detachment during early postoperati ve period	DMD incidence significantl y lower in FL group at week-1, month-1, and month-3 (all $p < 0.05$); no DMD observed beyond 1 month in	Femtoseco nd laser– created CCIs were associated with a consistentl y lower incidence of postoperati ve incision- site DMD compared	Moder ate

					steel keratome CCI; single experienc ed surgeon			FL group; posterior wound gape also lower at POD-1	with manual CCIs, suggesting more stable and reproducib le incision architectur e	
Grewal & Basti (2014)⁸	United States; Northweste rn University Feinberg School of Medicine, Chicago	Comparati ve case series (retrospect ive analysis of consecutiv e cases)	Adults with age- related cataract undergoing uncomplicated phacoemulsifica tion; excluded prior ocular surgery, corneal pathology, intraoperative complications,	20 / 16	FL group: Catalys femtosec ond laser– created triplanar CCI, width 2.6 mm, intended	Anterior segment OCT at 1 month postoperativ ely; images analyzed using ImageJ by masked investigator	Incision- site Descemet membrane detachment at postoperati ve evaluation	DMD observed in 0/20 eyes (FL) vs 3/16 eyes (manual), p = 0.04; endothelial gape and misalignm	Femtoseco nd laser– created CCIs were associated with a significant- ly lower incidence of incision- site DMD	Moder ate

			or need for wound enlargement		length 2.1 mm; Manual group: 2.65-mm steel keratome triplanar CCI; all surgeries by single surgeon			ent significant -ly lower in FL group	and superior incision morpholo- gy compared with manual keratome CCIs	
Rodrig ues et al. (2019)¹⁰	Brazil; Hospital de Olhos Paulista, São Paulo	Prospectiv e observatio nal non- randomize d cohort	Adults with cataract and low visual acuity; excluded ocular comorbidities, prior ocular surgery or trauma, corneal wound-healing	9 eyes / 9 eyes	FL group: VICTUS femtosec ond laser– created 2.75-mm triplanar clear	Anterior segment OCT at postoperativ e day 1 and day 30; qualitative assessment by three	Incision- site Descemet membrane detachment and other wound- architecture features	POD-1 DMD: 33.3% (FL) vs 66.7% (manual), p = 0.35; POD-30 DMD: 0%	Although femtoseco nd laser incisions were more consistent- ly triplanar and precisely	Moder ate

			disorders, intra- or postoperative complications		corneal incision; Manual group: 2.75-mm steel keratome CCI; all surgeries by a single surgeon	masked corneal specialists		vs 11.1%, p = 0.99; differences not statistical- ly significant	constructe d, the incidence of incision- site DMD did not differ significant- ly from manual keratome incisions	
Meng et al. (2025)¹²	China; Beijing New Vision Eye Hospital	Retrospect ive matched comparati ve cohort	Adults aged 18– 45 years undergoing implantable collamer lens (ICL) surgery for moderate– high myopia; no prior ocular	42 eyes / 42 eyes	FL group: Catalys femtosec ond laser– created clear corneal incision	Not reported for DMD (OCT used for biometric assessment, not DMD incidence)	Visual acuity, astigmatism, refractive predictabili ty, safety parameters	Short-term (≤1 month) visual acuity and astigma- tism were worse in the	Femtoseco nd laser– created CCIs did not provide clinical advantages over manual	Moder ate

surgery or	(3.0–3.2	femtoseco	CCIs in
corneal	mm) for	nd group;	ICL
pathology	ICL	mid- and	surgery;
	implantati	long-term	Descemet
	on with	outcomes	membrane
	blunt	(3–6	detachmen
	separatio	months)	t was not
	n; Manual	were	assessed or
	group:	comparabl	reported
	3.0-mm	e; no	
	manual	superiority	
	clear	of	
	corneal	femtoseco	
	incision;	nd incision	
	single	demonstrat	
	experienc	ed	
	ed		
	surgeon		

*Sample size number based on FL CCI/Manual CCI ratio

Femtosecond laser–created incisions were generated using various commercially available platforms, including LenSx, Catalys, and VICTUS systems, with predefined incision parameters. These incisions were predominantly bi- or triplanar, with precisely controlled tunnel length, depth, and angulation. In contrast, manual incisions were performed with conventional steel keratomes, with incision architecture determined by the surgeon's technique and tactile feedback. This fundamental difference in incision creation methodology underpins the hypothesized disparity in wound morphology and subsequent risk of DMD.

Figure 2 shows risk-of-bias summary of the included observational studies using the Newcastle–Ottawa Scale domains. Green indicates low risk of bias, yellow indicates moderate risk of bias, and red indicates high risk of bias. Most studies were judged to have an overall moderate risk of bias, mainly because of non-randomized study design, limited sample size, and potential selection bias.

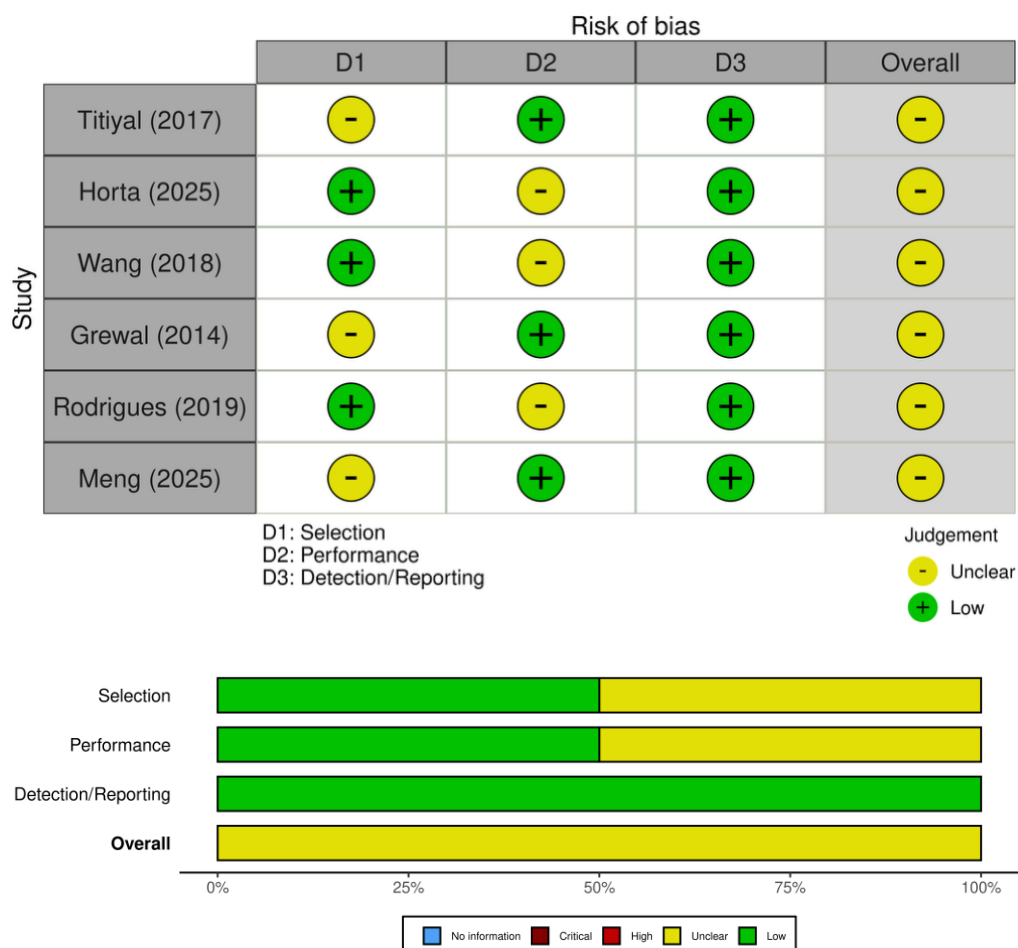


Figure 2. Risk of bias assessment result using NOS

Assessment and detection of Descemet membrane detachment

Across the included studies, DMD was primarily detected using anterior segment optical coherence tomography (AS-OCT), underscoring the importance of high-resolution imaging in identifying subtle incision-related corneal changes. Several studies performed OCT imaging within the early postoperative period, most commonly on postoperative day 1 or within the first postoperative week, while others extended imaging to one month or beyond.

One study uniquely incorporated microscope-integrated intraoperative OCT, allowing real-time detection of DMD occurring during incision creation or intraoperative manipulation. This approach provided valuable insight into the temporal onset of DMD and suggested that many detachments originate at the internal wound lip during surgery rather than developing exclusively postoperatively.

The use of standardized OCT protocols across studies enhanced comparability, although heterogeneity persisted regarding imaging time points, scan orientation, and criteria for defining DMD. Most studies defined DMD as any visible separation of Descemet membrane from the posterior corneal stroma at the incision site, regardless of size or clinical significance.

Incidence of Descemet membrane detachment

All included studies reported numerically higher rates of incision-site DMD following manual CCIs compared with femtosecond laser-created incisions, although the absolute incidence and statistical significance varied. In studies employing intraoperative OCT, the difference was particularly pronounced, with manual incision groups demonstrating markedly higher rates of immediate DMD formation. One prospective study reported intraoperative DMD in nearly half of eyes undergoing manual incision, compared with approximately one-tenth of eyes in the femtosecond laser group.

Early postoperative OCT assessments corroborated these findings. Reported early DMD incidence in femtosecond laser groups is ranged from 0% to approximately one-third of eyes, whereas corresponding rates in manual incision groups frequently exceeded 50% in some cohorts. Several studies demonstrated statistically significant differences favoring femtosecond laser-created incisions, suggesting superior wound integrity and reduced mechanical stress on Descemet membrane.

Nevertheless, not all studies have reached statistical significance. In smaller observational cohorts, although DMD rates remained numerically higher in the manual incision group, limited sample size and wide confidence intervals reduced the ability to detect significant differences. These findings highlight the influence of study power and underscore

the need for cautious interpretation of null results.

Temporal course and clinical relevance of DMD

Longitudinal OCT follow-up revealed that the majority of incision-site DMDs were transient and self-resolving, regardless of incision technique. Studies that extended follow-up to one month or longer consistently demonstrated progressive reattachment of Descemet membrane, with few or no persistent detachments observed beyond the early postoperative period.

Importantly, none of the included studies reported visually significant DMD requiring surgical intervention, such as air or gas descemetopexy. Visual outcomes were generally unaffected by the presence of small, localized DMDs, suggesting that most detachments represented subclinical imaging findings rather than clinically consequential complications.

Despite their transient nature, the higher early incidence of DMD in manual incision groups may reflect less predictable incision architecture, increased endothelial trauma, or greater susceptibility to internal wound lip irregularities. These mechanistic considerations support the biological plausibility of reduced DMD risk with femtosecond laser-created incisions.

Overall summary of findings

The timing of OCT-based DMD assessment varied across the included studies. Most studies evaluated DMD during the early postoperative period, particularly on postoperative day 1 or within the first postoperative week, when incision-related mechanical changes are expected to be most apparent. Other studies extended the assessment to one month or longer, allowing evaluation of the temporal resolution of DMD. This variation is important because early OCT tends to capture transient and subclinical detachments, whereas later OCT may underestimate the initial incidence due to spontaneous reattachment. Therefore, DMD incidence was interpreted according to the timing of assessment rather than as a uniform endpoint across all studies.

Taken together, the evidence from six comparative studies indicates that femtosecond laser-created CCIs are associated with a lower incidence of incision-site DMD compared with manual keratome incisions, particularly during the intraoperative and early postoperative phases. While heterogeneity in study design, incision parameters, and imaging protocols exists, the direction of effect was consistent across studies.

However, the certainty of evidence is limited by the absence of randomized controlled trials and the predominance of non-randomized observational designs. Furthermore, the largely self-limiting nature of most DMDs raises questions regarding the clinical significance of these

findings. These considerations warrant cautious interpretation and emphasize the need for well-designed prospective trials to clarify the impact of femtosecond laser incision technology on meaningful clinical outcomes.

Discussion

This systematic review presents a targeted synthesis of comparative evidence evaluating incision-site DMD following femtosecond laser–created versus manual CCIs in cataract surgery. The principal finding of this study is that femtosecond laser–created CCIs are associated with a lower incidence of DMD during the intraoperative and early postoperative periods compared with manual keratome incisions. Although the degree of risk reduction varied across studies and statistical significance was not uniformly achieved, the direction of effect was consistent, supporting a meaningful association between incision construction technique and posterior corneal stability.

Interpretation of the main findings

Across the included studies, incision-site DMD was detected more frequently in manual incision groups, particularly when high-resolution AS-OCT was employed early after surgery. This observation was most evident during intraoperative or postoperative day 1 imaging, whereas later follow-up demonstrated a marked decline in DMD prevalence in both groups. These temporal patterns suggest that DMD is predominantly an early mechanical phenomenon, arising from stresses imposed on the posterior corneal layers during incision creation and initial intraocular manipulation.

Importantly, the higher early incidence of DMD in manual incision groups does not appear to be a random finding. Rather, it reflects systematic differences in incision architecture and wound reproducibility between the two techniques. Manual keratome incisions, even when performed by experienced surgeons, inherently involve variability in tunnel geometry, internal wound smoothness, and posterior lip configuration.⁶ These subtle inconsistencies may not be clinically apparent at the slit lamp but become evident when assessed with OCT-based imaging modalities.^{3,4}

Mechanistic rationale for reduced DMD with femtosecond laser incisions

The reduced incidence of DMD observed with femtosecond laser–created CCIs is biologically plausible and supported by morphologic and biomechanical evidence. Femtosecond laser incisions are generated through photo disruption, allowing precise separation of corneal tissue along preprogrammed planes with minimal collateral trauma. This contrasts with manual keratomes, which rely on mechanical cutting forces that may induce localized stress at the stromal–Descemet interface.^{7,8}

Imaging studies have consistently demonstrated that femtosecond laser incisions produce smoother internal wound surfaces, more consistent tunnel length, and improved alignment of the internal and external wound lips.^{8,9} These characteristics likely reduce shear forces acting on the Descemet membrane during phacoemulsification, irrigation–aspiration, and intraocular lens implantation. In addition, improved posterior wound apposition may limit fluid ingress into the potential space between Descemet membrane and posterior stroma, further reducing the likelihood of detachment.⁵

Another potential mechanism relates to endothelial preservation. Experimental and clinical data suggest that femtosecond laser energy, when appropriately applied, may result in less endothelial traction at the incision site compared with mechanical blade entry.¹³ Given the critical role of endothelial integrity in maintaining stromal–Descemet adhesion, even modest reductions in endothelial trauma could contribute to improved posterior corneal stability.

Contextualization within existing literature

Previous literature evaluating femtosecond laser–assisted cataract surgery has largely emphasized refractive precision, surgically induced astigmatism, endothelial cell loss, and global complication rates.^{14–16} While several studies have described improved incision architecture with femtosecond laser technology,^{7–9,17} DMD has rarely been examined as a dedicated outcome. When reported, it has often been treated as a minor or incidental finding rather than a clinically relevant endpoint.

The present systematic review addresses this gap by isolating incision-site DMD as a specific outcome of interest. By incorporating studies that employed intraoperative or early postoperative OCT assessment, this analysis captures both clinically apparent and subclinical detachments. In doing so, the findings complement rather than contradict prior meta-analyses of femtosecond laser–assisted cataract surgery, which may have overlooked incision-related posterior corneal changes due to broader outcome definitions.^{15,16}

Notably, the present findings suggest that femtosecond laser–assisted cataract surgery may provide selective advantages in terms of incision-related outcomes, even if overall complication rates or visual outcomes are comparable to manual surgery. This nuanced interpretation aligns with the growing recognition that surgical quality should not be assessed solely on final visual acuity but also on tissue-level integrity and reproducibility.

Clinical significance and practical implications

From a clinical perspective, the largely subclinical and self-resolving nature of most incision-site DMDs must be carefully considered. Longitudinal imaging studies indicate that the majority of small detachments reattach spontaneously within weeks, without the need for

intervention or adverse visual consequences.^{3,5} As such, the findings of this review should not be interpreted as evidence that femtosecond laser–assisted cataract surgery is required to prevent clinically significant DMD.

However, the presence of early DMD may serve as a surrogate marker of incision quality and posterior wound integrity. In this context, a lower incidence of DMD with femtosecond laser–created incisions suggests improved surgical consistency and reduced microtrauma at the corneal incision site. These factors may be particularly relevant in eyes with compromised corneal endothelium, shallow anterior chambers, or increased susceptibility to wound-related complications.

Moreover, as OCT-based assessment becomes increasingly integrated into routine postoperative evaluation, the ability to minimize subclinical corneal alterations may assume greater importance in surgical benchmarking and quality assurance.

Limitations of evidence

The present analysis is subject to several limitations that warrant consideration. First, the included studies were predominantly non-randomized and observational in nature, introducing potential selection bias and confounding. Second, sample sizes were generally modest, limiting statistical power and precision of pooled estimates. Third, heterogeneity existed with respect to laser platforms, incision parameters, surgeon experience, and OCT imaging protocols.

In addition, definitions of DMD varied across studies, and standardized thresholds for clinically meaningful detachment were lacking. The timing of DMD assessment also differed, with some studies focusing on intraoperative detection and others emphasizing early postoperative imaging. These factors may have contributed to heterogeneity and limit direct comparability.

Finally, the analysis focused primarily on early DMD incidence. The long-term clinical relevance of subclinical DMD, including its potential association with endothelial cell loss or delayed corneal recovery, remains insufficiently explored.

Future research directions

Future investigations should prioritize prospective randomized controlled trials specifically designed to evaluate incision-related outcomes, including DMD, using standardized OCT protocols and predefined assessment time points. Studies correlating OCT-detected DMD with endothelial cell density, corneal thickness changes, visual recovery, and patient-reported outcomes would further clarify the clinical implications of these findings.

Additionally, comparative evaluations of different femtosecond laser platforms,

incision geometries, and energy settings may help identify optimal parameters for minimizing posterior corneal trauma. As femtosecond laser technology continues to evolve, such data will be essential for refining surgical techniques and maximizing the benefits of precision incision construction.

Conclusion

This systematic review demonstrates that femtosecond laser-created CCIs are associated with a lower incidence of early incision-site DMD compared with manual keratome incisions. While most detected detachments are subclinical and self-resolving, the findings highlight the importance of incision architecture in posterior corneal stability. Future well-designed prospective studies are required to better elucidate the clinical significance of subclinical DMD and to define the role of femtosecond laser technology in optimizing corneal wound integrity.

Conflicts of Interest

The authors confirm that the research was carried out independently and declare no conflict of interest.

Funding Sources

This research was completed independently without financial assistance from any external institutions.

Acknowledgment

The authors gratefully acknowledge the researchers whose work contributed to this systematic review for their important academic contributions. The authors also extend their heartfelt appreciation to all individuals and parties who offered support, guidance, and encouragement throughout the research and writing process, which enabled the completion and publication of this work.

References

1. Hal dipurkar SS, Shikari HT, Gokhale V. Wound construction in manual small incision cataract surgery. *Indian J Ophthalmol*. 2009;57(1):9-13.
2. Lundström M, Dickman M, Henry Y, Manning S, Rosen P, Tassignon MJ, et al. Risk factors for refractive error after cataract surgery: Analysis of 282 811 cataract extractions reported to the European Registry of Quality Outcomes for cataract and refractive surgery. *J Cataract Refract Surg*. 2018;44(4):447-452.

3. Dai Y, Liu Z, Wang W, Qu B, Liu J, Congdon N, et al. Real-Time Imaging of Incision-Related Descemet Membrane Detachment During Cataract Surgery. *JAMA Ophthalmol.* 2021;139(2):150-155.
4. Horta G, Horta R, Kara-Junior N. Evaluation of corneal incision in femtosecond laser-assisted phacoemulsification. *Clinics (Sao Paulo).* 2025;80:100572.
5. Masnec S, Kokot A, Kralj T, Zlatar M, Loncaric K, Sablic M, et al. Challenge of Corneal Ulcer Healing: A Novel Conceptual Framework, the “Triad” of Corneal Ulcer Healing/Corneal Neovascularization/Intraocular Pressure, and Avascular Tendon Healing, for Evaluation of Corneal Ulcer Therapy, Therapy of Neovascularization, Glaucoma Therapy, and Pentadecapeptide BPC 157 Efficacy. *Pharmaceuticals.* 2025;18(12):1822.
6. Bhagat N, Nissirios N, Potdevin L, Chung J, Lama P, Zarbin MA, et al. Complications in resident-performed phacoemulsification cataract surgery at New Jersey Medical School. *Br J Ophthalmol.* 2007;91(10):1315-1317.
7. Mastropasqua L, Toto L, Mastropasqua A, Vecchiarino L, Mastropasqua R, Pedrotti E, et al. Femtosecond laser versus manual clear corneal incision in cataract surgery. *J Refract Surg.* 2014;30(1):27-33.
8. Grewal DS, Basti S. Comparison of morphologic features of clear corneal incisions created with a femtosecond laser or a keratome. *J Cataract Refract Surg.* 2014;40(4):521-530. doi:10.1016/j.jcrs.2013.11.028
9. Wang X, Zhang Z, Li X, Xie L, Zhang H, Koch DD, et al. Evaluation of Femtosecond Laser Versus Manual Clear Corneal Incisions in Cataract Surgery Using Spectral-Domain Optical Coherence Tomography. *J Refract Surg.* 2018;34(1):17-22.
10. Rodrigues R, Santos MSD, Silver RE, Campos M, Gomes RL. Corneal incision architecture: VICTUS femtosecond laser vs manual keratome. *Clin Ophthalmol.* 2019;13:147-152.
11. Titiyal JS, Kaur M, Ramesh P, Shah P, Falera R, Bageshwar LMS, et al. Impact of Clear Corneal Incision Morphology on Incision-Site Descemet Membrane Detachment in Conventional and Femtosecond Laser-Assisted Phacoemulsification. *Curr Eye Res.* 2018;43(3):293-299.
12. Meng ZY, Yang L, Zhou P. Femtosecond laser versus manual clear corneal incision in implantable collamer lens surgery. *Sci Rep.* 2025;15(1):1086.
13. Friedman NJ, Palanker DV, Schuele G, Andersen D, Marcellino G, Seibel BS, et al. Femtosecond laser capsulotomy. *J Cataract Refract Surg.* 2011;37(7):1189-1198.
14. Roberts HW, Day AC, O’Brart DP. Femtosecond laser-assisted cataract surgery: A review.

Eur J Ophthalmol. 2020;30(3):417-429.

15. Chen L, Hu C, Lin X, Li HY, Du Y, Yao YH, et al. Clinical outcomes and complications between FLACS and conventional phacoemulsification cataract surgery: a PRISMA-compliant Meta-analysis of 25 randomized controlled trials. *Int J Ophthalmol.* 2021;14(7):1081-1091.
16. Chen X, Xiao W, Ye S, Chen W, Liu Y. Efficacy and safety of femtosecond laser-assisted cataract surgery versus conventional phacoemulsification for cataract: a meta-analysis of randomized controlled trials. *Sci Rep.* 2015;5:13123.
17. Zhu S, Qu N, Wang W, Zhu Y, Shentu X, Chen P, et al. Morphologic features and surgically induced astigmatism of femtosecond laser versus manual clear corneal incisions. *J Cataract Refract Surg.* 2017;43(11):1430-1435.

Analysis of the Relationship between Hygiene Level and Nutritional Status among Children in Wonosari Village, Boalemo, Gorontalo

Siti Rakhmatia Paramita Th. Kum¹, Pascal Adventra Tandiabang^{2,*}, Dewi Nurindah Panai³, Astri Anita⁴

¹Department of Parasitology, Faculty of Medicine, Universitas Negeri Gorontalo, Gorontalo, Indonesia

²Department of Anatomy, Faculty of Medicine, Universitas Negeri Gorontalo, Gorontalo, Indonesia

³Department of Medical Education, Faculty of Medicine, Universitas Negeri Gorontalo, Gorontalo, Indonesia

⁴Department of Physiology, Faculty of Medicine, Universitas Negeri Gorontalo, Gorontalo, Indonesia

*Corresponding Author. Email: pascaladventra@ung.ac.id, Telp: +6282191446866

ABSTRACT

Introduction: Nutritional status is a complex health outcome determined by multiple interacting factors, while hygiene's independent role remains unclear. This study examined its link with nutritional status in Wonosari Village, Gorontalo.

Method: A cross-sectional study of 48 children aged 10–13 years in Wonosari Village, Boalemo, Gorontalo was conducted in July 2026. BMI was calculated from measured weight and height. Hygiene level was assessed using a standardized questionnaire, with scores categorized by median split into poor (<8) and good (≥8). Nutritional status was determined based on BMI-for-age using CDC 2000 growth charts and classified into three categories: underweight, normal, and overweight (combining overweight and obesity). The Fisher-Freeman-Halton Exact Test was used due to violated Chi-Square assumptions.

Results: The majority of respondents had normal nutritional status (62.5%), followed by overweight (29.2%) and underweight (8.3%). The mean score for hygiene level was 7.17 ± 2.10 , with a range of 4 to 12. 21.4% of children with poor hygiene were overweight, 7.1% were underweight, and 71.4% had a normal nutritional condition. Of the children who practiced good hygiene, 10.0% were underweight, 40.0% were overweight, and 50.0% had normal nutritional status. Hygiene status and nutritional status did not significantly correlate, according to the Fisher-Freeman-Halton Exact Test ($p = 0.3181$).



Published by:
Universitas Negeri Gorontalo

Mobile number:
+62852 3321 5280

Address:
Jend. Sudirman St. No.6, Gorontalo
City, Gorontalo, Indonesia

Email:
jmhsj@ung.ac.id

Article History:
Received 29 July 2026
Accepted 31 July 2026
Published 31 July 2026

DOI:
<https://doi.org/10.37905/jmhsj.v5i2.40665>

Conclusion: No association was found between hygiene level and nutritional status in this study. This finding suggests that while hygiene may play a role, nutritional status is influenced by a complex interplay of dietary, socioeconomic, behavioral, and environmental factors that extend beyond hygiene practices alone.

Keywords: Body mass index, elementary school children, hygiene level, nutritional status

Introduction

One important indicator of public health and child development is the nutritional status of school-age children. Well-nourished children have improved immune system performance, physical development, and cognitive abilities.¹ On the other hand, malnutrition, both undernutrition and overnutrition, can lead to a number of health problems, such as stunted growth, impaired cognitive development, metabolic disorders associated with obesity, and increased susceptibility to infection.² Nutritional status is a complex health outcome that is influenced by a number of interrelated factors, such as dietary intake, physical activity, socioeconomic conditions, and the burden of infectious diseases.³

Maintaining personal hygiene is essential, especially for kids. The risk of infectious disorders including diarrhoea, respiratory infections, and soil-transmitted helminth infections is greatly decreased by good hygiene habits, such as frequent hand washing with soap, keeping fingernails clean, oral hygiene, and bathing techniques.⁴ Recurrent infections can impede the absorption and utilisation of nutrients, which can eventually impact a child's growth and nutritional status.⁵ Despite being a component of this intricate system, it is unclear how hygiene behaviours, particularly in adult populations, independently impact nutritional status.

Previous studies have demonstrated a significant relationship between personal hygiene and nutritional status in children. Previous research has found that poor personal hygiene is associated with a higher risk of stunting in children under five years of age.⁶ Similarly, research in several developing countries has shown that children with good hygiene practices have better anthropometric measurements and lower prevalence of undernutrition.⁷

However, the relationship between personal hygiene and nutritional status in Indonesian elementary school children, particularly in rural and peri-urban areas, remains insufficiently explored. Wonosari Village in Boalemo Regency, Gorontalo Province, represents a unique setting where socioeconomic conditions, access to clean water and sanitation facilities, and nutritional patterns may differ from urban centers. The double burden of malnutrition, where both undernutrition and overnutrition coexist, is increasingly observed

in such communities. The aim of this study was to examine the connection between the nutritional status and hygiene level of the people living in Wonosari Village, Boalemo, Gorontalo. It is anticipated that the results would aid in the creation of focused health promotion initiatives in rural areas.

Methods

Study design and settings

This study was carried out in Wonosari Village, Boalemo Regency, Gorontalo Province, Indonesia, using a cross-sectional design. In July 2026, a single day was dedicated to data collecting. Wonosari Village was chosen as the research site because it exemplifies Gorontalo's rural settlements with a range of socioeconomic circumstances and restricted access to sanitary facilities.

Population and sample

This study was conducted at SDN 11 Wonosari, a single elementary school in Wonosari Village, selected purposively based on accessibility and school willingness to participate. Wonosari Village has two elementary schools; the other school was unavailable during the data collection period. Thus, the study population comprised all students aged 10–13 years enrolled at SDN 11 Wonosari, with 48 students meeting the eligibility criteria. Inclusion criteria were (1) active student status, (2) age 10–13 years, and (3) parental consent and child assent. Exclusion criteria included chronic diseases or disabilities affecting nutritional status. Given the single-school setting, the findings are not generalizable to all children in the village.

Variables

The independent variable was hygiene level, assessed using a standardized questionnaire consisting of items measuring handwashing habits, fingernail cleanliness, bathing frequency, oral hygiene, and overall cleanliness behavior. The maximum possible score was 12. Respondents were classified into two categories using a median split: "poor hygiene" (score < 8) and "good hygiene" (score ≥ 8).

The dependent variable was nutritional status, assessed using Body Mass Index (BMI) calculated as weight (kg) divided by height squared (m²). Nutritional status was determined based on BMI-for-age according to the CDC 2000 growth charts, which classify nutritional status into four categories: Underweight: BMI < 5th percentile; Normal weight: BMI 5th to < 85th percentile; Overweight: BMI 85th to < 95th percentile; and Obesity: BMI ≥ 95th percentile.

The CDC 2000 growth reference was selected because it is widely used in Indonesian epidemiological studies and provides age- and sex-specific BMI percentiles that are applicable

for school-aged children in this population. For the purpose of statistical analysis, the overweight and obesity categories were combined into a single "overweight" category, resulting in three nutritional status categories: underweight, normal, and overweight. This consolidation was necessary to address the small sample size (N=48), as the original four-category classification resulted in very low expected cell counts (more than 20% of cells had expected counts less than 5), which would violate the assumptions of the Fisher-Freeman-Halton Exact Test. Combining these two categories also provides clinically meaningful interpretation, as both overweight and obesity represent excess adiposity and are often grouped together in public health analyses when sample size is limited. This consolidation was necessary to meet the minimum expected cell count requirements for the Fisher-Freeman-Halton Exact Test and to provide clinically meaningful interpretation.

Data collection

Anthropometric measurements were conducted by trained physicians and physiotherapists. Weight was measured using a digital scale with an accuracy of 0.1 kg, with the children wearing light clothing and barefoot. Height was measured using a portable stadiometer with an accuracy of 0.1 cm, with the children standing upright barefoot. Hygiene data were collected through direct observation and in-person interviews using a structured questionnaire. The questionnaire was administered and completed directly by trained researchers (the authors) based on their observations of each child's hygiene practices and the children's verbal responses to standardized questions. This approach minimized bias from parental over-reporting and ensured consistent data collection across all participants.

Data analysis

Data were analyzed using SPSS version 25.0. Descriptive statistics were presented as frequencies, percentages, means, and standard deviations. The Fisher-Freeman-Halton Exact Test was used to examine the association between hygiene level category and nutritional status category, as the Chi-Square test assumptions were violated (more than 20% of cells had expected counts less than 5). A p-value < 0.05 was considered significantly significant.

Ethical considerations

This study used written consent obtained from parents/guardians, and verbal assent was obtained from all participating children. All data was anonymized and treated confidentially.

Result

A total of 48 children aged 10-13 years from Wonosari Village, Boalemo, Gorontalo participated in this study. The demographic and descriptive characteristics are presented in Table 1. The respondents' average age was 10.63 ± 0.73 years. According to the age

distribution, the majority were 10 years old (43.8%), followed by 11 years old (39.6%), 12 years old (14.6%), and 13 years old (2.1%). In terms of sex distribution, there were somewhat more female respondents (54.2%) than male respondents (45.8%). Hygiene level assessment revealed that 58.3% of children had poor hygiene, while 41.7% had good hygiene.

Table 1. Demographic characteristics of study participants from Wonosari Village, Boalemo, Gorontalo (N=48)

Characteristic	Category	Frequency (n)	Percentage (%)
Age (years)	10	21	43.8
	11	19	39.6
	12	7	14.6
	13	1	2.1
Sex	Male	22	45.8
	Female	26	54.2
Hygiene Level	Poor	28	58.3
	Good	20	41.7

As shown in Table 2, the majority of respondents had normal nutritional status (62.5%), followed by overweight (including obesity) (29.2%), and underweight (8.3%).

Table 2. Distribution of nutritional status among respondents in Wonosari Village, Boalemo, Gorontalo (N=48)

Nutritional Status	Frequency (n)	Percentage (%)
Underweight	4	8.3
Normal	30	62.5
Overweight (including obesity)	14	29.2

Table 3 shows that hygiene scores ranged from 4 to 12, with a mean score of 7.17 ± 2.10 , indicating moderate overall hygiene practices among the study population in Wonosari Village.

Table 3. Hygiene level descriptive statistics (N=48)

Variable	Minimum	Maximum	Mean	Std. Deviation
Hygiene Score	4.00	12.00	7.17	2.10

The cross-tabulation analysis on Table 4 shows that among children with poor hygiene, 71.4% had normal nutritional status, 21.4% were overweight, and 7.1% were underweight. Among children with good hygiene, 50.0% had normal nutritional status, 40.0% were overweight, and 10.0% were underweight.

Table 4. Cross-tabulation of hygiene level and nutritional status in Wonosari Village, Boalemo, Gorontalo

Hygiene Category	Underweight	Normal	Overweight	Total
Poor	2 (7.1%)	20 (71.4%)	6 (21.4%)	28 (100.0%)
Good	2 (10.0%)	10 (50.0%)	8 (40.0%)	20 (100.0%)
Total	4 (8.3%)	30 (62.5%)	14 (29.2%)	48 (100.0%)

The Fisher-Freeman-Halton Exact Test found no statistically significant correlation ($p = 0.3181$) between children's nutritional status and hygiene level in Wonosari Village. This suggests that there was no significant correlation between the research population's nutritional status and hygiene level.

Discussion

This study investigated the relationship between hygiene level and nutritional status among elementary school children aged 10-13 years in Wonosari Village, Boalemo, Gorontalo. Data were collected in July 2026. The findings revealed that the majority of children had normal nutritional status (62.5%), with a considerable proportion being overweight/obese (29.2%) and a smaller proportion being underweight (8.3%). Hygiene scores were generally moderate, with more than half of the children categorized as having poor hygiene (58.3%). However, no statistically significant association was found between hygiene level and nutritional status.

The prevalence of overweight/obesity (29.2%) in this study population is concerning and reflects the growing trend of childhood obesity in Indonesia, including in rural and peri-urban areas such as Gorontalo. This finding is consistent with recent national data showing an increasing prevalence of overweight and obesity among school-aged children across various regions.⁸ The double burden of malnutrition, where undernutrition and overnutrition coexist, is evident in this population, although with overnutrition being more prevalent. Similar findings have been reported in other developing countries undergoing rapid economic and nutritional transitions.⁹ The prevalence of overweight in this study is higher than that reported in some

other rural Indonesian settings, where rates typically range between 10-20%.¹⁰ This relatively high prevalence may reflect the specific socioeconomic and dietary characteristics of Wonosari Village, which may be undergoing a more rapid nutritional transition than other rural areas.

Interestingly, the proportion of overweight children was higher in the good hygiene group (40.0%) compared to the poor hygiene group (21.4%). Although this difference was not statistically significant, this finding warrants cautious interpretation. One possible explanation, based on findings from previous studies, is that families with better socioeconomic status may have greater access to hygiene facilities and education, but may also have higher purchasing power for processed snacks and sugary beverages, which are known contributors to excess weight gain in children.¹¹ Additionally, in some rural settings, the perception of a "well-fed" child may be associated with higher social status, potentially leading to overfeeding.¹² This phenomenon highlights the complexity of nutritional status determinants and suggests that interventions targeting nutritional status must be multidimensional rather than focusing solely on hygiene promotion. However, it is important to note that socioeconomic status, dietary patterns, and purchasing power were not directly measured in this study. Therefore, this explanation remains speculative and should be interpreted with caution. Another possible interpretation is that the lack of a significant association simply reflects the limited statistical power of the study due to the small sample size (N=48), rather than indicating a true absence of relationship. The finding highlights the complexity of nutritional status determinants and suggests that further research with larger samples and comprehensive measurement of socioeconomic and dietary factors is needed to better understand the underlying mechanisms.¹³

The lack of a significant correlation between nutritional status and hygiene in this study contradicts the results of several previous studies conducted in developing countries.^{7,14} This difference may be explained by several factors. First, children living in rural or village areas constituted the majority of the study population, which may differ from urban populations in terms of nutritional habits and hygiene practices. Second, there may not have been sufficient statistical power to identify a true association due to the study's small sample size (N=48). Third, poor hygiene can contribute to malnutrition through recurrent infections, but this association may be less pronounced in populations where overall access to clean water and sanitation may be suboptimal but not a primary driver of nutritional status. This is because the cross-sectional study design cannot establish temporal causality.

The use of the Fisher-Freeman-Halton exact test was necessary due to the violation of the chi-square test assumptions. When expected cell counts are low, this particular test yields more trustworthy p-values, guaranteeing that the statistical conclusion is strong even with a

small sample size.

The importance of personal hygiene in preventing infectious diseases that lead to undernutrition, especially in children under five, has been repeatedly shown by earlier studies. However, among school-age children living in rural areas, the relationship might be more complicated and mediated by additional variables like parental education, physical activity, dietary quality, socioeconomic status, and access to healthcare services.¹⁵ According to this research, nutritional status is impacted by a complex interaction of dietary, socioeconomic, behavioural, and environmental factors that go beyond hygiene practices alone, even though hygiene may play a part.

Study limitations

This study has several limitations. First, the small sample size limited statistical power and may have prevented the detection of significant associations. Second, the cross-sectional design precludes causal inference. Third, hygiene was assessed using self-reported questionnaires, which may be subject to social desirability bias. Fourth, the study was conducted in a single village/school, limiting generalizability to other populations in Gorontalo or elsewhere. Future studies with larger sample sizes, longitudinal designs, and objective hygiene measures are needed to confirm these findings.

Conclusion

There was no statistically significant correlation ($p = 0.3181$) between children's nutritional status and hygiene level in Wonosari Village, Boalemo, Gorontalo. According to this research, nutritional status is impacted by a complex interaction of dietary, socioeconomic, behavioral, and environmental factors that go beyond hygiene practices alone, even though hygiene may play a part. However, Wonosari Village needs integrated school-based and community-based health promotion programs that address both hygiene practices and healthy nutrition, as evidenced by the alarming prevalence of overweight/obesity (29.2%) and the discovery that a significant portion of children (58.3%) had poor hygiene. To fully comprehend the intricate relationship between hygiene practices and nutritional outcomes in this age group and environment, more research with larger sample sizes and longitudinal designs is necessary.

Conflicts of Interest

The authors declare no conflicts of interest in this study.

Funding sources

This research was self-funded by the authors. No external funding was received for this study.

Acknowledgment

The authors would like to express their gratitude to the Head of Wonosari Village, Boalemo

Regency, for granting permission to conduct this research. Special thanks are also extended to the principal of SDN 11 Wonosari for providing permission to carry out the study at the school. The authors are deeply grateful to all participants who voluntarily contributed their time and information to this research. The authors also acknowledge the support of the Faculty of Medicine, Gorontalo State University, for facilitating this study.

References

1. Morales F, Montserrat-de la Paz S, Leon MJ, Rivero-Pino F. Effects of Malnutrition on the Immune System and Infection and the Role of Nutritional Strategies Regarding Improvements in Children's Health Status: A Literature Review. *Nutrients*. 2023;16(1):1.
2. Titi-Lartey OA, Daley SF. Severe Acute Malnutrition: Recognition and Management of Marasmus and Kwashiorkor. *StatPearls* [Internet]. 2025 Aug 2 [cited 2026 Jul 29]; Available from: <https://www.ncbi.nlm.nih.gov/books/NBK559224/>
3. Wrottesley S V., Mates E, Brennan E, Bijalwan V, Menezes R, Ray S, et al. Nutritional status of school-age children and adolescents in low- and middle-income countries across seven global regions: a synthesis of scoping reviews. *Public Health Nutr*. 2022;26(1):63.
4. Angelica E, Wardani S, Firdaus J, Hermansyah B, Utami WS, Armiyanti Y. Personal Hygiene as a Risk Factor for STH Infection Among Farmers In Jember Regency. *J Vocat Heal Stud*. 2026;9(3):169–75.
5. Grant FK, Wanjala R, Low J, Levin C, Cole DC, Okuku HS, et al. Association between infection and nutritional status among infants in a cohort study of vitamin A in western Kenya. *Front Nutr*. 2022;9:921213.
6. Nusantri rusdi PH. Hubungan personal hygiene dengan kejadian stunting pada balita. *Hum Care J*. 2022;7(2):369.
7. Chakrabarti S, Singh P, Bruckner T. Association of Poor Sanitation With Growth Measurements Among Children in India. *JAMA Netw Open*. 2020;3(4):e202791.
8. Rachmi CN, Li M, Alison Baur L. Overweight and obesity in Indonesia: prevalence and risk factors—a literature review. *Public Health*. 2017;147:20–9.
9. Leocádio PCL, Lopes SC, Dias RP, Alvarez-Leite JI, Guerrant RL, Malva JO, et al. The Transition From Undernutrition to Overnutrition Under Adverse Environments and Poverty: The Risk for Chronic Diseases. *Front Nutr*. 2021;8:676044.
10. Fithra Alhanifa A, Ananda Dewi Purbasari T, Cintya Denny Yuliyatni P, Fithra Alhanifa JI Sudirman AP, Sudirman K, et al. Prevalence, Trends, and Projections of Overweight and Obesity Among Children and Adolescents in Indonesia, 1993–2050: A Meta-Analysis of Observational Studies. *Maj Kesehat Indones*. 2026;7(3):131-154–131–154.

11. Darmon N, Drewnowski A. Contribution of food prices and diet cost to socioeconomic disparities in diet quality and health: a systematic review and analysis. *Nutr Rev.* 2015;73(10):643–60.
12. Ewusie TB, Coulthard H, Sharps M, Ochieng B. Influence of cultural beliefs and parental feeding practices on obesity among primary schoolchildren aged 6–12 in Ghana: a qualitative study. *BMJ Open.* 2025;15(5):e087160.
13. Autret K, Bekelman TA. Socioeconomic Status and Obesity. *J Endocr Soc.* 2024;8(11):bvae176.
14. Bhattacharyya H, Medhi G., Pala S, Sarkar A, Lynrah W, Kharmujai OM. Nutritional status and personal hygiene practices of primary school children: A cross-sectional study from Meghalaya, India. *J Fam Med Prim Care.* 2020;9(11):5506.
15. Adeline Mia, Anggraeni LD, Pasaribu J. Faktor-Faktor Yang Berhubungan Dengan Status Gizi Lebih Pada Anak Sekolah Dasar Swasta Rw 006 Kelurahan Sunter Agung Jakarta Utara. *Carolus J Nurs.* 2021;3(1):44–59.

Animated Video-Based Health Education on Primary School Students' Knowledge of Scoliosis: One Group Pretest-Posttest Study

Tinah Tan¹, Serly Daud², Jesica Mulyadi^{3*}

¹Citylife Sehat, North Jakarta, Indonesia

²Department of Public Health, Faculty of Medicine, Universitas Negeri Gorontalo, Gorontalo, Indonesia

³Department of Midwifery, Faculty of Medicine, Universitas Negeri Gorontalo, Gorontalo, Indonesia

*Corresponding Author. Email: jscmulyadi29@ung.ac.id, Telp: +6282279387595

ABSTRACT

Introduction: Scoliosis is a musculoskeletal disorder that commonly develops during periods of growth and may lead to long-term complications if not detected early. Health education represents a key preventive approach to improving students' knowledge and awareness of spinal health. This study aimed to assess the effect of animated video-based education on primary school students' knowledge of scoliosis.

Method: A quantitative pre-experimental design with a one-group pretest–posttest approach was employed. The sample comprised 66 students in grades 4–6 at SDN 03 Tilongkabila, selected through purposive sampling. Data were collected using a 15-item questionnaire that was previously validated ($r > 0.444$) and demonstrated acceptable reliability (Cronbach's Alpha = 0.728). The intervention consisted of an 8-minute animated video on scoliosis and its prevention. Data was analyzed using a paired t-test.

Results: The findings revealed a statistically significant improvement in students' knowledge following the intervention (mean pretest = 6.80; mean posttest = 12.29; $p < 0.001$), with a mean difference of 5.485. These results indicate that animated video-based health education is effective in enhancing students' understanding of scoliosis, its risk factors, and preventive measures.

Conclusion: Integrating engaging health education into school settings may serve as an effective promotive and preventive strategy to reduce the risk of musculoskeletal disorders among school-aged children.

Keywords: Knowledge improvement, prevention, school-based health education, scoliosis



Published by:
Universitas Negeri Gorontalo

Mobile number:
+62852 3321 5280

Address:
Jend. Sudirman St. No.6, Gorontalo
City, Gorontalo, Indonesia

Email:
jmhsj@ung.ac.id

Article History:
Received 30 April 2026
Accepted 31 July 2026
Published 31 July 2026

DOI:
<https://doi.org/10.37905/jmhsj.v5i2.38580>

Introduction

Scoliosis is a musculoskeletal disorder characterised by a lateral curvature of the spine accompanied by vertebral rotation, with a Cobb angle of $\geq 10^\circ$.^{1,2} The condition typically develops during periods of rapid growth in childhood and adolescence. In its early stages, scoliosis is often asymptomatic, leading to delayed detection until the curvature becomes more pronounced. If not appropriately managed, it may progress into a chronic condition associated with impaired respiratory function, reduced physical activity, persistent pain, and decreased quality of life.³⁻⁵ Musculoskeletal disorders are among the leading causes of disability worldwide, significantly affecting functional capacity, productivity, and overall well-being, while imposing a substantial burden on healthcare systems. Within this context, scoliosis represents an important public health concern, particularly among school-aged populations.^{6,7} Most cases in children and adolescents are classified as adolescent idiopathic scoliosis (AIS), a subtype for which the etiology remains unclear. The prevalence of AIS ranges from 2% to 5% in the general pediatric population and tends to increase during puberty.

Variations in prevalence across regions suggest the influence of genetic, environmental, and lifestyle factors.⁴ School-based screening programmes have been widely implemented to facilitate early detection, with large-scale studies indicating that approximately 3–4% of students are identified with scoliosis. Early identification enables timely conservative management, including corrective exercises, postural therapy, and bracing, which are effective in preventing curve progression.^{6,8} However, the effectiveness of these strategies depends not only on screening but also on awareness and understanding of spinal health. Health education plays a key role in improving knowledge of risk factors and preventive behaviors from an early age.⁹ Primary school children are particularly vulnerable to postural problems due to prolonged sitting during classroom activities. Poor posture, inappropriate furniture, excessive schoolbag loads, and increased use of digital devices often associated with non-ergonomic positions may further elevate the risk of musculoskeletal disorders.^{6,9}

In developing countries, including Indonesia, attention to scoliosis among children remains limited. Reported prevalence ranges from 2% to 3% among adolescents; however, these estimates may underestimate the true burden due to limited screening and low awareness of early detection. Inadequate knowledge among students, parents, and educators also contributes to delayed case identification.¹⁰ From a public health perspective, promotive and preventive strategies are essential to reduce the risk of musculoskeletal disorders. Health education has been shown to improve knowledge and encourage healthier postural behaviors.^{8,11,12} With advances in educational technology, digital media such as animated

videos, are increasingly used in health education. These media can effectively visualise abstract concepts, including spinal alignment and proper posture, thereby enhancing comprehension and information retention.^{11,12} Animated videos can facilitate the visualization of complex concepts, such as spinal curvature and proper postural principles, thereby enhancing conceptual understanding and information retention.¹²

Schools provide a strategic setting for implementing health promotion programmes due to the high level of student engagement. Integrating health education into the curriculum offers an effective approach to instilling healthy behaviors from an early age. However, empirical evidence on students' knowledge of scoliosis and the effectiveness of educational interventions remains limited, indicating a research gap. Therefore, this study aims to assess the effect of scoliosis-related health education on students' knowledge at SDN 03 Tilongkabila.

Methods

This study employed a quantitative approach using a pre-experimental one-group pretest–posttest design. The study was conducted in January 2026 at SDN 03 Tilongkabila, Bone Bolango Regency. The population comprised all students in grades 4–6 ($n = 124$), from which 66 participants were selected through purposive sampling. Inclusion criteria included students actively enrolled in grades 4–6, willing to participate, attending the full health education session, and consenting to scoliosis screening using the Adam's Forward Bend Test following the posttest. Exclusion criteria were students outside grades 4–6, those who did not complete the study, or those absent during the intervention.

Data were collected using a 15-item questionnaire that had been pilot-tested on 20 primary school students. All items were valid ($r > 0.444$), and the instrument demonstrated acceptable internal consistency (Cronbach's Alpha = 0.728). Data were analyzed using SPSS version 27.0 (IBM, USA). Differences in knowledge scores before and after the intervention were assessed using a paired t-test. The intervention consisted of an approximately 8-minute animated video providing information on scoliosis, including its risks and early prevention strategies. Ethical approval was obtained from the Ethics Committee of Gorontalo State University (No. 019A/UN47.B7/KE/2026).

Result

A total of 66 students participated in this study. The baseline characteristics of respondents were shown on Table 1. The majority were aged 11–12 years (37.8%) and were in grade 6 (37.8%). Female students accounted for 60.6% of the sample, while 39.4% were male. Based on scoliosis screening, 12.12% of participants were identified as having scoliosis.

Table 1. Characteristics of respondents (N=66)

Characteristics		Frequency (n)	Percentage (%)
Age	9 – 10	20	30.2%
	10 – 11	21	32.0%
	11 – 12	25	37.8%
Gender	Female	40	60.6%
	Male	26	39.4%
Scoliosis Status	Yes	8	12.12%
	No	58	87.88%
Grade	4	20	30.3%
	5	21	32.0%
	6	25	37,7%

As shown in Table 2, the results of the paired t-test showed a significant increase in students' knowledge scores following the intervention. The mean pretest score was 6.80, which increased to 12.29 in the posttest, with a mean difference of 5.485 (SD = 2.488). Statistical analysis indicated that this difference was significant ($p < 0.001$), demonstrating that the health education intervention had a positive effect on students' knowledge of scoliosis.

Table 2. Effect of health education on knowledge

Knowledge	Mean	Mean Difference	SD	<i>p</i> -value
Pretest	6.80	5.485	2.488	<0.001
Post test	12.29			

Discussion

This study demonstrates that health education plays a significant role in improving primary school students' knowledge of scoliosis and increasing awareness of the importance of maintaining proper posture from an early age. The significant increase in knowledge scores following the intervention indicates that educational strategies are effective in supporting promotive and preventive efforts to reduce the risk of musculoskeletal disorders in school-aged children.¹³ The findings also suggest that animated video-based education can effectively convey key information regarding scoliosis, including its risks, contributing factors, and preventive measures.¹² This is particularly important given that scoliosis is often asymptomatic in its early stages, leading to delayed detection and increased risk of complications such as

chronic pain, respiratory dysfunction, and reduced quality of life.^{5,14} These results are consistent with previous studies demonstrating that school-based health education improves musculoskeletal health literacy and promotes positive postural behaviors.^{8,11}

Schools represent a strategic setting for such interventions, as they enable systematic and continuous engagement with children during a critical period of habit formation. In addition to knowledge, behavioral factors play a crucial role in the development of postural disorders. Prolonged sitting, particularly in non-ergonomic positions, may negatively affect postural balance and increase the risk of spinal abnormalities, highlighting the importance of posture-related education.¹¹ The effectiveness of health education is influenced by the methods and media used. Interactive and engaging approaches, such as animated videos, can enhance student participation and facilitate understanding. In addition, game-based learning has been shown to increase motivation and engagement, which may further support knowledge acquisition and retention.^{15,16} From a public health perspective, these findings support the integration of health education into school settings as a sustainable strategy for early prevention of musculoskeletal disorders. Such interventions not only improve knowledge but also have the potential to promote long-term healthy behaviors.^{12,16}

However, this study has several limitations. The relatively small sample size and the use of a single study site limit the generalizability of the findings. Moreover, this study did not assess long-term behavioral changes or consider other contributing factors, such as genetic predisposition, physical activity levels, and environmental influences. Future research should involve larger and more diverse samples, as well as longitudinal designs to evaluate sustained behavioral outcomes. The development of more innovative and technology-based educational approaches is also recommended to enhance intervention effectiveness. Overall, the implementation of engaging, participatory, and sustainable health education programmes in schools represents a promising strategy for reducing the risk of musculoskeletal disorders among children.

Conclusion

Health education significantly improves primary school students' knowledge of scoliosis. The use of audiovisual media is effective in delivering information on risk factors and preventive measures. Therefore, integrating health education into school settings represents a valuable promotive and preventive strategy to reduce the risk of musculoskeletal disorders from an early age.

Conflicts of Interest

None.

Funding sources

None.

Acknowledgment

The authors gratefully acknowledge the headmaster, teachers, and students of SDN 03 Tilonkabila for their participation and support in this study.

References

1. Park SH, Sung WS, Lee SH, Lee YJ, Ha IH, Seo BK, et al. The effectiveness and safety of Chuna manual therapy on scoliosis: A protocol for systematic review and meta-analysis. *Medicine (Baltimore)*. 2021;100(9):e24778.
2. Huang F, Liu Y, Wu J, Yang J, Huang S, Zhang Z, et al. Incidence of scoliosis among junior high school students in Zhongshan city, Guangdong and the possible importance of decreased miR-30e expression. *J Int Med Res*. 2020;48(6):0300060519889438.
3. Gashaw M, Janakiraman B, Belay GJ. Idiopathic scoliosis and associated factors among school children: a school-based screening in Ethiopia. *Arch Public Heal*. 2021;79(1):1–8.
4. Li M, Nie Q, Liu J, Jiang Z. Prevalence of scoliosis in children and adolescents: a systematic review and meta-analysis. *Front Pediatr*. 2024;12:1399049.
5. Cheung PWH, Chan OKO, Wu H, Lai MKL, Wong LPK, Tang S, et al. Immediate vs Gradual Brace Weaning Protocols in Adolescent Idiopathic Scoliosis: A Randomized Clinical Trial. *JAMA Pediatr*. 2024;178(7):657–68.
6. Wang Y, Yang D, Zhang F, Qi W, Lu Q, Wu H, et al. Analysis of the association between reading and writing postures and comorbidity of myopia and scoliosis in junior middle school students. *Front Pediatr*. 2025;13:1576575.
7. Setiawan F, Setianing R. The Association of Severity of Scoliosis Curvature And Quality of Life in Adolescent Idiopathic Scoliosis Patients. *Indones J Phys Med Rehabil*. 2025;14(2):189–95.
8. Glavaš J, Rumboldt M, Karin Ž, Matković R, Kresina S, Dragaš-Zubalj N, et al. The role of school medicine in the early detection and management of adolescent idiopathic scoliosis. *Wien Klin Wochenschr*. 2023;135(11–12):273–81.
9. Zhu L, Ru S, Wang W, Dou Q, Li Y, Guo L, et al. Associations of physical activity and screen time with adolescent idiopathic scoliosis. *Environ Health Prev Med*. 2023;28(55):1–10.
10. Komang-Agung IS, Dwi-Purnomo SB, Susilowati A. Prevalence Rate of Adolescent

- Idiopathic Scoliosis : Results of School-based Screening in Surabaya. *Malaysian Orthop J.* 2017;11(3):17–22.
11. Jang CW, Kim M, Kang S woong, Cho HE. Reliability, Quality, and Educational Suitability of TikTok Videos as a Source of Information about Scoliosis Exercises : A Cross-Sectional Study. *Healthcare.* 2022;10(1622):10.
 12. Oirschot G Van, Purcell C, Keogh A, Greene CM, Doherty C. A feasibility randomised controlled trial of patient education videos assessing multimedia design effects on engagement and learning in adolescents with scoliosis. *BMC Med Educ.* 2026;26(679):13.
 13. Wang Q, Li X, Liu X, Chen N, Dai R, Zhang H, et al. Behavioral effects of academic pressure on the risk of adolescent idiopathic scoliosis: a case-control study. *Sci Rep.* 2025;15(1):1–10.
 14. Jin L, Wei QE, Dong J, Wang C, Han Y, Li Y. Modifiable factors affecting the development of adolescent idiopathic scoliosis in Chinese students: insights from a questionnaire survey on abnormal performance. *BMC Publ Health.* 2025;25:1489.
 15. Kavak Ş. Digital Game-Based Learning Model as an Educational Approach. *Prizren Soc Sci J.* 2022;6(2):62–70.
 16. Guo PJ, Kim J, Rubin R. How Video Production Affects Student Engagement: An Empirical Study of MOOC Videos. *Proc first ACM Conf Learn @ scale.* 2014;41–50.

Effectiveness of a Digital Flipbook Intervention on Health Cadres' Knowledge Regarding Child Growth and Development Detection and Stimulation

Putri Rhadiyah^{1*}, Annisa Sali Pinaremas¹, Akhiat²

¹Department of Midwifery, Pangkalpinang Health Polytechnic of Ministry of Health, Pangkal Pinang, Indonesia

²Department of Nursing, Pangkalpinang Health Polytechnic of Ministry of Health, Pangkal Pinang, Indonesia

*Corresponding Author. Email p.rhadiyah@gmail.com, Telp: +6285274835843

ABSTRACT

Introduction: Early detection and stimulation of child growth and development are crucial strategies for preventing developmental disorders. Health cadres play a pivotal role at the community level; however, their knowledge requires continuous enhancement through effective educational media. Digital flipbooks offer an interactive and independent learning approach. This study aimed to analyze the effectiveness of a digital flipbook intervention on health cadres' knowledge of child growth and development detection and stimulation.

Method: This study used a one-group pretest-posttest methodology in a quasi-experimental design. 74 health cadres from South Bangka Regency's Air Gegas District were chosen using total sampling. Data was collected using a 20-item validated knowledge questionnaire administered before and immediately after the educational intervention. The non-parametric Wilcoxon Signed-Rank Test was used with a significance level of $\alpha = 0.05$.

Results: The mean knowledge score of the cadres significantly increased from 83.71 (SD = 8.74) in the pretest to 94.72 (SD = 9.41) in the posttest. The pretest and posttest scores differed statistically significantly, according to the Wilcoxon Signed-Rank Test ($Z = -6.712$, $p = 0.001$).

Conclusion: The digital flipbook intervention demonstrated a significant improvement in health cadres' knowledge regarding the detection and stimulation of child growth and development, suggesting its potential as an effective educational medium. However, considering the limitations of the one-group pretest-posttest design, these findings should be interpreted as a preliminary evaluation. To establish its efficacy, more study using a randomised controlled trial is required.

Keywords: Child growth and development, digital flipbook, health cadres, health education, knowledge



Published by:
Universitas Negeri Gorontalo

Mobile number:
+62852 3321 5280

Address:
Jend. Sudirman St. No.6, Gorontalo
City, Gorontalo, Indonesia

Email:
jmhsj@ung.ac.id

Article History:
Received 30 June 2026
Accepted 2 July 2026
Published 1 August 2026

DOI:
<https://doi.org/10.37905/jmhsj.v5i2.39462>

Introduction

Maternal and neonatal mortality, alongside child growth and developmental delays, remain critical public health challenges in developing countries, including Indonesia. Children represent the future generation and a vital component of national human resource development. Mothers and children are vulnerable groups requiring priority in health service provision due to their sensitivity to family and environmental conditions. Health maintenance efforts for infants and children must be directed toward preparing a healthy, intelligent, and quality generation, as well as reducing infant and child mortality rates.¹

Monitoring child growth and development is essential for identifying early signs of disorders. Data indicate that approximately 5–10% of children experience general developmental delays, two per 1,000 infants suffer from motor development disorders, three to six per 1,000 infants have hearing impairments, and one in 100 children has intellectual deficits and speech delays.² According to the 2023 Indonesian Health Survey (Survey Kesehatan Indonesia, SKI), stunting among Indonesian toddlers reached 21.5%, with an annual increase in the number of short and very short toddlers, making stunting a serious health issue requiring immediate intervention.³

Early detection and stimulation are imperative strategies to mitigate these developmental issues. However, during the COVID-19 pandemic, mothers of infants and toddlers became hesitant to bring their children to integrated healthcare posts (Pos Pelayanan Terpadu, *Posyandu*) for routine examinations, highlighting the need for innovative educational media that can empower cadres and mothers to perform independent growth monitoring. Health cadres, as community-level frontline workers, play a pivotal role in disseminating information and training mothers to independently monitor their children's growth and development.⁴ Interactive digital education media, such as flipbooks, have appeared as effective pedagogical tools.

Digital flipbooks integrate text, graphics, and video, making learning more interactive, enjoyable, and accessible, while also enabling cadres to review materials independently through their personal devices. Several previous studies have demonstrated that well-designed educational media can significantly enhance cadres' knowledge and performance in maternal and child health services.⁵ Nevertheless, research specifically evaluating the effectiveness of Canva-based digital flipbooks for training cadres on child growth and development detection remains limited. Considering this, the purpose of this study was to assess how well a digital flipbook intervention improved health cadres' understanding of how to identify and promote children's growth and development in Air Gegas District, South Bangka Regency.

Methods

This study used a one-group pretest-posttest methodology and a quantitative quasi-experimental design. The study was carried out in the South Bangka Regency's Air Gegas District, which is around 89 kilometers away from the central health referral center. The population comprised all health cadres in the district. 74 cadres in all, chosen using a complete sampling technique, took part in the study. The independent variable was the educational intervention using a digital flipbook developed using Canva and integrated with instructional videos. The dependent variable was the cadres' knowledge score regarding growth measurement and developmental stimulation.

The dependent variable was the cadres' knowledge score regarding growth measurement and developmental stimulation. The instrument used was a 20-item validated knowledge questionnaire developed by the researchers, covering four domains: basic concepts of growth and development (6 items), growth measurement (5 items), developmental detection and danger signs (4 items), and growth and development stimulation and the cadres' role (5 items). The maximum raw score was 20, which was then transformed to a scale of 0–100. Each right response received a score of 1, while each wrong response received a score of 0. The *pretest* was administered before the intervention, and the *posttest* was administered immediately after the educational session and practical demonstration concluded to measure short-term knowledge retention.

Statistical software was used to analyse the data. The demographic and knowledge scores were summarised using descriptive statistics (mean, standard deviation, frequency, and percentage). The Kolmogorov-Smirnov test was used to determine the normality of the data before hypothesis testing. The non-parametric Wilcoxon Signed-Rank Test was used to assess the significance of the difference between pretest and posttest scores because the posttest data were not normally distributed, with a significance level set at $p < 0.05$.

Universitas Negeri Gorontalo Health Research Ethics Committee accepted this study on September 29, 2023, with the number 091A/UN47.B7/KE/2023. Prior to their participation, each subject gave written informed consent, and the study rigorously protected their identities and data confidentiality.

Result

This study involved 74 health cadres in Air Gegas District, South Bangka Regency, who participated fully in the educational intervention and completed both the pretest and posttest assessments. The results are presented in logical sequence, starting with the demographic characteristics of the respondents, followed by the descriptive analysis of

knowledge scores, and concluding with the inferential statistical analysis of the intervention's effectiveness.

The demographic profile of the 74 participating health cadres is summarized in **Table 1**. Majority of respondents were in the productive age range of 31–40 years (40.5%). Most responders had finished senior high school (78.3%), indicating a sufficient educational foundation to comprehend the digital flipbook materials. Furthermore, the largest proportion of cadres had served for 6–10 years (43.2%), suggesting that they possessed adequate field experience. All participants in this study were female, which aligns with the general demographic composition of *Posyandu* cadres in Indonesia.

Table 1. Demographic characteristics of respondents (N = 74).

Characteristic	Category	Frequency	Percentage
Age (years)	21 – 30	15	20.2%
	31 – 40	30	40.5%
	41 – 50	20	27.1 %
	> 50	9	12.2%
Education Level	Junior High School	11	14.9%
	Senior High School	58	78.3%
	Diploma/Degree	5	6.8%
Length of Service	1 – 5 Years	22	29.7%
	6 – 10 years	32	43.2%
	>10 years	20	27.1%

This study's main goal was to evaluate the effectiveness of the digital flipbook intervention on the cadres' knowledge of child growth and development detection and stimulation. The descriptive analysis revealed a notable improvement in the cadres' knowledge scores following the digital flipbook intervention, as presented in **Table 2**. The descriptive analysis revealed a notable improvement in the cadres' knowledge scores following the digital flipbook intervention. The mean pretest score was 83.71 (SD = 8.74), indicating a moderately high baseline knowledge among the cadres prior to the intervention. After the educational session utilizing the flipbook media, the mean posttest score increased significantly to 94.72 (SD = 9.41). This upward shift in the mean score, along with an increase in the minimum score (from 60 to 70), reflects a substantial enhancement in their understanding of child growth and development detection and stimulation.

Table 2. Comparison of knowledge scores before and after intervention (N = 74).

Descriptor	Pretest	Posttest
Mean	83.71	94.72
Standard Deviation	8.74	9.41
Minimum Score	60	70
Maximum Score	100	100
Kolmogorov-Smirnov (sig)*	0.2	0.001*

*Significant at $p < 0.05$

The Kolmogorov-Smirnov test was used to perform a normality test prior to hypothesis testing. The findings showed that while the posttest data were not normally distributed ($\text{sig} = 0.001 < 0.05$), while the pretest data were normally distributed ($\text{sig} = 0.200 > 0.05$). The significance of the difference between the pretest and posttest scores was therefore ascertained using the non-parametric Wilcoxon Signed-Rank Test, as shown in **Table 3**. The Wilcoxon Signed-Rank Test yielded a Z-value of -6.712 with a p-value of 0.001 ($p < 0.05$). The mean difference between the pretest and posttest scores was 11.01 points, indicating a substantial improvement in cadres' knowledge following the digital flipbook intervention. It can be stated that there is a statistically significant difference between the pretest and posttest knowledge scores because the p -value is less than the predefined alpha level of 0.05. This finding confirms that digital flipbook intervention significantly improved the health cadres' knowledge regarding child growth and development detection and stimulation.

Table 3. Result of Wilcoxon Signed-Rank test on knowledge score.

Parameter	N	Z-value	p-value
Pretest-Posttest	74	-6.71	0.001*

*Significant at $p < 0.05$

Discussion

This study demonstrated that digital flipbook intervention significantly improved health cadres' knowledge regarding the detection and stimulation of child growth and development. The mean knowledge score increased from 83.71 in the pretest to 94.72 in the posttest, with a statistically significant difference ($p = 0.001$). These results are consistent with earlier studies showing that interactive digital instructional materials can successfully improve community health workers' knowledge and abilities.⁵

The in-depth effectiveness of flipbooks can be explained by their ability to stimulate

learners' engagement and interest through interactive features. Demonstrated flipbook media significantly increased students' learning interest compared to conventional methods, with post-test interest scores rising from the "low" to "very high" category.⁶ Similarly, Arisanti et al. found that interactive digital flipbooks effectively enhanced learners' creative thinking skills, with N-Gain scores reaching the moderate category.⁷ These findings corroborate the present study, suggesting that flipbooks serve not only as informational tools but also as catalysts for active learning and cognitive development.

Furthermore, the integration of instructional videos within the flipbook significantly improves information retention. Wachtler et al. showed that interactive learning videos with strategically positioned questions could transform passive watchers into active learners, thereby enhancing selective attention and long-term learning success.⁸ In the context of community health education, this mechanism explains how cadres who viewed video demonstrations of anthropometric measurements were able to form accurate mental models of the procedures, leading to better recall and application during routine Posyandu activities. This is consistent with Minar et al., who reported that digital learning media significantly improved students' creativity and skill acquisition in educational settings.⁹

From the perspective of conventional learning methods, traditional printed handouts and one-way lecture approaches often result in passive learning and rapid knowledge decay.^{10,11} In contrast, the Canva-based flipbook allows cadres to navigate the material at their own pace, reinforcing the learning process through self-directed exploration and repeated access to multimedia content. This aligns with Gumilar et al., who found that digital media-based contextual learning significantly improved learners' critical and creative thinking skills.¹² Using flip sheets to show information can expedite and simplify the transmission of communications by combining text and images.¹³

These findings are further supported by recent international research. Santosa et al. showed that the effectiveness of learning interventions targeted at enhancing creative thinking skills was greatly enhanced by contextually relevant and expert-validated teaching materials.¹⁴ Additionally, Anas and Hasibuan supported the idea that interactive digital learning materials improve student engagement and comprehension by confirming that digital flipbooks might raise scientific literacy in the disruptive era.¹⁵

The demographic characteristics of the respondents may also have contributed to the success of the intervention. The majority of cadres were in the productive age range (31–40 years, 40.5%), had at least a senior high school education (78.3%), and had served for 6–10 years (43.2%). This profile indicates that the cadres were relatively young, digitally literate,

and experienced enough to absorb and apply the new knowledge effectively. Age, education level, and information sources are recognized factors influencing individual knowledge.¹⁶

Furthermore, the practical advantages of the digital flipbook enhanced learning outcomes. Unlike traditional printed handouts or static presentations, the Canva-based flipbook can be accessed through personal smartphones, enabling cadres to review the materials independently at any time and in any location. This feature supports self-directed learning and continuous knowledge reinforcement, which is particularly valuable in remote areas. The flipbook also served as a reference tool that cadres could consult during their routine Posyandu activities, thereby improving the quality of growth monitoring and developmental stimulation provided to mothers and children.

Notwithstanding these favourable results, a number of restrictions should be noted. First, it is more difficult to credit the observed benefits to the intervention alone when using a one-group pretest-posttest design without a control group. Second, this study only measured short-term knowledge gains, without evaluating long-term knowledge retention or actual behavioral changes in cadres' daily practices. A randomised controlled trial design with a control group should be used in future studies and include follow-up assessments to evaluate the sustained impact of the flipbook intervention on cadres' competencies and, ultimately, on child growth and development outcomes at the community level.

Conclusion

The digital flipbook intervention demonstrated a significant improvement in health cadres' knowledge scores regarding the detection and stimulation of child growth and development in Air Gegas District, South Bangka Regency, suggesting its potential as an effective educational medium. The mean knowledge score increased significantly from 83.71 to 94.72 ($p = 0.001$). Nevertheless, taking into account the drawbacks of the one-group pretest-posttest design without a control group, these findings should be interpreted as a preliminary evaluation. Further research, with a more rigorous design with a control group, is needed to confirm its effectiveness and rule out potential confounding factors. It is recommended that the local health office consider adopting this digital medium as a sustainable educational tool for cadre training programs, while continuously evaluating its long-term impact.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

Funding sources

This research received no specific grant from any funding agency in the public, commercial,

or not-for-profit sectors.

Acknowledgment

The authors sincerely thank the South Bangka Regency Health Office, the Head of Air Gegas Community Health Center, and all 74 health cadres who participated enthusiastically in this study.

References

1. Soetjiningsih. Tumbuh Kembang Anak. Jakarta: EGC; 2021.
2. Black MM, Walker SP, Fernald LCH, Andersen CT, DiGirolamo AM, Lu C, et al. Early childhood development coming of age: science through the life course. *Lancet*. 2017;389(10064):77–90.
3. Kementerian Kesehatan Republik Indonesia. Survei Kesehatan Indonesia (SKI) 2023. Jakarta; 2023.
4. World Health Organization. Community Health Workers: Improving Maternal and Child Health Outcomes. Geneva: World Health Organization; 2018.
5. Dzandini PB, Alamsah D, Asmi NF, Lestari W, Nurpratama. Hubungan Tingkat Pengetahuan terhadap Keterampilan Kader dalam Pengukuran Tinggi Badan dan Berat Badan Balita di Posyandu Cikarang Selatan. *Klinik: J Ilm Kedokt Kesehat*. 2026;5(1):76–84.
6. Marwan M, Yuliantri RDA. Investigating the Impacts of Flipbook Media on Middle School Students ' Learning Interests in History. *Al-Ishlah J Pend*. 2023;15:795–804.
7. Arisanti TD, Tinus A, Restian A. Developing An Interactive Digital Flipbook To Enhance Junior High School Students' Creative Thinking Skills. *Scaffolding J Pend Islam Multikultur*. 2026;8(1):589–609.
8. Wachtler J, Hubmann M, Zöhrer H, Ebner M. An analysis of the use and effect of questions in interactive learning-videos. *Smart Learn Environ*. 2016;3(1):13.
9. Tobing MT Sibarani IS, Butar-butur Z. The Effectiveness of Use of Digital Learning Media on Student Creativity in Citizenship Education Subjects. *Int J Edu Res Exc*. 2024;03(02):584–94.
10. Roemintoyo R, Budiarto MK. Flipbook as Innovation of Digital Learning Media: Preparing Education for Facing and Facilitating 21st Century Learning. *J Educ Technol*. 2021;5(1 SE-Articles):8–13.
11. Sari WN, Ahmad M. Pengembangan Media Pembelajaran Flipbook Digital di Sekolah Dasar. *Edukatif J Ilm Pend*. 2021;3(5):2819–26.
12. Gumilar G, Wulandari MD, Widyasari C. Effectiveness of Digital Media- Based

- Contextual Learning on Critical and Creative Thinking Skills in Photosynthesis for Elementary Students. *Sci Edu J*. 2025;9(2):135–56.
13. Rhadiyah P, Akhiat, Arisanti N, Susiarno H, Dhamayanti M, Dhamayanti D, et al. Health Workers Perspective on Developing An Effective Model For Sexual and Reproductive Health Education for Adolescents with Intellectual Disabilities: A Qualitative Study in Pangkal Pinang City. *Indones J Public Heal*. 2025;20(3):582–95.
 14. Santosa AB, Febrianto R, Dzikry LF, Metalin A, Puspita I, Adelina F, et al. The Effectiveness Of Local Wisdom-Oriented Teaching Materials To Improve The Creative Thinking Ability. *Scaffolding J Pend Islam Multikultur*. 2025;7(3):91–105.
 15. Anas N, Hasibuan AT. Development of Traditional Parmayaman-Based Digital Flifbooks in Increasing Scientific Literacy in the Disruptive Era. *J Penelit Pend IPA*. 2023;9(4):1813–8.
 16. Damayanti M, Sofyan O. Hubungan Tingkat Pendidikan Terhadap Tingkat Pengetahuan Masyarakat di Dusun Sumberan Sedayu Bantul Tentang Pencegahan Covid-19 Bulan Januari 2021. *Maj Farmaceu*. 2022;18(2):220-6.

Problem-Based Learning as a Strategy to Enhance Metacognitive Skills in Midwifery Education

Annisa Sali Pinaremas^{1,*}, Putri Rhadiyah¹, Rohmatun Karimah¹

¹Department of Midwifery, Pangkalpinang Health Polytechnic of Ministry of Health, Pangkal Pinang, Indonesia

*Corresponding Author. Email: pinaremas89@gmail.com, Telp: +6285743164422

ABSTRACT

Introduction: Metacognitive skills are essential for midwifery students as they support critical thinking, clinical decision-making, and lifelong learning. Problem-Based Learning (PBL) has been widely used to encourage active and self-directed learning; however, its impact on metacognitive skills among students in vocational midwifery education has not been well established. This study aimed to evaluate the effect of the PBL model on the metacognitive skills of midwifery students in a Maternity and Newborn Care course.

Method: A quasi-experimental, two-group post-test-only study was conducted in 2021. Total sampling was used to recruit all 37 eligible second-semester midwifery students, who were randomly allocated by lottery to the PBL group ($n = 20$) or the discussion group ($n = 17$). Metacognitive skills were assessed after the intervention using a researcher-developed 30-item questionnaire rated on a five-point Likert scale (possible score range, 30-150; Cronbach's $\alpha = 0.940$). Group means were compared using an independent-samples t -test in SPSS version 24.0.

Results: The PBL group had a higher mean post-intervention metacognitive-skill score than the discussion group (128 ± 12.1 vs. 112 ± 19.3). The 16-point between-group difference was statistically significant ($t(35) = -3.100, p = 0.004$).

Conclusion: Problem-Based Learning was associated with significantly higher post-intervention metacognitive-skill scores than discussion-based learning among midwifery students. These findings support the integration of PBL as a student-centered instructional approach for strengthening metacognitive learning in maternity and newborn care education.

Keywords: Problem-based learning, metacognitive skills, midwifery education



Published by:
Universitas Negeri Gorontalo

Mobile number:
+62852 3321 5280

Address:
Jend. Sudirman St. No.6, Gorontalo
City, Gorontalo, Indonesia

Email:
jmhsj@ung.ac.id

Article History:
Received 5 June 2026
Accepted 21 July 2026
Published 2 August 2026

DOI:
<https://doi.org/10.37905/jmhsj.v5i2.39511>

Introduction

The key to the realization of a professional midwife is starting from the education process. Students must develop not only clinical knowledge but also the capacity to make reasoned decisions, solve problems, and continually update their competence throughout professional practice.¹ Therefore, educational institutions must implement learning strategies that promote active learning and cognitive development. Learning is a central component of education because it provides students with meaningful opportunities to acquire knowledge and develop relevant competencies. The model used during this process plays an important role in shaping the learning experience and supporting the achievement of intended outcomes.

One of the key competencies that supports these processes is metacognition. Metacognition is a fundamental ability that underpins these learning processes. It refers to a learner's capacity to plan, regulate, and assess their own learning and is increasingly regarded as an important competency in health-professions education.² Students with strong metacognitive skills are better able to identify their learning needs, regulate their learning strategies, and critically reflect on their performance. These competencies are especially relevant in midwifery education, where students must connect theoretical understanding with clinical judgment and the application of evidence-based care.³

Metacognitive skills are closely linked to clinical reasoning, a core competency in midwifery practice. Students who can effectively monitor and evaluate their thinking processes are better prepared to make clinical judgments, identify knowledge gaps, and adapt their decision-making in complex healthcare situations. Therefore, educational strategies that strengthen metacognition may contribute to the development of competent future healthcare professionals.⁴

Lecturer-centered instruction remains common in many classrooms, with greater emphasis often placed on final outcomes than on the learning process itself. This approach may limit student engagement and make learning feel repetitive or less interactive.⁵ Given the importance of metacognitive development, learning approaches should provide opportunities for students to actively engage in problem-solving, reflection, and self-directed learning. Problem-Based Learning (PBL) is a learner-centered teaching method in which real-world problems serve as the starting point for learning. Through collaborative discussions, independent inquiry, and reflective activities, PBL encourages students to construct knowledge actively while monitoring and evaluating their own understanding.⁶ These learning processes align closely with the core dimensions of metacognition, suggesting that PBL may be an effective strategy for enhancing metacognitive skills among midwifery students.

PBL is grounded in constructivist theory, which considers learning an active process in which students build knowledge through experience rather than simply receive information.⁷ By engaging students in authentic problems and collaborative inquiry, PBL promotes deeper cognitive processing and encourages learners to reflect on their understanding and learning strategies.⁸

Previous studies have generally shown that PBL has been reported to support a broad range of educational outcomes in health-professions education. By engaging students in the analysis of authentic problems, collaborative discussion, independent information seeking, and reflective decision-making, PBL may contribute to better academic performance while also strengthening critical thinking, problem-solving ability, and self-directed learning skills.^{9,10} However, the findings have not been entirely consistent. Some reviews have reported meaningful improvements, particularly in critical thinking, whereas others have found no significant advantage over conventional teaching for knowledge, problem-solving, or self-directed learning outcomes.^{9,11} These variations indicate that the success of PBL may be shaped by the educational context, learner characteristics, intervention design, and outcome measures. Moreover, improvements in academic performance or critical thinking do not necessarily demonstrate improvement in metacognitive skills, which specifically encompass the capacity to plan, monitor, control, and assess one's own learning process.²

Direct evidence concerning the effect of PBL on metacognition remains limited and has largely been obtained from nursing or general health-professions education rather than vocational midwifery settings.^{12,13} Although some studies have reported improved metacognitive abilities following PBL-based interventions, differences in student populations, course content, and instructional formats limit their applicability to midwifery education. Evidence is particularly scarce in maternity and newborn care courses and within Indonesian vocational health institutions.¹⁴ Accordingly, this study examined whether PBL, relative to conventional discussion-based instruction, was associated with the metacognitive skills of midwifery students taking a Maternity and Newborn Care course.

Methods

This study employed a quasi-experimental two group post-test only design, targeting second-semester midwifery students (N = 37) at Poltekkes Kemenkes Pangkalpinang. The research was conducted over a eight months period from January to August 2021. Ethical approval was obtained from the Health Research Ethics Committee of Poltekkes Kemenkes Pangkalpinang (Approval No. 26/EC/KEPK-PKP/VII/2021, July 12, 2021). All participants gave informed consent before taking part, and their information was kept confidential

throughout the research. Participants were eligible if they were second-semester midwifery students enrolled at Poltekkes Kemenkes Pangkalpinang, registered in the Maternity and Newborn Care course during the study period, and willing to participate by providing informed consent. Students were excluded if they were on academic leave, withdrew from the study, did not complete the learning intervention or post-intervention assessment, or submitted incomplete metacognitive-skill data. All students who met the eligibility criteria were recruited using total sampling. All second-semester students who satisfied the eligibility requirements were invited to participate, resulting in a sample of 37 students. The participants were then assigned by lottery to either the PBL group ($n=20$) or the discussion group ($n=17$). The structural workflow of the study enrollment, allocation, and analysis is visually detailed in in **Figure 1**.

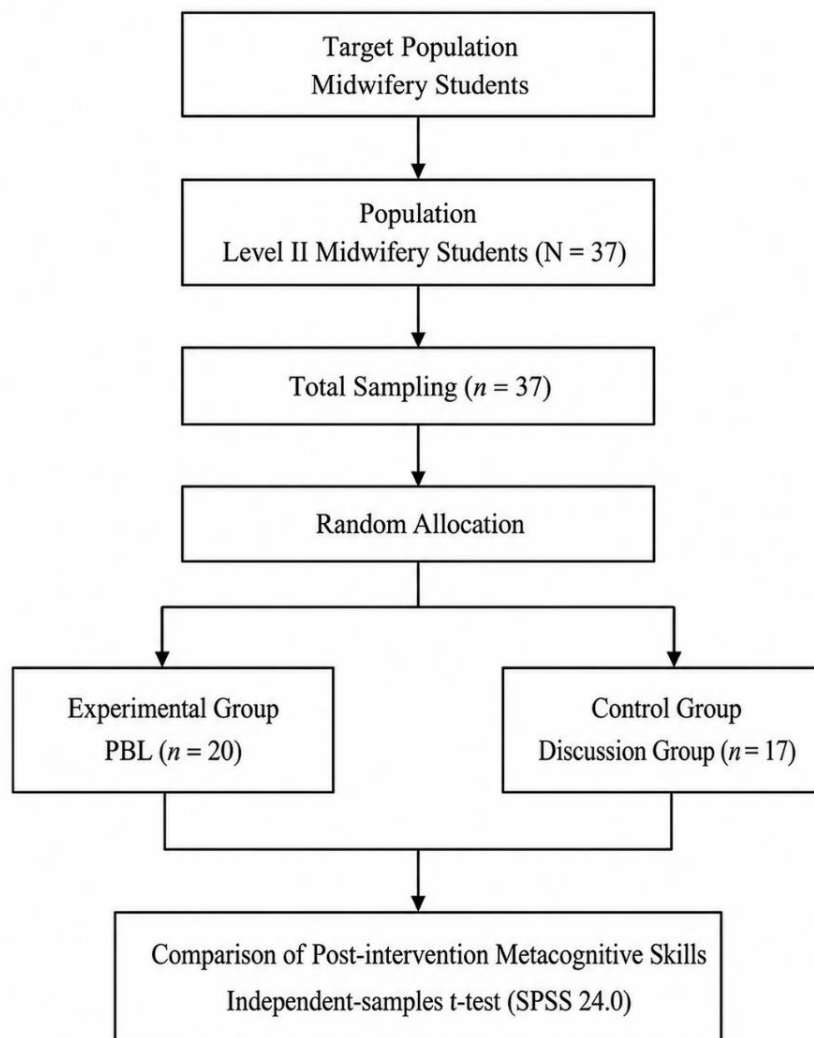


Figure 1. Flow of participant recruitment, random allocation, intervention groups, and statistical analysis.

This study used a two groups post-test only design. Metacognitive skills were assessed only after completion of the instructional intervention; therefore, no baseline metacognitive-skill scores were available for either group. Random allocation was used to reduce the likelihood of systematic baseline differences between the groups; however, baseline equivalence in metacognitive skills could not be directly verified. Metacognition was evaluated using a researcher-developed questionnaire containing 30 items. Responses were recorded on a five-point scale, producing total scores between 30 and 150; higher values represented stronger metacognitive skills. Internal consistency in the present sample was excellent (Cronbach's alpha coefficient of 0.940).

Before conducting the independent-samples t-test, the assumptions of normality and homogeneity of variance were examined. Normality was assessed separately for each group using the Shapiro–Wilk test because of the relatively small sample size, while homogeneity of variance was evaluated using Levene's test. The Shapiro–Wilk results indicated that metacognitive-skill scores were normally distributed in both the group. Therefore, the normality assumption for the independent-samples t-test was satisfied. Statistical significance was set at $p < 0.05$.

Result

Participant characteristic

Table 1 summarizes the participants' characteristics. All 37 participants were female second-semester midwifery students aged 19–21 years. The mean cumulative GPA was 3.52 ± 0.12 in the PBL group and 3.45 ± 0.08 in the **discussion group**.

Table 1. Participants characteristic.

Characteristic	PBL group	Discussion group	Total
Female, n (%)	20 (100.0)	17 (100.0)	37 (100.0)
Cumulative GPA (Grade Point Average), mean $\pm$ Standard Deviation	3.52 ± 0.12	3.45 ± 0.08	3.49 ± 0.11

Means differences

Figure 2 illustrates the distribution of metacognitive skill scores among students in the PBL and Discussion Group learning methods. Students in the PBL group demonstrated higher metacognitive skill scores (mean = 128 ± 12.1) than those in the Discussion Group (mean = 112 ± 19.3). The between-group comparison showed a statistically significant difference

($p=0.004$), with higher post-intervention scores observed among students who received PBL.

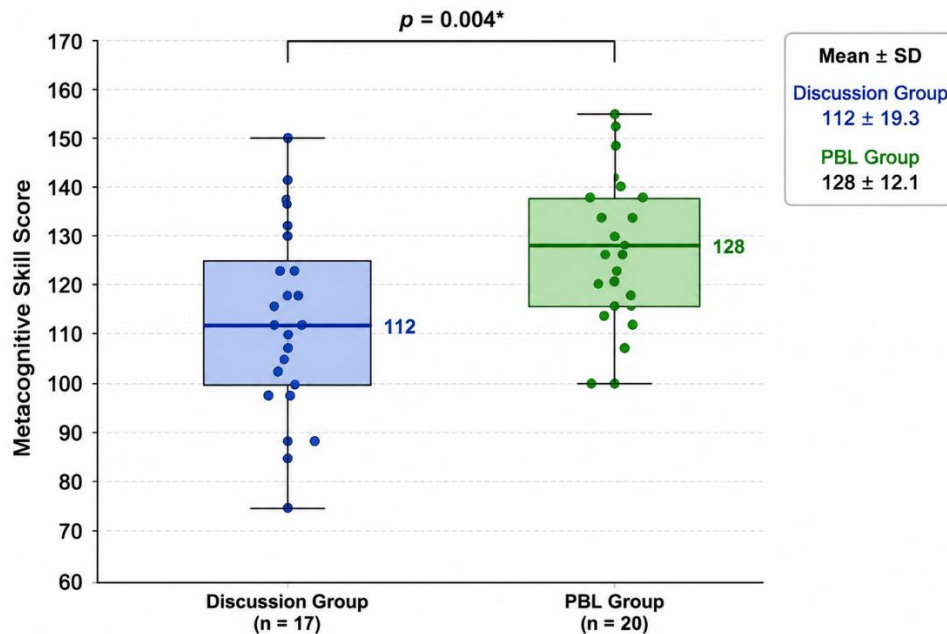


Figure 2. Metacognitive score by learning group.

Metacognitive skill difference test

To evaluate the impact of the instructional interventions, an independent samples t-test was conducted to compare the post-test metacognitive skill scores between the two cohorts. As illustrated in **Figure 2** and detailed in **Table 2**, students who participated in the PBL model achieved significantly higher metacognitive skill scores compared to those in the traditional Discussion Group ($t(35) = -3.100$, $p = 0.004$). This statistically significant divergence indicates that the structured, student-centered inquiry of PBL was considerably more effective at fostering metacognitive development than conventional discussion-based instruction.

Table 2. Results of the difference test metacognitive skills

Group	Independent Sample T-Test				
	n	Mean	SD	T (df)	p-value
PBL Group	20	128	12.1	-3.100 (35)	0.004*
Discussion Group	17	112	19.3		

Abbreviations: PBL, Problem Based Learning; SD, standard deviation

*Significant at $p<0.05$

Discussion

Students in the PBL group had significantly higher post-intervention metacognitive-skill scores than those in the discussion group, with mean scores of 128 ± 12.1 and 112 ± 19.3 , respectively. The mean between-group difference was therefore 16 points. This finding is consistent with Millanzi and Kibusi, who reported a significant improvement in metacognition among nursing students exposed to a problem-based facilitative teaching approach.¹² In contrast, Son reported no statistically significant pre–post change in metacognition following a short simulation-based PBL intervention ($p=0.063$), suggesting that longer and repeated exposure to PBL may be required to produce measurable metacognitive development.¹⁵ These differing findings suggest that the effect of PBL on metacognition may vary according to the duration and structure of the intervention, the educational setting, student characteristics, and the instrument used to measure metacognitive skills.

The observed 16-point between-group difference may be explained by the structured learning processes incorporated into PBL. Students in the PBL group were required to identify clinical problems, activate prior knowledge, determine their learning needs, search for relevant information, discuss alternative solutions, and evaluate their understanding.¹⁶ These activities correspond closely to the principal components of metacognitive regulation, including planning, monitoring, and evaluating one's own learning.^{2,16} Earlier studies have also suggested that PBL can strengthen metacognitive awareness and self-directed regulation by helping learners recognize gaps in understanding, manage their learning activities, and review their own progress.¹⁷

However, because no baseline assessment was conducted, the 16-point difference cannot be interpreted as a measured improvement or attributed solely to PBL. It represents only the difference observed between the two groups after the intervention. Baseline equivalence in metacognitive skills could not be directly established, and the possibility that pre-existing differences contributed to the findings cannot be excluded. The slightly higher cumulative GPA in the PBL group may also reflect differences in prior academic performance, although its influence on the outcome was not examined in this study.

In health-professions education, metacognitive competence is especially valuable because learners must connect theoretical understanding with clinical judgment and decision-making.¹⁸ The ability to recognize knowledge gaps, evaluate information critically, and adjust learning strategies is essential for effective professional practice. Learning environments that encourage active participation and reflection may therefore contribute to the development of these competencies.¹⁹ In midwifery education, where students must apply theoretical concepts

to diverse maternal and neonatal care scenarios, the ability to monitor and regulate one's thinking is crucial for safe and effective practice. Furthermore, healthcare professionals are expected to engage in lifelong learning to keep pace with advances in evidence-based practice, making metacognitive competence an important foundation for continuous professional development and high-quality patient care.

Another possible explanation is that PBL creates opportunities for continuous reflection during learning activities. As students analyze problems, discuss alternative solutions, and evaluate evidence, they become more aware of their thinking processes. This reflective practice enables learners to develop greater control over their cognitive strategies and learning behaviors, ultimately strengthening metacognitive competence.²⁰

The results of this study provide valuable insights for curriculum development in midwifery education. As healthcare systems increasingly demand practitioners who can engage in evidence-based decision-making and lifelong learning, educational approaches that promote metacognitive competence should be prioritized. Integrating PBL into professional courses may provide students with opportunities to develop reflective, self-directed, and inquiry-based learning habits that extend beyond the classroom.²¹ Higher post-intervention scores observed among students in the PBL group suggest that this approach may support the development of higher-order thinking skills required for effective clinical reasoning and professional practice. Consequently, PBL may serve as a valuable pedagogical strategy for preparing future midwives to become independent learners and competent healthcare professionals.

Despite the promising results, this study is constrained by its execution at a single institution, involving a relatively small sample size of 37 students and used a post-test-only design. Future studies should employ validated metacognitive instruments, adopt a pre-test–post-test design, use clearly defined random allocation procedures, recruit larger multicenter samples, and control for relevant baseline characteristics, including prior academic achievement.

Conclusion

Problem-based learning was associated with significantly higher post-intervention metacognitive-skill scores among midwifery students compared with discussion-based learning. These findings suggest that PBL may strengthen students' capacity to organize, oversee, and assess their own learning. However, because the study used a post-test-only design, the findings should be interpreted as a between-group association rather than definitive evidence of improvement from baseline.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

Funding sources

This research was funded by the Budget Implementation List (DIPA) of Poltekkes Kemenkes Pangkalpinang through the institutional research grant program.

Acknowledgment

The author would like to express sincere gratitude to Poltekkes Kemenkes Pangkalpinang for providing financial support through the DIPA research funding scheme. Appreciation is also extended to the Department of Midwifery, faculty members, and all students who participated in this study. Their cooperation and support were invaluable to the successful completion of this research

References

1. International Confederation of Midwives. ICM Essential Competencies for Midwifery Practice. The Hague: International Confederation of Midwives; 2024.
2. Medina MS, Castleberry AN, Persky AM. Strategies for Improving Learner Metacognition in Health Professional Education. *Am J Pharm Educ.* 2017; 81(4):78.
3. Carter AG, Sidebotham M, Creedy DK. International consensus definition of critical thinking in midwifery practice: A Delphi study. *Women Birth.* 2022;35(6):e590–7.
4. Merduaty RC, Arum AA. How guided self-reflection improves critical thinking of nursing students in the pre-clinical stage? *J Holist Nurs Sci.* 2023;10(2):111–7.
5. Hajar N ‘Azmi, Darmono AYD, Budiati AC. Penerapan Model Pembelajaran Problem Based Learning (PBL) Untuk Meningkatkan Hasil Belajar Siswa Kelas X-3 Pada Mata Pelajaran Sosiologi SMA Negeri Kebakkramat Tahun Ajaran 2015/2016 [Implementation of the Problem-Based Learning Model to Improve the Learning Outcomes of Grade X-3 Students in Sociology at SMA Negeri Kebakkramat during the 2015/2016 Academic Year]. *Sosialitas: J Ilm Pend Sociol Antropol.* 2015.
6. Yew EHJ, Goh K. Problem-Based Learning: An Overview of its Process and Impact on Learning. *Health Profes Edu.* 2016;2(2):75–9.
7. Sucipto S. Pengembangan Keterampilan Berpikir Tingkat Tinggi dengan Menggunakan Strategi Metakognitif Model Pembelajaran PBL [Development of Higher-Order Thinking Skills Using Metacognitive Strategies in the Problem-Based Learning Model]. *J Pend.* 2017;2(1):63–71.
8. Salsabila YR, Muqowim M. Korelasi Antara Teori Belajar Konstruktivisme Lev Vygotsky dengan Model Pembelajaran *Problem Based Learning* (PBL) [The Correlation Between

- Lev Vygotsky's Constructivist Learning Theory and the Problem-Based Learning Model]. *J Inov Penelit Pembelajaran*. 2024;4(3):813–27.
9. Wei B, Wang H, Li F, Long Y, Zhang Q, Liu H, et al. Effectiveness of Problem-Based Learning on Development of Nursing Students' Critical Thinking Skills: A Systematic Review and Meta-analysis. *Nurse Educ*. 2024;49(3):E115–9.
 10. Trullàs Joan Carles, Blay C, Sarri E, Pujol R. Effectiveness of problem-based learning methodology in undergraduate medical education: a scoping review. *BMC Med Educ*. 2022;22(1):104.
 11. Manuaba IBAP, No Y, Wu CC. The effectiveness of problem based learning in improving critical thinking, problem-solving and self-directed learning in first-year medical students: A meta-analysis. *PLoS One*. 2022;17(11 November):1–12.
 12. Millanzi WC, Kibusi SM. Exploring the effect of problem-based facilitatory teaching approach on metacognition in nursing education: A quasi-experimental study of nurse students in Tanzania. *Nurs Open*. 2020;7(5):1431–45.
 13. Son HK. Effects of s-pbl in maternity nursing clinical practicum on learning attitude, metacognition, and critical thinking in nursing students: A quasi-experimental design. *Int J Environ Res Public Health*. 2020;17(21):1–12.
 14. Komuhangi G, Neuhan F, Louis VR, Ocan M, Kinengyere AA, Wacker J. Efficacy of problem-based learning approach for teaching evidence-based practice to midwives and nurses: A systematic review protocol. *Eur J Midwifery*. 2025;9(56).
 15. Son HK. Effects of simulation with problem-based learning (S-PBL) on nursing students' clinical reasoning ability: based on Tanner's clinical judgment model. *BMC Med Educ*. 2023;23(1):601
 16. Hmelo-Silver CE. Problem-Based Learning: What and How Do Students Learn? *Educ Psychol Rev*. 2004; 16:235-66.
 17. Jusma, Nasution R, Akhmad, Masitah. Pengaruh Penggunaan *Problem Based Learning* (PBL) Terhadap Metakognitif dan Hasil Belajar Kognitif Siswa Kelas VIII di SMP Negeri 37 Samarinda pada Materi Sistem Ekskresi Manusia (The Effect of Use Problem Based Learning (PBL) on Metacognitive and Cognitive Learning Outcomes of Class VIII Students at SMP Negeri 37 Samarinda on Human Excretion System Materials). *Biosel Biol Sci Edu*; 15(1):95-105.
 18. Richards JB, Hayes MM, Schwartzstein RM. Teaching Clinical Reasoning and Critical Thinking: From Cognitive Theory to Practical Application. *Chest*. 2020;158(4):1617–28.
 19. Cho KK, Marjadi B, Langendyk V, Hu W. The self-regulated learning of medical students

- in the clinical environment - A scoping review. *BMC Med Educ.* 2026; 17(1): 112.
20. Elvén M, Welin E, Wiegleb Edström D, Petreski T, Szopa M, Durning SJ, et al. Clinical Reasoning Curricula in Health Professions Education: A Scoping Review. *J Med Educ Curric Dev.* 2023;10:1–15.
21. Zimmerman BJ. Self Regulated Learning and Academic Achievement: An Overview. *Educ Psychol.* 1990;25:3–17.

Effect of an Interactive Educational Intervention on Knowledge and Attitudes toward Cervical Cancer and Its Prevention among Adolescent Girls

Gaipyana Sembiring^{1,*}, Lestarida Nainggolan¹, Ayi Diah Damayani¹, Astri Yulia Sari Lubis¹, Arica¹, Akhiat²

¹Midwifery Department, Health Polytechnic Ministry of Health, Pangkal Pinang, Indonesia

²Nursing Department, Health Polytechnic Ministry of Health, Pangkal Pinang, Indonesia

*Corresponding Author. Email gaipyana.sembiring@gmail.com, Telp: +6281368480030

ABSTRACT

Introduction: Cervical cancer continues to pose a major public health challenge, particularly in low- and middle-income countries. Adolescent girls are the primary target group for prevention efforts, but their knowledge and attitudes about cervical cancer and its prevention are still limited. This study aimed to determine the effect of an interactive educational intervention on the knowledge and attitudes of adolescent girls.

Method: This quasi-experimental study, with a one-group pretest–posttest design, involved 87 adolescent girls aged 15–18 years selected through simple random sampling from a total of 500 students at SMAN 1 Pangkalan Baru, Central Bangka, Indonesia. The intervention consisted of a single 90-minute interactive educational session combining group presentations and discussions. Knowledge and attitudes were measured using a valid and reliable questionnaire (Cronbach's alpha of 0.772 and 0.743). Data were analyzed using the Wilcoxon signed-rank test.

Results: After the intervention, all participants (100%) achieved high knowledge levels, and attitude scores improved significantly. Significant improvements were observed in knowledge ($Z = -8.063$; $p < 0.001$) and attitudes ($Z = -3.135$; $p = 0.002$), with large and medium effect sizes, respectively.

Conclusion: An interactive educational intervention significantly improved adolescent girls' knowledge and attitudes regarding cervical cancer and its prevention. School-based health education has the potential to be an effective strategy to support cervical cancer prevention.

Keywords: Attitudes, cervical cancer, educational intervention, knowledge



Published by:
Universitas Negeri Gorontalo

Mobile number:
+62852 3321 5280

Address:
Jend. Sudirman St. No.6, Gorontalo
City, Gorontalo, Indonesia

Email:
jmhsj@ung.ac.id

Article History:
Received 26 June 2026
Accepted 26 July 2026
Published 2 August 2026

DOI:
<https://doi.org/10.37905/jmhsj.v5i2.40099>

Introduction

Cervical cancer remains a major public health problem worldwide. In 2022, an estimated 660,000 new cases and 350,000 deaths were reported, making it the fourth most common cancer among women globally.¹ The impact of this disease is disproportionately allocated, with almost 90% of cases and 85% of fatalities arising in low- and middle-income nations, particularly in Sub-Saharan Africa, which exhibits the highest cervical cancer fatality rate.² In several developing countries such as Ghana, Nigeria, and Sudan, cervical cancer ranks as the primary cause of cancer-induced fatalities in women.^{3–5} Indonesia persists in grappling with a considerable disease burden, having recorded approximately 36,964 new cases and 20,708 fatalities in 2022, positioning the nation among nations with the highest incidence of cervical cancer globally.⁶

The principal factor contributing to cervical cancer is Human Papillomavirus (HPV), accountable for over 99% of global cervical cancer instances.^{2,5} HPV is the predominant viral infection affecting the reproductive system, with the majority of women encountering the virus soon after initiating sexual activity.² High-risk HPV variants, especially strains 16 and 18, are responsible for about 70% of cervical cancer instances.^{2,7} Nevertheless, cervical cancer is essentially a preventable disease through two main approaches: HPV vaccination and regular cervical screening to detect precancerous lesions before they progress to invasive cancer.^{3,5} Scientific evidence shows that the HPV vaccine can prevent more than 75% of cervical cancer cases.²

The World Health Organization (WHO) initiated the Global Strategy to Expedite the Eradication of Cervical Cancer in 2020, aiming for 90% of girls to be completely vaccinated against HPV by the age of 15, 70% of women to be screened with high-efficacy tests, and 90% of women diagnosed with cervical disease to receive treatment by 2030.⁸ However, actual global HPV vaccination coverage remains far below this target. The full-course vaccination coverage among adolescent girls aged 10–20 years was recorded at only 1.2% in Africa, 1.1% in Asia, and 31.1% in Europe in 2014.² HPV vaccination coverage varies from 15% to 66.5% in Ethiopia, whereas Sudan's national immunization schedule does not currently contain HPV vaccination.^{2,5}

In line with the WHO targets, the Ministry of Health of the Republic of Indonesia aims to have 90% of 15-year-old girls vaccinated against HPV by 2030. This effort is being carried out through the School Children Immunization Month (*Bulan Imunisasi Anak Sekolah*, BIAS) program, which provides free HPV vaccines to fifth- and sixth-grade girls in elementary school. However, adolescent girls in high school are no longer targeted by this program, so vaccination

coverage in this group remains poorly documented and they may not be receiving optimal vaccination services.⁹

The persistently low HPV vaccination coverage highlights challenges regarding public knowledge and attitudes toward HPV vaccination and cervical cancer prevention. These knowledge gaps are not limited to adolescents but are also evident among parents or guardians who play a role in vaccination-related decision-making. For example, a study in Sudan reported that more than half of the respondents were unaware that cervical cancer is preventable, while 68% had never heard of a Pap smear.⁵ In Ethiopia, only 55.12% of adolescent girls have adequate knowledge about the HPV vaccine, while 45.34% hold a positive attitude toward vaccination.² In Nigeria, more than 90% of adolescent girls in secondary school were unaware that HPV is the leading cause of cervical cancer before receiving educational interventions.⁴ A similar situation occurred in Japan, where HPV vaccination coverage among adolescent girls born after 2002 dropped dramatically to below 1% due to the spread of misinformation regarding the vaccine's side effects. This situation led the Japanese government to suspend its active recommendation for HPV vaccination for eight years.¹⁰

Adolescent girls are a strategically important target population in cervical cancer prevention efforts, as the HPV vaccine is most effective when administered before a person becomes sexually active.^{4,11} It is commonly acknowledged that one of the most successful and efficient methods for addressing this demographic at scale is through school-based educational initiatives.^{2,3} A study conducted in Ghana demonstrated that overall knowledge about cervical cancer improved significantly from 79.1% to 92.3% following a multimodal educational intervention comprising drama performance, PowerPoint presentation, a question-and-answer session, and the distribution of informational leaflets.³ Research in Nigeria confirmed that peer education was capable of raising the mean knowledge score from 12.94 to 53.74 following peer training in schools.⁴ In Turkey, a structured two-session health education program delivered over 12 weeks significantly improved HPV knowledge, health beliefs, and mothers' intention to vaccinate their daughters compared to the control group.¹¹

However, the relationship between increased knowledge and changes in attitude and vaccination behavior is not always clear. A randomized trial in Japan found that health literacy among participants improved regardless of the educational method used, whether print-based or social networking service-based, although between-group differences did not reach statistical significance.¹⁰ In Turkey, despite significant improvements in knowledge and vaccination intention, actual vaccination rates did not increase substantially due to affordability barriers.¹¹ Additional factors such as urban versus rural residence, maternal education level,

access to digital information, socioeconomic status, and ethnicity have also been shown to significantly influence HPV vaccine uptake.^{2,7} A study representative of the national population in Brazil found that mothers' educational attainment, access to cell phones, and sexual health education—each independently—were associated with a higher likelihood that adolescents would receive the HPV vaccine.⁷

Several studies examining the effectiveness of educational interventions on adolescent girls' knowledge and attitudes toward cervical cancer and its prevention have been conducted in various countries; however, the available evidence remains specific to certain contexts and has not yet yielded definitive conclusions.¹¹ There is still a significant gap between awareness levels and actual preventive behaviors in many communities, underscoring the continued need for well-designed educational strategies tailored to specific population groups.^{3,5} It is widely believed that an early and accurate understanding of cervical cancer and its prevention can shape health-promoting mindsets and behaviors, which will benefit individuals well into adulthood.³

However, evidence on the impact of educational interventions among adolescent girls in Indonesia, particularly in underserved areas, remains limited. Furthermore, data on adolescent girls' knowledge and attitudes toward cervical cancer prevention in Central Bangka Regency are scarce. Because SMAN 1 Pangkalan Baru has the largest female student population in the regency, SMAN 1 Pangkalan Baru is an important target for cervical cancer prevention initiatives. Therefore, this study was conducted to evaluate the effect of an interactive educational intervention on knowledge and attitudes toward cervical cancer and its prevention among adolescent girls at SMAN 1 Pangkalan Baru, Central Bangka, Indonesia.

Methods

This study used a quasi-experimental framework with a single-group pretest-posttest methodology to assess the impact of health education on knowledge and attitudes about cervical cancer and its prevention among adolescent girls. This design was chosen because the educational intervention was implemented as a school-based health promotion program intended for all eligible participants. Establishing a non-intervention control group was considered ethically inappropriate, as withholding evidence-based cervical cancer education from a subset of adolescent girls could limit their opportunity to receive potentially beneficial health information. Furthermore, the primary objective of this study was to assess immediate changes in knowledge and attitudes following an interactive educational intervention rather than to compare different intervention strategies. The pretest–posttest design allowed each participant to serve as her own control, thereby reducing between-subject variability and

enabling assessment of within-group changes after the intervention. Nevertheless, this design does not permit definitive causal inference because it lacks a comparison group to control for potential confounding factors, such as maturation, history, or concurrent exposure to other health information. To minimize the influence of external factors, the posttest was administered immediately after completion of the educational intervention, which consisted of a structured presentation and interactive group discussion. This limitation is further addressed in the Discussion section.

The study was conducted at SMAN 1 Pangkalan Baru, Bangka Tengah Regency, Bangka Belitung Islands Province, Indonesia, between April and October 2025. The study population consisted of all female students enrolled at the school ($N = 500$). The minimum required sample size was calculated using the Slovin formula, $n = N / (1 + N(e)^2)$, with a margin of error (e) of 10%, yielding a minimum requirement of 84 participants. A total of 87 female students aged 15–18 years, exceeding the minimum required sample size, were subsequently selected from the sampling frame of 500 students using simple random sampling, conducted through a computer-generated random number list.

The inclusion criteria were: (1) female students aged 15–18 years, (2) actively enrolled at SMAN 1 Pangkalan Baru, (3) had not received HPV vaccination, and (4) willing to participate in the study. Students with a history of chronic illness or immunocompromising conditions and those who had previously received HPV vaccination were excluded.

This educational intervention was conducted using an interactive learning approach consisting of a structured presentation followed by a group discussion session. The intervention took place in a single 90-minute session, comprising a 45-minute PowerPoint-based presentation followed by a 45-minute facilitated group discussion. All 87 participants took part in the intervention together in a single large group session. The presentation was delivered by one of the researchers, a midwifery instructor with expertise in reproductive health. During the subsequent discussion session, four facilitators, including the keynote speaker, were involved in answering questions and facilitating discussions among the participants. All facilitators were midwifery instructors with expertise in midwifery, reproductive health, and public health. Participants were encouraged to actively engage in the learning process by sharing their opinions, asking questions, and discussing misconceptions and facts related to cervical cancer and its prevention. This interactive approach is intended to increase participant engagement and facilitate a better understanding of the educational material. This educational intervention material includes an explanation of cervical cancer, risk factors, clinical signs and symptoms, HPV infection, HPV vaccination, and steps to prevent cervical cancer, and is presented using

a standardized PowerPoint presentation to ensure consistency of content among all participants.

Participants first completed a pretest questionnaire assessing their baseline knowledge and attitudes. Following the pretest, the educational session was conducted, and participants were encouraged to actively engage through discussion and questions. Immediately after the educational session, participants completed the posttest questionnaire.

Participants' knowledge about cervical cancer and HPV vaccination was assessed using a 12-item structured multiple-choice questionnaire adapted from Ambarwulan, where each item had one correct answer. One point was awarded for each correct answer, while incorrect answers and "don't know" responses received a score of zero. Based on the total score obtained, knowledge levels were classified into three categories: low (≤ 4), moderate (5–8), and high (> 8). In addition, attitudes toward cervical cancer prevention and HPV vaccination were measured using a separate five-item instrument, also adapted from Ambarwulan, using a five-point Likert scale ranging from strongly disagree (0) to strongly agree (4).¹² For descriptive purposes, total attitude scores (range 0–20) were divided into three approximately equal categories: poor (score 0–6), fair (score 7–13), and good (score 14–20); the bivariate analysis comparing pretest and posttest scores was conducted using the continuous (numeric) scores.

As validity and reliability data for these instruments were not reported in the source publication, the psychometric properties of both questionnaires were evaluated by the researcher using baseline (pretest) responses from all 87 participants. Item validity was assessed using corrected item–total correlation, and internal consistency was evaluated using Cronbach's alpha. All knowledge items demonstrated satisfactory validity (corrected item–total correlation > 0.201), with acceptable internal consistency (Cronbach's alpha = 0.772). For the attitude questionnaire, four of the five items met the corrected item–total correlation criterion (≥ 0.30), with acceptable internal consistency for the attitude questionnaire (Cronbach's alpha = 0.743).

Statistical analysis was performed with IBM SPSS Statistics version 27. Participant characteristics and study variables were described using descriptive statistics, with continuous variables reported as means and standard deviations, and categorical variables—including the descriptive categorization of knowledge and attitude scores—reported as frequencies and percentages. The Kolmogorov-Smirnov test was applied separately to examine whether the distributions of knowledge and attitude scores met the assumption of normality, which is considered appropriate for the present sample size ($n = 87$). For each variable, if the pretest and posttest scores were normally distributed, the paired-samples t-test was used to compare mean scores; if the data were not normally distributed, the Wilcoxon signed-rank test was used to

compare median scores. Statistical significance was set at $p < 0.05$.

Ethical approval for this study was granted by the Health Research Ethics Committee of Poltekkes Kemenkes Pangkal Pinang, Ministry of Health (No. 078/EC/KEPK-PKP/IX/2025). Institutional permission to conduct the study was obtained from the school administration of SMAN 1 Pangkalan Baru prior to data collection. As all participants were under 18 years of age, written informed consent was obtained from both the participants and their parents or legal guardians following a full explanation of the study. Participation was voluntary, and participants could withdraw at any time without penalty. Confidentiality of participant information was maintained throughout the study through anonymized data coding and secure data storage.

Result

A total of 87 adolescent girls completed all phases of the study and were included in the final analysis. The findings presented below describe changes in knowledge and attitudes toward cervical cancer and its prevention observed before and after the educational intervention and evaluate the intervention's effectiveness in improving both outcomes.

A total of 87 adolescent girls participated in this study. Based on age, 44 respondents (50.6%) were in the 15–16 years age group, and 43 respondents (49.4%) were in the 17–18 years age group. In terms of grade level, 44 respondents (50.6%) were in Grade X (tenth grade), and 43 respondents (49.4%) were in Grade XI (eleventh grade). Regarding prior exposure to information on cervical cancer and HPV vaccination, 66 respondents (75.9%) had previously received related information, while 21 respondents (24.1%) had never been exposed to such information. **Table 1** presents the characteristics of the respondents.

Table 2 presents the distribution of knowledge and attitude categories before and after the educational intervention. Before the educational intervention, most respondents had a moderate level of knowledge (66.7%), followed by high (17.2%) and low knowledge (16.1%). After the intervention, all respondents (100%) achieved a high level of knowledge. Regarding attitudes toward cervical cancer and its prevention, most respondents had a fair attitude before the intervention (62.1%), followed by a good attitude (35.6%) and a poor attitude (2.3%). After the educational intervention, the proportion of respondents with a good attitude increased from 35.6% to 44.8%, while the proportion of those with a poor attitude decreased from 2.3% to 1.1%.

Table 1. Characteristics of respondents (N=87).

Characteristics	n	%
Age		
15-16 years	44	50.6
17-18 years	43	49.4
Grade level		
Grade X	44	50.6
Grade XI	43	49.4
Prior Information		
Exposure		
Previously exposed	66	75.9
Never exposed	21	24.1

Table 2. Distribution of knowledge and attitude categories before and after educational intervention (N=87).

Variable	Pretest n (%)	Posttest n (%)
Knowledge Level		
Low	14 (16.1)	0 (0.0)
Medium	58 (66.7)	0 (0.0)
Height	15 (17.2)	87 (100)
Attitude		
Less	2 (2.3)	1 (1.1)
Enough	54 (62.1)	47 (54.0)
Good	31 (35.6)	39 (44.8)

Table 3 shows that the median knowledge score increased from 7.00 (range: 0–11; IQR: 6–8) before the educational intervention to 11.00 (range: 9–22; IQR: 11–13) after the intervention. Similarly, the median attitude score increased from 12.00 (range: 6–17; IQR: 10–14) before the intervention to 13.00 (range: 3–18; IQR: 12–15) after the intervention.

Based on **Table 4**, the results of the normality test show that all variables produce p-values below 0.05, indicating that the data do not follow a normal distribution. Therefore, the non-parametric Wilcoxon signed-rank test was used to evaluate the effect of educational interventions on knowledge and attitudes.

Table 3. Descriptive statistics of knowledge and attitude scores before and after educational intervention.

Variable	Median (Min-Max)	IQR (Q1-Q3)
Knowledge		
Pretest Knowledge	7.00 (0-11)	6-8
Posttest Knowledge	11.00 (9-22)	11-13
Attitude		
Pretest Attitude	12.00 (6-17)	10-14
Posttest Attitude	13.00 (3-18)	12-15

Table 4. Normality test of knowledge and attitude scores.

Variable		<i>p</i> -value
Knowledge	Before education	<0.001*
	After education	<0.001*
Attitude	Before education	0.006*
	After education	<0.001*

Kolmogorov smirnov test. *Significant at $p < 0.05$.

Based on **Table 5**, it shows that there was a statistically significant increase in knowledge after the educational intervention ($Z = -8.063$; $p < 0.001$). Likewise, there was a significant increase in attitude scores following the intervention ($Z = -3.135$; $p = 0.002$). These findings suggest that knowledge and attitude scores were significantly higher following the educational intervention.

Table 5. Effect of educational intervention on knowledge and attitude scores.

Variable	Pretest Median (IQR)	Posttest Median (IQR)	<i>Z</i>	<i>p</i> -value
Knowledge	7.00 (6-8)	11.00 (11-13)	-8.063	<0.001*
Attitude	12.00 (10-14)	13.00 (12-15)	-3.135	0.002*

Wilcoxon Signed Rank Test. *Significant at $p < 0.05$.

The magnitude of the educational intervention was further assessed using effect size analysis. The intervention demonstrated a large effect on knowledge improvement ($r = 0.86$) and a moderate effect on attitude improvement ($r = 0.34$). These findings indicate that the

observed increase in knowledge scores was of substantial practical magnitude, while the increase in attitude scores was of moderate practical magnitude. Effect size of educational intervention on knowledge and attitude scores are presented in **Table 6**.

Table 6. Effect size of educational intervention on knowledge and attitude scores.

Variable	Z	Effect Size (r)	Interpretation
Knowledge	-8.063	0.86	Large effect
Attitude	-3.135	0.34	Moderate effect

Note: Effect size (r) was calculated using the formula $r = |Z|/\sqrt{N}$, where $N = 87$.

Discussion

The findings of this study indicate that adolescent girls' knowledge and attitudes regarding cervical cancer and its prevention significantly improved after the educational intervention, compared to baseline. After the intervention, all respondents were classified as "highly knowledgeable," with a statistically significant increase in attitude scores. Furthermore, the large effect size observed for knowledge and the moderate effect size for attitude suggest that these improvements have practical significance beyond mere statistical significance for adolescent girls' understanding and attitudes toward cervical cancer prevention. Overall, these findings highlight reproductive health education as a key strategy in promotion and prevention efforts aimed at reducing the future burden of cervical cancer.

Knowledge improvement following the educational intervention

Prior to the intervention, pre-test results indicated that most respondents had moderate knowledge about cervical cancer and its prevention, while a small proportion still showed low knowledge. These findings indicate an overall limited understanding of cervical cancer and its prevention among young women at an early stage. This limited knowledge may be due to limited access to reproductive health information, inadequate coverage of cervical cancer topics in educational institutions, and the persistence of several misconceptions about the disease and its prevention efforts.

The post-test results showed that all respondents fell into the high knowledge category, and the median knowledge score increased significantly. These results indicate that adolescent girls' understanding of cervical cancer, its risk factors, symptoms, and preventive measures—including healthy lifestyle practices and HPV vaccination. The large effect size ($r = 0.86$) indicates that the magnitude of the observed increase in knowledge scores was substantial.

These findings align with prior research demonstrating that educational interventions

can enhance knowledge related to cervical cancer prevention. A school-based education program in Ghana increased students' knowledge from 79.1% to 92.3%, while peer-led education in Nigeria and school-based education in Kenya were also shown to increase adolescents' knowledge of cervical cancer.^{3,4,13} A study in Indonesia showed that a board-game-based HPV vaccine education intervention significantly improved knowledge about HPV vaccination among adolescent girls.¹⁴ This highlights the necessity of implementing structured health education programs to improve knowledge of and acceptance toward the HPV vaccine. The consistency of these findings suggests that structured and interactive health education is effective in increasing adolescents' knowledge of cervical cancer across various contexts. Nevertheless, the improvement observed in this study appears more substantial than that reported in some earlier studies. This difference is likely influenced by participants' baseline knowledge levels, the methods and duration of the interventions, and the characteristics of the study populations.

The improvement observed in the present study may be attributed to the interactive teaching strategy used. The use of PowerPoint slides likely helped present information in a more visually accessible way, while discussion and question-and-answer sessions may have encouraged active participation, clarification of misconceptions, and better retention of material. This is consistent with evidence that engaging and interactive formats can strengthen learning outcomes and improve both knowledge and preventive attitudes.^{14,15}

These findings support the use of school-or community-based educational interventions as an effective approach to raising awareness about cervical cancer prevention among adolescent girls. These interventions are particularly important in settings where limited knowledge about cervical cancer and misconceptions regarding HPV and vaccination remain common. Integrating interactive health education into adolescent reproductive health programs can contribute to greater acceptance of HPV vaccination and stronger efforts to prevent cervical cancer.^{3,13,16}

Attitude improvement following the educational intervention

This study showed a significant improvement in attitudes following the educational intervention, although the effect size was moderate ($r = 0.34$). These results indicate that changes in attitudes occur more slowly than increases in knowledge because attitudes are influenced not only by information but also by an individual's beliefs, perceptions, and experiences.

According to attitude formation theory, knowledge is a predisposing factor that plays a role in shaping attitudes. A better understanding of cervical cancer and its prevention can

increase awareness of disease risks and the importance of preventive measures, thereby fostering more positive attitudes. Previous research has also shown that increased knowledge plays a crucial role in improving attitudes toward HPV vaccination and adherence to cervical cancer screening.^{17,18} Among adolescents, Higher knowledge levels are also linked to greater acceptance of the HPV vaccine and improved adherence to screening recommendations.¹⁹

These findings align with studies reporting that educational interventions can improve knowledge, attitudes, and intentions regarding cervical cancer prevention and HPV vaccination acceptance.²⁰ The improvement in attitudes observed in this study was likely influenced by the interactive educational methods used. Discussions and question-and-answer sessions provided participants with the opportunity to express their opinions, ask questions, and seek clarification. This process helped participants better understand the information and fostered more positive attitudes toward cervical cancer prevention. Ongoing exposure to health information can also encourage preventive behaviors, such as HPV vaccination acceptance and participation in screening.²¹

However, increased knowledge is not always followed by changes in attitudes or behavior. A study in Turkey showed that structured education increased mothers' knowledge and intention to provide the HPV vaccine but did not increase vaccination coverage due to cost barriers.¹¹ Similar findings were observed in this study, where cost remains one of the barriers to HPV vaccination. Moreover, studies conducted in Japan and China suggest that HPV vaccine acceptance is shaped not only by knowledge levels but also by social norms, financial cost, and accessibility of health services.²¹ Therefore, health education must be supported by policies that improve affordability and access to the HPV vaccine so that changes in knowledge can be followed by changes in attitudes and behavior.

The intervention in this study employed an interactive learning approach that combined multimedia presentations with question-and-answer discussions. This approach is participant-centered because participants did not merely receive information passively but were also actively engaged in the learning process. Previous research has shown that interactive educational forums involving two-way communication and group discussions can increase participant engagement and improve understanding of health information.²⁰ Therefore, interactive educational methods can serve as an effective strategy within reproductive health promotion programs targeting adolescents.

The findings of this study have practical implications: education about cervical cancer and its prevention needs to be continuously integrated into reproductive health programs in schools. Providing education starting in adolescence is expected to raise awareness of the

importance of behaviors that prevent cervical cancer, including maintaining reproductive health and increasing acceptance of HPV vaccination in the future.

This study has several strengths, namely the use of a pretest-posttest design, the measurement of two important outcomes—knowledge and attitude—and the use of an interactive educational approach that demonstrated a large effect size on knowledge improvement. In addition, the use of numerical scores as the primary analysis method allows for more sensitive detection of changes compared to the use of categorical data alone.

However, this study also has several limitations. It employed a single-group pretest-posttest design without random assignment to a control group; thus, the influence of external factors and potential confounding variables could not be fully eliminated or attributed to the intervention. The relatively small sample size ($n = 87$), drawn from a single school, limits the generalizability of these findings to the broader adolescent population. Assessments were conducted immediately after the intervention, so this study could not evaluate the long-term retention of knowledge and attitudes. Therefore, future research is recommended to include a randomized control group, a larger and more diverse sample, and follow-up assessments to evaluate the sustainability of the educational effects.

Conclusion

This study showed that adolescent girls' knowledge and attitudes toward cervical cancer and its prevention significantly improved after participating in an interactive educational intervention, although the single-group pre-test-post-test design without a control group precludes definitive causal conclusions. These findings suggest that school-based interactive health education is an effective strategy for increasing adolescent awareness and fostering positive attitudes toward cervical cancer prevention. Future research using a controlled study design and a longer follow-up period is recommended to evaluate the long-term sustainability of this educational effect.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Funding sources

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Acknowledgment

The authors gratefully acknowledge the support of the principal, teachers, and students of SMAN 1 Pangkalan Baru for their support and participation in this study. The authors also

thank all individuals who contributed to the implementation of this research.

References

1. Saini S, Nagar R, Kumar M, Shekhar H, Goyal P. Perception and acceptability towards HPV vaccination among mothers of adolescent girls employed in health care sector-a cross sectional study. *Clin Epidemiol Glob Health*. 2024;30(30):1018441.
2. Addisu D, Gebeyehu NA, Belachew YY. Knowledge, attitude, and uptake of human papillomavirus vaccine among adolescent schoolgirls in Ethiopia: a systematic review and meta - analysis. *BMC Womens Health*. 2023;23:279.
3. Dedey F, Nsaful J, Nartey E, Labi J, Adu-aryee NA, Kuti C, et al. Assessing the impact of cervical cancer education in two high schools in Ghana. *BMC Cancer*. 2024; 24(1):1359.
4. Sadoh AE, Okonkwo C, Nwaneri DU. Effect of Peer Education on Knowledge of Human Papilloma Virus and Cervical Cancer among Female Adolescent Students in Benin City, Nigeria. *Ann Glob Health*. 2018;84(1):121–8.
5. Siddig EE, Ahmed A, Ahmed ES, Mohammed MA, Kunna E, El-sadig SM, et al. Knowledge and attitudes towards cervical cancer prevention among women in Khartoum state , Sudan. *Womens Health (Lond)*. 2023; 19:17455057231166286.
6. Li Z, Liu P, Yin A, Zhang B, Xu J, Chen Z, et al. Global landscape of cervical cancer incidence and mortality in 2022 and predictions to 2030: The urgent need to address inequalities in cervical cancer. *Int J Cancer*. 2025;157(2):288–97.
7. Ferreira L, Marques T, José A, Mattos C. Education and social determinants shaping HPV vaccine uptake : Insights from a nationwide cross-sectional study. *Hum Vaccin Immunother*. 2025;21(1):1–10.
8. World Health Organization. Global strategy to accelerate the elimination of cervical cancer as a public health problem [Internet]. Geneva: World Health Organization; 2020 [cited 2026 Jul 25]. 52 p. Available from: <https://www.who.int/publications/i/item/9789240014107>
9. Direktorat Jenderal Pencegahan dan Pengendalian Penyakit Kementerian Kesehatan Republik Indonesia. Petunjuk Teknis Pelaksanaan Program Introduksi Imunisasi Human Papilloma Virus (HPV) dalam Bulan Imunisasi Anak Sekolah (BIAS) Tahun 2022-2024. Jakarta: Kementerian Kesehatan RI; 2022.
10. Takahashi Y, Sasamori Y, Higuchi R, Kaku A, Kumagai T, Watanabe S, et al. Effects of different educational interventions on cervical cancer knowledge and human papillomavirus vaccination uptake among young women in Japan : Preliminary results of a cluster randomized controlled trial. *PLoS One*. 2025;20(1):1–16.

11. Ozdemir S, Caglayan R. Health education on HPV vaccination and cervical cancer prevention: A randomised controlled trial on knowledge, attitudes, beliefs, and behaviours. *J Pak Med Assoc.* 2026;76:140–50.
12. Ambarwulan P, Puspitasari RT, Afandi AN, Khairunnisa NZA, Haryanti NTM, Putri RA, et al. Pengetahuan dan Sikap tentang Kanker Serviks dan Vaksinasi HPV pada Mahasiswa Kampus C Universitas Airlangga. *J Farm Komunitas.* 2024;11(2):128–33.
13. Kivuti-Bitok LW, Mugo CW, Mituki D, Marete C, Ngune I, Wells J. The effect of school-based educational session on knowledge, attitudes, and beliefs of cervical cancer among adolescents in mixed day high schools in Embu County: a quasi-experimental study. *BMC Public Health.* 2026;26(1):1267.
14. Hamka H, Elsanti D, Dewiyanti D, Pranata GstKAW, Sumarmi S. Effectiveness of Board Game–Based Education in Enhancing Knowledge and Intention Toward HPV Vaccination Among Adolescent Girls. *J Keperawatan Komprehensif.* 2026;12(1):127–36.
15. Ifediora CO, Azuike EC. Targeting cervical cancer campaigns on teenage high schoolers in resource-limited economies: lessons from an intervention study of Nigerian senior secondary school girls. *Fam Pract.* 2019;36(5):600–6.
16. Rashid S, Labani S, Das BC. Knowledge , Awareness and Attitude on HPV , HPV Vaccine and Cervical Cancer among the College Students in India. *Plos One.* 2016; 11(11):e0166713.
17. Seyrafi N, Homayuni A, Hosseini Z, Aghamolaei T, Ghanbarnejad A, Mouseli A. Effectiveness of educational intervention on women’s participation to cervical cancer screening: a quasi-experimental study based on PEN-3 model. *BMC Cancer.* 2022;22(1):1226.
18. Lo SHS, Chau JPC, Choi KC, Butt L, Lui GCY, Lee VWY, et al. Effects of an educational health promotion intervention to improve human papillomavirus vaccination acceptance and uptake among adolescent girls: a cluster randomized controlled trial. *BMC Public Health.* 2025;25(1).
19. Zewdie A, Kasahun AW, Habtie A, Gashaw A, Ayele M. Human papillomavirus vaccine acceptance among adolescent girls in Ethiopia: a systematic review and meta-analysis. *BMC Public Health.* BioMed Central Ltd; 2023;23(1):3419.
20. Chu H, Ko LK, Ibrahim A, Bille Mohamed F, Lin J, Shankar M, et al. The impact of an educational forum intervention on East African mothers’ HPV vaccine-related knowledge, attitudes, and intentions to vaccinate their adolescent children. *Vaccine.* 2021;39(28):3767–76.

21. Gokdemir O, Tamburro M, Laurenti P, Chen Y. The impact of exposure to HPV related information and injunctive norms on young women's intentions to receive the HPV vaccine in China: A structural equation model based on KAP theory. *Front Public Health*. 2023;10:1–10.

Reconstruction at The Edge of Oncologic Safety: Immediate Latissimus Dorsi Flap After Neoadjuvant Chemotherapy in Locally Advanced Triple Negative Breast Cancer

Aldhi Tri Budhi¹, Taufiq Qurrohman^{2,*}, Annisa Verawati³, Indra³

¹Department of General Surgery, Bhayangkara Hospital, Gorontalo, Indonesia

²Faculty of Medicine, Gorontalo State University, Gorontalo, Indonesia

³Department of Oncology Surgery, Faculty of Medicine, Hasanuddin University, Makassar, Indonesia

*Corresponding Author. Email: taufiquipq28@gmail.com, Telp: +6281245580498

ABSTRACT

Triple negative breast cancer (TNBC) is an aggressive subtype characterized by rapid progression, early recurrence, and limited targeted therapies. Neoadjuvant chemotherapy (NACT) is standard in locally advanced TNBC to improve resectability and assess tumor response. Immediate breast reconstruction (IBR) after NACT was historically approached with caution because of concerns regarding wound complications, treatment delay, and oncologic safety; growing evidence, however, now supports its oncologic safety when patients are carefully selected, so that the clinically relevant question has shifted from whether IBR should be offered to how candidates should be chosen. A 49 years old woman presented with a 6 × 8 cm ulcerated right breast mass and ipsilateral axillary lymphadenopathy. Biopsy confirmed grade II invasive carcinoma of no special type (NST), ER/PR/HER2 negative. After three cycles of cyclophosphamide, doxorubicin, and paclitaxel, a partial clinical response was achieved. She underwent modified radical mastectomy with axillary dissection and immediate pedicled latissimus dorsi (LD) flap reconstruction for an 8 × 18 cm defect. Final pathology showed residual disease with Miller–Payne grade 3 response and negative lymph nodes. Recovery was uneventful, and adjuvant therapy commenced without delay. With appropriate patient selection, negative margins, and multidisciplinary planning, immediate LD flap reconstruction can provide reliable coverage in high risk fields without compromising oncologic outcomes. This case supports the feasibility and oncologic prudence of immediate LD flap reconstruction after NACT in selected patients with locally advanced TNBC, while underscoring that broader conclusions require validation beyond a single case.

Keywords: Breast reconstruction, latissimus dorsi flap, neoadjuvant chemotherapy, triple negative breast cancer



Published by:
Universitas Negeri Gorontalo

Mobile number:
+62852 3321 5280

Address:
Jend. Sudirman St. No.6, Gorontalo
City, Gorontalo, Indonesia

Email:
jmhsj@ung.ac.id

Article History:
Received 13 February 2026
Accepted 31 August 2026
Published 2 September 2026

DOI:
<https://doi.org/10.37905/jmhsj.v5i2.37414>

Introduction

Triple negative breast cancer (TNBC) is a highly aggressive molecular subtype defined by rapid proliferation, early recurrence, and the absence of actionable hormone or HER2 targets, contributing disproportionately to breast cancer-related mortality.^{1,2} TNBC accounts for approximately 10–15% of all breast cancers and presents significant therapeutic challenges, especially in the locally advanced setting.² Neoadjuvant chemotherapy (NACT) is now a central component of treatment for operable, locally advanced TNBC, facilitating tumor downstaging, in vivo assessment of chemosensitivity, and improved surgical resectability.³ Standard NACT regimens typically combine an anthracycline (doxorubicin or epirubicin) with a taxane (paclitaxel or docetaxel); the addition of a platinum agent, most commonly carboplatin, further increases pathological complete response rates, particularly among BRCA1/2 mutation carriers, although its effect on long term event free and overall survival remains under active investigation.⁴ Pathological complete response (pCR) following NACT is a validated surrogate endpoint for improved disease free survival (DFS), event free survival (EFS), and overall survival (OS) in TNBC.^{3,5} However, pCR rates remain suboptimal, typically ranging from 40–55%, and a substantial proportion of patients still require extensive mastectomy, resulting in soft tissue deficits and reconstructive challenges.^{5,6}

The physical and psychological consequences of mastectomy have prompted the development of (IBR), which has been shown to improve body image and quality of life without diminishing patient satisfaction.⁷ Patients with locally advanced TNBC have historically been regarded as high risk candidates for IBR because of their elevated risk of locoregional and distant recurrence, the aggressive biology of the tumor, and the frequent need for intensive adjuvant therapy, factors that raise theoretical concerns about masking recurrence, delaying systemic treatment, and impairing wound healing in an already chemotherapy exposed field.^{8,9} Achievement of pCR should inform, rather than solely dictate, the decision to pursue IBR; the choice of reconstructive strategy is more directly guided by the extent of the post mastectomy defect, confirmation of negative margins, the quality of the remaining skin and soft tissue, the anticipated need for post mastectomy radiotherapy (PMRT), and the patient's overall fitness for a combined oncologic reconstructive procedure.^{9,10} Accumulating evidence from recent series and meta analyses indicates that immediate autologous reconstruction after NACT, including with the latissimus dorsi (LD) flap, can be performed with acceptable complication rates and without adverse effects on DFS or OS, provided that patient selection and multidisciplinary planning are rigorous, evidence that has shifted the clinical debate from whether IBR should be offered at all toward how candidates should best

be selected.⁸⁻¹⁰ Among autologous techniques, the LD flap is recognized as a reliable and versatile option, providing consistent vascularity, acceptable donor site morbidity, and adaptability to a wide range of chest wall defects.^{7,10}

This is particularly relevant for patients anticipated to require PMRT, which is commonly indicated after mastectomy for locally advanced disease: pedicled autologous flaps such as the LD flap are more resistant to radiation induced fibrosis and capsular contracture than implant based reconstructions, carry a lower risk of infection and implant exposure in a previously irradiated or chemotherapy exposed field, and provide durable, well vascularized soft tissue coverage even for large or ulcerated defects.^{10,11} Advanced imaging modalities, particularly contrast enhanced breast MRI, may further refine candidate selection by providing a more accurate estimate of residual disease burden after NACT than clinical examination alone, supporting both the timing of surgery and the oncologic rationale for proceeding with immediate reconstruction.¹² The intersection of locally advanced TNBC, NACT, and immediate LD flap reconstruction therefore represents a complex yet increasingly relevant clinical scenario. This case report aims to illustrate the feasibility and oncologic prudence of immediate LD flap reconstruction following NACT in locally advanced TNBC and to contribute to the still limited body of evidence regarding the oncologic safety and reconstructive outcomes of IBR in this high risk population, emphasizing the balance between optimal cancer control and restoration of physical and psychological wellbeing.

Case

A 49 years old woman presented with a progressively enlarging mass in the right breast that had been noticed approximately one year prior to presentation. The mass initially appeared as a small, marble sized lump and enlarged rapidly over six months, eventually reaching the size of a hand ball. As the tumor progressed, ulceration developed at the central portion of the breast, accompanied by malodor. There were no associated respiratory symptoms, bone pain, or constitutional complaints. The patient had no personal or family history of malignancy. Her gynecologic history included menarche at 12 years of age, three full term pregnancies with breastfeeding for up to two years, and menopause at the time of presentation. Her medical history was notable for well controlled hypertension treated with amlodipine.

On physical examination, the patient was in moderately ill condition with a Karnofsky performance status of 70%. Examination of the right breast revealed a firm, irregular, nontender mass measuring approximately 6 × 8 cm, with poorly defined margins (Figure 1A). The nipple areolar complex and a large portion of the breast skin showed evidence of healed ulceration consistent with a previously fungating carcinoma, along with residual satellite

nodules. Palpation of the right axilla identified a single mobile lymph node at level I measured approximately 3 cm in diameter, without matting or fixation to surrounding structures. Examination of the left breast and contralateral axilla was unremarkable. No signs of distant metastasis were identified on general physical examination.

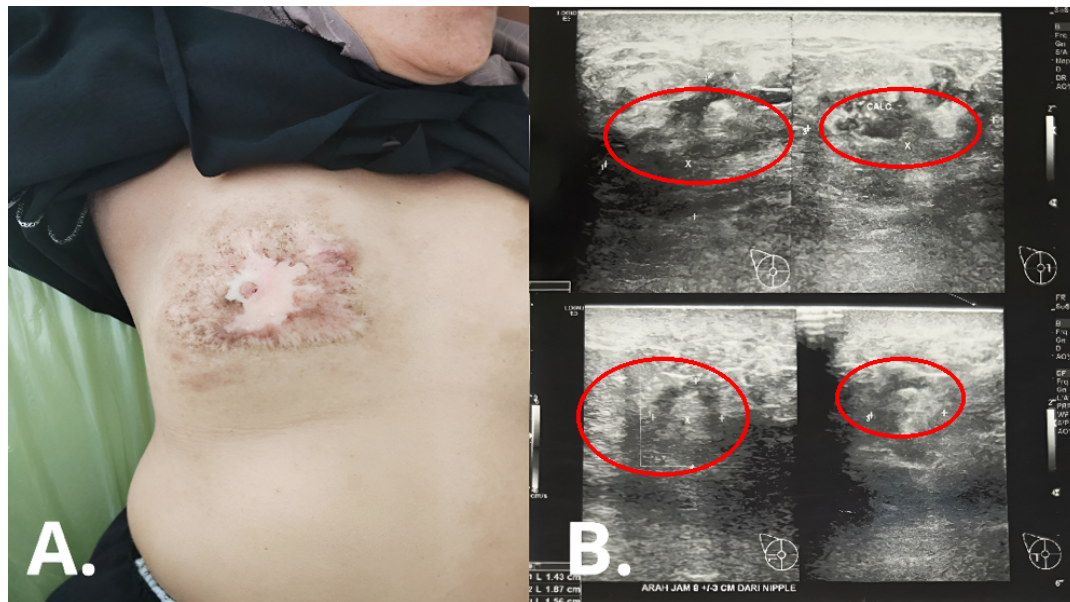


Figure 1. Preoperative clinical presentation and imaging findings. (A) Clinical photograph of the right breast demonstrating a centrally ulcerated lesion with surrounding skin changes consistent with locally advanced breast carcinoma. (B) Breast ultrasonography (red circles) showing irregular hypoechoic masses with heterogeneous echotexture, categorized as BI-RADS 6, suggestive of biopsy proven malignancy.

Breast ultrasonography demonstrated multiple masses in the right breast consistent with BI-RADS 6 lesions, along with multiple enlarged right axillary lymph nodes at level I (Figure 1B). The left breast was within normal limits. Chest radiography and abdominal ultrasonography showed no evidence of distant metastatic disease. Routine laboratory investigations, including complete blood count, renal and hepatic function tests, and coagulation profile, were within acceptable limits for surgical intervention, with no evidence of systemic inflammatory or metabolic derangement.

An incisional biopsy of the breast lesion revealed NST with moderate differentiation (histopathological grade II) (Figure 2A). Immunohistochemical analysis showed negative expression of estrogen receptor, progesterone receptor, and HER2, consistent with TNBC (Figure 2B); Ki 67 immunohistochemical staining had not yet been performed at the time of reporting and was recommended in the most recent pathology evaluation for further assessment of tumor proliferative activity. The patient subsequently underwent NACT consisting of

cyclophosphamide, doxorubicin, and paclitaxel for three cycles. Response to NACT was assessed clinically through serial breast and axillary examination, corroborated by breast ultrasonography prior to surgery; formal radiological restaging with contrast enhanced imaging was not performed in this setting, which is acknowledged as a limitation of the pre surgical work up. A partial clinical response was achieved.

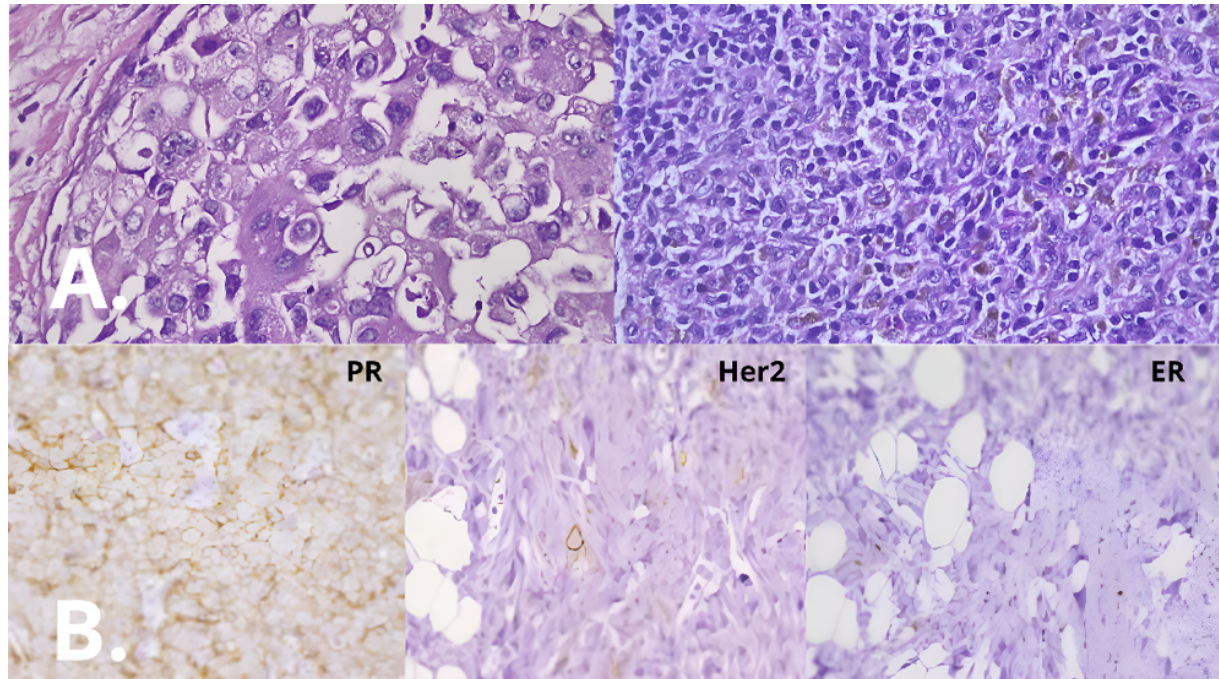


Figure 2. Histopathological and immunohistochemical findings from the tumor specimen. (A) Hematoxylin and eosin (H&E) staining showing NST, histological grade II, with marked nuclear pleomorphism, brisk mitotic activity, an infiltrative growth pattern, and a moderate desmoplastic stromal response (original magnification $\times 200$ – 400 ; scale bars not available in the original photomicrographs). (B) Immunohistochemical staining demonstrating absence of nuclear staining for estrogen receptor (ER) and progesterone receptor (PR) (positivity threshold $\geq 1\%$ of tumor nuclei per current ASCO/CAP guidelines) and absence of membranous HER2 staining (score 0 per ASCO/CAP HER2 testing criteria), consistent with TNBC.

Following neoadjuvant therapy, the patient underwent right modified radical mastectomy with axillary lymph node dissection, followed by immediate reconstruction using a pedicled LD flap to address a post mastectomy chest wall defect measuring approximately 8×18 cm. Preoperative skin marking of the LD flap was performed with the patient in the sitting position to delineate the anterior, posterior, superior, and inferior borders of the LD muscle. A skin island measuring approximately 20×10 cm was designed obliquely over the muscle,

oriented to allow adequate rotation to the anterior chest wall while facilitating primary closure of the donor site (Figure 3A). Surface markings of the anticipated mastectomy margins and chest wall defect were made concurrently (Figure 3B).

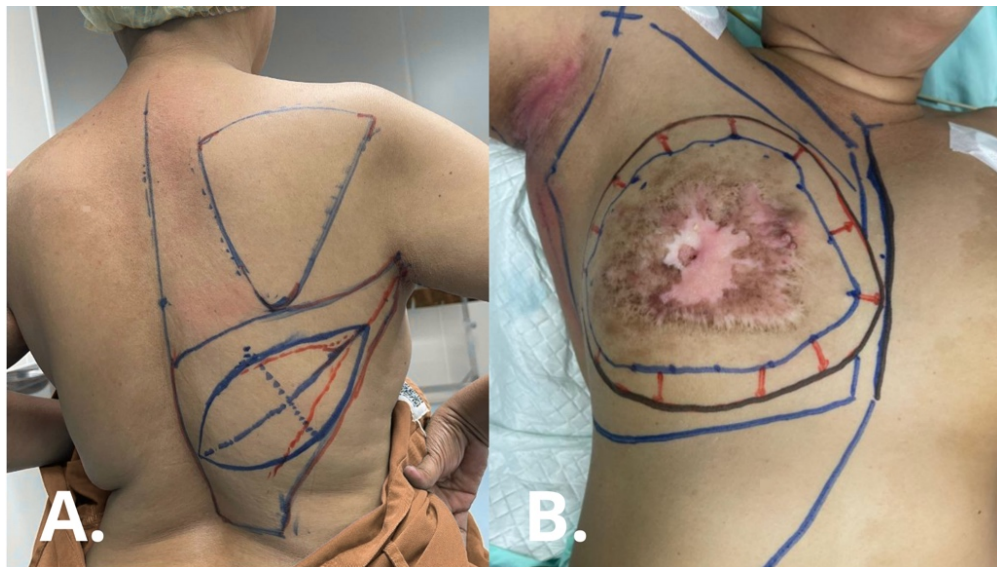


Figure 3. Preoperative surgical planning and flap design. (A) Preoperative marking of the LD flap on the donor site, outlining the muscle borders and planned skin island. (B) Surface marking of mastectomy margins and anticipated chest wall defect prior to reconstruction.

After completion of the mastectomy, the patient was repositioned into a lateral decubitus position to allow access to the donor site. The ipsilateral arm was abducted to no more than 90 degrees and supported appropriately to prevent brachial plexus and ulnar nerve injury. A skin incision was made according to the preoperative markings, and subcutaneous dissection was carried out to expose the underlying LD muscle.

The muscle was dissected free from its surrounding attachments, separating it laterally from the serratus anterior muscle, medially from the paraspinal and thoracolumbar fascia, superiorly from the fibers of the trapezius muscle, and inferiorly from the teres major muscle (Figure 4A). Dissection was performed predominantly with sharp technique using Metzenbaum scissors along the fascial and myofascial planes, combined with blunt finger dissection of the loose areolar tissue overlying the neurovascular pedicle to minimize thermal or traction injury. The muscle was harvested together with a thin layer, approximately 0.5–1 cm, of overlying subcutaneous fat to preserve the subdermal vascular plexus supplying the skin island. The thoracodorsal vascular pedicle was identified at its entry point on the deep surface of the muscle, following standard anatomical landmarks along the lateral border of the LD, and was dissected and meticulously preserved to maintain flap viability; pedicle integrity was

confirmed visually and by palpation of pulsatile flow. Adequate pedicle length and mobility were confirmed to ensure tension free transfer (Figure 4B). Once the flap was fully mobilized, a subcutaneous tunnel was created from the donor site to the anterior chest wall. The flap was then rotated anteriorly through the tunnel, taking care to avoid kinking or compression of the vascular pedicle.

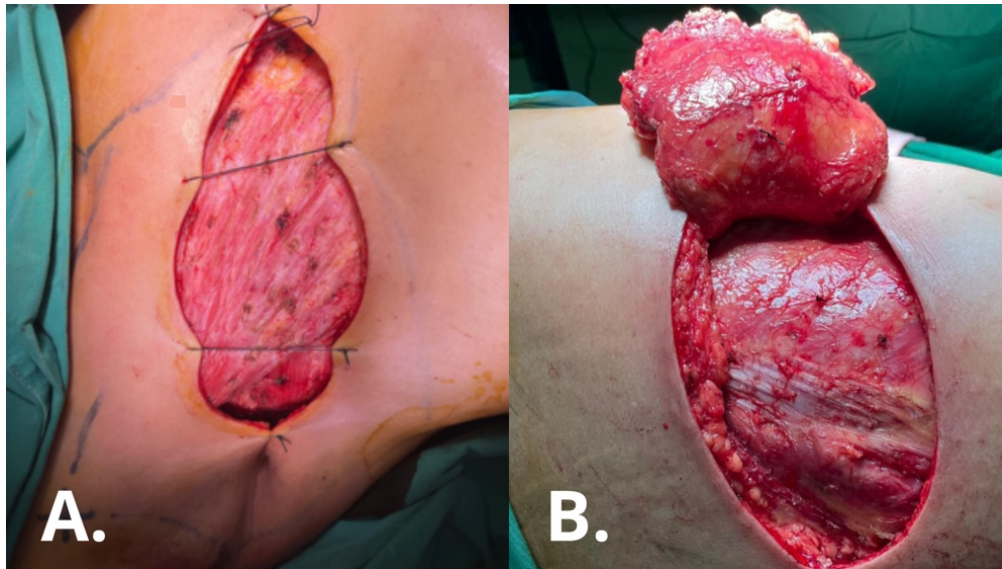


Figure 4. Intraoperative flap harvest and mobilization. (A) The LD muscle flap dissected and elevated from the donor site, demonstrating the skin island and underlying muscle prior to full mobilization. (B) The flap fully mobilized on its thoracodorsal vascular pedicle, confirming adequate pedicle length and viability prior to transfer through the subcutaneous tunnel to the chest wall defect.

Flap viability was assessed intraoperatively based on skin and muscle color, capillary refill, and brisk dermal bleeding at the flap margins; perfusion of the distal skin paddle was further confirmed by confirmed by brisk bleeding from a small superficial incision at the flap edge before final inset. The LD flap was inset into the chest wall defect and fixed circumferentially to the wound margins, with additional quilting sutures placed between the flap and the underlying chest wall using interrupted absorbable sutures to obliterate dead space and reduce shear forces, thereby lowering the risk of seroma formation. Two closed suction drains, one at the donor site and one at the recipient site, were placed and maintained until output fell below 30 mL over 24 hours. The donor site was closed primarily in layers and covered with a well padded compression dressing, and the ipsilateral shoulder was immobilized in a sling for the initial postoperative days to protect the pedicle and minimize donor site shear. The recipient site skin was closed without tension.

The patient was returned to the supine position, and final inspection confirmed adequate flap perfusion and satisfactory wound closure (Figure 5A). Histopathological examination of the surgical specimen demonstrated residual invasive carcinoma with post chemotherapy changes, showing a 30–40% reduction in tumor cellularity consistent with Miller-Payne grade 3 response. No metastatic carcinoma was identified in the excised axillary lymph nodes, which showed features of sinus histiocytosis on histopathological examination (not separately illustrated). The final pathological staging confirmed locally advanced TNBC without evidence of distant spread. The postoperative course was uneventful, with satisfactory wound healing and preserved flap viability, allowing timely continuation of adjuvant oncologic management (Figure 5B).

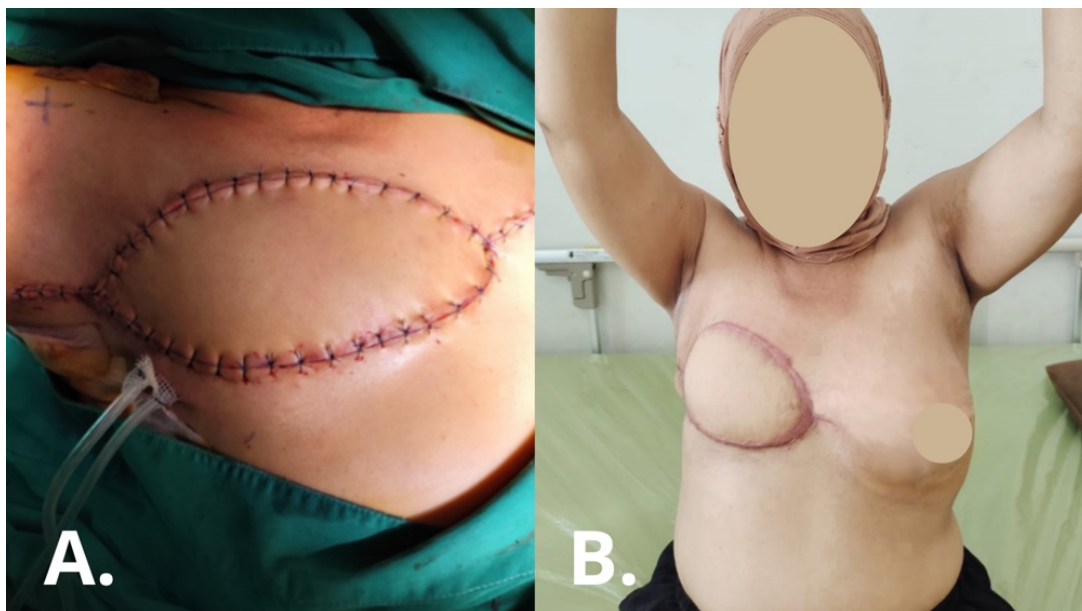


Figure 5. Immediate postoperative and follow up outcomes. (A) Immediate postoperative appearance following inset of the pedicled LD flap, demonstrating adequate flap perfusion and primary donor site closure. (B) Postoperative follow up showing satisfactory chest wall contour restoration and preserved upper limb mobility.

Discussion

This case illustrates the oncologic risks inherent to locally advanced TNBC presenting as an ulcerated, fungating tumor, clinical features that have historically raised concerns regarding infection, impaired wound healing, and the safety of immediate reconstruction, reinforcing the perception that surgery in this context occurs at the “edge” of oncologic safety.⁹ In the present patient, three cycles of anthracycline/taxane based NACT produced a partial clinical response sufficient to permit a margin negative mastectomy, which, together with the absence of nodal metastasis on final pathology, provided the oncologic basis for offering

immediate rather than delayed reconstruction.

Immediate reconstruction can be considered oncologically acceptable when several criteria are met: a documented response to NACT, achievement of negative surgical margins, absence of comorbidities that could impair healing, adequate soft tissue coverage, and a low likelihood that adjuvant therapy will be meaningfully delayed.^{1,11} Several of these criteria were met in this case: the patient demonstrated a clinical response to NACT, negative surgical margins were achieved, her performance status permitted a combined procedure, and postoperative recovery allowed adjuvant therapy to proceed without clinically significant delay. Appropriate patient selection for IBR after NACT further requires careful evaluation of nodal status, performance status, and the patient's ability to tolerate both complex surgery and subsequent adjuvant therapy;¹³ multidisciplinary decision making was accordingly central to balancing oncologic safety with the patient centered benefit of avoiding a staged reconstruction.

The LD flap was selected for this patient based on its well established reliability, robust vascularity, and versatility in covering moderate to large chest wall defects such as the 8 × 18 cm defect encountered here.^{9,14} Its pedicled blood supply confers resilience in tissue previously exposed to systemic chemotherapy, an important consideration given the extent of prior tumor ulceration and skin compromise. Although implant based reconstruction is commonly performed, it carries a higher risk of infection, implant exposure, and wound complications in compromised fields, particularly in patients anticipated to receive PMRT, as this patient was.^{12,14} Compared with abdominally based free flaps, which may be limited by patient comorbidities, prior abdominal surgery, or operative complexity, the LD flap offered dependable coverage with lower technical demands and shorter operative time, factors that favored this approach for this particular patient.

A major concern surrounding immediate reconstruction in locally advanced TNBC is the potential delay of adjuvant therapy, which may adversely affect disease free and overall survival, particularly in this aggressive subtype.¹⁵ In this case, postoperative recovery was uneventful, flap viability was preserved, and adjuvant treatment was initiated without clinically significant delay. This experience aligns with published evidence demonstrating that immediate autologous reconstruction, including LD flap reconstruction, does not inherently delay adjuvant chemotherapy when perioperative management is optimized.^{11,12} This case is consistent with published evidence suggesting that immediate reconstruction can be oncologically safe in carefully selected patients and are consistent with the broader literature indicating that time to adjuvant chemotherapy, rather than the reconstructive procedure itself,

is a key determinant of outcome in TNBC.¹⁵

Beyond oncologic safety, immediate reconstruction offers meaningful psychosocial and functional benefits. For patients presenting with previously ulcerated or fungating tumors, restoration of chest wall integrity and body contour plays a critical role in psychological recovery and quality of life.⁹ In this case, the LD flap provided durable soft tissue coverage and an acceptable aesthetic outcome, supporting functional recovery without compromising cancer control.¹⁴

Future patient selection may also incorporate emerging biomarkers, further refine patient selection for immediate reconstruction in locally advanced TNBC. Tumor infiltrating lymphocytes (TILs) have gained attention as prognostic and predictive markers in TNBC: higher stromal TIL density in the pre-treatment biopsy is associated with a greater likelihood of pCR to NACT, while higher residual TIL density after NACT is independently associated with improved recurrence free and overall survival, even among patients with residual disease.¹⁶ In the present case, formal TIL quantification was not performed, but incorporating this parameter into future practice could help identify which patients with residual disease after NACT still carry a favorable enough prognosis to justify immediate, rather than delayed, reconstruction, potentially serving as an adjunct to Miller–Payne grading and margin status in multidisciplinary decision making. Germline BRCA1/2 mutation status is similarly relevant, as carriers often demonstrate enhanced sensitivity to platinum-based chemotherapy and may achieve higher pCR rates with platinum containing regimens;⁴ pre-treatment knowledge of BRCA status may therefore help anticipate the extent of tumor regression before NACT and inform reconstructive planning. Importantly, accumulating evidence indicates that, with appropriate patient selection, immediate autologous reconstruction after NACT does not increase complication rates, delay adjuvant therapy, or compromise oncologic outcomes.^{13,17}

Conclusion

Immediate autologous reconstruction with a pedicled LD flap can be feasible from an oncologic and reconstructive perspective in selected patients with locally advanced triple-negative breast cancer following neoadjuvant chemotherapy NACT, but this conclusion must be interpreted cautiously given the absence of comparative data and the limited follow-up inherent to a single case report. Successful application of this approach depends on careful patient selection, confirmation of negative surgical margins, adequate control of systemic disease, and close multidisciplinary coordination among surgical oncology, plastic surgery, and medical oncology teams to ensure that adjuvant therapy timelines are preserved. When these conditions are met, the LD flap offers reliable vascularized coverage for extensive chest wall

defects, even in previously ulcerated or chemotherapy-exposed fields, while also providing meaningful reconstructive advantages, including durable defect coverage, preserved upper-limb function, and improved body image and quality of life. Although broader conclusions cannot be drawn from a single case, and longer-term oncologic follow-up in this patient remains necessary, this report adds to the limited evidence base supporting immediate LD flap reconstruction in patients at the margins of conventional reconstructive indications when guided by strict patient selection and multidisciplinary judgment.

Conflict of interest

All authors declare that they have no conflicts of interest.

Informed consent

Written informed consent was obtained from the patient for publication of this case report and the accompanying clinical images. The preparation and publication of this case report were approved by the Department of Surgery, Division of Surgical Oncology, Hasanuddin University.

Funding source

Nothing to declare.

Acknowledgments

Nothing to declare.

References

1. Andreev DA, Zavyalov AA. Triple-negative breast cancer: new options for systemic targeted therapy. A review. *J Modern Oncol.* 2022;24(3):368-72.
2. Hao X, Jiang Z. Hot issues in triple-negative breast cancer. *Cancer Biol Med.* 2024;20(12):981-4.
3. Konstantinova VV, Dashyan GA, Ahmedov RM, Belousav AM. Pathological complete response of locally advanced triple-negative breast cancer: case report. *Siberian J Oncol.* 2024;23(4):186-93.s
4. Mason SRE, Willson ML, Egger SJ, Beith J, Dear RF, Goodwin A. Platinum-based chemotherapy for early triple-negative breast cancer. *Cochrane Database Syst Rev.* 2023;9(9):CD014805.
5. Raxith Sringeri R. Neoadjuvant chemotherapy in triple-negative breast cancer: impact on early stage and outcomes-comprehensive review. *Indian J Surg Oncol.* 2024;15(Suppl 3):501–8.
6. Sin TH, Huang J, Nie L, Mao F, Shen S, Li Y, et al. Successful treatment of enormous

- locally advanced breast cancer through neoadjuvant chemotherapy and surgical intervention: a case report. *Gland Surg.* 2024;13(6):1126-36.
7. Hari MD, Wiramur A, Pradana HY. Revitalizing femininity: successful latissimus dorsi flap reconstruction following breast cancer mastectomy - a case report. *J Ilm Kedokt Kesehat.* 2025;12(7):1481-88.
 8. Banys-Paluchowski M, Brus L, Krawczyk N, Kopperschmidt SV, Gasparri ML, Bündgen N, et al. Latissimus dorsi flap for breast reconstruction: a large single-institution evaluation of surgical outcome and complications. *Arch Gynecol Obstet.* 2023;309(1):269-80.
 9. Clement Z, Egbeare D, Kollias J, Gill G, Whitfield R, Bingham J, et al. Safety and efficacy of immediate autologous breast reconstruction after mastectomy in patients undergoing neoadjuvant chemoradiotherapy for locally advanced breast cancer. *Breast Dis.* 2022;41(1):267-72.
 10. Sabitovic A, Trøstrup H, Damsgaard TE. The impact of neoadjuvant chemotherapy on surgical outcomes following autologous and implant-based immediate breast reconstruction: A systematic review and meta-analysis. *J Plast Reconstruct Aesth Surg.* 2023;87:17-23.
 11. Syed A, Thomas H, Smith S, Ramakrishnan V. Do modern methods of post-mastectomy immediate breast reconstruction for breast cancer delay adjuvant therapy? *Glob Surg.* 2018; 4(3):1-6.
 12. D'Alessandro GS, Munhoz AM, Takeuchi FM, Povedano A, Góes JCS. Neoadjuvant chemotherapy impact on outcomes in immediate breast reconstruction with latissimus dorsi flap and silicone implant. *J Surg Oncol.* 2024;129(2):208-18.
 13. D'Alessandro GS, Munhoz AM, Takeuchi FM, Povedano A, Goes JCS. Is immediate breast reconstruction with a latissimus dorsi myocutaneous flap safe for starting adjuvant chemotherapy in patients with breast cancer? *Clin Breast Cancer.* 2024;24(5):e408-16.
 14. Hernandez DFN, Santiago AA, Tijerina SFE, Hernández AC, Solís LFP, Ferrel EAP, et al. Breast reconstruction with latissimus dorsi flap. *Int J Med Med Sci Clin Res Stud.* 2024;4(8):1447-51.
 15. Zhan QH, Fu JQ, Fu FM, Zhang J, Wang C. Survival and time to initiation of adjuvant chemotherapy among breast cancer patients: a systematic review and meta-analysis. *Oncotarget.* 2017;9(2):2739-51.
 16. Denkert C, von Minckwitz G, Darb-Esfahani S, Lederer B, Heppner BI, Weber KE, et al. Tumour-infiltrating lymphocytes and prognosis in different subtypes of breast cancer: a pooled analysis of 3771 patients treated with neoadjuvant therapy. *Lancet Oncol.*

2018;19(1):40-50.

17. Nogi H, Ogiya A, Ishitobi M, Mori H, Shimo A, Narui K, et al. Impact of neoadjuvant chemotherapy on the safety and long-term outcomes of patients undergoing immediate breast reconstruction after mastectomy. *Breast Cancer*. 2024;31(3):507-18.



JMHSJ

Jambura Medical and
Health Science Journal

INDEX BY

Google Scholar

 **GARUDA**
CARTA BUKU KANAL DIGITAL

 Crossref

 Dimensions



Supported by OJS PKP

JAMBURA MEDICAL AND HEALTH SCIENCE JOURNAL

e-ISSN : 2830-4608

p-ISSN : 2830-0580

Publisher : Universitas Negeri Gorontalo

ISSN 2830-0580



THIS WORK IS LICENSED UNDER A CREATIVE COMMONS ATTRIBUTION-SHAREALIKE 4.0