

Meta-analysis: Relationship between Body Mass Index (BMI) and anemia in adolescent women

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Abstract

Adolescent girls are one of the groups that are prone to iron deficiency anemia because they have a high need for iron for growth. Iron nutritional anemia in adolescent girls is at a higher risk because they are very concerned about body shape (body image). Many limit their food consumption and follow a strict diet. Riskesdas 2018, the prevalence of anemia in adolescents is 32%, meaning that 3-4 out of 10 adolescents suffer from anemia. Riskesdas 2018 data shows that 25,7% of adolescents aged 13-15 years and 26,9% of adolescents aged 16-18 years with short and very short nutritional status. In addition, 8,7% of adolescents aged 13-15 years and 8.1% of adolescents aged 16-18 years with thin and very thin conditions. In contrast, the prevalence of overweight and obesity is 16,0% in adolescents aged 13-15 years and 13,5% in adolescents aged 16-18 years. The purpose of this study was to determine the relationship between Body Mass Index (BMI) and the incidence of anemia in adolescent girls. This study uses a meta-analysis study. Researchers carried out research data collection by browsing online journals, using the PubMed, ScienceDirect, and Google Scholar databases. Analysis of the results using the application Review Manager 5.4.1. The results of this study are the BMI variable with the I^2 value obtained is 74% and the p -value of the heterogeneity test < 0.05 , meaning that the heterogeneity between studies is quite high. The Random Effect Model produces a combined effect size value of 1,84 (95% CI 1,17-2,90) diamond with a significant test z -value = 2,63, $p = 0.009$. The results of the meta-analysis of 9 articles showed that there was a tendency of the relationship between BMI and the incidence of anemia in adolescent girls, with a p -value $< 0,05$, namely $p = 0,009$ and a pooled odds ratio value of 1,84 (95% CI 1,17 - 2,90).

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I. INTRODUCTION

Anemia is defined as a condition in which the level of Hemoglobin (Hb) in the blood is lower than the normal value for groups of people according to age and gender[1]. The criteria for anemia are based on the normal level of hemoglobin in adult women is 12 mg/dL – 15 mg/dl and in adult men is 14 g/dL – 18 g/dL. Community groups that are prone to anemia are infants, toddlers, young women, women of childbearing age, and pregnant women. Adoles-

cent girls are one of the groups that are prone to iron nutritional anemia because they have a high need for iron for growth [2].

Healthy adolescents under normal conditions have Hb levels around > 12 g/dl. Adolescent girls are said to be anemic if their Hb level is < 12 g/dl1. Adolescence is an age stage that comes after childhood ends, characterized by rapid physical growth. In general, anemia is more common in women and young women compared to men, which is very

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unfortunate is that most sufferers do not know or do not realize it; even when they know, they still consider anemia as a trivial problem [3].

The incidence of anemia in adolescent girls in developing countries, one of which is Indonesia, according to information from the World Health Organization (WHO), is around 53,7% of all adolescent girls; anemia often attacks young women due to stress menstruation or late eating. This cannot be separated from what happened to teenagers scattered throughout Indonesia. Based on the 2018 Riskesdas data, the prevalence of anemia in adolescents is 32%, meaning that 3-4 out of 10 adolescents suffer from anemia. Riskesdas 2018 data shows that 25,7% of adolescents aged 13-15 years and 26,9% of adolescents aged 16-18 years with short and very short nutritional status. In addition, there are 8,7% of adolescents aged 13-15 years and 8,1% of adolescents aged 16-18 years with thin and very thin conditions. While the prevalence of overweight and obesity is 16,0% in adolescents aged 13-15 years and 13,5% in adolescents aged 16-18 years [4].

Anemia in adolescent girls is currently one of the most common public health problems encountered in Indonesia. The impact of anemia on adolescents can reduce concentration and learning achievement, as well as affect productivity among adolescents. Besides that, it also lowers the body's resistance so that it is susceptible to disease. As a result of long-term anemia in young women, young women who will become pregnant will not be able to meet the nutrients for themselves and their fetuses so that it can increase the risk of maternal death, LBW prematurity, and perinatal death [5, 6]. The causes of anemia are generally due to lack of knowledge about anemia, lack of iron, folic acid, vitamin B12, and vitamin A. Acute and chronic inflammation, parasitic infections, inherited disorders that affect hemoglobin synthesis, lack of red blood cell production can cause anemia [7, 8].

Adolescents with underweight nutritional status have 1,5 times the risk of experiencing anemia compared to adolescents with normal nutritional status [9, 10, 11].

Nutritional status positively correlates with Hb levels, meaning that the worse a person's nutritional status eats, the lower his Hb levels. Malnutrition in adolescent girls often occurs due to wrong body image followed by restrictions on food consumption by not paying attention to nutrition and health rules. Lack of iron intake in adolescents can be caused by a lack of knowledge of adolescents about food sources of iron and the role of iron for adolescents [12, 13]. In line with the research of Noviatiningsih et al. [14], which found that there was a relationship between counseling in-

formation from health workers. As a result, nutritional intake in quantity and quality is not in accordance with the recommended Nutrient Adequacy Ratio (RDA). The recommended average RDA for women in Indonesia aged 16-18 years with an average weight of 50 kg and height of 154 cm is about 2200 calories of energy and 50 grams of protein per day [14, 15].

Anemia, which is characterized by a decrease in hemoglobin levels in developing countries, is related to the economic crisis, the occurrence of protein-energy deficiency, which is manifested by low body BMI and upper arm circumference (LILA), as well as low intake of iron sources (heme and nonheme). Similarly, research conducted in Yogyakarta showed that other factors that affect hemoglobin levels include BMI, individual and family health history, health behavior, and menstruation for women. Obesity can also affect hemoglobin levels in the blood because it inhibits the absorption of iron in the blood. Similar to the research by Pinhas-Hamiel et al., which showed that iron levels had a significant negative correlation with the Z-score of BMI, i.e., with every increase in the Z-score of BMI, there was a decrease in iron levels [16, 17].

In line with Martini's research results [18], Akma Listiana's research [19], and Mahmut Jaelani [20] showed a relationship between BMI and the incidence of anemia in adolescent girls. On the other hand, there are several other research results, such as the research of Ikea Ekayanti [21], the research of Irfan Ekasanti [22], and Sabuj Kanti Mistry [23], stated that there was no relationship between BMI and the incidence of anemia in adolescent girls.

Based on the results of the previous studies above, shows that there are inconsistencies or differences in research results. The existence of these differences in results will confuse future researchers in determining which results to follow. Therefore, it is considered important to conduct a meta-analysis study by combining several research results regarding the relationship between BMI and the incidence of anemia in adolescent girls. Thus, new quantitative data will be obtained with a large number of subjects, and more definitive conclusions can be drawn.

II. METHOD

This type of research is a meta-analysis study where the researcher uses several articles to analyze empirical studies that previous researchers, quantitative research results have carried out, and research results in a form that can be compared, for example, mean correlation coefficient, and odds-ratio.

Identification of research questions is a question that is

used as the basis for conducting a review. As a reference for formulating research questions, you can use "SPIDER": S for Sample: adolescent girls, PI for Phenomenon of Interest: Why is BMI with anemia in adolescent girls related or unrelated, D for Design: Cross-Sectional, E for Evaluation: there is a *p*-value and P. OR with 95% CI which can represent the situation in the actual population, R for Research Type: Quantitative.

The research protocol is detailed planning that includes the scope of the study, procedures, criteria for assessing quality (inclusion and exclusion criteria), and the scale of the research to be carried out. The research protocol in the meta-analysis can use the concept of Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) is this method is carried out systematically by following the stages or the correct research protocol. Data search refers to database sources such as Science Direct, PubMed, Google Scholar, Research Gate, Garuda, which are adjusted to the research title, abstract, and keywords used to search for articles, namely "indeks Massa Tubuh (MT)," "status gizi," "anemia remaja Puteri," "BMI," "nutritional status," "anemia adolescent girls."

Screening of research data begins with screening the title of research articles on search results in the databases of Google Scholar (Google Scholar), Science Direct, Garuda Portal (indexed by SINTA 1-4), and PubMed. Research screening begins by looking for titles that have the same variables. Then the screening was continued to the research objectives in the articles obtained. After the title screening process is complete, the research objectives on the articles obtained in the screening are also adjusting the objectives to the problems taken. Research articles with similar research objectives. Then proceed with abstract screen-

ing. The research method is homogeneous in the abstract. The final stage of screening carried out is to scan the article as a whole (full-text article) to assess whether the research articles filtered in the search results are similar articles overall. Journal quality assessment is carried out using the Critical Appraisal Skills Program (CAPS) table and data synthesis using the SPIDER format (Sample, Phenomenon of Interest, Design, Evaluation, and Research type). The search strategy is carried out by referring to the protocol that has been created and determines the location or source of the database (PubMed and Google Scholar) for data retrieval. Searches were made on these databases, named Google Scholar (in Indonesian for Sinta 1-4 indexed articles) and PubMed (in English). The search time is carried out from January 20, 2021 to April 14, 2021. The process of screening and extracting search results articles based on the keywords that have been searched is carried out according to PRISMA. Then the data synthesis was carried out using a meta-analysis technique (forest plot) using the Comprehensive Meta-Analysis Version statistical application.

Sampling in this study used a purposive sampling technique, which is a sampling technique by selecting a sample among the population in accordance with what the researcher wants (objectives and problems in the study) so that the sample can represent the characteristics of the population that have been known previously. Based on the known characteristics of the population, selection criteria are made.

Criteria for selecting articles in journals include inclusion and exclusion. Inclusion criteria are all aspects that must exist in a study that we will review, and exclusion criteria are factors that can cause a study to be unfit for review. Inclusion criteria include:

TABLE 1
RESEARCH INCLUSION CHARACTERISTICS OF THE RELATIONSHIP BETWEEN BMI AND THE INCIDENCE OF ANEMIA IN ADOLESCENT GIRLS

Criteria	Inclusion
Time period	C1 Maximum period of journal publication is 5 years (2016-2020)
Language	C2 Indonesian and English
Subject	C3 Young girl
Journal type	C4 Original research article full text available
Journal theme and content	C5 The relationship between BMI and the incidence of anemia in adolescent girls
Research design	C6 Cross-Sectional Study
DataBase	C7 Accredited national journals and reputable international journals
Research result	C8 There is a <i>p</i> -value and Prevalence Ratio (CI 95%)

III. RESULTS AND DISCUSSION

The search was conducted on three databases, namely: Science Direct, Google Scholar, and PubMed. In the Google Scholar database, the results obtained are 2.720 for Indonesian and 23.600 for English when searched. In the PubMed database, 22 results were obtained. Science Direct found 1.248. Articles that were excluded because they did not meet the inclusion criteria were 22.981. So that a total of

1.889 articles were filtered based on the title, abstract, and full text. Next, the article is reviewed in the abstract. Articles with potentially relevant abstracts will then be reviewed in full text. Meanwhile, articles that are not relevant are excluded 1.880 articles were excluded. From this review, 9 articles were included in the systematic review and entered the inclusion criteria and were included in the quantitative synthesis of the meta-analysis.

Body Mass Index (BMI)

TABLE 2
CHARACTERISTICS OF BMI VARIABLES

No	Researcher	Publication Year	N(sample)	P-value	P-OR	CI 95%
1	Fransiske	2019	172	0,034	2,048	1,040 - 4,035
2	Jaelani	2017	100	0,000	5,405	1,522 - 18,465
3	Liliana	2016	255	0,002	2,329	1,377 - 3,937
4	Mengistu	2019	443	0,0047	3,2	1,43 - 7,05
5	Yulianingsih	2020	306	0,009	0,518	0,315 - 0,851
6	Fentie	2020	551	0,01	2,31	0,91 - 5,45
7	Ekasanti	2020	97	0,468	1,818	0,580 - 5,700
8	Jayanti	2020	84	0,448	2,217	0,221 - 22,254
9	Mistry	2019	1.314	0,093	1,42	1,0 - 2,1
Total Sample			3.322			

The results of data analysis from 9 research articles regarding the relationship between BMI and the incidence of anemia in adolescent girls are p -value = 0,0002, then the null hypothesis is accepted. This proves that all studies have unequal effect sizes. The variance in the effect size includes the variance in the actual effect size of the research study, the I^2

value obtained is 74%, and the p -value of the heterogeneity test is < 0,05, meaning heterogeneity between studies is high. The results of the analysis show that the variation between studies is heterogeneous, so the model used to calculate the combined effect is the random effect model.

TABLE 3
HETEROGENEITY TEST RESULTS

Heterogeneity				
Tau squared	Chi-square	df (Q)	P-value	I squared
0,31	30,37	8	0,0002	74%

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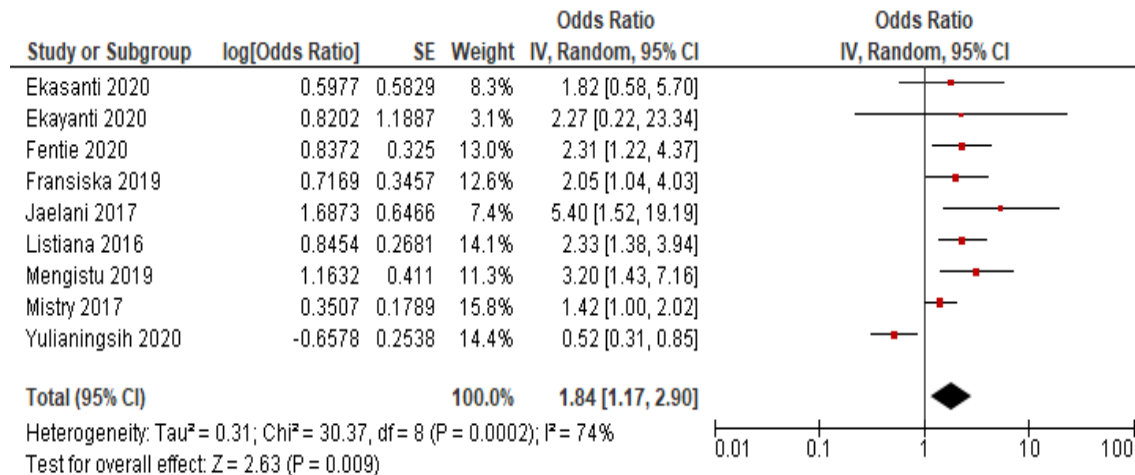


Fig. 1. Forest Plot BMI

TABLE 4
EFFECT SIZE OF COMBINED RESEARCH ON BMI VARIABLES

Effect Size and 95% CI					Significant Test	
Model	Number of Research	Combined Effect	Lower limit	Upper limit	Z	P
Random	9	4,8509	0,1789	1,1887	2,63	0,009

It can be seen that the analysis using the Random Effect Model resulted in a combined effect size value of diamond of 1.84 (95% CI 1,17-2,90) with a significant test z-value = 2,63 p -value = 0,009. Because the p -value < 0,05, this means

that the null hypothesis is rejected, in other words, there is a relationship between BMI and the incidence of anemia in adolescent girls.

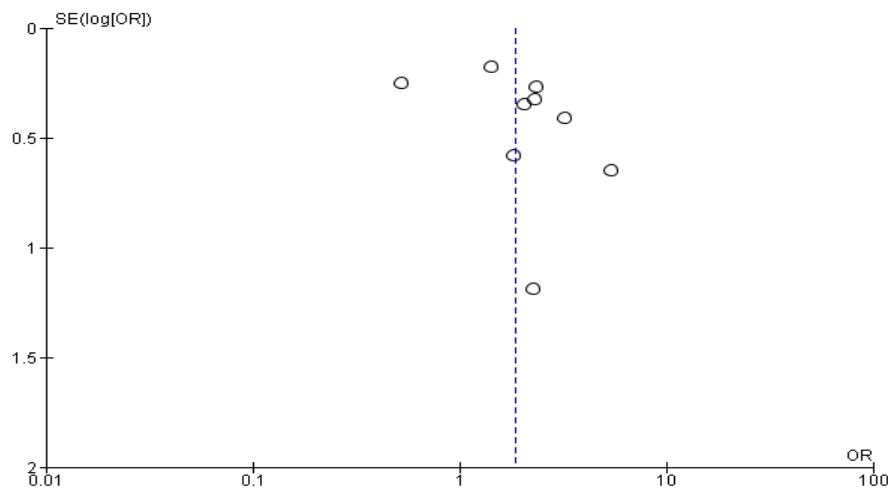


Fig. 2. Funnel Plot BMI

The plot in the picture has publication bias because it is marked by the asymmetrical distribution of plots on the right and left of the vertical line, the number of plots on the right and left but uneven, and 2 plots touching the vertical line. Plots above the curve indicate that the study has a high effect size, while studies with plots below the curve indicate that the study has a low effect size, and plots that touch the vertical line indicate that the study causes bias in the meta-

analysis.

The results of data analysis from this study indicate that there is a relationship between BMI and the incidence of anemia in adolescent girls. This is evidenced by the overall effect p test value of less than 0,05, namely $p = 0,009$. The pooled odds ratio value is 1.84 with a 95% confidence interval of 1,17 – 2,90, so it can be concluded that BMI tends to be 1,84 times, increasing the incidence of anemia in ado-

lescent girls. The average effect size is 0,5126, which means that BMI has a moderate effect on the incidence of anemia in adolescent girls.

The results of the analysis of 6 research articles which stated that there was a relationship between BMI and the incidence of anemia in adolescent girls showed that the pooled odds ratio value was 2.00 with a 95% confidence interval of 1,02 – 3,91, overall effect (combined effect) also produces a Z value of 2,02 and a p -value = 0,04. Statistically, the overall effect is significant if the p -value < 0,05, so it can be concluded that for this group of articles, there is a relationship between BMI and the incidence of anemia in adolescent girls. Thus, the BMI tends to increase 2,00 times the incidence of anemia in adolescent girls.

In Fig 2 the forest plot is the result of synthesis in the meta-analysis that describes the conclusions drawn from several similar studies, which were combined together with the effect size value of each study and the combined effect size value. In the forest plot, there is a small black box ■ this is the estimated effect in each study, and (–) the horizontal line in the small box is the 95% CI value; the narrow horizontal line of the CI value indicates good precision and is always more informative than the CI wide, if the sample is small then the horizontal line will be wide. Then in the form of diamond ♦ which is the effect size value of the combined study with a certain confidence interval confidence.

Based on the results of the effect size value, the largest value in the group of unrelated articles was 0,6502, which showed a tendency for a moderate effect, so the researchers concluded that BMI was associated with the incidence of anemia in adolescent girls with a moderate effect. The average value of the largest effect size is 0,6502 from the analysis of the group of articles which states that there is no relationship between BMI and the incidence of anemia in adolescent girls, while the average effect size in the group of articles which states there is a relationship is 0,3750. So it can be concluded that BMI has no relationship with the incidence of anemia in adolescent girls and has a moderate effect on the occurrence of anemia in adolescent girls. The absence of this relationship could be due to the data in unrelated studies being homogeneous compared to related studies with heterogeneous data.

Effect size is a measure of the magnitude of the effect of a variable on other variables, the magnitude of the difference, and the relationship, which is free from the influence of the size of the sample [24]. The related variables are usually in the form of response variables, also called independent variables and outcome variables or often called dependent variables. Effect size can also be considered as a measure

of the meaningfulness of research results at a practical level [25, 26].

This measure is needed because statistical significance does not provide meaningful information regarding the magnitude of the difference or correlation. Statistical significance only describes the probability that a statistic with a certain value will appear in a distribution [27].

From the results of the synthesis of articles, there are 6 articles which state that there is a relationship between BMI and the incidence of anemia in adolescent girls, namely research by Jaelani [20], Listiana [19], Martini [18], Mengistu [28], serta Yulianingsih [29]. In research by Martini [18], Nutritional status based on BMI shows the relationship between nutritional status BMI and the incidence of anemia in adolescent girls. Adolescents with a lean BMI have a 3.1 times risk of experiencing anemia compared to adolescents with normal nutritional status (OR = 3,059 (95% CI 1,425-6,761). Food consumption is related to nutritional status; if the food consumed has good nutritional value, then the nutritional status is also good. Good nutrition can be achieved by providing balanced food for the body according to the needs, and lack of nutrition describes the imbalance of food consumed with human needs.

In line with Listiana's research [19] states that there is a significant relationship between BMI and the incidence of anemia in adolescent girls. Based on the results of the analysis, the value of OR = 2,329 means that young women whose BMI is not normal to have a 2,329 times risk of developing anemia compared to young women whose BMI is normal. The wrong diet or diet will result in not optimal growth in adolescents. BMI is an indicator of nutritional status because it can express both other anthropometric measurements [30].

Research by Jaelani [20] stated that there was a significant relationship between nutritional status using BMI and the incidence of anemia in adolescent girls with an OR = 5,301 which means that in this study, female adolescents who had an abnormal BMI had a 5,301 risk of experiencing anemia compared to female adolescents. Who have a normal BMI. From the results of the study, adolescents with anemia reached 53,5% who had an abnormal nutritional status of BMI.

Research by Thamban [31], also found that BMI was significantly associated with anemia in adolescent girls with a p -value = 0.000. Anemia and abnormal BMI are two nutritional disorders worldwide, especially in developing countries. Underweight, overweight, and obese adolescents are prone to anemia, especially adolescent girls. Adolescents, especially young women, are most susceptible to ane-

mia problems and increase the risk of maternal, neonatal, and child mortality. Anemia during adolescence can impair physical and mental development, impair behavioral and cognitive development, reduce physical fitness, reduce work performance and even contribute adversely to pregnancy.

In addition to seeing the magnitude of the combined effect of the 9 journals, the funnel plot images in this study represent the presence of bias or not. The funnel plot shows publication bias. If there is no bias, the plot will form a symmetrical distribution. If there is a bias, the funnel plot will appear asymmetrical, with gaps on the right and left sides of the graph. The funnel plot in this study shows a publication bias which is indicated by the asymmetric distribution of the plot (dots) bounded by vertical lines. This bias may be due to the fact that smaller studies did not show a statistically significant effect and were not published, resulting in a publication bias. Funnel plot asymmetry is often attributed to publication bias without consideration of other possibilities. Publication bias is only one of several reasons that al-

low funnel plots to be asymmetrical [32]. We would like to thank the Faculty of Medicine, Lambung Mangkurat University supported this research.

IV. CONCLUSION

Based on the results of meta-analysis and synthesis of data from previous research articles that match the inclusion criteria, it can be concluded that there is a relationship between BMI and the incidence of anemia in adolescent girls with p -value $< 0,05$, namely $p = 0,009$.

V. ETHICAL CLEARANCE

There is no ethical test because it uses the journal analysis method.

VI. SOURCE OF FUNDING

This research used self-funding.

VII. DECLARATION OF CONFLICTING INTEREST

The authors declared no potential conflict of interest with respect to the research, authorship, and/or publication of this article.

REFERENCES

- [1] Merryana Adriani S. Peranan gizi dalam siklus kehidupan. Jakarta, Indonesia: Prenada Media; 2016.
- [2] Amalia A. efektifitas minuman kacang hijau terhadap peningkatan kadar HB. In: RAKERNAS AIPKEMA: Semarang, Indonesia; 2016. .
- [3] Nur Ia Kaimudin JRA Hariati Lestari. Skrining dan determinan kejadian anemia pada remaja putri SMA negeri 3 kendari tahun. Jurnal Ilmiah Mahasiswa Kesehatan Masyarakat Unsyiah (JIMKESMAS). 2017;2(6):1-10.
- [4] of Health Research IM, Agency D. Basic Health Research (Riskesdas). Jakarta, Indonesia: Ministry of Health Research and Development Agency; 2018.
- [5] Hayati R. Knowledge and attitude of iron deficiency anemia and its impact on reproductive health in MAL IAIN Medan in 2009/2010. Medan, Indonesia: University of North Sumatra; 2010.
- [6] Indartanti D, Kartini A. Hubungan status gizi dengan kejadian anemia pada remaja putri. Journal of Nutrition College. 2014;3(2):310-316. doi: <https://doi.org/10.14710/jnc.v3i2.5438>.
- [7] Apriyanti F. Hubungan status gizi dengan kejadian anemia pada remaja putri SMAN 1 pangkalan kerinci kabupaten pelalawan Tahun 2019. Jurnal Doppler. 2019;3(2):18-21.
- [8] Khan TI, Jam FA, Akbar A, Khan MB, Hijazi ST. Job involvement as predictor of employee commitment: Evidence from Pakistan. International Journal of Business and Management. 2011;6(4):252-262. doi: <https://doi.org/10.5539/ijbm.v6n4p252>.
- [9] Permaesih D, Herman S. Faktor-faktor yang mempengaruhi anemia pada remaja. Jakarta, Indonesia: Badan Penelitian dan Pengembangan Kesehatan; 2005.
- [10] Waheed M, Kaur K, Ain N, Sanni SA. Emotional attachment and multidimensional self-efficacy: extension of innovation diffusion theory in the context of eBook reader. Behaviour & Information Technology. 2015;34(12):1147-1159. doi: <https://doi.org/10.1080/0144929X.2015.1004648>.
- [11] Shahbaz M, Jam FA, Bibi S, Loganathan N. Multivariate Granger causality between CO2 emissions, energy intensity and economic growth in Portugal: evidence from cointegration and causality analysis. Technological and Economic Development of Economy. 2016;22(1):47-74. doi: <https://doi.org/10.3846/20294913.2014.989932>.
- [12] Silalahi V, Aritonang E, Ashar T. Potensi pendidikan gizi dalam meningkatkan asupan gizi pada remaja putri yang anemia di Kota Medan. KEMAS: Jurnal Kesehatan Masyarakat. 2016;11(2):295-301. doi: <https://doi.org/10.15294/>

kemas.v11i2.4113.

- [13] Jam FA, Donia MB, Raja U, Ling CH. A time-lagged study on the moderating role of overall satisfaction in perceived politics: Job outcomes relationships. *Journal of Management & Organization*. 2017;23(3):321-336. doi: <https://doi.org/10.1017/jmo.2016.13>.
- [14] Noviatiningsih A, Panghiyangani R, Noor MS, Marlinae L, et al. Associated factors of anemia incidences in adolescent girls at guntung manggis public health center working area Banjarbaru City. *Indian Journal of Public Health Research & Development*. 2019;10(10):832-835.
- [15] Ali A, Ahmad-Ur-Rehman M, Haq IU, Jam FA, Ghafoor MB, Azeem MU. Perceived organizational support and psychological empowerment. *European Journal of Social Sciences*. 2010;17(2):186-192.
- [16] Pinhas-Hamiel O, Newfield R, Koren I, Agmon A, Lilos P, Phillip M. Greater prevalence of iron deficiency in overweight and obese children and adolescents. *International Journal of Obesity*. 2003;27(3):416-418. doi: <https://doi.org/10.1038/sj.ijo.0802224>.
- [17] Farooq AJ, Rauf AS, Husnain I, Bilal HZ, Yasir A, Mashood M. Combined effects of perception of politics and political skill on employee job outcomes. *African journal of business management*. 2011;5(23):9896-9904. doi: <https://doi.org/10.5897/AJBM11.1059>.
- [18] Martini M. Faktor-faktor yang Berhubungan dengan Kejadian Anemia pada Remaja Putri di MAN 1 Metro. *Jurnal Kesehatan Metro Sai Wawai*. 2016;8(1):1-7.
- [19] Listiana A. Analisis faktor-faktor yang berhubungan dengan kejadian anemia gizi besi pada remaja putri di SMKN 1 Terbanggi Besar Lampung Tengah. *Jurnal Kesehatan*. 2016;7(3):455-469.
- [20] Jaelani M, Simanjuntak BY, Yuliantini E. Faktor risiko yang berhubungan dengan kejadian anemia pada remaja putri. *Jurnal Kesehatan*. 2017;8(3):358-368.
- [21] Ekayanti I, Rimbawan R, Kusumawati D. Faktor risiko anemia pada santri putri di pondok pesantren darusalam bogor risk factor of anemia among female students in Darusalam Islamic Boarding School Bogor. *Media Gizi Indonesia*. 2020;15(2):79-87. doi: <https://doi.org/10.20473/mgi.v15i2.79-87>.
- [22] Ekasanti I, Adi AC, Yono M, Isfandiari MA, et al. Determinants of anemia among early adolescent girls in Kendari City. *Amerta Nutrition*. 2020;4(4):271-279. doi: <https://doi.org/10.20473/amnt.v4i4.2020.271-279>.
- [23] Mistry SK, Jhohura FT, Khanam F, Akter F, Khan S, Yunus FM, et al. An outline of anemia among adolescent girls in Bangladesh: Findings from a cross-sectional study. *BMC Hematology*. 2017;17(1):1-8. doi: <https://doi.org/10.1186/s12878-017-0084-x>.
- [24] Olejnik S, Algina J. Generalized eta and omega squared statistics: measures of effect size for some common research designs. *Psychological Methods*. 2003;8(4):434. doi: <https://doi.org/10.1037/1082-989X.8.4.434>.
- [25] Huck SW. *Reading Statistics and Research*. Boston, MA: Pearson; 2012.
- [26] Moore DS. *The Basic Practice of Statistics*. New York, NY: W. H. Freeman and Company; 2007.
- [27] Olejnik S, Algina J. Measures of effect size for comparative studies: Applications, interpretations, and limitations. *Contemporary Educational Psychology*. 2000;25(3):241-286. doi: <https://doi.org/10.1006/ceps.2000.1040>.
- [28] Mengistu G, Azage M, Gutema H. Iron deficiency anemia among in-school adolescent girls in rural area of Bahir dar city administration, North West Ethiopia. *Anemia*. 2019;2019:1-8. doi: <https://doi.org/10.1155/2019/1097547>.
- [29] Yulianingsih E, Porouw HS. Risk Factors determinants anemia events in adolescent puskesmas in Kota Selatan. *Jurnal Ners dan Kebidanan Indonesia*. 2020;8(3):194-205. doi: [http://dx.doi.org/10.21927/jnki.2020.8\(3\).194-205](http://dx.doi.org/10.21927/jnki.2020.8(3).194-205).
- [30] Supariasa IDN. *Penilaian status gizi I Dewa Nyoman Supariasa*. Jakarta, Indonesia: EGC; 2001.
- [31] Veena Thamban SPKSEM Kavana G Venkatappa. Anemia in relation to body mass index among female students of North Kerala: A pilot study. *International Journal of Research in Medical Sciences*. 2018;6(11):3607-3610. doi: <http://dx.doi.org/10.18203/2320-6012.ijrms20184416>.
- [32] Sedgwick P. How to read a forest plot in a meta-analysis. *Bmj*. 2015;351:1-3. doi: <https://doi.org/10.1136/bmj.h4028>.