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Research Article

The Effect of Jelly Candy Snake Fruit and Banana With Ferrous Fumarat Fortified using Nano Technology in Adolescent Female at Junior High School

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ABSTRACT

Aim: Adolescent Female are a population at risk for anemia. Nutritional factors such as calories, protein, iron, dietary fiber, and folic acid induce this disease. Furthermore, fishy odor and nausea are two factors that contribute to adolescent females' lack of iron consumption. Jelly candy formulations of snake and banana fruit with ferrous fumarate fortification using nanotechnology also decrease these diseases as an alternative to food consumption. Young adolescents ought to embrace this jelly formulation, considering its reasonable pricing. Therefore, this study aims to determine the effect of jelly candy formulations of snake and banana fruit with ferrous fumarate fortification using nanotechnology on the increase in hemoglobin levels. **Materials And Methods**: A quasi-experimental approach was adopted with a Pretest-Posttest Control Group design. The study included a cohort of 150 adolescent girls hailing from Tamansari District, Tasikmalaya City, within the age range of 12 to 18 years. Additionally, the subjects were divided into three distinct groups, namely the treatments (involving jelly, snack fruit, banana, and ferrous fumarate supplementation, abbreviated as JEPISA), control group 1 (comprising jelly and ferrous fumarate supplementation, denoted as JFumarate), and control group 2 (receiving iron and folic acid supplementation as part of the Programme), each consisting of 50 participants. The sample selection process employed the purposive sampling technique and the collected data were subjected to analysis using T-Test, Chi-square and Multiple Logistic Regression methods. **Results**: The results of the T-Test analysis showed that the mean rise in hemoglobin after lean period of 13 week after giving treatments increased hemoglobin levels by 0.65 ± 0.39 g/dl (95% CI 0.53-0.75 g/dl), significantly (p-value=0,000). Their mean post intervention haemoglobin of three group was 12.10 ± 0.80 g/dl, 12.42 ± 0.70 g/dl and 11.73 ± 0.90 g/dl respectively. The results of statistical test were obtained, the treatment and control group 1 (p=0,044) and the treatment and control group 2 (p=0,33). The result of the multivariate analysis showed that complaince (p=0,000), nutritional status (p=0,000) and menstrual duration (p=0,000) variable were confounding variables for the incidence of anemia (Exp(B)=17,769). **Conclusion**: There were differences in Hb levels before and after administering the treatment. However, there was statistically significant difference between treatment with controls 1 and 2. Weekly supplementation of treatment's in Iron Deficiency Anemia patients is as good as weekly supplementation of control 1 and but higher than control 2. Adolescent female who did not adhere to consuming iron had a chance of experiencing anemia 17,769 times compared to obedient adolescents after controlling for the variable nutritional status and length of menstruation.
Key words: Jelly Candy, Fortified, Anemia, Hemoglobin, Adolescent female.

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INTRODUCTION

Jelly candy products formulated with snake fruit and banana, enriched through nanotechnology with ferrous fumarate, are an innovative dietary option that addresses the prevalent issue of inadequate iron intake among adolescent female. The provision of iron and folic acid via a supplementation program is recommended across the entirety of the life cycle, regardless of an individual's anemia status[1]. In this study, the dose and duration of iron therapy were compared to standard recommendations (60-120 mg). Enhancing the nutritional status of adolescent female holds the potential to disrupt the cycle of stunting, prevent anemia, and foster the accumulation of essential iron reserves within their bodies. This foundational effort sets the stage for the cultivation of a robust and thriving generation, marked by optimal health and productivity. The World Health Organization (WHO, 2013) reports that the prevalence of anemia ranges from 40-88%. Based on the study from the Ministry of Health (2014), the prevalence of anemia in Indonesia is 21.7% with anemia sufferers aged 5-14 and 15-24 years (26.4%) and (18.4%). Women have the highest risk of developing anemia, and adolescent female received blood supplement tablets in West Java at 8.2%. The contributing factors to insufficient iron intake among adolescent females are the occurrence of a fishy smell and episodes of nausea. Addressing these concerns is essential for fostering greater iron consumption among young women, thereby improving adherence to recommended dietary practices. A potential solution lies in the fortification of ferrous fumarate through nanotechnology, incorporating snake fruit and banana formulations within jelly packaging as a viable alternative. Therefore, this study assesses the impact of ferrous fumarate fortification with nano-enhanced snake fruit and banana formulations on the elevation of hemoglobin levels in adolescent female in Tasikmalaya Regency.

MATERIALS AND METHODS

Study Design

This study was conducted using a quasi-experimental and pretest-posttest control group design. Potential

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disparities in hemoglobin levels were investigated among adolescent female before and after the consumption of jelly candy. At Public Junior High School (SMPN), the impact of jelly candy formulations on the augmentation of hemoglobin levels was examined. This study also encompasses the assessment of several factors associated with the prevalence of anemia in adolescent female. The factors include adherence to the dietary regimen, nutritional status, and duration of menstruation.

Participating and setting

The study enlisted the participation of 150 adolescent female attending SMPN 21 in Tamansari District, Tasikmalaya City, under the supervision of Puskesmas Tamansari. The inclusion criteria included an age range of 12 to 18 years. The participants were categorized into three distinct groups, namely an treatmenet (receiving jelly, snake fruit, banana, and ferrous fumarate, referred to as JEPISA), a control 1 (receiving jelly and ferrous fumarate, denoted as JFumarate), and control 2 (receiving iron and folic acid supplementation, known as the Programme), each consisting of 50 participants.

Data collection

Before conducting the study, the production of jelly candy was initiated, followed by the execution of an acceptability assessment among adolescent female at SMPN 1 Manonjaya, Tasikmalaya Regency. After the selection of variants, an intervention was administered to 150 students at SMP 21. The assessment included the utilization of observation sheets to monitor adherence to iron supplement consumption, distribution of questionnaires aimed at evaluating the nutritional status, scrutiny of menstrual duration among female adolescents, and employment of a Hb Digital meter for precise hemoglobin quantification.

Data analysis

Data analysis was performed using data processing software. Comparison test between groups was carried out by Paired Sample Test, while a correlation test with chi-square and multiple logistic regression was applied to determine the relationship between variables and dominant factors influencing the incidence of anemia. The results of multiple logistic regression analysis obtained a mathematical equation to determine the probability of anemia based on the factors proven to be influential.

Ethical considerations

This study received a permit from the Medical And Health Research Ethics Committee (MHREC) and was assessed for feasibility after receiving approval based on The Ethical Examination Pass Certificate Number, Ref. No.:KE/FK/1291/EC/2022.

RESULT

Anemia among school-age children and adolescents presents a significant health concern that can precipitate diminished concentration during learning, reduced comprehension abilities, heightened susceptibility to infectious ailments, and emotional despondency. This condition detrimentally impacts the growth and maturation of brain cells, while posing potential threats to the future reproductive health prospects of young women. A prevailing factor contributing to anemia in young women predominantly manifests as iron deficiency. Poor dietary practices, such as the omission of iron-supplement tablets, and hesitance toward ingesting iron tablets owing to their unfavorable taste, associated discomfort, and aversion, encapsulate the core rationales underpinning inadequate iron intake. The introduction of functional food products in the form of jelly candies enhances adherence to optimal iron consumption. This innovative approach seeks to counterbalance the obstacles that impede consistent iron intake. Likewise, it is well-established that tooth loss is a prevailing issue among the elderly demographic. This investigative study is motivated by the aspiration to discern variances in hemoglobin levels both before and after the consumption of jelly candies formulated with snake fruit and banana extracts. This intervention specifically targets adolescent female and explores associated variables relevant to the manifestation of anemia. The study included a cohort of 150 adolescent female from levels I, II, and III at SMPN 21 Kota Tasikmalaya, meeting the inclusion criterion of an age range spanning from 12 to 18 years. The analysis of the results obtained study data as follows:

Table 1 showed that the majority of respondents were aged 13-15 years, namely 45 (91%) in the JEPISA group; most were aged 16-18, namely 100% in the JFumarat and the program groups. Most of the respondents experienced an increase in hemoglobin levels in each group, namely 43 (86%), 44 (88%), and 49 (98%) in the JEPISA, Jfumarat, and program groups. The proportion of young women before being given the intervention was mostly 27 (28.4%), 32 (33.7%), and 36 (37.9%) in the JEPISA, JFumarat, and program groups. Meanwhile, the proportion after being given the intervention was mostly 33 (66%), 36 (72%), and 26 (52%) in the three groups. Most of the respondents had normal nutritional status, namely 38 (76%), 34 (68%), and 37 (74%) with normal menstrual periods, namely 38 (76%), 37 (74%), and 32 (64%) in the JEPISA, Jfumarat, and program groups, respectively. The respondents adhered to consuming iron, namely 26 (52%) in the JFumarat group. In the two groups, the majority were disobedient, namely 26 (52%) and 34 (68%) in the JEPISA and program groups.

Table 2 presents the descriptive statistics in terms of the mean and standard deviation of hemoglobin levels. Before the intervention, the hemoglobin level of the intervention group measured 11.48 ± 1.03 g/dl. The value increased to 12.10 ± 0.80g/dl, reflecting an elevation of 0.65 g/dl in hemoglobin levels. The statistical analysis employing the Paired T-Test yielded a p-value = 0.000 (95% CI = 0.53–0.75), underscoring the significance of the observed changes.

The average hemoglobin level at the beginning of control group 1 was 11.42 ± 1.03 g/dl, and the final measurement was 12.41 ± 0.70 g/dl. There was an increase in hemoglobin levels, namely 1.00 g/dl, p value = 0.000 (95% CI = 0.83-1.17).

The average hemoglobin level at the beginning of the measurement in control group 2 was 11.33 ± 0.98 g/dl, and the final was 11.73 ± 0.90 g/dl. There was an increase in hemoglobin levels, namely 0.43 g/dl, p value = 0.000 (95% CI = 0.36-0.50).

Based on Table 3, shows independent t-test statistics, there is a difference in the average increase in hemoglobin levels between treatment and control 1 (p = 0.044), and a difference in the average increase in hemoglobin levels between treatment and control 2 (p = 0.033).

Based on the data in Table 4, a significant association was established between compliance and anemia in adolescent female. This was evident from the remarkably low p-value of 0.000 and the odds ratio (95% CI) of 26.5 (8.7-79.9). Moreover, a correlation existed between hemoglobin levels and anemia as indicated by the p-value of 0.000 and the odds ratio (95% CI) of 12.133 (2.6-56.5). A substantial connection was observed between nutritional status and anemia, evident by the p-value of 0.000 and the odds ratio (95% CI) of 18.161 (7.1-46.2). Lastly, a significant relationship was identified between prolonged menstrual duration and anemia in adolescent female, as indicated by the p-value of 0.000 and the odds ratio (95% CI) of 9.542 (4.2-21.6).

In Table 5, the confounding analysis showed that complaince, nutritional status, and length of menstruation were Exp(B)=17,769, Exp(B)=7,402, and Exp(B)=9,121 respectively.

Table 1. Frequency distribution of the characteristics of respondents at SMPN 21 Tamansari Tasikmalaya City.

Variable	Treatment's Groups					
	JEPISA		JFumarat		Iron+folic acid	
	F	%	F	%	F	%
Age						
13-15	45	91	0	0	0	0
16-18	5	9	50	100	50	100
Hemoglobin Levels						
Stay/Down	7	14	6	12	1	2
Up	43	86	44	88	49	98
Anemia' Status Before						
Anemia	27	54	32	64	36	72
Normal	23	46	18	36	14	28
Anemia' Status After						
Anemia	17	34	14	28	26	52
Normal	33	66	36	72	24	48
Nutrition's Status						
Normal	38	76	34	68	37	74
Unnormal	12	24	16	32	13	26
Long's Menstrual						
Normal	38	76	37	74	32	64
Unnormal	12	24	13	26	18	36
Compliance						
Obey	24	48	26	52	16	32
Not obey	26	52	24	48	34	68

Table 2. Hemoglobin Levels Before and After Treatments.

Variable	n	Pre-test	Post-test	Difference Δ	p value (95%CI)
Treatment	50	11,48 ±1,03	12,10 ± 0,80	0,65 ± 0,39	0,000 (0,53-0,75)
Control 1	50	11,42 ± 1,03	12,41 ± 0,70	1,00 ± 0,59	0,000 (0,83-1,17)
Control 2	50	11,33 ± 0,98	11,73 ± 0,90	0,43 ± 0,24	0,000 (0,36-0,50)

Table 3. Test the difference in hemoglobin levels after treatment in the intervention and control groups.

Variable	Hemoglobin Levels		
	n	Mean ± SD	P Value
Treatment (Jepisa)	50	12.10 ± 0.80	0.044
Control 1 (JFumarat)	50	12.1 ± 0.70	
Treatment (Jepisa)	50	12.10 ± 0.80	0.033
Control 2 (TTD)	50	11.73 ± 0.90	

Table 4. Relationship between factors associated and Status of anemia after Treatment.

variable	Anemia Category				Total		OR (95% CI)	P value
	Anemia		Unnormal					
	F	%	F	%	F	%		
Compliance								
Obey	53	63,1	31	36,9	84	100	26,500 (8,7-79,9)	0,000
Not Obey	4	6,1	62	93,9	66	100		
Total	57	38	93	62	150	100		
Nutrition's Status								
Unnormal	34	82,9	7	17,1	41	100	18,161 (7,1-46,2)	0,000
Normal	23	21,1	86	78,9	109	100		
Total	57	38	93	62	150	100		
Long's Menstrual								
Unnormal	32	74,4	11	25,6	43	100	9,542 (4,2-21,6)	0,000
Normal	25	23,4	82	76,6	107	100		
Total	57	38	93	62	150	100		

Table 5. Modeling results on multiple logistic regression analysis.

Variable	Model confounding			95%C.I for EXP(B)	
	Wald	P value	Exp (B)	lower	upper
Constant	25,601	0,000	0,036	-	-
Compliance category	18,370	0,000	17,769	4,766	66,239
Nutrition Status	13,291	0,000	7,402	2,523	21,714
Length's menstrual	14,768	0,000	9,121	2,954	28,165

DISCUSSION

The results show a disparity between the hemoglobin levels before and after the consumption of treatment (JEPISA). This distinction is substantiated by a considerably low p-value of 0.000. Specifically, the average hemoglobin level before and after treatment was at 11.48 ± 1.03 g/dl and 12.10 ± 0.80 g/dl. There was an increase in hemoglobin levels, namely 0.65 g/dl. An evident and statistically significant difference was observed between the hemoglobin levels before and after the administration of control 1 (Jfumarat). This distinction was underscored by a remarkably low p-value of 0.000 and the average hemoglobin level before and after treatment was recorded at 11.42 ± 1.03 g/dl and 12.41 ± 0.70 g/dl. There was an increase in hemoglobin levels, namely 1.00 g/dl. In addition, a significant difference between hemoglobin levels before and after consumption in the program group can be seen from p value=0,000 with the average of hemoglobin levels before and after treatment being 11.33 ± 0.98 g/dl and 11.73 ± 0.90 g/dl. There was an increase in hemoglobin levels, namely 0.43 g/dl. This was in line with Gupta A., et al. (2014), where intermittent iron-folic acid therapy was an effective intervention to increase hemoglobin levels at the end of the study period in the Shimla hills of North India. Hemoglobin increased in all three groups, namely once a week, twice in two weeks, and daily at 12.2 g/dl, 12.9 g/dl, and 12.0 g/dl. Serum ferritin also increased in all three intervention groups. On a weekly, biweekly, and daily basis, it increased to 35.5 µg/l, 34.3 µg/l, and 34.8 µg/l, respectively. Meanwhile, the prevalence of anemia in Nepali adolescent female was high. Supervised weekly iron and folic acid therapy was an effective alternative to daily administration and helped reduce the prevalence of anemia (p=0.04)[6].

The average Hb level before and after consuming bananas was 12.51 g/dl and 12.89 g/dl, hence the average increase was 0.39 g/dl. The analysis using the dependent t-test obtained a value of p = 0.000, meaning that there was a significant difference in students' Hb levels before and after consuming Ambon bananas[7].

The result show a significant difference in adolescent girls' s Hb levels between treatment and control 1. The analysis using the independent t-test obtained a value of p = 0.044, and a significant difference in adolescent girls' s Hb levels between treatment and control 2. The analysis using the independent t-test obtained a value of p = 0.033.

Furthermore, several factors were found related to the incidence of anemia, namely adherence with anemia (p-value = 0.000), nutritional status with anemia (p-value = 0.000), and length of menstruation with anemia (p-value = 0.000). The three variables above were all associated with the incidence of anemia.

Mahmudiono, et.al. (2019) explained that the average hemoglobin level of the respondents was 13.43 ± 1.4 g/dl and the prevalence of anemia among young women was 13.9%. However, the average energy intake of students was still below the normal Nutrition Adequacy Rate for young women aged 15-18 years (2125 Kcal/day). The results of testing using the Pearson Correlation test showed that the only food intake variable having a significant relationship with hemoglobin levels was energy intake (p=0.02). The practice of consuming iron supplementation from government programs was also a voluntary supplement or purchased for less. Additional government-provided iron and folic acid were not received during their junior high school years. Therefore, the current practice of consuming iron supplements and food intake among young women in the Lamongan Regency was classified as poor. The prevalence of anemia was low and related to the success of the participants' iron supplementation program during junior high school (2-3 years ago). The result of Utami, D.L. (2021) showed that 24.3% of the respondents experienced diseases of anemia, and 42.9% experienced long menstrual periods. In addition, there was a relationship between the menstrual period and the diseases of anemia in young women with a p-value = 0.018. The school was advised to improve the ability of their students. The enhancement of public health involved the revitalization of school health units and the youth Red Cross, alongside the systematic screening of students to identify health issues, with a specific emphasis on the prevalence of anemia. Furthermore, Pohan's study in 2022 showed a significant relationship between adherence to the regimen of consuming iron tablets and the incidence of anemia in pregnant women. This empirical connection was illuminated through the application of a chi-square test, which yielded a p-value of 0.005. For expectant mothers, the emphasis was placed on cultivating consistent prenatal examinations and the diligent observance of prescribed iron supplementation.

The results of the confounding test analysis obtained changes in the OR values of the main variables in confounding I modeling (OR=19.05%) and confounding II modeling (OR=77.55). Therefore, it can be concluded that all variables are confounding variables.

The results of the last modeling on compliance variables, nutritional status and length of menstruation are confounding variables. Consequently, several conclusions can be inferred from these findings, as follows: adolescent female who did not adhere to consuming iron had a chance of experiencing anemia 17,769 times compared to obedient adolescents after controlling for the variable nutritional status and length of menstruation. The assumption of 150 non-compliant respondents, namely 31 (36.9%) did not experience anemia due to a normal nutritional status and menstrual period.

CONCLUSION

Several conclusions can be obtained from these findings, as follows:

1. Hemoglobin increased in all three groups after 13 weeks, giving of jelly candy: Jepisa (12.10 g/dl) was as effective as JFumarat (12.41 g/dl) in increasing hemoglobin levels in both groups, but higher than supervised weekly iron and folic acid therapy (11.73 g/dl).
2. There was a significant difference between hemoglobin levels before and after consuming JEPISA (p-value = 0.000), JFumarat (p-value = 0.000), and Programme (p-value = 0).
3. There was a significant difference between treatment and control 1 (p value = 0.44) and a significant difference between treatment and control 2 (p value = 0.033).
4. There was a significant relationship between compliance and anemia in adolescent girls (p value = 0,000); between nutrition status and anemia (p value = 0,000) and between length of menstruation and anemia (p value = 0,000).

5. Modeling of confounding test analysis obtained changes in the OR values of the main variables in confounding I modeling (OR = 19.05%) and confounding II modeling (OR = 77.55%). Therefore, it was concluded that all variables were confounding variables.
6. The results of multiple regression analysis, adolescent girls who are disobedient have a 17,769 chance of anemia occurs compared to adolescent girls who obedient after being controlled by the variables nutritional status and length of menstruation.

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