



ARTICLE RESEARCH

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Chronic Energy Deficiency Associated with Body Mass Index of Adolescent Girls in Poka-Rumah Tiga Village, Ambon

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ABSTRACT

Chronic Energy Deficiency (CED) is a nutritional issue that poses a threat to adolescents in Indonesia, particularly to adolescent girls. According to the 2018 Basic Health Survey (Riskesdas), the proportion of CED among adolescent girls in Indonesia was 36.3%. This study aimed to identify the factors associated with CED among adolescent girls in the catchment area of Poka-Rumah Tiga, Ambon City. The study was conducted in August 2022 and used a cross-sectional approach with total sampling. The respondents were students aged 15-19 years from three high schools/equivalents in the catchment area of Poka-Rumah Tiga Health Center (SMKN 5 Ambon, SMAN 3 Ambon, and MA Al-Mabrur), with a total of 441 respondents. CED was determined based on the mid-upper arm circumference size being less than 23.5 cm. Logistic regression analysis was used to identify factors associated with CED in adolescent girls. Of the 441 adolescent girls who participated in this study, 45.80% were found to have CED. The odds of CED were lower in adolescent girls with normal BMI (18.5-22.9 kg/m²) (OR=0.09; 95%CI: 0.05-0.15; p<0.001) and overweight (≥ 23 kg/m²) (OR=0.01; 95%CI: 0.00-0.07; p<0.001) compared to those who were underweight (BMI<18.5 kg/m²). This study highlights the importance of conducting nutrition-specific and nutrition-sensitive interventions for adolescent girls. This includes raising the awareness and knowledge of adolescent girls, family members, and school teachers regarding the importance of balanced nutrition to reduce CED.

Keywords: Chronic energy deficiency; body mass index; adolescent girls; Ambon

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INTRODUCTION

Nutrition is a complex problem with multifactorial causes that require various approaches to overcome.¹ Women of childbearing age (15-49 years), especially adolescent girls (10-19 years), are one of the most important target groups for nutrition programs, given their crucial role in determining the quality of future generations.¹⁻³ One of the nutritional problems that threaten adolescents in Indonesia is Chronic Energy Deficiency (CED), which is caused by a lack of nutrients, either for economic or psychosocial reasons (appearance).⁴

The CED is a chronic undernutrition of energy and protein.⁵ In adolescent girls, if this condition is not addressed early, it will have a major impact during pregnancy.⁵ One of the commonly used indicators of CED in women of childbearing age is the upper arm circumference measurement of <23.5 cm.⁶ Adolescents with CED may experience anemia, suboptimal organ development, and poor physical growth, affecting their productivity.⁷ The CED experienced by adolescents into the pregnancy phase might have adverse effects on the fetus, such as miscarriage, stillbirth, neonatal death, congenital defects, anemia in the baby, and low birth weight (LBW).⁸ In labor, CED could result in difficult and prolonged labor, untimely delivery, and bleeding.⁸ CED in pregnant women also contributes to stunted children later in life.⁹

According to the Basic Health Research data of 2018 in Indonesia, the highest percentage of Chronic Energy Deficiency (CED) in women of childbearing age was found in the age group of 15-19 years, with a percentage of 36.3%,¹⁰ In 2017, the percentage of women at risk of CED in Indonesia was 10.7%, and Maluku Province ranked 12th lowest with a percentage of CED in women of childbearing age of 7.8%.¹¹ A report from the Maluku Provincial Health Office in 2013 stated that 17.2% of adolescent girls in the region suffered from CED.⁹ The Basic Health Research data from Maluku province in 2018 reported that the prevalence of CED in women aged 15-19 was 45.78%.¹²

Numerous studies have revealed that CED in adolescent girls could be influenced by direct factors, such as dietary intake, activity levels, infectious diseases, and Body Mass Index (BMI), and indirect factors like age, knowledge, attitude, socioeconomic status, or family income.¹ Additionally, some studies have reported that CED in adolescent girls is associated with education level, diet, nutrient intake, body image, and Body Mass Index for Age (BMI/A).^{1,6,13}

In August 2022, the Faculty of Medicine at Pattimura University conducted a survey on the prevalence of anemia and CED among adolescent girls in three senior high schools in Poka-Rumah Tiga villages. These areas are known to have a high prevalence of stunting in Ambon City, Maluku Province. The survey data was used to analyze the factors associated with CED among senior high school students in these villages. The results could provide valuable input to program holders and policymakers for planning appropriate prevention and treatment efforts to reduce the prevalence of CED in Ambon City.

METHODS

Data source

This study is an analytical observational study using a cross-sectional design. The data for this study came from the Anemia Prevalence Survey of Adolescent Girls in Teluk Ambon Sub-district conducted by the Faculty of Medicine, Pattimura University, in collaboration with the City Health Office in August 2022.¹⁴

Survey location

The survey was conducted in the working area of the Poka-Rumah Tiga Health Centre in Ambon City. Poka Village covered an area of 2.78 km² and Rumah Tiga covers 28.39 km².¹⁵ Both villages are located in the Teluk Ambon Sub-district, which spans an area of 90.68 km² with a population density of 506.86 people/km² as of 2019.¹⁶ The data for the survey were collected from three senior high schools located within the catchment area of Poka-Rumah Tiga Health Centers. The schools included SMKN 5 Ambon, SMAN 3 Ambon, and MA Al-Mabrur.

Research sample

The study focused on adolescent girls aged 15-19 years who were attending high school or equivalent in the Poka-Rumah Tiga areas, which included SMKN 5 Ambon, SMAN 3 Ambon, and MA Al-Mabrur. The researchers conducted anthropometric measurements of blood Hb levels, weight and height, and upper arm circumference, as well as interviews to gather information on factors associated with CED. The total sampling included all active adolescent girls in the three schools. The analysis used data collected from 441 adolescent girls aged 15 years and above who participated in the survey.

Instruments and data collection personnel

This survey used a structured questionnaire that covered various aspects such as sociodemographic characteristics (school, grade, residential location, father's occupation, mother's occupation, father's education, mother's education), disease history (history of TB, history of worms), dietary behavior (daily food frequency, dietary restrictions, consumption of animal side dishes, consumption of green vegetables), BMI, and knowledge level. All the questions in the questionnaire were adopted from the Anemia Survey of Adolescent Girls in Depok City in 2011.¹⁷ The questionnaire was entered into the CommCare application, which was operated using an Android-based device. Trained interviewers conducted the interviews and electronically recorded the respondents' answers.

In addition to interviews, blood hemoglobin (Hb) levels and anthropometry (upper arm circumference, height, and weight) were checked. Hb levels were measured using a HemoCue Hb 301. Body weight was measured using a body weight scale. Height was measured using a Gea Medical microtoise with an accuracy of 0.1 cm. Height measurement was carried out with the subject standing upright against the wall (subscapular, buttocks, and heels against the wall) then the microtoise was lowered to touch the cranium to read the measurement results. Upper arm circumference was measured using a metline (0.1 cm accuracy). Measurement of upper arm circumference is carried out by standing

upright but relaxed, not holding anything, and not tensing arm muscles, then measured between the acromion process and olecranon process of the less dominant arm, usually on the left arm.

Prior to data collection, the research team from the Faculty of Medicine, Pattimura University, Ambon, selected and trained 17 enumerators. The training program covered detailed explanations of the questionnaire questions, how to take blood Hb and anthropometric measurements, and the use of Commcare.

Data collection

The licensing process was conducted with the school to communicate with parents. Parents who objected to their children being involved in this study were not included in the survey. For students whose parents were willing to be involved in the survey, at the time of data collection, the interviewer first explained the purpose of the interview and once again asked about the willingness of prospective respondents to be interviewed and blood Hb and anthropometric checks (upper arm circumference, height, and weight) were carried out.

Variables

The dependent variable in this study was CED (based on measurement of upper arm circumference <23.5 cm). Several independent variables were considered, including sociodemographic characteristics (such as school, class, location of residence, father's occupation, mother's occupation, father's education, and mother's education), history of illness (TB and worm infection), dietary behavior (frequency of daily meals, dietary restrictions, consumption of animal side dishes, consumption of green vegetables), BMI, and the level of knowledge of respondents regarding anemia.

Data analysis

The descriptive presentation of the frequency distribution of each variable was conducted in this study. Bivariable and multivariable logistic regression analyses were then performed to identify the factors associated with CED in adolescent girls. The bivariate analysis was conducted to test the association between one variable and CED without controlling for other variables. All variables with a *p-value* of less than 0.25 were included in the multivariable analysis to determine the factors significantly associated with CED in adolescent girls (using a significance value of 0.05) after controlling for other variables. The study data were analyzed using STATA 17.0 software.

This research has been granted approval by the ethics committee of the Faculty of Medicine at Pattimura University in Ambon (No. 141/FK-KOM.ETIK/VIII/2022.) Students whose parents had given their permission for their children to participate in the survey had been asked to sign an informed consent form to confirm their willingness to be included as research subjects.

RESULTS

Prevalence of CED in adolescent girls

Of the 441 adolescent girls who were respondents in this study, the average age of respondents was 18 years old, and based on the results of upper arm circumference measurements, the prevalence of adolescent girls who experienced CED was 45.8% (202 respondents) (Figure 1).

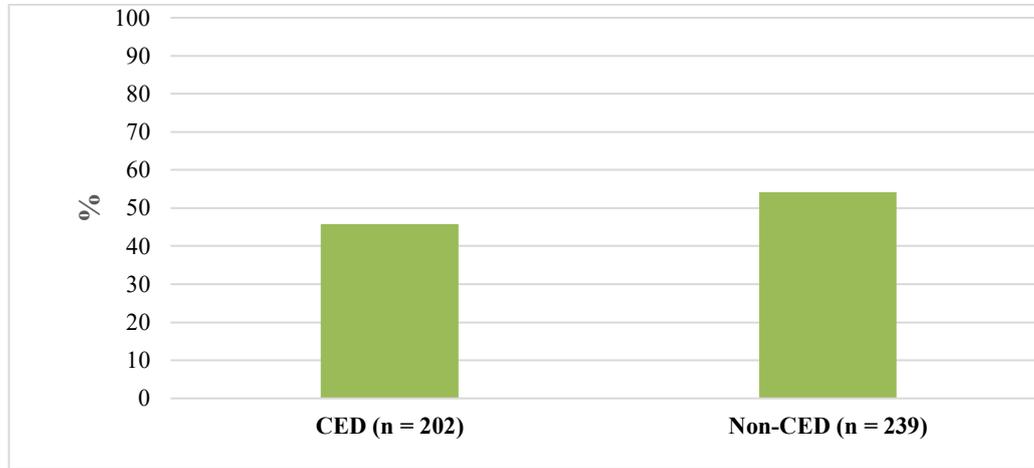


Figure 1: Prevalence of CED among adolescent girls

Frequency distribution of variables by CED status

Table 1 shows the frequency distribution of sociodemographic characteristics of the adolescent girls used in this study and by CED status. The majority had fathers and mothers with at least a junior high school education.

Table 1. Frequency distribution of sociodemographic characteristics of adolescent girls based on Chronic Energy Deficiency (CED) status

Variables	n	%	Non-CED		CED		p-value
			n	%	n	%	
Schools							
SMAN 3 Ambon	335	75.96	193	57.61	142	42.39	0.036
SMKN 5 Ambon	84	19.05	37	44.05	47	55.95	
MAN Al-Mabrur Ambon	22	4.99	9	40.91	13	59.09	
Class							
10	97	22.00	46	47.42	51	52.58	0.253
11	182	41.27	99	54.40	83	45.60	
12	162	36.73	94	58.02	68	41.98	
Place of residence							
Coastal lowlands	188	42.63	99	52.66	89	47.34	0.043
Non-coastal lowlands	149	33.79	42	61.74	57	38.26	
Highlands	104	23.58	48	46.15	56	53.85	
Maternal occupation							
Housewife	283	64.17	152	53.71	131	46.29	0.903
Formal	85	19.27	45	52.94	40	47.06	
Non-formal	71	16.10	40	56.34	31	43.66	
Paternal occupation							
Formal	134	30.39	75	55.97	59	44.03	0.883
Non-formal	241	54.65	129	53.53	112	46.47	
Not working/retired/don't know	66	14.97	35	53.03	31	46.97	

Variables	n	%	Non-CED		CED		p-value
			n	%	n	%	
Maternal education							
College	95	21.54	51	53.68	44	46.32	0.971
Junior or senior high school	265	60.09	143	53.96	122	46.04	
Primary school	47	10.66	27	57.45	20	42.55	
Not in school/don't know	34	7.71	18	52.94	16	47.06	
Paternal education							
College	87	19.73	49	56.32	38	43.68	0.761
Junior or senior high school	261	59.18	140	53.64	121	46.36	
Primary school	34	7.71	16	47.06	18	52.94	
Not in school/don't know	59	13.38	34	57.63	25	42.37	

The percentage of CED was not significantly different based on the infection status of adolescent girls. However, based on dietary pattern (Table 3), it is interesting to see that the percentage of adolescent girls with CED was higher among those who mentioned the frequency of eating at least three meals per day.

Table 2. Distribution of history of illness in adolescent girls based on Chronic Energy Deficiency (CED) status

	n	%	Non-CED		CED		p-value
			n	%	n	%	
Tuberculosis							
Yes	6	1.36	3	50.00	3	50.00	0.831
No	434	98.41	236	54.38	198	45.62	
Worm infection							
Yes	13	2.95	7	53.85	6	46.15	0.972
No	427	96.83	232	54.33	195	45.67	

Table 3. Distribution of dietary patterns of adolescent girls based on Chronic Energy Deficiency (CED) status

	n	%	Non-CED		CED		p-value
			n	%	n	%	
Daily meals frequency							
<3 times	254	57.60	152	59.84	102	40.16	0.006
≥3 times	187	42.40	87	46.52	100	53.48	
Dietary restriction							
Yes	138	31.29	73	52.90	65	47.10	0.712
No	303	68.71	166	54.79	137	45.21	
Daily consumption of animal-based side dishes							
Yes	360	81.63	198	55.00	162	45.00	0.474
No	81	18.37	41	50.62	40	49.38	
Daily consumption of green vegetables							
Yes	238	53.97	120	50.42	118	49.58	0.085
No	203	46.03	119	58.62	84	41.38	

Table 4 shows that most of the adolescent girls had normal BMI (52.83%). However, the percentage of CED was highest among respondents with lean BMI (79.07%) and lowest among those with obese BMI (5.56%).

Table 4. Distribution of nutritional status of adolescent girls based on Chronic Energy Deficiency (CED) status

	n	%	Non-CED		CED		<i>p-value</i>
			n	%	n	%	
BMI (kg/m ²)							
Under-weight (<18,5 kg/m ²)	172	39.00	36	20.93	136	79.07	<0,001
Normal (18,5-22,5 kg/m ²)	233	52.83	169	72.53	64	27.47	
Over-weight (≥ 23 kg/m ²)	36	8.16	34	94.44	2	5.56	
Anemia							
Yes (Hb <12 g/dL)	220	49,89	121	55.00	99	45.00	0.735
No (Hb ≥12 g/dL)	221	50,11	118	53.39	103	46.61	

Table 5 shows that the percentage of CED was higher among adolescents with low levels of knowledge about anaemia than those with high levels of knowledge. The mean Hb level of adolescent girls was 11.9 g/dL. According to the level of knowledge of adolescent girls about anaemia, 53.51% had a low level of knowledge.

Table 5. Distribution of knowledge history of adolescent girls regarding anaemia based on Chronic Energy Deficiency (CED) status

	n	%	Non-CED		CED		<i>p-value</i>
			n	%	n	%	
Knowledge							
Low	236	53.51	118	50.00	118	50.00	0.058
High	205	46.49	121	59.02	84	40.98	

Relationship between BMI and CED

Table 6 shows the analysis results for factors associated with CED. There was a significant association between BMI and CED among adolescent girls after controlling for the variables of school, class, name of school location, frequency of daily meals, the habit of consuming green vegetables, level of knowledge about anemia, and anemia status ($p < 0.001$). The odds of CED among adolescent girls were lower among respondents with normal BMI (OR=0.09; 95%CI: 0.05-0.15, $p < 0.001$) and among respondents with over-weight BMI (OR=0.01; 95%CI: 0.00-0.07, $p < 0.001$) compared to those with underweight BMI.

Table 6. Factors Associated with CED in Adolescent Girls, Anaemia Prevalence Survey, 2022

Variables	Univariable				Multivariable			
	OR	95% CI		<i>p</i>	OR	95% CI		<i>p</i>
Sociodemographic Characteristics								
Schools								
SMAN 3 Ambon	1.00				1.00			
SMKN 5 Ambon	1.72	1.06	2.79	0.026	1.38	0.73	2.59	0.312
MA Al-Mabrur Ambon	1.96	0.81	4.71	0.132	1.24	0.42	3.68	0.691
Class								
10	1.00				1.00			
11	0.75	0.46	1.23	0.267	0.78	0.42	1.44	0.437
12	0.65	0.39	1.08	0.098	0.90	0.47	1.72	0.767
Place of residence								
Coastal lowlands	1.00				1.00			
Non-coastal lowlands	0.68	0.44	1.06	0.095	0.66	0.38	1.13	0.138

Variables	Univariable				Multivariable			
	OR	95% CI		<i>p</i>	OR	95% CI		<i>p</i>
Highlands	1.29	0.28	2.09	0.287	1.29	0.71	2.31	0.392
Maternal occupation								
Housewife	1.00							
Formal	1.03	0.63	1.67	0.901				
Non-formal	0.89	0.53	1.51	0.691				
Paternal occupation								
Formal	1.00							
Non-formal	1.10	0.72	1.68	0.649				
Not working/retired/don't know	1.12	0.62	2.03	0.694				
Maternal education								
College	1.00							
Junior or senior high school	0.98	0.61	1.58	0.963				
Primary school	0.85	0.42	1.73	0.672				
Not in school/don't know	1.03	0.46	2.25	0.941				
Paternal education								
College	1.00							
Junior or senior high school	1.11	0.68	1.81	0.664				
Primary school	1.45	0.65	3.21	0.359				
Not in school/don't know	0.94	0.48	1.84	0.876				
History of illness								
Tuberculosis infection								
Yes	1.00							
No	0.83	0.16	4.20	0.831				
Worm infection								
Yes	1.00							
No	0.98	0.32	2.96	0.972				
Dietary Pattern								
Daily meals frequency								
<3 times	1.00							
≥3 times	1.71	1.16	2.50	0.006	1.42	0.89	2.27	0.136
Dietary restriction								
Yes	1.00							
No	0.92	0.61	1.38	0.712				
Daily consumption of animal-based side dishes								
Yes	1.00							
No	1.19	0.73	1.93	0.475				
Daily consumption of green vegetables								
Yes	0.71	0.49	1.04	0.085	0.64	0.40	1.03	0.069
No								
Nutritional Status and Anemia								
IMT (kg/m ²)								
Kurus (<18,5 kg/m ²)	1.00				1.00			
Normal (18,5-22,5 kg/m ²)	0.10	0.06	0.15	<0,001	0.09	0.05	0.15	<0,001
Gemuk (≥ 23 kg/m ²)	0.01	0.00	0.06	<0,001	0.01	0.00	0.07	<0,001
Anemia								
Yes (Hb <12 g/dL)	1.99							
No (Hb ≥12 g/dL)	0.94	0.64	1.36	0.735				
Knowledge Adolescent girls								
Knowledge About Anemia								
Low	1.00				1.00			
High	0.69	0.47	1.01	0.058	0.71	0.44	1.13	0.153

DISCUSSION

Prevalence of CED in Poka-Rumah Tiga Village

The prevalence of CED among adolescent girls in the working area of Poka-Rumah Tiga Health Center in the three senior high schools was found to be similar to the provincial average (45.78%).¹² This prevalence, however, was higher than the national rate reported in the 2018 Basic Health Research (36,3%).¹⁰ The high prevalence of CED could be caused by inadequate nutrient intake and infectious diseases. Optimal nutrition is required to support the body's defense system. Adolescent consumption patterns determine the nutrients adolescents need for growth and development.¹⁹ Many adolescent nutritional problems occur due to incorrect nutritional behavior, such as an imbalance between nutrition and the recommended nutritional adequacy.²⁰ Lack of nutrient intake could adversely affect the health of adolescent girls, including a decrease in endurance, making them susceptible to various diseases that could lead to CED.⁶ Chronic energy and protein deficiencies affect the body, resulting in obesity and anemia, leading to sub-optimal growth and development and greater susceptibility to chronic diseases such as cardiovascular disease, cancer, and osteoporosis in adulthood.²⁰

Relationship between CED and BMI in adolescent girls

This study found that there is a significant connection between BMI and CED. This is consistent with a previous study conducted by Fakhriyah et al., Field 21, that showed a relationship between CED and BMI. Various factors could influence a person's nutritional status. Poor eating habits such as irregular meal times, low intake of vegetables and fruits, excessive consumption of fast food and unhealthy snacks, and foods high in glucose could lead to poor nutritional status. When the energy intake is lower than what is expended, it could result in malnutrition. Arista *et al.*,²² reported a significant association between low BMI and CED in adolescent girls. Research by Kumar et al,²³ also reported a significant relationship between CED and BMI with a correlation coefficient of 0.860 (95% CI: 0.831-0.883; $p < 0.001$).

The results of previous studies showed that the dietary intake patterns of adolescent girls²⁴ and anemia²⁵ also had an association with CED. This highlights the importance of maintaining a nutritious and balanced diet, as well as ensuring compliance with taking IFA tablets to prevent CED. To achieve this, it is necessary to implement effective health promotion efforts that involve various sectors. These efforts should aim to increase adolescent girls' awareness about the importance of balanced nutrition and encourage them to adopt positive behaviors to prevent CED.²⁶

This study shows the need for health promotion efforts to improve adolescents' nutritional knowledge and form a healthy lifestyle to apply balanced nutrition guidelines in everyday life.²⁷ IEC (Communication, Information, and Education) interventions on balanced nutrition are one of the efforts to tackle CED. The IEC activities could be implemented by conducting counseling, as well as disseminating information through social media or other print media. It is important to increase

community knowledge and provide continuous encouragement to apply a diet with balanced nutrition. Health promotion interventions are needed, including during the pre-conception period, to increase public awareness about consuming a varied diet with balanced nutrition, encourage adherence to IFA supplementation, especially during pregnancy, and provide certified foods for the community.²⁸

It is important to involve both parents and teachers in shaping the eating habits of adolescent girls and promoting nutrition concepts.²⁹ The School Health Unit might provide a forum for students to assess their nutritional status, socialize balanced nutrition, and discuss healthy food options for both school and home environments. This is expected to encourage better diet habits and improve the health, productivity, and academic potential of adolescent girls.²⁹ Research by Sofianita *et al*,²⁹ suggested that adolescent girls' knowledge increased significantly (from 4.44% to 24.44%) after receiving nutrition education intervention.

Nutrition education could help improve knowledge and attitudes about healthy behavior practices. Nutrition education, with the help of media with an attractive and informative design, will make it easier to understand healthy behavior practices well. Choosing the right media also helps to increase learning intentions. Auditive, visual, and audiovisual media could be used to provide nutrition education, but video is particularly effective in helping people understand balanced nutrition guidelines. Videos that contain clear illustrations and music will provide a pleasant and engaging atmosphere for learning.^{23,24} Research by Nurcahyani has shown that using videos as an educational tool could lead to changes in the nutritional intake of adolescent girls.³⁰ Therefore, schools could collaborate with health centers to provide educational activities for their students.

Delivering nutrition information to adolescents could be achieved effectively by providing balanced nutrition education through peer educators. This approach, known as peer education, involves sharing information with peers in the hope of influencing their attitudes and actions. By doing so, balanced nutrition messages could be disseminated efficiently among adolescents.³¹

Collaboration with various stakeholders should be considered, including with higher education institutions, by conducting various community service activities that support nutrition and health programs for adolescents. Other research has shown that community service should not only be limited to checking the nutritional status of adolescents, but also enabling adolescents to detect their nutritional status early.³²

CONCLUSIONS AND SUGGESTIONS

The study conducted in the catchment area of Poka-Rumah Tiga Health Centre in Ambon City revealed a high prevalence of CED among adolescent girls at the senior high school level. CED has a significant relationship with BMI, highlighting the importance of health promotion activities. Educational interventions on balanced nutrition are crucial to combat CED. These interventions could be conducted using various methods and media to reach adolescent girls and increase their knowledge.

It is important to cooperate with various stakeholders, such as parents, schools, and other health institutions, to ensure the success of these interventions and to promote a healthy lifestyle.

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