Analysis of Factors Influencing Chronic Energy Deficiency (CED) in Adolescent Girls in the Development of the RF-AR Mobile Health Application for Early Detection and Effective Intervention

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Abstract: Chronic Energy Deficiency (CED) is one of the nutritional problems that pose a threat to adolescents in Indonesia, especially adolescent girls. According to the 2018 Basic Health Research (Riskesdas), the proportion of CED among adolescent girls in Indonesia was 36.3%. This study aims to analyze the factors that influence the risk of CED in adolescent girls and develop an RF-AR mobile health application for early detection and effective intervention. This study used an observational design with cross-sectional data. The respondents were adolescents aged 15-19 years from three high schools in Pesawaran, with a total of 100 adolescents in Pesawaran. Bivariate analysis was conducted to evaluate the relationship between nutrient intake (energy, carbohydrate, fat) and nutritional status with the risk of CED in adolescent girls. The results of the analysis showed that energy, carbohydrate, and fat intake had a significant relationship with the risk of CED. Adolescents with deficient nutrient intake had a higher risk of developing CED. Underweight nutritional status was also found to be a significant factor that increases the risk of CED. The results of this study emphasize the importance of fulfilling adequate nutritional intake and monitoring nutritional status in the prevention of CED. The RF-AR mobile health application has the potential to be an effective tool for early detection and intervention in adolescent girls, helping them to effectively monitor their nutritional intake and nutritional status

1 INTRODUCTION

Adolescents are the next generation that plays an important role in the future sustainability of the nation (Setiawan, 2023; Patton et al., 2018). The adolescent phase is a critical stage in the human life cycle characterised by significant physical and mental growth and development (Zuhri & Haryanti, 2023; Bonnie & Backes, 2019). According to the 2018 Riskesdas data, the proportion of nutritional status in adolescent girls aged 13-18 years based on BMI by age in the very thin and thin categories in Indonesia was 9.7%, while in Lampung Province it was 16.3% (Kemenkes RI, 2018) (Yastirin & Dewi, 2022; Purwaningsih & Sumarmi, 2022). In Lampung Province, the prevalence of chronic energy deficiency (CED) in adolescents aged 15-19 years was 36.93%. The prevalence of chronic energy deficiency (CED) in non-pregnant women of childbearing age in Pesawaran District is 19.02%, which is a fairly high rate (Ministry of Health of the Republic of Indonesia, 2019) (Titaley et al., 2024). The condition of adolescents who experience chronic energy deficiency (CED) increases the risk of various infectious diseases and hormonal disorders that have a negative impact on health (Yulia et al., 2024; Harna et al., 2024). During this period, adolescents experience increased nutritional needs, especially for nutrients such as protein and calcium that are important for body mass formation and overall health (Soliman et al., 2022; Lopes et al., 2022). One of the health problems often faced by adolescent girls is Chronic Energy Deficiency (CED) (Titaley et al., 2024; Ananda et al., 2022).

CED is influenced by various factors, which can be categorised into direct and indirect factors (Yang et al., 2020; Deng et al., 2023). Direct factors include inadequate food intake and the presence of diseases that can interfere with metabolic processes (Ahmed et al., 2022; Pereira et al., 2020). Meanwhile, indirect factors relate to the adolescent girls' own eating behaviour and habits, which are often influenced by the social and educational environment (Dian Isti Angraini et al., 2023) Adolescents aged 15-19 years are particularly vulnerable to CED as this period marks the transition from childhood to adulthood characterised by physical and psychosocial changes (Povey et al., 2022; Krasniqi & Cakirpaloglu, 2020). Physical changes may lead to increased nutritional

requirements for growth. In addition, one form of psychosocial change in adolescents is an increased focus on appearance, which may trigger dieting behaviour, despite increased nutritional requirements for growth (Soliman et al., 2022; Christian & Smith, 2018). If this continues, it can lead to nutritional problems, including chronic energy deficiency. To address the problem of chronic energy deficiency, various efforts have been made, including reproductive health programmes for adolescents such as School Health Efforts (UKS) and Adolescent Care Health Services (PKPR) (Jaelani & Sitawati, 2024; Saavedra & Prentice, 2023). These programmes aim to provide health education and support to adolescents, so that they can make better choices regarding diet and lifestyle (Kulandaivelu et al., 2023). In this context, technological innovations such as mobile health (m-health) are highly relevant. M-health is a form of e-health service that can be used to detect and treat CED among adolescents more effectively (da Fonseca et al., 2021; Kwee et al., 2022).

This study aims to develop an RF-AR mobile health application as a tool to predict SEZ, with the hope of reducing health risks and supporting the development of better health services. This research was conducted through an observational study with cross-sectional data from 100 adolescents in Pesawaran, which is expected to make a significant contribution to disease prevention and health expenditure reduction.

2 METHODS

2.1 Data source

This study is an analytical observational study using a cross-sectional design. The data for this study came from the Survey of Factors affecting CED in Adolescent Girls in Pesawaran conducted by Puskesmas Pesawaran Province Lampung District..

2.2 Survey location

The time of this study was 6 months, from September 2023 to February 2024. This research was conducted in the working area of the Pesawaran District Health Centre.

2.3 Research sample

This study focused on adolescent girls aged 15-19 years who attended senior high school or equivalent in the Pesawaran area. We conducted anthropometric measurements of blood Hb levels, weight and height, and upper arm circumference, and interviews to collect information on factors associated with SEZ. The sample was 100 people calculated based on the sample size formula for unpaired categorical analytics. The sample was drawn using purposive sampling technique. The analyses used data collected from 100 adolescent girls aged 15 years and above who participated in the survey.

2.4 Instruments and data collection personnel

The 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 behaviour (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 Pesawaran. The questionnaire was entered into the COMM Care 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 haemoglobin (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 met line (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. The training program covered detailed explanations of the questionnaire questions, how to take blood Hb and anthropometric measurements, and the use of Commcare.

2.5 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 interviewerfirst 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.

2.6 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 behaviour (frequency of daily meals, dietary restrictions, consumption of animal side dishes, consumption of green vegetables), BMI, and the level of knowledge of respondents regarding anaemia.

2.7 Data analysis

In this study, descriptive presentation of the frequency distribution of each variable was conducted in this study, univariate, bivariate (chi square) and multivariate (mathematical model logistic regression) analyses were then conducted to identify factors associated with CED in adolescent girls. Bivariate analyses were conducted to examine the association between one variable and CED without controlling for other variables using a significance value of 0.05).

2.8 Research Flow

The flow of this research is starting from the preparation and submission of proposals, obtaining research permits and ethical clearance, coordination with relevant agencies, searching for intended subjects / informants, screening inclusion and exclusion criteria, informed consent, anthropometric measurements, measurement of nutritional factors, internal, education, environment and personality, data processing, data analysis and development of mobile health 'RF-AR'; the final stage is the preparation of results, discussion, dissemination and publication. More details can be seen in the flow chart below.

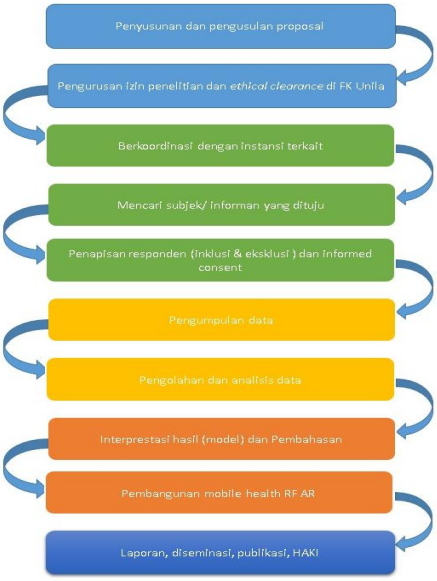

Figure 1. Research flow.

3 RESULTS

3.1 Univariate Analysis

Univariate analysis is a description of demographic data and the variables studied related to the characteristics of respondents (Tessler, 2023). Based on the factors that determine the status of chronic energy deficiency (CHD) of adolescent girls consists of direct and indirect factors. Direct factors consist of food intake and disease. Indirect factors are factors that influence the behaviour and dietary intake of adolescent girls themselves. Indirect factors consist of predisposing factors (knowledge, age, nutritional status, personality, body image), supporting factors (socio-economic, mass media influence, influence of idol figures) and push factors (family, peers). The results of the analysis are as follows:

3.1.1 Risk of CED

Table 1: Frequency distribution of Chronic Energy Deficiency (CED)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	KEK	29	29.0	29.0	29.0

	No KEK	71	71.0	71.0	100.0
	Total	100	100.0	100.0	

Table 1 shows that the majority of individuals in the sample, 71%, were not at risk of CED, while the remaining 29% were at risk. This suggests that while most individuals are not at risk of CED, almost a third of the sample is at risk, indicating the need for attention and possibly intervention for these individuals.

3.1.2 Energy Intake

Table 2: Frequency Distribution Of Energy Intake Factors

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less	75	75.0	75.0	75.0
	Enough-More	25	25.0	25.0	100.0
	Total	100	100.0	100.0	

Table 2 of this data shows that most individuals in the sample, i.e. 75%, had deficient energy intake. This indicates a potential nutritional problem where a large proportion of the sample population is not meeting their daily energy needs, which could have a negative impact on health and productivity. Only a quarter of the sample had sufficient or more energy intake. Therefore, there is a need for interventions to increase energy intake for individuals in the 'Deficient' category.

3.1.3 Protein Intake

Table 3: Frequency Distribution Of Protein Intake Factors

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less	44	44.0	44.0	44.0
	Enough-More	56	56.0	56.0	100.0
	Total	100	100.0	100.0	

Based on Table 3, the data shows that the majority of individuals in the sample (56%) had sufficient energy intake or exceeded their daily needs. However, there were still 44% of individuals who experienced insufficient energy intake. Although more individuals were in the 'Adequate-Exceeding' category, the percentage of individuals with insufficient energy intake was still quite significant. This emphasises the need for attention and interventions to increase energy intake for individuals in the 'Deficient' category to meet their daily energy needs, which is important for their overall health and well-being.

3.1.4 Carbohydrate Intake

Table 4: Frequency Distribution of Carbohydrate Intake Factors

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less	69	69.0	69.0	69.0
	Enough-More	31	31.0	31.0	100.0
	Total	100	100.0	100.0	

Table 4 shows that the majority of individuals in the sample, 69%, had insufficient energy intake. This indicates that a large proportion of the sample population is not meeting their daily energy needs, which could negatively impact their health and productivity. Based on the results of the data analysis, 31% of the sample had sufficient or more energy intake, indicating an imbalance in the fulfilment of energy needs. Therefore, interventions and attention are needed to increase energy intake for those individuals who are in the 'Deficient' category to ensure their health and well-being.

3.1.5 Fat Intake

Table 5: Frequency Distribution Of Fat Intake Factors

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less	75	75.0	75.0	75.0
	Enough-More	25	25.0	25.0	100.0
	Total	100	100.0	100.0	

Based on Table 5, it shows that the majority of individuals in the sample (75%) had fat intake that was less than their daily requirement. This suggests that a large proportion of the population may have a deficit in fat intake, which is essential for optimal body

functions such as vitamin absorption and hormone production. With only 25% having adequate or more fat intake, this indicates the need for efforts to increase fat consumption in the diet to fulfil nutritional needs and maintain good health. Appropriate interventions may be needed to increase awareness and access to healthy fat sources.

3.1.6 Iron (Fe) Intake

Table 6: Frequency Distribution Of Iron (Fe) Intake Factors

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less	82	82.0	82.0	82.0
	Enough-More	18	18.0	18.0	100.0
	Total	100	100.0	100.0	

Table 6, shows that most of the individuals in the sample (82%) had deficient iron intake. This data indicates a high risk of iron deficiency anaemia in this population, which can lead to symptoms such as fatigue, weakness and reduced cognitive function. With only 18% of the sample having adequate iron intake, interventions are needed to increase awareness and access to iron-rich foods or supplements. Increased iron intake is important for overall health and preventing more serious health complications due to iron deficiency.

3.1.7 Knowledge Factors

Table 6: Frequency distribution of knowledge factors

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Kurang	56	56.0	56.0	56.0
	Baik	44	44.0	44.0	100.0
	Total	100	100.0	100.0	

Table 7, shows the results of the analysis that the majority of individuals in the sample (56%) had insufficient knowledge. This indicates that there is a need for increased education or dissemination of information related to the topics discussed. With 44% of individuals having good knowledge, there are a number of individuals who are already sufficiently informed, but still need efforts to improve overall knowledge. Efforts such as training, information campaigns, or access to educational resources can help address these shortcomings and improve people's understanding.

3.1.8 Age Factors

Table 8: Frequency distribution of age factors

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Early adolescence	11	11.0	11.0	11.0
	Middle adolescence	89	89.0	89.0	100.0
	Total	100	100.0	100.0	

Table 8, shows that the majority of individuals in the sample (89%) were in the middle adolescent age category, while only 11% were in the early adolescent category. This data suggests that the age distribution in the sample is dominated by middle adolescence. A greater representation of the middle adolescent age group may influence the results and conclusions of the study in this research.

3.1.9 Nutritional Status

Table 9. Frequency distribution of nutritional status

		Frequency	Percent	Valid Percent	Cumulative Percent
id	Underweight	14	14.0	14.0	14.0
	Normal-Overweight	86	86.0	86.0	100.0
	Total	100	100.0	100.0	

Based on the data in Table 9, the majority of individuals in the sample (86%) had a nutritional status that ranged from normal to overweight, while the remaining 14% were in the underweight category. These results indicate that the majority of the sample population has a body weight that is appropriate or more than their body needs. However, attention needs to be paid to the 14% of individuals who are underweight, as they may be at risk of health problems related to malnutrition or insufficient body weight. Efforts to support weight gain and nutritional intake

for this group could help improve their overall health and well-being.

3.1.10 Personality Factors

Table 10. Frequency distribution of Personality Factors

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	deficient	51	51.0	51.0	51.0
	Good	49	49.0	49.0	100.0
	Total	100	100.0	100.0	

Based on table 10, these data show that there is an almost even split between individuals with personality assessed as fair and good, with slightly more than half of individuals in the 'fair' category. This indicates a need to further understand the factors that influence personality judgements and may involve interventions to support positive personality development. Approaches that focus on improving personality qualities and social skills training may benefit individuals in the 'unfavourable' category to achieve a better balance in personality assessment.

3.1.11 Body image

Table 11. Body image frequency distribution

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	not satisfied	50	50.0	50.0	50.0
	Satisfied	50	50.0	50.0	100.0
	Total	100	100.0	100.0	

Table 11, This data shows that there is an equal split between individuals who are satisfied and dissatisfied with their body image, with each group comprising 50% of individuals. This suggests a diversity of opinions about physical appearance among the sample. The significant dissatisfaction among half of the individuals may indicate the need for interventions in the form of psychological support or confidence-building programmes to help individuals feel better about their body image. Conversely, it is also important to continue to support and nurture positive attitudes for those who are already satisfied with their body image.

3.1.12 Social media

Table 12. Frequency distribution Social media

Media Sosial					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Take effect	54	54.0	54.0	54.0
	No	46	46.0	46.0	100.0
	Total	100	100.0	100.0	

Based on Table 12, this data shows that the majority of individuals in the sample (54%) feel that social media has an influence on them. This result suggests that social media plays an important role in many people's lives and can affect their personal or social aspects. On the other hand, 46% of individuals felt that social media had no effect, which suggests that the impact of social media may vary between individuals. It is important to consider both perspectives in social media-related research or interventions, as well as to understand how social media affects different aspects of life in greater depth. Efforts to utilise social media positively and address the negative impacts that may arise can help improve the well-being of individuals who experience it. On the other hand, it is important to understand how social media affects individuals differently and tailor approaches to support those who are negatively affected, while maintaining awareness of the potential benefits of social media for those who feel unaffected.

3.1.13 Idol Characters

Table 13. Frequency distribution of idol characters

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Take effect	55	55.0	55.0	55.0
	No	45	45.0	45.0	100.0
	Total	100	100.0	100.0	

This data shows that the majority of individuals in the sample (55%) felt influenced by idolised figures. This suggests that idol figures can have a significant

impact on an individual's views, behaviour or aspirations. On the other hand, 45% of individuals felt that idolised figures had no influence, which suggests that the impact of idolised figures can vary between individuals. It is important to understand the different ways that idol figures influence people, both positively and negatively, and consider how this influence can be used to drive change or promote positive values. Interventions or programmes involving idol figures can be designed to harness this influence constructively.

3.1.14 Family

Table 14. Family frequency distribution

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Take effect	70	70.0	70.0	70.0
	No	30	30.0	30.0	100.0
	Total	100	100.0	100.0	

This data shows that the majority of individuals in the sample (70%) felt a significant influence from family. This result indicates that family is considered an important factor in shaping individuals' values, behaviour and decisions. On the other hand, 30% of individuals felt that family was not influential, which suggests that the impact of family may vary between individuals. Understanding the influence of family in an individual's life is crucial, especially in the context of emotional, social and personal decision support. Programmes or interventions that involve families can improve well-being and support positive development, taking into account the role of family as a key factor in individuals' lives.

3.1.15 Peer Factors

Table 15. Frequency distribution of peers

Peers					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Take effect	66	66.0	66.0	66.0
	No	34	34.0	34.0	100.0
	Total	100	100.0	100.0	

Based on table 15, this data shows that the majority of individuals in the sample (66%) perceive significant influence from peers. This indicates that peers are considered an important factor in shaping individuals' views, behaviours and decisions. Peers can influence various aspects of life, such as social choices, behaviour and values. Meanwhile, 34% of individuals felt that peers had no influence, which suggests that the impact of peers may vary between individuals. Understanding the role of peers in an individual's life is important for creating a supportive and positive social environment. Programmes or interventions involving peers can help strengthen positive influences and address negative impacts that may arise.

3.1.16 physical activity

Table 16. Frequency distribution of physical activity

Aktifitas Fisik					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Ringan	64	64.0	64.0	64.0
	Sedang	36	36.0	36.0	100.0
	Total	100	100.0	100.0	

Table 15, shows that the majority of individuals in the sample (64%) engage in light intensity physical activity.This data indicates that most individuals engage in a type of activity that may not provide optimal health benefits when compared to more intense physical activity.Meanwhile, 36% of individuals engaged in moderate-intensity physical activity, indicating a group that is more active and may derive greater health benefits from their physical activity.Increasing the intensity of physical activity in the population may help improve overall health, and strategies to motivate individuals to move from light to higher intensity activity may be beneficial for long-term wellbeing.

3.2 Bivariant Analysis

Bivariate analysis is used to determine whether or not there is a correlation between 2 variables, in this study, namely the variable of work stress and nurse work productivity. There is a relationship in these variables if the p-value < a (0.05). It can be concluded that there is a relationship between the factors of

Chronic Energy Deficiency (CED) with the Risk of CED.

Table 17. Frequency distribution of energy intake with CED risk

Variables	Risk of CED				Total		
	KEK		Tdk KEK				
	f	%	f	%	f	%	P Value
Energy Intake							
Less	17	58,6	58	81,7	75	100	0.016
Enough-More	12	41,4	13	18,3	25	100	
Protein Intake							
Less	9	31,1	35	49,3	44	100	0.095
Enough-More	20	69,0	36	50,7	56	100	
Carbohydrate Intake							
Less	15	51,7	54	76,1	69	100	0.017
Enough-More	14	48,3	17	23,9	31	100	
Fat Intake							
Less	17	58,6	58	81,7	75	100	0,016
Enough-More	12	41,4	13	18,3	25	100	
Iron Intake							
Less	23	79,3	59	83,1	82	100	0.655
Enough-More	6	20,7	12	16,9	18	100	
Knowledge Category							
Less	19	65,5	37	52,1	56	100	0.220
Good	10	34,5	34	47,9	44	100	
Age Category							
Early Adolescence	5	17,2	9	8,5	11	100	0.202
Middle Adolescence	24	82,8	65	91,5	89	100	
Nutritional Status							
Underweight	13	44,8	1	1,4	14	100	0.000
Normal-Overweight	16	55,2	70	98,6	86	100	
Personality							
Not good	16	55,2	35	49,3	51	100	0.594
Good	13	44,8	36	50,7	49	100	
Body Image							
Not Satisfied	18	62,1	32	45,1	50	100	0.123
Satisfied	11	37,9	39	54,9	50	100	
Social Media							
Influential	15	51,7	39	54,9	54	100	0.770
No	14	48,3	32	45,1	46	100	
Role Model							
Influential	19	65,5	36	50,7	55	100	0.177
No	10	34,5	35	49,3	45	100	
Family							
Influential	20	69,0	50	70,4	70	100	0.885
No	9	31,0	21	29,6	30	100	
Peers							
Influential	20	69,0	46	64,8	66	100	0.689
No	9	31,0	25	35,2	34	100	
Physical Activity							
Mild	19	65,5	45	63,4	64	100	0.840
Medium	10	34,5	26	36,6	36	100	

Table 17, shows the results of the analysis of factors that may influence the risk of CED and help identify areas that require further attention in interventions or further research. Based on the analysis of Energy Intake, Carbohydrate Intake, Fat Intake, Nutritional Status. Obtaining a P-value of less than 0.05 indicates a significant difference between the CED and Non-SEC groups, meaning that there is a relationship or association with the risk of CED. Therefore, special attention should be paid to meeting the needs of energy and balanced nutrition to prevent CED. Factors such as protein intake, iron, knowledge category, age, personality, body image, social media, idol figures, family, peers, and physical activity did not show significant differences, suggesting that they may not have a strong direct influence on the risk of CED in this group or that other factors are more dominant.

4. DISCUSSION

Chronic Energy Deficiency (CED) in adolescent girls is a serious health problem, especially in developing countries (Titaley et al., 2024; Mukaddas et al., 2021). Factors that influence CED include nutrient intake, nutritional status, and various social and psychological

aspects. Analyses showed that several nutritional factors, such as energy, carbohydrate and fat intake, had significant associations with CED risk (Yuliastanti et al., 2023). Nutritional status is also a strong predictor of CED risk, with underweight adolescent girls being more vulnerable (Singh et al., 2021). Other factors such as knowledge, personality, and social influence (social media, family, and peers) did not show a significant association with CED risk (Leijse et al., 2023).

Based on the results of the bivariate analysis conducted, it was found that energy, carbohydrate, and fat intake had a significant association with the risk of CED. Adolescent girls with deficient intake in these three aspects have a higher risk of developing CED (Titaley et al., 2024; Taqwin et al., 2023). Relevant research supports these findings by showing that inadequate energy intake contributes to an increased risk of CED, especially among adolescents (Wati et al., 2024). For example, a study by (Yulia et al., 2024; Smith, 2023) found that calorific deficit significantly increased the risk of CED in the adolescent population. In addition, a study by (Clemente-Suárez et al., 2022a) showed that adequate carbohydrate intake plays an important role in preventing CED, as complex carbohydrates help fulfil daily energy needs and support optimal health. Similarly, research by (Clemente-Suárez et al., 2023) revealed that fat, as an important source of energy, also contributes to the prevention of CED, with fat deficiency exacerbating the risk of CED. These findings emphasise the importance of ensuring adequate intake of energy, carbohydrates and fats to prevent CED and support healthy nutritional status (Wan et al., 2023; Clemente-Suárez et al., 2022)

The analysis showed the importance of ensuring adequate nutrient intake in the prevention of CED. Nutritional status also emerged as a significant factor, with adolescents with underweight nutritional status having a higher risk of developing CED. Relevant research supports these findings by highlighting the role of nutrient intake in the prevention of CED. The study by (Dagne et al., 2021) showed that robust energy intake significantly reduced the risk of SEZ in adolescents. Research by (Harna et al., 2024) also found that a lack of carbohydrates and fat in the diet can increase the risk of CE, underscoring the need for adequate nutrition in the daily diet. In addition, nutritional status acts as a significant factor in the risk of SEE; adolescents with underweight nutritional status show a higher risk of experiencing SEE, as found in the study by (Clemente-Suárez et al., 2022; Lee et al. 2023). The findings emphasise the need for attention to nutritional status and adequate nutrient intake for CED prevention as well as long-term health support in adolescents. The findings underscore the importance of ensuring adequate nutrient intake to prevent CED and also emphasise the need for attention to the nutritional status of adolescents.

These factors are highly relevant to consider in the development of RF-AR applications. The app can be optimised with features that monitor the user's daily nutrient intake and provide appropriate dietary recommendations to reduce the risk of CED (Gonzalez-Ramirez et al., 2022). By utilising real-time data from the user, the app can provide alerts if there are indications of insufficient nutrient intake, thus enabling early intervention.

Furthermore, while social and psychological factors such as personality, body image, and influences from social media, family, and peers did not show significant associations with SEZ risk in this analysis, they remain important to consider in a broader context. Supported by a study by (Cheikh Ismail et al., 2022) found that although psychosocial factors can influence eating behaviour and nutritional status, their influence on the risk of CED was not statistically significant. The study by (Qutteina et al., 2022; Smith et al., 2022) also confirmed that although influences from social media and social environment may affect diet, a direct relationship between these factors and SEZ risk was not found in their data. This suggests that while social and psychological factors may have an impact on other aspects of health, in the context of CED, they do not contribute significantly to increased risk. These factors may influence adolescents' eating behaviours and perceptions of their health and weight, which in turn may influence their nutritional status and risk of CED.

The RF-AR app can incorporate educational modules and psychological support to help young women understand the importance of adequate nutrition and building a positive body image (Tort-Nasarre et al., 2023). Thus, the app not only focuses on the physical aspect but also on the mental and emotional aspects of the user. The development of mobile health applications such as RF-AR is very relevant in today's digital era (Istepanian, 2022). It can

be an effective tool for early detection and intervention of CED, especially among vulnerable adolescent girls. With features such as nutrition tracking, food intake reminders, and dietary guidance, as well as integration with other health data, this app can provide comprehensive support for adolescent girls to prevent CED.

The findings of this study indicate that it is necessary to develop RF-AR applications with features designed for 1) Early detection, using user input data to monitor nutritional intake and nutritional status in real-time, providing early warnings if there are indications of CED. 2)Effective Intervention, providing educational information and personalised advice to increase nutritional intake and improve nutritional status. 3)Engagement, using Augmented Reality technology to make the user experience more interesting and interactive, motivating adolescent girls to improve their eating habits.

5 CONCLUSIONS

Factors Nutrition and nutritional status are important determinants of CED risk in adolescent girls. Interventions targeted at these aspects through digital health apps can provide effective solutions. Can provide an effective solution. App development RF-AR application for early detection and intervention of CED offers an innovative approach in improving the health of adolescent girls and preventing long-term complications. The importance of nutritional factors in the risk of of CED in adolescent girls and the potential of mobile health technologies to address this issue. The development of RF-AR applications that combine early detection, nutrition monitoring, and educational support could be an innovative solution for reduce the prevalence of SEZ. This technology-based intervention can help young women take care of their health in a more proactive and informative way.

These findings provide important implications for health interventions among adolescent girls. A comprehensive approach to ensuring adequate nutritional intake and monitoring nutritional status is needed to reduce the risk of SEZ. Educational programs on the importance of balanced nutrition and regular health monitoring can help identify and address nutritional problems early. Further research to improve the effectiveness of the app should be conducted to test and develop additional features that can better understand the psychological and social aspects that may contribute to the risk of CED. In addition, partnerships with educational and health institutions could expand the reach and impact of this intervention.

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