International Journal of Public Health Science (IJPHS)
Vol. 11, No. 3, September 2022, pp. 920~926
ISSN: 2252-8806, DOI: 10.11591/ijphs.v11i3.21592

Infection and undernutrition increase the risk of stunting among rural children

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Article Info

Article history:

Received Dec 6, 2021
Revised May 13, 2022
Accepted June 21, 2022

Keywords:

Children
Energy consumption
Infection history
Protein consumption
Public health center
Stunting

ABSTRACT

The prevalence of stunting in Indonesia is remaining high. Stunting is found to be more common in rural areas than in urban areas. This study aimed to determine the factors associated with stunting in rural areas. We conducted a case-controlled study in Public Health Center Jetis 1 Yogyakarta, Indonesia. We recruited 80 children with the purposive sampling technique. Data on birth weight and disease history were taken from their medical records. Data on consumption patterns of energy, protein, carbohydrate, and fat were collected through a nutritional survey. Different proportions were tested using the fisher test and the mean difference was tested using an independent t-test. The results showed that child stunting had lower energy and protein consumption levels than non-stunting children ($p=0.000$). Diarrheal infection, frequency, and duration of illness were more common in stunted than in non-stunted children ($p<0.05$). Consumption of protein and energy was associated with stunting ($p<0.05$). This research found differences in the incidence of infection, frequency, length of illness, and hospital stay between stunted and non-stunted children. There is a significant association between the consumption of protein and energy with stunted growth in children in rural public health children.

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1. INTRODUCTION

Stunting is one of the most common nutritional problems in children in developing countries including Indonesia [1], [2]. Currently, the global prevalence of stunting is 22% [3]. According to World Health Organization (WHO), Indonesia is ranked third in the highest prevalence of stunting under five with 36% [4]. The Special Region of Yogyakarta is one of the provinces with a high prevalence of stunting in Indonesia [5]. Stunting is a problem because it is associated with an increased risk of morbidity and mortality [6], [7]. Stunting is caused by many factors including direct factors such as food intake and chronic infectious diseases and indirect factors such as economic, cultural, educational, occupational factors, environmental hygiene factors, and health care facilities [8], [9]. The direct factors are determined by food intake [10], which includes protein, and infections that often coincide [11]. Cigarette exposure also increases the risk of

stunting [12], especially when a child has a weak immune system. As a result, the child will be more susceptible to illness, which can cause a decrease in nutritional intake in the child's body. Diarrhea and respiratory tract infections are the most common infections in children [13], [14]. Children with weaker immune are more susceptible to infection [15]. Stunted children are thought to have weaker immunity [16]. It is suspected that there are differences in protein consumption and a history of infectious diseases between stunted and non-stunted children [17].

It is suspected that there is a disparity in stunting prevalence and determinants between rural and urban areas [18]. Urban areas which tend to have better facilities and availability of resources are associated with a lower incidence of stunting [19]. Based on the annual performance report of the Bantul Health Office, it is known that malnutrition in the region is 0.31% [20] Respiratory tract infections are the second-largest outpatients at Bantul's public health center (PHC). Pneumonia in children under five in Bantul Regency was reported in 2020 to have reached 424 cases. The diarrhea morbidity rate in Bantul Regency in 2020 was 64.53 per 1,000 population [21]. Although diarrhea is not included in the top ten diseases at the public health center (PHC), diarrhea in children can have a long-term impact [22], [23].

Chronic malnutrition is associated with stunting and infection in children under five [24]. Long-term malnutrition can disrupt the child's immune system development [25]. Whether malnutrition increases the incidence of infection or increases the severity of the disease remains debatable [26]. The data show that malnourished children have a higher risk of death after infection [27]. The increased susceptibility to infection may be partly due to decreased immune function by malnutrition [16], and infections and deaths in malnourished children are common in low-income environments. Stunted children are at high risk of infection, including respiratory tract infections. Diarrhea is one of the infectious diseases that can cause impaired absorption and even loss of nutrients, and if it is not treated and balanced with appropriate intake, growth wil stunt [28], [29]. In addition, when children have diarrhea, they lose their appetite that further reduces nutritional intake and the nutrients consumed are not absorbed properly by the body. Also, in the same area, another study reported undernutrition as one of the risk factors for mortality in children with moderate-severe-diarrhea [22], [30]. This study aimed to determine differences in the incidence of infection, frequency and duration of illness and hospitalization in stunted and non-stunted children and identify differences in the amount of energy and protein consumption between the two groups.

2. RESEARCH METHOD

2.1. Research design and ethical clearance

This research was an analytical observational study with a case-control design. This study combined interview and questionnaires to collect data on infection and a questionnaire for measuring food intake with 24-hour nutritional recall in children under five years old. For 3 x 24 hours, researchers (who has beed trained in food recal interviews) asked the respondents about food intake data directly to biological mothers or foster mothers. In addition, this study also used secondary data from the medical recordsof the Public Health Center (PHC) Jetis 1 Bantul, Yogyakarta, Indonesia. The research protocol was reviewed by the Health Research Ethics Committee, Faculty of Medicine and Health Sciences, University of Muhammadiyah Yogyakarta. The research protocol has been declared ethically appropriate with an ethical certificate no. 166/EP-FKIK-UMY/VI/2019 by the ethics committee.

2.2. Population and sample

The population in this study was stunted and non-stunted children in the working area of PHC Jetis 1, Bantul, Yogyakarta. There were 77 stunted toddlers in the working area of PHC Jetis 1. Purposive sampling method with inclusion and exclusion criteria were used to select respondents. Inclusion criteria were children aged 24-59 months, children without disability/abnormalities (stump leg, small foot on one side), and mother was willing to be a research respondent. Exclusion criteria were children with special needs and mothers who resigned from the research. Based on the inclusion criteria, 40 stunted toddlers were selected. Due to this study used case-control with a ratio of 1:1, the sample size for the control group was also 40 children under five, so that the total sample was 80 toddlers. A sample of 80 children was taken from the PHC Jetis 1 Working Area, precisely from Trimulyo village, in August-September 2019.

2.3. Research instrument

This study used questionnaire with several written questions which can be used to obtain information from the respondents. Two types of questionnaires were used: i) a questionnaire of respondents' characteristics and infection history, which collected respondents' demographic data such as names of mothers and toddlers, gender of toddlers, ages of mothers and toddlers, the height of toddlers, weight of toddlers, environmental sanitation, and history of infectious diseases of toddlers using 53 question items; and ii) the 24-hour food memory questionnaire (24-hour food recall) which was used three times (1x24 hours) to

gain information regarding nutrient intake and provide a greater variety of individual daily intakes. In addition, the food recal method can obtain a quantitative picture of the calories consumed daily by respondents.

The food recall assessment was used to obtain data on food ingredients consumed by respondents within 24 hours. Nutrient consumption data was obtained utilizing food recall 1x24 hours, which were then converted into energy and nutrients using the list of food ingredients (LFI). The data were processed using Nutrisurvey 2007 software to measure repondent's the level of protein and energy consumption. Furthermore, the data were processed using statistical analysis of IBM statistical package for the social sciences (SPSS) 22.00 for assessment and categorization. Results from 24-hour food recall were divided in two categories: sufficient or low consumption per individual. Protein consumption is considered sufficient if it is 35 grams/day and low if it is <35 grams/day. Sufficient energy consumption is sufficient if the consumption is 1600kcal/day; and low consumption is if the energy consumption is <1,600kcal/day.

2.4. Data collection procedure

2.4.1. Preparation stage

We identify the problems that exist in the community before preparing the research proposal and determine the area to be selected as the research location at random. The next stage is the preparation of the protocol, the preparation of the questionnaire and data collection forms, and the preliminary test. Primary data collection from the research subjects' families was carried out after obtaining informed consent through interviews and data collection forms. We collected secondary data related to weight by age, height by age, and the percentage incidence of malnutrition from the nutrition management section at the PHC Jetis 1, Bantul, Yogyakarta. Respondents were selected using the purposive sampling technique and primary data were collected through questionnairesand interviews related to food intake, especially protein intake and history of infectious diseases.

2.4.2. Implementation stage

We visited the respondent's house and if the respondent met the inclusion criteria, the researcher asked the toddler's parents for their availability to be interviewed. We started by explaining the objectives and benefits of becoming research subjects to the respondent. If the respondent agreed, then they were asked to give their signature on the informed consent.

Data were collected through guided interviews with a questionnaire. The researcher gave an infection questionnaire which contained a list of questions, which were filled by circling the given answers, and a 24-hour food recall questionnaire by interviewing the toddlers' parents. After all the questionnaires were completed, the researcher checked the completeness of the questionnaire and then carriedout data processing, data analysis, and reporting.

2.5. Data analysis

Bivariate analyses were conducted to test the proportions of the two groups using the Fisher test to identify sex proportion, age group, birth weight, parental occupation, parental education, energy, and protein consumption status, history of diarrhea and acute respiratory infection (ARI), frequency and duration of illness, history of hospitalization, exposure to cigarettes, and consumption of multivitamins). The mean difference between groups of stunted and non-stunted children was tested using an independent t-test on the total consumption of energy, carbohydrates, protein, fat, and fatty acids. We also conducted a simple correlation analysis (bivariate correlation) to determine the relationship between each variable protein consumption and energy consumption indicators with the incidence of stunting in children.

3. RESULTS AND DISCUSSION

3.1. Description of respondent's characteristics

Respondents of this study were 80 children (40 stunted as cases, and 40 non-stunted children as controls) with an age range of 24-59 months within the working area of the Public Health Center Jetis 1 in August-September 2019. Table 1 shows the respondents' characteristics based on gender, age, history of low birth weight (LBW), parental education, and parental occupation.

Table 1 shows that most of the respondents were male, aged between 24-41 months, had an average birth weight, and had a history of maternal education of nine years or longer. There was no difference in the demographic characteristics and weight at birth between the two groups. Most mothers of stunted children had a job outside the home, in contrast to mothers of non-stunted children ($p<0.05$). Most stunted children experienced a lack of energy and protein consumption, were exposed to cigarette smoke, did not take multivitamin supplements, had a history of diarrhea, were sick more often, and were hospitalized, compared

to non-stunted children ($p<0.05$). Based on the history of the disease, there were two infectious diseases observed in this study (diarrhea and ARI). Children with stunting experienced diarrhea infections more often than children without stunting ($p<0.05$). However, in stunted and non-stunted children, there was no difference in the proportion of history of respiratory tract infection/ARI ($p>0.05$). It was also found that stunted children were more exposed to cigarette smoke and consumed fewer protein supplements than non-stunted children ($p<0.05$).

Table 1. Demographic characteristics, history of energy and protein consumption, birth weight, exposure to cigarette smoke, consumption of multivitamins, diarrheal illness and ARI, frequency and length of illness, history of hospitalization and education, and mothers' occupation at PHC Jetis 1, Bantul

Characteristic	Stunted (n=40) (%)	Non-stunted (n=40) (%)	p
Sex (male/female)	27 (67.5)	26 (65)	0.81
Age (24-41/42-59 month)	24 (60)	25 (62.5)	0.82
LBW history(yes/no)	6 (15)	3 (7.5)	0.11
Mother with 9 years education (no/yes)	14 (35)	17 (42.5)	0.39
Mother's job (housewife/working woman)	6 (15)	24(60)	0.00**
Protein consumption status (low/enough)	37 (92.5)	0 (0)	0.00**
Energy consumption (low/enough)	38 (95)	13 (32.5)	0.00**
Tobacco smoke exposure (yes/no)	33 (82.5)	10 (25)	0.00**
Multivitamin consumption (yes/no)	14 (35)	22 (55)	0.04*
Diarrhea history (yes)	40 (100)	3 (7.5)	0.00**
Acute respiratory infection history (yes)	40 (100)	30 (75)	0.06
More than 6x diseases (yes/no)	35 (87.5)	3 (7.5)	0.00**
More than seven days of illness (yes)	34 (85)	11 (27.5)	0.00**
Hospitalization history (yes)	30 (75)	11(27.5)	0.00**

There is a reciprocal interaction between infectious diseases (diarrhea and ARI) with nutritional status. Malnutrition can increase the risk of infection, which then can cause malnutrition. Children with malnutrition, with lower body resistance to diseases, are more likely to fall ill. Their reduced nutrition will weaken their capacity to fight diseases and interfere with their growth period [27], [31].

3.2. Differences in consumption of protein, energy, carbohydrates, fats, and fatty acids in stunted and non-stunted children

Malnutrition in children is a global public health problem with broad implications. Malnourished children have an increased risk of dying from infectious diseases. It is estimated that malnutrition is the underlying cause of 45% of global deaths in children under five years. Lack of protein intake can cause stunted growth and bone maturity because protein is an essential nutrient in the growth period. Even though the energy intake is adequate, if protein intake is lacking, it will inhibit the children's growth and development. The nutrition survey results among stunted and non-stunted children are presented in Table 2.

Table 2. Comparison of consumption of protein, carbohydrates, fats, and fatty acids

Characteristic	Stunted (n=40)	Non-stunted (n=40)	p
Energy (kcal)	628.02±143.82	1400.44±423.03	0.00**
Carbohydrate (gram)	87.32±23.51	179.37±79.97	0.00**
Pufa (gram)	7.92±17.68	8.68±4.68	0.72
Protein (gram)	19.00±3.32	49.87±13.46	0.00**
Fat (gram)	22.79±6.05	49.95±16.02	0.00**

Table 2 shows that there are differences in the amount of energy, protein, carbohydrates, and fat consumption between stunted and non-stunted children. However, there is no difference in fatty acid consumption in these two groups. Low protein intake is one of the risk factors for stunted growth in children aged 24-59 months. Protein forms new tissue during the body growth and development and maintains, repairs, and replaces damaged tissue. Even though their energy intake is adequate, children with long-term protein deficiency will experience stunted height growth [32], [33].

3.3. The relationship between energy and protein consumption with the incidence of stunting

Pearson correlation analysis was performed to determine the relationship between the incidence of stunting and the adequacy of protein and energy consumption. The results are presented in Table 3. Based on the significant p-value and r-value from Table 3, it is known that there is a correlation between the status of

protein consumption and the incidence of stunting. This study found that protein consumption in nearly all stunted children (95.0%) was low while in all non-stunted children (100%), the consumption was adequate. Protein is one of the nutrients needed by humans, especially for growth and development. Previous research has shown that stunted children have a much lower protein intake than children who are not stunted. Children who lack protein consumption will be at higher risk of stunting compared to those whose protein consumption is adequate [5], [10]. Based on the significant p-value and r from Table 3, it is known that there is a correlation between the status of energy consumption and the incidence of stunting. From various research results, protein energy malnutrition (PEM) is one of the forms of malnutrition that reduces physical quality and lowers the body's resistance, resulting in an increased risk of illness and death, especially in vulnerable groups. It has been shown that the level of energy consumption is related to the incidence of stunting in children under five years. Toddlers with low energy consumption have a higher risk of stunting than toddlers with sufficient energy consumption levels [34].

Table 3. The relationship between protein consumption and energy consumption with the incidence of stunting

Variable	Pearson correlation	P-Value
Stunting status		
Status of lack of protein consumption	0.951**	0.000
Status of lack energy consumption	0.714**	0.000

Stunted growth has been associated with a weakened immune system [16] because the chemotactic ability of granulocytes in stunted children decreases. Results for phagocytosis were mixed. Five of 12 studies found that leukocytes of malnourished children had reduced ability to ingest particles or bacteria [32]. The results of other studies also show that stunted children experience a decrease in complement system activity. The complement system plays an essential role in self-defense against infection as a natural defense system. Nutritional energy and protein deficiencies are associated with an increased incidence of rotavirus infection in children under five years of age. Studies conducted in Angola and Bangladesh observed an association between different types of undernutrition with rotavirus a infection [35], [36].

4. CONCLUSION

Stunted children are more susceptible to diarrhea, more frequent and longer sickness, and hospitalized more often when compared to non-stunted children. They also consume less energy, protein, carbohydrates, and fat. Consumption of energy and protein is associated with the incidence of stunting.

Based on the research data, it is known that adequate energy and protein consumption is the main component in the prevention and treatment of stunting in rural areas in Indonesia. As a tropical country, Indonesia is rich in various plants and animals as a source of energy and protein. Communities in rural areas need knowledge and skills to diversify energy and protein sources using local resources to meet children's energy and protein needs sustainably.

ACKNOWLEDGEMENTS

The authors thank to the Research Institute and Community Service (*Lembaga Penelitian dan Pengabdian Kepada Masyarakat/LPPM*) Universitas Ahmad Dahlan for providing research funding assistance.

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