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Differences Nutritional Status, Dietary Patterns, Diarrhea History, and Nutritional Knowledge between Children with Autism and children without Autism in Jakarta

Perbedaan Status Gizi, Pola Makan, Riwayat Diare, dan Pengetahuan Gizi Seimbang pada Anak Autisme dan Non-Autisme di Jakarta

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ABSTRACT

Background: Autism Spectrum Disorder (ASD) is characterized by difficulties in social interaction and communication. Children with ASD are at risk of being overweight due to selective eating patterns and parents' lack of nutritional knowledge, and they often experience diarrhea due to enzyme deficiencies.
Objectives: This study aims to determine the differences in nutritional status, dietary patterns, and diarrhea history between children with ASD and children without ASD, as well as the differences in the nutritional knowledge of parents or caregivers of children with ASD and children without ASD.
Methods: The research uses a case-control design with 102 samples (51 children with ASD and 51 children without ASD) obtained through cluster random sampling. Nutritional status data were collected from anthropometric measurements, dietary patterns through the SQ-FFQ, and parents' nutritional knowledge and children's diarrhea history through questionnaires. Data analysis utilized Independent Sample T-test or Mann Whitney tests.
Results: Results showed significant differences in nutritional status (height-for-age, p-value=0.006), frequency of staple food consumption (p-value=0.018), animal protein (p-value=0.014), dairy products (p-value=0.001), amount of staple food consumption (p-value=0.016), dairy products (p-value=0.003), fat intake (p-value=0.037), fiber intake (p-value=0.033), frequency of diarrhea (p-value=0.042), and duration of diarrhea (p-value=0.042). However, there were no significant differences in BMI-for-age (p-value=0.410) and caregiver's nutritional knowledge scores (p-value=0.855).
Conclusions: It can be concluded that children with ASD and without ASD have differences in nutritional status, dietary patterns, and diarrhea history.

INTRODUCTION

According to the World Health Organization (WHO), Autism Spectrum Disorder (ASD) is defined as a group of conditions characterized by difficulties in socializing and communicating. ASD can occur in children as a result of abnormalities in the brain related to the number of nerve cells either during the mother's pregnancy or after childbirth[1]. The Center for Disease Control and Prevention (CDC) reports that 1 in 36 children will have ASD by 2020 in the United States[2]. Although there is no exact data on the prevalence of people with ASD in Indonesia, the Ministry of Health states that the number of children with autism in Indonesia has increased significantly to reach around 2.4 million children in 2021 and continues to increase by 500 children every year[3].

School-age children are children aged 6-12 years who experience the transition from early childhood to late childhood to pre-puberty[4]. In school-age children, nutritional status plays an important role in shaping physical growth, brain development, optimal work ability[5]. However, in children with ASD, nutritional status can be different because children with ASD have limitations in the use of nutrients in food which can affect the low or excessive intake of nutrients[6]. Some previous studies have also stated that children with ASD are more likely to have an overnutrition status compared to normal children as a result of high consumption patterns of high energy and fat foods[7].

Meanwhile, nutrition problems among primary school-aged children in Indonesia are still quite high. Nutritional problems that generally occur include

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stunting, very thin, and obesity or overweight. Based on Riskesdas data in 2018, the nutritional status of children aged 5-12 years based on BMI-for-age (BMZ) was in the underweight category as much as 9.2% were thin, 10.8% of children were overweight, and 9% were obese. Meanwhile, the incidence of stunting based on the weight-for-age (WAZ) index in children aged 5-12 years was 23.6%, consisting of 16.9% short and 6.7% very short[8] . In addition, the nutritional status of school-age children in the Jakarta area based on BMI-for-age (BMZ) was found to be fat 15.2%, obese 14%, thin 6%, and very thin 1.9%, and based on weight-for-age (WAZ) was found to be short 8.1%, and very short 2.7%. Problems with nutritional status can increase the risk of generative diseases, weaken the immune system, and inhibit cognitive, motor, and verbal development[9].

Diet is a description of the quantity, proportion, diversity, and frequency of foods and beverages commonly consumed[10] . Consumption patterns in children with ASD and without ASD show differences in nutrient preferences. Children with ASD prefer energy-dense foods, which are foods that have high calories in a small amount of food and have a low preference for vegetables, fruits, and dairy and processed products compared to children without ASD[11]. In addition, children with ASD showed higher levels of energy, protein, and fat adequacy, although not all differences were statistically significant. This suggests that the diet and nutrient intake of children with ASD may vary when compared to children without ASD. Thus, this may affect the intake of nutrients consumed, which will then reflect on the nutritional status of children with ASD[12,13].

Balanced nutrition is a daily food arrangement that contains nutrients in the types and amounts that are in accordance with the body's needs[14]. Balanced nutrition knowledge is important for every parent or caregiver to have so that children do not experience nutritional deficiencies, so that children can grow and develop optimally[15]. Knowledge greatly influences a person's mindset and behavior. A person's attitude and understanding of balanced nutrition play an important role in a person's compliance in implementing a balanced diet.

Nutritional problems in children with ASD generally result from imperfections in the digestive system in the absorption of nutrients[16]. Children with ASD often experience complex gastrointestinal problems. One of the most common digestive disorders experienced by children with ASD is non-infectious diarrhea. Non-infectious diarrhea in children with ASD is often associated with impaired digestion of gluten and casein proteins which then result in allergies. These food allergies or intolerances arise due to inadequate enzymes needed to digest certain substances in food, such as lactase enzyme deficiency that causes lactose intolerance, which is the sugar in milk[17].

Based on the background, children with autism are different from children with ASD. One of the differences is that children with autism have limited psychological abilities, difficulty in communicating, and brain abnormalities related to motor disorders, which can affect their nutritional status, diet, and digestive system disorders. Overall, the most common nutritional status problems of school-age children in Jakarta are obesity and stunting. This is in line with the preliminary study conducted by researchers on 10 school-age children at Meruya Utara 12 Pagi Jakarta State Elementary School, the results of nutritional status based on TB / U and BMI-for-age (BMZ) found as many as 2 short children (20%), 2 obese children (20%), and 2 obese children (20%). While the results of a preliminary study of nutritional status in autistic children based on weight-for-age (WAZ) and BMI-for-age (BMZ) at SLBN 10 Jakarta found as many as 1 short child (6.7%), 3 tall children (20%), and 1 obese child (6.7%). In addition, other studies related to differences in children with ASD and children without ASD in Jakarta area are still rare. This study aims to determine the differences in nutritional status, diet, and history of diarrhea between children with ASD and without ASD, as well as the differences in balanced nutrition knowledge among their caregivers, for children aged 6–12 years in schools in the Jakarta area. This study is expected to add insight for researchers, subjects, and schools involved, and can be used as a reference for further research.

METHODS

In this study, a case-control design was applied to determine differences in several independent variables studied. With a sample population of all ASD subjects as a case group and all Children with ASD as a control group with matching ages 6-12 years in the Jakarta area. The sample size calculation in this study used the formula of Lemeshow et al. (1997) and obtained a minimum sample size of 46 samples of ASD and children with ASD respectively with a ratio of 1:1. Furthermore, the sample was added 10% to prevent drop out, so that the number of samples of each population was 51 samples. Therefore, the minimum sample size required was 102 samples.

The sampling technique used in this study was cluster random sampling for sampling the population of children with ASD and stratified random sampling for sampling the population of Children with ASD. The schools used as research samples were SLBN 10 Jakarta, SLBN 6 Jakarta, SLBN 5 Jakarta, SLB Tri Asih, SLB Dian Kusuma, SLB Dian Grahita, SLB Autisma Talitakum, SLB Cahaya Bintang, SLBN 9 Jakarta, SLBN 11 Jakarta, and SLBN 3 Jakarta, and SDN 12 Meruya Utara Jakarta.

Inclusion criteria in this study consisted of (1) Guardians / parents / caregivers / caregivers / companions of students with ASD and Children with ASD who were willing to become respondents, fill out informed consent, can cooperate in filling out questionnaires, and follow the research until completion. (2) Children with ASD aged 6-12 years in special schools in the Jakarta area. (3) school-age children without ASD aged 6-12 years in elementary schools in the Jakarta area. The exclusion criteria were children with ASD who were sick, epileptic, and had limitations to stand/be paralyzed during data collection.

Data collection consists of primary data and secondary data. Primary data included (1) Respondent characteristics data in the form of personal identity obtained directly from filling out or interviewing. (2)

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Anthropometric data, namely measurements of body weight, height using digital scales and microtoise (3) Data on the incidence of diarrhea including history of diarrhea in the last three months, frequency, and duration of diarrhea using a questionnaire. (4) Data on feeding patterns using the Semi Quantitative Food Frequency Questionnaire (SQ-FFQ). (5) Data on parents/guardians/caregivers' knowledge of balanced nutrition were obtained from 11 questionnaire questions related to the 10 balanced nutrition messages indicator. Meanwhile, secondary data used were sourced from the school and prevalence data on nutritional status from the 2018 Basic Health Research.

Nutritional status data were classified according to the growth requirements of children aged 5-19 years based on the Z Score by WHO in 2009[18]. A history of diarrhea was defined as diarrhea if in the last three months, a health worker had diagnosed diarrhea or had 3-6 bowel movements a day or more with a mushy or liquid consistency. The diarrhea frequency and duration questionnaire used open-ended questions. The dietary pattern questionnaire used SQ-FFQ (Semi Quantitative Food Frequency Questionnaire) consisting of 60 food items from a market survey. The food items were classified by food type including staple foods, animal protein, vegetable protein, vegetables, fruits, and dairy products, along with the frequency and amount of consumption in a month, as well as the average macronutrient intake per day. The balanced nutrition knowledge score is obtained from the total score of 11 questions based on the 10 balanced nutrition messages indicators which are then measured in the range 0-100. Indicator questions consisted of (1) understanding food diversity, (2) recommended portions of vegetable and fruit consumption, (3) grouping of animal side dishes, (4) grouping of staple foods, (5) recommendations for consumption of sugar, salt, and oil, (6) recommendations for drinking water, (7) appropriate breakfast time, (8) contents of food labels, (9) how to wash hands properly, (10) physical activity time, and (11) normal body weight indicators. The balanced nutrition knowledge score is measured based on the good category if the score ≥ 80%, sufficient if the score = 60-80%, and less if < 60%[19].

Validity and reliability tests have been carried out on the variable of balanced nutritional knowledge of caregivers. The validity test results obtained as many as 11 out of 22 questions have a value of R count> R Table (0.361), therefore, it is considered valid. Furthermore, the reliability test results show reliable results with a Cronbach's Alpha value of 0.693 greater than 0.06 and greater than R Table 0.361. In addition, normality tests were conducted on all variables. Based on the normality test results, the Z Score weight-for-age (WAZ) and Z Score BMI-for-age (BMZ) variables are normally distributed because the significance value is more than 0.05. The difference test for data that is not normally distributed uses the Mann Whitney test method. As for normally distributed data, it was tested using the Independent Sample T-Test method. Then it is said that there is a significant difference if the p-value is < 0.05 which is analyzed using SPSS software. In addition, this study has obtained a research permit and approval letter on February 16, 2024 with letter number 52/II/2024/KEP from the Research Ethics Code Commission of Universitas Pembangunan Nasional Veteran Jakarta.

RESULTS AND DISCUSSIONS

Respondent Characteristics

Table 1. Overview of Respondents' Characteristics, Nutritional Status, History of Diarrhea, and Caregivers' Nutritional Knowledge

Characteristics	ASD		Without ASD	
	n	%	n	%
Child Gender				
Male	40	78,4	20	39,2
Female	11	21,6	31	60,8
Child's age				
6 years	0	0	1	2,0
7 years	2	3,9	3	5,9
8 years	4	7,8	14	27,5
9 years	7	13,7	9	17,6
10 years	12	23,5	8	15,7
11 years	8	15,7	8	15,7
12 years	18	35,3	8	15,7
Father's Education				
Elementary school/equivalent	1	2,0	3	5,9
Junior high school/equivalent	2	3,9	14	27,5
High school/equivalent	23	45,1	26	51,0
Diploma	3	5,9	2	3,9
College	22	43,1	5	9,8
More	0	0	1	2,0
Father's occupation				
Civil Servant/TNI/Police	4	7,8	3	5,9
Private/State Owned Enterprise Employee	18	35,3	9	17,6
Merchant	3	5,9	4	7,8
Farmers	1	2,0	0	0

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Characteristics	ASD		Without ASD	
	n	%	n	%
Self-employed	13	25,5	18	35,3
Not Working	2	3,9	4	7,8
More	10	19,6	13	25,5
Mother's Education				
Elementary school/equivalent	1	2,0	4	7,8
Junior high school/equivalent	4	7,8	16	31,4
High school/equivalent	17	33,3	22	43,1
Diploma	10	19,6	2	3,9
College	19	37,3	7	13,7
Mother's Occupation				
Civil Servant/TNI/Police	2	3,9	3	5,9
Private/State Owned Enterprise Employee	10	19,6	0	0
Merchant	1	2,0	3	5,9
Self-employed	3	5,9	4	7,8
Not Working / Housewife	35	68,6	41	80,4
Weight-for-age (WAZ)				
Short	1	2,0	4	7,8
Normal	50	98,0	47	92,2
BMI-for-age (BMZ)				
Skinny	3	5,9	3	5,9
Normal	25	49,0	27	52,9
Fat	23	45,1	21	41,2
History of diarrhea (last 3 months)				
No	47	92,2	51	100,0
Yes	4	7,8	0	0
Diarrhea Frequency (times/month)				
0 times	47	92,2	51	100,0
1 time	2	3,9	0	0
2 times	2	3,9	0	0
Duration of Diarrhea (days)				
0 days	47	92,2	51	100,0
1 day	1	2,0	0	0
2 days	2	3,9	0	0
3 days	1	2,0	0	0
Balanced Nutrition Knowledge of Caregivers				
Good	7	13,7	5	9,8
Simply	17	33,3	22	43,1
Less	27	52,9	24	47,1

Based on Table 1 most ASD child subjects are male. This is inversely proportional to the Child without ASD respondents who are predominantly female. According to a statement by the Diagnostic and Statistical Manual of Mental Disorders (DSM-V), boys tend to have a 4 times greater risk of being diagnosed with ASD compared to girls[20] . This is because male brain characteristics and higher levels of testosterone may increase the risk of autism. In addition, the X and Y chromosome theory also states that males are more vulnerable because they have one X chromosome.

Most of the ASD child respondents were 12 years old and the least was 7 years old. Meanwhile, the age of the child without ASD respondents was mostly 8 years old and the least was 6 years old. The average age of the ASD child respondents was 10 years old, while the Child without ASD respondents were 9 years old.

Furthermore, descriptive analysis was conducted on family socioeconomic data. Overall, most of the fathers of the ASD group respondents had a high school/equivalent education, followed by college. Meanwhile, in the group of children without ASD, most fathers also had a high school education followed by junior high school education. Father's occupations in both groups were dominated by the self-employed. The education of mothers in the ASD group was mostly college and senior high school/equivalent, while in the group of children without ASD, the majority were senior high school/equivalent and junior high school/equivalent. Maternal occupations in both groups were mostly unemployed or housewives. Meanwhile, the average family income of respondents with ASD was higher than that of respondents without ASD.

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Table. 2 Results of Descriptive Analysis of Respondents' Characteristics, Nutritional Status, History of Diarrhea, and Caregiver's Nutritional Knowledge

Variables	ASD		Without ASD	
	Min ± Max	Mean ± SD	Min ± Max	Mean ± SD
Child's age (year)	7 ± 12	10,45 ± 1,487	6 ± 12	9,49 ± 1,642
Family Income (IDR/month)	1,000,000 ± 20,000,000	7,151,788,06 ± 4,996,819,304	2,000,000 ± 20,000,000	4,705,882,35 ± 3,204,647,361
Z Score weight-for-age (WAZ)	-2,94 ± 4,11	0,30 ± 1,54	-2,91 ± 4,52	0,72 ± 1,70
Z Score BMI-for-age (BMZ)	-3,62 ± 1,84	-0,46 ± 1,16	-2,84 ± 3,66	0,45 ± 1,62
Diarrhea Frequency	0 ± 2	0,12 ± 0,431	0 ± 0	0 ± 0
Duration of Diarrhea (days)	0 ± 3	0,16 ± 0,579	0 ± 0	0 ± 0
	Min ± Max	**Median ± IQR**	**Min ± Max**	**Median ± IQR**
Nutrient Intake				
Energy (kcal/day)	461,1 ± 2116	1028,6 ± 566,8	386,4 ± 2134,3	1003,5 ± 485,6
Protein (g/day)	12,5 ± 124,2	46,1 ± 22,3	16,7 ± 104,9	44,5 ± 27,7
Fat (g/day)	2,3 ± 90,4	30,3 ± 25,5	10 ± 81,9	36 ± 24,5
Carbohydrate (g/day)	65 ± 403	156,3 ± 78,3	66 ± 351,9	149,3 ± 87,4
Fiber (g/day)	1 ± 83,7	8.1 ± 9.2	1,7 ± 90	11,5 ± 20,4
Balanced Nutrition Knowledge Score	18,2 ± 100	54,5 ± 27,2	9,1 ± 90,9	63,6 ± 27,2

Nutritional Status Overview

Based on the results of the frequency distribution analysis, the nutritional status of stunted children was more prevalent in the group without ASD compared to the ASD group. In addition, the percentage of obese children was higher in the ASD group (45.1%) compared to the group without ASD (41.2%). This is in line with the study of Rouphael et al[21] which found that the percentage of fat/obese children was higher in Children with ASD(58%) compared to Children with ASD (20%).

Diet Overview

Out of 60 food items in total from the food items group, the researcher only took the 5 most frequently consumed food items in subject with ASD and without ASD. Descriptive analysis results used the median and interquartile range (IQR) because the data was not normally distributed. Consumption frequency indicates how often a particular food is consumed in one week, while consumption amount indicates how much of that food is consumed in gram per week.

Staple food is the main source of energy that is very important in carrying out daily activities. Table 3 shows that the frequency of staple food consumption per week was higher in the group of children without ASD (25.8 ± 6) compared to the ASD group (23.8 ± 4.7), although the total consumption of the ASD group (2150 ± 1207.5) was greater than the group without ASD (1680 ± 551.2).

Animal protein is a source of nutrients that play a role in growth and repairing damaged body cells. Based on Table 3, animal protein was consumed more frequently by the group of children without ASD (15.5 ± 14 times/week) than ASD (11.7 ± 12 times/week), with the amount of consumption higher in children without ASD (837.5 ± 652.5 g) than ASD (612.5 ± 535 g). This finding is in line with research by Plaza-Diaz et al[7] who found that the average frequency per day of meat and fish food groups was higher in children without ASD (4.6 ± 1.4 and 2.6 ± 1.1) than in the group of children with ASD (2.0 ± 0.5 and 2.5 ± 1.2).

Table 3. Overview of Diet based on Frequency of Consumption, Amount of Consumption, and Type of Food

Food Type	Consumption Frequency (x/week)				Total Consumption (g/week)			
	ASD		Without ASD		ASD		Without ASD	
	Min ± Max	Median ± IQR	Min ± Max	Median ± IQR	Min ± Max	Median ± IQR	Min ± Max	Median ± IQR
Staple Food								
Rice	0 ± 21	21 ± 0	14 ± 28	21 ± 0	0 ± 6300	2100 ± 1050	700 ± 2800	1260 ± 420
Fresh Bread	0 ± 7	0,5 ± 2	0 ± 35	2 ± 3	0 ± 560	35 ± 140	0 ± 735	70 ± 105
Corn	0 ± 14	0 ± 2	0 ± 6	1 ± 0,8	0 ± 540	0 ± 70	0 ± 450	35 ± 87,5
Egg Noodles	0 ± 21	0,3 ± 1	0 ± 4	1 ± 1,7	0 ± 1407	10 ± 50	0 ± 400	87,5 ± 175
Potatoes	0 ± 4	0,8 ± 1,7	0 ± 4	1 ± 1,5	0 ± 450	56,25 ± 197,5	0 ± 1200	100 ± 150

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Overall Staple Food	10,5 ± 39	23,8 ± 4,7	15 ± 59	25,8 ± 6	652,5 ± 6975	2150 ± 1207,5	922,5 ± 2915	1680 ± 551,2
Animal Protein								
Eggs	0 ± 14	4 ± 5	0,8 ± 14	4 ± 4	0 ± 1680	240 ± 300	45 ± 840	240 ± 240
Chicken Meat	0 ± 21	3 ± 5	0,5 ± 21	3 ± 4	0 ± 1680	120 ± 200	15 ± 840	150 ± 270
Sausages	0 ± 7	0 ± 1	0,3 ± 21	2 ± 3	0 ± 525	0 ± 50	3,8 ± 525	100 ± 175
Nugget	0 ± 7	0 ± 2	0 ± 14	2 ± 2,3	0 ± 480	0 ± 80	0 ± 840	120 ± 200
Catfish	0 ± 4	0 ± 2	0 ± 21	1 ± 1,5	0 ± 250	0 ± 80	0 ± 840	40 ± 60
Beef	0 ± 35	0,25 ± 2	0 ± 3	0,5 ± 0,8	0 ± 1400	10 ± 100	0 ± 120	15 ± 13,8
Overall Animal Protein	0 ± 43	11,7 ± 12	3,8 ± 47	15,5 ± 14	0 ± 2240	612,5 ± 535	198,8 ± 2125	837,5 ± 652,5
Vegetable Protein								
Tempeh	0 ± 14	2 ± 3,5	0 ± 21	2 ± 2	0 ± 1200	90 ± 200	0 ± 1050	50 ± 100
Know	0 ± 21	2 ± 4	0 ± 21	2 ± 3	0 ± 840	80 ± 240	0 ± 640	90 ± 240
Soy Milk	0 ± 14	0 ± 0	0 ± 7	0,5 ± 1	0 ± 3500	0 ± 0	0 ± 1400	100 ± 225
Green Beans	0 ± 7	0 ± 1	0 ± 7	0,25 ± 1	0 ± 300	0 ± 100	0 ± 700	25 ± 70
Oncom	0 ± 1	0 ± 0	0 ± 2	0 ± 0,3	0 ± 20	0 ± 0	0 ± 112,5	0 ± 7,5
Vegetable Protein	0 ± 44	5 ± 7,6	0 ± 44	6 ± 7,8	0 ± 5000	232,5 ± 630	0 ± 1690	403,8 ± 655
Vegetable								
Carrots	0 ± 21	3 ± 6	0 ± 7	2 ± 1	0 ± 630	60 ± 125	0 ± 350	30 ± 48
Green Mustard	0 ± 21	0,75 ± 3	0 ± 4	0,5 ± 2	0 ± 4200	15 ± 45	0 ± 300	11,25 ± 60
Spinach	0 ± 7	1 ± 1,8	0 ± 7	1 ± 1	0 ± 700	22,5 ± 52,5	0 ± 700	60 ± 170
Kale	0 ± 14	0,5 ± 2	0 ± 7	1 ± 1	0 ± 700	7,5 ± 45	0 ± 700	10 ± 37,5
Chickpeas	0 ± 14	0 ± 2	0 ± 4	1 ± 2	0 ± 420	0 ± 40	0 ± 120	10 ± 30
Overall Vegetable	0 ± 63	7 ± 10	0 ± 22	6,5 ± 5,7	0 ± 4830	180 ± 265	0 ± 1760	210 ± 265
Fruit								
Bananas	0 ± 14	0,75 ± 2	0 ± 7	2 ± 2	0 ± 1400	50 ± 200	0 ± 700	200 ± 200
Papaya	0 ± 7	0,25 ± 3	0 ± 7	1 ± 1,5	0 ± 700	25 ± 300	0 ± 315	75 ± 200
Oranges	0 ± 14	1 ± 2	0 ± 7	1 ± 1,3	0 ± 1540	100 ± 200	0 ± 900	110 ± 160
Watermelon	0 ± 3	0 ± 1	0 ± 7	1 ± 1,8	0 ± 400	0 ± 100	0 ± 1400	100 ± 275
Red Dragon	0 ± 21	0 ± 1	0 ± 3	1 ± 1	0 ± 5040	0 ± 160	0 ± 960	80 ± 160
Overall Fruit	0 ± 37	5 ± 7,1	0 ± 17	8 ± 7,7	0 ± 5160	600 ± 761,3	0 ± 2160	870 ± 815
Dairy Products								
Liquid Cow's Milk	0 ± 7	1 ± 7	0 ± 49	3 ± 5	0 ± 350	200 ± 1750	0 ± 840	500 ± 1025
Cow's Milk Powder	0 ± 6	0 ± 0	0 ± 21	1 ± 3	0 ± 1275	0 ± 0	0 ± 1200	20 ± 60
Cheese	0 ± 7	0 ± 0,5	0 ± 21	1 ± 2,8	0 ± 840	0 ± 7,5	0 ± 960	15 ± 37,5
Yoghurt	0 ± 7	0 ± 0,3	0 ± 6	1 ± 1,5	0 ± 3500	0 ± 40	0 ± 6125	120 ± 320
Overall Dairy Products	0 ± 21	3 ± 8,9	0 ± 36	8 ± 9	0 ± 3675	390 ± 1748,7	0 ± 3740	955 ± 1290

Vegetables are an important source of fiber, vitamins, and minerals for health. Based on Table 3, the frequency of vegetable consumption was more frequent in the group of children with ASD group (7 ± 10 times/week) compared to the children the group of children without ASD (6.5 ± 5.7 times/week), but the amount of consumption was found to be higher in group of children without ASD (210 ± 265 g) compared to ASD (180 ± 265 g). This new result on the frequency pattern of vegetable consumption was not found in several previous studies which stated that the frequency of vegetable consumption was higher in the group of children with ASD compared to the group of children without ASD.

Apart from vegetables, fruits are also an important source of vitamins, minerals, and fiber. Overall, fruit consumption showed slightly different patterns, with higher frequency in the group of children without ASD (8 ± 7.7 times/week) compared to the group of children with ASD (5 ± 7.1 times/week). Similarly, the amount of consumption was greater in the group of children without ASD (870 ± 815 g) compared to the group of children with ASD (600 ± 761.3 g). These results are in line with research by Evans et al[22] who found that the frequency of fruit consumption was higher in the Typically Developing (TD) group compared to ASD group.

Dairy products such as liquid cow's milk and yoghurt are important sources of calcium and protein for bone growth. Based on Table 3, dairy products were

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consumed more frequently by the children without ASD (8 ± 9 times/week) than ASD (3 ± 8.9 times/week), and the amount of consumption was also higher in the group of children without ASD (955 ± 1290 g) than ASD (390 ± 1748.7 g). These results are in line with research by[23] , which found that the amount of consumption of dairy products was significantly lower in the ASD group.

In performing daily activities, the body needs energy as a source of power obtained from staple foods such as rice, bread, potatoes, and so on. Based on Table 3, the average energy intake in the group of children with ASD is slightly higher than in the group of children without ASD. The higher average energy consumption in ASD may occur because Children with ASD prefer energy dense foods and sugary drinks[22]. Protein intake in the group of children with ASD tended to be higher compared to the group of children without ASD. This is supported by the study of Ghazali et al[24] who found that the ASD group (72.35 ± 23.17) consumed more protein than the group of children without ASD (54.4 ± 20.18) at the age of 7-9 years in Malaysia.

Meanwhile, fat intake in the group with ASD was lower compared to the group of children without ASD. These results were similar in a study by Al-Kindi[25] who found a lower mean fat intake in the ASD group (38.9 ± 3.3) than in the TD group (47.4 ± 1.8). Carbohydrate intake in both groups showed that the group with ASD consumed slightly higher compared to the group of children without ASD. The high average carbohydrate intake in the group of children with ASD (258.74 ± 77.75) compared to the group of children without ASD group (192.51 ± 69.76) was also found in the study of Ghazali et al[24]. Fiber intake showed a significant comparison between the two groups. The group of children with ASD consumed much lower fiber compared to the group of children without ASD. Findings in line with fiber intake were also found to be lower in the group of children with ASD group (9.8± 0.7) compared to the group of children without ASD(12.5± 0.7.0)[25]

History of diarrhea

Based on Table 1, most of the subjects in the ASD group had no history of diarrhea, but 7.8% of them had experienced diarrhea in the past month. In contrast, all subjects in the group of children without ASD had no history of diarrhea in the past month. This result is in line with the findings by Babinska et al[26], he found that subjects who experienced diarrhea were significantly more in the ASD group subjects (46.6%) than in the control group (44.6%).

Meanwhile, based on the frequency of diarrhea in a month, 3.9% had diarrhea once and 3.9% had diarrhea twice a month. The average frequency of diarrhea in the group with ASD was 0.12 ± 0.431 times per month. Meanwhile, a study comparing the difference between autistic and non-autistic groups in Bogor City showed that there were 5.7% of Children with ASD who experienced diarrhea 1 time and there were 2.9% of children who experienced diarrhea 2 times in the last month with an average overall frequency of 0.1± 0.4[12].

The duration of diarrhea also showed differences between the two groups. A total of 2% experienced diarrhea for one day, 3.9% for two days, and 2.0% for three days. The average duration of diarrhea in the group with ASD was 0.16 ± 0.579. Similar results were also found in a study by Pestia[12], he found as many as 8.6% of Children with ASD who had diarrhea for less than 4 days compared to the non-autistic group who had no diarrhea at all in the past month.

Overview of Balanced Nutrition Knowledge of Caregivers

Overall, the median score of balanced nutrition knowledge of parents of children with ASD (54.5 ± 27.2) was lower compared to parents of children without ASD (63.6 ± 27.2). Meanwhile, based on the minimum and maximum values in ASD parents (18.2±100) was greater compared to parents of children without ASD (9.1± 90.9). Based on the category of parents' balanced nutritional knowledge score, most parents of the children with ASD and without ASD had a poor level of nutritional knowledge, but this number was higher in the group of parents of children with ASD (52.9%, compared to the group of parents of children without ASD (47.1%).

Differences in Nutritional Status of Children with Autism Spectrum Disorder (ASD) and without ASD

Table 4. Differential Test Results of Nutritional Status, History of Diarrhea, and Nutritional Knowledge of Caregivers

Variables	p-value
Nutrition Status	
Weight-for-age (WAZ) Zscore	$0{,}006^{a)*}$
BMI-for-age (BMZ) Zscore	$0{,}410^{a)}$
Diet	
Consumption Frequency	
Staple Food	$0{,}018^{b)*}$
Animal Protein	$0{,}014^{b)*}$
Vegetable Protein	$0{,}192^{b)}$
Vegetable	$0{,}263^{b)}$
Fruit	$0{,}145^{b)}$
Dairy Products	$0{,}001^{b)*}$

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Total Consumption	
Staple Food	$0{,}016^{b)*}$
Animal Protein	$0{,}051^{b)}$
Vegetable Protein	$0{,}098^{b)}$
Vegetable	$0{,}880^{b)}$
Fruit	$0{,}192^{b)}$
Dairy Products	$0{,}003^{b)*}$
Nutrient Intake	
Energy (kcal/day)	$0{,}825^{b)}$
Protein (g/day)	$0{,}733^{b)}$
Fat (g/day)	$0{,}037^{b)*}$
Carbohydrate (g/day)	$0{,}678^{b)}$
Fiber (g/day)	$0{,}033^{b)*}$
History of Diarrhea Events	
Diarrhea Frequency	$0{,}042^{b)*}$
Duration of Diarrhea	$0{,}042^{b)*}$
Balanced Nutrition Knowledge of Caregivers	
Balanced Nutrition Knowledge Score	$0{,}855^{b)}$

a) Independent Sample T-test
b) Mann Whitney Test
*significantly different

Nutritional status data based on weight-for-age (WAZ) and BMI-for-age (BMZ) Z Score calculations were analyzed using the Independent Sample T-test because the data was normally distributed. Based on Table 4, there is a difference between nutritional status based on the weight-for-age (WAZ) indicator with a p-value of 0.006 (<0.05). Stunting nutritional status was found more in the group of children without ASD compare to the group of children with ASD. These results are in line with research conducted by Ghazali et al[24] in Malaysia on ASD and Typical Development (TD) children who found differences in nutritional status based on the TB / U indicator significantly more found in the TD group with a p-value of 0.003. weight-for-age (WAZ) is an indicator that reflects past nutritional status. This indicator uses height as a reference for bone and skeletal growth in accordance with age[27]. Lack of nutrient intake over a long period of time, especially in the first 1000 days of life (HPK) will inhibit the growth of children's height, so that children are at risk of stunting[28]. This study found lower protein intake in children without ASD compared to children with ASD based on median values, which is associated with more stunting in the ASD group. Protein plays an important role in the structure, function, and regulation of living cells and viruses during the growth and development of children. If protein intake is inadequate, the body will lack energy sources, so energy formation will be obtained from the breakdown of protein in the muscles. If this happens in the long term, it will cause muscle shrinkage and affect the nutritional status of a person to become thin and will experience stunting[29].

Meanwhile, the opposite result was found in nutritional status based on the BMI-for-age (BMZ) indicator. The results of the analysis state that there is no difference in nutritional status based on the BMI-for-age (BMZ) indicator with a p-value of 0.410. This result is in line with research by Esteban-Figuerola et al[30] who found no difference with a p-value of 0.802 on the BMI for Age variable. Although there is no significant difference, this study also states that school-age children with ASD have greater weight and BMI than normal or Typical Development (TD) children. Different results in a study by Rouphael et al[21] in Lebanon found that there were differences in BMI/U in ASD and Children with ASD of pre-school age (3-9 years) with a p-value of 0.000. Children with ASD have an 8 times as high as risk of obesity compared to normal children[31].

Results from studies show that children with autism (ASD) are more overweight and obese than children with Typical Development (TD) or normal development. Ghazali et al[24] reported that 11.8% of Children with ASD were overweight and 27.5% were obese, totaling 39.3%, compared to TD children who were 14.5% and 9.1% respectively, totaling 23.6%. One of the main risk factors affecting weight status is selective food behaviors, with 88.2% of Children with ASD having behavioral problems at mealtime, especially in the selection of limited food groups. Therefore, Children with ASD tend to be picky eaters. Picky eater is defined as a child who consumes a smaller variety of food groups by rejecting familiar and unfamiliar foods and rejecting certain food textures[32]. These selective habits can affect nutritional adequacy, both macro and micronutrients, which in turn will affect children's growth and development.

Research by Toscano et al[33] also added that restricted and repetitive behaviors in Children with ASD can inhibit the development of motor skills and physical fitness levels, thus leading to low levels of physical activity in a day. As a result of low physical activity, the incidence of overweight/obesity in ASD may increase and risk complications. In addition, Children with ASD undergoing therapy using antipsychotic drugs also contribute to increased body mass and inhibit body metabolism. In addition, Rouphael et al[21] also stated that factors such as sleep disturbance, lack of physical activity, motor impairment, genetic predisposition, and selective behavior towards food also play a role in increasing body weight in ASD children. In addition, the

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results of higher prevalence of overweight or obesity in the group of children with ASD group compared to the group of children without ASD in this study may be attributed to greater energy and carbohydrate intake and lower fiber intake in the ASD group.

Differences in Diet of Children with Autism Spectrum Disorder (ASD) and without ASD

Diet is a description of eating habits that include types of food groups, frequency, and amount of consumption. Based on the results of the normality test, dietary pattern data which includes the frequency and amount of consumption of several types of food are not normally distributed. Therefore, to determine differences in dietary patterns, a Mann Whitney test was conducted. The results of the macronutrient intake analysis are attached in Table 4.

Based on the t-test results, there was no significant difference in energy intake between the groups of children with ASD and without with a p-value of 0.825. The slightly higher mean value of energy consumption in ASD may occur because Children with ASD prefer energy dense foods[22]. Energy dense foods are foods that contain high energy and carbohydrate density. If consumed in the long term, it will cause an imbalance between the energy consumed and used (Kemenkes RI, 2018). Zeybek[34] found that energy dense and high carbohydrate foods that are often and widely consumed by Children with ASD are pasta, potato chips, rice, cookies/pies.

Analysis of protein intake showed no significant difference between the group of children with ASD and the group of children without ASD with a p-value of 0.733, although it was higher in the group of children with ASD. The slightly higher protein intake in the ASD group based on the median value could be due to the frequency and amount of egg consumption that tends to be higher in the group of children with ASD compared to the group of children without ASD. Based on the interview results, Children with ASD prefer eggs because of their soft texture and the availability of food that is easily accessible to ASD parents. Meanwhile, Children with ASD tend to avoid consuming protein that has too hard texture such as beef and has many bones or thorns such as fish. In addition, many of them dislike plant-based proteins such as tofu and tempeh because of the distinctive aroma of fermentation. This finding is in line with the results of a study by Raspini[35] who found that Children with ASD showed a higher intake of animal protein than plant protein. However, excess protein intake cannot be stored in the body, so the protein will be broken down into triglyceride form so that it can be stored in the body. The amount of triglycerides stored will lead to an increase in fat tissue which will increase the risk of overnutrition or obesity[36].

Fat intake showed a significant difference with a p-value of 0.037, where the group of children without ASD had a higher intake. Based on the dietary data, the significantly lower fat intake in the group of children with ASD was due to the smaller amount of chicken meat consumption compared to the group of children without ASD. In this case, chicken meat is a high source of fat at 25 g per 100 g BDD. Previous research has suggested that children with ASD may have insufficient n-3 PUFA fatty acids[37]. This is due to changes in phospholipid-fatty acid composition in plasma and red blood cells in ASD children. In addition, excessive consumption of fat through food can lead to obesity and risk degenerative diseases if not properly managed[38].

The bivariate test results showed that there was no significant difference in carbohydrate intake between the group of children with ASD and the group of children without ASD, although it was higher in the ASD group with a p-value of 0.678. This is in line with the findings of Al-Kindi et al[25] who also reported no significant difference in carbohydrate intake, with a p-value of 0.160. In this study, carbohydrate intake was found to be higher in the group of children with ASD compared to the group od children without ASD. This is because rice consumption as one of the largest contributors to carbohydrates in the results of dietary analysis, was consumed more in the group of children with ASD (2100 ± 1050) compared to the group of children without ASD (1260 ± 420).

Fiber intake showed a significant difference with a p-value of 0.033, where the ASD group had a lower intake. This result is in line with the research of Al-Kindi et al[25] which found that fiber intake in the ASD group was significantly lower, with a p-value of 0.017. In autistic children, the tendency of food selectivity also applies to the selection of fiber source foods such as vegetables and fruits. Fruits and vegetables contain high fiber, which plays an important role in inhibiting fat absorption and lowering blood cholesterol levels. Low fiber intake can increase the absorption of fat and blood cholesterol[39] . Fiber helps delay gastric emptying, reduces hunger, facilitates digestion, and promotes weight loss[40]. The low fiber intake in the ASD group may be related to the high prevalence of obesity compared to the ASD group.

Based on the t-test results, the frequency of staple food consumption in the ASD group was significantly lower with a p-value of 0.018, but the amount of consumption was significantly higher in the ASD group. The frequency of animal protein consumption in the group of children without ASD also showed a significantly higher difference with a p-value of 0.014, but no significant difference was found in the amount of animal protein consumption. Meanwhile, no significant difference was found in the frequency and amount of vegetable protein consumption between the group of children with ASD and the group of children without ASD. The frequency of vegetable consumption showed no significant difference with a p-value of 0.263, although it was higher in ASD. In addition, the amount of vegetable consumption was also not significantly different. The frequency and amount of fruit consumption also showed no significant difference in this study, although the frequency and amount of consumption were lower in the ASD group. The frequency of consumption and amount of consumption of dairy products showed a significant difference with a p-value of 0.001, where the group of children without ASD had a higher frequency of consumption and amount of consumption. This finding is similar to Diaz's

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study[7] which found that the frequency of consumption of dairy food groups in the control group was lower than the ASD group, with a p-value of 0.041.

Based on the results of bivariate tests on several food groups, it appears that there are differences in several food groups. Some studies reinforce that differences in diet and eating diversity in the group of children with ASD and the group of children without ASD are influenced by factors of selective eating behavior or picky eater. According to Zeybek[34] , in his research stated that as many as 70% percent of Children with ASD have selective behavior in the selection of food consumed, especially in the vegetable (57.1%) and fruit (32.1%) groups.

In addition to the type of food ingredients, this food selectivity behavior often arises because Children with ASD are sensitive to the sensory characteristics of food such as aroma, texture, color, and temperature[41]. In addition, Children with ASD also have a higher preference for energy dense foods, and low preference for fruits, vegetables, and fiber sources. This may result in an increased risk of overweight and obesity due to higher energy and carbohydrate intake[42].

Previous studies have shown that children with ASD are more sensitive to bitter flavors[43]. This may result in lower vegetable intake in ASD compared to the Typically Developed (TD) group. Meanwhile, fruit consumption was also not found to be significantly different and less consumed in ASD children. This is because fruits have striking colors, varied flavors, and textures. This study also found that Children with ASD preferred eggs and chicken meat compared to fish, because Children with ASD are sensitive to fishy odor in fish, although both have a soft texture. Meanwhile, the finding of lower dairy consumption patterns of the group of children without ASD in this study is similar to some previous studies[7,23] . This may be because many parents or caregivers of children with ASD adopt a gluten- and casein-free diet, resulting in limited food consumption and risk of malnutrition.

Differences in Diarrhea History of Children with Autism Spectrum Disorder (ASD) and children without -ASD

Based on Table 4, the Mann Whitney test results show that there are significant differences in the frequency of diarrhea (p-value 0.042) and duration of diarrhea (p-value 0.042) between the group of children with ASD and those of without ASD. This result is not in line with the findings by Babinska et al[26] who found that there was no difference in the incidence of diarrhea between the ASD and control groups with a p-value of 0.651, although subjects who experienced diarrhea were significantly more in the ASD group subjects (46.6%) than in the control group (44.6%). However, according to the findings of Chaidez et al[44] found that there was a significant difference in the frequency of diarrhea occurrence between subjects of the ASD group and the control group consisting of Typical Development (TD) and developmental delay (DD) groups with a p-value < of 0.0001. Another study also found a significant difference in the incidence of diarrhea between the ASD and Typical Development (TD) groups with a p-value of < 0.001[45].

Diarrhea is one of the factors of stunting or short nutritional status. In this study, the incidence of stunting was found more in the group of children without ASD compared to the group of children with ASD. However, the results of the diarrhea incidence history data showed that diarrhea only occurred in ASD children, while in the group of children without ASD it was not found at all. Diarrhea is strongly associated with malnutrition. Each time diarrhea occurs, it can lead to malnutrition due to anorexia and decreased ability to absorb nutrients. If diarrhea continues, it will affect the growth and health of the child[46].

Based on previous research, the results prove that most ASD have experienced impaired gastrointestinal function with a prevalence range of 46% - 84%. Children with ASD are at four times higher risk of gastrointestinal dysfunction compared to Children with ASD. Gastrointestinal disorders that often occur in children with ASD include food intolerance, nausea, vomiting, constipation, diarrhea, abdominal pain, bloating, gastroesophageal pain, intestinal inflammation, and ulcers[47].

Children with ASD are more prone to diarrhea compared to normal children in general. Diarrhea in autism can be caused by several risk factors such as sensory sensitivity, dietary changes, food intolerance/allergy, gastrointerstinal dysfunction, medication, supplement consumption, anxiety disorders, stress, and PICA[47] . PICA is a behavior or habit of consuming non-food items, such as paper, soap, soil, bricks, chalk, etc.[48] . Although it does not have a direct impact, PICA behavior can increase the risk of intestinal inflammation, blockage of the digestive tract, bacterial or parasitic infections, and poor nutrient absorption[47] . Children with ASD have food allergies or intolerances to gluten and casein. This happens because Children with ASD do not have the enzymes to digest these compound, so if this allergy occurs, it will increase malabsorption. Meanwhile, food restrictions because of these allergies make nutrient intake limited, especially in fiber which is needed to facilitate digestion. In addition, the unbalanced composition of the gut microbiota in ASD also increases the risk of diarrhea. The gut microbiota plays a role in maintaining the integrity of the cell barrier. However, when dysbiosis occurs, increased intestinal permeability allows macromolecules from the gastrointestinal tract to enter the bloodstream and affect the central nervous system[49].

Differences in Balanced Nutrition Knowledge of Caregivers of Children with Autism Spectrum Disorder (ASD) and of Children without ASD

Balanced nutrition knowledge is an understanding of the arrangement of recommended portions of daily food ingredients and the application of a healthy lifestyle. In this study, balanced nutrition knowledge was measured using 11 questionnaire questions from 10 indicators of balanced nutrition messages. The final balanced nutrition scores were then compared between the group of children with ASD and the group children without ASD to see whether there were differences, the results of which are attached in

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Table 4.

Based on the Mann Whitney test results, the caregiver's balanced nutritional knowledge score showed no difference between the group of parents of children with ASD and those of children without ASD. This finding is not in line with Chasanah's research[50] which proves that the nutritional knowledge of mothers of autistic subjects (78.9 ± 16.7) is significantly ($p<0.05$) higher than mothers of non-autistic subjects (63.6 ± 16.5).

Nutritional knowledge plays an important role in the feeding patterns of children with ASD. Based on research conducted in Malaysia, it was found that the level of nutritional knowledge of parents and special educators with ASD was low. Only 37.9% of parents stated that their child's diet was balanced. The majority of ASD parents and special educators knew that sugar, snacks and gluten were not good for their children, but they still provided these foods because of easy access to food[51].

Children's nutritional intake is associated with low levels of maternal education[52]. Mothers with low education levels have a harder time receiving information than mothers with higher education levels. This lack of knowledge can have an impact on children's food intake at home which can affect brain function in children with autism. Therefore, it is important for parents to have good nutritional knowledge to know which foods are recommended and which are not recommended for children with ASD.

The nutritional knowledge of parents or caregivers greatly influences the nutritional status of ASD children, especially mothers. Mothers are the main decision-makers in the family, especially regarding food consumption. Mothers should have an in-depth understanding of autism and appropriate therapies. This knowledge helps mothers to manage their children's diet, ensure proper food consumption, and prohibit certain types of food if necessary. Therefore, good maternal nutrition knowledge is essential in maintaining the health and nutritional status of autistic children[53].

This study has the advantage of using a comprehensive data collection method, involving various nutritional indicators as well as diet, which provides a comprehensive picture of the differences in nutritional status and diet between ASD and Children with ASD. However, this study also has some limitations, such as limited area coverage and not analyzing other factors such as physical activity, sleep patterns, and psychological conditions that also play a role in children's nutritional status. Therefore, the author hopes that the results of this study can be used as a credible reference to be developed in future studies by expanding the coverage area and considering these factors to obtain more comprehensive results. In addition, the author also hopes that schools can collaborate with health institutions to organize balanced nutrition counseling, anthropometric measurements regularly to achieve optimal nutritional status.

CONCLUSIONS

Based on the results of the study, the results showed that there were significant differences in nutritional status based on weight-for-age (WAZ) indicators, frequency of consumption per week of staple foods, animal protein, and dairy products, total consumption in the last month of staple foods and dairy products, fat intake, fiber intake, frequency of diarrhea, and duration of diarrhea between the group of children with ASD and those of without ASD.

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CONFLICT OF INTEREST AND FUNDING DISCLOSURE

The authors have no conflict of interest in this article. All researchers funded the research independently.

AUTHOR CONTRIBUTIONS

ARA: conceptualization, data curation, formal analysis, investigation, methodology, writing-original draft; SF: conceptualization, supervision, validation, writing-review & editing; FAR: supervision, validation, writing-review & editing.

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