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Family Characteristics, Food Security, Expenditure, and Dietary Diversity among Families with and without Concurrently Wasted and Stunted Children in Semarang

*Karakteristik Keluarga, Ketahanan Pangan, Pengeluaran Pangan, dan Keanekaragaman Pangan Keluarga dengan dan tanpa WaSt (*Wasting-Stunting*) pada Anak di Kota Semarang*

Rachma Purwanti[1]*, Ignasia Agatha Br Ginting[1], Nurhanna Putri Aulia[1], Nuryanto1, Fillah Fithra Dieny[1]

[1]Departemen Ilmu Gizi, Fakultas Kedokteran, Universitas Diponegoro, Kota Semarang, Indonesia

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Correspondent:
Rachma Purwanti
rachmapurwanti@fk.undip.ac.id

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Family characteristics, Food security, Food diversity, Food expenditure, Concurrent wasting and stunting (WaSt)

ABSTRACT

Background: Family characteristics, food security, expenditure, and diversity are indirectly associated with children's nutritional status.
Objectives: This study aimed to examine the differences between food security, expenditure, and diversity among children under five with and without concurrent wasting and stunting (WaSt) in Semarang City.
Methods: This study utilized an observational analytic approach with cross-sectional design. Subject selection using a consecutive sampling method obtained 72 subjects consisting of 18 subjects in each group of normal, stunted, wasted, and concurrently wasted and stunted (WaSt). Structured questionnaires collected data on the characteristics of fathers, mothers, and families. Interviews were conducted using the Household Food Insecurity Access Scale (HFIAS), which was obtained to measure food security among families. In contrast, the Individual Dietary Diversity Score (IDDS) was used to obtain food diversity. Differences were analyzed using one-way ANOVA and the Kruskal-Wallis test. A confidence level of 95% was utilized, and the results were significant, with a p-value<0.05
Results: There were significant differences in age, maternal nutrition knowledge, family income, food security, food expenditure, and food diversity between children under five with and without WaSt (p-value=0.010; 0.002; 0.026; 0.001; <0.001; 0.021).
Conclusion: The WaSt group has a different age composition, maternal nutritional knowledge, family income, food security, food expenditure, and food diversity from other groups.

INTRODUCTION

Data for 2022 shows that there are 148.1 million (22.3%) children under the age of five worldwide who experience stunting and 45 million (6.8%) who experience wasting, mainly from Africa and Asia[1]. In Indonesia, the prevalence of stunted toddlers is 21.6%, a decrease of 2.8% from the previous year, and the prevalence of wasted under-five children is 7.7%, an increase of 0.6% from the previous year[2]. These prevalence rates remain above the targets set in the National Medium-Term Development Plan, which are 14% for stunting and 7% for wasting by 2024)[3].

Wasting results from acute malnutrition and is characterized by rapid weight loss due to inadequate energy intake and recurrent infections. It is measured by weight-for-height (BW/TB) with a z-score < -2 SD (undernutrition) or < -3 SD (severe undernutrition). Stunting is a chronic nutritional issue characterized by the inability of children to achieve optimal growth and development, resulting in height that is below the standard of their age, as measured by the z-score[4,5]. This nutrition problem is responsible for 45% of child mortality, amounting to approximately 3.1 million deaths per year. Unaddressed nutritional problems can hinder growth and development, increase disease risk, reduce academic performance, and lower work productivity[6].

Concurrent wasting and stunting (WaSt) are a condition where wasting and stunting occur simultaneously in children and share similar determinants. These conditions can influence each other and exacerbate their severity[7,8]. The presence of WaSt significantly increases mortality rates[9–11]. Wasting children

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who are not appropriately treated have a threefold risk of becoming stunted[12]. This occurs because the body's response to weight loss involves slowing or stopping height growth until normal weight is regained[13]. Conversely, stunted children have 1.5 times higher risk of becoming wasted compared to well-nourished children[14]. Stunted children are more susceptible to metabolic disorders and decreased immunity, which can lead to a lack of appetite, impaired absorption of nutrient intake, and wasting[15,16].

The causes of wasting and stunting are multifactorial. Based on previous research, in addition to food intake and infectious diseases, nutritional problems such as stunting, wasting, and WaSt can also be attributed to the characteristics of children under five, parents, and families. Stunting is more prevalent in children aged 1-3 years, both male and female, with low birth weight (LBW), low birth length (LBL), a history of infectious diseases, short maternal height, parents with primary school education, fathers working as farmers, mothers who are housewives, and families with income below the minimum wage[17,18]. Wasting is more common in boys aged 4- 6 years, those with a history of infection, mothers with poor nutritional knowledge, and those with LBW[16].

Research conducted in Ghana and Kersa has identified several characteristics of under-five children, parents, and families that are associated with the occurrence of WaSt. These characteristics include LBW, child age, child gender, mother's age, exclusive breastfeeding history, family size, parental employment, maternal education and nutritional knowledge, and parental income[19,20]. The nutritional status of the mother before pregnancy also plays a significant role in determining the nutritional status of the child. Pre-pregnancy Body Mass Index (BMI) serves as a reference for assessing maternal nutritional status and helps determine optimal weight gain during pregnancy. A pre-pregnancy BMI that is below normal increases the likelihood of the child being born with low birth weight or length[21].

Family food security also indirectly affects children's nutritional status[22]. Prolonged periods of inadequate food security can lead to nutritional problems, even in the absence of illness[23]. Household food security can be determined using indicators of nutrient adequacy, which typically include macronutrient adequacy levels[24]. The Household Food Insecurity Access Scale (HFIAS) questionnaire is a tool that can measure household perceptions and experiences regarding physical and economic access to food[25,26]. Previous studies have shown that families experiencing food insecurity are at a higher risk of having children under five who suffer from concurrent wasting and stunting. However, these conditions are also influenced by parenting practices, breastfeeding, nutritious food, parental education and knowledge, family size, household income and expenditure, and genetics[27,28].

Household food security can be reflected in household food expenditure[24]. Ernst Engel's 1857 economic theory posits that the percentage of food expenditure is inversely proportional to income[29]. However, previous research shows no significant relationship between the proportion of food expenditure and the incidence of stunting. Most low-income respondents allocate their entire income to purchasing daily food[30]. Children from families with a high percentage of food expenditure are more at risk of wasting than those from families with a low percentage of food expenditure[31].

Food availability determines nutrient intake. Food quantity is measured by summing up food availability (energy/capita/day), while food quality can be measured from household food diversity. The Individual Dietary Diversity Score (IDDS) measures the quality of food consumption, reflecting nutritional adequacy[32–34]. The diversity of food consumption is inversely related to malnutrition[32,35].

The prevalence of stunting and wasting in Semarang City is 10.4% and 6.2%, respectively[2]. There is no data on the prevalence of under-five children with WaSt conditions in Semarang City. Research on family characteristics, food security, food expenditure, and food diversity among under-five children with WaSt is limited. This study aimed to analyze the differences between the characteristics of under-five children, their parents, and families, as well as food security, expenditure, and diversity in under-five children with and without WaSt in Semarang City.

METHODS

The study was conducted in Semarang City, Central Java, from March to August 2024, using a cross-sectional observational analytic design. Subjects were categorized into four groups based on their nutritional status: normal, stunted, wasted, and concurrently wasted and stunted (WaSt). Ethical approval was obtained with No. 217/EC/KEPK/FK-UNDIP/V/2024, issued on May 14, 2024 by the Health Research Ethics Commission (KEPK) of the Faculty of Medicine, Diponegoro University (FK UNDIP).

Subjects were children under the age of five, with their mothers as respondents. The sample size was calculated using the two-group unpaired comparative analysis calculation formula in the Sample Size Determination in Health Studies 2.0 software with a 1:1 ratio, 95% confidence level, 80% power, anticipated population proportion of 74.4% and 25.6%[36], and 10% dropout estimation. A total of 72 subjects were included, with 18 subjects in each group (normal, stunted, wasted, and WaSt). Subjects were selected using a consecutive sampling technique. Inclusion criteria included children aged 24-59 months who lived and were registered in the working area of the health center in Semarang City, with a z-score value of height for age < -2 SD for the stunted group, weight for height < -2 SD for the wasted group, height for age < -2 SD and weight for height < -2 SD for the WaSt group, height for age -2 SD to +3 SD and weight for height -2 SD to +1 SD for the normal group, and parents/caregivers who provided informed consent. Exclusion criteria included parents of children under five who withdrew from the study for specific reasons (illness, undergoing certain treatments, relocating, or death) or children under five with congenital diseases from birth.

The dependent variable is the nutritional status of under-five children (normal, stunted, wasted, and WaSt). Nutritional status was determined through

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anthropometric measurements following the WHO Child Growth Standards for children aged 0-5 years[37]. Children's nutritional status was analyzed based on the z-score of weight for age, height for age, and weight for height with WHO Anthro software version 3.2.2. The independent variables in this study included characteristics of under-five children (age, sex, birth weight, birth length, exclusive breastfeeding history, and history of infectious diseases), parental characteristics (mother's age, mother's height, mother's pre-pregnancy BMI, parent's education, mother's nutritional knowledge, and parent's occupation), family characteristics (family size and total family income), food security, expenditure, and diversity.

Data on characteristics were collected through direct interviews with mothers using a research questionnaire. Data on child characteristics, including birth weight and length, were obtained from the Mother and Child Health book. Birth weight was categorized as low birth weight (LBW) if < 2500 grams and normal if ≥ 2500 grams. Birth length was categorized as normal (≥48 cm) and short (<48 cm)[38]. Maternal height was categorized as short stature for height < 150 cm and normal if ≥ 150 cm[39]. Parents' education was categorized into basic-medium (completed elementary to high school) and high (attended college)[40]. Parents' occupations were categorized into working and not working. The level of maternal nutritional knowledge was assessed using a knowledge questionnaire with 14 questions; each correct answer was given a score of 1 and the incorrect one was given a score of 0, and categorized as lacking if the total score was ≤ 7. The questionnaire's reliability was tested in previous studies, yielding a Cronbach's alpha of 0.90[41]. Family size was obtained from interviews and family cards, and categorized into small families (≤4 people) and large families (>4 people)[42].

Household food security was measured using the Household Food Insecurity Access Scale (HFIAS) instrument, which was tested for reliability in previous studies conducted in Indonesia, with a Cronbach alpha of 0.831[43]. Based on HFIAS, household food security was categorized into food secure, mildly, moderately, and severely food insecure[25]. Food expenditure data were obtained from the ratio of expenditure on food to total expenditure, expressed as a percentage (%). Household food expenditure is considered low if ≤ 60% and high if > 60%[44]. Children's food diversity was measured using a 24-hour recall questionnaire and categorized based on food groups in the Individual Dietary Diversity Score (IDDS) food diversity guide[45]. Children's dietary diversity was categorized as poor if they consumed < 5 food groups and good if they consumed ≥ 5 out of 7 food groups.

The study results were processed and statistically analyzed. Descriptive data were presented using frequency distribution tables. The Kolmogorov-Smirnov test was utilized to determine data normality. A p-value > 0.05 indicated normally distributed data. Bivariate analysis for normally distributed numerical data was conducted using the one-way ANOVA test and Bonferroni's post hoc test. The Kruskal-Wallis and U Mann-Whitney tests were used for non-normally distributed numerical data and categorical data analyses. Differences were considered significant if the p-value < 0.05 and not significant if the p-value ≥ 0.05.

RESULTS AND DISCUSSIONS

Concurrent wasting and stunting (WaSt) are a combined form of malnutrition in children under five. Wasting occurs when children are underweight relative to their height, while stunting occurs when children are underweight for their age. Both nutrition problems can co-occur[46].

Characteristics of Under-five Children

Research findings indicate differences in the age of under-five children with and without WaSt. The age of children with WaSt differs from those in the normal group, with the average age of children in the WaSt, wasted, and stunted groups being 24-47 months. Studies in Africa show that children aged 1-3 years are at a higher risk of stunting, wasting, and underweight simultaneously compared to children aged < 1 year. In addition, a study in Niakhar, Senegal, found significant incidences of stunting and wasting in children aged 6-29 months and older children aged 30-59 months. This is because children aged 6-24 months are in the complementary feeding phase (MPASI), and inadequate nutritional intake during this period can lead to malnutrition as they age[47,48]. Nutritional problems tend to occur in children aged 30-59 months. The age factor is also related to the history of infectious diseases in under-five children, as children begin to be weaned and often put objects in their mouths, increasing susceptibility to infections, especially if the objects are dirty. However, after reaching 48 months of age, children can better identify safe objects, reducing exposure to infectious diseases[49].

Gender did not show differences in the incidence of malnutrition among under-five children in this study. One possible reason is that the growth spurt between boys and girls is less pronounced during the under-five years. Girls typically experience a growth spurt earlier when entering adolescence[50]. Equal treatment in nutrition and health can also influence the risk of WaSt, wasting, and stunting, giving boys and girls an equal chance of experiencing these health problems[49].

There was no significant difference in birth length (BL) and birth weight (BW) between the groups. In this study, the mean value of BW in each group was above the normal limit of ≥2500 grams[51]. The normal birth length of children is 48-52 cm[52]. Another source states that newborns are categorized as stunted if their birth length is < 46.1 cm for male infants and < 45.4 cm for female infants[53]. The absence of differences in BW or BL between children with nutritional problems and normal under-five children differs from previous studies. Previous research suggests that low birth weight (LBW) can increase the likelihood of stunting, underweight, and wasting due to the interconnected BL and BW; shorter children naturally have lower birth weights. Low birth weight (LBW) infants face challenges in achieving optimal development in the early stages of life. Other research indicates that birth length is significant to under-five nutrition problems, especially stunting. Low birth weight (LBW) is associated with an increased risk of growth faltering from young age[51]. However, other studies suggest that both factors can be improved if parents focus on nutritional fulfillment. As children age, their growth and development of can be

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optimized[54].

Exclusive breastfeeding refers to the provision of breast milk alone for the first 6 months of a baby's life without introducing other food or drink. Breast milk is considered the best food for newborns because it emulates fat in protein, lactose, and inorganic salts secreted by the mother's breast glands, which are beneficial for the immune, psychological well-being, and nutritional needs of the baby[55]. There was no significant difference in exclusive breastfeeding history between the four groups studied, with most children under five having been exclusively breastfed, especially in the malnutrition group. Children exclusively breastfed for 6 months had a lower risk of impaired growth in weight and height compared to those exclusively breastfed for a shorter duration[55]. Despite this, studies show some children with a history of exclusive breastfeeding still experience nutritional problems such as WaSt, wasting, or stunting. The incidence of WaSt, wasting, and stunting in children is multifactorial. For children under five years old, nutritional needs must be met not only by breast milk but also through adequate intake of macronutrients and micronutrients[56].

Table 1. Characteristics of under-five children

Variable	Nutrition Status				p-value
	Concurrently Wasted & Stunted (WaSt)	Wasted	Stunted	Normal	
	Mean±SD or n (Percentage)				
Age of under-five children (months) (#)	36.67±10.74[a]	39.44±10.32[ab]	42±10.52[ab]	47.94±8.74[b]	0.010*
Birth length of under-five children (cm)¥	47.50±2.04	45.5±3.22	47.53±2.40	48±2.33	0.067
Birth weight of under-five children (grams)#	2791.11±418.72	2594.22±699.28	2827.22±461.96	2876.11±359.61	0.358
Gender of under-five children ¥					
Male	10 (55.6)	11 (61.1)	8 (44.4)	5 (27.8)	0.202
Female	8 (44.4)	7 (38.9)	10 (55.6)	13 (72.2)	
Exclusive breastfeeding history¥					
No	3 (16.7)	2 (11.1)	2 (11.1)	3 (16.7)	0.928
Yes	15 (83.3)	16 (88.9)	16 (88.9)	15 (83.3)	

Notes: # = One-way ANOVA test; ¥ = Kruskal Wallis test; * = Significant data (p-value ≤ 0.05) was further tested using the Bonferroni post hoc test, and U Mann-Whitney test, different superscripts [(a,b,c)] indicate significantly different groups.

Parental Characteristics of Under-Five Children

One factor determining the parental characteristics of under-five children in this study is the mother's nutritional knowledge. Knowledge is an important domain for shaping actions and behaviors, as it can lead to beliefs that influence behavior. Based on the research results, maternal nutritional knowledge was the only parental characteristic that showed a significant difference between under-five children with and without WaSt group. The difference was evident between the WaSt group with stunted and the WaSt group with normal nutritional status. The average value of maternal nutritional knowledge in the WaSt group was Wasted < Stunted < Normal, with the average knowledge score in the four groups classified as good (total score > 7). Parents, especially mothers, have gained additional nutritional knowledge from activities outside the integrated service post (Posyandu), such as from social media or nutrition houses.

Most mothers correctly answered questions regarding the appropriate timing of breastfeeding initiation, age limits, and minimum breastfeeding frequency per day. However, the most commonly answered questions in the WaSt group were regarding the definition of wasting and the frequency of complementary feeding by age (6-8 months and 9-12 months); in the wasting group, regarding the definition of stunting, optimal breastfeeding techniques, and the frequency of complementary feeding in children aged 6-8 months; and in the stunting and normal groups, regarding the frequency of complementary feeding in children 6-8 months. This indicates that some mothers still lack sufficient knowledge, especially regarding the frequency of complementary feeding for children aged 6-8 months. Insufficient knowledge of complementary foods can lead to inadequate complementary feeding that does meet the baby's needs, affecting the nutritional status. Previous studies have shown that parents, especially mothers with good nutrition and health knowledge, can choose and provide foods that meet nutritional adequacy for under-five children in terms of quality and quantity, positively affecting their nutritional status. However, a good level of nutritional knowledge without a corresponding attitude toward proper parenting and feeding practices can still result in nutritional problems in under-five children[57,58].

There was no difference in parental education levels between the WaSt and non-WaSt groups. An increase in education does not always correlate with

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adequate knowledge of nutrition, as evidenced by the presence of WaSt, wasting, or stunting in children from families with educated parents. The education level of mothers can indirectly affect their knowledge about health care, especially nutrition. The ability of mothers to choose affordable yet nutritionally balanced and quality foods is crucial. Many affordable food options can provide the necessary quality and nutritional value[59]. Formal education alone is insufficient to increase parents' nutritional knowledge. However, regularly attending Posyandu activities or nutrition counseling for children under five can enhance mothers' nutritional knowledge and help them meet their children's nutritional needs[60].

The occupations of parents, both mothers and fathers, showed no difference between the groups of under-five children with and without WaSt. Working mothers have less time to care for and nurture children at home directly, but they can contribute economically to meet family needs. Conversely, if the mother does not work, the family economy depends on the father's income, potentially leading to inadequate food needs, especially if the family size is large and the father's income is low[61].

Maternal age did not show any significant difference among the four groups studied. Mothers under the age of 20 are not ideally suited for pregnancy, as they are still physiologically growing. This can lead to "competition" between the mother and fetus for nutritional needs. Additionally, mothers under 20 years old may have less experience or knowledge related to nutrition, potentially affecting their children's nutritional status.

On the other hand, mothers over 35 years old may face physical challenges in bearing the burden of pregnancy[62]. The majority of mothers in this study became pregnant between the ages of 20 - 35, an age range when they are physically and mentally prepared for pregnancy. Thus, nutritional problems in this study's subjects are not attributable to maternal age.

There was no significant difference in maternal height among the four groups studied. This may be because most mothers' heights were classified as normal, and the frequency distribution of each group was similar, showing no significant difference. Previous research suggests that maternal height can be passed on to the next generation through a cycle of malnutrition. However, this chain can be broken with good parenting practices during pregnancy and the first two years of the baby's life[49]. Other studies also indicate that genetic factors such as maternal height only affect 30% of a child's height, with external factors influencing the remaining 70%[63].

There was no significant difference in the BMI of pre-pregnant women among the four groups studied. The mean BMI of pre-pregnant women in all groups was within the normal range. The BMI of pre-pregnant women reflects the mother's nutritional quality before pregnancy, affecting the health of the mother and fetus during pregnancy, and the quality of the baby to be born. This study found no significant differences in the BMI of pre-pregnant mothers, indicating that BMI is not associated with the incidence of WaSt, wasting, and stunting in under-five children. Instead, other causal factors after the birth may affect children's nutritional status [21].

Table 2. Parental characteristics of under-five children

Variable	Nutrition Status				p-value
	Concurrently Wasted & Stunted (WaSt)	Wasted	Stunted	Normal	
	Mean±SD or n (Percentage)				
Mother's Age (years) (#)	28.33±6.64	30.39±6.87	28.83±6.20	29.67±8.43	0.828
Mother's Height (cm)¥	150.67±6.00	151.69±5.34	153.25±5.21	154±4.35	0.110
Pre-Pregnant Mother's BMI (kg/m^2) (#)	19.94±3.16	22.25±6.42	22.25±4.15	21.97±4.25	0.383
Mother's Nutrition Knowledge (score)¥	7.89±2.65^a	8.89±2.72^{ab}	10.22±3.08^b	11.33±2.03^b	0.002*
Mother's Occupation¥					
Working	10 (55.8)	9 (50)	12 (66.7)	10 (55.6)	0.786
Non-Working	8 (44.4)	9 (50)	6 (33.3)	8 (44.4)	
Father's Occupation¥					
Working	17 (94.4)	16 (88.9)	16 (88.9)	17 (94.4)	0.869
Non-Working	1 (5.6)	2 (11.1)	2 (11.1)	1 (5.6)	
Mother's Education¥					
Higher Education (Senior High School and College)	12 (66.7)	15 (83.3)	10 (55.6)	15 (83.3)	0.135
Secondary Education (Junior High School)	3 (16.7)	3 (16.7)	6 (33.3)	3 (16.7)	
Low Education (Elementary and Not in School)	3 (16.7)	0 (0)	2 (11.1)	0 (0)	
Father's Education¥	10 (55.6)	15 (83.3)	13 (72.2)	15 (83.3)	0.145
Higher Education (Senior High School and College)					

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Variable	Nutrition Status				p-value
	Concurrently Wasted & Stunted (WaSt)	Wasted	Stunted	Normal	
	Mean±SD or n (Percentage)				
Secondary Education (Junior High School)	4 (22.2)	3 (16.7)	2 (11.1)	2 (11.1)	
Low Education (Elementary and Not in School)	4 (22.2)	0 (0)	3 (16.7)	1 (5.6)	

Notes: # = One-way ANOVA test; ¥ = Kruskal Wallis test; * = Significant data (p-value ≤ 0.05) was further tested using the Bonferroni post hoc test, and U Mann-Whitney test, different superscripts [(a,b,c)] indicate significantly different groups.

Family Characteristics of Under-Five Children

The results indicated a significant difference in total family income between the WaSt-normal, wasted-stunted, and wasted-normal groups. Total family income ≥ Semarang City's minimum wage (UMR) was most common in the normal group, while total family income < Semarang City's UMR was most common in the wasted group. Family income influences the ability to purchase nutritious food in a family. Low income makes it difficult for families to obtain nutritious and varied food. Families with limited income often struggle to meet the food needs of all family members, putting children at greater risk of nutritional issues. In contrast, families with higher incomes can provide better food in terms of both quality and quantity, meeting the nutritional needs of each member in a balanced way[27]. Large families, including members beyond the father, mother, and child (e.g., grandparents) were found in five under-five children in the WaSt group, three in the wasted group, one in the stunted group, and three in the normal group. Including grandparents in the household can increases total family income. Therefore, the analysis of family size showed no significant difference between the groups of children with and without WaSt. The family size calculation included all family members living and eating together. In the WaSt group, family sizes ranged from 3 to 8 people; in the wasted group, 3-7 people; and in the stunted and normal groups, 3-6 people. The WaSt group had the largest families. Larger families (>4 family members) face more undernutrition issues in children under five compared to smaller families. Family size can affect portion distribution and the type of food provided. Families with many members may allocate smaller portions to each individual, resulting in inadequate nutritional intake for family members. Additionally, having many members can reduce the mother's attention to childcare[27].

Table 3. Family characteristics of under-five children

Variable	Nutrition Status				p-value
	Concurrently Wasted & Stunted (WaSt)	Wasted	Stunted	Normal	
	Mean±SD or n (Percentage)				
Large family[¥]	4.89±1.28	4.56±0.92	4.28±0.90	4.33±0.84	0.496
Total Family Income[¥]					
≥UMR of Semarang City	9 (50)[a]	7 (38.9)[a]	13 (72.2)[ab]	15 (83.3)[b]	0.026[*]
<UMR of Semarang City	9 (50)	11 (61,1)	5 (27,8)	3 (16.7)	

Notes: ¥ = Kruskal Wallis test; * = Significant data (p-value≤ 0.05) was further tested with U Mann-Whitney test; different superscripts [(a,b,c)] indicate significantly different groups.

Household Food Security

Food security is defined as a condition in which every individual or family has access to adequate, safe, and nutritious food, both physically and economically, to meet their nutritional intake needs and make food choices for an active and healthy life[64]. Food security focuses on ensuring food provision at regional, local, household, and individual levels to fulfill nutrient intake needs[23]. There are notable differences in household food security between children with and without WaSt. Specifically, the WaSt group's household food security differs from that of the wasted, stunted, and normal groups.

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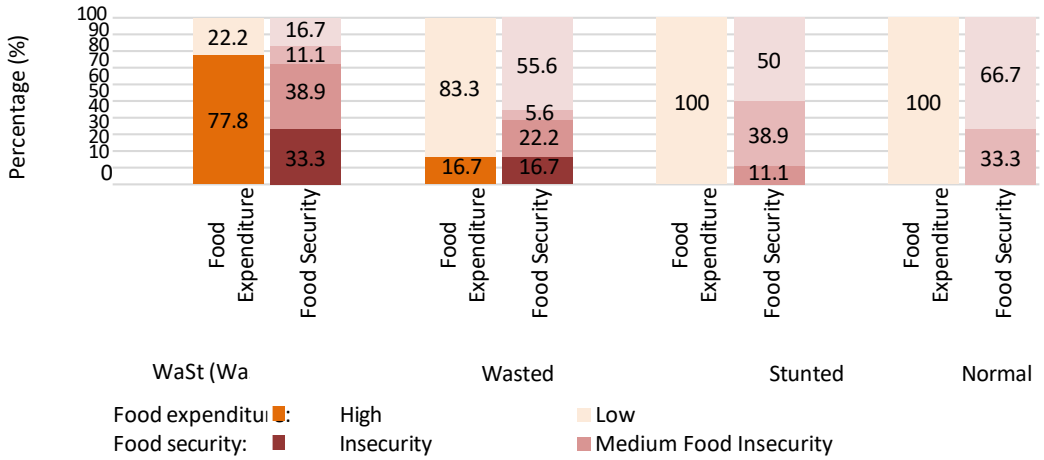

Images 1. Percentage of frequency of food security and expenditure

Figure 1 shows that only 16.7% of households in the WaSt group are food-insecure. Food insecurity refers to the lack of access to adequate, safe, and nutritious food. This study's results show that most food-insecure households in the WaSt group fall into the medium food-insecure category. This illustrates that most households experience concern or uncertainty about accessing sufficient food, cannot consume food according to preferences, consume less varied food due to resource limitations, and reduce the portion and amount of food due to limited food supplies. However, they do not reach the point of being forced to skip meals or go to sleep hungry due to the absence of food[65].

Food availability is related to sufficient food in quality and quantity to fulfill the adequate intake of nutrients for individuals in the family. Research in Semarang City shows that under-five children in food-insecure households are prone to stunting because they have less access to food, forcing the portion of food to be reduced and shared among all family members[66,67]. These findings align with the results of this study, showing that the WaSt group has higher food expenditure and more family members than the other groups. Research conducted in the Tangerang district shows that both food-insecure and food-resistant households can have children under five who are wasted, stunted, and have normal nutritional status. Various factors influence this condition, including parenting style, parents' education and knowledge level, family size, household expenditure, and income. In addition, exclusive breastfeeding and nutritious food intake for under-five children play a role in determining these conditions[23]. The study results demonstrate no significant difference in household food security between the wasted, stunted, and normal groups.

Household Food Expenditure

Household food security can be indicated by food expenditure. Food insecurity occurs when a high proportion of food expenditure (>60%) is present. There are differences in household food expenditure between under-five children with and without WaSt. Specifically, the household food expenditure in the WaSt group differs from that in the wasted, stunted, and normal groups. Figure 1 shows that high food expenditure was found in the WaSt group (77.8%). Previous studies have shown that the proportion of undernutrition among children under five increases with the proportion of food expenditure compared to total expenditure. Poor households with low food security generally have a high percentage of food expenditure[31].

The results of this study align with Ernst Engel's economic theory in 1857, which states that the percentage of food expenditure decreases as income increases. Thus, the composition of household food expenditure can be an indicator of population welfare. The higher the percentage of food expenditure in a household, the lower the level of food security[29]. The analysis regarding household food security also indicates that only the WaSt group has more food-insecure households compared to the other groups.

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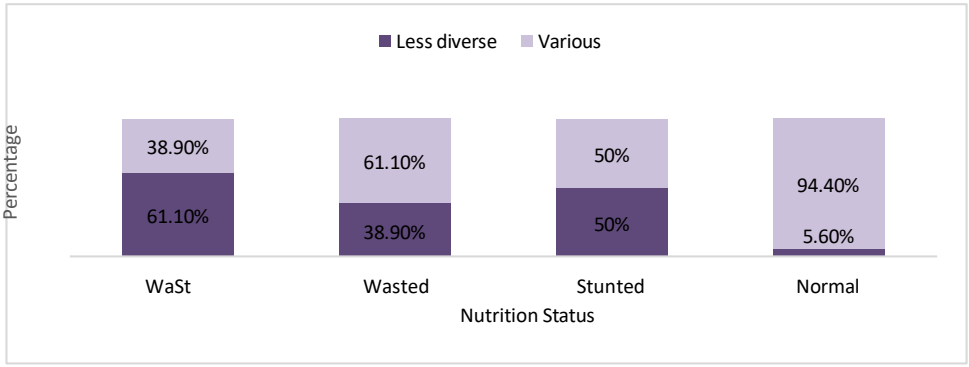
Food Diversity



Images 2. Percentage of frequency of food diversity

The dietary diversity of children under five can be determined by summing the food groups consumed from seven categories. Children with a score ≥5 (five types of food groups) are classified as having a diverse diet, whereas those with a score of less than 5 are considered to have a less diverse diet[45,68]. The results of the food diversity analysis showed a significant difference between the WaSt, wasted, and stunted groups compared to the normal group. Figure 2 indicates that the normal under-five children consume the most diverse food. A high food diversity score is associated with a lower risk of undernutrition in children[35]. A food diversity assessment from a study in Myanmar revealed that children who consumed three or fewer food groups were at a higher risk of malnutrition compared to those who consumed four or more[69]. This finding is consistent with the analysis that children under five with normal nutritional status had a minimum food diversity score of four food groups.

Table 4. Food security, expenditure, and diversity of children under five

Variable	Nutrition Status				p-value
	Concurrently Wasted & Stunted (WaSt)	Wasted	Stunted	Normal	
	Median (Min-Max)				
Food Security Household (score) ¥	15 (0-33)[a]	2 (0-26)[b]	3.5 (0-17)[b]	0 (0-8)[b]	0.001*
Food Expenditure Household (%) ¥	62.91 (32-70)[a]	30 (20-66,7)[b]	31.62 (14.6-50)[b]	30 (11.11-50)[b]	<0.001*
Food Diversity (score) ¥	4 (3-6)[a]	5 (2-5)[a]	4,5 (3-6)[a]	5 (4-7)[b]	0.021*

Notes: ¥ = Kruskal Wallis test; * = Significant data (p-value ≤ 0.05) was further tested by U Mann-Whitney test; different superscripts [(a,b,c)] indicate significantly different groups.

This study has limitations due to the lack of a robust study design that establishes causal relationships, such as cohort or case-control study. However, it has the strength of examining family factors (parent and family characteristics), food security, food expenditure, and food diversity and comparing them between groups using a methodologically sound sample size.

CONCLUSIONS

There are differences in the age of under-five children, maternal nutrition knowledge, total family income, food security, food expenditure, and food diversity between groups of under-five children with and without concurrent wasting and stunting (WaSt). The age of under-five children with WaSt is significantly different from that of toddlers with normal nutritional status. The maternal nutrition knowledge of under-five children with WaSt differed from that of stunted and normal groups. The total family income of WaSt and wasted under-five children differs from that of stunted and normal groups. Food security and family food expenditure of WaSt under-five children differ from the wasted, stunted, and normal groups. The food diversity of WaSt under-five children differs from that of under-five children with normal nutrition status. There are no differences in parents' education, occupation, and family size between groups with and without WaSt.

Policymakers need to develop more specific policies and targeted interventions to prevent and reduce the incidence of WaSt, such as more intensive nutrition education programs and economic support for low-income families. Health workers should focus on nutrition education, especially in low-income families, as low nutrition knowledge is directly related to WaSt. For academics, this finding indicates the need for further research on WaSt. For families and communities, this finding highlights the importance of maternal nutrition knowledge and food diversification in preventing WaSt in under-five children.

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CONFLICT OF INTEREST AND FUNDING DISCLOSURE

The authors declare no conflict of interest in this article. This research was funded by the Beginner Lecturer Research Grant (RDP), Faculty of Medicine (FK), Universitas Diponegoro Number 33/UN7.F4/PP/III/2024.

AUTHOR CONTRIBUTIONS

RP: funding acquisition, methodology conceptualization, project administration, original draft writing - review & editing; IA & NPA: resources, software, data analysis, visualization, draft writing; NYT & FFD: draft review.

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