Sociodemographic, Infectious Diseases, Food Security, and Environmental Conditions in the Family of Children with and without Intraindividual Double Burden Malnutrition WaSt

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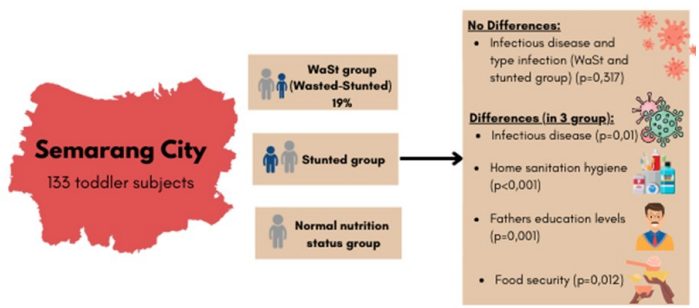
ABSTRACT

Intraindividual double-burden malnutrition, Wasted-Stunted (WaSt), frequently occurs in the same child simultaneously or at different moments throughout their life. This study aims to identify differences in the sociodemographic characteristics, incidence of infectious diseases, food security, and environmental conditions in the family of children with and without WaSt. The research employed a cross-sectional design conducted from April to October 2022 in Semarang City involving 133 subjects. The independent variables included toddler, mother, father, and family characteristics. The dependent variable was WaSt. The statistical tests used were the Kruskal-Wallis test with the Mann-Whitney U test for data that were not normally distributed and the one-way ANOVA test with the Bonferroni post hoc test for normally distributed data. This research shows that 19% of toddlers have WaSt. There were differences in the incidence of infectious diseases, home sanitation hygiene, father's education, and food security between toddlers with normal nutritional status and the other two groups (stunted and WaSt) with a p-value <0.05. There were no differences in the incidence and types of infection between WaSt and stunted groups. Most family expenditures were allocated to food (70% in the WaSt and stunting groups and 60% in the normal nutritional status group). The government and related stakeholders need to pay more attention to families of children under five with limited access and facilities for hygiene and sanitation, low income, low parental education, and low food security to prevent an increase in the risk of WaSt.

ABSTRAK

Beban gizi ganda pada tingkat individu, Wasted-Stunted (WaSt), sering terjadi pada anak yang sama pada waktu yang sama atau berbeda sepanjang hidupnya. Penelitian ini bertujuan untuk menganalisis perbedaan sosiodemografi, kejadian penyakit menular, ketahanan pangan, dan kondisi lingkungan pada keluarga balita dengan dan tanpa beban ganda malnutrisi intraindividu: WaSt. Penelitian ini merupakan penelitian cross-sectional yang dilaksanakan pada bulan April sampai Oktober 2022 di Kota Semarang dengan subjek sebanyak 133 orang. Variabel bebas dalam penelitian ini adalah karakteristik balita, ibu, ayah, dan keluarga. Variabel terikat dalam penelitian ini adalah kejadian beban ganda malnutrisi wasted-stunted/WaSt. Uji statistik yang digunakan adalah uji Kruskal Wallis dengan uji lanjutan Mann-Whitney untuk data yang tidak berdistribusi normal dan uji oneway ANOVA dengan uji post hoc Bonferroni untuk data yang berdistribusi normal. Penelitian ini menunjukkan bahwa 19% balita mengalami WaSt. Terdapat perbedaan kejadian penyakit menular, higiene sanitasi rumah, pendidikan ayah, dan ketahanan pangan antara balita berstatus gizi normal dengan dua kelompok lainnya (stunted dan WaSt) dengan p-value <0,05. Tidak terdapat perbedaan angka kejadian dan jenis infeksi pada kelompok WaSt dan stunted. Sebagian besar pengeluaran keluarga dialokasikan untuk makanan (70% pada kelompok WaSt dan stunted dan 60% pada kelompok status gizi normal). Pemerintah dan pemangku kepentingan terkait perlu memberikan perhatian lebih terhadap keluarga balita dengan akses dan fasilitas kebersihan dan sanitasi yang terbatas, pendapatan rendah, pendidikan orang tua rendah, dan ketahanan pangan rendah untuk mencegah peningkatan risiko WaSt.

GRAPHICAL ABSTRACT



Keyword
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INTRODUCTION

Child malnutrition remains a significant issue in many parts of the world (UNICEF, 2019). It has implications for future adult health (Shekar et al., 2017). In childhood, malnutrition entails either a chronic state of reduced growth (stunting) or an acute state of wasting, characterized by loss of (or failure to acquire) fat stores and muscle mass (Briend et al., 2015). Stunting is a concern in developing countries, such as Indonesia. Stunting in children is more common in Indonesia (30.8%) than it is globally (22.2%). In Ethiopia, the frequency of stunting is 52.4%, in the Congo it is 40%, and throughout sub-Saharan Africa it is 34.5% (Budiastutik & Rahfiludin, 2019). The average prevalence of stunted toddlers in Indonesia from 2005-2017 was 36.4%. Based on SKI 2023 data, it is known that the prevalence of stunting in Indonesia is still relatively high at 21.5%, and wasting at 8.5% (Ministry of Health of Indonesia, 2023).

Most nutritional screening initiatives emphasize detecting wasting, which indicates acute undernutrition and carries the highest risk of morbidity and mortality. Nonetheless, it has been proposed that wasting and stunting have similar risk factors and should be considered when designing programs (Briend et al., 2015). Early-life stunting is typically viewed as a secondary effect of long-term malnutrition. This leads to the common misconception that stunting develops later in the impoverished state after wasting occurs first (Richard et al., 2012; Schoenbuchner et al., 2019). According to another study, stunting happens around the age of 24 months, and wasting happens around the age of 10–12 months. One theory about stunting is that it is a biological reaction to past bouts of lost energy. This result raises the possibility that stunting is a harmful adaptation to more obvious undernutrition (wasting) (Schoenbuchner et al., 2019). However, some have pointed out that in areas where wasting is uncommon, significant stunting may exist, and stunting may have started as early as birth. On the other hand, stunting may not be primarily caused by wasting in underdeveloped nations (Richard et al., 2012).

Children with multiple anthropometric deficits, including wasted-stunted (WaSt), are known to have the highest risk of near-term mortality compared with children with any deficit alone (Thurstans et al., 2022). Wasted-stunted (WaSt) significantly increased the risk of death, particularly in very young infants, but more deaths overall were associated with stunting (Wright et al., 2022). Children affected by stunting can experience severe and irreversible physical and cognitive damage that accompanies stunted growth. The harmful consequences of stunting can last a lifetime and affect the next generation. Meanwhile, wasting or wasted-stunted (WaSt) was associated with 10–23% of child deaths beyond six months. However, in the second year, over half of deaths occurred in stunted, non-wasted children. Wasted children were more likely than non-wasted or non-stunted children to become stunted (RR, 1.93; 95% CI, 1.7–2.2), but 94% of children who progressed to stunting had not been wasted in the previous period (Wright et al., 2022).

Both stunting and wasting are present in the majority of developing countries and contexts (something also highlighted in the 2014 Global Nutrition Report) (Haddad et al., 2015) and can occur concurrently in the same child (highlighted in the 2015 Global Nutrition Report) (Hawkes et al., 2015; IFPRI, 2015) and share underlying and essential causal factors such as infectious diseases, environmental enteric dysfunction, a diet with inadequate nutrients, and suboptimal infant feeding and caring practices (Angood et al., 2016).

Socioeconomic level, urban area, and caregiver education did not reliably predict double-burden malnutrition or its components (Engle-Stone et al., 2020). However, child sex and household characteristics compared with ≥24 months had more considerable adjusted risks of double-burden malnutrition-anemia. Stunting has been linked to several factors, including poverty, women's education, hygienic

habits, and community access to health care (Brar et al., 2020). A greater risk of mild stunting was also linked to household air pollution in boys, not girls (Lu et al., 2024). Research from 35 low- and middle-income nations also reveals that, for the most part, household socioeconomic circumstances were the most significant risk factors for child stunting, wasting, and underweighting (1st to fourth), with a few notable exceptions (for instance, maternal education was ranked 18th–20th in 8 countries for child wasting) (Li et al., 2020).

Other studies show that the significant social determinants of child stunting encompassed whether the child is insured, maternal education level, maternal employment status, mother's average working days, household per capita income, household asset index, urbanization index, and living regions. Children's maternal employment status, mothers' average working days, living areas, and living regions are the significant factors impacting child wasting (Li et al., 2024). Low knowledge and education levels of a mother affect choices of dietary habits, attitudes, and behaviors in choosing food to eat (Dewi & Kartini, 2017; Géa-Horta et al., 2016; Pramudyat et al., 2017; Sineke et al., 2019). Limited access to safe water and maternal exposure to intimate partner violence (IPV) are also reported as risk factors for child stunting. Child deworming, being born at a low weight, and food insecurity were some of the risk factors for child underweight. Households near the domestic water supply had a low risk of registering wasted children (Chilanga & Chilanga, 2023). A study in Indonesia using nationwide basic health research (Riskesdas) 2018 data also showed similar results. The risk factors associated with stunting in children between the ages of 24-59 months were the father's education, mother's education, mother's height, father's BMI (body mass index), and location of birthplace (Aditianti et al., 2021). According to the latest research, WaSt is more prevalent in children from middle-class families (2.54 times) and in children from rural areas (1.37 times) (Jokhu & Syauqy, 2024).

The prevalence of underweight in Indonesia ranged from 13.0% to 29.6%; severe underweight ranged from 2.0% to 7.4%; wasting ranged from 3.5% to 10.6%; severe wasting ranged from 1.1% to 6.7%; stunting ranged from 11.5% to 26.7%; and severe stunting ranged from 5.6% to 18.9%. The prevalence of wasting and severe wasting in Central Java is 5.8% and 2.7%, below the national average of wasting and severe wasting prevalence (7.3% and 3.6%). However, the prevalence of stunting and severe stunting in Central Java is 20.1% and 11.2%, respectively, above the national average (19.1% and 11.2%) (Ayuningtyas et al., 2022). WaSt, driven by common factors, frequently occurs in the same child simultaneously or at different moments throughout their life (Thurstans et al., 2022).

The still relatively high prevalence of stunting and the increasing prevalence of wasting in children under five need special attention. Is there any difference in the characteristics of a child without malnutrition, with a single malnutrition (only one of stunting or wasting), and a double malnutrition condition (WaSt)? This study aims to identify differences in sociodemographics, the incidence of infectious diseases, food security, and environmental conditions in families of children with and without intraindividual double-burden malnutrition.

METHODS

The research employed a cross-sectional design conducted from April to October 2022. The subjects in Semarang City were included in the research screening, totaling 133 toddlers. Subjects were selected using consecutive sampling techniques. Subject inclusion criteria were children aged 0-59 months with a mother as a caregiver, non-divorced parents, and living in the research area for the duration of the study. The exclusion criterion was that the mother cannot read or write and is unwilling to be interviewed due to illness or other

Table 1
The characteristics of children subjects

Variable	Group			p
	IDBM	non IDBM		
	WaSt	Stunted	Normal	
Gender				
Boys	10 (47.6%)	41 (45.6%)	12 (54.5%)	0.752
Girls	11 (52.4%)	49 (54.4%)	10 (45.5%)	
Aged (month old) ¥	25 (7-39)[a]	27 (8-39)[a]	18.5 (5-34)[b]	0.015*
Birth Anthropometric Measurements				
Birth weight (gr) #	2750 (995-3500)	2872.5 (1510-4400)	2950 (2050-4500)	0.104
Birth length (cm) ¥	47 (38.0-51.0)	47 (41.0-54.0)	49 (31.0-62.0)	0.242
Actual Anthropometric Measurements				
Actual weight (kg) ¥	7.8 (5.1-10.1)[a]	9.45 (6.7-12.5)[b]	10,2 (7.0-15.0)[c]	<0.001*
Actual length or height (cm) ¥	77.8 (61.0-89.5)	80.15 (65.9-87.3)	78.95 (69.5-97.5)	0.467
Actual upper arm circumferences (cm) ¥	12.5 (10.3-14.0)[a]	13.25 (10.2-18.3)[b]	14.6 (13.0-16.5)[c]	<0.001*

Note: *Significant ($p < 0,05$; ¥ = Kruskal Wallis test, # = one way ANOVA test); * post hoc test with Mann Whitney and Bonferroni test (different superscripts a, b, c indicate significantly different groups)

reasons. The implementation of this research received approval from the Health Research Ethics Commission, Faculty of Medicine, Diponegoro University, No. 437/EC/KEPK/FK-UNDIP/XII/2022.

The independent variables in this study were toddler characteristics, mother characteristics (mother's age at pregnancy, current age, mother's education, mother's occupation, mother's income, nutritional knowledge, and history of illness during pregnancy), father's characteristics (father's age, father's education, employment, father's smoking history and frequency) and family characteristics (family expenditure, expenditure on food, family food security, access to health services, and environmental sanitation hygiene). The dependent variable in this study was the individual incidence of double-burden malnutrition (wasted-stunted/WaSt). The group with individual double-burden malnutrition was the group of toddlers with stunting nutritional status (LAZ <-2SD or HAZ <-2SD) as well as wasting (WHZ or WLZ <-2SD). The group without individual double-burden malnutrition included stunted toddlers (without wasting) and toddlers with normal nutritional status (without stunting and wasting).

Data on the characteristics of toddlers, mothers, fathers, and families were obtained through interviews with structured questionnaires. Birth weight and body length data were from the Mother and Child Health (MCH) book, while actual weight, height, and upper arm circumference were measured using anthropometric methods. The monthly income category was determined based on less than or more than the Semarang UMK in 2021, IDR 2,835,021.29 based on the Decision of the Governor of Central Java Number 561/39 Year 2021. Household food expenditure was the amount used for food in one week. Data on nutritional knowledge were obtained based on the results of a questionnaire that had previously been validated with a p-value <0.05. Nutritional knowledge in this study included knowledge about stunting, obesity, breastfeeding, MPASI, nutrition, and feeding when children are sick. This data were collected through a validated questionnaire with a p-value of < 0.005. The questionnaire consisted of 14 questions, with one score for each correct answer and 0 score for each wrong answer. Scores were categorized as good if the score was > 7 and poor if ≤ 7 (Demilew, 2017). Food security data were collected through interviews using the Household Food Insecurity Access Scale (HFIAS) questionnaire, which was tested for reliability in previous research in Indonesia (Cronbach's alpha 0.831) (Mahmudiono et al.,

Table 2
The characteristics of father

Variable	Group			p
	IDBM	non IDBM		
	WaSt	Stunted	Normal	
Aged[#]	39 (22-59)	35 (18-62)	32 (22-51)	0.517
Father's occupation[¥]				
Government employees	0 (0%)	1 (1.1%)	1 (4.5%)	0.89
Private sector employee	12 (57.1%)	43 (47.8%)	9 (40.9%)	
Labourer	3 (14.3%)	27 (30.0%)	5 (22.7%)	
Self-employed	6 (28.6%)	10 (11.1%)	7 (31.8%)	
Others	0 (0.0%)	9 (10.0%)	0 (0.0%)	
Father's education [¥]				
Not schooling	0 (0.0%)	1 (1.1%)	0 (0.0%)	0.001*
Elementary school	2 (9.5%)	20 (22.2%)	0 (0.0%)	
Junior High School	3 (14.3%)	16 (17.8%)	4 (18.2%)	
Senior High School	14 (66.7%)	45 (50.0%)	8 (36.4%)	
D1/D3/S1/more	2 (9.5%)	8 (8.9%)	10 (45.5%)	
Father's income [¥]				
Rp.0	0 (0.0%)	1 (1.1%)	0 (0.0%)	0.23
<Rp.2.835.021,29	10 (47.6%)	57 (63.3%)	11 (50.0%)	
>Rp.2.835.021,29	11 (52.4%)	32 (35.6%)	11 (50.0%)	
Smoking history [¥]				
Yes	15 (71.4%)	71 (78.9%)	12 (54.5%)	0.066
No	6 (28.6%)	19 (21.1%)	10 (45.5%)	
Number of cigarettes/day [¥]				
0 pack	6 (28.6%)	19 (21.1%)	10 (45.5%)	0.124
< ½ pack	3 (14.3%)	19 (21.1%)	4 (18.2%)	
½ pack	6 (28.6%)	15 (16.7%)	2 (9.1%)	
One pack	5 (23.8%)	31 (34.4%)	6 (27.3%)	
Two pack	1 (4.8%)	6 (6.7%)	0 (0.0%)	

Note: *Significant (p < 0,05; ɣ = uji Kruskal Wallis, # = uji one way ANOVA); * Post Hoc with Mann-Whitney test for father's education: Stunting vs WaSt p = 0,164; Stunting vs normal p = <0,001; WaSt vs normal p = 0,036

2018). Access to health services was assessed based on distance, ease of access, travel time, and costs incurred to reach health services. A health-level assessment questionnaire was used to scale hygiene and environmental sanitation according to healthy house criteria based on the Minister of Health Decree Number 829/ Minister of Health/SK/VII/1999. Houses were categorized as healthy if they scored ≥ 1068 (Purwanti et al., 2022). The data on infectious diseases among children were based on doctor/ medical diagnoses written in the Maternal and Child Health Book.

Data analysis included univariate and bivariate analyses. Univariate analysis provided an overview of the characteristics of groups with and without individual double-burden malnutrition (wasted-stunted). Bivariate analysis tested whether there were differences between the three groups: IDBM: WaSt, non-IDBM: stunted, and normal. The statistical tests used were the one-way ANOVA test with the Bonferroni post hoc test when the data were normally distributed, and the Kruskal-Wallis test to analyze differences between three independent groups, and the Mann-Whitney U test as a post hoc alternate test for Kruskal-Wallis when the data were not normally distributed .

RESULTS

Based on Table 1, it is known that there are differences in age, actual body weight, and MUAC (mid-upper arm circumference) in the subject groups with normal nutritional status,

Table 3
The characteristics of mother and family economic status

Variable	Group			p
	IDBM	non IDBM		
	WaSt	Stunted	Normal	
Mother's characteristic				
Mother's occupation				
Housewife	19(90.5%)	60 (66.7%)	14 (63.6%)	0.275
Private sector employee	2 (9.5%)	14 (15.6%)	4 (18.2%)	
Labour	0 (0.0%)	9 (10.0%)	0 (0.0%)	
Self-employee	0 (0.0%)	5 (5.6%)	3 (13.6%)	
Others	0 (0.0%)	2 (2.2%)	1 (4.5%)	
Mother's education				
Not schooling	0 (0.0%)	0 (0.0%)	0 (0.0%)	0.128
Elementary school	0 (0.0%)	11 (12.2%)	2 (9.1%)	
Junior High School	4 (19.0%)	25 (27.8%)	4 (18.2%)	
Senior High School	15 (71.4%)	45 (50.0%)	11 (50.0%)	
D1/D3/S1/more	2 (9.5%)	9 (10.0%)	5 (22.7%)	
Mother's income				
Rp.0	19 (90.5%)	60 (66.7%)	12 (57.1%)	0.038*
<Rp.2.835.021,29	2 (9.5%)	17 (18.9%)	5 (23.8%)	
>Rp.2.835.021,29	0 (0.0%)	13 (14.4%)	4 (19.0%)	
There is a history of pregnancy sickness				
No	11 (52.4%)	48 (53.3%)	16 (72.7%)	0.217
Yes	10 (47.6%)	42 (46.3%)	6 (27.3%)	
Mother's actual age (years)[#]	32 (19-44)	32 (18-46)	32 (19-48)	0.539
Maternal age at birth (years)[#]	30 (18-41)	29.5 (17-43)	31.5 (17-43)	0.207
Family Economic Characteristics				
Family Expenditures per Week (IDR) [¥]	500.000 (200.000-1.800.000)	500.000 (100.000-4.000.000)	625.000 (125.000-4.500.000)	0.151
Expenditure on food per week (IDR) [¥]	350.000 (100.000-800.000)	350.000 (50.000-300.000)	375.000 (200.000-2.500.000)	0.086

Note: *Significant ($p < 0,05$; Kruskal Wallis test) *Post Hoc with Mann-Whitney test for mother's income: Stunting vs WaSt $p = 0,029$; Stunting vs normal $p = 0,114$; WaSt vs normal $p = 0,003$; *Significant ($p < 0,05$; ¥ = Kruskal Wallis test, # = one way ANOVA test) *post hoc with Mann Whitney and Bonferroni test (different superscript a, b, c indicate significantly different groups)

stunted, and WaSt. The WaSt group had lower body weight and MUAC than the other groups. The normal nutritional status of toddlers exhibited higher body weight and MUAC than the other two groups.

Table 2 shows differences in father's education in the three groups (p=0.001). The subjects with normal nutritional status had a different level of father's education from those with stunted and WaSt nutritional status. Highly educated fathers were most often found in the group of toddlers with normal nutritional status (45.5%) compared to the stunted (8.9%) and WaSt (9.5%) groups.

Table 3 shows differences in maternal income and number of family members in the three groups. The WaSt toddler group had mothers with different incomes from the other two groups (p=0.038). Most mothers of WaSt toddlers had no income (90.5%). This percentage is much higher than that of mothers in the stunting (66.7%) and normal (57%) groups.

Based on Table 4, it is known that there is a difference in the food security of families of toddlers with normal nutritional status compared to the stunted and WaSt groups (p=0.012). Most of the families of toddlers with normal nutritional status were included in the food secure category (81.8%), much higher than those with stunted (45.5%) and WaSt (57.1%). Conditions of severe food insecurity were most often found in the stunted group (20%) compared to the WaSt group (4.8%) and the group with normal nutritional status (4.5%). Addition-

Table 4
Maternal nutritional knowledge, family food security, access to family health services, and home sanitation hygiene

Variable	Group			p
	IDBM	non IDBM		
	WaSt	Stunted	Normal	
Mother's knowledge score	12 (9-14)	11 (5-14)	10.5 (8-14)	0.139
Good	21 (100%)	89 (98.9%)	22 (100%)	0.788
Poor	0 (0%)	1 (1.1%)	0 (0%)	
Family food security				0.012*
Food Secure	12 (57.1%)	41 (45.5%)	18 (81.8%)	
Mildly Food Insecure	6 (28.6%)	19 (21.1%)	1 (4.5%)	
Moderately Food Insecure	2 (9.5%)	12 (13.3%)	2 (9.1%)	
Severely Food Insecure	1 (4.8%)	18 (20.0%)	1 (4.5%)	
Access to Health Services				0.628
Easy (skor 9-12)	20 (95.2%)	87 (96.7%)	22 (100%)	
Moderate (skor 5-8)	1 (4.8%)	3 (3.3%)	0 (0%)	
Difficult (skor 1-4)	0 (0%)	0 (0%)	0 (0%)	
Home sanitation hygiene score	1086 (693-1249)[a]	1042.5 (630-1280)[a]	1077.5 (687-1280)[b]	<0.001*
Healthy home	12 (57.1%)	36 (40%)	12 (54.5%)	0.229
Unhealthy home	9 (42.9%)	54 (60%)	10 (45.5%)	

Note: *Significant (p < 0,05; Kruskal Wallis test) *Post Hoc with Mann-Whitney test for family food security: Stunting vs WaSt p = 0,155; Stunting vs normal p = 0,006; WaSt vs normal p = 0,137; post hoc with Mann Whitney and Bonferroni test for home sanitation hygiene score (different superscripts a, b, c indicate significantly different groups)

ally, there were differences in home sanitation hygiene between the stunted and WaSt groups compared to toddlers with normal nutritional status. Families of toddlers with normal nutritional status had higher home sanitation hygiene scores than the other two groups.

Table 5 shows differences in the incidence of infectious diseases between toddlers with normal nutritional status and the other two groups (p=0.011). Most toddlers with normal nutritional status do not experience infectious diseases (95.5%).

DISCUSSION

Prevalence of stunted and WaSt

Based on research results, it is known that 19% of toddlers have wasted-stunted (WaSt), which is a form of intraindividual double-burden malnutrition. The low percentage of WaSt in this study cannot provide evidence that stunting is a chronic/long-term form of overt and acute malnutrition problems, namely wasting. The low percentage of WaSt could be because the toddlers in this study were more than one year old (25 months in the WaSt group and 27 months in the stunting group). Another study shows that wasting occurs when children are 10–12 months, and stunting usually occurs at 24 months (Schoenbuchner et al., 2019). Because most of the subjects in this study were >20 months old, the prevalence of wasting may be lower. It is also known that stunting is partly a biological response to previous episodes of being wasted. This finding suggests that stunting may represent a deleterious adaptation to more overt undernutrition (wasting) (Schoenbuchner et al., 2019).

These findings also illustrate that the relatively high prevalence of stunting in this study population can occur when the prevalence of wasting is classified as rare/low. Research related to WaSt found that high stunting rates may occur where wasting is rare and stunting may have already occurred at birth. Instances of wasting may not be the primary cause of stunting in developing countries (Richard et al., 2012).

Incidence of Infectious Diseases

This research also shows differences in

Table 5
Incidence of infectious diseases in children

Variable	Group			p
	IDBM	non IDBM		
	WaSt	Stunted	Normal	
Infectious disease incidence				
No	16 (76.2%)	58(64.4%)	21 (95.5%)	0.011*
yes	5 (23.8%)	32 (35.6%)	1 (4.5%)	
Breakdown types of infectious diseases:				
Diarrhoea				
Yes	7 (33.3%)	28 (31.1%)	5 (22.7%)	
No	14 (66.7%)	62 (68.9%)	17 (77.3%)	
Acute respiratory tract infection (ARI)				
Yes	14 (66.7%)	48 (53.3%)	10 (45.5%)	
No	7 (33.3%)	42 (46.7%)	12 (54.5%)	
Pulmonary tuberculosis				
Yes	1 (4.8%)	5 (5.6%)	0 (0%)	
No	20 (95.2%)	85 (94.4%)	22 (100%)	
Asthma				
Yes	0 (0%)	1 (1.1%)	0 (0%)	
No	21 (100%)	89 (98.9%)	22 (100%)	
Other infection (without medical diagnosis)				
Yes	0 (0%)	1 (1.1%)	0 (0%)	
No	21 (100%)	89 (98,9%)	22 (100%)	

Note: *Significant (p < 0,05; Kruskal Wallis test); *Post Hoc with Mann-Whitney test for infectious disease infection: Stunting vs WaSt p = 0,317; Stunting vs normal p = 0,004* ; WaSt vs normal p = 0,058

the incidence of infectious diseases between toddlers with normal nutritional status and the other two groups (stunted and WaSt). Consistent with the conceptual framework of toddler nutrition problems, essential causal factors of stunting and wasting are infectious diseases, environmental enteric dysfunction, a diet with inadequate nutrients, and suboptimal infant feeding and caring practices (Angood et al., 2016). However, there was no difference in the incidence of infection in the WaSt and stunted groups in this study.

Most toddlers with normal nutritional status do not experience infectious diseases (95.5%). Based on the results of this study, there were no significant differences in the types of infectious diseases that occurred in the stunting and WaSt groups. This could be because environmental factors (hygiene, sanitation, and access to services) in the stunting and WaSt groups are no different. Most of the hygiene and sanitation were classified as inadequate, while access, for the most part, is relatively easy. Apart from that, there was no difference in smoking history between fathers of WaSt and stunted toddlers. Pulmonary tuberculosis (TB) and asthma are more common in stunted toddlers compared with WaSt.

Toddlers with stunted nutritional status are at higher risk of developing TB compared to toddlers who have normal nutritional status (Nurwitasari & Wahyuni, 2015). According to Crofton, children have immature immune systems. Immunity also decreases if the child suffers from malnutrition (Purnamasari et al., 2022). Other studies show that the risk factor with a significant correlation with stunting is a history of pulmonary TB disease. One of the possible factors affecting the result of pulmonary TB association with stunting prevalence is the possibility of early and repeated exposure to diseases that cause a change in body weight and height. Stunted under-fives can reduce immunity and make children more susceptible to TB germs. Untreated TB in children can also lead to impaired nutritional growth (Purnamasari et al., 2022).

Studies in stunted, underweight children

have also found an increase in the proportion of the total number of B cells with low-affinity IgE receptors (CD23+). CD23+ plays an essential role in allergen presentation facilitated by IgE to T cells and strongly activates allergen-specific T cells and the secretion of Th2-driving cytokines. Stunted children present with low vitamin D and leptin levels, impaired lung growth, decreased lung function, and increased IL-4 and CD23+ levels. These factors may be considered consequential in asthma in stunted children (Sapartini et al., 2022).

Environmental Conditions

Compared with the normal nutritional status group, diarrhea and other infectious diseases are more common in families of stunted and WaSt toddlers because they are related to home sanitation hygiene. This research found differences in home sanitation hygiene in the stunting and WaSt groups compared to toddlers with normal nutritional status. Families of toddlers with normal nutritional status had higher home sanitation hygiene scores than the other two groups.

Based on the research results, it is also known that the average home sanitation hygiene score in the WaSt group is 1086 (693-1249), which is descriptively higher than the average home sanitation hygiene score in the stunting group of 1042.5 (630-1280). Home sanitation, classified as meeting the requirements, is also more common in families of WaSt toddlers (57%) than in stunted toddlers (40%). This can impact the risk of infectious diseases in the WaSt group, which is not significantly different from the stunting group due to the protective factor of home sanitation hygiene.

Previous studies reported that diarrhea morbidity in children <5 years was associated with the unsafe disposal of children's feces and the wealthy status of households (Mulatya & Ochieng, 2020). Another study also shows that one risk factor for diarrhea mortality rate is reduced exposure to unsafe sanitation (Troeger et al., 2020). Younger children, male children, and children of young mothers are more likely to suffer from the disease than their counterparts. Children who have improved toilets and use salt above 15 PPM iodine face a lower risk of illness (Methun et al., 2021).

Water without soap for toilet-washing before the child defecates and a house near the street were found to be the determinants of under-five pneumonia. Animal dung is also a source of fuel. So, childcare given by the house worker or housemaid and having an acute respiratory tract infection in the last two weeks were significantly associated with under-five pneumonia (Girma et al., 2023). Another study shows that after controlling for socioeconomic status, healthcare use, maternal factors, community-level factors, and all wealth index items, the following wealth index items were the most consistently associated with child health: type of toilet facilities, water source, refrigerator, pressure cooker, type of cooking fuel, land usable for agriculture, household building material, mobile phone, and motorcycle/scooter (Karlsson et al., 2020).

Food Security

Another factor that can protect the individual group of double-burden malnutrition in the form of WaSt from infectious disease morbidity in this study is that there is no difference in the food security of families of stunted toddlers and WaSt toddlers. The food security score for stunted toddlers (45.5%) was lower than that of the WaSt group of toddlers (57.1%), although this difference was statistically insignificant.

Differences in food security were found between the normal nutritional status group of toddlers and the malnourished group (stunted and WaSt). Most families of toddlers with normal nutritional status were in the food-secure category (81.8%). Apart from that, conditions of severe food insecurity were most often found in the stunting group (20%) compared to the WaSt group (4.8%) and the toddler

group with normal nutritional status (4.5%).

Food insecurity was known as one of the child underweight risk factors. Households near the domestic water supply had a low risk of registering wasted children (Chilanga & Chilanga, 2023). Food-insecure households (food insecurity) have also been reported to be associated with a higher prevalence of stunting in children under five. Food insecurity harms the nutritional status of children; this is related to the lack of consumption of highly nutritious foods such as animal products, fruit, and vegetables, coupled with recurrent infections and unhealthy living conditions associated with poverty. These factors contribute to loss of appetite, increased metabolic needs, and nutrient deficits (Shamah-Levy et al., 2014, 2017). Previous research results show that food diversity decreases with decreasing food security in the household; the lower the food security, the less variation in food intake. Food insecurity is also related to the lower intake of micronutrients, which are essential for children's growth and development, thereby increasing the risk of stunting in children (Shamah-Levy et al., 2014).

Sociodemographic Characteristics

This research also found differences in the fathers' education levels between the WaSt and stunted groups and the normal nutritional status group. Low-educated fathers (no school and only completed elementary school) were more often found in the WaSt and stunted groups than in the normal nutritional status group. A low level of education can cause an imbalance in the food serving in the family, affecting the nutritional status of family members (Rachmah et al., 2021). On the other hand, a person with a high educational level will choose high-nutrition food based on availability and change diet habits to fulfill nutritional needs (Mosli et al., 2020).

Apart from that, there were also differences in maternal income in the three groups. The WaSt group of toddlers had mothers with different incomes from the other two groups ($p=0.038$). Most WaSt mothers of toddlers had no income (90.5%). This percentage is much higher in the stunting (66.7%) and normal (57%) groups . Employed mothers affect income, family economics, and parenting (Agustin & Rahmawati, 2021). However, there was no difference in fathers' income between the WaSt and stunting groups. Likewise, family expenditure and expenditure on food in both groups. Therefore, the impact of differences in maternal income on only partial economic status is only partially significant. Data regarding the food expenditure of toddler families support this.

Based on Engel's law, the decreased share of food expenditure in the household budget is in line with the increase in income. According to this law, the poorer a family is, the greater the proportion of its total expenditure that must be devoted to providing food. In line with this theory, this study found that most family expenditure was allocated to food (70% in the WaSt and stunting groups and 60% in the normal nutritional status group). This allocation indicates that the average family economy of the research subjects is classified as poor because food expenditure is ≥60%. This level of low income and poverty is closely related to food insecurity, which can contribute to the nutritional status of the family (Mahmudiono et al., 2018; Rachmah et al., 2021). Lack of purchasing power and limited access to food due to socioeconomic constraints are potential factors that cause diets to lack diversity and low quality, which can cause malnutrition in children (Krismanita et al., 2022; Lee et al., 2017). Family characteristics such as low family income cause low purchasing power, which results in buying cheap and low-protein food. Poor environmental sanitation can cause infection, leading to stunting (Astuti et al., 2020).

The strengths of this study include a large sample size, the broad scope of the study, and the analysis of various factors that indirectly pose a risk to WaSt, such as sociodemographic characteristics, the incidence of disease in

children under five, family food security, and the hygienic and sanitary conditions of the home environment. This study did not compare the wasting, stunting, and normal groups in a proportional number of subjects, thereby allowing bias in the research subjects. However, researchers have minimized the risk of bias in data analysis.

CONCLUSIONS

This research shows that 19% of toddlers have Wasted-stunted (WaSt). There were differences in the incidence of infectious diseases between toddlers with normal nutritional status and the other two groups (stunted and WaSt). Most toddlers with normal nutritional status do not experience infectious diseases (95.5%). This research also found differences in home sanitation hygiene in the stunting and WaSt groups compared to toddlers with normal nutritional status. Families of toddlers with normal nutritional status had higher home sanitation hygiene scores than the other two groups. Differences in food security were found between the normal nutritional status group of toddlers and the malnourished group (Stunted and WaSt). This research also found differences in the fathers' education levels between the WaSt and stunted groups and the normal nutritional status group. Low-educated fathers (no school and only completed elementary school) were more often found in the WaSt and stunting groups than in the normal nutritional status group. This study also found that most family expenditure was allocated to food (70% in the WaSt and stunting groups and 60% in the normal nutritional status group). The government and related stakeholders need to pay more attention to families of children under five with limited access and facilities for hygiene and sanitation, low income, low parental education, and low food security to prevent an increase in the risk of WaSt in the community.

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AUTHORS' CONTRIBUTIONS

Rachma Purwanti, designed the study, formulated the concept, wrote the manuscript, enrolled participants, collected data, revise the manuscript, performed the field work, and read and approved the final manuscript. Novitasari D. Ajeng, collected data, acquired the data, analyze the data, and revise the manuscript.

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COMPETING INTERESTS

The authors confirm that all of the text, figures, and tables in the submitted manuscript work are original work created by the authors and that there are no competing professional, financial, or personal interests from other parties.

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