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CASE STUDY

Clean and healthy environmental behavior in terms of malnutrition and sanitation

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ABSTRACT

BACKGROUND AND OBJECTIVES: A lousy environment has the potential to be a predictor of disease transmission, which ultimately results in malnutrition among children. Meanwhile, the mother's role is crucial in the first 1000 days of life. This research aimed to determine the determinants of maternal behavior in preventing chronic malnutrition in children on the basis of environmental aspects.

METHODS: This cross-sectional study with a quantitative design was conducted in Surabaya, Indonesia, with a sample of 208 pregnant women and 222 mothers of toddlers. A questionnaire was used to identify information related to the dependent variable, chronic malnutritional prevention behavior, on the basis of environmental aspects, and independent variables related to the determinants of maternal behavior. Data were analyzed via Chi-square test using the Statistical Program for Social Sciences.

FINDINGS: As many as 80.8 percent of pregnant women and 65.8 percent of mothers under five had good chronic malnutritionchronic malnutrition prevention behavior. The perception of behavioral control in using clean water is significantly related to the behavior of pregnant women and mothers of toddlers, with significance values of 0.012 and 0.013, respectively. The perceived behavioral control towards washing hands with soap has a significant relationship with the behavior of pregnant women and mothers of toddlers, with significance values of 0.003 and 0.005, respectively. Pregnant women with poor behavioral control in washing their hands with clean water and soap were 2.963 times more likely to have poor chronic malnutritionchronic malnutritional prevention behavior than the comparison group. Subjective norms of using clean water and washing hands with clean water and soap in pregnant women are significantly related to chronic malnutritionchronic malnutrition prevention behavior, with significance values of 0.011 and 0.049, respectively, and odds ratios of 2 and 2.280, respectively.

CONCLUSION: Environment-based chronic malnutritionchronic malnutritional prevention behavior in mothers is primarily influenced by perceived behavioral control and subjective norms. The family can be part of the subjective norms that drive aspects of attitudes and perceptions of behavioral control related to environment-based chronic malnutritionchronic malnutrition prevention practices. Meanwhile, the aspects of controlling maternal behavior can be intervened through efforts to minimize obstacles and increase the perception of benefits from behavior to prevent chronic malnutrition. Maternal behavioral change interventions could encourage the implementation of good behavior in preventing malnutrition in children. In the end, children could learn the behavior given by their mothers and adopt it.

NUMBER OF REFERENCES
51

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4

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INTRODUCTION

The problem of malnutrition in children is not only related to food availability or access but also driven by environmental sanitation aspects (Oginawati *et al.,* 2023). Environmental factors indirectly influence children's growth and development (Yenita *et al*., 2021), which can ultimately lead to poor nutritional status in children (Ainy *et al.,* 2021). In Indonesia, environmental factors that threaten children come from exposure to contaminated water, air, food, and soil (Haryanto, 2020). These sources of exposure indicate the importance of implementing hygiene and sanitation. Good environmental sanitation can reduce the potential for a history of infectious diseases in children (Bliznashka *et al*., 2021). In Indonesia, the proportion of households with access to adequate sanitation services reached 80.92 percent (%) in 2022. This percentage increased by 0.63% compared with that in 2021 (BPSRI, 2022). Environmental sanitation factors include water, sanitation, and hygiene (WASH), which is a factor that explains most (24.0%) of the difference in the incidence of chronic malnutrition in children living in urban and rural areas. Poor WASH access and behavior causes 1.6 million deaths annually (Chirgwin *et al*., 2021), and it is a determinant of chronic malnutrition in children (Lin *et al*., 2023). The incidence of malnutrition becomes more frequent in low-income families. Low-income family environmental sanitation increases the potential for children to experience chronic malnutritionchronic malnutrition 1.979 times compared with children from families with good sanitation (Oginawati *et al*., 2023). Healthy environmental sanitation needs to be continuously maintained by involving families (Ainy *et al*., 2021). Good environmental sanitation can reduce the potential for a history of infectious diseases in children (Bliznashka *et al*., 2021). Efforts to avoid chronic malnutritionchronic malnutrition can be made in the first 1000 days of life, which is a critical period for children's growth and development (Shirisha *et al.,* 2022). In the first 1000 days of a child's life, the child's body is in a dynamic stage of body development, so it is vulnerable to exposure to environmental factors. Exposure to these four sources can increase the risk of potential diseases, such as acute hepatitis A, diarrhea, dengue fever, and malaria, due to lack of water supply and sanitation, vectors, parasites, and others (Haryanto, 2020; Truong *et al.,* 2023). Infectious diseases can have implications for

poor nutritional conditions in children. When a child suffers from an infectious disease, the child's appetite becomes poor. The absorption of nutrients into the child's body becomes less than optimal. Disturbances in food intake and insufficient supply of essential substances needed by the body can result in weight loss among children, resulting in nutritional and energy intake that is less than what the child should need. In the long term, infection with infectious diseases can encourage child malnutrition due to decreased appetite and absorption of nutrients in the intestine (Fadjriah *et al*., 2021). The most significant proportion of children's nutritional problems is chronic malnutritionchronic malnutrition (Lefebo *et al*., 2023). Chronic malnutritionChronic malnutrition is a failure in a child's anthropometry, resulting in a disproportionate body due to weight loss (Li *et al*., 2020). In 2019, Indonesia experienced a decrease in the proportion of chronic malnutritionchronic malnutrition from 27.7% to 24.4% in 2021. However, the decrease in the proportion of chronic malnutritionchronic malnutrition is inversely proportional to the number of provinces where the prevalence rate is higher than the national average. In 2019, 17 provinces had prevalence rates higher than the national prevalence rate. In 2021, 19 provinces had a prevalence above the national prevalence (Wulandari *et al*., 2022). The accumulation of these conditions places Indonesia in fourth place, with the highest incidence of children with chronic malnutrition globally. The spread of this deformation could affect the Indonesian economy. Clean and healthy living behavior/Perilaku Hidup Bersih dan Sehat (PHBS) is a public health improvement program that was launched in 1996. The application of PHBS indicators can provide short- and long-term positive effects. However, 27 years after the PHBS program was launched, its implementation remains far from expectations. Basic health research in Indonesia, carried out every 5 years, reported its latest findings in 2018 that only 39.1% of households implemented PHBS (Kementerian Kesehatan, 2020a). Risk factors for stunted child growth, which leads to malnutrition, are infections during pregnancy, teenage mothers (too young), poor parenting patterns, working mothers, and mothers exposed to cigarette smoke during pregnancy (Kementerian Kesehatan, 2020b). In other words, the mother is the key that comes from outside the child, related to the potential

for malnutrition in children. Prevention of chronic malnutrition in children depends on the mother's behavior in fulfilling children's nutrition (Pedro *et al.,* 2022). The productive, reproductive, and social roles of pregnant women and toddler mothers are very strategic, and they determine the nutritional status of children (Yenita *et al.,* 2021). Maternal behavior is supported by knowledge regarding factors that influence malnutrition status in children. However, in previous research, the knowledge of mothers, especially pregnant women, was lacking and one of the causes of chronic child malnutrition in Indonesia (Li *et al*., 2020). Environmental sanitation is part of the benchmark for implementing PHBS. Various cultural, social, and economic prohibitions become challenges in implementing PHBS. Meanwhile, one of the causes of chronic malnutrition in Indonesia is the mother's poor perception regarding preventing chronic malnutritionchronic malnutrition in children (Siswati *et al*., 2022), which reflects maternal behavior. In this case, environment-based PHBS indicators are a form of chronic malnutritionchronic malnutrition prevention behavior. Previous research focused on epidemiological analysis using clean water and washing hands with soap on poor nutritional status in children (Gaffan *et al*., 2023), biological impacts (Hendricks *et al.* 2022), determinants based on nutritional provision, and exclusive breastfeeding (Zeleke *et al.*, 2022). Meanwhile, studies focusing on behavioral determinants of preventing unequal nutritional status in children still need to be improved, especially those focusing on environmental relationships. The present study, which was conducted in Surabaya, Indonesia, in 2022, aimed to explore maternal behavior while detailing each sanitation practice associated with chronic malnutritional prevention behavior.

MATERIALS AND METHODS

This study is a cross-sectional study. The population consisted of mothers related to the first 1000 days of a child's life, namely, pregnant women and mothers of toddlers. Previous research generally focused on child characteristics (Gizem, 2023) and mother characteristics without distinguishing between pregnant women and toddler mothers (Singh *et al.,* 2023). Meanwhile, the present study focuses on mothers. They were differentiated into two groups: pregnant women and mothers of toddlers. These two groups are closely related to the first 1000 days of a child's life, so the behavior of these two groups of mothers can represent the results of identifying determinants of preventing chronic malnutrition in children. The two groups of mothers were further divided to determine their chronic malnutrition prevention behavior, which may be similar or different. Thus, identifying each group of mothers could indicate appropriate interventions for both groups. This study was conducted in Surabaya, the capital of East Java Province, which is a province that administratively oversees 29 districts and nine cities (Fig. 1). Surabaya was chosen as the location for this study because of its massive chronic malnutrition phenomenon. In 2020, the local government recorded that more than 12,000 children under five experienced chronic malnutrition.

Data collection and sample size

During the study, respondents agreed to participate by signing a consent form. Respondents answered questions accompanied by research assistants in that field of study. Structured questionnaires and interviews were used to collect accurate data regarding demographic data, chronic malnutritional prevention behavior based on environmental aspects, and behavioral determinants based on theory of planned behavior (TPB). Maternal characteristics are essential in preventing child malnutrition (Hossain *et al*., 2022). Demographic data includes age, education, employment status, maternal characteristics based on babies or toddlers, and number of children. TPB consists of three groups: attitudes, perceived behavioral control, and subjective norms for each environment-based PHBS element (Table 1).

Respondents' opinions regarding chronic malnutrition prevention behavior based on environmental aspects gave 4 points for "yes, I have done it for more than six months," 3 for "yes, I have done it but less than six months," 2 for "yes, I have done it but less than six months," 1 for "no, but I plan to do it in the next 30 days," and 0 for "no and I do not plan to do it in the next six months." Respondents' opinions regarding attitudes were measured using a 5-point Likert scale with the range of 1 (never), 2 (rarely), 3 (sametimes), 4 (often), and 5 (always). An example of an attitude statement in the questionnaire is as follows: "I consider that not using clean water for daily activities is dangerous for my

Fig. 1: Geographic location of the study area in Surabaya, East Java, Indonesia

children and me." A Likert scale with the range of 1 (not tempted at all), 2 (not tempted enough), 3 (quite tempted), 4 (tempted), and 5 (very tempted) was also used to identify perceived behavior. An example of a statement of perceived behavioral control in the questionnaire is as follows: "I feel tempted not to use clean water because I am in an environment that does not support me to use clean water." Respondents' subjective norms were described using a Likert scale with the range of 1 (not important), 2 (slightly important), 3 (quite important), 4 (important), and 5 (very important). An example of a subjective norm statement in the questionnaire is as follows: "Using clean water for daily activities will be a hassle for my family." A sample of 208 pregnant women and 222 mothers of toddlers was randomly selected as respondents.

Data analysis

Data were analyzed using SPSS. The dependent variable is chronic preventive behavior that is based on environmental aspects. The independent variables are attitude towards the use of clean water, attitude towards washing hands with soap and clean water, perceived behavioral control towards the use of clean water, perceived behavioral control towards washing hands with soap and clean water, subjective norms towards the use of clean water, and subjective norms against washing hands with soap and clean water. Univariate analysis was used to explain the demographic features of the respondents (age, occupation, education, and total number of children). Chronic malnutrition awareness were analyzed, and the number of respondents with behavioral response categories of good and poor was compared. Bivariate data between the dependent variable (chronic malnutritional prevention behavior based on environmental aspects) of mothers under five and pregnant women on environment-based PHBS indicators were analyzed on the basis of three aspects of TPB. Bivariate analysis was conducted using Chi-square test to show which factors significantly

Table 1: Study questionnaire

Question	Answer
Respondent identity	
Age	In year
Education	Middle/junior high school, senior high school, diploma, bachelors, no answer
Occupation	Not working, working, no answer
Total number of children	1,2,3,4,5, or 6 children
Chronic malnutritional prevention behavior based on environmental aspects	
Do you use clean water in your daily household activities? (e.g. washing, cooking, bathing)	Yes, I have been doing it for over 6 months; yes, I have done it but for less than 6 months; no, but I plan to do it in the next 30 days; no, but I plan to do it in the next 6 months; no and I do not plan to do so in the next 6 months
Do you wash your hands using soap and clean water?	Yes, I have been doing it for over 6 months; yes, I have done it but for less than 6 months; no, but I plan to do it in the next 30 days; no, but I plan to do it in the next 6 months; no and I do not plan to do so in the next 6 months
Attitudes (behavioral believes and outcome evaluations)	
Utilize clean water (20 questions)	Never, rarely, sometimes, often, always
Wash hands with clean wáter and soap (20 questions)	Never, rarely, sometimes, often, always
Perceived behavioral control (control ideas and their influence)	
Not utilizing clean wáter (9 questions)	Not tempted at all, not tempted enough, quite tempted, tempted, very tempted
Not washing hands with clean wáter and soap (9 questions)	Not tempted at all, not tempted enough, quite tempted, tempted, very tempted
Subjective norms (normative beliefs and motivation to comply)	
Utilizing clean water behavior (6 questions)	Not important, slightly important, quite important, important, very important
Washing hands with clean water and behavior soap (6 questions)	Not important, slightly important, quite important, important, very important

differed, with a statistical significance level at a p-value > 0.05.

RESULTS AND DISCUSSION

As shown in Table 2, the respondents consisted of 208 pregnant women, with an average age of 25 years and 8 months. The average age of mothers of toddlers is around 29 years and 9 months. This study aligns with previous research, which had an average age of mothers of 29.53 ± 2.92 years (17–45 years) (Yeganeh *et al.*, 2023). Maternal age is related to the possibility of child nutrition. Children of mothers aged 20–25 years are 4.3 times more likely to not pay special attention to child nutrition than mothers aged 30 years (Getu *et al.,* 2023). Malnutrition is more common in children whose mothers are under 18 years old (Hossain *et al.,* 2022). Most pregnant women (124 people, 59.6%) had high school education (52%) and work. Meanwhile, 131 mothers of toddlers (59%) had high school education, and 112 (50.5%) did not work. This study aligns with that of Yeganeh *et al.* (2023), who found that most mothers (41%) had a high school diploma. A higher education indicated 1.329 times better feeding behavior in mothers (Akbar *et al.*, 2022). Mothers' working status can be considered in looking at mothers' level of awareness regarding the prevention of chronic malnutrition in children. Non-working mothers have a higher probability of having malnourished children by 3.31 times than working mothers (Shahid *et al.*, 2022). Shahid *et al.* (2022) research looked into the implications of mothers' work on family income. Even though her employment status, mothers can also have implications for the time they can devote to implementing chronic malnutritional prevention behavior, mainly those based on environment. A

total of 168 pregnant women (80.8%) had awareness about good chronic malnutrition, and 146 mothers were under five (65.8%). Another characteristic factor is the total number of children in the household. Mothers under five predominantly have one child, namely 92 mothers under five (41.4%). This study aligns with Yeganeh *et al*. (2023), who found an average number of children of 1.77 ± 0.78 (range of 1–6 children). The number of children can indicate aspects of the mother's experience and attention to the number of children in the household.

Kementerian Kesehatan (2020b) explains that the risk factors for malnutrition in children come from the mother and the child. Factors in children include low-birth-weight babies, child's difficulty drinking breast milk from the mother, suffering from infections (acute or chronic), congenital births, introducing solid foods too late or too early, and inadequate feeding. Meanwhile, maternal factors are infections during pregnancy, teenage mothers, poor parenting patterns, mothers exposed to cigarette smoke during pregnancy, and working mothers (Fig. 2). Previous research stated that malnutrition is prevented through providing breast milk, colostrum, and complementary foods (Forth *et al.,* 2022). In particular, giving complementary foods to breast milk is related to the mother's ability to prepare these foods hygienically. Hygienic preparation of complementary breast milk foods can prevent exposure to infectious diseases and malnutrition in children aged 6–24 months. One indicator of the hygienic preparation of complementary foods for breast milk is the household water source (Zeleke *et al.*, 2022). Water is the most basic need for all living creatures, including humans (Moghadam and Samimi, 2022). However, human activities cause an increase in the burden of air pollution (Abidin, 2023), which could ultimately become a vehicle for infectious diseases. Chronic malnutrition prevention behavior includes improving sanitation and implementing handwashing with soap to reduce the risk of further transmission and recurrent infections (Wulandari *et al*., 2022). These two behaviors are preventive efforts in the environment-based PHBS concept. The first two years of life are crucial for implementing chronic malnutritional prevention interventions in children (Woldesenvent *et al.,* 2023).

Chronic malnutritional events early in life result in growth disorders that are directly proportional to functional disorders of the child's body. In other words, chronic undernutrition affects cognitive abilities and affects education, productivity, and employment. Babies aged 0–6 months who experience chronic malnutrition and are still experiencing chronic malnutrition at the age of 7–8 years have a 2.8 times greater risk of experiencing decreased cognitive

Table 2: Respondent demographic characteristics

Variables	Pregnant women		Women with a child (under 5 years young)	
	n	%	n	%
Age	208	(25.8 ± 5.08)	222	(29.9 ± 4.9)
Education				
Middle/junior high school	6	2.9	11	5
Senior high school	108	52	131	59
Diploma	21	10	10	4.5
Bachelors	73	35.1	70	31.5
Occupation				
Not working	84	40.4	112	50.5
Working	124	59.6	110	49.5
Total number of children				
1			92	41.4
2			84	37.8
3			35	15.8
4	-	-	9	4.1
5			1	0.5
6			1	0.5
Chronic malnutritional prevention behavior based on environmental aspects				
Poor	40	19.2	76	34.2
Good	168	80.8	146	65.8

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┌─────────────────────────────────────────────┐
│ Risk factors for growth retardation           │
│                                                │
│  ┌──────────────────────────────────────┐     │
│  │           Children                    │     │
│  │ Low Birth Weight (LBW) babies, child's│     │        ┌─────────────────────┐
│  │ difficulty drinking breast milk from  │     │        │ Potential malnutrition│
│  │ the mother, suffering from infections │     │───────▶│ status in children    │
│  │ (acute or chronic), coningetal birth, │     │        └─────────────────────┘
│  │ introducing solid foods too late or   │     │
│  │ too early, and inadequate feeding.    │     │
│  └──────────────────────────────────────┘     │
│                                                │
│  ┌──────────────────────────────────────┐     │
│  │            Mother                     │     │
│  │ Infections during pregnancy, teenage  │     │
│  │ mothers, poor parenting patterns,     │     │
│  │ mothers exposed to cigarette smoke    │     │
│  │ during pregnancy, and working mothers.│     │
│  └──────────────────────────────────────┘     │
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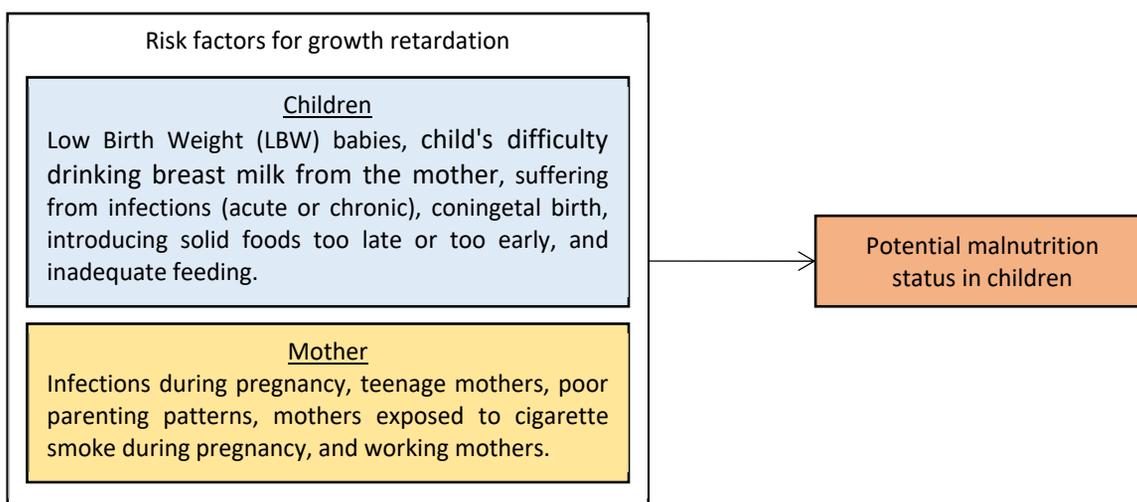
Fig. 2: Potential malnutrition status in children (Kementerian Kesehatan, 2020b)

function than babies who do not experience chronic malnutrition. David Barker's research began in the 1980s in England by comparing affluent and low-income countries with the prediction that the risk factor for noncommunicable diseases is lifestyle, which is related to economic conditions. Barker stated that rich countries have a higher prevalence of heart disease than low-income countries. However, data obtained in the field showed a different phenomenon. Low-income countries have a higher prevalence of heart disease than rich countries. Therefore, Barker concluded that noncommunicable diseases are not only caused by economic conditions but also past factors that influence the genetic conditions that humans carry from the beginning of life and develop with the encouragement of environmental factors (Barker, 2012). Using clean water is the first environmental factor that can influence children's nutritional status.

Table 3 shows that 105 mothers did not have good attitudes, although 83 (79%) had good chronic malnutrition prevention behavior. Meanwhile, 103 respondents had good attitudes towards using clean water, of which 85 pregnant women (85.5%) had good chronic malnutrition prevention behavior. Pregnant women's attitudes towards the use of clean water were not significantly related to chronic malnutritional prevention behavior (p-value = 0.525). Perceived behavioral control over the use of clean water in pregnant women was related to chronic malnutritional prevention behavior, with a significant p-value of 0.012. A total of 110 pregnant women experienced behavioral control related to inappropriate use of clean water. Ninety-six pregnant women (87.3%) knew about good chronic malnutrition. Meanwhile, 98 people (86.7%) had the perception of behavioral control related to good clean water, and 78 people (86.7%) had good chronic malnutrition prevention behavior. Pregnant women with the perception of not having good behavioral control regarding the use of clean water had 2.476 times the potential to have poor chronic malnutrition prevention behavior compared with pregnant women with good behavioral control. Meanwhile, the subjective norm aspect of clean water use had a significant relationship (p-value = 0.011). Pregnant women without good subjective norms regarding the use of clean water were two times more likely to not carry out good chronic malnutrition prevention behavior than pregnant women with good subjective norms. Meanwhile, the environmental-based prevention of chronic malnutrition in children included washing hands with clean water and soap. Most of the attitudes of pregnant women in washing their hands by using clean water and soap were poor. A total of 118 pregnant women did not have good attitudes, of which 76.3% (118 pregnant women) had good chronic malnutrition prevention behavior. The

Table 3: Results of Chi-square analysis in pregnant women

Variable	Chronic malnutritional prevention behavior based on environmental aspects				Total	OR (95% Cl)	p-value
	Poor		Good				
	n	%	n	%			
Attitudes (behavioral believes and outcome evaluations)							
Utilize clean water							
Poor	22	21	83	79	105	1.252	0.525
Good	18	17.5	85	85.5	103	(0.626–2.502)	
Wash hands with clean water and soap							
Poor	28	23.7	90	76.3	118	2.022	0.059
Good	12	13.3	78	86.7	90	(0.964–4.243)	
Perceived behavioral control (control ideas and their influence)							
Utilize clean water							
Poor	26	26.5	72	73.5	98	2.476	0.012*
Good	14	12.7	96	87.3	110	(0.197–0.828)	
Wash hands with clean water and soap							
Poor	28	27.4	74	72.6	102	2.963	
Good	12	11.3	94	88.7	106	(0.161–0.708)	0.003**
Subjective norms (normative beliefs and motivation to comply)							
Utilize clean water							
Poor	32	22.2	112	77.8	144	2.000	0.011*
Good	8	12.5	56	87.5	64	(0.865–4.626)	
Wash hands with clean water and soap							
Poor	32	23	107	77	139	2.280	
Good	8	11.5	61	88.5	69	(0.988–5.262)	0.049*

attitude of washing hands with clean water and soap was good in 90 pregnant women, of which 78 (86.7%) had good chronic malnutrition prevention behavior. The second TPB aspect analyzed was the perception of control behavior regarding the use of clean water and washing hands with clean water and soap. The perceived behavioral control regarding washing hands with clean water and soap showed a significant relationship with the behavior to prevent chronic malnutrition in pregnant women (p-value = 0.003). Pregnant women whose perception of behavioral control was poor in terms of washing their hands with clean water and soap had 2.963 times the potential to have poor chronic malnutrition prevention behavior compared with pregnant women whose perception of behavioral control was good. The number of mothers who perceived good and poor behavioral control was almost the same at 106 and 102, respectively. Most pregnant women (94, 88.7%) perceived that they do not have good behavioral control and good chronic malnutritional prevention behavior. The subjective norms regarding washing hands with clean water and soap for pregnant women were significantly related to children's chronic malnutritional awareness (p-value =

0.049). Pregnant women with poor subjective norms regarding washing with clean water were 2.280 times more likely to not carry out good chronic malnutrition prevention behavior than pregnant women with good subjective norms. Regarding frequency, 139 pregnant women had subjective norms regarding washing their hands with clean water and soap, and 107 people (77%) did not have good chronic malnutrition prevention behavior (Table 3).

Chronic malnutrition or linear growth disorders involve a complex interaction of genetic, family, environmental, socioeconomic, and cultural influences. Clean environmental sanitation and PHBS practices support the success of family health (Fadjriah *et al*., 2021). Previous research stated that the behavior of washing hands with soap and using clean water is the primary determinant in preventing chronic malnutrition (Lin *et al*., 2023). Based on Table 4, the attitudes of mothers of toddlers regarding the use of clean water were not related to chronic malnutritional prevention behavior (p-value = 0.917). One hundred fifteen mothers of toddlers did not have good attitudes towards using clean water, whereas 107 had good attitudes. Thirty-nine mothers of

toddlers (33.9%) did not have good chronic malnutritional prevention behavior nor good attitude towards using clean water. The attitudes towards washing hands with soap among mothers of toddlers were not significantly related to chronic malnutritional prevention behavior (p-value = 0.840). One hundred sixteen mothers of toddlers had no good attitudes towards washing their hands with clean water and soap, whereas 106 had good attitudes. Mothers of toddlers (77, 66.4%) predominantly had no good attitudes towards handwashing with soap and good chronic malnutritional prevention behavior. Two environment-based clean living behaviors in perceived behavioral control were found to be significant for chronic malnutritional prevention behavior. Perceived behavioral control in using clean water had a p-value of 0.013. Mothers of toddlers with no good perceived behavioral control regarding the use of clean water were 2.027 times more likely to have poor chronic malnutritional prevention behavior than mothers of toddlers with good perceived behavioral control. Most mothers of toddlers (87, 73.1%) had good perceived behavioral control regarding the use of clean water and good chronic malnutritional prevention behavior. Meanwhile, the perceived behavioral control related to washing hands with clean water and chronic malnutritional prevention behavior exhibited a p-value of 0.005. Mothers of toddlers with no good perceived behavioral control regarding washing their hands with clean water were 2.207 times more likely to have poor chronic malnutritional prevention behavior than mothers of toddlers with good perceived behavioral control. Most mothers of toddlers (83, 74.8%) had good perceived behavioral control regarding washing hands with clean water and good chronic malnutritional prevention behavior. Previous research on mothers' exclusive breastfeeding behavior showed that their behavioral control influences their perceived benefits. Awareness of these benefits can be encouraged through nutrition education programs that educate children about breast milk's benefits. The knowledge that mothers of toddlers gain could reflect what the mother feels (Rachmah *et al.,* 2023). Meanwhile, research in Africa suggested that perceived behavioral control is related to barriers experienced by mothers, such as limited resources and income, lack of knowledge, and time constraints for working mothers (Anyango *et al.,*

2021). Thus, preparing intervention formulations that could strengthen the perceived benefits and find solutions to obstacles is essential to encourage the perception of maternal behavioral control in a good direction in implementing behavior to prevent malnutrition in children. The subjective norms in environment-based PHBS were not significantly related to chronic malnutrition awareness of mothers of toddlers. The relationship between subjective norms regarding the use of clean water for mothers of under 5 years old and chronic malnutritional prevention behavior had a p-value of 0.566. As many as 114 mothers of toddlers had subjective norms related to poor use of clean water, whereas 77 (67.6%) had good chronic malnutritional prevention behavior. By contrast, 108 mothers of toddlers had subjective norms regarding using good clean water, and 69 (63.9%) had good chronic malnutrition awareness. The relationship between subjective norms related to washing hands with clean water and soap and chronic malnutritional prevention behavior had a p-value of 0.129. A total of 115 mothers of toddlers did not have good subjective norms regarding washing hands with clean water and soap, and 81 (70.4%) had good chronic malnutrition awareness. By contrast, 107 mothers of toddlers had subjective norms regarding washing their hands with clean water and good soap, and 65 (60.7%) had good chronic malnutrition awareness (Table 4). The availability of sanitation facilities is the primary determinant of the incidence of chronic malnutrition in children (Saheed *et al*., 2022). Malnutrition in children under 5 years old is a public health problem in low-income countries (Sufri *et al.,* 2023). Most of the world's poor, especially in rural areas, do not have access to safe drinking water (Mulyaningsih *et al*., 2023) and basic sanitation or handwashing facilities (Hasan *et al*., 2023). More than half of children (55.3%) live in households without access to basic sanitation facilities, and almost two out of every three (62.6%) children live without access to washing facilities that offer soap and pure water (Hasan *et al*., 2023). Children from families that do not have access to clean water and sanitation are 1.27 times more likely to suffer from chronic malnutrition than children from households with access to clean water and sanitation (Gaffan *et al*., 2023). Previous research found that access to tap water at home does not guarantee access to clean water. Water often does

Table 4: Results of Chi-square analysis on mothers of toddlers

Variable	Chronic malnutritional prevention behavior based on environmental aspects				Total	OR (95% CI)	p-value
	Poor		Good				
	n	%	n	%			
Attitudes (behavioral believes and outcome evaluations)							
Utilize clean water							
Poor	39	33.9	76	66.1	115	0.971	0.917
Good	37	34.6	70	65.4	107	(0.557–0.1691)	
Wash hands with clean water and soap							
Poor	39	33.6	77	66.4	116	0.945	0.840
Good	37	34.9	69	65.1	106	(0.542–1.645)	
Perceived behavioral control (control ideas and their influence)							
Utilize clean water							
Poor	44	42.7	59	57.3	103	2.027	0.013*
Good	32	26.9	87	73.1	119	(0.281–0.866)	
Utilize clean water							
Poor	48	43.2	63	56.8	111	2.207	0.005*
Good	28	25.2	83	74.8	111	(0.250–0.783)	
Subjective norms (normative beliefs and motivation to comply)							
Utilize clean water							
Poor	37	32.4	77	67.6	114	0.850	0.566
Good	39	36.1	69	63.9	108	(0.488–1.481)	
Utilize clean water							
Poor	34	29.6	81	70.4	115	0.650	0.129
Good	42	39.3	65	60.7	107	(0.372–1.135)	

not flow to residents' homes. Thus, the tap water supply is considered unable to meet the residents' clean water needs. Moreover, processing tap water, which is generally boiled first, is considered to be another obstacle. The process of boiling water incurs additional costs for purchasing fuel (Dickson-Gomez *et al.,* 2023). Other research added that changes in the prevalence of malnutrition in an area are influenced by access to piped water. Enhanced access to piped water could reduce the prevalence of malnutrition. Thus, stakeholders must collaborate in a multisectoral manner to ensure accessibility of factors that could increase the prevalence of malnutrition, including access to clean water (Brar *et al*., 2020). Based on the Republic of Indonesia Government Regulation Number 185 of 2014, the central, provincial, and district governments must accelerate public infrastructure development to ensure all residents have access to safe drinking water, sanitation, and cleanliness. This investment significantly improves children's health and reduces chronic malnutrition in Indonesia (Mulyaningsih *et al*., 2023). In addition, additional costs are an obstacle to washing hands with soap and clean water (Watson *et al*., 2023). Consistent and effective WASH behavioral practices are urgently needed to improve children's health in low-income areas with difficult hygiene conditions (Meierhofer *et al*., 2023). Meanwhile, facilities for basic hygiene, such as soap for washing hands, have a significant effect. Children who come from households that do not have basic hygiene facilities are 1.33 times more likely to be underweight (Gaffan *et al*., 2023). Using clean water and washing hands with soap and clean water can mediate 23.96% of the difference in chronic malnutrition incidence between urban and rural areas. Children from households with poor WASH behavior have a higher risk of experiencing chronic malnutrition, with a crude relative risk of 2.19 (Lin *et al*., 2023). Sanitation is an essential factor in reducing the number of illnesses and deaths due to nutritional problems, such as those caused by diarrhea in low-income areas (Hendricks *et al.,* 2022). Diarrhea is an infectious disease that can affect the incidence of chronic malnutrition. It is the leading cause of child morbidity and mortality, and it is directly related to chronic malnutrition in early childhood (Wolf *et al.,* 2023). Diarrhea causes the deaths of around 525,000

children every year. Chronic diarrhea places children at risk of cognitive deficits, less-than-optimal performance at school, and reduced immunity into adulthood. Bad behavior in using clean water and not washing hands with soap is the main determining factor in diarrhea through contamination from unclean water (Dickson-Gomez *et al.,* 2023). One of the bacteria that causes diarrhea is *Shigella*, the second leading cause of diarrheal morbidity and mortality in children in low- and middle-income countries. Poor sanitation is one of the risk factors for *Shigella*. Children with good sanitation can reduce the risk of *Shigella* incidence by 98.85% compared with children from families with poor sanitation (Rogawski *et al*., 2020). Other research found that washing hands with soap and using clean water is significantly associated with *Giardia lamblia* infection, fever, coughing, and chronic malnutrition in children. The frequency of washing hands with soap significantly reduces the odds ratio (OR) for the potential incidence of *G. lamblia* infection, fever, and chronic malnutrition. Meanwhile, using clean containers as an intermediary between the water source and the water storage location is essential. Using clean containers to transport drinking water significantly reduces the OR of *G. lamblia* infection (Meierhofer *et al.,* 2023), which can trigger chronic malnutrition. In other research, mothers play an important role in determining the determinants of chronic malnutrition behavior. Previous research found that children whose mothers do not wash their hands before feeding their children are a critical factor in chronic malnutrition children aged 24–59 months. These findings are based on mothers washing their hands after defecating, cleaning the baby's anus, and breastfeeding the child (Woldesenvent *et al.,* 2023). This finding relates to other factors related to chronic malnutrition, making it important to formulate nutrition promotion and disease prevention interventions at the community level (Mshida *et al.,* 2018). For maternal and fetal nutrition to be met, providing health education or promotion regarding pregnancy health is necessary, which can be performed via telephone (Konyole *et al.,* 2023). The Indian state provides an example of health promotion related to maternal and child nutrition through the Mobile Solutions Aiding Knowledge for Health Improvement (M-SAKHI) program to assist health workers in providing

education about pregnancy health to pregnant women and their families (Ogutu *et al.,* 2022). Furthermore, clean living habits need to be applied to children for them to get used to living cleanly, from teaching children to wash their hands before and after eating and before carrying out daily activities to teaching children to fulfill their defecation needs at home toilets (Nurjazuli *et al*., 2023). Other driving factors include social norms involving family members and lack of knowledge about the health effects on children (Parveen *et al*., 2018). Access to WASH facilities with enhanced quality can help children survive and thrive (Hasan *et al.,* 2023). Environmental sanitation and personal hygiene programs must be strengthened (Woldesenvent *et al*., 2023). WASH must be considered a system, and various improvements are needed to function (Dickson-Gomez *et al.,* 2023). Coordination between relevant institutions to overcome these two factors is needed to reduce and prevent chronic malnutrition effectively (Sufri *et al.,* 2023). Equalizing perceptions regarding factors related to poor nutritional status in children based on using clean water and washing hands with soap is essential. The same perception can facilitate the design of appropriate interventions to encourage the implementation of good behavior in preventing malnutrition among children. The relationship between factors that influence poor nutritional status in children is explained on the basis of the results of the present study and those of previous research in Fig. 3.

The mother's attitude in using clean water and washing hands with clean water and soap is critical in reducing the incidence of chronic malnutrition in children. Another study found that simply washing hands with clean water and soap did not reduce the incidence of chronic malnutrition in children in low-income countries (Humphrey *et al.,* 2019). Previous research found that the source of obstacles to implementing cleanliness habits was piped water access to resident's homes (Yunitasari *et al.,* 2022). Interventions can be carried out by conveying health promotion messages through household visits and group meetings. Interventions through health promotion programs can be designed on the basis of the risk, attitudes, norms, abilities, and self-regulation (RANAS) behavior change model. This health promotion program intervenes with mothers by providing tools and materials regarding
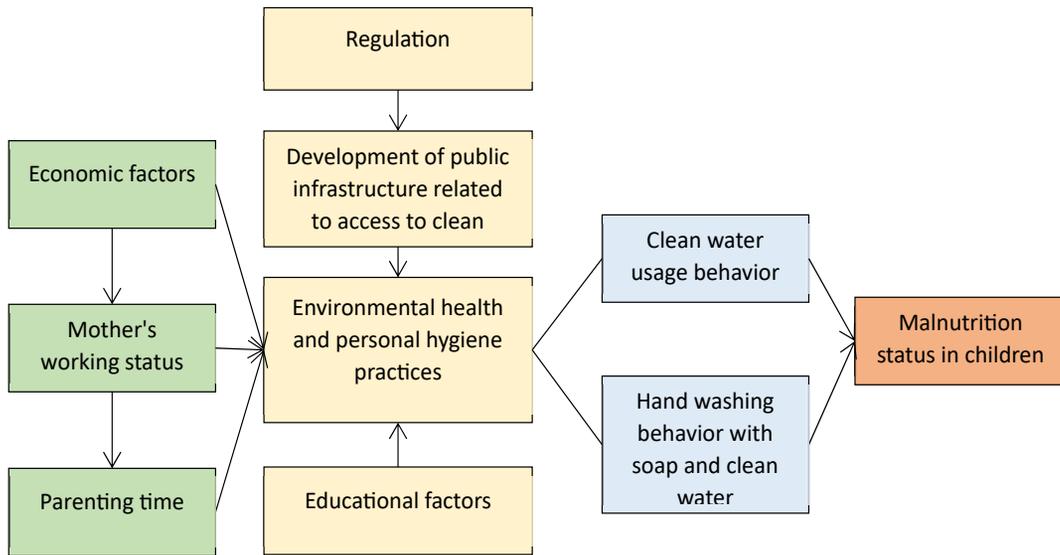
Fig. 3: Relationship between determinants of malnutrition in children based on environmental health and personal hygiene practices

malnutrition prevention behavior. It can provide behavioral support facilities, such as soap for washing hands. Health activists use local languages to convey information to mothers effectively. This program also provides bracelets for mothers containing short messages inviting them to wash their hands with soap (Panulo *et al*., 2022). Thus, health promotion program interventions include efforts to provide not only information to targets but also items they need to behave well, such as soap. However, providing goods is an effort to encourage trial behavior in mothers. So, mothers' behavioral abilities depend on the results of the assessment of their experimental behavior. Therefore, designing an action plan that includes regular training for Posyandu cadres is essential to increase knowledge and skills regarding chronic malnutrition in children. Action can be taken by starting regular campaigns to improve WASH practices and providing adequate facilities to prevent children from experiencing chronic malnutrition (Sufri *et al.,* 2023). The government must be able to educate mothers through health workers at the Community Health Center (Puskesmas), Community Health Center (Puskesmas), Posyandu, or other affairs.

CONCLUSION

Awareness about chronic malnutrition in both groups of mothers was predominantly good. However, behavioral factors based on TPB showed that they were still less dominant. The attitudinal aspect of using clean water and washing hands with soap was not significantly related to pregnant women's chronic malnutrition prevention behavior, with significance values 0.525 and 0.059, respectively. Meanwhile, the two environment-based chronic malnutrition prevention factors were related to chronic malnutrition prevention behavior in perceived behavioral control and subjective norms. Pregnant women with poor perceived behavioral control regarding the use of clean water had 2.476 times more significant potential to have poor chronic malnutritional prevention behavior. Pregnant women without good perceived behavioral control regarding washing their hands with clean water had 2963 times more significant potential to have poor chronic malnutritional prevention behavior. Pregnant women with unfavorable subjective norms regarding the use of clean water had two times more significant potential to have poor chronic malnutritional prevention behavior. Pregnant women with poor subjective norms regarding washing hands with clean water and soap had 2.280 times more significant potential to have poor chronic malnutritional prevention behavior. Meanwhile, for mothers of toddlers, a significant relationship was found in the perceived

behavioral control aspect of using clean water and washing hands with clean water and soap only, with significance values of 0.013 and 0.005, respectively. Mothers of toddlers without good subjective norms regarding washing hands with clean water and soap had 2.207 times more significant potential to have poor chronic malnutritional prevention behavior. Mothers of toddlers with unfavorable subjective norms regarding using clean water and soap had 2.027 times more significant potential to have poor chronic malnutritional prevention behavior. The factors that made these two groups of mothers have different results in identifying behavioral determinants are worthy of further analysis. The two groups tended to come from different demographic groups. In addition, the status of pregnant women may be related to cultural rules that tend to apply and bind mothers during pregnancy. These rules can generally influence maternal behavior through subjective norm aspects. In addition, this study recognizes the limitations of a research design that only focuses on behavioral aspects by using closed questions. Future research could explore the awareness of chronic malnutrition and maternal behavior more deeply through in-depth interviews and focus group discussions. Socioeconomic and cultural factors that encourage the application of PHBS indicators in these two groups must be studied. This study demonstrated the need to increase maternal awareness and behavior in preventing chronic malnutrition through environment-based PHBS practices. The government and multisectors must be able to carry out collaborative interventions in educating mothers through the closest health services in the community to strengthen mothers' awareness of preventing chronic malnutrition in all aspects of behavior formation, including beliefs, motivation, and perceived behavioral control.

AUTHOR CONTRIBUTIONS

E. Parahyanti was the corresponding author, supervising the study, obtaining funding, and conceptualization. Nuraeni participated in writing the original draft, reviewing and editing, preparing pictures and tables of study results, and drawing conclusions. N.I. Hawa participated in data analysis and interpretation. D. Utari participated in the investigation, methodology, and resource preparation.

CONFLICT OF INTEREST

The author declares that there is no conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy have been completely observed by the authors.

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ABBREVIATIONS

%	Percent
>	More than
<	Less than
≥	More than or equal to
_	Until
±	Plus/minus

BPSRI	Badan Pusat Statitik Republik Indonesia
LBW	Low Birth Weight
M-SAKHI	Mobile Solutions Aiding Knowledge for Health Improvement
MGRS	Multicenter growth reference study
OR	Odd ratio
p-value	Probability value
PHBS	Perilaku Hidup Bersih dan Ssehat (Clean and healthy living behavior)
Posyandu	Pos Pelayanan Terpadu (integrated service post)
Puskesmas	Pusat Kesehatan Masyarakat (Community Health Center Community Health Center)
RANAS	Risk, attitudes, norms, abilities, and self-regulation
RI	Republic Indonesia
RR	Relative risk
SD	Standard deviation
SPSS	Statistical package for the social science
TPB	Theory of planned behavior
WASH	Water, sanitation, and hygiene
WHO	World Health Organization

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