








ORIGINAL

Toddler's Nutritional Status: the effect of infection rate as a mediating factor

Estado nutricional del niño pequeño: el efecto de la tasa de infección como factor mediador

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ABSTRACT

This article examines how infection rate, as a mediating factor, affects toddlers' nutritional status in developing regions. A comprehensive cross-sectional study was conducted on 302 pairs of mothers and toddlers in four districts of West Sumatra, Indonesia. The research collected extensive data on socioeconomic factors including household income, maternal nutritional knowledge, feeding practices, toddlers' nutritional status mediated by infection rate, and the relationship between maternal knowledge and feeding practice. The findings support three of the four proposed hypotheses, providing valuable insights into child health determinants in resource-limited settings. The collected data was analyzed using SPSS 21 with descriptive statistics and partial least squares structural equation modeling (PLS-SEM) to ensure statistical rigor. Statistical analysis demonstrated significant relationships between variables. The findings reveal several important relationships: 1) there is a positive effect of income on nutritional status mediated by infection, highlighting socioeconomic influences; 2) there is a positive effect of maternal knowledge on nutritional status mediated by infection, emphasizing educational components; 3) there is no indirect effect of feeding practices on nutritional status mediated by infection, contrary to initial expectations; and 4) there is a direct relationship between maternal knowledge and feeding practice, confirming educational impact on care behaviors. Nutritional status and infection are strongly interrelated in a synergistic relationship, where each factor impacts the other. The infection rate serves as a critical mediating factor affecting toddlers' nutritional status in developing regions. These results support further longitudinal studies to investigate specific infection factors affecting toddlers across different developmental stages and socio-economic contexts.

Keywords: Nutritional Status; Infection; Mother Knowledge; Feeding Practice; Socioeconomic; Toddlers.

RESUMEN

Este artículo examina cómo la tasa de infección, como factor mediador, afecta el estado nutricional de los niños pequeños en regiones en desarrollo. Se realizó un estudio transversal integral con 302 pares de madres y niños pequeños en cuatro distritos de Sumatra Occidental, Indonesia. La investigación recopiló datos extensos sobre factores socioeconómicos incluyendo ingresos familiares, conocimiento nutricional materno, prácticas de alimentación, estado nutricional de los niños pequeños mediado por la tasa de infección, y la relación entre el conocimiento materno y las prácticas de alimentación. Los hallazgos respaldan tres

de las cuatro hipótesis propuestas, proporcionando valiosas perspectivas sobre los determinantes de la salud infantil en entornos con recursos limitados. Los datos recopilados fueron analizados utilizando SPSS 21 con estadísticas descriptivas y modelado de ecuaciones estructurales de mínimos cuadrados parciales (PLS-SEM) para asegurar rigor estadístico. El análisis estadístico demostró relaciones significativas entre las variables. Los hallazgos revelan varias relaciones importantes: 1) existe un efecto positivo del ingreso sobre el estado nutricional mediado por infección, destacando influencias socioeconómicas; 2) existe un efecto positivo del conocimiento materno sobre el estado nutricional mediado por infección, enfatizando componentes educativos; 3) no existe un efecto indirecto de las prácticas de alimentación sobre el estado nutricional mediado por infección, contrario a las expectativas iniciales; y 4) existe una relación directa entre el conocimiento materno y las prácticas de alimentación, confirmando el impacto educativo en los comportamientos de cuidado. El estado nutricional y la infección están fuertemente interrelacionados en una relación sinérgica, donde cada factor impacta al otro. La tasa de infección sirve como un factor mediador crítico que afecta el estado nutricional de los niños pequeños en regiones en desarrollo. Estos resultados respaldan futuros estudios longitudinales para investigar factores específicos de infección que afectan a los niños pequeños a través de diferentes etapas de desarrollo y contextos socioeconómicos.

Palabras clave: Estado Nutricional; Infección; Conocimiento Materno; Práctica de Alimentación; Socioeconómico; Niños Pequeños.

INTRODUCTION

The World Health Organization (WHO) defines malnutrition as a condition of unbalanced nutrition, whether it is more or less food intake. Malnutrition is the cause of death for more than a third of children worldwide.⁽¹⁾ In developing countries, this number rises to more than half of all child deaths each year.⁽²⁾ Stunting, underweight, wasting, overweight, and obesity are considered the main forms of malnutrition in early childhood.^(3,4)

Nutritional improvement is at the core of the 2030 Agenda for Sustainable Development. Global data in 2020 shows an estimate of 149 million (22 percent) children under the age of five suffering from stunting, 45 million (67 percent) experiencing wasting, and 39 million (5,7 percent) being overweight. There has been a decrease in cases of stunting, in accordance with the 2030 target, but cases of overweight in children are actually getting worse.⁽⁵⁾ The Indonesian Nutrition Status Survey (SSGI) in 2022 shows similar results in cases of stunting, namely a decrease in cases from 24,4 percent to 21,6 percent. Overweight cases also decreased from 3,8 percent to 3,5 percent. Meanwhile, cases of wasting and underweight increased from 7,1 and 17 percent previously to 7,7 and 17,1 percent, respectively.⁽⁶⁾ West Sumatra occupies the number 5 position above the Indonesian average for stunting and underweight cases, with a percentage of 25,2 percent and 19,4 percent, respectively. Meanwhile, the wasting and overweight rates were below the Indonesian average, at 6,6 percent and 1,7 percent, respectively.⁽⁷⁾

According to the UNICEF conceptual framework, infection is a disease factor that ranks at the top for directly causing malnutrition.⁽⁸⁾ The World Health Organization (WHO) reported a synergistic relationship between malnutrition and infection. A large number of communicable or infectious diseases can have a direct or indirect effect on nutritional status. For example, AIDS, which specifically causes wasting syndrome,⁽⁹⁾ or parasitic infections in the intestines, which can cause anemia and malnutrition.^(7,8,9,10)

Transmission of infections and other health risks can be affected by economic and environmental conditions.⁽¹¹⁾ In lower socio-economic communities, families have difficulty meeting their needs for food intake, medical care, sanitation, and the cleanliness of their living environment, which can increase the risk of infection and other health problems, leading to malnutrition.^(12,13,14) In addition to economic and environmental factors, maternal knowledge and feeding practices are the most important elements in supporting children's growth and development.^(15,16) Previous study shows that mothers who have a high level of nutritional knowledge tend to include vegetables, fruit, nuts, and low-sugar drinks in their child's diet.⁽¹⁷⁾

This study aims to examine the effect of family economic condition as assessed by monthly per capita income, the mother's nutritional knowledge, and feeding practice mediated by infection rate on nutritional status in toddlers. In addition, this study also examines the effect of mother's nutritional knowledge on feeding practice.

METHOD

Research Aims and The Model

This study focuses on three indirect relationships: 1) the effect of income on nutritional status, which is mediated by infection; 2) the effect of maternal knowledge on nutritional status, which is mediated by infection; and 3) the relationship between feeding practice and nutritional status, which is mediated by infection. In

addition, this study also examines the direct relationship between a mother's knowledge and feeding practice. The causal relationships among all variables are demonstrated with the path diagrams in figure 1. In these models, feeding practice, infection rate, and nutritional status are endogenous variables that are affected by other variables, and income and maternal knowledge are exogenous variables that affect the outcomes without being affected by other variables.

In mediation analysis, the effect of the independent variables (income, maternal knowledge, and feeding practice) on the dependent variable (nutritional status) is explained by means of a mediator (infection rate). Thus, in this study, the mediating effect is defined as a reduction in the regression coefficient of infection, maternal knowledge, and feeding practice on nutritional status when the effect of nutritional status is controlled. The hypotheses generated in line with the research's aims are shown below:

1. H1: there is a positive effect of income on nutritional status that is mediated by infection.
2. H2: there is a positive effect of maternal knowledge on nutritional status that is mediated by infection.
3. H3: there is a positive effect of feeding practice on nutritional status that is mediated by infection.
4. H4: maternal knowledge has a positive effect on feeding practices.

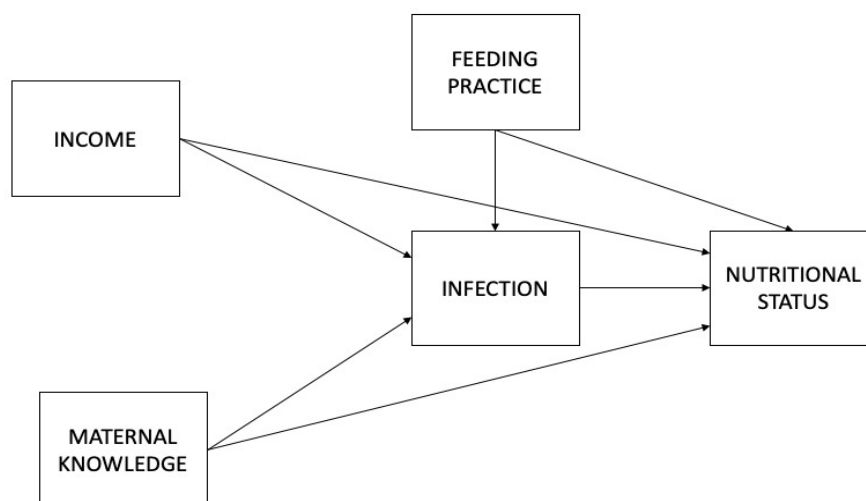


Figure 1. Path diagram showing causal relationship between variables contributing to nutritional status

Subjects

The study was conducted on 302 pairs of mothers and toddlers. Samples were taken by multistage random sampling; in each sub-district in the sample district, systematic random sampling was done to get 2 sub-districts each, then 2 jorong were selected from 4 districts each, for a total of 8 jorong. Jorong is an administrative division of regions in Indonesia that is located under Nagari. Then, simple random sampling was used to make a list of the population in the selected jorong and choose a sample of 302 people who fulfilled the inclusion and exclusion criteria in four districts/cities in West Sumatra (Padang, Padang Pariaman, Solok, and Pasaman Regencies).

The questionnaire items were explained when necessary and administered in one sitting as much as possible. Participants' consent was obtained prior to the commencement of the study. Each participant signed a voluntary participation form and filled out the questionnaires adhering to the Declaration of Helsinki (World Medical Association). The nutritional status of toddlers was assessed based on a weight-for-height index. The interpretation of nutritional status was based on the category of Z-score (SD) used by the Indonesian Ministry of Health, specifically severely wasted if $\leq -3SD$, wasted ($-3SD < Z \leq -2SD$), normal ($-2SD < Z \leq +2SD$), overweight ($+2SD < Z \leq +3SD$), and obese $\geq +3SD$.⁽¹⁸⁾

Instrumentations

The scales measured individuals' income, maternal knowledge, feeding practice, nutritional status, and infection rate. They were developed by modifying scales from previous studies.^(19,20) The questionnaire was divided into four sections, as follows:

1. A demographic section was used to collect data on participants' general characteristics, such as gender, father's education level, mother's education level, income, and nutritional status.
2. Income was measured by the total family income divided by the number of dependent family members.
3. Maternal knowledge was measured by 15 questions that must be answered correctly to obtain

a total score for each respondent. The measurement of this construct was referred to as “nutrition knowledge measurement techniques.”⁽²¹⁾

4. The scale of feeding practice behaviors consisted of 11 items on the Likert scale: always, often, sometimes, rarely, and never. The scale of feeding practice behavior was developed by modifying a scale used by Sanlier.⁽²²⁾

5. The morbidity rate was measured by the length of illness in one month for all infectious diseases (incidence rate).

Cronbach’s alpha coefficients were used to verify the reliability of the knowledge, attitude, and behavior scales. The values obtained were 0,782, 0,718, and 0,711 ($> 0,70$), respectively. Reliability coefficients close to 1,0 indicate high internal consistency of the items in the scales.

Measurement and Model Assessment

The collected data was analyzed and interpreted using descriptive statistics with SPSS 21 and partial least squares structural equation modeling (PLS-SEM). SMART-PLS was used to perform these analyses. Results were considered significant at a p -value $\leq 0,05$. Measurement and Model Assessment (MMA) is useful for investigating the relationship between latent variables and indicators or statement items. This study used four latent variables and 38 indicators and tested convergent and discriminant validity. Convergent validity describes how items of measurement for a particular variable comply with the five criteria. Items are valid when outer loading is greater than 0,7, and data is reliable when Cronbach’s alpha is greater than 0,7, composite reliability is greater than 0,7, and average extracted variance (AVE) is greater than 0,5.⁽²³⁾

RESULTS AND DISCUSSION

Characteristics of Respondents

Table 1 shows the descriptive analysis of the data: gender, mother’s and father’s level of education, income and nutritional status of toddlers. The majority of respondents’ gender was female (53 percent). 33,8 percent of fathers were college-educated, whereas most were high school-educated (37,4 percent). Meanwhile, the majority of the mothers were college-educated (48,3 percent). Overall, family income was low (66,9 percent). In terms of nutritional status, almost all toddlers were normal (51 percent), but few were underweight (10,9 percent) and obese (21,2 percent).

Table 1. Respondents’ Characteristic		
Variable	Frequency (n)	Percentage (%)
Gender		
Male	142	47
Female	160	53
Father’s Education Level		
Elementary School	37	12,3
Junior High School	50	16,6
Senior High School	113	37,4
College	102	33,8
Mother’s Education Level		
Elementary School	21	7
Junior High School	41	13,6
Senior High School	94	31,1
College	146	48,3
Income		
Low	202	66,9
High	100	33,1
Nutritional Status		
Stunted	33	10,9
Underweight	32	10,6
Normal	154	51
Overweight	19	6,3
Obese	64	21,2

The indicators of feeding practice by parents in this study are presented in table 2. Monitoring toddlers was the most frequently used feeding practice (mean = 3,36, standard deviation (SD) = 0,7), followed by child control (mean = 2,56, SD = 0,9). Conversely, feeding practices that encouraged balance and variety were rarely

used (mean = 1,33, SD = 0,3).

Table 2. Indicator of Feeding Practice by Parents	
Feeding Practice	Mean (SD)
Monitoring	3,36 (0,7)
Encouraging balance and variety	1,33 (0,3)
Child Control	2,56 (0,6)

Infectious disease, Maternal knowledge and Income on nutritional status

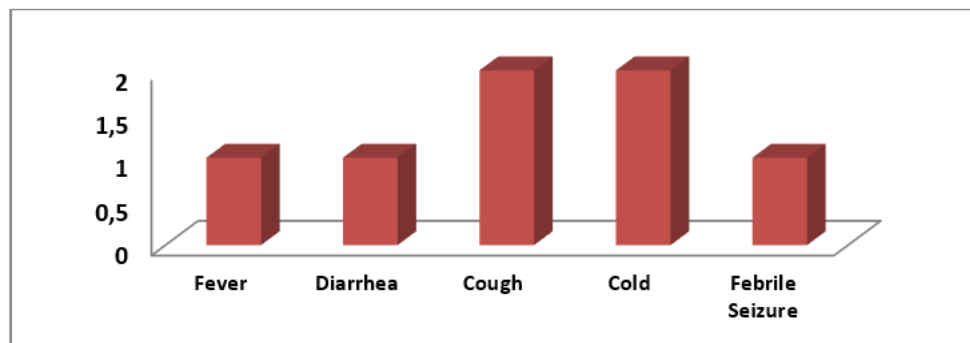


Figure 2. Average Frequency of Infectious Disease in Toddlers per Month

Figure 2 shows the average frequency of infectious disease symptoms experienced by toddlers per month. In this study, cough and cold were the most common symptoms experienced by toddlers. As for fever, diarrhea, and febrile seizures, the average frequency of toddlers getting these symptoms in a month was almost similar. Figure 3 shows how the average frequency of infectious disease is related to the nutritional status of toddlers under five. Toddlers with nutritional problems (either malnutrition or overnutrition) were more often affected by infectious disease compared to toddlers with normal nutritional status.

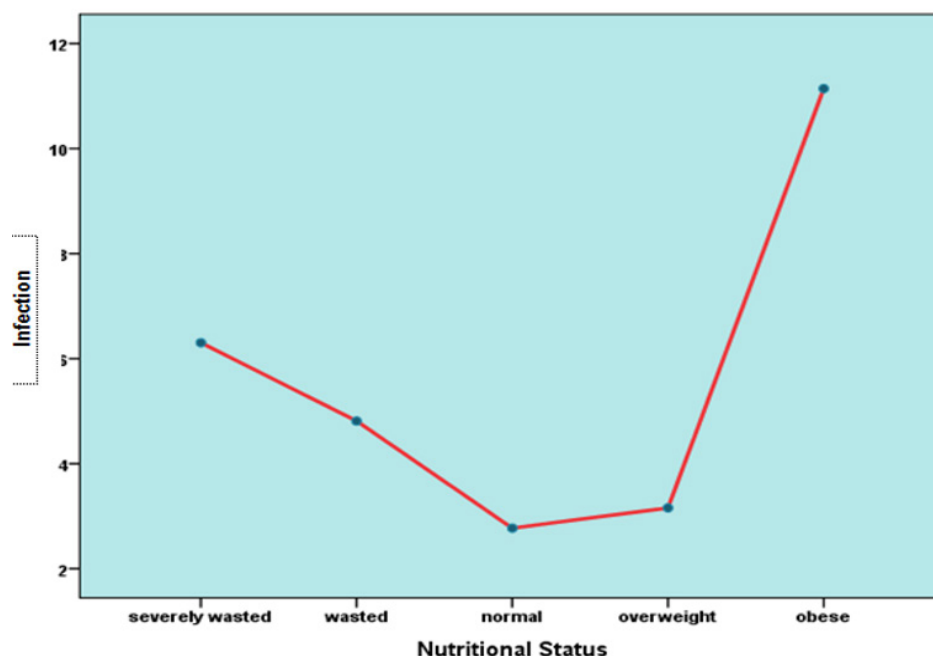
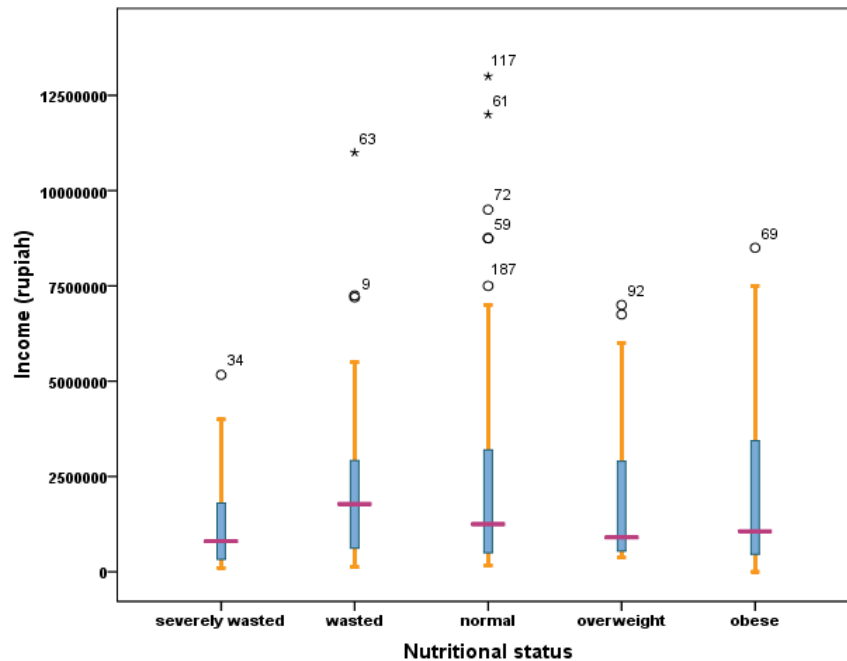


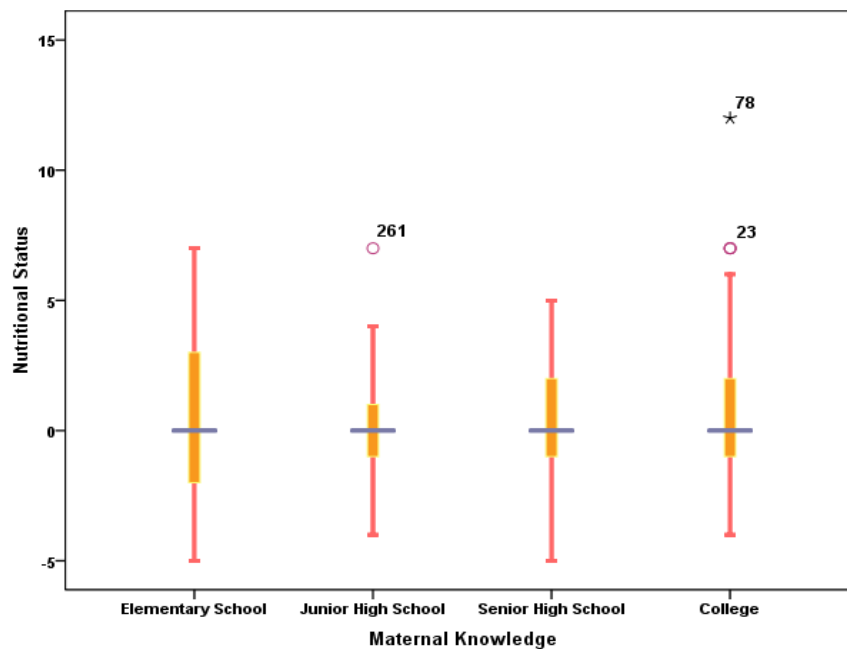
Figure 3. Mean of Infectious Rate Diseases in Toddlers with Nutritional Status

The data in figure 4 was analyzed using SPSS Version 21. Box plot and whisker plot analyses were conducted to determine data normality and distribution. In the box plot method, the input dataset is divided into quartiles; minimum values, lower quartile, median, upper quartile, outliers, and maximum values were determined from the analysis.⁽²⁴⁾ Values above or below the whiskers were outliers and extreme values. Outlier values were data

values located more than 1,5 times the box length (IQR), measured from UQ (top box) or LQ (bottom box). Meanwhile, extreme values were values located more than 3x the length of the box (IQR), measured from UQ (top box) or LQ (bottom box).^(25,26)



(a)



(b)

Figure 4. Effect of Maternal Knowledge and Income on Nutritional Status

The box plot shows variation in the distribution of income, maternal knowledge, and nutritional status. Overall, the average data in each group was not normally distributed. Outliers and extreme values were observed in each set of data. The data distribution was skewed to the right (positive).

Direct and Indirect Effects of Mother's Knowledge, Income and Incidence of Infectious Disease on Nutritional Status

Based on table 3, the parameter coefficient for maternal knowledge on feeding practice was 0,323, indicating a positive effect of maternal knowledge on feeding practice, where higher maternal knowledge

increased feeding practice by 32,3 percent. Based on bootstrap calculations or resampling, the estimated coefficient test results for maternal knowledge on bootstrap feeding practice was 0,324 with a t-statistic of 5,591 and a standard deviation of 0,058. p-value was 0,000, indicating a significant relationship between maternal knowledge and feeding practice.

Variable Direct	Original Sample (O)	Sample Mean (M)	Standard Deviation	T Statistics (O/STDEV)	P Values
Maternal Knowledge - Feeding Practice (Direct)	0,323	0,324	0,058	5,591	0,000
Maternal Knowledge - Infection rate - Nutritional Status (Indirect)	0,109	0,108	0,030	3,627	0,000
Income - Infection rate - Nutritional Status (Indirect)	0,034	0,038	0,017	1,970	0,049
Feeding practice - Infection rate - Nutritional Status (Indirect)	0,081	0,099	0,056	1,451	0,147

Table 3 revealed a positive indirect relationship between maternal knowledge and nutritional status mediated by infection rate (0,109). This relationship was significant, with a statistical t-statistic of 3,672 and a p-value of 0,000. There was also a positive indirect relationship between income and nutritional status mediated by infection rate (0,034), with a t statistic of 1,970 and a p-value of 0,049. Despite there being a positive indirect relationship of 0,081 in the indirect relationship between feeding practice and nutritional status through the infection rate, the relationship between the three variables was insignificant, with a t-statistic value of 1,451 and p-value of 0,147. Hence, infection rate did not have a mediating role in the relationship between feeding practice and nutritional status.

DISCUSSION

Nutritional status and infection rate are two parts of a vicious cycle. Infection can cause disturbances in nutrient absorption in the body, which leads to malnutrition in toddlers.^(27,28) Malnutrition is a manifestation of inadequate dietary intake and disease. The underlying causes of malnutrition include not having optimal access to nutritious food, poor maternal and child care, an unhealthy environment, and inadequate health services.⁽⁵⁾ Malnutrition due to inadequate food intake in toddlers can also cause a decrease in the body's innate and acquired immune functions, which can cause toddlers to get infectious diseases.⁽²⁹⁾

The results show a positive effect of income on nutritional status that is mediated by infection. The interaction between nutrition and infection is synergistic, where infection not only worsens nutritional status but also reduces an individual's ability to prevent infection, increasing the risk of developing new infections or complications from existing infections.⁽³⁰⁾ Nutritional conditions and the immunological response to infection are closely related.⁽³¹⁾ Moreover, some infections can lead to complications, increasing overall morbidity and case fatality in developing and developed countries. The disparity of income is closely related to many factors associated with socioeconomic risks, which may contribute to susceptibility to infectious diseases.^(32,33,34) Individuals from low economic backgrounds are more likely to reside in unhealthy environments with poor hygiene, increasing their susceptibility to infection.⁽³⁵⁾

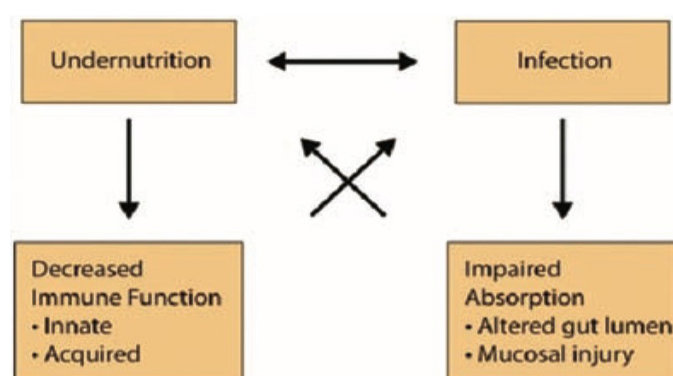


Figure 5. Interaction Between Malnutrition and Infection⁽³⁰⁾

Furthermore, the findings also show a strong positive effect of maternal knowledge on nutritional status

that is mediated by infection. Poor maternal knowledge is strongly connected to infection.^(36,37) The results are consistent with prior reporting that poor maternal knowledge due to a lack of education and socialization with healthcare professionals⁽³⁸⁾ and family environmental factors⁽³⁹⁾ were major factors contributing to infection.⁽⁴⁰⁾ Additionally, according to a previous study, knowledge in mothers plays a very important role in prevention and intervention in disease, since mothers are the first to identify infection in their child.⁽⁴¹⁾ Hence, increasing maternal knowledge can also prevent infections.

The results further show no indirect effect of feeding practice on the nutritional status of children that is mediated by infection. However, feeding practices had a significant negative effect on the nutritional status of children. Feeding practice is a type of parent-child interaction that involves specific behaviors intended to influence a child's food intake, such as what, how, and when they are fed. This practice may be situational, vary from time to time, and be different for each toddler.⁽⁵⁾

Identifying specific nutritional gaps and feeding practices in toddlers is very important to provide fact-based interventions that are useful for improving nutritional status in toddlers. A study on vegetable and fruit consumption conducted in Gardermoen Region, Norway, on parents with children aged 1-5 found that feeding practices had an effect on dietary intake in children. Five of the feeding practices applied in this study were significantly related to food intake in children, and children whose parents implemented these feeding practices consumed fish, vegetables, and fruit more frequently.⁽⁴²⁾ Another study conducted in Tampa, Florida, found a potential relationship between parental eating behavior, their feeding practices, and children's food behavior on their food intake.⁽⁴³⁾ This is in line with previous studies that report that mothers' complementary feeding practices may be a key strategy for lowering the burden of infectious disease and child malnutrition.^(44,45) Further, complementary feeding may promote linear growth while inhibiting infectious growth.

Additionally, the findings indicate that infection cannot be a mediator between feeding practice and nutritional status, since there is a direct relationship between the two factors. In this case, infection should be the result of this relationship. Hence, good feeding practices also produce good nutritional status, which can ultimately reduce the risk of children contracting infectious diseases.

The findings also reveal that maternal knowledge has a positive effect on feeding practice. It is in line with a previous study that stated maternal knowledge can be one of the elements impacting feeding practice.⁽⁴⁶⁾ A study conducted in the Calabar South Local Government Area, Cross River State, Nigeria, reported a significant relationship between maternal nutritional knowledge and feeding practices and children's nutritional status. Further, the research also found a significant relationship between poor knowledge of nutrition among mothers and their child's health. Suboptimal feeding practices predisposed the children to malnutrition in their first two years of life. However, the findings of this study clearly show a significant gap in knowledge regarding desirable infant and young child feeding practices and a disparity between ideal and practical infant feeding practices.⁽⁴⁷⁾

According to the World Health Organization, optimal complementary feeding includes a minimum meal frequency, a minimum adequate diet, and a minimum dietary diversity.⁽⁴⁸⁾ It also refers to the timely introduction of solid, semi-solid, or soft foods. Some previous studies also concurred that a number of factors, including maternal education, income levels, antenatal attendance, spouse employment status, the quality of institutional healthcare delivery, women's empowerment in decision-making, and others, affected ideal complementary feeding.^(49,50)

CONCLUSIONS

The study explains the infectious factors that affect toddlers' nutritional status. First, there is a positive effect of income on nutritional status that is mediated by infection; second, there is a positive effect of maternal knowledge on nutritional status that is mediated by infection; third, there is no indirect effect of feeding practices on nutritional status that is mediated by infection; and last, there is a direct relationship between a mother's knowledge and feeding practices. This research reveals infection as a significant factor that affects the nutritional status of toddlers. Hence, further research should focus on determining infection factors that affect school-age children.

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