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ORIGINAL RESEARCH

Determinants of Maternal Adherence to Complementary Feeding Guidelines in Padang City, Indonesia: An Application of the Integrated Change Model

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Abstract

Background: Maternal adherence to complementary feeding guidelines is crucial in preventing childhood malnutrition, yet adherence remains low. Although previous studies have identified several influencing factors, evidence from Indonesia is limited and lacks a theory-based explanation of how cognitive and behavioral determinants influence maternal feeding practices.
Purpose: This study applied the Integrated Change Model (I-Change Model) to examine determinants of maternal adherence to complementary feeding guidelines.
Methods: A cross-sectional design was used, involving 579 mothers of children aged 6–23 months selected through cluster-stratified random sampling. Maternal adherence to complementary feeding guidelines was assessed using the Infant and Young Child Feeding (IYCF) indicators, while a self-developed questionnaire, along with several modified questionnaires, was used to evaluate the associated factors. Multiple logistic regression analysis was applied to identify the determinants of maternal adherence to these guidelines.
Results: Only 40.1% of mothers adhered to complementary feeding guidelines. Maternal adherence to complementary feeding guidelines was significantly associated with higher education (AOR = 1.984; 95% CI: 1.053–3.739), positive attitudes (AOR = 5.752; 95% CI: 1.283–25.794), high self-efficacy in providing complementary feeding (AOR = 2.695; 95% CI: 1.426–5.091), and non-provision of formula milk (AOR = 0.549; 95% CI: 0.384–0.784).
Conclusion: Maternal education, attitudes, self-efficacy, and non-provision of formula milk were identified as key determinants of adherence. These findings highlight the need for interventions focusing on enhancing maternal education, promoting positive attitudes, and improving self-efficacy. Future research should examine social support and sociocultural or economic factors through longitudinal studies to better understand their impact on adherence behaviors.

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1. Introduction

Malnutrition remains one of the most critical health issues affecting children's growth and development worldwide. It has lasting effects on cognitive function, physical health, and future potential (Black et al., 2020; Fanta & Cherie, 2020; United Nations Children's Fund (UNICEF) et al., 2021; Wali et al., 2019). In 2020, approximately 22% of children under five experienced stunting, 6.7% suffered from wasting, and 5.7% were overweight—predominantly in Asia and Africa (UNICEF et al., 2021). Among six Southeast Asian countries surveyed, Indonesia reported the highest prevalence of childhood malnutrition: 31% stunting, 10.2% wasting, and 11.1% underweight (UNICEF, 2021).

Feeding practices during infancy play a critical role in determining a child's nutritional status. Suboptimal practices, such as not exclusively breastfeeding for the first six months or delaying appropriate complementary feeding, have been linked to stunting and undernutrition (UNICEF,

2021). Studies in Ghana and Bangladesh show that both early and delayed introduction of complementary foods can negatively affect nutritional outcomes, highlighting the importance of providing appropriate, diverse, and timely complementary feeding from six months onward (Saaka et al., 2021; Sheikh et al., 2020).

Maternal adherence to complementary feeding guidelines is central to preventing early childhood malnutrition (Som et al., 2021). However, adherence remains suboptimal in many Southeast Asian countries, where early introduction of complementary foods is common and dietary diversity and meal frequency often fall below the recommended standards (Fanta & Cherie, 2020). In Indonesia, nearly half of infants are introduced to complementary foods prematurely and do not receive the minimum dietary diversity (MDD) or minimum meal frequency (MMF) (Ministry of Health, Republic of Indonesia, 2024). While interventions such as nutritional counseling and education have been implemented, they have had limited success in improving adherence and reducing malnutrition rates.

A range of factors has been associated with complementary feeding practices, including maternal knowledge, attitudes, perceived social support, self-efficacy (Herman et al., 2023), and sociocultural influences (Ahmed et al., 2022; Allotey et al., 2022; Assefa et al., 2021; Gebretsadik et al., 2023). Previous qualitative research in Indonesia found that mothers often introduced complementary foods early due to beliefs about the benefits of weight gain (Yeni et al., 2023). A related study in Uganda reported low adherence (40%) in rural areas, influenced by maternal education, child's age, household income, and caregiver beliefs (Aber et al., 2018). However, the specific determinants of adherence remain unclear, particularly in the context of Indonesia. Existing research has often failed to provide detailed statistical analyses or identify how these factors interact to influence maternal behavior. In particular, very few studies have examined these determinants using a comprehensive behavioral theory to explain how cognitive, motivational, and social factors jointly shape maternal adherence to complementary feeding guidelines.

In this study, the Integrated Change Model (I-Change Model) (de Vries, 2017) is used as a theoretical framework to understand maternal adherence to complementary feeding guidelines. This model, which integrates multiple behavioral theories such as the Theory of Planned Behavior (Ajzen, 1991) and the Health Belief Model (Janz & Becker, 1984), provides a comprehensive approach to examining the psychosocial factors that influence maternal behavior. According to the I-Change Model, behavior change is not only a result of individual intention but also the interaction of motivation and information processing (de Vries, 2017). Furthermore, the model assumes that maternal adherence to complementary feeding guidelines is influenced by motivational factors and the mother's intention to comply with the guidelines. Maternal adherence is the result of the mother's intention and ability. The three main factors determining a mother's motivation are maternal attitudes, perceived social support, and self-efficacy. The I-Change Model also assumes that motivational factors are determined by various distal factors, including awareness factors (e.g., maternal knowledge), preceding factors (e.g., biological, behavioral, and sociocultural factors), and information factors (see Figure 1).

Applying the I-Change Model to complementary feeding adherence allows researchers to examine both internal and external influences on maternal behavior. For example, positive maternal attitudes toward complementary feeding are linked to perceived benefits for child health (Assefa et al., 2021; Rakotomanana et al., 2020), while high self-efficacy reflects confidence in providing appropriate foods according to the guidelines (Herman et al., 2023). Similarly, perceived social support from family members, community health workers, and peers can strengthen maternal motivation and adherence behavior (Allotey et al., 2022; Reynolds et al., 2021). Conversely, limited knowledge, negative beliefs, or weak social support networks can act as barriers to compliance (Athavale et al., 2020).

The I-Change Model is particularly relevant in the Indonesian context, where social norms, extended family influence, and cultural feeding beliefs play a major role in maternal decision-making. By incorporating these sociocultural dimensions into the model, this study aims to contextualize how maternal knowledge, attitudes, self-efficacy, and social support interact to shape adherence behaviors. This theoretical approach also allows for the identification of leverage points for designing culturally appropriate and evidence-based interventions to improve maternal feeding practices.

Therefore, the present study aims to analyze the determinants of maternal adherence to complementary feeding guidelines using the I-Change Model framework. Specifically, it investigates the influence of motivational factors (attitudes, self-efficacy, and social support), the awareness factor (knowledge), and information factors, while accounting for predisposing factors such as maternal and child characteristics and sociocultural influences. By applying this model, the study seeks to fill an existing research gap by providing an integrated, theory-based understanding of the factors influencing maternal adherence, offering insights for public health strategies to promote optimal feeding practices in Indonesia.

2. Methods

2.1. Research design

This study employed a community-based cross-sectional design to examine the determinants of maternal adherence to complementary feeding guidelines using the Integrated Change Model framework.

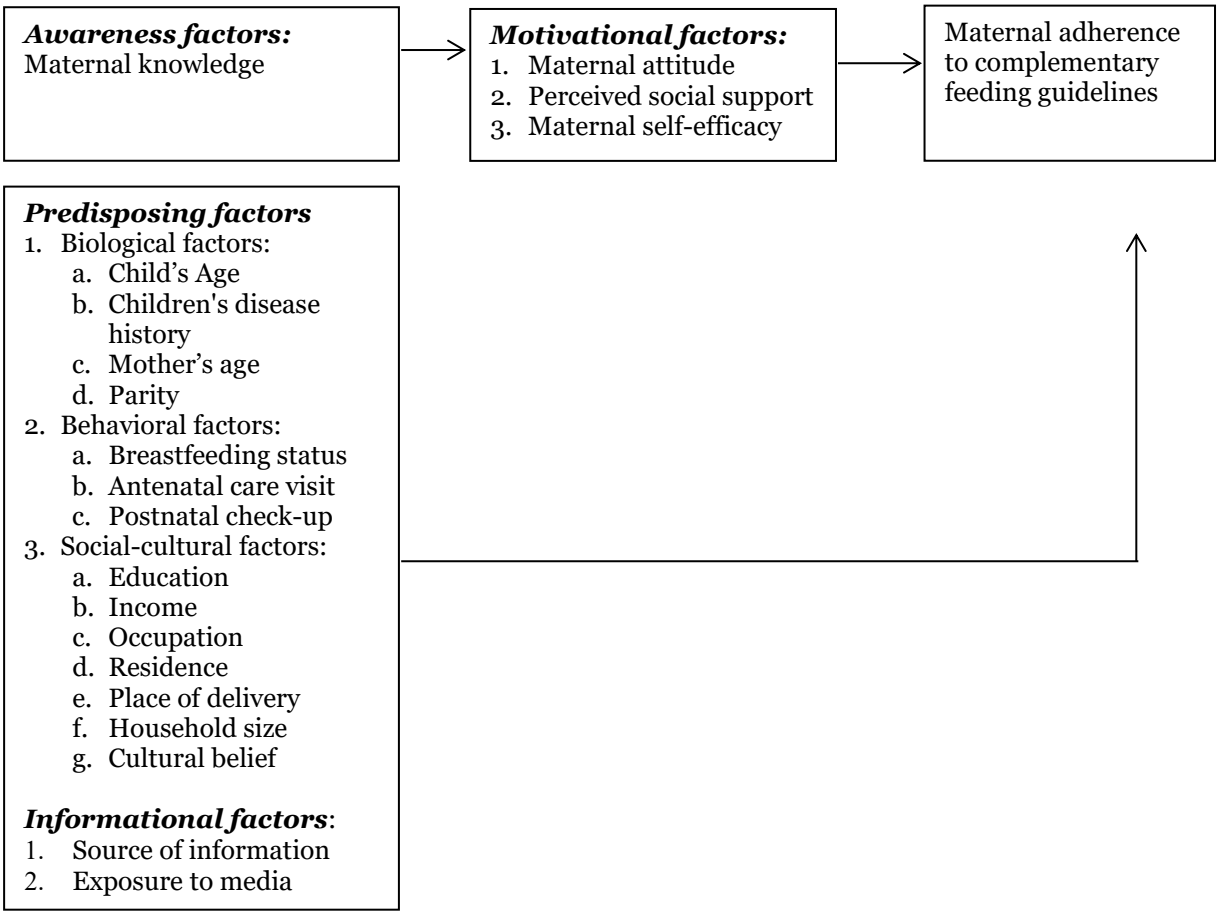

Figure 1. Theoretical framework of the study

2.2. Setting and samples

This study was conducted from November 2022 to May 2023 in Padang City, West Sumatra Province, Indonesia, and recruited mothers with infants and young children aged 6-23 months. Eligible participants were mothers aged 18-49 years with children aged 6-23 months who were residing in Padang. The mothers needed to be able to communicate in either Minang or Indonesian, ensuring they could understand and respond to the questionnaire. Additionally, participants had to be willing to participate in the study. Mothers with psychosocial issues (e.g., depression, anxiety, or severe mental health conditions) were excluded to avoid potential biases in feeding practices. Similarly, children with chronic or congenital illnesses were excluded because these conditions could influence feeding behaviors and adherence to complementary feeding guidelines.

The sample size was estimated using the rule-of-thumb for logistic regression proposed by Bujang et al. (2018), which recommends 100 subjects plus 10–20 per independent variable to ensure model stability and sufficient power. With 20 independent variables, the minimum required sample was 500. To compensate for potential non-response, an additional 20% was added following Gupta et al. (2016), resulting in a total of 625 participants, which was considered adequate for multivariable logistic regression analysis.

A two-stage cluster sampling followed by simple random sampling was used to recruit participants. In the first stage, five districts (two urban, two rural, and one suburban) were randomly selected from 11 districts in Padang City using the Research Randomizer software. In the second stage, two sub-districts were randomly selected from each chosen district, resulting in 10 sub-districts. A list of eligible mothers was obtained from the related community health centers (*Posyandu* registers), and participants were selected using simple random sampling. The total sample of 625 was proportionally allocated to each sub-district based on the number of eligible mothers to ensure representativeness across study areas.

2.3. Measurement and data collection

In this study, the dependent variable was maternal adherence to complementary feeding guidelines, measured via the WHO-recommended Infant and Young Child Feeding (IYCF) indicators. Meanwhile, independent variables included predisposing factors (biological, behavioral, sociocultural, informational), maternal knowledge, attitude, perceived social support, and self-efficacy. Validated and adapted instruments were used or developed for each factor. Reliability testing was conducted on a pilot group of 40 mothers.

The data collection process involved participant selection, obtaining informed consent, and conducting face-to-face interviews. Participants were selected using a stratified cluster random sampling technique, in which 60 *Posyandu* were randomly selected from sub-districts based on population proportions. Mothers who met the inclusion criteria and attended the *Posyandu* were invited to participate. Before participation, data collectors provided detailed information about the study, and upon consent, participants signed an informed consent form. Data were collected using structured questionnaires, with interviews typically lasting 15 to 30 minutes. If needed, follow-up home visits were scheduled. The data collectors ensured that questionnaires were completed accurately, and the principal investigator reviewed the data daily for completeness, consistency, and quality control.

2.3.1. Infant and Young Child Feeding Indicator (IYCE)

Maternal adherence to complementary feeding guidelines was measured using the IYCF indicators (WHO & UNICEF, 2021). These indicators are a globally recognized standard tool for assessing infant and young child feeding practice, including complementary feeding. The IYCF indicators have been validated and widely used in many countries and have demonstrated both reliability and validity in various settings globally. In Indonesia, the IYCF indicators have been used in numerous public health studies to assess complementary feeding practices, focusing on critical aspects such as meal frequency, dietary diversity, and continued breastfeeding (WHO & UNICEF, 2021). The instrument has been translated and adapted for the Indonesian context, making it highly suitable for assessing complementary feeding practice among mothers in Indonesia (Ministry of Health, Republic of Indonesia, 2024).

In this study, the IYCF indicators were used to assess the five aspects of maternal adherence: introduction of solid, semi-solid, and soft foods (ISSSF), minimum meal frequency (MMF), minimum dietary diversity (MDD), minimum acceptable diet (MAD), and continued breastfeeding (CBF). ISSSF assesses the proportion of children aged 6–23 months who are introduced to solid, semi-solid, or soft foods, and a child is classified as adhering to this guideline if complementary foods are introduced between 6 and 8 months of age. MMF refers to the number of times a child is fed complementary foods per day. For children aged 6–8 months who are breastfed, the recommended frequency is 2–3 times daily; for those aged 9–23 months, it is 3–4 times daily. For non-breastfed children aged 6–23 months, the frequency should be at least four times a day. A child is classified as adherent if they meet these frequencies, as per WHO guidelines. MDD measures the proportion of children who receive foods from at least five of the eight recommended food groups. The eight food groups include breast milk; grains, roots, vegetables, tubers, and plantains; nuts and seeds; pulses (beans, peas, lentils); dairy products

(milk, infant formula, yogurt, cheese); flesh foods (meat, fish, poultry, organ meats); eggs; vitamin A–rich fruits and vegetables; and other fruits and vegetables. A child is classified as adhering to this guideline if they consume at least five food groups on a given day. Meanwhile, MAD combines MMF and MDD to assess whether a child is receiving meals at an appropriate frequency and sufficient dietary diversity. Adherence is defined as meeting both the MMF and MDD criteria. Finally, CBF measures the proportion of children aged 6–23 months who continue to be breastfed; a child is classified as adherent if the mother continues breastfeeding beyond 6 months, regardless of whether complementary foods are introduced.

Maternal adherence was defined as meeting all five IYCF indicators: ISSSF, MMF, MDD, MAD, and CBF. A mother was considered adherent if she met the criteria for all 5 indicators. If any indicator was not met, the mother was classified as non-adherent.

Since the IYCF indicators have been widely used in previous research and health policy programs, additional reliability testing was not conducted in this study. The validity and reliability of the IYCF indicators are internationally recognized and have proven consistent in measuring adherence to complementary feeding guidelines.

2.3.2.Mother's cultural beliefs about complementary feeding

To measure cultural beliefs about complementary feeding, the researchers modified and adopted a questionnaire on mothers' cultural beliefs about weaning to develop questionnaire items on cultural beliefs about complementary feeding. This questionnaire consists of 49 statements constructed to measure maternal cultural beliefs about weaning among mothers of infants and young children in Iran (Jannat-Alipoor et al., 2021). The modified questionnaire on mothers' cultural beliefs about complementary feeding has satisfactory reliability with Cronbach's alpha = 0.80.

2.3.3.Adaptable Knowledge, Attitude, and Practice (KAP) model questionnaires

The KAP model questionnaire, which relates to feeding children aged 6-23 months, was used to measure maternal knowledge. In Indonesia, this knowledge questionnaire was previously used by Ahmad et al. (2020), who adopted 23 question items and had good validity and reliability (Cronbach's alpha = 0.85). The researchers then modified this questionnaire, which consisted of 18 items. Before modification and use, the authors obtained permission from the original author. The response to each question consisted of multiple-choice options. The correct answer received one point, while incorrect or "do not know" responses received zero points. The knowledge score was then calculated and converted into a percentage by dividing the knowledge score by the highest possible score and multiplying by 100. A high percentage score indicates better knowledge. Maternal knowledge was classified as good (≥70%) or poor (<70%) (Food and Agriculture Organization of the United Nations [FAO], 2014).

Maternal attitude was measured using the adaptable KAP model questionnaire related to attitudes toward complementary feeding. The researchers modified 14 items of the maternal attitude questionnaire after obtaining permission from the author (Ahmad et al., 2020). The attitude questionnaire used a 5-point Likert scale ranging from 1 = strongly disagree to 5 = strongly agree. There were eight positive statements and six negative statements. Items 4, 7, 8, 10, 11, and 12 were negatively worded and scored inversely. The total score was converted into a percentage, and a cut-off score of 70 was used to classify attitudes as positive (≥70%) or negative (<70%) (FAO, 2014).

2.3.4.The Medical Outcome Study-Social Support Survey (MOS-SSS)

This study used the MOS-SSS to measure mothers' perceived social support. This instrument is a multidimensional scale consisting of 19 items covering informational and emotional support (8 items), tangible support (4 items), positive social interaction (3 items), and affectionate support (4 items). The measurement scale used a Likert scale ranging from 1 = none of the time to 5 = most of the time. High scores indicate high social support (Sherbourne & Stewart, 1991). All information about the instrument and its use is open to the public and available on the RAND Health Care website (The RAND Corporation, 2023). This instrument was tested on mothers of children aged 6-23 months in Indonesia and showed acceptable validity and internal consistency with a Cronbach's Alpha value = 0.96 (Herman et al., 2024). Scores were expressed as percentages and categorized as high (≥70%) or low (<70%) social support (FAO, 2014).

2.3.5. The Self-Efficacy in Infant Care Scale (SICS) diet dimension

The SICS diet dimension was used to measure maternal self-efficacy in providing complementary feeding. This tool consists of seven statement items using a 10-unit interval scale ranging from 0 = not confident at all, to 50 = quite confident, I can do it, and 100 = very confident, I can do it (Prasopkittikun et al., 2006). This questionnaire demonstrated satisfactory validity and reliability, with a Cronbach's alpha of 0.65. Scores below 70 were classified as low self-efficacy, and those ≥70 as high self-efficacy (FAO, 2014).

2.4. Data analysis

The data were analyzed using SPSS version 25. Descriptive statistics, including means, standard deviations, frequencies, and percentages, were computed. Chi-square tests were used to examine relationships among knowledge, attitude, self-efficacy, social support, biological factors, behavioral factors, sociocultural factors, and maternal adherence to complementary feeding guidelines. The significance level for these tests was set at $p < 0.05$, and confidence intervals (CI) were calculated to assess the precision of the results. Additionally, binary logistic regression was utilized to identify the determinants of maternal adherence to these guidelines. Odds ratios (ORs) and their corresponding 95% confidence intervals were reported to estimate the strength and direction of the associations.

Missing data were handled using multiple imputation to preserve statistical power and reduce potential bias. Imputation was performed for essential variables to maintain an adequate sample size and minimize data loss. Composite scores for maternal knowledge, attitude, and self-efficacy were computed by summing the responses to each construct's questionnaire items. These were subsequently categorized based on a 70% threshold: scores ≥70% indicated adequate knowledge, a positive attitude, and high self-efficacy, whereas scores <70% indicated inadequate knowledge, a negative attitude, and low self-efficacy. This categorization approach ensured analytical consistency across constructs and improved the interpretability of the results.

2.5. Ethical consideration

The study was approved by the Health Ethics Committee of RSUP Dr M. Djamil Padang (No. LB.02.02/5.7/539/2022). Before seeking informed consent, the data collectors explained the study's objectives, procedures, and potential risks to the mothers. Once the mothers understood the study details and voluntarily agreed to participate, they were asked to sign the informed consent form, documenting their willingness to participate. Furthermore, participant confidentiality and the right to withdraw from the study without any consequences were emphasized and guaranteed.

3. Results

3.1. Sociodemographic characteristic of the respondents

Of the 625 questionnaires distributed, only 579 were returned and completed. Table 1 provides information on respondents' characteristics. The majority (70.6%) of mothers had children aged 12-23 months. The average maternal age was 31.28 years (SD = 5.1 years), with most mothers (92.4%) being over 25 years old. A majority of mothers were multiparous (64.4%), while 3.1% were grand multiparas. Regarding breastfeeding practices, 43.2% of mothers exclusively breastfed their infants. Most mothers had four or more antenatal care visits (81.9%), and 51.3% had 2-3 postnatal check-ups.

In terms of education and employment, 88.6% of mothers completed secondary education, and 74.1% were not employed. Most of the respondents lived in rural areas (61.1%) and gave birth in hospitals (61.7%). Over half of the mothers had 2-5 children (51.2%), while only 1.9% had more than five. Regarding cultural beliefs about complementary feeding, 50.1% of mothers held positive cultural views.

Figure 2 shows the media mothers use to access information about complementary feeding, and Figure 3 shows the sources of this information. Approximately 84.8% of mothers accessed information on complementary feeding through online media, with 24.0% using television and 15.7% using mobile applications. Most mothers obtained their information from professionals (79.8%), followed by grandmothers (31.6%) and husbands (15.2%).

Table 1. Sociodemographic characteristics of the respondents (n=579)

Characteristics	Frequency (f)	Percentage (%)
Children's age		
Infant (6-11 months)	170	29.4
Young children (12-23 months)	409	70.6
Disease's history		
No	211	36.4
Yes	368	63.6
Mother's age		
Young mother (≤ 25 years)	44	7.60
Older mother (>25 years)	535	92.4
Parity of mother		
Primipara	188	32.5
Multipara	373	64.4
Grand multipara	18	3.1
Breastfeeding status		
Non-formula feeding	250	43.2
Formula feeding	329	56.8
Antenatal care visit		
Never	4	0.7
1 time	10	1.7
2-3 times	91	15.7
4 times or more	474	81.9
Postnatal check-up		
Never	56	9.7
1 time	139	24.0
2-3 times	297	51.3
4 times or more	87	15.0
Education level		
Lower education	66	11.4
Higher education	513	88.6
Occupation		
Unemployed	429	74.1
Working mother	150	25.9
Family income		
Low income	317	54.7
Middle income	247	42.7
High income	15	2.6
Residence		
Rural area	354	61.1
Urban area	225	38.9
Place of delivery		
Hospital	357	61.7
Other than hospital	222	38.3
Number of children		
1 child (Only child)	186	32.1
2-5 children (Small)	382	66.0
More than 5 children (Large)	11	1.9
Cultural belief		
Negative	289	49.9
Positive	290	50.1
Exposure to media		
No	13	2.2
Yes	566	97.8
Source of information		
No	10	1.7
Yes	569	98.3

Note. Participants were on average 31.2 years old (SD=5.1), and children's average age was 15.3 months (SD=5.1).

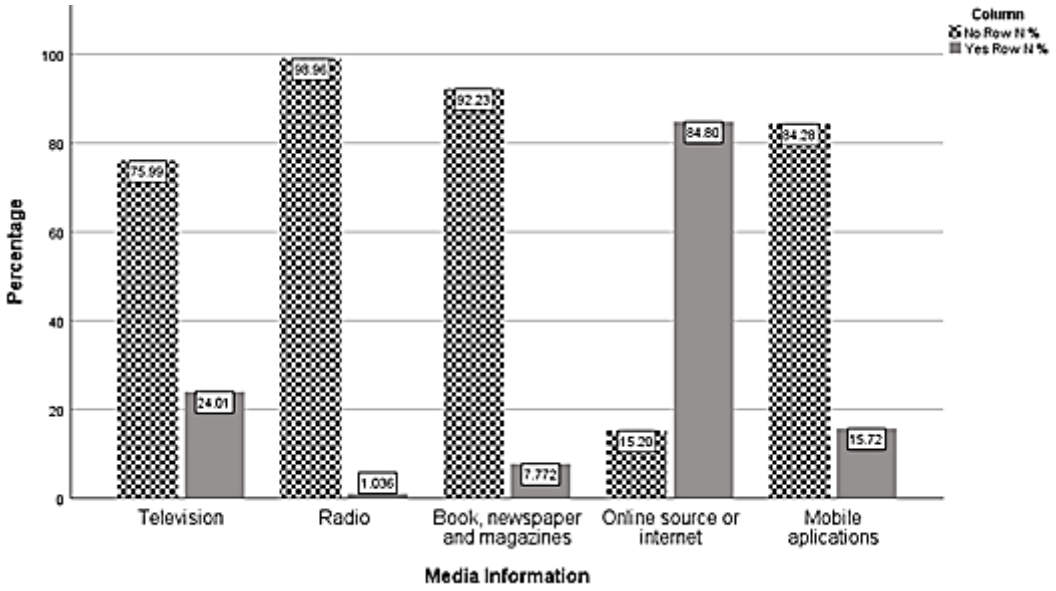

Figure 2. Media information that mothers used (n=579)

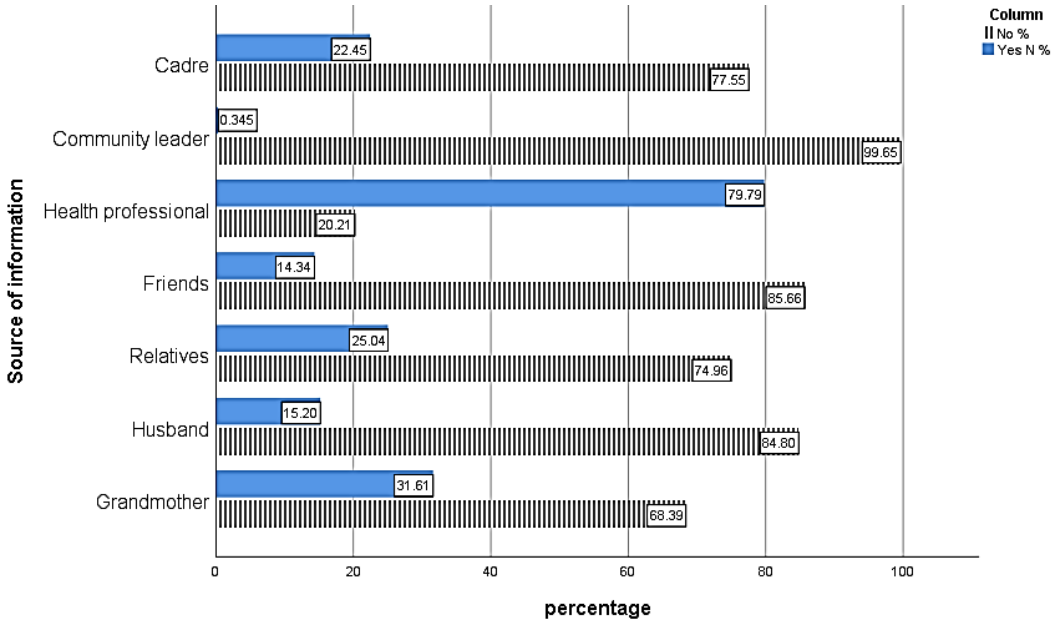

Figure 3. Mothers' source of information (n=579)

3.2. Maternal knowledge, attitude, self-efficacy, and perceived social support

Table 2 presents the study's results on maternal knowledge, attitude, self-efficacy, and perceived social support. The majority of mothers (90.5%) demonstrated good knowledge of complementary feeding, with 95.9% displaying a positive attitude toward complementary feeding practices. Mothers showed particularly good knowledge regarding the recommended age for breastfeeding (86%) and the importance of introducing complementary foods at 6 months (97.4%). However, item-specific analysis revealed that some knowledge gaps persisted. For instance, only 64.1% of mothers knew the reason why complementary feeding should be introduced at six months. Additionally, only 37.3% of mothers were aware of the recommended feeding frequency.

3.2.1 Maternal knowledge

Supplementary Table 1 provides detailed results for each question in the knowledge questionnaire. Most mothers exhibited good knowledge about complementary feeding, especially regarding the recommended age for breastfeeding (86%) and the importance of introducing complementary foods at 6 months (97.4%). However, item-specific analysis revealed that some knowledge gaps persisted. For instance, only 64.1% of mothers knew the reason why complementary feeding should be introduced at six months. Additionally, 37.3% of mothers were aware of the recommended feeding frequency.

Table 2. Maternal knowledge, attitude, self-efficacy, and perceived social support (n=579)

Characteristics	Frequency (f)	Percentage (%)
Knowledge		
Good (> 70%)	524	90.5
Poor (≤ 70%)	55	9.5
Attitude		
Positive (> 70%)	555	95.9
Negative (≤ 70%)	24	4.1
Self-Efficacy		
High (> 70%)	506	87.4
Low (≤ 70%)	73	12.6
Perceived Social Support		
High (> 70%)	214	37.0
Low (≤ 70%)	365	63.0

3.2.2 Maternal attitudes toward complementary feeding

Further analysis of individual attitude items revealed nuanced patterns despite the overall positive maternal attitudes toward complementary feeding (Supplementary Table 2). While most mothers agreed with the recommended introduction of complementary foods at six months (52.3%), 40.2% still disagreed with introducing foods before this age. Some misconceptions persisted, as 22.6% of mothers believed that peanuts should be avoided, and 6.6% thought that excessive fish consumption could cause intestinal worms.

3.2.3 Maternal self-efficacy

Item-level analysis of maternal self-efficacy (Supplementary Table 3) identified several specific challenges. About 20.4% of mothers reported difficulty managing three regular meals per day for their infants, while 39.6% found it challenging to maintain physical contact during feeding, such as holding the infant while breastfeeding or bottle-feeding.

3.2.4 Perceived social support

Item-level analysis of perceived social support (Supplementary Table 4) showed that emotional support was relatively strong, with 54.7% of mothers reporting positive emotional connections, whereas problem-solving and stress-relief support were notably limited. Only 14.7% of mothers felt they had adequate support in addressing feeding-related challenges, and 15.2% reported having sufficient assistance to relieve daily stress.

3.3. Maternal adherence to complementary feeding guidelines

Based on the results presented in Figure 4, maternal adherence to complementary feeding guidelines showed varying levels of compliance across different indicators. The highest adherence was observed for the introduction of Solid, Semi-Solid, or Soft Foods (ISSSF), with 90.16% of mothers following the recommended guidelines for introducing complementary food at the appropriate age of 6-8 months. Both Minimum Dietary Diversity (MDD) and Continued Breastfeeding (CBF) showed similarly high adherence, with 79.45% of mothers meeting the MDD guideline and 79.27% continuing breastfeeding beyond 6 months. However, adherence to the Minimum Meal Frequency (MMF) and Minimum Acceptable Diet (MAD) guidelines was lower, with 56.30% and 54.92% of mothers adhering to the respective guidelines. The overall maternal adherence to complementary feeding guidelines was 40.07%.

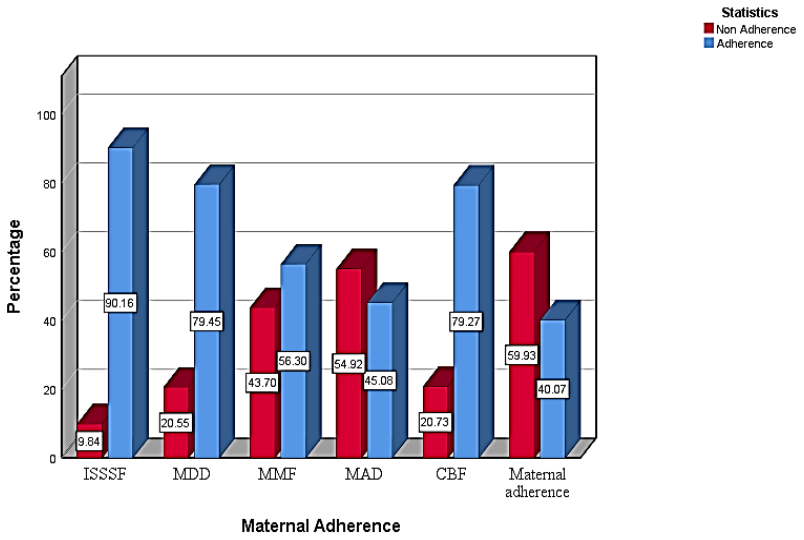

Figure 4. Maternal adherence to complementary feeding guidelines

As shown in Figure 5, the majority of mothers provided grains, roots, and tubers (95.51%) and vitamin A-rich fruits and vegetables (83.59%) to their children, followed by flesh foods (82.04%) and eggs (71.33%). Dairy products were provided by 60.10% of mothers, while pulses (beans, peas, lentils, nuts, and seeds) had the lowest adherence rate, with only 36.44% of mothers providing these foods. Additionally, 79.27% of mothers continued breastfeeding their children.

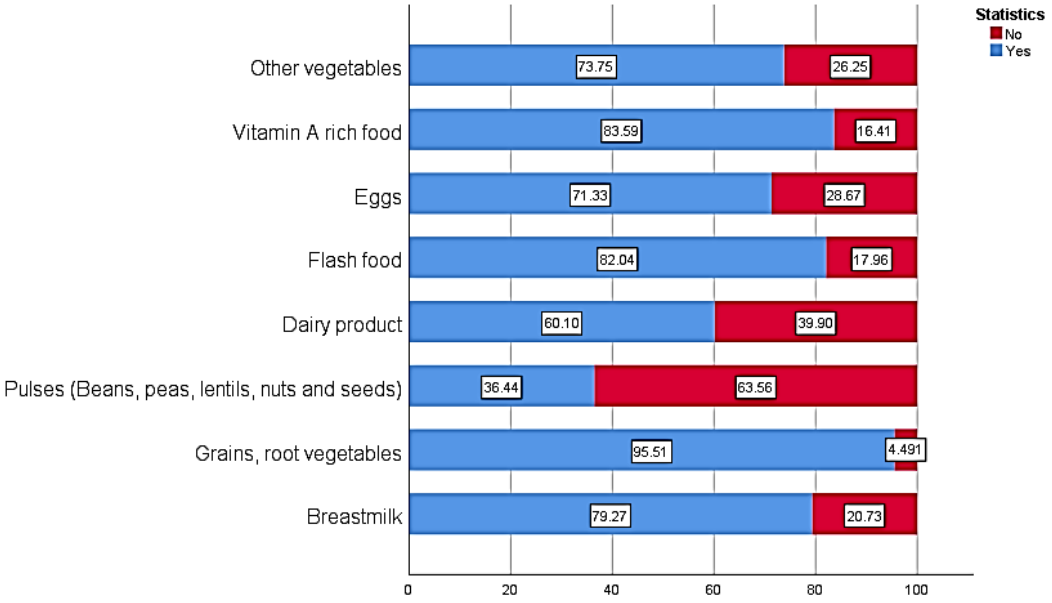

Figure 5. Type food groups consumed by children aged 6-23 months

3.4. Factors associated with maternal adherence

Bivariate analysis revealed that breastfeeding status was significantly associated with adherence (p = 0.006), with mothers who did not formula feed showing higher adherence. Maternal knowledge (p = 0.042), positive attitudes (p = 0.001), high self-efficacy (p < 0.0001), and social support (p = 0.039) were also significantly linked to better adherence. However, maternal age, education level, and cultural beliefs did not show significant associations with adherence, with p-values ranging from 0.120 to 0.587 (Table 3).

Table 3. Bivariate analysis of factors associated with maternal adherence

Variables	Maternal Adherence				*p*
	Non Adherence		Adherence		
	f	%	f	%	
Children's age					
Infant (6-11 months)	102	60.0	68	40.0	0.983
Young children (12-23 months)	245	59.9	164	40.1	
Disease's history					
No	130	61.6	81	38.4	0.532
Yes	217	59.0	151	41.0	
Mother's age					
Young mother (≤ 25 years)	28	63.6	16	36.4	0.602
Older mother (>25 years)	319	59.6	216	40.4	
Parity of mother					
Primipara	122	64.9	66	35.1	0.103
Multipara	212	56.8	161	43.2	
Grand multipara	13	72.2	5	27.8	
Breastfeeding status					
Formula feeding	166	66.4%	84	33.6%	0.006 *
Non-formula feeding	181	55.0%	148	45.0%	
Antenatal care visit					
Never	3	75.0	1	25.0	0.787
1 time	6	60.0	4	40.0	
2-3 times	58	63.7	33	36.3	
4 times or more	280	59.1	194	40.9	
Postnatal check-up					
Never	37	66.1	19	33.9	0.638
1 time	86	61.9	53	38.1	
2-3 times	175	58.9	122	41.1	
4 times or more	49	56.3	38	43.7	
Education level					
Lower education	49	74.2	17	25.8	0.120
Higher education	298	58.1	215	41.9	
Occupation					
Unemployed	258	60.1	171	39.9	0.682
Working mother	89	59.3	61	40.7	
Family income					
Low income	198	62.5	119	37.5	0.172
High Income	149	56.9	113	43.1	
Residence					
Rural area	209	59.0	145	41.0	0.583
Urban area	138	61.3	87	38.7	
Place of delivery					
Hospital	215	60.2	142	39.8	0.855
Other than hospital	132	59.5	90	40.5	
Number of children					
1 child (Only child)	121	65.1	65	34.9	0.056
2-5 children (Small)	217	56.8	165	43.2	
More than 5 children (Large)	9	81.8	2	18.2	
Cultural belief					
Negative	170	58.8	119	41.2	0.587
Positive	177	61.0	113	39.0	
Exposure to media					
No exposure	10	76.9	3	23.1	0.206
Exposure to media	337	59.5	229	40.5	
Source of information					
No source of information	5	50.0	5	50.0	0.518
Source of information	342	60.1	227	39.9	
Knowledge					
Poor	40	72.7	15	27.3	0.042 *
Good	307	58.6	217	41.4	
Attitude					
Negative	22	91.7	2	8.3	0.001 *
Positive	325	58.6	230	41.4	
Self-efficacy					
Low	59	80.8	14	19.2	<0.0001 *
High	288	56.9	218	43.1	
Social support					
Low	140	65.4	74	34.6	0.039 *
High	207	56.7	158	43.3	

Note. *Level of significance (p-value < .05)

3.5. Determinants of maternal adherence to complementary feeding guidelines

As shown in Table 4, multivariate logistic regression analysis revealed that only breastfeeding status, maternal education, attitude, and self-efficacy were significantly associated with maternal

adherence to complementary feeding guidelines. Mothers who provided formula were 45% less likely to adhere to the guidelines compared to those who did not provide formula (AOR = 0.549, 95% CI = 0.384–0.784). Mothers with secondary education or higher were 1.9 times more likely to adhere to the guidelines compared to those with lower education (AOR = 1.984, 95% CI = 1.053-3.739). Mothers with high self-efficacy had 2.6 times higher odds of adhering to the guidelines compared to those with low self-efficacy (AOR = 2.695, 95% CI = 1.426-5.091). Lastly, mothers with a positive attitude were 5.7 times more likely to follow the guidelines than those with a negative attitude (AOR = 5.752, 95% CI = 1.283-25.794).

Table 4. Multivariate analysis of factors associated with maternal adherence to complementary feeding guidelines

Variables	Maternal Adherence		COR (95% CI)	AOR (95% CI)
	Adherence f(%)	Non Adherence f(%)		
Parity				
Primipara	66 (35.1)	122 (64.9)	1	1
Multipara	161 (43.2)	212 (56.8)	1.404 (0.977–2.018)	0.879 (0.235–3.286)
Grand multipara	5 (27.8)	13 (72.2)	0.711 (0.243–2.081)	0.852 (0.136–5.344)
Breastfeeding status				
Formula feeding	84 (33.6)	166 (66.4)	0.619 (0.440–0.870)	0.549 (0.384–0.784)**
Non-formula feeding	148 (45.0)	181 (55.0)	1	1
Education				
Low	17 (25.8)	49 (74.2)	1	1
High	215 (41.9)	298 (58.1)	2.08 (1.166–3.710)	1.984 (1.053–3.739)*
Income				
Low	119 (37.5)	198 (62.5)	1	1
High	113 (43.1)	149 (56.9)	1.262 (0.904–1.762)	1.063 (0.740–1.528)
Number of children				
Only child	65 (34.9)	121 (65.1)	1	1
Small	165 (43.2)	217 (56.8)	1.415 (0.984–2.035)	1.601 (0.425–6.022)
Large	2 (18.2)	9 (81.8)	0.414 (0.087–1.972)	0.532 (0.057–5.005)
Exposure to media				
No	3 (23.1)	10 (76.9)	1	1
Yes	229 (40.5)	337 (59.5)	2.265 (0.617–8.320)	1.017 (0.235–4.397)
Knowledge				
Poor	15 (27.3)	40 (72.7)	1	1
Good	217 (41.4)	307 (58.6)	1.885 (1.016–3.498)	1.166 (0.592–2.297)
Attitude				
Negative	2 (8.3)	22 (91.7)	1	1
Positive	230 (41.4)	325 (58.6)	7.785 (1.813–33.431)	5.752 (1.283–25.794)*
Self-efficacy				
Low	14 (19.2)	59 (80.8)	1	1
High	218 (43.1)	288 (56.9)	3.190 (1.736–5.863)	2.695 (1.426–5.091)**
Social support				
Low	74 (34.6)	140 (65.4)	1	1
High	158 (43.3)	207 (56.7)	1.444 (1.018–2.048)	1.353 (0.934–1.959)

Notes. COR Crude odds ratio, AOR Adjusted odds ratio, CI Confidence interval; *$p < 0.05$, **$p < 0.01$, ***$p < 0.0001$

4. Discussion

This study aimed to explore the factors influencing maternal adherence to complementary feeding guidelines using the Integrated Change Model (I-Change Model). According to this model, behavior change is influenced by a sequence of factors: awareness, motivation, and behavior. The study found that maternal education, attitude, self-efficacy, and breastfeeding status were key determinants of maternal adherence to complementary feeding guidelines, even after adjusting for potential confounding factors. These findings align with the I-Change Model's premise that awareness factors (e.g., knowledge) and motivational factors (e.g., attitude, self-efficacy) significantly influence behavioral outcomes (de Vries, 2017), such as adherence to complementary feeding guidelines.

However, maternal knowledge about complementary feeding did not show a direct relationship with adherence in this study. This finding contrasts with previous studies from several African countries (Ahmed et al., 2022; Assefa et al., 2021; Carabaza et al., 2021), where better knowledge was associated with better adherence to complementary feeding practices. This

discrepancy can be attributed to differences in respondent characteristics, research methodologies, or sociocultural contexts. In line with the I-Change Model (de Vries, 2017), while awareness (in this case, knowledge) is necessary, motivational and behavioral factors (such as maternal attitudes and self-efficacy) more directly predict adherence to feeding guidelines.

Interestingly, while 90.5% of mothers demonstrated good knowledge of complementary feeding, specific gaps were observed in areas such as feeding frequency and the rationale for introducing complementary feeding after six months. These gaps highlight the importance of not only enhancing knowledge but also focusing on motivational and behavioral factors to improve adherence, as the I-Change Model suggests.

Positive maternal attitudes were strongly associated with adherence; mothers with positive attitudes were 5.7 times more likely to adhere to the guidelines than those with negative attitudes. This finding is consistent with studies in Ethiopia (Assefa et al., 2021) and Madagascar (Rakotomanana et al., 2020), which also highlighted the importance of maternal attitudes in determining adherence to complementary feeding guidelines. Positive attitudes toward complementary feeding often stem from a mother's understanding of the benefits of a timely introduction and diverse foods for a child's growth and development.

However, several misconceptions were also observed among the mothers, particularly in their beliefs about the frequency and simplicity of meals. For example, 53.9% of mothers fed their children 3-4 times a day, which is in line with the recommended frequency. This means that 46.1% of mothers were providing fewer meals per day than the recommended guideline. This result may indicate that many mothers either underestimate the need for more frequent feeding or face practical barriers (e.g., time, resources) that prevent them from feeding their children the recommended number of times. Additionally, some mothers believed that giving children a simple meal was sufficient, with 7.1% thinking that too much fish could cause intestinal worms and 11.7% believing that complementary foods could be introduced before six months. These beliefs could be indicative of misunderstandings about the nutritional needs of young children, highlighting the importance of correcting misconceptions during health education interventions. In the context of the I-Change Model, these findings suggest that improving awareness through targeted educational programs, particularly those emphasizing the importance of a balanced diet, appropriate feeding frequency, and the nutritional requirements of young children, could help shift maternal attitudes toward healthier feeding behaviors. Addressing these knowledge and motivation gaps is essential to improving maternal adherence to complementary feeding guidelines.

Self-efficacy, which refers to a mother's belief in her ability to perform feeding tasks, was also a significant predictor of adherence. Mothers with higher self-efficacy were more likely to follow the guidelines, particularly in terms of introducing complementary foods at the right time and ensuring dietary diversity. This aligns with findings from the United Kingdom (Spyreli et al., 2022), where higher self-efficacy was linked to better adherence. Despite overall high self-efficacy, specific tasks such as managing three regular meals a day at 12 months and holding the baby during breastfeeding showed lower self-efficacy, suggesting that self-efficacy interventions could significantly improve adherence. These interventions could focus on skills-building and confidence-enhancing strategies to address specific gaps in maternal self-efficacy.

Mothers who did not provide formula were more likely to adhere to the guidelines. This finding supports the I-Change Model's emphasis on behavioral factors and suggests that exclusive breastfeeding or at least breastfeeding without formula is associated with better adherence to complementary feeding guidelines. This is consistent with findings from Southern Brazil (Holand et al., 2022). The breastfeeding behavior pattern, particularly the practice of not providing formula until 12 months, supports the I-Change Model's assertion that positive behaviors promote greater adherence to the guidelines. This study also identifies a significant issue: one-third of mothers with infants aged 6-11 months provided formula, contradicting feeding recommendations. This suggests that formula feeding may reduce adherence to complementary feeding guidelines. In terms of the I-Change Model, promoting awareness of breastfeeding's importance, enhancing self-efficacy through support, and reinforcing positive attitudes toward breastfeeding are essential to improving maternal adherence to complementary feeding guidelines.

Furthermore, this study showed that education emerged as a key sociocultural factor influencing adherence. The I-Change Model suggests that education enhances awareness, leading

to more informed decisions and greater adherence to health guidelines (de Vries, 2017). Mothers with secondary education or higher were significantly more likely to adhere to complementary feeding guidelines. This finding is consistent with studies in Ethiopia (Mamo et al., 2022) and Indonesia (Sekartaji et al., 2021), which highlighted the impact of maternal education on health behavior. Educated mothers may have better access to healthcare services and information, enabling them to make better feeding decisions. The I-Change Model supports this by emphasizing that increased awareness from education drives both motivation (through a positive attitude) and behavioral change (increased adherence) (de Vries, 2017).

5. Implications and limitations

The findings of this study are needed to examine how changes in awareness, attitudes, and self-efficacy over time influence maternal adherence to complementary feeding guidelines and child health outcomes. Based on the findings, it is recommended that health interventions focus on improving maternal awareness, attitudes, and self-efficacy in relation to complementary feeding. The I-Change Model provides a useful framework for structuring these interventions, highlighting the importance of awareness (increasing maternal knowledge on the timing and benefits of complementary feeding), motivation (fostering positive attitudes toward feeding practices), and behavior (enhancing self-efficacy through practical support and training). Specifically, community-based educational programs, healthcare provider training, and peer support networks could be developed to reinforce these elements and improve adherence to complementary feeding guidelines. Additionally, targeted campaigns addressing cultural beliefs, misconceptions, and specific feeding practices could further support mothers in adhering to the guidelines. These interventions could be implemented through maternal and child health services, community health workers, and local nutrition education programs. Additionally, research should explore other factors not covered in this study, such as family dynamics and cultural influences, to provide a comprehensive understanding of the factors that drive maternal adherence to complementary feeding guidelines.

Although this study provides valuable insights into the determinants of maternal adherence to complementary feeding guidelines, several limitations must be considered when interpreting the findings. First, the cross-sectional design of the study limits our ability to draw causal conclusions between the identified factors and maternal adherence. Therefore, longitudinal studies are needed to explore the causal links between these variables over time. Second, self-report bias is a potential concern, as maternal adherence was assessed using a 24-hour dietary recall, which may be subject to social desirability bias. Mothers may have reported feeding behaviors they believe are socially acceptable. To mitigate this, future research should consider using objective measures, such as food diaries, direct observation, or biomarker assessments, to verify the accuracy of dietary data. Moreover, the findings from this study are specific to Padang city and may not be generalizable to mothers across other regions of Indonesia. Therefore, further research with broader geographic coverage and larger sample sizes is needed to enhance the external validity of the findings and provide a more comprehensive understanding of maternal adherence to complementary feeding guidelines in diverse settings.

Despite the limitations, the study has strengths, including the use of a large, representative sample from multiple districts in Padang, which increases the relevance of the findings to the local context. Additionally, the use of validated instruments to measure maternal knowledge, attitudes, and self-efficacy ensured data reliability, and the application of the I-Change Model provided a strong theoretical foundation for understanding the factors influencing maternal adherence to complementary feeding guidelines.

6. Conclusion

This study aimed to explore the determinants of maternal adherence to complementary feeding guidelines using the I-Change Model. The results highlight that maternal adherence to complementary feeding guidelines is influenced by factors such as breastfeeding status, maternal education, attitude, and self-efficacy. The study found that mothers who did not provide formula feeding were more likely to adhere to complementary feeding guidelines compared to those who did. Additionally, higher maternal education, positive attitudes, and high self-efficacy were all significantly associated with better adherence to the guidelines. Despite high levels of knowledge and positive attitudes toward complementary feeding, adherence remained relatively low, with

only 40.1% of mothers meeting the guidelines. This discrepancy suggests that, while knowledge and attitudes are crucial, other factors, such as social support and practical challenges in feeding, may also play a significant role.

Health interventions should focus on enhancing maternal education, particularly regarding the feeding frequency and food diversity. Efforts should also aim to foster positive attitudes by emphasizing the benefits of complementary feeding for child development, alongside strategies to overcome misconceptions about complementary feeding, and to enhance maternal self-efficacy by providing training and resources that build mothers' confidence in managing the feeding schedule and food variety. Future interventions should consider increasing social support, especially through peer support groups, community-based interventions, and health worker involvement, to help mothers overcome practical barriers. Future research should also focus on conducting longitudinal studies to confirm causal relationships between identified determinants and maternal adherence to guidelines, and investigating the role of social support, including support from family members and community resources, and how it affects maternal adherence to complementary feeding guidelines.

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Author contribution

HH: Conceptualization, methodology, software, formal analysis, investigation, data curation, project administration, writing original draft, and visualization. YJC: Validation, data curation, writing-review & editing, and supervision.

Conflict of interest

We have no known conflict of interest to disclose.

Declaration of the use of Artificial Intelligence (AI)

We used AI-assisted tools for English translation and grammar checking to improve language clarity. All scientific content, interpretations, and conclusions remain the sole responsibility of the authors.

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Appendixes

Supplementary Table 1. The proportion of maternal knowledge regarding complementary feeding

Knowledge's items	Frequency (f)	Percentage (%)
Recommendation age for breastfeeding	499	86.2
The first age of providing complementary foods	564	97.4
Why should children be given complementary foods	371	64.1
Type of food ingredients for diversity	521	90.0
Example of animal protein sources foods	543	93.8
Dietary diversity standard	484	83.6
Feeding frequency	216	37.3
Hygiene and sanitation practice before feeding a child	526	90.8
Feeding practice when the child is sick	508	87.7
Example of iron base food ingredients	547	94.5

Supplementary Table 2. The proportion of maternal attitude toward complementary feeding

Attitudes	Strongly Disagree		Disagree		Not sure		Agree		Strongly Agree	
	f	%	f	%	f	%	f	%	f	%
Children can be given food before six months old	215	37.1	233	40.2	51	8.8	68	11.7	12	2.1
Breastfeeding should be given to children until two years old	5	0.9	2	0.3	6	1.0	209	36.1	357	61.7
Food can be introduced to children after the age of six months	5	0.9	1	0.2	11	1.9	303	52.3	259	44.7
Give children a simple meal	141	24.4	289	49.9	80	13.8	62	10.7	7	1.2
Children should be given rice, animal protein sources, vegetable protein sources, vegetables and fruits every day	11	1.9	3	0.5	14	2.4	230	39.7	321	55.4
Children need to be given green and orange vegetables	3	0.5	3	0.5	40	6.9	357	61.7	176	30.4
Nuts do not need to be given	44	7.6	249	43.0	138	23.8	131	22.6	17	2.9
Left the child alone If he/she does not want to eat	141	24.4	347	59.9	54	9.3	34	5.9	3	0.5
Mother should wash her hand before feeding her child	5	0.9	2	0.3	11	1.9	286	49.4	275	47.5
Food storage does not need to be covered	6	1.0	35	6.0	19	3.3	317	54.7	202	34.9
Children do not need to consume fruits	165	28.5	357	61.7	31	5.4	20	3.5	6	1.0
Giving lots of fish can cause worms	139	24.0	331	57.2	68	11.7	38	6.6	3	0.5
Children are given a variety of foods every day	3	0.5	4	0.7	46	7.9	282	48.7	244	42.1
Feeding children in a responsive way	6	1.0	8	1.4	28	4.8	270	46.6	267	46.1

Note. The items in bold text are reverse coded for scoring purposes. The responses for these items are inverted when calculating the overall maternal attitude score.

Supplementary Table 3. The proportion of maternal self-efficacy in infant feeding

Self-efficacy Question	Low		High	
	f	%	f	%
Clean utensils (e.g., bottle, pacifier) correctly.	45	7.8	534	92.2
Manage a regular meal for my baby when s/he is 6 months old.	64	11.1	515	88.9
Manage three regular meals for my baby when s/he is 12 months old.	118	20.4	461	79.6
Provide solid food that is appropriate for my baby's age.	89	15.4	490	84.6
Let my baby have breast milk on schedule even I am not at home or at a place of work.	107	18.5	472	81.5
Hold my baby every time s/he is breast or bottle fed.	229	39.6	350	60.4
Always burp my baby after breast or bottle feeding.	62	10.7	517	89.3

Note. Maternal self-efficacy was measured on a 0-100 scale, where scores below 70 were classified as low self-efficacy and scores 70 or above as high self-efficacy, based on previous studies using 70 as the cut-off point for behavior-related measures.