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Impact of the Introduction of Complementary Feeding Prior to the Sixth Month on Hemoglobin Levels and Weight Status

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ABSTRACT

Background: An infant's requirement for daily energy and nutrients appears to exceed what breast-feeding gives; consequently, incorporating complementary foods into the diet becomes vital for the growth and development of the infant. The study aims to explore the correlation between the age of complementary feeding introduction before the sixth month and its impact on hemoglobin levels and weight status.

Subjects and Method: We conducted a case-series study at the Primary Health Care Center/Al-Tahrir, Baquba City, from April 18 to August 30, 2018. The study included a sample of three hundred fully developed infants, aged between 6 and 12 months, consisting of 180 males and 120 females. The dependent variable was complementary feeding. The independent variables were weight status, haemoglobin levels, and weught for age z-score. We obtained the data through face-to-face interviews with the child's mother using a structured questionnaire.

Results: Among the women who took part in the study, 43% initiated the practice of providing additional food to their infants between the ages of 4 and 6 months. It was observed that the average hemoglobin level was higher in infants who consumed complementary feeding during the period of 4–6 months. A significant percentage of infants (52.6%) who initiated food intake by nursing or bottle feeding between the ages of 4-6 months exhibited weight levels within the normal range. In contrast, infants who had not yet commenced supplemental feeding showed a lower prevalence of normal weight levels. Furthermore, a majority of infants (83.3%) who engaged in supplemental feeding experienced an increase in hemoglobin levels and an improvement in weight. The research findings indicate that the introduction of supplemental nutrition throughout the period of 4 to 6 months of age has a significant impact on enhancing hemoglobin levels and weight among infants.

Conclusion: The study's findings show that mothers frequently reported offering rice water, biscuits, and tea-soaked bread as their primary food sources.

Keywords: complementary feeding, haemoglobin, weight status.

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BACKGROUND

Complementary foods are regarded as any solid or liquid meals of nutritional content other than breastfeeding to achieve the

nutritional demands of the infant from 6 to 23 months of age and are considered a period extremely prone to signs of malnutrition (Giugliani et al., 2021; Rao et al., 2011; Friel et al., 2009). Currently, the World Health Organization recommends continued exclusive breastfeeding for the first six months of an infant's life, thus providing adequate and suitable complementary food (Mathew, 2015). Accordingly, it is indicated to start supplemental feeding after 4-6 months of the infant's life (Prieto and Detzel, 2013).

An infant's requirement for daily energy and nutrients appears to exceed what breast-feeding gives; consequently, incorporating supplementary foods into the diet becomes vital for the growth and development of the infant (Prieto and Detzel, 2013). At about six months, term infants who are exclusively breastfed are at risk of developing iron deficiency (Qasem, 2015). Because iron stores diminish faster in the body throughout the first six months of an infant's life, the problem of iron insufficiency emerges (Reinbott et al., 2016). Children with iron deficiency anemia in the first year of life are more sensitive to academic, social, and emotional deficits (Luo et al., 2014). Also, kids can have unfavorable effects associated with their school performance and behavior, and this will lower their prospects of working into adulthood (Luo et al., 2014). If complementary foods are offered, nursing should continue on demand or more often to ensure that children obtain all the health benefits of breastfeeding (Tamiru et al., 2013).

Iron is available in many foods, including animal products like meat, eggs, and milk, and plant products like dark leafy vegetables, soybeans, and beans (Queiroz et al., 2000). Therefore, the main factors that may contribute to low hemoglobin levels in infants in their first year of life are low iron stores in the foetus, a lack or deprivation of breast-feeding, or low consumption of iron-rich foods (Assis et al., 2004). The success of providing complementary food to infants in order to maintain their health and growth depends on several variables, including maternal age, level of education, and living and environmental circumstances (Kostecka et al., 2020).

SUBJECTS AND METHOD

1. Study Design

We conducted a case-series study at the Primary Health Care Center/Al-Tahrir, Baquba City, from April 18th to August 30th, 2018.

2. Population and Sample

This study focused on a cohort of three hundred healthy (full-term) infants, their ages between 6 and 12 months, comprising 180 (60%) boys and 120 (40%) girls. The mean age was 8.79 months. A face-to-face interview with the mother of the immunized child using a questionnaire.

3. Study Variables

The dependent variables were the infants' weight status and haemoglobin level. The independent variable was the age of complementary feeding introduction.

4. Operational Definition of Variables

Complementary feeding is when breast milk isn't enough to meet an infant's nutritional needs and other liquids and foods are required, feeding is the procedure that takes place.

Weight status is the amount of weight or mass that an individual possesses. Pounds or kilos are used to express it.

Haemoglobin levels is a protein found in red blood cells that is responsible for delivering oxygen to tissues, and its amount in whole blood is expressed in grams per decilitre (g/dL).

Weight for age z-score is it indicates the weight of a child in relation to the reference

population for their age and gender.

5. Data Instrument

The interview included a structured questionnaire consisting of three sections. The initial section consisted of closed-ended inquiries pertaining to the attributes of the infant, including age and gender. Conversely, the subsequent section encompassed three queries concerning the introduction of supplements, with one requiring a binary response of either "yes" or "not yet," and the remaining questions being open-ended in nature. The third section of the questionnaire consisted of two open-ended inquiries. The initial query pertained to the measurement of hemoglobin, while the subsequent question focused on the customary complementary foods provided to the youngster. The study involves female volunteers who are mothers, together with their offspring who fall between the age range of 6 and 12 months. To check the levels of hemoglobin (Hb), blood samples from babies were taken, and the cyanmethemoglobin technique was used by skilled lab staff to do the analysis. According to the World Health Organization's hemoglobin reference for children aged 6 to 12 years, the established threshold for hemoglobin concentration was 110 g/L (WHO, 2011). An infant is considered anemic if their hemoglobin level is below 11.0 g/L. The weight measurement was conducted with an electronic infant scale, namely the Laica Electronic Baby and Toddler Scale, Model: PS3004E, which has a precision of 0.01 kg. Every child's mother in the study cohort was instructed to recline her child on the measuring platform in a controlled manner, ensuring no contact with any objects subsequent to the removal of footwear and bulky garments. Subsequently, the weight was read and documented.

6. Data analysis

The data underwent statistical analysis using SPSS software, namely version 26, in order to present and summarize the variables through frequency, percentage, and graphical representations. The Demographic and Health Surveys (DHS) and the World Health Organization (WHO) provided standard references for the analysis of the anthropometric data. The weight-for-age index was employed. Infants were classified as underweight if their weight-for-age index deviated more than 2 standard deviations below the reference mean. The Kolmogorov-Smirnov test was used to check the distribution of variables before starting the statistical analysis to make sure they had a normal distribution. The t-test was used to measure the strength of the linear relationship between the paired data, while the chi-square test was used to measure the relationships between the categorical variables. A significance level of less than 0.05 was deemed statistically significant. Ethical considerations were not deemed necessary for the research, as it did not involve any experimentation involving human subjects or animals. Following a thorough evaluation of the questionnaire's content and ongoing monitoring throughout the data collection process, the researcher also received verbal consent from the director of the healthcare facility.

7. Research Ethics

This article adheres to ethical guidelines by not conducting any studies involving human experimentation. All procedures implemented in this study are in compliance with the 1975 Declaration of Helsinki, as revised in 1983. The primary healthcare provider prescribed a number of tests, one of which was the collection of blood samples for hemoglobin testing. The author refrained from utilizing the initials of the participants' names or any unique numerical identifiers in the explanatory materials and also neglected to document the titles of

the participants.

RESULTS

1. Sample Characteristics

According to Table 1, the study reveals that the proportion of male children (60%) was higher than that of female children (40%), with a mean age of 8.79 months.

2. Univariate analysis

The mean hemoglobin concentration was significantly different between infants who were given extra meals on top of their approved feeding schedule (11.234 g/L) and infants who hadn't been given any extra foods yet (10.647 g/dL), as shown in Table 2.

The study's results reveal a significant difference in the mean hemoglobin levels between infants who started complementary feeding at 4-6 months of age (11.549 g/dl) and those who began complementary feeding after six months (10.483 g/dL). A p-value of less than 0.05 was determined to be statistically significant, reflecting the observed discrepancy (Table 2).

Table 1. Sample characteristics

Variables	Frequency	Percentage (%)
Males	180	60
Females	120	40
Total	300	100

Table 2. Hemoglobin and weight parameters in relation to the initiation and introduction of complementary feeding

State of CF	Variables	No.	%	Mean (Hb)	SD	t-test value	p
Introduction of complementary foods	Yes	183	61	11.23	1.22	4.36	0.039 (S)
	Not yet	117	39	10.64	1.57		
	Total	300	100	11.00	1.39		
Age of introduction of complementary foods	Not yet	117	39	10.64	1.57	6.45	0.002(HS)
	4 - 6 months	129	43	11.54	1.22		
	> 6 months	54	18	10.48	0.85		
	Total	300	100	11.00	1.39		

CF= complementary foods, Hb= hemoglobin, SD= standard deviation, S= Significant, HS= highly significant

3. Bivariate analysis

The findings of the present study indicate that a greater proportion of infants (52.6%) who initiated complementary feeding beside breastfeeding or bottle feeding between the ages of 4-6 months exhibited normal weight levels. In contrast, a majority of infants (83.3%) who had not yet commenced supplemental feeding were classified as underweight. Table 3 shows that these results show a strong and statistically significant link between weight status and the timing of introducing complementary foods, as shown in Table 3.

According to the study's findings, children who ate rice soup (thin rice porridge) had the highest percentages (19.31%), while those who ate biscuits or bread with tea had the second-highest percentage (18.45%). Conversely, the lowest percentages were observed among children who consumed protein foods, specifically meat products (4.29%), egg yolks (3.43%), and livers (2.15%), respectively (Figure 1).

Table 3. Relationship between weight status level and state of complementary food introduction

State of complementary feeding	Weight for age z-score categories				r	p
	Normal-weight		Underweight			
	N	%	N	%	26.10	<0.001
Not yet	57	25	60	83.3		
4 - 6 months	120	52.6	9	12.5		
> 6 months	51	22.4	3	4.2		
Total	228	100	72	100		

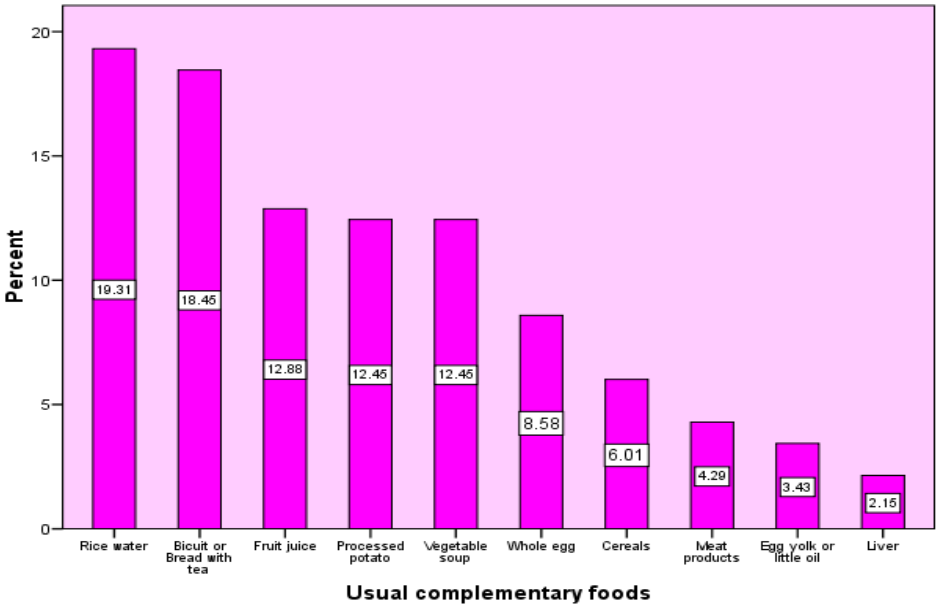

Figure 1. Distribution of usual foods consumed by Infants aged 6-12 Months

DISCUSSION

1. Relationship between hemoglobin level and state of complementary food introduction

The proportion of males exceeded more than half in the current study, and this is in agreement with several studies (Kostecka et al., 2020; Souza et al., 2014; Rao et al., 2011; Ntouva et al., 2014). This study showed that infants who consumed supplemental foods had significantly higher Hb levels than their non-supplemented counterparts. The reason is that any delay in the introduction of complementary foods can cause an increased risk of depleting iron stores, which in turn can lead to a decrease in hemoglobin concentration (Mathew, 2015). Also, increasing infant growth after the age of six months also requires more iron, which breast milk or formula may fail to meet (Kostecka et al., 2020; Puranitee et al., 2021).

An integrated and comprehensive guide has been conceded to complementary nutrition for infants, which says that iron-rich foods should be served between 4 and 6 months, especially if the child is exclusively breastfed (Asphn.org, 2018). Also, Spanish authors from the Faculty of Medicine, University of Granada, recommended that complementary foods could be started after the infant completed four months and would prefer to start at the age of six months (Campoy et al., 2018). The American Academy of Pediatrics advises mothers to provide

complementary foods between the ages of four and six months, provided that this period precedes exclusive breastfeeding while breastfeeding continues for at least one year to maintain hemoglobin levels and a normal weight (Friel, et al., 2009). Accordingly, this study indicates that the mean hemoglobin value was significantly higher among infants who started supplemental feeding at the age of 4-6 months and was lower among those who had not yet started supplemental feeding. Researchers agree that the early introduction of complementary feeding at four months of age in many developing countries is linked to higher hemoglobin levels (Mathew, 2015). This practice can improve hemoglobin levels, and this improvement is revealed significantly with the early introduction of complementary foods in developing countries (Mathew, 2015).

An infant's iron stores decline rapidly during the first six months of life, and then they become at risk of iron deficiency (Reinbott et al., 2016). Thus, the introduction of complementary foods after 4-6 months can prevent the decrease in hemoglobin levels, while it was observed in a Brazilian study that the predominant breastfeeding pattern among children under six months of age led to a significant decrease in hemoglobin levels. It is also interesting that replacing breast milk with complementary foods after the age of six months is less important (Giugliani et al., 2021).

2. Relationship between weight status level and state of complementary food introduction

The current study showed a significant link between starting extra feeding between the ages of 4 and 6 months and an increase in hemoglobin levels. This significant improvement was also seen in the study by (Mathew, 2015) who suggested that extra feeding could begin at 4 months. Based on a number of observational studies and randomized controlled trials that looked at the timing of food introduction, it was found that babies in developing countries had much higher hemoglobin levels when they were given solid foods early (Mathew, 2015). According to studies conducted across many Brazilian regions, supplementary feeding may be the cause of anemia in nearly 30% of young children, including infants (Beinner et al., 2010).

This study also indicated that there is a significant difference between delayed complementary feeding among Iraqi infants and underweight. Similarly, in a study by Rasania and Sachdev (2001) it was found that severe malnutrition was significantly higher among children if food weaning was delayed.

The majority of children who were given complementary food with breast milk or a bottle had normal weight levels in this study. Compared with those children who consumed milk alone, the majority of them were significantly underweight. This indicates that milk, whether breast-sourced or formula, is no longer sufficient to meet the infant's nutritional needs after six months, and not being provided with appropriate complementary foods leads to a deterioration of growth that can lead to malnutrition (Samuel and Ibidapo, 2020).

Health-related reports in northern Iraq demonstrated a close correlation between acute malnutrition among infants and raised bottle feeding. Therefore, it is preferable to provide supplementary nutrition between the ages of four and six months to avoid nutritional issues (Infant Formula Distribution in Northern Iraq, 2003). To maintain the child's health and safety, the mother must provide him or her with nutritious foods, provided that all possible hygiene requirements are applied in the preparation of these foods and in quantities that

are easy for the child to accept to prevent any health issues later (WHO, 2021).

3. Usual foods consumed by infants aged 6-12 months

With regard to complementary nutrition, which the mother is used to providing the infant as a supplement in this study, nearly two-thirds of these mothers (19.31%) are frequently used to giving the infant's iron-fortified processed cereal besides feeding. Similarly, it was found that these processed cereals are purchased from various supermarkets by 20% of Indonesian families to feed their infants (Asian Development Bank, 2009). Investigations in the Asia-Pacific region have found that rice water is a supplemental food frequently served to infants besides breastfeeding (Binns et al., 2020). A recent Iraqi study found that rice water is a complementary food commonly introduced to infants aged 5–6 months in Anbar province (Al-Samarrai et al., 2020). This could suggest that Iraqi mothers feed their children rice as an easily and cheaply available meal (Saleem, 2006).

The Iraqi mother of the infant traditionally provides biscuits or bread to soak in tea, which may be due to the food's softness and infant acceptance as well as its accessibility and undervaluation. The results of another Iraqi study in Karbala showed that half of mothers serve soft foods, including biscuits, to their infants as complementary foods (Jamil and Abul-Razzak, 2008).

This study revealed that the introduction of animal products like eggs and meat to infants' supplemental foods was limited. This may be due to the mother's belief that protein-rich foods are not suitable for the infant and that may cause a particular disease or food allergies, since food allergies to infants appear to be less common in developing countries, including Iraq (WHO, 2012).

The mother must provide limited quantities of meat, poultry, fish, or eggs to the infant daily to ensure that food needs are met. Among these products are red meat, particularly the liver, which involves significant iron levels, and as a result of its biological availability, it is considered better than milk and its products. Egg yolks also have proper supplies of iron, but their rate of absorption is poor (Giugliani, et al., 2021). In a survey of Canadian infants, it was found that the proportion of meat consumption among those aged six to nine months was no more than 10 percent (Friel et al., 2009).

This means that mothers are not keen to introduce meat into the infant's supplementary feeding system, and this attitude may increase iron deficiency rates. In conclusion, the introduction of supplemental nutrition has been found to have a significant impact on enhancing serum hemoglobin levels and weight status in infants, particularly when given at the critical period between 4 and 6 months of age. Furthermore, it was determined that rice water, cookies, and tea-soaked bread were prevalent food items offered by the maternal figure.

AUTHOR CONTRIBUTION

Although a statistician analysed the data, Aqeel Noaman gathered, measured, and wrote the paper.

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CONFLICT OF INTEREST

The authors state that there are no conflicts of interest related to the material reported in this study.

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