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ASSOCIATION OF WEANING PATTERN WITH WEIGHT GAIN IN INFANTS 1-2 YEARS OF AGE

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Abstract

Objective: *The aim of the study was to determine the association of weaning pattern with weight gain in infants 1-2 years of age.*

Study Design: *Cross-sectional analytical study*

Study Duration: *06 months from Oct 24-Mar 25*

Study Place: *Department of Pediatrics, CMH Lahore*

Methods: *A cross-sectional analytical study to assess the relationship between weaning practices and weight gain in 200 infants aged 12–24 months. Data from caregivers were collected using a structured, WHO-based questionnaire. Anthropometric measurements were recorded, and analysis was performed using SPSS 25 with Chi-square, ANOVA, and regression tests ($p < 0.05$).*

Results: *200 infants aged 12 to 24 months found that those properly weaned (at 6 months) had substantially greater weight gain, improved weight-for-age scores, and a lower prevalence of underweight than those weaned too early or too late. The education level of mothers and the socioeconomic status of families positively shaped weaning practices and the associated growth outcomes.*

Conclusion: *A strong association between weaning patterns and weight gain in children aged 1-2 years. Better growth and nutrition were recorded for appropriate weaning over six months. Maternal education and social class and nutrition education on the community level should help alleviate undernutrition in early childhood.*

INTRODUCTION

The age range between 1 and 2 years of age is a crucial period in child development in which trajectories of weight gain are sensitive to early life feeding practices as well as the introduction of complementary and family foods (or formula feeding). Weaning strategies, or the timing, type, and frequency of complementary feeding, mode of feeding, and dietary variety have been linked in several studies with weight gain and growth in infancy and early childhood.[1]

Early or late weaning could interfere with the nutrient intake balance required for normal growth. Complementary foods have been associated in some cohorts with accelerated weight gain in infancy when introduced before 4 months of age, which could be a

consequence of an energy-dense composition or less regulation of intake compared to forced feeding of breastmilk or formula alone. For instance, in one UK study, weaned infants were heavier than later weaned infants at 7 or 14 months and put on more weight between 8 weeks and 14 months of age than later-weaned infants (even after adjustment for breastfeeding status). However, late weaning or low complementary feeding at 6 months or more can predispose to under-nutrition or growth retardation. Among infants in Pakistan who were weaned (complementary feeding) after 6 months, underweight and linear growth were more prevalent. [2,3]Apart from timing, it is the quality of complementary feeding which is important. The WHO reviews indicate that, compared to diets with less dietary diversity or adequate energy content, the introduction of complementary foods around 6 months of age, which are rich in energy and properly diversified, improves weight and linear growth in children 6 to 24 months of age. However, other studies (e.g. CHOP cohort, Europe) indicate that introduction of solids before 4 months, particularly in formula feeding infants, is related to higher early weight gain and may increase risk of later overweight. On the other hand, the frequency and/or diversity of complementary feedings during 9-23 months is found to be inadequate and associated with malnutrition and lower weight-for-age in some South Asian settings. [4]Weaning patterns are also affected by socioeconomic factors, maternal education, cultural forms, perceived appetite and feeding behaviour, which mediate relationships with growth. For example, educational interventions about appropriate complementary feeding in Karachi, Pakistan, resulted in significantly greater mean weight, length, and less underweight and stunting as compared to controls. [5]Given these mixed findings in regards to timing, type and mode of complementary feeding, and heterogeneity across settings, a more in-depth analysis of weaning patterns relative to weight gain among infants aged 1-2 years is needed. This study aims to examine associations of weaning timing (time of introduction of solids), dietary diversity, feeding frequency, and patterns (e.g. spoon vs. self feeding) on weight gain trajectories in infants 12-24 months with control of breastfeeding history, socioeconomic and maternal education. Such information can be used to guide feeding practices and early intervention to optimize growth and prevent under-nutrition as well as early overweight.

Methodology:

A cross-sectional analytical study, which aims at evaluating the relationship between weaning and weight gain in infants aged 1-2 years was conducted at department of Pediatrics, CMH Lahore . The research was set to establish the influence of timing, frequency, and nature of complementary feeding on the weight status of infants. The study was carried out for 06 months from Oct 24-Mar 25. The target population were the infants between the age of 12-24 months who visited CMH Lahore to get immunization or normal check-up. The respondents of the interview-based questionnaire were their mothers or their primary caregivers. Ethical approval was taken from institutional IRB board as per letter ID; 2024/EC/36

Inclusion Criteria:

1. All infants greator than 37 week of gestation
2. Infants born without any visible deformity or metabolic anomaly
3. Mother or attendants willing for participation

Exclusion Criteria:

1. Premature infants, born less than 37 weeks gestation
2. Infants born with congenital of metabolic illness
3. Infants with chronic illness
4. Care taker or mother unwilling for participation

Sample size was determined based on the formula of the estimation of proportions with 95% confidence interval with 5% margin of error assuming a prevalence of 50% regarding inappropriate weaning practices (assuming maximum sample size). In this regard, 200 infants were included in study as per inclusion criteria. A random sampling method was used in which systematic random sampling was done on the outpatient registry in order to have a representation of the participants of various socioeconomic backgrounds.

The questionnaire that was used to gather data was structured and pre-tested, and it was based on the analysis of the existing literature and the WHO guidelines on feeding infants and young children (IYCF). The questionnaire was split into three parts:

1. Socio-demographic information (age of the mother, mother education, family income, parity, residence).
2. Feeding habits -when weaning starts, the nature of food introduced (homemade or commercial), feeding frequency, variety of diet and mode of feeding.
3. Anthropometric measurements- weight and height/ length of infants measured by use of standard equipment.

Weight of infants was taken to the nearest 0.1 kg using a digital infant weighing scale and length recorded using infanto-meter. The *z*-scores of the weight-for-age was computed based on the WHO Child Growth Standard (2006).

Independent variables like age at which the complementary feeding was initiated, the frequency of feeding per day, the nature of foods introduced, mode of feeding and the diversity score of the diet. Dependent variable like infant weight-age *z*-score (weight gain and nutritional status indicator). Confounding variables included birth weight, exclusive breastfeeding period, education of the mother and socioeconomic status.

The data was analyzed in Statistical package of the social sciences (SPSS) version 25. Participant characteristics and feeding patterns were summarized using descriptive statistics (mean, standard deviation, frequencies and percentages). Categorical variables were evaluated using Chi-square tests whereas independent t-tests or ANOVA were used to evaluate continuous variables to determine the association between weaning patterns and weight gain. To identify independent predictors of weight gain, a multiple linear regression analysis was used to control confounders. A p-value below 0.05 was taken as significant.

Results:

The study enrolled a total of 200 participants aged between 12 to 24 months. There were 102 males (51%) and 98 females (49%) with an average of 17.3 months (±3.4 months). The subjects' average birth weight was 2.9 kilograms with no statistically significant difference ($p = 0.42$). table 1

Based on the weaning practices, infants were placed into three groups:

- Appropriate weaning (n = 120; 60%) — introduction of complementary foods at 6 months of age plus breastfeeding and straying a broader diet.
- Early weaning (n = 38; 19%) — introduction of solid and semi-solid foods before the age of 4 months.
- Late weaning (n = 42; 21%) — starting after the age of 8 months.

The proportion of mothers with higher schooling and more advantageous socioeconomic status was greater ($p < 0.05$).

Regardless of the 3 groups, breastfeeding was more common in the appropriately weaned group. Many of those that were appropriately weaned (68%) continued breastfeeding for more than 1 year whereas, in the early/late weaning groups, only 39% were able to breastfeed that long ($p < 0.01$). There were greater scores for dietary diversity in the appropriately weaned (4.3 ± 0.8) than the inappropriate (2.9 ± 1.1, $p < 0.001$) group. Chart 2

The mean weights of infants with appropriate weaning was 10.8 ± 1.5 kg and those with inappropriate weaning weighed 9.5 ± 1.3 kg ($p < 0.001$). Weight gain from 6 months and appropriate weaning was 3.4 ± 0.9 kg while those with early or late weaning gained weight of 2.6 ± 0.8 kg ($p < 0.001$). Appropriately weaned infants also had better weight-for-age *z*-scores (–0.25 ± 0.71) compared to inappropriate weaned infants (–1.02 ± 0.83) which shows positive changes in growth ($p < 0.001$). The prevalence of underweight (WAZ < –2 SD) was 10.8% in appropriately weaned infants and 28.7% in inappropriately weaned infants ($p < 0.01$). table 3

Infants from high socio-economic status had better weaning practices (72% appropriate) and mean weights (10.9 ± 1.4 kg) compared to those

from low socio-economic status (47% appropriate; 9.6 ± 1.5 kg; $p < 0.01$). Mothers with secondary or higher education also had higher prevalence of appropriate weaning (70% vs. 48%; $p < 0.05$) and better weight gain (3.3 ± 0.8 kg vs. 2.7 ± 0.9 kg; $p < 0.01$). pie chart 4

No considerable difference was observed between means of weight or weight gain for male and female infants ($p = 0.47$). Nevertheless, the inappropriate weaning females did show a tendency to be underweight, more so than the males, 32% versus 25% but this was also not statistically significant ($p = 0.21$).

Table 1. Baseline Characteristics of Study Population (n = 200)

Variable	Total	Male n=102	Female n=98	p-value
Mean Age (month)	17.3 ± 3.4	17.5 ± 3.2	17.1 ± 3.6	.48
Mean birth weight (Kg)	2.9 ± 0.4	2.9 ± 0.3	2.8 ± 0.4	.42
Appropriate weaning	60%	58%	62%	.62
Breastfeeding contd	55%	53%	57%	.59
Mean dietary diversity score	3.8 ± 1.2	3.7 ± 1.1	3.9 ± 1.3	.33

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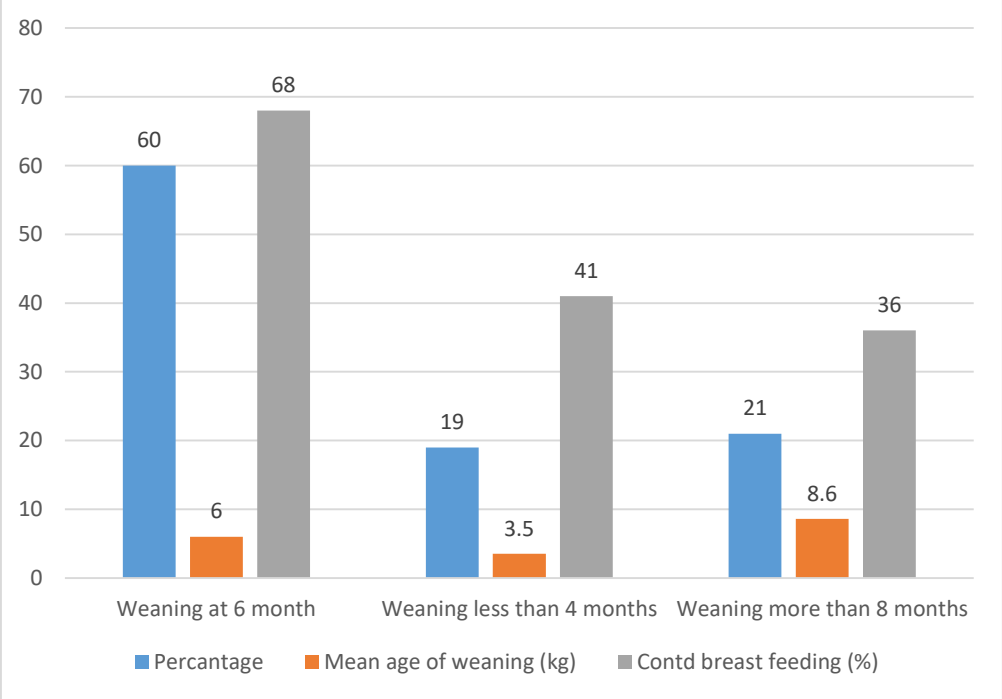
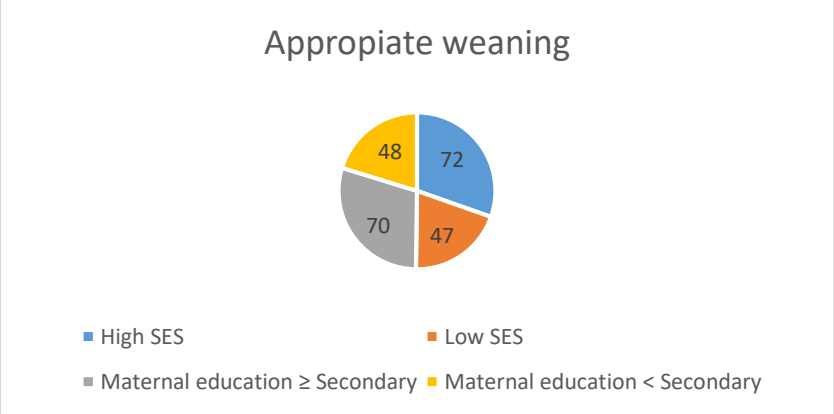


Chart 2. Distribution of Infants According to Weaning Pattern

Table 3. Comparison of Growth Indicators by Weaning Pattern

Parameter	Appropriate Weaning (n=120)	Inappropriate Weaning (n=80)
Mean current weight (kg)	10.8 ± 1.5	9.5 ± 1.3
Mean weight gain since 6 months (kg)	3.4 ± 0.9	2.6 ± 0.8
Weight-for-age z-score	−0.25 ± 0.71	−1.02 ± 0.83
Underweight prevalence (%)	10.8	28.7
Dietary diversity score	4.3 ± 0.8	2.9 ± 1.1



Pie Chart 4. Influence of Maternal and Socioeconomic Factors on Weaning

Discussion

In the current study, the relationship between weight gain and weaning patterns in infants (1-2 years) was determined. The results show that when weaning was done at the right time (at six months), was fed at a rate of three or more times
a day, and a proper balance in the types of food intake; this was positively linked to healthy weight gain and negatively linked to internal weight underweight and weight faltering. These findings are in line with evidence of earlier international and regional research that incorporates the idea that complementary feeding patterns play a big role in defining nutritional status during the early childhood.[6]

A number of studies have shown that early or delayed weaning influences the infant growth patterns. Arjama Thakur et al. (2024) discovered that the infants who were exposed to the complementary foods before four months showed a rapid weight gain at an early age, which can make them susceptible to overweight when they grow up. However, the Pakistani and Bangladeshi studies also demonstrated that delayed introduction (when it is performed after seven months) may lead to undernutrition because of the lack of enough calories in the diet and the deficiency of micronutrients (Khan et al., 2022; Islam et al., 2020). The current findings or results also align with the WHO guidelines on the introduction of complementary feeding at approximately six months of age to moderate growth promotion and metabolic health (WHO, 2021).[7,8]

The variety of the diet consumed and the frequency of meals also proved to be major factors

in weight gain. Like the contemporary findings, a cross-sectional study in Egypt also revealed that the weight-for-age z-score was much higher in infants fed foods belonging to four or more food groups on a daily basis (Ali et al., 2019). In Ethiopia, it was found that infants fed three meals per day put on weight better than those fed less often (Abebe et al., 2017). This underscores the importance of nutrient adequacy coupled with feeding frequency in the promotion of an adequate weight gain in the second year of life.[9,10]

Weaning patterns and the infant growth were also found to depend on maternal education and the socioeconomic status. The current research found that more educated mothers tended to adhere to the recommended weaning practices, which was in line with the findings of the studies in India and Nepal that the knowledge of the mothers, in general, has a positive correlation with the best infant feeding and growth outcomes (Bhattaraj et al., 2018; Choudhury et al., 2021). Educational interventions on mothers have been proved to have a positive effect of enhancing weight gain in infants through diverse and timely supplementary feeding (Sohail et al., 2019).[11,12]

Cultural and regional differences in feeding practices are still high all over the world. In developed nations, early weaning and formula feeding are commonly associated with convenience and simplicity, whereas in the developing and middle-income nations, delayed or monotonous diet is prevalent because of the insufficient resources (Arikpo et al., 2018). The current results reiterate the value of the context-specific nutritional counseling and community-based interventions in promoting the practice of complementary feeding.[13]

To sum up, this paper supports the global evidence that optimal weaning including the sufficient start of weaning, the correct frequency of meals and the variety of the diet plays a significant role in ensuring that infants at the age of 1 2 years gain weight healthily. Maternal education empowering, access to a wide variety of food, and support of WHO guidelines on infant feeding can greatly decrease growth retardation and undernutrition in early childhood.[14]

There is abundant international evidence on the relationship between weaning patterns and weight gain in infants aged 12 years. According to some studies (cohort and randomized) that have provided early introduction of complementary foods (before approximately 4 months) with faster short-term weight gain and increased risk of subsequent overweight, especially among formula-fed infants (Huh et al., 2011; Sloan, 2008). Huh et al. have concluded that in case of formula-fed infants, preschool obesity odds were significantly higher by 4 months in case of solids before 4 months, but the signal was smaller in case of breastfed infants (Huh et al., 2011). The same cohort by Sloan also indicated more weight gain among those who were weaned early which supported the idea that early solids are able to facilitate the intake of more energy and speedy growth during infancy (Sloan, 2008).[15]

Yet, there are a few bigger syntheses and cohort studies that make the interpretation of earlier is heavier a little more difficult. The re-analysis of a series of birth cohorts by Vail et al. indicated that in the situation of confounding (reverse causality where weaning of smaller infants happens earlier) there is an overall neutral impact of introduction of solids between 3 and 6 months on growth (Vail et al., 2015). Similarly, the systematic reviews demonstrate inconsistent findings based on the status of breastfeeding, socioeconomic environment, and outcome outcome assessed (short-term weight gain versus obesity risk in the long term) (Verga et al., 2022). Briefly, the early solids may be associated with faster early growth, however, the causality and maintained effect depends on the situation.[16]

Locality and resource environment have a significant impact on results. Low- and middle-income countries (LMICs) often highlight delayed or inadequate complementary feeding (after six months or low dietary diversity) as the primary cause of undernutrition and ineffective weight gain (Ajmal et al., 2022; Metwally et al., 2022). Interventions that enhanced the timely adoption of complementary feeding and dietary diversity in Egypt and Pakistan resulted in quantifiable weight gains and a decrease in the number of underweight (Metwally et al., 2022; Ajmal et al.,

2022). This is contrary to most of the findings in high income countries, which may consider early introduction to be the principal worry due to excess weight and not the growth faltering.[17]

These discrepancies in research design are the reason why some findings are contradictory. A randomized trial that prescribes the timing of introduction (e.g., 4 vs. 6 months) frequently found that smaller or no long-term effect of introduction existed on weight at 12 months, whereas observational cohort studies (which are susceptible to reverse causality and confounding) tended to show stronger associations (Pluymen et al., 2018; Vail et al., 2015). Timing of measurement is also important: early weight velocity changes are often identified during short trials (usually the first years after weaning) and may wear off during the next year. The nature and quality of complementary food also plays a critical role, as the rapid weight gain caused by introducing energy-rich but low-nutrition foods cannot be improved by the higher nutrient density of diverse diets, whereas nutrient-dense diets can be used to promote healthy catch-up growth (Verga et al., 2022; Gol and colleagues).[18]

Mechanistically, infants can boost caloric intake and regulate feeding behaviors and especially formula-fed infants who do not self-regulate energy intake when solids are introduced, can raise caloric intake and adjust feeding behavior (Huh et al., 2011). On the other hand, poor complementary feeding after six months means that infants will remain breastmilk- or low-energy staples-dependent, which will expose them to the risk of growth faltering in LMICs (Ajmal et al., 2022).[19,20]

Combined, the international literature indicates that there is no universal rule: the practice and timing of weaning have to be adjusted to feeding realities (breastfed vs. formula-fed), food quality and resource environment. Timely introduction of a variety of nutrient-rich complementary foods at approximately six months old in LMICs should help prevent undernutrition, whereas very early (below four months) introduction should be discouraged, particularly in infants fed formula, to help avoid excess early weight gain and subsequent risk of obesity. Future studies must focus on randomized and longitudinal studies that sequentially integrate timing, dietary quality, breastfeeding, and long-term growth and metabolic results.

Conflict of study: nil

Limitation of study: the study had been conducted in single center, and had limited population and hence results cannot be generalized on population level.

Conclusion:

This research clearly shows a correlation between weaning patterns and weight gain for children aged 1 to 2 years. Infants who were breastfed for six months and appropriately weaned enjoyed a significantly higher weight gain and improved nutritional status relative to infants who were breastfed for too long or too short periods. For a number of reasons, rearing practices including maternal education and socioeconomic status had a notable effect weaning practices and growth outcomes. Gender differences were practically absent. The benefits of weaning, especially on infant health, could be more pronounced through community maternal education coupled with nutrition programs evidentially geared toward combating under nutrition for children, age five and below.

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