Original Article

Predictors of Weight Velocity in the First 6 Months of Life in a Rural Block of West Bengal: A Longitudinal Study

Arista Lahiri, Arup Chakraborty
Department of Community Medicine, Medical College, Kolkata, West Bengal, India

Abstract

Background: Monthly weight gain (weight velocity) is important in early infancy, with several factors affecting and interacting within the healthy-born children. The current study aims to estimate on the effects of different factors on the trend of weight gain during the first 6 months of life. **Methods:** A longitudinal (repeated-measures) study was conducted on the 42 nonlow birth weight healthy children born in selected rural areas during December 2016. Infant feeding attitude, effective breastfeeding, timely feeding, and episodes of diarrheal illnesses were the major predictors along with the age of the children on the weight velocity in a sex-dependent repeated-measures analysis using Generalized Estimating Equations. **Results:** Mothers of the children were mostly below the mean age of 20.1 years (60.905%), majority being homemakers (71.429%). Majority (73.809%) had a better infant feeding attitude. The mean birth weight for male infants was 2.941 (±0.299) kg and females 2.938 (±0.352) kg. Age of the child, birth weight, timely feeding, and episodes of diarrheal illnesses had statistically significant effect on monthly weight gain. Feeding breast milk only proved advantageous for males. **Conclusions:** Effectively, only breastfeeding, timely feeding, and prevention of diarrheal episodes were the most important recommendations at the field level.

Keywords: Exclusive breastfeeding, infant, longitudinal studies, weight gain

Introduction

Growth monitoring in terms of monthly weight measurement of the newborn is an integral part of the comprehensive community-based care and also a key cost-effective intervention within the pragmatic purview of "life cycle approach" for continuum of care for the community.[1,2] Growth monitoring is done by plotting the weights of the babies in the World Health Organization (WHO) growth chart, with the notion that monthly weight gain also known as weight velocity is more important.[3-5]

The pattern of weight gain among healthy born infants is different from that of the low birth weight (LBW) infants with LBW infants having a better catch-up growth.[6-9] Although LBW infants are focus group in many interventions, healthy born infants need the attention as well because with differing weight gain pattern healthy born infants can contribute to the burden of malnutrition heavily. First 6 months during infancy is very important in terms of growth in light of the findings of many researchers who have investigated the relationship of the different determinants with the trend of weight gain in early infancy.[10-12]

In simple terms, factors that are very important for early infancy weight gain can be summarized to exclusive breastfeeding (EBF), birth weight, and sex of the baby to be important.[3,13,14] The social cognitive theory in this regard enforces the concept of infant feeding attitude to be another important factor, as this can have effect on the different aspects of feeding practices.[15,16] It is even more important for the primimothers because first childbirth often builds the basic attitude regarding child feeding ultimately having effect on growth of the children. The current study was therefore conducted to understand the effects of different factors related

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Address for correspondence: Dr. Arup Chakraborty, 240, Golpukur Road, P.O - Baruipur, Distt-24 Parganas (South), Kolkata, West Bengal, India.
E-mail: dr.arupchakraborty@gmail.com

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to growth in infancy on the trend of weight gain during the first 6 months of the healthy born babies.

Methods

Study design and participants

A longitudinal follow-up study was conducted among infants of villages under two preselected sub-centers in a community development block. Children born at term to primigravida mothers through normal vaginal delivery in December 2016 were recruited and followed-up in 6 visits, that is, one visit on completion of a month till attaining the age of 6 months. However, twins or children born LBW or having any diagnosed disorders such as any congenital anomaly and metabolic diseases were excluded from the study. Children whose mothers were severely ill or had a complicated childbirth were also not included in the study.

Sampling and recruitment

Sampling in view of a repeated-measure follow-up study pertains to the temporal clustering and the recruitment of participants is usually a temporally prospective phenomenon till the desired sample size is reached within the stipulated time frame for recruitment. The minimum required sample size was calculated based on the previous monthly weight gain pattern in the first 6 months calculated from the observed weights available from subcenter register. The minimum sample size required was calculated by the GLIMMPSE-guided study design calculator[17] at 5% level of significance and 80% power of the study. The optimum sample size at this level was obtained with scale variability 2 and scale mean to be 0.5. Thus, the minimum required sample size was obtained to be 34 for 6 repeated measures, that is, without any missing observation. On inflating, the sample size by 25% for loss of efficiency due to probable missing values in observations the sample size was 43. Therefore, the required sample size for assessing the temporal effect of the predictors in weight gain of the infants was between a minimum of 34 to an optimum of 43. Children born on the December 2017 in the study area were line-listed and recruitment was done on the basis of inclusion and exclusion criteria mentioned and 42 children were included. In case of more than one child being eligible from a single family, one child from that family was selected randomly.

Study variables and data collection

Monthly weight gain was considered the time-dependent (repeated measure) outcome in the study. Infant feeding attitude, birth weight of the child, sex of the child, and prelacteal and colostrum feeding were time-invariant predictors. Effective-only breastfeeding (i.e., only breast milk and nothing else in last month), timely feeding (feeding at least eight times a day and on demand), and episode of diarrheal illnesses during the past month were considered time-dependent predictors directly affecting growth (weight gain) of the infant. The weight of the infant was measured with the help of a standardized salter weighing scale. The mothers were interviewed with a predesigned pretested validated schedule of infant feeding attitude – the Iowa Infant Feeding Attitude Scale (IIFAS)[18,19] at the baseline. The IIFAS was translated to Bengali and then backtranslated to English by different experts. Reiterative translation–backtranslation process was used till an agreement level of 10%. Validation of the tool was done before the current study. During the follow-up, mothers were enquired about feeding practices and occurrences of episodes of diarrheal diseases during the past month.

Statistical analysis

The data collected was compiled in Epi Info™ 7 (Epi Info™, Centers for Disease Control and Prevention, USA) and analyzed in STATA 14.2 software (Stata Corporation, College Station, TX, USA). The data were analyzed with marginal population model – Generalized Estimating Equations (GEE)[20,21] to find out the effect of the predictors with change in time. Robust standard errors were used to achieve an unbiased model-fit, especially with respect to outliers. Effect size was estimated in terms of the coefficients obtained and the 95% confidence intervals (95% CI) were reported. $P < 0.05$ was considered statistically significant. While infant feeding attitude was incorporated to be a direct predictor of weight gain itself, it was conceptualized to be associated with several sociodemographic factors, which was tested with the help of Chi-squared test. The feeding attitude is in turn thought to affect effective breastfeeding, colostrum and prelacteal feeding, even occurrences of diarrheal episodes. The interaction in between was considered and the model was compared to GEE model without the interaction terms. Although both the models showed overall fit ($P\chi^2 < 0.001$), model with interaction did not differ from the main model significantly. Therefore, the primary GEE model with robust standard error estimation was accepted for building an overall model and two comparative models for sex-specific effects.

Ethical considerations

Ethical permissions were obtained from the Institutional Ethics Committee of Medical College and Hospital, Kolkata. Following the administrative approvals, data collection was conducted maintaining confidentiality and on obtaining written consent from the respondent mothers.

Results

Background information and infant feeding attitude of the mothers

The background information of the infants included and mother's attitude regarding infant feeding are given in Table 1. The mean age of the mothers was 20.09 years (±1.56 years). Male (52.38%) and female (47.62%) infants were comparable in numbers. While 71.43% of the respondent mothers were homemakers, 73.81% had at least primary level of education. In comparison, majority of the fathers were farmers or manual laborers (71.43%), with 90.48% educated at least up to primary level. Most of the infants were from joint family background (64.29%).

Table 1: Infant feeding attitude and different sociodemographic characteristics ($n=42$)

Sociodemographic characteristics	Category	Infant feeding attitude		Total (%)	Adjusted OR (95% CI)
		Better (%)	Poor (%)		
Total		31 (73.809)	11 (26.191)	42 (100.000)	-
Mother's age	Below mean age	17 (40.476)	9 (21.429)	26 (61.905)	0.409 (0.069-2.419)
	Mean age and above	14 (33.333)	2 (4.762)	16 (38.095)	
Gender	Male	19 (45.238)	3 (7.143)	22 (52.381)	6.789 (0.846-54.451)
	Female	12 (28.571)	8 (19.048)	20 (47.619)	
Religion	Hinduism	18 (42.857)	6 (14.286)	24 (57.143)	2.402 (0.338-17.068)
	Islam	13 (30.952)	5 (11.905)	18 (42.857)	
Mother's occupation	Homemaker	23 (54.762)	7 (16.667)	30 (71.429)	0.685 (0.092-5.114)
	Other	8 (19.047)	4 (9.524)	12 (28.571)	
Mother's education	Below primary	8 (19.047)	3 (7.143)	11 (26.190)	0.174 (0.013-2.276)
	Primary and above	23 (54.762)	8 (19.048)	31 (73.810)	
Father's occupation	Farmer and laborer	26 (61.905)	4 (9.524)	30 (71.429)	14.539 (1.836-115.154)
	Business	5 (11.905)	7 (16.666)	12 (28.571)	
Father's education	Below primary	2 (4.762)	2 (4.762)	4 (9.524)	0.108 (0.005-2.190)
	Primary and above	29 (69.047)	9 (21.429)	38 (90.476)	
Family type	Nuclear	10 (23.810)	5 (11.905)	15 (35.714)	0.320 (0.023-4.396)
	Joint	21 (50.000)	6 (14.286)	27 (64.286)	

OR: Odds ratio, CI: Confidence interval

Among the mothers, 73.81% had a better infant feeding attitude as measured by IIFAS at the beginning. Despite the statistical insignificance in association, young mothers (0.409), homemakers (0.685), nuclear family background (0.320), and lower status of education in mothers and fathers (0.174 and 0.108, respectively) had a lower odds of better feeding attitude. However, infants whose fathers were employed as farmers or manual laborers had a statistically significant odds of 14.539 (95% CI: 1.836–115.154) of having a better attitude to feeding from the mothers.

Weight trend and weight velocity of the infants

The mean birth weight of the infants was 2.939 (±0.321) Kgs. Male children had a mean weight of 2.941 (±0.299) kg and females 2.938 (±0.352) kg. The Box and Whisker plots in Figure 1a and b depict the trend of measured weights in the first 6 months of life and the weight gain in each month, respectively. In every month, weights of the male children were comparatively higher than the female children with observable difference during later months. The dispersion in month-wise weight gain was more with male infants. Similar to the trend of weight-for-age observed in Figure 1a, the weight gain was more for males as compared to females. Interestingly, the weight gain during the 3rd month was higher in females in terms of the maxima though the median weight gain (male: 0.9 kg, female: 0.85 kg) was estimated to be higher in males. During the 4th month of life, the median weight gain (male: 0.775 kg, female: 0.875 kg) in the female children was observed to be higher, while in the 5th month, they were almost comparable (male and female: 0.7 kg). As was observed for weight after 6th completed month, the weight gain during this month (male: 0.7 kg, female: 0.5 kg) was clearly favoring the male infants as evident in Figure 1b.

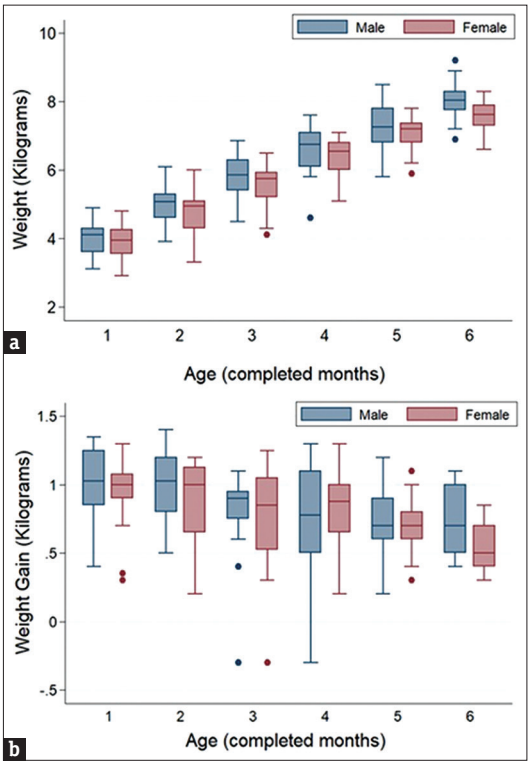

Figure 1: Sex-specific comparison of weight of the infants and weight velocity during the first 6 months (male = 22, female = 20). (a) Weight of the infants up to 6 months of age. (b) Weight velocity of the infants up to 6 months of age

Feeding and illness of the infants

In the 2nd month, all the infants were only breastfed, with 85% of female infants and 86.27% of males were fed timely. No male infants suffered any episodes of diarrheal disease during

the 2nd and 6th month, though in the 6th month 81.82% of the male infants were only breastfed with 95.46% male infants fed timely. During the 4th month, 5% female children suffered from at least one episode of diarrheal diseases which was lowest in all the 6 months among the female children. During this month, 80% of females were only breastfed and 90% were fed timely, which were better compared to males during the month.

Predictors of weight gain

The different factors affecting the pattern of weight gain per month are summarized in Table 2. The full model with the different direct predictors showed age of the child, only breastfeeding during each month, timely feeding of the infant, and episodes of diarrheal diseases had statistically significant effect on weight gain on the infants during the first 6 months of life. Monthly weight gain in female infants was 0.005 kg (95% CI: −0.068, 0.078) compared to males. With 1 month increase in age the monthly weight gain reduced by 0.057 kg (95% CI: −0.075, −0.038). Children who were only breastfed during each month had 0.097 kg (95% CI: 0.019, 0.175) more weight gain per month. Timely feeding of infants resulted in 0.329 kg (95% CI: 0.239, 0.418) increase in monthly weight gain. With each episode of diarrheal illness in each month, the weight gain is decreased by 0.209 kg (95% CI: −0.308, −0.110).

The factors directly affecting infant weight gain in the first 6 months were further examined separately for males and females. Age of the child, birth weight, timely feeding, and diarrheal episodes were found to be statistically significant with concordant directionality in estimated effect size in the independent GEE models for both the genders. Reduction in monthly weight gain was noted with higher age (male: −0.052 kg [95% CI: −0.077, −0.027] and female: −0.062 kg [95% CI: −0.088, −0.036]) and more episodes of diarrheal illnesses encountered in a month (male: −0.273 kg [−0.403, −0.144] and female: −0.138 kg [−0.262, −0.013]). With each kilogram increase in birth weight, the mean weight gain was increased by 0.154 kg (95% CI: 0.092, 0.216) for male children and 0.291 kg (95% CI: 0.220, 0.361) for females. Infants who were fed timely had a higher weight gain by 0.312 kg (95% CI: 0.177, 0.448) and 0.317 kg (95% CI: 0.191, 0.442), respectively. While a poor infant feeding attitude manifested in a statistically significant decrease in weight gain by 0.205 kg (95% CI: −0.327, −0.082) in females, effective breastfeeding had a significant increase in weight gain by 0.193 kg (95% CI: 0.088, 0.298) in males only. Although both prelacteal and colostrum feedings showed positive effect, it did not achieve statistical significance in the current model.

Discussion

The growth velocity measured in terms of weight gain per month of advancement in life and also the weight trends observed from Figure 1a and b, were comparable to the WHO standards for boys and girls.[3,22] The studies by Carling *et al*.[13] and Otaigbe *et al*.[23] focused on the importance of EBF during the first 6 months. The results by Faisal *et al*.[24] was in consonance with the current study, i.e., with each month of effective breastfeeding weight velocity increased significantly. In consonance with the conceptual background and work of other researchers on malnutrition of infants,[25-27] episodes of diarrhea resulted in decreased growth velocity.

While prelacteal feeding is considered not to be healthy, still marginal increase in growth velocity was observed which was not statistically significant. It may most likely be because, infant feeding attitude of the mother works as a potential confounder, the analysis of which is beyond the scope of the current article. Better effect of colostrum feeding though insignificant statistically was consistent with the conceptual framework. One potential reason for this statistical insignificance is that colostrum feeding mostly affects the health of the newborn during the neonatal period.[28] Birth weight in the statistical models suggested of an increase in weight gain with each kilogram increase in birth weight. The fact that babies with birth weight between 2.5 and 4 kg have a similar growth pattern favoring higher birth weight in this range evident from the Multicentre Growth Survey.[3,22,23]

The current study did not find any significant effect of Infant Feeding Attitude, measured once at the beginning, on the weight velocity except in females. It can be argued that latent measurements like feeding attitude could be measured on each follow-up marking the variability with time. But with a

Table 2: Generalized estimating equations model with direct predictors of infant weight gain (*n*=42, *N*=252)

Factors	Overall		Male		Female	
	Weight Velocity (95% CI)	*P*	Weight Velocity (95% CI)	*P*	Weight Velocity (95% CI)	*P*
Sex (female)	0.005 (−0.068, 0.078)	0.890	-	-	-	-
Age of the infants (completed months)	−0.057 (−0.075, −0.038)	<0.001	−0.052 (−0.077, −0.027)	<0.001	−0.062 (−0.088, −0.036)	<0.001
Birth weight (Kg)	0.232 (0.172, 0.292)	<0.001	0.154 (0.092, 0.216)	<0.001	0.291 (0.220, 0.361)	<0.001
Infant feeding attitude (poor)	−0.042 (−0.173, 0.088)	0.524	0.011 (−0.152, 0.174)	0.897	−0.205 (−0.327, −0.082)	0.001
Prelacteal feeding (yes)	0.040 (−0.054, 0.134)	0.400	0.114 (−0.084, 0.312)	0.261	0.028 (−0.060, 0.116)	0.531
Colostrum feeding (yes)	0.014 (−0.113, 0.142)	0.829	0.148 (−0.019, 0.315)	0.082	0.031 (−0.072, 0.134)	0.555
Breastfeeding only (yes)	0.097 (0.019, 0.175)	0.015	0.193 (0.088, 0.298)	<0.001	0.012 (−0.106, 0.130)	0.841
Timely feeding (yes)	0.329 (0.239, 0.418)	<0.001	0.312 (0.177, 0.448)	<0.001	0.317 (0.191, 0.442)	<0.001
Episode of diarrheal illness	−0.209 (−0.308, −0.110)	<0.001	−0.273 (−0.403, −0.144)	<0.001	−0.138 (−0.262, −0.013)	0.030

n: Number of participants (sample size), *N*: Total number of observations (data points)

monthly follow-up of total 6 months, the measurement in the latent continuum is unlikely to shift radically. On the other hand, the marginal changes of feeding attitude are manifested on the time-varying predictors such as breastfeeding and illness episodes, thus conceptually allowing a spectrum of time-dependent interactions. Such interactions did not hold true statistically and neither the models that included them. However, to find out the effect of feeding attitude along with the potential interactions, the required power would be very high. The different sociodemographic factors such as parents' education and occupation were conceptually thought as factors that can have direct bearing on illnesses and thereby weight-gain, but they could not be studied statistically at the current power. In further research, this can be overcome with a higher power and multicenter design.

An attempt was made to quantify the effect of the major predictors of infant weight velocity. The potential recommendations that emerged from this community-based longitudinal study were effectively providing only breast milk to the child is helpful even if discontinued earlier since each month of successful breastfeeding independently improves weight gain. Furthermore, better feeding attitude and hygiene practices can definitely lead to even lesser episodes of diarrheal illnesses, which in turn will be helpful in growth. Although there may be some other factors which could influence the weight velocity, the current study focused on the major predictors of infant growth and quantifies the effect on the concept of weight gain pattern.

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Conflicts of interest

There are no conflicts of interest.

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