Journal of Biostatistics and Epidemiology

J Biostat Epidemiol. 2024;10(4): 421-433

DOI: https://doi.org/10.18502/jbe.v10i4.18523

Original Article

Unraveling Growth: Analyzing the Key Factors Influencing Growth Rate of Children Under Two Years

Fatemeh Atarodi[1], Nouraddin Mousavinasab[1], Danie Zamanfar[2], Ramezan Fallah[3], Simin Moadikhah[4], Soheila Moadikhah[5*]

[1]Department of Biostatistics, Faculty of Health, Mazandaran University of Medical Sciences, Sari, Iran.
[2]Department of Pediatrics, Sari Bu Ali Sina Hospital, School of Medicine Diabetes Research Center, Mazandaran University of Medical Sciences, Sari, Iran.
[3]Department of Epidemiology and Biostatistics, School of Medicine, Zanjan University of Medical Sciences, Zanjan, Iran.
[4]Faculty of Medicine, Innovative Medical Research Center, Mashhad Medical Science, Islamic Azad University, Mashhad, Iran.
[5]Mashhad Medical Science, Islamic Azad University, Mashhad, Iran.

ARTICLE INFO

Received 19.05.2024
Revised 25.06.2024
Accepted 06.08.2024
Published 15.12.2024

Key words:
Children under 2 years old;
Growth;
Transmission model;
Marginalized transfer model;
Random effects model;
Longitudinal data

ABSTRACT

Introduction: According to the significance of children in the culture, economy, and human resources for the country's future, their growth in the first 2 years and its influencing factors are crucial for the country's progress. The study investigates and identifies the factors influencing growth rates through the transitional and marginal longitudinal models.
Methods: This retrospective cohort study evaluates the determinants that impact children's growth in their first two years. We used longitudinal models (transmission-random-marginal) and SPSS software version 26. the Corrected Quasi Likelihood under the Independence Model Criterion (QICC) was used to evaluate the models, with a significance level of 0.05.
Results: The mean weight was 3257 ± 491 grams at birth and 12105 ± 1633 grams at two years old. The mean height was 50.4 ± 2.6 cm at birth and 87.6 ± 0.3 cm at two years old. Factors such as the child's gender, place of residence, mother's education, type of breastfeeding, gestational age, singleton births, and mother's weight all significantly affect children's growth. Evaluating these factors using a marginal model was also meaningful. The results from the transfer model indicate that when controlling for the child's previous weight, factors such as the child's gender, mother's age, and exclusive breastfeeding with breast milk impact weight growth in children. Similarly, when controlling for the child's previous height, the child's gender, mother's age, and level of education significantly influence children's height. A comparison between the transfer and marginal models revealed that the transfer model provides a better fit.
Conclusion: A comparison between the transfer and marginal models revealed that the transfer model provides a better fit. According to the results of this study, adequate training on factors affecting children's growth should be provided to both mothers and health workers, which may reduce the risk of developing disorders.

*.Corresponding Author: moadikhahsimin@gmail.com

Introduction

Children play a significant role in shaping the culture, economy, and human resources of the country's future. The first two years of a child's life are crucial for their growth, and providing and preserving their health in the healthcare system is necessary. Regularly measuring weight, height, and head circumference and comparing them with standard growth trajectories is practical for the early detection of growth disorders and timely intervention is increasingly important. Nowadays, growth charts based on data from developed countries such as England, Sweden, and the United States are utilized to assess children's growth characteristics and physical features.[1] Approximately 226 million children worldwide suffer from stunted growth.[2] Children under 5 years are the most vulnerable members of communities, and it's crucial that we prioritize their well-being.[3] To improve child nutrition and development, it's essential to consider the impact of different factors on growth rates, including socioeconomic and nutritional issues that contribute to low birth weight, stunted growth, and slow cognitive development in early childhood, especially in developing countries with high malnutrition rates.[4-6] A drop in weight growth is an essential sign of a growth disorder, especially in the first year of life. This is particularly concerning because the brain develops the most in the first six months. It can lead to mental disabilities and a reduction in intelligence quotient (IQ), which can be a burden for both the family and society.[7] During every visit, it's important to carefully assess the children's weight, length, and head circumference to monitor their growth and identify deviations from the normal growth pattern.[8] It is essential to correctly implement new strategies by perceiving health threats and evaluating society's performance in the health sector. Moreover; using advanced statistical methods to analyze children's growth curves and identify influencing factors is beneficial.

Methods

This study is a retrospective cohort analysis utilizing data from the Ministry of Health's system for children under two years old who visited health service centers in North Khorasan province between March 2020 and March 2024. A checklist was utilized to gather data. Approximately 1,800 cases were examined, with samples selected using a stratified sampling method (considering each city as a separate class) and then chosen from each city based on the population size. If a child has not been examined in the 10 ages mentioned later or if their records are transferred to another province, they will be excluded from the study. This exclusion also applies in cases of circumstances such as death, or the child being unable to participate in the examinations. Through this approach, the health records for 601 children, who received care across 10 sessions, were reviewed. Demographic information of their parents was recorded including age, education, occupation, maternal weight at the beginning and end of pregnancy, and gestational age, along with child specifics like sex, nutrition exclusivity, feeding type, weaning age, and weight and height measurements at various ages (birth, 1, 2, 4, 6, 9, 12, 15, 18, and 24 months.)

The general way to assess children's growth is by measuring their weight, height, and head circumference.[11]

The current study aims to identify the key factors influencing the growth of children under two years of age. To achieve this, the study utilizes the analysis of longitudinal models, including transfer and random effects models, as well as marginal models and their comparison was done. Additionally, it compares the efficiency of different models using the QICC (Corrected Quasi Likelihood under Independence Model Criterion). The collected information was entered into Excel. After adjusting the data to meet the established objectives for modeling and analysis, the relevant information was input into SPSS version 26 software. A significance level of 0.05 was used for all analyses. Tables and appropriate statistical indicators such as mean, median, and standard deviation have been used in data description, and chi-square and Mann-Whitney tests have been used in data analysis.

All information was obtained with permission from the Vice-Chancellor of Research and Technology at the university, as per the code of ethics specified by IR.MAZUMS.REC.1401.16080. Data regarding children from birth to 24 months was collected from the files of two-year-olds in the SIB system, without including any personal information. The study and its findings will remain confidential and will not be shared with unauthorized individuals.

DATA Analysis

Transmission model

The transmission model is an extension of the generalized linear models to describe the conditional distribution of each response. y_{ij} as a known function of the previous response variables $y_{i1}, y_{i2,} \cdots, y_{ij-1}$ and the independent variable x_{ij} . Transmission models or Markov models take into account the correlation problem between the responses of each sample by modeling the response in the present to the condition of the reaction in the past. In other words, generalized linear models, if the past observations of unit *i* with:

$$H_{ij} = \{y_{i1}, y_{i2}, ..., y_{i(j-1)}\}$$

Conditional expectation of observing *i* with:

$$\mu_{ij}^c = E(Y_{ij} \mid H_{ij})$$

and its conditional variance with:

$$v_{ij}^c = c(y_{ij}, \phi) \mid H_{ij})$$

to show.

The most common model used in the transmission model is the use of the Markov chain, in which the current response. y_{ij} to the condition of H_{ij} depends only on the previous response q. The number q is referred to as the order of the model. For example, in a first-order transmission model, we have (9):

$$h(\mu_{ij}^c) = h(E(Y_{ij} \mid Y_{i(j-1)}) =$$
$$x'_{ij}\, \beta + \alpha(Y_{i(j-1)} - x'_{i(j-1)}\beta)$$

Marginalized transfer model

To determine the factors affecting children's weight, since the growth rate of children is a quantitative variable and is repeated over time, as a result, the observations of each person are correlated. Therefore, for the simultaneous modeling of the effect of independent variables on the dependent variable, a model should be used that examines the correlation between the observations of each individual. The marginal model is one of the statistical methods for longitudinal data analysis, which by considering the correlation between observations, gives more accurate estimates of the effect of factors on children's growth.

The main feature of marginal models is that they model the response variable on the auxiliary variables, apart from the intra-unit correlation structure.[10] A marginal model is characterized by three basic assumptions:

The marginal Mean of the response $E(Y_{ij} \mid X_{ij}) = \mu_{ij}$ depends on auxiliary variables x_{ij} through the correlation function h, that is, $h(\mu_{ij}) = x'_{ij}\beta, j = 1,2,...n_i, i = 1,2,...m$ where h is a specific function such as a logarithm or logit.

The marginal variance itself is a function of the marginal mean and the scale parameter ϕ , Ie $\text{var}(Y_{ij} \mid X_{ij}) = \phi v(\mu_{ij})$ where v is a specific function and a parameter that needs to be estimated in some cases.

The third hypothesis considers the non-independence between longitudinal data by modeling the relationship between repeated measures. In this characteristic, the covariance between repeated responses is shown as a function of marginal means, scale parameter, and α (pairwise correlation between repeated measures):

$Corr(y_{ij}, y_{ik}) = \rho(y_{ij}, y_{ik}; \alpha)$

random effects model

In this model, the assumption of correlation among the repeated responses is shown by employing different regression coefficients in different subjects. In the random effects model, the response is assumed as a function of explanatory variables with regression coefficients that are different from one subject to another. These differences are due to unmeasured factors that result from natural and genetic factors. For example, consider a simple linear regression for child growth, where the coefficients of the model express birth weight and growth index. Children have different weight and growth indexes at the time of birth due to environmental and genetic factors. For this example, a random coefficients model is appropriate, because there are uncontrollable factors such as environmental and genetic factors that vary from one subject to another as a random variable.

The general form of the random effects model was proposed as follows:

$$Y = X\beta + Z\alpha + \varepsilon$$

where Y is a 1×N column vector of sampling for subjects, X is a P×N matrix for fixed effects, β is aP×1 fixed effects vector, and Z is a P×N matrix for random effects and α is a 1×q random effects vector. α has a normal distribution with zero mean and variance-covariance matrix. εs are within-subjects errors. It is also assumed that ε and α are independent of each other. In this model, if the value of the Z matrix is equal to zero, it becomes a fixed effects model.[10]

Results

601 children under 2 years were studied, of which 304 (50.6%) were boys and 297 (49.4%) were girls.

The mean age for fathers was 34.3±5.9, and 21.6% had higher education.

The mean values for mothers' age, weight, and height were 29.4±6.1 years, 65.4±11.7 kilograms, and 160.3±5.7 centimeters, respectively.

27.5% of mothers had advanced education.

Out of 601 mothers, 82.9% were housewives.

41.8 %of mothers had a normal range of BMI.

9.5% of the pregnancies were unwanted. 26

mothers (4.3%) need intensive care due to inappropriate weight, comorbidities, and being older than 35 years. During pregnancy, 18.5% of mothers had diseases (i.e., diabetes, thyroid disorder, and asthma). Among mothers, 6.7% had an intrauterine age of less than 37 weeks (Table 1).

The mean weight for girls at birth was 3213±507 grams, and at 24 months it was 11882±1569 grams. Their average height was 50.1±2.7 centimeters at birth and 86.8±3.9 centimeters at 24 months. The average head circumference was 34.6±1.5 centimeters at birth and 47.7±1.4 centimeters at 24 months.

The average measurements for weight, height, and head circumference of boys at birth were 3300±471 grams, 50.6±2.5 cm, and 35.0±1.3 cm, respectively. At 24 months, the measurements were 12324±1667 grams (weight), 88.3±3.8 cm (height), and 48.6±1.4 cm (head circumference).

The study shows a significant difference in weight between genders, with boys being 356 grams heavier than girls (marginal model,

Table 1. Frequency distribution of demographic variables of households with children under 2 years of age in North Khorasan

Variables	Groups	Frequency	Percentage
Gender of children	Boy	304	50.6
	Girl	297	49.4
Mothers' education	Undergraduate	336	72.5
	graduate	165	27.5
Fathers' education	Undergraduate	471	78.4
	graduate	130	21.6
Mothers' occupation	employee	103	17.1
	housewife	498	82.9
Fathers' occupation	employee	219	38.9
	Self-employment	382	61.1
Exclusive Brest feeding	Breast milk	426	70.9
	Formula and breast milk	135	22.5
	Formula	40	6.7
Mothers' age	Under 25	142	23.6
	25-34	335	55.7
	+35	124	20.6
Mothers 'Body Mass Index	Underweight	27	4.5
	normal	251	41.8
	Overweight	220	36.6
	Obese	89	14.8
	Undetermined	14	2.3
singleton birth	Only one	577	96
	Twins	24	4
Intrauterine age (weeks)	Mean±SD	38.6±1.52	
Mother's weight(kg)	Mean±SD	65.11±4.7	
Mother's height (cm)	Mean±SD	160.5±3.7	

Table 2. Marginal models in estimating factors affecting the weight of children under two years of age in North Khorasan Province

Variable	Group	Estimation	Standard Error	Confident Interval		P-value
				Lower Limit	Upper Limit	
Constant		-2/435	1/594	-5/660	0/592	0/112
Residential Area	Shirvan	0/655	0/178	0/305	1/005	0/001
	Bjnoord	0/474	0/192	0/097	0/851	0/014
	Faroj	Reference				
Gender of child	Boy	0/356	0/075	0/209	0/504	<0.001
	Girl	Reference				
Mother's age (Years)	Under 25	0/195	0/107	0/016	0/406	0/070
	25-34	0/247	0/095	0/062	0/432	0/009
	+35	Reference				
Mother's education	graduate	0/174	0/077	0/023	0/325	0/024
	Undergraduate	Reference				
singleton birth	Only one	0/602	0/248	0/116	1/088	0/015
	Twins	Reference				
Exclusive feeding	Has	0/663	0/292	0/090	1/236	0/023
	Does not have	Reference				
Mother's job	Employed	0/025	0/091	-0/154	0/205	0/070
	Housekeeper	Reference				
Exclusive Brest feeding	Breast milk	0/387	0/146	0/065	0/710	0/019
	Formula and breast milk	0/474	0/191	0/098	0/850	0/013
	Formula	Reference				
Intrauterine age (weeks)		0/074	0/029	0/017	0/131	0/011
Mother's height (cm)		0/030	0/007	0/015	0/045	<0.001
Mother's weight(kg)		0/012	0/004	0/004	0/019	0/003

p<0.001). Additionally, intrauterine age had a significant influence on weight (p<0.001), with a 74-gram increase per week intrauterine. Furthermore, children who were breastfed have higher weight than those who were fed formula during infancy (p=0.027), and children who received both types of feeding gained more weight than those who only consumed formula, with a significant difference. (p=0.005) (Table 2)

In the analysis using marginal modeling, it was determined that the residential area significantly impacts height. Boys were found to be 1.27 cm taller than girls, and this difference was found to be statistically significant (p<0.001). Additionally, there was a significant difference in height difference based on the education of mothers and twin status. (P<0.05) (Table 3)

In the analysis, it was found that gender significantly influences head circumference (p<0.001). Boys have a head circumference 0.81 cm larger than girls. Intrauterine growth also significantly influences head circumference (p<0.001). Children fed breastmilk have a greater head circumference size than formula-fed children (p=0.021). Additionally, children

Table 3. Marginal models in estimating factors affecting the height of children under two years of age in North Khorasan Province

Variable	Group	Estimation	Standard Error	Confident Interval		P-value
				Lower limit	Upper limit	
Constant	-	28.9	4.05	20.98	36.86	< 0.001
Residential Area	Shirvan	1.36	0.58	0.235	0.58	0.018
	Bojnurd	1.29	0.61	0.09	2.49	0.035
	Faruj			Reference		
Gender of child	boy	1.27	0.19	0.89	1.65	< 0.001
	girl			Reference		
Mother's education	Graduate	0.45	0.19	0.06	0.83	0.022
	Undergraduate			Reference		
singleton birth	Only one	1.99	0.60	0.81	3.17	0.001
	Twins			Reference		
Exclusive Brest feeding	Breast milk	0.31	0.46	- 0.59	1.22	0.50
	Formula and Breast milk	0.65	0.50	- 0.33	1.63	0.196
	Formula			Reference		
Intrauterine age (weeks)		0.48	0.07	0.33	0.63	< 0.001
Mother's height (cm)		0.09	0.02	0.06	0.13	< 0.001
Mother's weight(kg)		0.03	0.01	0.01	0.05	0.002

with mixed feeding have a larger head circumference size than children only fed formula. (p=0.033)

The results of Goodness of fit in the transmission model indicate that gender has a significant influence on the weight of children. Additionally, the age of the mother has a significant impact on the weight growth of children, with a greater influence observed in mothers aged 25 to 34 compared to those older than 35, showing a difference of 48 grams ($p<0.05$). Furthermore, the type of feeding significantly affects children's weight gains under two years, with exclusive breastfeeding with the strongest impact, followed by mixed feeding, and then exclusive formula feeding. Additionally, the weight of the previous growth period significantly influences weight gain. This indicates that the previous weight holds importance in the study, making longitudinal models suitable for this purpose as they incorporate delayed variables (Table 4).

In longitudinal models, gender has a significant effect on the height of children ($p < 0.001$). Mothers under 25 years of age have children with an average height that is 0.13 cm less than mothers over 35 years (p=0.026). The height of a mother and her level of education significantly influence the growth in height. ($p<0.05$) (Table 5)

Based on Table 6, two marginal and longitudinal models were analyzed to determine the most suitable model for the weight and height of children based on QICC indexes.

Multilevel model

The data in this study has a hierarchical (cluster) structure. Ignoring this structure in the statistical analysis can lead to an increase in type 1 error and a potential underestimation of the standard error of the regression coefficients,

Table 4. Transmission models in estimating factors affecting the Weight of children under two years of age in North Khorasan Province

Variable	Group	Estimation	Standard Error	Confident Interval		P-value
				Lower limit	Upper limit	
Constant	-	0.375	0.41	0.426	1.176	0.359
Residential Area	Shirvan	0.107	0.04	0.023	0.19	0.012
	Bojnurd	0.073	0.05	- 0.02	0.16	0.112
	Faruj			Reference		
Gender of child	boy	0.058	0.02	0.02	0.09	0.002
	girl			Reference		
Mother's age (years)	Under 25	0.030	0.03	- 0.02	0.08	0.242
	25-34	0.048	0.02	0.002	0.09	0.042
	35+			Reference		
Mother's education	Graduate	0.05	0.02	0.01	0.09	0.010
	Undergraduate			Reference		
Exclusive feeding	Has	0.147	0.07	0.02	0.28	0.028
	Does not have			Reference		
Exclusive Brest feeding	Breast milk	0.084	0.04	0.01	0.16	0.026
	Formula and Breast milk	0.142	0.05	0.05	0.23	0.002
	Formula			Reference		
Intrauterine age (weeks)		- 0.012	0.01	- 0.03	0.003	0.121
Mother's height (cm)		0.006	0.002	0.00	0.10	0.001
Mother's weight(kg)		0.002	0.01	0.01	0.003	0.081
Previous Weight		0.942	0.003	0.003	0.948	< 0.001

Table 5. Transmission models in estimating factors affecting the height of children

Variable	Group	Estimation	Standard Error	Confident Interval		P-value
				Lower Limit	Upper Limit	
Constant		5/26	0/96	3/37	7/15	<0/001
Residential Area	Shirvan	0/166	0/12	-0/08	0/41	0/183
	Bjnoord	-0/048	0/13	-0/30	0/20	0/708
	Faroj			Reference		
Mother's education	graduate	0/09	0/04	0/003	0/17	0/041
	Undergraduate			Reference		
Gender of child	Boy	0/175	0/04	0/09	0/26	<0/001
	Girl			Reference		
Mother's age (Years)	Under 25	-0/131	0/06	-0/025	-0/015	0/026
	25-34	-0/053	0/05	-0/156	0/05	0/306
	+35			Reference		
Exclusive Brest feeding	Breast milk	0/011	0/07	-0/14	0/16	0/88
	Formula and breast milk	0/142	0/09	-0/005	0/346	0/057
	Formula			Reference		
Intrauterine age (weeks)		-0/035	0/019	-0/073	0/003	0/070
Mother's weight (kg)		0/001	0/002	-0/003	0/005	0/534
Mother's height (cm)		0/013	0/004	0/004	0/021	0/003
Previous height (cm)		0/970	0/002	0/965	0/974	<0/001

Table 6. Comparison of the marginal model and the transfer model of weight growth and height growth of children under two years in North Khorasan province

	QICC*	
	Marginal model	Transmission model
Weight	9/37970	32/1183
Height	04/645067	24/13678

*Corrected Quasi Likelihood under Independence Model Criterion

introducing variability. In a multi-level model, some variables may not be significant, but in a single-level model without considering random effects, they may be incorrectly deemed significant. Additionally, the single-level model cannot accurately determine the relationship between changes and both individual and time-related factors. When using the ICC index in a multilevel model, it helps in interpreting the amount. In longitudinal studies, hierarchical data can be analyzed with multiple levels. In this study, the first level consists of measurement repetition times, the second level consists of individuals and the third level consists of cities.

$$ICC = \frac{Var\left(v_{0j}\right)}{Var\left(u_{0j}\right)+Var\left(e_{0ij}\right)} = \frac{0.464}{0.464+1.289} = 0.264$$

The randomized effect between individual and time is found to be significant in the Two-level model of children's weight. The Intraclass Correlation Coefficient (ICC) is equal to 0.264. Therefore, the Two-level model was approved for determining the parameters of individual effect, time effect, and independent variables.

In this study, since the results at the third level are limited, the two-level model is equivalent to ICC’s three-level model. As a result, we only reported the random effect results.

Therefore, a multi-level model (three-level) was utilized for longitudinal data. For investigating the three-level structure, we calculated the ICC based on the provided formula.

$$ICC = \frac{Var\left(v_{0k}\right)}{Var\left(v_{0k}\right)+Var\left(u_{0jk}\right)+Var\left(e_{0ijk}\right)} = \frac{0.0001}{0.0001+0.232+1.289} = 0.000065$$

In assessing the Goodness-of-Fit of children's weight, it is important to note that the random effect of residential area (environmental effect) and ICC is very small (0.000065). Therefore, it is necessary to investigate the two-level model of children's weight including different factors, random effects, and variance of unexplained factors.

$$ICC = \frac{Var\left(v_{0j}\right)}{Var\left(u_{0j}\right)+Var\left(e_{0ij}\right)} = \frac{2.145}{2.145+13.562} = 0.136$$

Based on the results for the two-level model of children's height, the interpersonal random effect and the time effect are both significant. Additionally, the obtained ICC value is 0.136, indicating that the two-level model is suitable for estimating the parameters of the individual effect, time effect, and independent variables.

$$ICC = \frac{Var\left(v_{0k}\right)}{Var\left(v_{0k}\right)+Var\left(u_{0jk}\right)+Var\left(e_{0ijk}\right)} = \frac{0.0005}{0.0005+0.232+13.56} = 0.000036$$

According to the results, the random effect between cities is not significant, and the ICC value is very small (0.000036). Therefore, the two-level model of children’s height with different factors and variance of the investigated error factors is more appropriate.

Discussion

The current study is of a longitudinal type to identify longitudinal data in medical studies, referring to the Statistical modeling and application of models: transmission, marginal, and random effects and analysis of them in studying the growth process of children and determining factors affecting growth. The growth trajectory is used to assess the feeding and health status of children worldwide to determine growth disorders.

In our study, the highest prevalence of at least one drop in weight growth in children under two years was 11.8%, with the highest amount of weight loss observed at 12-15 months (3%). The prevalence of at least one stop of weight growth in children was 9.1%, with the highest prevalence found at 12-15 months (3.2%). In the age group of 2-6 months, there was no stoppage of weight growth. The prevalence of at least one stoppage of height growth in children was 12.8%, with the highest prevalence at 0-1 months (3.2%).

In the Panther S study, it was found that Nepali children experienced a decrease in average weight and height at birth and after four months, and significantly at 21 months due to various factors including insufficient mother's nutrition during pregnancy, health status, inadequate complementary food, diarrhea, and unfavorable economic situation.[11] However, there was no drop in weight growth observed in the age group of 2-4 months and no stoppage of weight growth in the age group of 2-6 months.

Gohari et al.'s study in the east of Tehran found no correlation between mothers' education and children's growth disorder. They used regression modeling with randomized effects to study the factors influencing growth, showing that diarrhea, respiratory and urinary infections, teething, cessation of breastfeeding, and other diseases significantly affect children's growth disorders. However, their study also demonstrated that mothers' education has a significant impact on children's growth.[12]

In a study by Farzad Ebrahimzadeh and colleagues, based on a marginal model, it was found that the age and gender of children, as well as mothers' education, influence the weight and length of children. The effect of ordinal variables of birth only affects the height in infancy. Exclusive breastfeeding does not have a significant impact on the weight and height of children under 2 years old.[13]

In a study by Dr. Fallah et al., it was found that gender, residential area, intrauterine age, and singleton birth have a significant effect on the growth velocity of weight. Additionally, the growth velocity of height is influenced by gender, intrauterine age, and singleton birth.[14]

Our study shows that in the transmission model, gender, mothers' age, and type of feeding have a statistically significant impact on weight growth. The weight from the previous stage also affects growth. In the marginal model, gender and breastfeeding have a significant effect on weight gain. As for the goodness of fit in the transmission model, gender and mothers' height influence height, and educated mothers tend to have taller children.

Saeed Shahsavari and colleagues demonstrated that factors such as area of residence, singleton birth, mother's age, and weight affect growth in a goodness-of-fit transmission model. In addition, gender, residence region, singleton birth, mother's weight, and age also have an impact on growth in a marginal model.[15]

Another study in our country indicated that based on a transmission model, stopping the mother's milk, diarrhea, cold, and teething of the child significantly increased the probability of the child's weight disorder.[16] The results from our three-level randomized model show that gender and singleton birth have a significant impact on weight and height growth. However, the type of feeding has a significant effect on weight growth but not on height. In another study, Heidary and colleagues used marginal modeling to demonstrate that children's age, gender, and mother's education level significantly impact weight and height growth.[17] Kholdi and colleagues demonstrated in their study that discontinuation of breastfeeding and transition to formula feeding is the second most contributing factor to weight loss in infants at 6 and 7 months of age.[18] In another study, it is confirmed that children show growth disorders when transitioning from breast milk to other foods.[19-21] Becker and colleagues used a regression model with a randomized effect, which showed that having fever, diarrhea, and the number of calories received have a significant effect on weight changes. Nutritional status has the most effect on growth disorders and problems in children.[22]

Conclusion

Transmission models perform modeling on mean and internal correlation at the same time. This is done by conditioning each projection on other projections or a set of other projections. Due to the sequential nature of longitudinal data, it seems appropriate to use transfer models. In conditional distribution transmission models, each response is expressed as a function known from previous responses and associated variables. According to the results of the present study, in all three models, the height and weight of children have a statistically significant relationship with most of the independent variables in the study. The estimated coefficients of independent variables in marginal and multi-level models are almost the same, but in the transfer model, these coefficients were estimated less.

Suggestions

Future studies should focus on evaluating the growth status of children under 2 or 5 years of age at the provincial level and should explore the various factors affecting their growth. Poor child growth is the consequence of a range of factors that are closely linked to the overall standard of living. These findings can be utilized to inform macro health planning and ensure a greater focus on children's development during critical growth stages. Additionally, interventions for children with abnormal growth curves should be implemented promptly to prevent long-term issues such as malnutrition and stunted growth.

Acknowledgments

The authors are thankful to all the participants who voluntarily participated in this study.

Conflicts of interest

All authors declare that they have no conflicts of interest.

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