Mixed Cured Model Applied to malnutrition variation data of less than 1 year old children

Hamid Reza Ghafarian Shirazi[1,5], Kazem Mohamad [2], Mahmoud Mahmoudi[2], Kurosh Djafarian[3], Abas Rahimi Froushani[4*], Ali Keshtkar [1]

[1]Social Determinants of Health Research Centre, Yasuj University of Medical Sciences, Yasuj, I.R. Iran.
[2]Professor, Department of Epidemiology and Biostatistics, School of Public Health, Tehran University of Medical Sciences, Tehran, I.R. Iran.
[3]Assistant Professor, Department of Clinical Nutrition, School of Nutritional Sciences and Dietetics, Tehran University of Medical Sciences, Tehran, I.R. Iran.
[4]*Associate Professor, Department of Epidemiology and Biostatistics, School of Public Health, Tehran University of Medical Sciences, Tehran, I.R. Iran.
[5]PhD Student, Department of Epidemiology and Biostatistics, School of Public Health, Tehran, University of Medical Sciences, Tehran, I.R. Iran.
*Corresponding Author: rahimifo@tums.ac.ir

Background and purpose: Underweight and malnutrition at birth and the first year of lifetime will have lasting effects on reduction of physical and mental growth, and attenuation of the immune system throughout lifetime. Factors that lead to the incidence or improvement the malnutrition in children during the first year of lifetime include the low birth weight, rank of birth, maternal and child diseases, household economic situation and such that. But this is so important to know which factor and when it will has a greater effect on the incidence and improvement malnutrition in child. The purpose of this study was to examine effective factors, amount and timing of their effect in incidence or improvement malnutrition during first year of life. **Materials and Methods:** In this study, the health information of 1463 children that were born in the first half of 1390, resident in the rural areas of Boyer Ahmad city were collected in a form which was prepared for this purpose by continuing following up from the birth to the end of one year old. This information includes weight, height, and head circumstance in monthly intervals throughout and also maternal age, rank of baby and child nutrition, maternal and child diseases. Malnutrition was defined as weight-for-age with -1SD<Z standard. Changes of weight-for- normal or malnutrition status were examined and recorded in monthly intervals. In case of appearing malnutrition, child was monitoring especially and her/ his malnutrition changes were recording daily. In this study, 1463 children from birth to one year old, which are about fifty percent of overall people that were born in desired area, were examined. The WHO Anthro software was used to determine the malnourished children and also SPSS21 statistical software for overall data analysis and R programing language and its computational package related to the Semiparametic Mixed Cured model (SMCURED) was used for data analysis. Given that the new cases of changes from malnutrition state to healthy state or inverse was very low compared to the total population, calculating of standard deviation was not possible in monthly intervals. Thus, these intervals divided into intervals of "from birth to 3 months of age", "from 3 to 6 months of age" and also "from 6 to 12 months of age". Model was used during each interval once for shift from healthy state at the beginning of the time interval to health until end of the time interval as cured against the health to malnutrition as uncured and once for shift from malnutrition state to malnutrition or healthy until end of interval, and effect coefficients of independent variables was estimated in each stage. **Results:** From 1463 children were followed up, 247 cases (16.9%) were suffered malnutrition during the first year of their lifetime that for 109 cases (7.5%), it was occurred in the first month of life. Among the effective factors on the incidence or improvement malnutrition, low birth weight, child disease, maternal disease, maternal age more than 35 or less than 18 years, number of previous parturition of mother, twin babies, and infant sex have had a significant effect. Amount of effect of each variable on the incidence or improvement malnutrition in children in each time interval was estimated and reported. **Conclusion:** The most important factor affecting on the incidence malnutrition have been child disease, maternal disease, low birth weight and then factors: maternal age, twin babies, the number of previous parturition of mother and infant sex. These findings correspond to similar studies and it is necessary to consider. It should make culture about the number of low parturitions and pregnancy at ages of 18 to 35 years and identical attention to boy and girl. Using the mixed cured model, chance ratio of independent variables on the incidence or improvement malnutrition or invariance of status in each time interval is estimated as independent. One of the problems of this model is that it needs to enough non-cured occurrences to estimate the standard deviation of coefficients of independent variables based on these occurrences.

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1.Introduction

Numerous factors affect the children's health, prenatal factors, such as family health and situation, especially maternal health during pregnancy and parturition, and also factors such as parental education, household per capita income, number of previous parturition, asked baby, parturition type, maternal and child disease during pregnancy and after that, maternal age at birth, number of pregnancies, past abortions, baby sex, weight, height, head circumference at the birth and later, can lead to the incidence of malnutrition, and finally reduction of physical and mental growth, reduction of creativity and attenuation of the immune system and also increase the probability of many infectious and non-infectious diseases. While most of them are recognizable, they are easily preventable. The most important indicators of infant health are weight, height, normal head circumference and suitable growth chart based on the health road. The child health problems show themselves with the incidence of malnutrition and delay in normal growth which has a very slow process and in the early stages is not detectable easily by maternal and health care personnel look. Therefore, it must be determined by using a systematic method. This simple method is called "growth monitoring". Knowledge of factors that lead to appearing malnutrition in children during the first year of lifetime is so important. Also, awareness of effect time of each factor during the first year of lifetime and severity of their effect can be used to prevent the incidence the malnutrition and also improvement of malnourished children. According to the newest studies, 4.15 percent of children under age of 5 suffer from moderate and severe stunting (Bolourian, 2007) and 10.9 percent (540 thousand) suffer from moderate and severe underweight (montazery, 2002). However, the weight of 82 percent of children under age of 5 in our country is not recorded on growth card regularly and in fact their growth is not monitored (Mohamadzade, 2002). In the Keshavarzi and et al (2001) work, only three variables; baby sex, rank of baby birth and father's job have had significant effect on weight-for-age indicator until one year old. That the father's job variable has had a direct relationship with family's economic situation.. In Zeighami et al study (2006) twin, interval between maternal pregnancies, rank of birth and low parental education have been reported as most important factor influencing low birth weight (LBW) newborns. Namkin et al (2008), have been reported that the low birth weight, congenital malformations, birth interval with previous child and father's literacy are the most important factors affecting deaths under one year old. Also, awareness of effect time of each of these factors during the first year of life and its severity can be used to prevent the incidence and also improvement of malnourished children. The purpose of this study is recognition of effective factors and their severity and effect time on the incidence and improvement of malnutrition in children during the first year of lifetime. Above information can determine the attention priorities and planning and cost for children health who make up the future community. Another purpose of this study was to determine a model that can examine effects of effective variables on changes of incidence or improvement of the malnutrition according to the time which by examining various survival models, ultimately mixed cured survival model used as suitable approach for analyzing data with conditions of this study.

2.Material and method

This community-based descriptive analytical study was conducted as longitudinal. Babies that were born during the first half of 1390 and resident in the rural areas of Boyer Ahmad city were assisted in project until achieving the desired sample size and their health information was recorded from the birth to the first year old in a form that was prepared for that purpose. Children was monitored completely during the study time and specific disease conditions and other problems, their healthy changes, nutrition and weight were recorded and examined and the children which were entered the malnutrition state, were examined specifically until recovery. Data collection was carried with the active participation of health workers living in target villages that were trained in relation to the subject and objectives of the project and physicians of the health centers and medical students which pass their internships and apprenticeship in village. Collected data included general information about baby, his/her mother and family and relatively exact times of child changes to healthy status or malnutrition status during the first year of a child's life. This information also included parturition type, maternal and child, maternal age at birth, rank of birth, past abortions, weight, height, head circumference and other health information about mother and child. In this study, infant weighting less than 2500 g was considered as low birth weight (LBW) and having a weight-for-age with $-1SD<Z$ standard as malnutrition. Sample size according to the main purpose of research, study type and by considering the sampling error; a=0.05 and

the maximum estimation error d=0.005 and according to the p=0.1which has been a conservative value of malnutrition in children under age of one year as for the similar studies (Blourian, 1386); the necessary sample size was estimated 1440 people. Due to the possibility of studying children reduction, sample size with additional 5 percent was estimated 1500 people. Finally, 1463 children which were born in the first half of 1390 in rural areas of Boyer Ahmad city were studied from birth to the one year which is fifty percent of overall children who were born in the desired area. To determine the malnourished children, the WHO Anthro software was used and for general analysis of data, SPSS21 statistical software used and for calculations related to the mixed cured survival model analysis, R software package as Semiparametric Mixed Cured Model (SMCURED) (Chao, 2013), R software was used.

In data analysis using mixed cured survival model, effect parameters of independent variables on the incidence or improvement malnutrition were estimated. First, since the amount of assurances that has been the shift from health to malnutrition and/or from malnutrition status to healthy status, was very low in monthly intervals and practically model could not estimate the variance of parameters, thus, intervals were reduced from nine time intervals to 3 time intervals, "time interval from birth to 3 months of age", "time interval from 3 to 6 months of age" and finally "time interval from 6 to 12 months of age". In the first analysis group, all children that have been in the beginning of each healthy interval, if remained healthy until the end of interval, are considered as cured cases and the rest which are suffered malnutrition until the end of interval, are considered as uncured, and the model was run for them and desired parameters in the same interval were estimated to determine the effects of independent variable as cured or not cured. This operation was done the same way for all time intervals. In the second group, all children that were suffered from malnutrition in the beginning of each interval, if remained malnourished until the end of interval, are considered as cured cases and the rest which have changed their status until the end of interval, and have reached a lack of malnutrition state, are considered as uncured, and the model was run for them and desired parameters in the same interval were estimated to determine the effects of independent variable as cured or not cured.

3.Results

General health information of studied children has been as follows: 761 (52%) of children were male; maternal age; 132 (9%) were 18 years old or less, 1205 (82%) of children were 19 to 35 years old and the rest 126 (8.6%) of them were more than 35 years old. The mean and standard deviation of number of parturition was 2.25 and 1.41. The highest percentage of mothers (65.9%) has had 1-2 previous parturitions. 108 cases (7.4%) of these children have had the hospitalization background that the majority of them were related to their birth and the first month of their lifetime. The most frequent cause of hospitalization of RDS has been prematurity and respiratory diseases. About 60.7 % of parturitions were done by natural section and the rest by caesarean section. In total, there were 16 cases (11 per thousand) deaths which all of them had occurred in the first month of lifetime and the majority of them related to the first week of life. Averagely, in this study, mean of baby's weight has been about 500 g less than mean of acceptable weight in country. The estimated coefficients of the independent variables effect in each time interval on the incidence or non-incidence malnutrition in healthy children and/or improvement or non-improvement in malnourished children are presented in tables 1, 2 and 3.

4.Discussion

As it can be seen (Table 1), at the birth until 3 months old interval, being a female child, and maternal and child disease significantly reduce the chance of remaining healthy of healthy children. Also, number of parturition, infant sex and child disease significantly increase the risk of appearing malnutrition in healthy children. Thus, following cases are proposed to resolve the problem: making culture about identical encounter with the gender of the baby, making culture about reduction of the number of parturitions and attending to the child auxiliary nutrition and breastfeeding. Also, maternal age, maternal disease, more parturition, birth weight, child disease and twin or twain babies significantly have been increased the risk of appearing the malnutrition in healthy children.In this time interval, changes from malnutrition status to malnutrition or healthy status (Table 1); maternal disease, infant sex (being female child) and weight at the birth significantly lead to increasing the chance of remaining in malnutrition status in the first three months of life. Also number of high parturition and low birth weight lead to reducing the chance of improvement from malnutrition status in the first three months of life.

Between three and six months old, in changes from healthy status to malnutrition or healthy status (Table 2), maternal disease, numerous parturition, weight at the birth, child disease and number of twin significantly lead to reducing the chance of remaining the children in healthy status in the second three months of life. Also maternal disease, infant sex and

Table 1 - Estimated coefficients of the independent variables in the changes of malnutrition state(1) or normal state(0) to other states (0 0r 1) in time interval from 0 (at birth) to 3 (finished third month)

	Changes	Normal(0) → Normal(0) Cured					Normal (0) → Malnutrition(1) Un Cured				
	Estimated Parameters→	B	Sig	OR	*Lo	*Up	B	Sig	OR	*Lo	*Up
Normal to normal is Cured 0 → 0 0→1	Maternal age	-.108	.696	.898	.523	1.540	.147	.415	1.158	.814	1.649
	Mothers disease	-.258	.034	.772	.541	1.102	.250	.271	1.285	.822	2.007
	Deliveries kind	-.052	.808	.950	.626	1.441	-.048	.737	.953	.719	1.263
	Previous abortion	.091	.776	1.095	.584	2.053	-.255	.258	.775	.497	1.206
	Number of delivery	-.506	.030	.603	.336	1.083	.117	.039	1.122	.859	1.466
	Kind of gestation	.006	.981	1.006	.607	1.669	-.200	.271	.819	.574	1.169
	Baby gender	-2.15	.023	.116	.063	.214	.289	.039	1.335	1.015	1.757
	Birth weight	.270	.097	1.309	.952	1.800	.116	.397	1.122	.859	1.466
	Diseases of children	-.508	.040	.600	.336	1.283	.265	.037	1.304	.971	1.750
	Twin	.930	.299	2.535	.438	14.681	.144	.803	1.155	.371	3.599
	Complementary foods	.377	.138	.898	.886	2.401	.084	.600	1.088	.794	1.491
	Changes	Malnutrition(1)→ Malnutrition(1) Cured					Malnutrition(1)→ Normal(0) Un Cured				
Malnutrition to Malnutrition is Cred 1→1 1→0	Maternal age	.044	.790	1.045	.757	1.442	.424	.009	1.528	1.112	2.099
	Mothers disease	.842	.000	2.320	1.580	3.405	1.037	.124	2.822	1.891	4.212
	Deliveries kind	-.003	.978	.997	.776	1.281	-.025	.850	.976	.755	1.260
	Previous abortion	-.139	.474	.870	.595	1.272	.250	.271	1.285	.822	2.007
	Number of delivery	.044	.793	1.045	.750	1.457	-.286	.011	.751	.529	1.068
	Kind of gestation	.025	.872	1.026	.754	1.394	.053	.739	1.055	.772	1.442
	Baby gender	.434	.001	1.543	1.208	1.971	-.106	.594	.899	.608	1.330
	Birth weight	1.874	.000	6.515	4.191	10.129	-.506	.040	.603	.336	1.083
	Diseases of children	-.042	.762	.959	.732	1.257	.112	.419	1.118	.853	1.465
	Twin	.476	.357	1.609	.584	4.432	.554	.417	1.740	.457	6.619
	Complementary foods	-.018	.896	.982	.744	1.296	-.056	.698	.945	.712	1.255

- 95% Confidence Interval

low birth weight lead to increasing the chance of appearing malnutrition in children in the second three months of life. At the same time interval, changes from malnutrition status to malnutrition or healthy status (Table 2); maternal age, maternal disease, being female child and low birth weight significantly lead to increasing the chance of remaining the children in malnutrition status in the second three months of life. Also, maternal disease, low birth weight and number of twin lead to decreasing the chance of improvement in children in the second three months of life.

Between six and twelve months old, in changes from healthy status to malnutrition or healthy status (Table 3), maternal disease, low birth weight and child disease significantly lead to reducing the chance of remaining the children in healthy status in the second six months of life. Also maternal disease, infant sex and low birth weight lead to increasing the chance of appearing malnutrition in children in the second six months of life. At the same time interval, changes from malnutrition status to malnutrition or healthy status (Table 3); maternal disease, infant sex and low birth weight significantly lead to increasing the chance of remaining the children in malnutrition status in the second six months of life. Also, maternal disease, low birth weight and child disease lead to decreasing the chance of improvement malnutrition in children in the second six months of life.

From 11 independent variables that had the greatest effect in this study, child disease and maternal age more than 35 years or less than 18 years, low birth weight, number of parturitions of

table 2 - Estimated coefficients of the independent variables in the changes of malnutrition state(1) or normal state(0) to other states (0 0r 1) in time interval from 3 (Begin of onth4) to 6 (finished sixth month)

	Changes	Normal(0) → Normal(0) Cured					Normal (0) → Malnutrition(1) Un Cured				
	Estimated Parameters→	B	Sig	OR	*Lo	*Up	B	Sig	OR	*Lo	*Up
Normal to normal is Cured 0 → 0 0→1	Maternal age	.429	.009	1.536	1.113	2.119	.270	.097	1.309	.952	1.800
	Mothers disease	-.124	.044	.884	.593	1.318	.920	.000	2.510	1.684	3.742
	Deliveries kind	-.032	.810	.969	.747	1.256	.010	.939	1.010	.785	1.300
	Previous abortion	1.131	.112	3.098	2.063	4.651	-.225	.263	.799	.539	1.183
	Number of delivery	-.258	.034	.772	.541	1.102	-.267	.133	.766	.541	1.085
	Kind of gestation	.030	.853	1.031	.749	1.418	-.020	.900	.980	.718	1.338
	Baby gender	.453	.096	1.573	1.221	2.026	.382	.002	1.465	1.146	1.872
	Birth weight	-.255	.038	.775	.497	1.206	2.917	.000	18.491	10.214	33.477
	Diseases of children	-2.16	.023	.116	.063	.214	.116	.397	1.122	.859	1.466
	Twin	-.506	.040	.603	.336	1.083	.550	.415	1.734	.462	6.511
	Complementary foods	-.091	.532	.913	.685	1.216	-.021	.883	.979	.740	1.296
	Changes	Malnutrition(1)→ Malnutrition(1) Cured					Malnutrition(1)→ Normal(0) Un Cured				
Malnutrition to Malnutrition is Cred 1→1 1→0	Maternal age	.283	.088	1.327	.959	1.837	.275	.119	1.316	.932	1.859
	Mothers disease	.731	.000	2.078	1.378	3.132	-.200	.031	.819	.574	1.169
	Deliveries kind	-.084	.529	.920	.709	1.193	-.084	.551	.919	.696	1.213
	Previous abortion	-.152	.457	.859	.575	1.282	-.188	.395	.829	.538	1.277
	Number of delivery	-.198	.272	.820	.576	1.168	-.223	.251	.800	.547	1.171
	Kind of gestation	-.043	.794	.958	.695	1.320	-.203	.258	.816	.574	1.160
	Baby gender	.233	.070	1.263	.981	1.625	.049	.721	1.050	.802	1.375
	Birth weight	3.185	.000	24.168	12.675	46.084	-.506	.040	.603	.336	1.083
	Diseases of children	.176	.206	1.192	.908	1.565	.097	.514	1.102	.823	1.477
	Twin	2.58	NA				-2.15	.023	.116	.063	.214
	Complementary foods	-.058	.690	.943	.708	1.257	.132	.409	1.141	.834	1.562

mother and maternal disease causes significant changes in the incidence or improvement malnutrition in children under age of one year. Other variables had no significant effect on these changes. These results adapt with Keshavarz (2001), Namkin (2008), Zeighami (2005) and Imanieh (2010) works. In present study, weight indicator for children under age of one year in rural areas of Boyer Ahmad city significantly was lower in compared by national standard growth curve for all ages under one year in monthly interval. In Bolourian study (2005) also noted that the weight-for-age indicator for 10.5 percent of children has been under the third percentile of nation growth curve. Infants with low birth weight are estimated about 15.6 percent. These finding correspond to finding of these studies: Mohamad zade (2002) and Mullah Mohamad (2012), which have reported this index about 13.9 percent and 11.8 percent, respectively, although the time interval between present study and these studies indicates worse health conditions in the study area. Inordinate difference of weight indicators for age toward the national standards is significant and needs more discussion. The most important factors affecting the incidence or improvement malnutrition in children under age of one year included: low birth weight and child disease in the first months of lifetime; and after that factors: baby sex, maternal age, the number of parturition of mother and maternal disease. These results were reported similar in all studies and were so. So pay more attention to the supportive measurements of the mother and child during pregnancy, parturition and at least up to one year old are most important priorities of health care of area. Also, making culture in pay attention to the children without considering their gender is necessary.

Table 3 - Estimated coefficients of the independent variables in the changes of malnutrition state(1) or normal state(0) to other states (0 0r 1) in time interval from 6(Begin of month 7) to 12 (finished month 12)

	Changes	Normal(0) → Normal(0) Cured					Normal (0) → Malnutrition(1) Un Cured				
	Estimated Parameters→	B	Sig	OR	*Lo	*Up	B	Sig	OR	*Lo	*Up
Normal to normal is Cured 0 → 0 0→1	Maternal age	.042	.805	1.043	.747	1.455	.126	.437	1.134	.826	1.558
	Mothers disease	-.253	.021	.776	.518	1.164	.684	.001	1.982	1.329	2.954
	Deliveries kind	-.069	.599	.934	.723	1.206	.031	.805	1.032	.805	1.323
	Previous abortion	.147	.415	1.158	.814	1.649	-.286	.148	.751	.510	1.107
	Number of delivery	-.052	.808	.950	.626	1.441	-.060	.727	.942	.674	1.317
	Kind of gestation	.002	.989	1.002	.733	1.371	.006	.969	1.006	.741	1.365
	Baby gender	.535	.124	1.708	1.331	2.191	.513	.000	1.671	1.311	2.130
	Birth weight	-2.15	.023	.116	.063	.214	3.024	.000	20.569	10.987	38.510
	Diseases of children	-.341	.064	.711	.496	1.020	.168	.211	1.183	.909	1.540
	Twin	.421	.650	1.524	.248	9.385	-.602	.319	.548	.168	1.790
	Complementary foods	.066	.654	1.068	.802	1.422	.006	.966	1.006	.763	1.326
	Changes	Malnutrition(1)→ Malnutrition(1) Cured					Malnutrition(1)→ Normal(0) Un Cured				
Malnutrition to Malnutrition is Cred 1→1 1→0	Maternal age	.275	.119	1.316	.932	1.859	.132	.454	1.141	.808	1.612
	Mothers disease	.494	.028	1.639	1.056	2.544	-.508	.040	.600	.336	1.283
	Deliveries kind	-.084	.551	.919	.696	1.213	-.091	.517	.913	.695	1.201
	Previous abortion	-.188	.395	.829	.538	1.277	.116	.397	1.122	.859	1.466
	Number of delivery	-.223	.251	.800	.547	1.171	-.071	.705	.932	.645	1.345
	Kind of gestation	-.203	.258	.816	.574	1.160	-.208	.238	.812	.575	1.148
	Baby gender	.049	.721	1.050	.802	1.375	.099	.464	1.104	.847	1.440
	Birth weight	3.539	.000	34.423	17.971	65.936	-.602	.019	.548	.168	1.790
	Diseases of children	.377	.138	1.458	.886	2.401	-.208	.038	.812	.575	1.148
	Twin	2.839	.010	17.104	1.992	146.867	-.335	.129	.715	.464	1.103
	Complementary foods	.132	.409	1.141	.834	1.562	.139	.376	1.149	.844	1.564

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