The Pakistan Development Review
40 : 4 Part II (Winter 2001) pp. 1009–1031

Determinants of Growth Retardation in Pakistani Children under Five Years of Age

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Ensuring the survival and well being of children is a concern of families, communities, and nations throughout the world. Since the turn of the 20th century infant and child mortality in more developed countries has steadily declined and, currently, has been reduced to almost minimal levels. In contrast, although infant and child mortality has declined in the past three decades in most less developed countries, the pace of change and the magnitude of improvement vary considerably from one country to another. Children are at risk of both mortality and morbidity.

The problem of malnutrition is widespread in developing countries and particularly severe in South Asian countries, where almost fifty percent of the undernourished children of the world live [Carlson and Wardlaw (1990)]. Rural populations are especially prone to malnutrition because they are more likely to be poor [Tinger (1998)]. The analysis of Demographic and Health Surveys (DHS) in 19 developing countries shows that children living in rural areas are more likely to be malnourished [Sommerfelt and Stewart (1994)].

A poor diet and exposure to repeated illnesses are two of the major causes of malnutrition in developing countries [Mosley and Chen (1984)]. When the child survives the neonatal period, better child nutrition becomes an important part of child health since nutrition during childhood makes a major contribution to child development, growth, and survival, ultimately influencing the human and social capital of a society. The role of breastfeeding is very important in the post-neonatal period. The mother's milk not only provides the complete nutritional requirements of the child but also provides protection against infection [Jelliffe and Jelliffe (1978)]. Pregnant women who receive inadequate nutritional levels are likely to give birth to underweight babies who are more likely to get infectious diseases, leading to early death. Furthermore, those who survive but receive inadequate food in their early life are more likely to be exposed to permanent stunting of their physical growth.

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The physical environment, socio-economic status, diet, parental education and infections determine a child's growth [Sommerfelt and Stewart (1994)]. In developing countries, the first 2-3 years of growth are very important in determining their adult stature, work capacity and productivity [Martorell, *et al.* (1990)]. The reason for this is that children stunted early in life continue to live in the same deprived environment that precludes catch-up growth and, therefore, never catch up to their full growth potential in adulthood [Martorell (1995); Osmani (1992); Waterlow (1993)]. Genetic factors have a much smaller role because the growth potential in early childhood is similar across ethnic groups [Martorell (1985)].

Small stature in men leads to reduced work capacity and productivity. Underweight and stunting increases the risk of morbidity and mortality, and has functional consequences later in life such as diminished work capacity and increased obstetric risk for women [Osmani (1999)].

In this context, improving child health and nutritional status to prevent underweight and stunting has become very important. Therefore, improving the health and nutritional status of children 0–4 years of age deserves high priority. Understanding the factors that affect growth during these critical periods is essential for determining appropriate intervention strategies to address the problem. The Pakistan Demographic and Health Survey, 1990-91, [NIPS (1992)] for the first time collected information on household characteristics and children's morbidity and sickness care as well as anthropometric measurements of children 0-59 months of age. Using these data, this study aims to assess the growth retardation as reflected in anthropometric indicators of height measurements for children under 5 years old according to a set of proximate determinants.

ANTHROPOMETRIC INDICES: HEIGHT-FOR-AGE

Height-for-age is an indicator of past and also continuing or long-term problems in inadequate diet and high morbidity [Sommerfelt and Arnold (1998)]. It is considered as a proxy for the health of a population [Tanner (1982)] and this measure is referred to stunting. This term "stunting" is used by human biologists to denote retardation in height growth relative to the standard for well-nourished people [Martorell and Habicht (1986)]. It results from recurrent and chronic illness, especially when illenesses are not treated properly and from inadequate food intake. Each time the child experiences inadequate nutrition, the child will stop growing or grow more slowly. On the other hand, when the child's nutritional status improves, normal growth resumes, but the child is unlikely to "catch up" to the height that would have been attained if the incidence of poor nutrition had not occurred. Each time a child experiences poor nutrition, it falls further behind in height relative to a child with no such experience. Thus, Height-for-age measures a child's cumulative nutritional status since birth.

Anthropometric data around the world suggest that a strong relationship exists between the heights of children and adults in different populations and the measures of socio-economic development [WHO (1995)]. It is observed that in a population, if the socio-economic conditions develop, heights of children and adults also increase. Stunting in developing countries is a result of economic deprivation [Gopalan (1986); WHO (1995)].

In the assessment of nutritional status: choice of index which best represents the nutritional status; choice of reference population to compare the observed anthropometrical values of individual children; choice of best statistical measure to express the nutritional status of children; and what is the suitable cut-off points for the identification of children who are at risk, are very important [WHO (1995)].

DATA AND METHODOLOGY

The PDHS data include a total of 6492 births that occurred 5 years preceding the survey to 4061 women. To avoid the violation of the independence assumption, only the last births are included in the analysis.

Thus, this analysis is restricted to 2222 singleton births, born 1–59 months before the survey. To include the survival status of the older siblings in the analysis, only women are included who have at least two births. Those children share risks associated with family behaviour and childcare practice, such as infant feeding, use of health services and general standards of domestic environment and hygiene. Das Gupta (1990) called them parental competence. Following table depicts the number and percentage of births included in this analysis by each category of reaching at that number.

Description	Number of Births	Percentage
Total Sample	6492	100.00%
Number of Women	4061	62.55%
Women with First Order Births	634	15.61%
Women having at least Two Births	3427	84.39%
Women having Twins	55	1.60%
Women having Singleton	3372	98.40%
Births during the Month of the Interview	70	2.08%
Number of Births included in the Analysis	3302	97.92%
Effective Sample	3302	50.86%

Conceptual Framework

Boerma and Bicego (1993) used the conceptual framework proposed by Mosley and Chen (1984) with modifications based on the limitations and structure of the DHS data. Keeping in view the aforementioned frameworks, the model proposed here uses the nutritional status of the living children as the outcome variable categorised as normal growth; stunted; and severely stunted based on height-for-age. Like the Mosley and Chen (1984) framework, the socio-economic variables affect the outcome through the four proximate determinants (data on Injury is not available in the DHS) namely, demographic factors, environmental factors, nutritional factors and health seeking behaviour factors.

The following variables are included in the analysis:

- **Socio-economic Variables:** Parental education; household possessions; place of residence; region of residence.
- **Demographic Factors**: Age of the mother at the time of birth; birth order; birth interval; age of the child; sex of the child; previous sibling death.
- **Environmental Contamination**: Source of drinking water; toilet facilities; housing construction material.
- **Nutritional Factors**: Birth weight; premature birth; nipple feeding; diarrhea during 2 weeks before the survey.
- **Health-seeking Behaviour**: Prenatal care; Delivery attendance; place of birth; BCG vaccination and contraceptive use.

Statistical Analysis: Ordered Logistic Regression

The ordered logistic regression analysis, also called the cumulative logit model [Allison (1999)] is employed and the results are presented in the form of odds ratios. A child with a height-for-age Z-Score below –3SD is considered severely stunted (coded as 3) and a Z-Score lower than –2 standard deviations is considered stunted (coded as 2). Children with normal growth are coded as 1.

The ordered logistic regression models are fit to test the hypotheses that the socio-economic variables work through the proximate determinants to effect growth of the child. First the dependent variables are regressed on socio-economic variables, and then the proximate determinants and interactions are added one by one to observe the change in the regression coefficients. However, to get the final parsimonious model, all the non-significant variables are excluded from the model. The proposed model is shown at Figure 1.

RESULTS

Socio-economic Factors

As expected, maternal education is negatively associated with height-for-age of the children. As the number of years of maternal schooling increases, the odds of stunting decrease. In the bivariate logistic regression, each year increase in maternal schooling reduces the odds of stunting (OR=0.86, $p < 0.001$) by 14 percent. When other socio-economic variables are included in the model, model-6 shows that the each year increase in maternal education decreases the odds of stunting by 9 percent (OR=0.91, $p < 0.001$). Bicego and Boerma (1991) found more than doubling of risk of stunting among children of mothers with no education compared with children of mothers with at least secondary education in an analysis of 17 DHS countries.

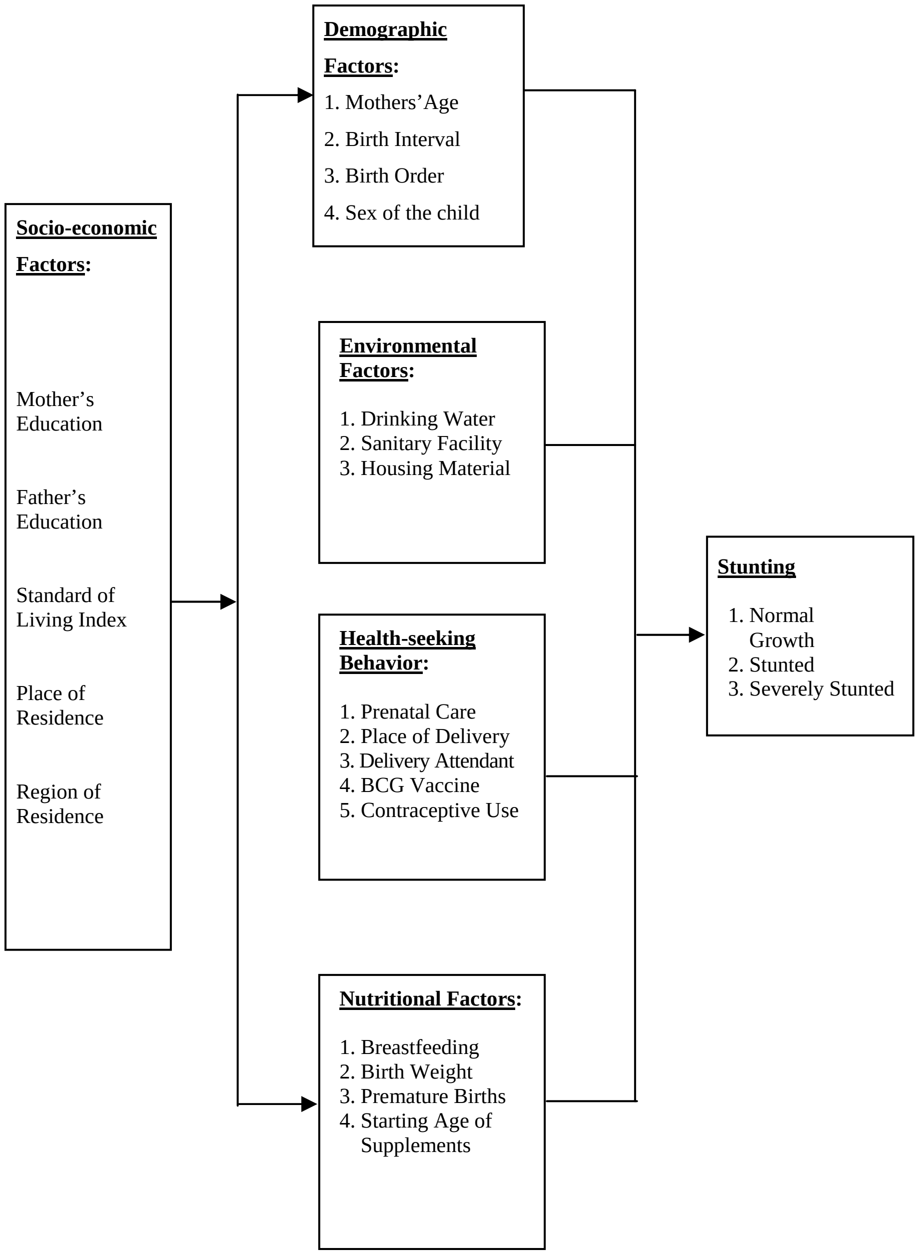

Fig. 1. Proposed Model for Child Survival in Pakistan.

Table 1 shows that stunting of children is strongly related to the fathers' education ($p < 0.001$). It shows that each year increase in the fathers' education decreases the odds of being stunted by 9 percent (OR=0.91, $p < 0.001$) at bivariate level. The fathers' education maintains its significance even when the mothers' education and other socio-economic variables are included in the model. Model-6 shows that each year increase in the fathers' education decreases the odds of stunting by 3 percent (OR=0.97, $p < 0.01$).

As expected, Table 1 also shows that the risk of stunting in children born to the mothers with the higher index of household possessions are 70 percent lower (OR=0.30, $p < 0.001$) than to the risk of stunting compared to the children born to mothers with lower index of household possessions in the bivariate model and 46 percent (OR=0.54, $p < 0.001$) in the multivariate model. The odds (OR=0.78, $p < 0.05$) of children with medium index are also 78 percent less to the risk of stunting compared to the children of lower possessions index. Children living in urban areas have the advantage of better nutritional status compared to the children living in rural areas. The bivariate logistic regression analysis shows that rural children are at least twice as likely to be stunted than urban children (OR=0.48, $p < 0.001$). When all other socio-economic variables are controlled, the odds are 24 percent lower of urban children than rural children to be stunted (OR=0.76, $p < 0.05$).

Table1

Odds Ratios Obtained from the Ordered Logistic Regression Models of Predicting the Nutritional Status of Children Aged 1–59 Months, PDHS, 1990-91

Independent Variables	Model-1	Model-2	Model-3	Model-4	Model-5	Model-6
Intercept						
Intercept 1	–0.7988	–0.6187	–0.6075	–0.777	–0.4633	–3.2493
Intercept 2	0.0851	0.2653	0.2722	0.0918	0.4403	–2.1943
Maternal Education	0.858***				0.923***	0.905***
Fathers Education		0.910***			0.956***	0.968**
Index of Household Possessions						
Lower			Reference		Reference	Reference
Higher			0.296***		0.595***	0.538***
Medium			0.634***		0.784**	0.784*
Place of Residence						
Rural				Reference	Reference	Reference
Urban				0.487***	0.798*	0.760*
Age of the Child						
Age						1.336***
Age-Square						0.992***
Age-Cube						1.000***
–2 Log Likelihood	127.05	114.412	100.764	66.231	182.341	591.9
DF	1	1	2	1	5	8

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, + $p < 0.10$.

Domestic Environment and Hygiene

The logistic regression shows that the source of drinking water, toilet facility and housing construction, each, has a significant effect on stunting both in bivariate and multivariate analysis.

The bivariate logistic regression model shows that the children of the parents who have piped water in the residence and piped water on the property are at lower risk of stunting (OR=0.61, $p < 0.001$) compared to the children of parents with a well as a source of drinking water. The children of those households depending on surface water have a significantly higher risk of stunting (OR=1.87, $p < 0.001$).

Table 2

Odds Ratios Obtained from the Ordered Logistic Regression Models of Environmental Factors for Predicting the Nutritional Status of Children Aged 1–59 Months, PDHS, 1990-91

Independent Variables	Model-1	Model-2	Model-3	Model-4	Model-5
Intercept					
Intercept 1	–0.9322	–0.7318	–0.7179	–0.802	–3.4939
Intercept 2	–0.0641	0.1518	0.1534	0.0909	–2.4555
Source of Drinking Water					
Piped into Residence	0.610***			1.138	1.072
Piped onto Property	0.656**			1.081	1.016
Public Tap	1.201			1.594***	1.661**
Surface	1.874***			1.712***	1.502**
Well	Reference			Reference	Reference
Toilet Facility					
Flush		0.377***		0.438***	0.398***
Bucket		0.997		0.990	0.986
Bush		Reference		Reference	Reference
Housing Construction Material					
Unbaked bricks			Reference	Reference	Reference
Baked bricks			0.493***	0.782*	0.758*
Age of the Child					
Age					1.329***
Age-Square					0.992***
Age-Cube					1.000***
–2 Log Likelihood	60.419	113.406	71.665	138.77	547.753
Degrees of Freedom	4	2	1	7	10

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, + $p < 0.10$.

In the multivariate model, when toilet facility and housing construction are included, the odds of stunting among children in households with surface water are 50 percent higher than the households with wells (OR=1.50, $p < 0.01$). Moreover, the odds of stunting of children with public tap are 66 percent higher (OR=1.66, $p < .01$) than the children depending on a well as the source of drinking water. This highly significant effect of tap water use on stunting may be that the tap water is contaminated by sewage outflows or the tap water is not chlorinated to any particular standard. According to United Nations (1998), Pakistan needs to address a vast array of problems regarding water usage, for example forty percent of urban deaths are caused by water-borne diseases.

Table 2 also depicts the effect of toilet facilities on stunting. It shows that the odds of stunting for children of households equipped with a flush toilet facility are 60 percent lower than the households without any toilet facility (OR=0.40, $p < 0.001$).

The housing construction material also shows a significant effect on stunting ($p < 0.001$). In the bivariate model, the odds of stunting (OR=0.49, $p < 0.001$) for children living in baked brick constructed houses are 50 percent lower than the children living in unbaked brick constructed houses. In the multivariate model, the effect is reduced to 24 percent but it is still significant (OR=0.76, $p < 0.05$).

Demographic Factors

Maternal age at birth less than 20 years has a significant association with stunting in the bivariate model (OR=2.17, $p < 0.001$) compared to maternal age at birth 20–29 years. In the multivariate model, children of younger mothers are significantly at higher risk of stunting (OR=1.93, $p < 0.01$) and children of older mothers are significantly less likely to be stunted (OR=0.79, $p < 0.05$) compared to the children of mothers aged 20–29 (reference category).

Table 3 shows that a long preceding birth interval of at least four years is associated with significantly better height-for-age (OR=0.72, $p < 0.001$) compared to the children born within a 36–47 months birth interval. In contrast to a long preceding birth interval, children born within 18 months of the preceding birth appear to be at no disadvantage in growth status compared to the children born within 36–47 months of the preceding birth.

Table 3 also shows that having more than 5 siblings has a significant effect on stunting (OR=2.19, $p < 0.01$). It is common for children to compete for parental resources, which include nurturing and food, among other more durable family resources. The logistic regression analysis shows no evidence of sex differentials in stunting either in bivariate or in multivariate analysis in Pakistan. However, if the sibling has an earlier death in the family, the analysis shows that the index child experiences significantly higher risks of stunting.

Table 3

Odds Ratios Obtained from the Ordered Logistic Regression Models of Demographic Factors for Predicting the Nutritional Status of Children Aged 1–59 Months, PDHS, 1990-91

Independent Variables	Model-1	Model-2	Model-3	Model-4	Model-5	Model-6	Model-7
Intercept							
Intercept 1	–1.066	–0.935	–0.831	–1.029	–1.1	–1.592	–4.0112
Intercept 2	–0.214	–0.082	0.0255	–0.18	–0.24	–0.716	–3.0229
Maternal Age at the Time of the Birth							
15–19	2.170***					2.451***	1.930**
20–29	Reference					Reference	Reference
30–49	1.115					0.831+	0.785*
Preceding Birth Interval							
Less than 18 Months		1.229				1.153	1.004
18–35		0.984				0.961	1.030
36–47		Reference				Reference	Reference
48 and over		0.729***				0.678***	0.815+
Number of Siblings							
No Sibling			Reference			Reference	Reference
1-2			0.706			1.408	1.339
3-4			0.804			1.763*	1.508
5 and More			1.151			2.657***	2.186**
Sex of the Child							
Girl				Reference		Reference	Reference
Boy				1.078		1.067	1.107
Previous Siblings Death					1.584***	1.739***	1.373**
Age of the Child							
Age							1.304***
Age-Square							0.993***
Age-Cube							1.000***
–2 Log Likelihood	11.42	14.907	24.225	0.864	22.06	81.515	430.72
Degrees of Freedom	2	2	2	1	1	10	13

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, + $p < 0.10$.

Nutritional Factors

Table 4 shows that prematurely born children continue to be significantly stunted compared to full-term children in bivariate logistic regression (OR=2.20, $p < 0.05$) while in multivariate logistic regression the association become very weak (OR=2.0, $p < 0.10$). However, very small-sized babies experience a significantly higher risk of stunting compared to normal-sized babies in the bivariate (OR=2.39, $p < 0.001$) and multivariate logistic regression analysis (OR=2.90, $p < 0.001$).

The analysis also shows that children of mothers who started feeding with nipples have a significantly lower risk of stunting (OR=0.49, $p < 0.001$). Table 3 also shows that children who experienced an episode of diarrhea during the two weeks before the survey are at higher risk of stunting. The odds of stunting for children who had diarrhea are 36 percent higher than those children who did not have a diarrhea episode during the two weeks before the survey (OR=1.36, $p < 0.01$).

Table 4

Odds Ratios Obtained from the Ordered Logistic Regression Models of Nutritional Factors for Predicting the Nutritional Status of Children Aged 1–59 Months, PDHS, 1990-91

Independent Variables	Model-1	Model-2	Model-3	Model-4	Model-5	Model-6
Intercept						
Intercept 1	–0.9996	–1.0527	–0.783	–1.026	–0.8833	–3.62
Intercept 2	0.1499	–0.1951	0.0845	–0.177	–0.0044	–2.602
Premature Birth						
Full-term	Reference				Reference	Reference
Pre-term	2.203*				1.944+	2.038+
Birth-weight/Birth-size						
Very-small Size		2.386***			2.338***	2.895***
Normal Size		Reference			Reference	Reference
Very-large Size		1.280			1.284	1.039
Bottle Feeding with Nipple						
Yes			0.503***		0.494***	0.487***
No			Reference		Reference	Reference
Diarrhea during two Weeks before the Survey						
Yes				1.201+	1.210+	1.355**
No				Reference	Reference	Reference
Age of the Child						
Age						1.321***
Age-Square						0.993***
Age-Cube						1.000***
–2 Log Likelihood	4.073	26.805	61.077	39.02	94.87	501.1
Degrees of Freedom	1	2	1	1	5	8

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, + $p < 0.10$.

Diarrhea is an important cause of malnutrition. This is because nutrient requirements are increased during diarrhea, whereas nutrient intake and absorption are usually decreased. Each episode of diarrhea can cause weight loss and growth faltering. Moreover, if diarrhea occurs frequently, there may be too little time to "catch up" on growth between episodes, therefore, they are more likely to become undernourished than children who experience fewer or shorter episodes of diarrhea. To prevent growth faltering, good nutrition must be maintained both during and after an episode of diarrhea. This can be achieved by continuing to give considerable amounts of nutritious foods throughout the episode and during the period of recovery.

HEALTH-SEEKING BEHAVIOUR

Table 5 depicts the relationship between the health seeking behavior variables with stunting. The bivariate (OR=0.87, $p < 0.001$) and multivariate logistic

Table 5

Odds Ratios Obtained from the Ordered Logistic Regression Models of Health Seeking Behaviour for Predicting the Nutritional Status of Children Aged 1–59 Months, PDHS, 1990-91

Independent Variables	Model-1	Model-2	Model-3	Model-4	Model-5	Model-6	Model-7
Intercept							
Intercept 1	–0.825	–0.799	–0.873	–0.883	–0.941	–0.7524	–3.3679
Intercept 2	20.046	0.0635	–0.004	–0.033	–0.896	0.1261	–2.3394
Prenatal Care							
No	Reference					Reference	Reference
Yes	0.870***					0.911***	0.914***
Delivery Attendant							
Un-trained		Reference				Reference	Reference
Medical Trained		0.560				0.804*	0.868
Place of Delivery							
Own Home			Reference			Reference	Reference
Government Hospital			0.429***			0.522	0.696
Private Hospital/Clinic			0.293***			0.804***	0.484***
BCG							
No				Reference		Reference	Reference
Yes				0.849*		0.992	0.686***
Contraceptive Use							
No					Reference	Reference	Reference
Yes					0.690**	1.028	0.786+
Age of the Child							
Age							1.347***
Age-Square							0.992***
Age-Cube							1.000***
–2 Log Likelihood	83.072	45.472	72.032	3.64	9.823	105.845	531.662
DF	1	1	2	1	1	6	9

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, + $p < 0.10$.

regression analysis (OR=0.91, $p < 0.001$) shows highly significant lower odds of stunting for children whose mothers received prenatal care compared to the children whose mothers did not receive prenatal care.

The place of delivery appears to be very important for predicting stunting. Table 5 shows that the significantly lower odds of stunting for children whose mothers delivered their babies at hospital {government hospital (OR=0.43, $p < 0.001$) and private hospitals (OR=0.29, $p < 0.001$)} for bivariate models and only private hospitals for multivariate level (OR=0.48, $p < 0.001$). The vaccination of BCG at birth also has a significant positive effect on stunting. In the bivariate model, the odds of stunting are 15 percent lower for children who received a BCG vaccine at birth compared to the children who did not receive BCG vaccine at birth. The effect of BCG vaccination even appears to be stronger at the multivariate level (OR=0.69, $p < 0.001$). However, when the age of the child was not included in the multivariate model, the BCG did not show any significant effect on stunting, which indicates that the effect of BCG is confounded by age of the child.

Socio-economic Factors and Proximate Determinants

In the previous section, it is observed that stunting significantly varies by age of the child, so the age of the child is included in all the models along with its square and cubic terms. It is seen here in multivariate analysis (Table 6) that all the three age variables are significant ($p < 0.001$). Model-1 shows the effects of socio-economic variables on stunting. It shows that the mothers' education, fathers' education as well as the index of the household possessions are significantly associated with stunting. It also shows significantly lower risk of stunting in urban children. Children living in the province of Punjab have significantly lower stunting and children living in the province of the Sindh have significantly higher stunting compared to the children living in the provinces of NWFP and Balochistan.

Model-2 includes the household environmental and hygiene variables along with the socio-economic variables. It shows that the children living in households with public tap as a source of drinking water have significantly higher odds of stunting compared to households depending on wells as a source of drinking water. Households with flush toilet facilities are better nourished compared to their counterparts living in households without any toilet facilities. The fit of the Model-2 based on the score test for the proportional odds assumption shows (Chi-square=14.17 with 17 DF and $p < 0.66$), hence, a good fit.

However, when the group of the demographic variables is included in the model along with the socio-economic and environmental variables, the p-value of score test shows that the proportion odds assumption of the model does not hold. To maintain the validity of this assumption, several variables were included/excluded from the analysis one by one. When the category of maternal age 15–19 years was

Table 6

Odds Ratios Obtained from the Ordered Logistic Regression Analysis to Predict the Probability of Stunting and Severely Stunting Among Children 1–59 Months, PDHS, 1990-91

Independent Variables	Model-1	Model-2	Model-3	Model-4
Intercepts				
Intercept 1	–3.124***	–3.148***	–3.465	–3.763***
Intercept 2	–2.044***	–2.059***	–2.362	–2.640***
Age of the Child				
Age of the Child	1.350***	1.356***	1.358***	1.364***
Age-square	0.992***	0.992***	0.992***	0.991***
Age-cube	1.000***	1.000***	1.000***	1.000***
Mother's Education	0.913***	0.924***	0.928***	0.932***
Father's Education	0.971**	0.977*	0.972*	0.973*
Socio-economic Status: Lower (Ref)				
Higher	0.505***	0.591**	0.573***	0.567***
Medium	0.790*	0.845	0.820+	0.798*
Place of Residence: Urban	0.636***	0.824	0.788	0.812
Province of Residence: NWFP and Balochistan (Ref)				
Punjab	0.615***	0.590***	0.589***	0.619***
Sindh	1.422*	1.431*	1.501**	1.428*
Source of Drinking Water: Well (Ref)				
Pipe Inside the Home		1.058	1.053	1.026
Pipe in to the Property		1.129	1.087	1.093
Public Tab		1.439*	1.410+	1.453*
Surface		1.208	1.193	1.178
Type of Toilet Facility: No Facility (Ref)				
Bucket		0.763+	0.756+	0.763+
Flush		0.541***	0.517***	0.530***
Construction Baked Bricks: Unbaked Bricks (Ref)		0.973	0.996	1.044
Mother's Age 15–29 (Ref)			0.811+	0.822+
Previous Birth Interval: 36 – 47 (Ref)				
Less than 18 Months			1.385*	1.439*
18–35			1.241+	1.297*
48 and More			0.736*	0.730*
Sex of the Child: Boy			1.075	1.092
Number of Surviving Sibling: No Sibling (Ref)				
1-2			1.348	1.498
3-4			1.394	1.588
5 and over			1.680+	1.911*
Sibling Death			1.145	1.157
Premature Birth				3.205*
Baby-size at Birth: Average (Ref)				
Small-size				2.360***
Big-size				1.136
Feeding with Nipple				0.778*
Had Diarrhea During 15 Days Before Survey				**1.337***
–2 Log Likelihood Ratio	652.37	672.34	703.16	744.22
Degrees of Freedom	10	17	26	31
Score Test: p-value	0.42	0.66	0.52	0.48

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, + $p < 0.10$.

excluded from the model, the score test for the proportionality assumption becomes non-significant (Model-3), therefore, only one maternal age-group 30-49 left in the model leaving 15–29 as reference age-group.

In model-3 (Score test: Chi-square 24.94 with $p < 0.52$), the effect of a short preceding birth interval on stunting is significant ($p < 0.05$). Moreover, preceding birth interval of 18–35 months also shows a marginally positive significance on stunting ($p < 0.10$), whereas, the interval more than 48 months shows a negative relationship on stunting ($p < 0.05$). Children of mothers thirty and over years of age show a negative effect on stunting compared to the children of mothers aged less than 30 years ($p < 0.05$). Moreover, it is observed that children with more than 5 living siblings have a significantly higher risk of stunting. However, sibling death does also appear to have a marginal significant effect on stunting ($p < 0.10$).

When variables presenting the nutritional factors are included in Model-4 (Score test: Chi-square 30.61 with $p < 0.48$), the effect of preceding birth intervals and having more than 5 siblings become more pronounced compared to the previous model without nutritional factors included. It means that children who born with short birth intervals and have more than 5 living siblings are more likely to be born premature or small birth size. Mothers who started giving bottle feeding with nipples to their children have significantly better nourished children compared to mothers who did not bottle-fed their children. Children who had episode of diarrhea two weeks before the survey are significantly stunted than those children who did not have episode of diarrhea.

Model-5 in Table 7 (Score test: Chi-square 39.37 with $p < 0.28$) includes all the explanatory variables; it shows that all the variables maintain their significance as observed in the previous model. Among the health seeking variables, mothers who delivered their babies in the private hospitals show a significant negative effect on stunting (OR=0.41, $p < 0.001$).

In the final model-6, two interactions are included to see whether there are any sex differentials or if the effect of diarrhea varies as the child grows. It is observed that both the interactions are statistically significant in the expected direction. The addition of interactions in the model shows that boys are at a significantly higher risk of stunting (OR=1.47, $p < 0.05$) compared to girls but the difference reduces as the age of the child increases (OR=0.99, $p < 0.05$).

The interaction between diarrhea and the age of the child also shows the effect of diarrhea on stunting increases (OR=1.02, $p < 0.05$) as the child grows. As observed earlier that the prevalence of diarrhea increase by age, so the effects of diarrhea on stunting. The incidence of diarrhea increases by age because of the reduction of exclusive breastfeeding along with increase in food supplementation. The food can become contaminated more easily under poor hygienic conditions so keeping the child on the breast is protective against diseases.

Table 7

Odds Ratios Obtained from the Ordered Logistic Regression Analysis to Predict the Probability of Stunting and Severely Stunting Among Children 1–59 Months, PDHS, 1990-91

Independent Variables	Model-5	Model-6
Intercepts		
Intercept 1	–3.817***	–3.966***
Intercept 2	–2.683***	–2.829***
Age of the Child		
Age of the Child	1.371***	1.378***
Age-square	0.991***	0.991***
Age-cube	1.000***	1.000***
Mother's Education	0.949**	0.954**
Father's Education	0.972*	0.973*
Socio-economic Status: Lower (Ref)		
Higher	0.592**	0.599**
Medium	0.822+	0.826+
Place of Residence: Urban	0.859	0.900
Province of Residence:NWFP and Balochistan (Ref)		
Punjab	0.588***	0.591***
Sindh	1.605**	1.636**
Source of Drinking Water: Well (Ref)		
Pipe Inside the Home	1.066	1.051
Pipe in to the Property	1.112	1.112
Public Tab	1.435*	1.439*
Surface	1.219	1.244
Type of Toilet Facility: No Facility (Ref)		
Bucket	0.739*	0.751*
Flush	0.560***	0.600***
Construction Baked Bricks: Unbaked Bricks (Ref)	1.066	
Mother's Age 15–29 (Ref)	0.813+	0.802+
Previous Birth Interval: 36–47 (Ref)		
Less than 18 Months	1.441*	1.497**
18–35	1.294*	1.291*
48 and More	0.745*	0.750*
Sex of the Child: Boy	1.110	1.471*
Number of Surviving Sibling: No Sibling (Ref)		
1-2	1.529	1.642+
3-4	1.586	1.713+
5 and Over	1.863*	2.057*
Sibling Death	1.214+	1.196
Premature Birth	4.194**	4.080**
Baby-size at Birth: Average (Ref)		
Small-size	2.221***	2.214***
Big-size	1.163	1.274
Feeding with Nipple	0.803*	0.793*
Had Diarrhea During 15 days before Survey	1.381**	0.865
Prenatal Care Visits	0.944**	0.947**
Place of Delivery: At Home (Ref)		
At Government Hospital	0.728	0.790
At Private Hospital	0.406***	0.434***
Delivery Attended by Medical Personal	1.142	
BCG Vaccine Received	0.937	
Contraceptive Used	1.224	
Interactions		
Age of the Child * Boy		0.988*
Age of the Child * Diarrhea		1.022*
–2 Log Likelihood Ratio	774.784	780.718
Degrees of Freedom	37	35
Score Test: p-value	0.23	0.27

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, + $p < 0.10$.

The predicted probabilities for the children of severely stunted, moderately stunted and with normal growth are calculated and presented to highlight the effect of one or more predictors by controlling the effect of other variables. Figure 2 depicts how the probability of severely stunted and moderately stunted children increases and the probability of the children with normal growth decrease as the age of the child increases. The probabilities of each category of the dependent variable are calculated keeping the average levels of the independent variables of the then age. Figure 2 shows that the probability of severely stunted children increases up to age 28 months when it reaches about 34.9 percent, and then slightly decreases to 30.7 percent at the age of 43 months and after that it again gets the momentum of higher probability of severely stunting. On the other hand, the probability of moderately stunting increases from 4 percent at age of 1 month to 27 percent at the age of 23 months and remains stable for rest of the months. However, the probability of children for normal growth sharply dropped from 94 percent at age 1 month to 80 percent at age 6 to 60 percent at age 12 and 37.5 percent at age 30 months. After the age of 30 months the probability of normal growth increases from 37.5 percent to 42 percent at age 47 months and then again declines sharply to 29 percent at age 59 months. Figure 2 demonstrates these differences more noticeably.

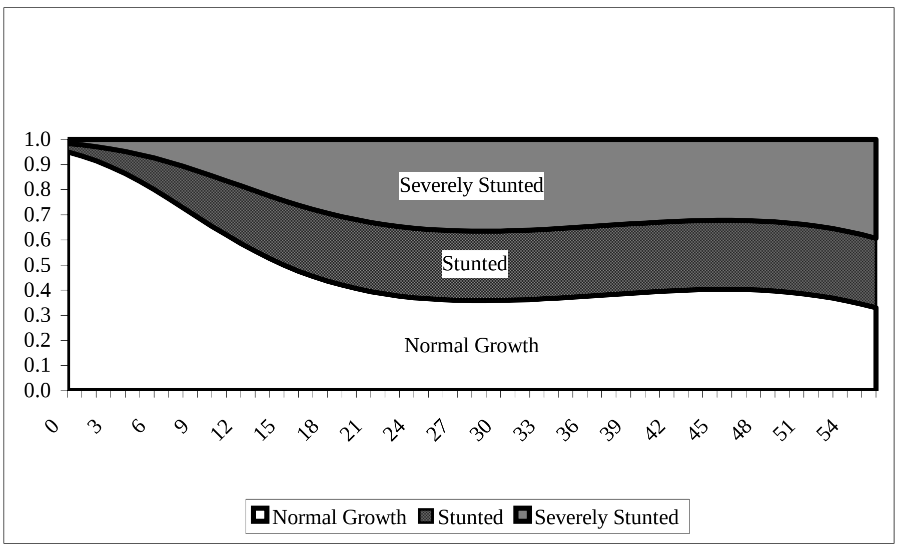

Fig. 2. Predicted Probabilities of Stunting based on Final Ordered Logistic Regression Model by Age of the Child, taking Mean Values of all the Independent Variables, PDHS, 1990-91.

Figure 3 and Figure 4 show the differences between the advantaged[1] and disadvantaged[2] children as they grow. It is observed that, at age zero, the proportion of stunting does not exist at birth for the advantaged children, compared to 20 percent of stunted among the disadvantaged children at birth. Moreover, the differences become widened as the children grow. It is clear that at age 5, only 10 percent (Figure 3) of the non-privileged children have normal growth compared to more than 70 percent (Figure 4) for the privileged children.

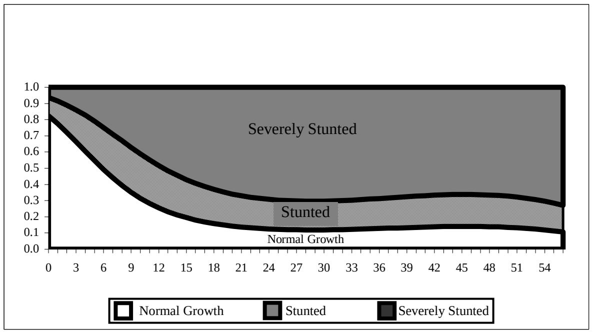

Fig. 3. Predicted Probabilities of Stunting based on Final Ordered Logistic Regression Model by Age of the Child, Lower SES Illiterate Parents Living in Rural with Well Water and No Toilet Facility, PDHS, 1990-91.

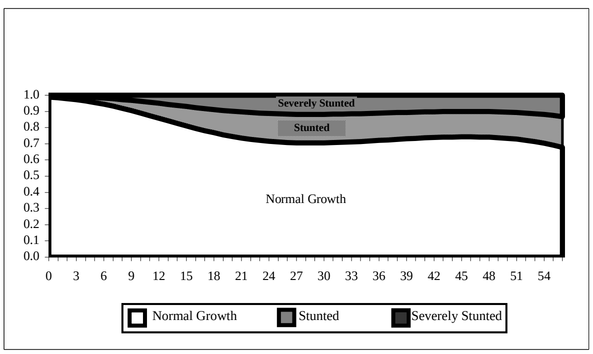

Fig. 4. Predicted Probabilities of Stunting based on Final Ordered Logistic Regression Model by Age of the Child, Higher SES 10 Years Education Parents Living in Urban Punjab with Piped Water and Flush System, PDHS, 1990-91.

[1]Children with parents who have 10 years of education, live in urban Punjab and have piped water connected to their houses and have flush toilet facilities.

[2]Children with illiterate parents, living in Sindh rural with Wells water and have no toilet facility.

Stunting is a phenomenon of early childhood and a direct result of poor diets and infection [Martorell and Habicht (1986)]. According to them the intense period of growth retardation is generally between 3 and 12 or 18 months. However, in some countries growth retardation continues into the third year or longer but to a lesser extent. At the end of this process, marked departure from normality will have often occurred. There are multiple reasons why stunting occurs in early childhood and not later. In childhood nutritional needs are greater, in relation to weight, than at any time later. One of the reasons that nutritional requirements are high is that growth velocities are the highest they will ever be [Martorell, *et al.* (1994)]. Thus, the opportunity for growth retardation is great in early childhood, partly because more growth is taking place. Moreover, infections limit growth in very young children because episodes are more frequent and more severe, especially the malnourished. Finally, young children are totally dependent on others for their care and are hence most vulnerable to poor care taking [Martorell, *et al.* (1994)].

CONCLUSION

The results of the ordered logistic regression show that higher socio-economic status significantly improves the nutritional status of living children. This pattern persists even when the differences in household environment, demographic, nutritional and health care factors are taken into account. These findings are also in accordance with the earlier results that say stunting is caused by poverty in developing countries. As the socio-economic status of parents increases, the prevalence of stunting decreases.

The highly statistically significant better nutritional status is observed for children living in households with flush toilet facilities. The children living in households having at least pit or bucket types of toilet facilities in their households also have better nutritional status compared to the children living in households without any toilet facility. The results are indicative of the importance of safe drinking water and better toilet facilities for improving child survival in Pakistan.

The ordered logistic regression analysis shows that children born at least 3 years after the preceding birth interval are significantly taller in Pakistan. Children who have more than 5 living siblings are significantly shorter than children who do not have any living siblings. This may be due to food competition between siblings in the family.

Our results clearly indicate that the children in families with shorter birth intervals and higher number of living siblings are at a higher risk of stunting. Longer intervals between births will allow more time for the allocation of sufficient family resources for the provision of food for additional needs of these children. In addition, the nutritional problems are also compounded when another child is born with shorter birth interval. Therefore, information, education, and communication efforts should encourage mothers not only 3-4 years intervals between births to reduce stunting, but also nutritional vulnerabilities as well as the attention needed for these children. Moreover, use of family planning to increase birth intervals and reduced family size can result in significant reductions in childhood stunting.

The analysis shows a curvilinear relationship between stunting and child age. It is because in early childhood nutritional needs are greater in relation to weight than at any time later in the life. Therefore, the opportunity for growth retardation is greater in early childhood, partly because more growth is taking place during this period. Moreover, infections limit growth in very young children because episodes are more frequent and more severe. The findings of this analysis show that diarrhea has a greater negative impact on child's nutritional status as the child grows. Diarrheal diseases are widespread in Pakistan. This analysis finds that the diarrheal disease is strongly associated with lower heights in children. In Pakistan, the ORS packets are distributed through the government service delivery outlets for free. In many cases people are taught how to use ORS, but do not use it because it does not conform to their understanding of the character of diarrhea. It is a common practice in Pakistan that mothers reduce the feeding or even stop feeding the child during diarrhea because they believe that giving food will increase the stool output and thus it make the diarrhea worse. To prevent growth faltering, good nutrition must be maintained both during and after an episode of diarrhea. This can be achieved by continuing to give considerable amounts of nutritious foods throughout the episode and during the period of recovery.

However, our findings also show that boys are at a higher risk of stunting compared to the girls; but as boys grow, the odds of stunting decreases compared to girls.

The data presented in this analysis documents a disturbing picture of under-nutrition among children less than five years of age in underprivileged subgroups. The findings confirm the great magnitude of under-nutrition, which continues to hamper the physical growth and mental development of more than a half of the Pakistani children. Indeed, it is a major threat to their very survival.

The analysis shows that the causes of growth retardation are deeply rooted in poverty, unhygienic household environment, non-utilisation of the health services and lack of parental education. In order to retain girls in rural schools, free textbooks and nutritional food may be provided in disadvantaged and far-flung areas. This will result in an increase in enrolment and a reduction in the female drop out rate.

The nutritional well being of people is a precondition for the development of societies. The tragic consequences of malnutrition include death, disability, and stunted physical and mental growth and, as a result, retarded national socio-economic development [WHO (2000)].

In order to continue to allow underprivileged environments to affect child development not only perpetuates the vicious cycle of poverty, but also leads to an enormous waste of human potential. The Pakistani government may not be successful in their efforts to accelerate economic development in any significant long-term sense until optimal child growth and development are ensured for the majority.

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Comments

Child malnutrition is an important topic as it not only affect the health status of the child but also puts strains on the economic well-being of the family. In the long run it lowers the productivity of the person and future earnings. A number of studies focused on this issue and came up with estimates of the future loss in productivity and earnings of malnourished children. There are number of programs in developed countries to ensure the normal growth of the children below five years of age. Due to good care provided by these countries to their citizens the prevalence of malnutrition among children is very low or in some cases non-existent.

The empirical evidence indicates that child malnutrition is pervasive in less developed countries. The UNDP report of 1998 shows about 30 percent children below five years of age are malnourished in least developed countries of the world. The prevalence of mal nutrition in Pakistan is also far from satisfactory. The latest Nutrition survey 2001-02 shows that about 40 percent children are malnourished in Pakistan and the situation is deteriorating with time due to rampant poverty in the country.

The author has chosen a topic of prime importance for Pakistan where health indicators does not show any improvement in the last twenty plus years. A set of different independent variables are used to see their impact on the stunting which is one of the indicator of malnutrition for children. Author has used ordered logistics and multinomial logistic models to analyzed the impact of these variables. The effort of the author is commendable because of choosing very challenging job of addressing this issue. The data used for the exercise is also very rich as it provides information on socio-economic as well as health and nutrition related variables. It is a good paper however there is always room for improvement. Some of the caveats of the papers are presented below which may improve the quality of the paper.

(1) There is no explanation given in the paper for including different variables in the model. The author can briefly explain the reasons for including socio-economic, demographic and other factors and expectations about the signs of these variables.

(2) The interpretation of the results is also very general and not properly explained or discussed in details. Some statements are included in text without any empirical grounds.

(3) The comparisons of the malnutrition among children are made with the standard population of children from the developed countries and not from

the standard population of the Pakistan. There is substantial difference in the food intake behaviour and food habits in developed countries and underdeveloped countries. Due to these differences the nutritional standards and their outcome differs in these countries. If we analyse the nutritional status of the children of underdeveloped country and compare it with developed countries, we not be able to draw policy conclusions relevant to LDCs. And therefore the comparison looses its credibility.

(4) There are three interrelated measures i.e. stunting, wasting and underweight. One can see the real picture if all three measures are taken into consideration while doing the analysis. The paper uses only one and made sweeping conclusion.

(5) Data is not properly described and there is no definition of some of the important variables in the paper.

In the end I must say that the paper with all its weaknesses provide a good empirical evidence of socio-economic , demographic and nutritional factors having impact on the nutritional status of the children under five.

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