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# Weaning initiation patterns and subsequent linear growth progression among children aged 2–4 years in India

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| **Background** | Reliance on full breastfeeding alone for a longer time could have deleterious nutritional and health implications at later stages of children's lives. About 47% of children are weaned at age ⩾6 months and more than 50% of children in India under 4 years are stunted. We investigated the association between timing of weaning and stunting of children in India, using the data from National Family Health Survey, 1992–1993. |
| **Methods** | Logistic analyses were employed on pooled data comprising one state each from six regions of India (N = 6285) with height status of children aged 2–4 years as the dependent variable. Timing of weaning was considered as the main control variable in the regression models. |
| **Results** | Children weaned at age 6 months (odds ratio [OR] = 1.57) and after 6 months (OR = 1.88) were more likely to be stunted at later age compared with those weaned before 6 months ($P < 0.001$). Stunting appeared to be considerably lower for children weaned at age 3 months and showed an upward trend thereafter. The effect of age at weaning on stunting attenuated but persisted with statistical significance after controlling for important demographic, health, social and region variables. The likelihood of stunting was 77% for children weaned at age >6 months who had not received full immunization in the first year and had lived in poor conditions. |
| **Conclusions** | Timing of weaning is significantly associated with stunting among children in India. The underlying causal associations between weaning behaviour and growth retardation need to be further examined by using longitudinal data. |


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| **Keywords** | Weaning, stunting, full breastfeeding, complementary feeding, India/regions, logistic models, NFHS, social and health care utilization factors |
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The health of children is related to many inter-linked biological and behavioural processes; the relative importance of the mothers' characteristics and the onset of growth processes from conception to childhood have been well documented in scientific research.[1–5] The Mosley and Chen model on child survival in less developed countries proposed that growth faltering and mortality are the cumulative consequences of multiple disease processes including their bio-social interactions that operate through a set of intermediate variables.[1] For example, maternal factors, environmental contamination through infectious agents, nutrient availability, injury, personal illness, and control factors are intermediate variables that affect the malnutrition infections syndrome eventually influencing the demographic outcome.

Among other important intermediate variables, breastfeeding plays a vital role in determining the health and survival of children. Breast milk contains several nutrients and antimicrobial constituents mainly macrophages, lymphocytes and anti-streptococcal factors that protect the baby against viral and bacterial infections.[6,7] The age at which complementary foods (CF) are introduced is a sensitive time in infant growth since breast milk alone is insufficient to meet their full nutritional needs. Over time, there has been considerable discussion on the ideal age at introduction of CF and the optimal duration of exclusive breastfeeding.[8] The World Health Assembly in 1990, 1992 and 1994 suggested 4–6 months and about 6 months,

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respectively, as an ideal age for introducing CF.[9] However, the recent WHO/UNICEF guidelines recommend exclusive breastfeeding for 6 months and the introduction of CF at 6 months of age.[9,10] Exclusive breastfeeding refers to breastfeeding without offering any CF including plain water/tea. If breast milk is given along with plain water/tea, it is referred to as predominant breastfeeding. The term full breastfeeding (FB) refers to either truly exclusive or predominant breastfeeding.[9] The guidelines also suggested that breastfeeding should be continued along with CF until the child is ⩾2 years. This policy is widely adopted particularly in developing countries including India where more than 50% of children <4 years are undernourished.[11–13] According to the National Family Health Survey (NFHS; 1998–1999) that recently published the All-India Report, the proportion of undernourished children did not decline much in India compared with NFHS (1992–1993); the decline is less than 10%.[11,14] The NFHS also indicates that breastfeeding is almost universal in India (95%). Mothers continue breastfeeding for more than 2 years and many rely on FB even after 6 months.[11,15] Mothers' reliance on FB for a longer duration posits a need to examine the growth potentials of their children at later ages.

Some research studies that examined the role of breastfeeding on infant growth pointed out that energy and nutrient supply from breast milk beyond 4–5 months might be inadequate for meeting an infant's nutritional needs.[15–17] Research in African countries showed that mothers deliberately postpone introduction of CF especially amongst undernourished children.[18–21] A recent study based on NFHS reported that breastfeeding with an introduction of CF below 4 months is advantageous in reducing early infant mortality in India.[22] Timing of weaning is socially and bio-culturally patterned and varies across societies.[23,24] It is determined by the mother's characteristics, her choices, her knowledge and perceptions about child's health or cultural beliefs related to breastfeeding.

The main objective of this paper is to examine the associations between timing of weaning and height status of the children at later ages controlling for important demographic, social and health variables. We use the height-for-age (HFA) as an indicator of nutritional status. Height-for-age is unlikely to be influenced by the factors present at survey such as child morbidity, infections/diarrhoea, or food/nutritional intake. A low HFA indicates chronic under-nutrition or nutritional stunting. Height-for-age is a stable measurement of growth and is sensitive to changes in nutritional levels and health status in the past. This study is based on cross-sectional data from the NFHS conducted in India during 1992–1993. Because of wide inter-state social and cultural differences, a detailed analysis is restricted to one selected state each from six regions of India.

## Materials and Methods

### Data source

The NFHS is the first nationally representative survey that collected demographic, social, health and anthropometric information simultaneously. The survey was initiated by the Ministry of Health and Family Welfare, Government of India and co-ordinated by the International Institute for Population Sciences, Mumbai. The survey adopted a systematic, stratified sample design of households and collected data from 89 777 ever-married women aged 13–49 years from 88 562 households.[11] Data was collected between April 1992 and September 1993 from 25 states including Delhi, which comprise 99% of the total population of India.

### Description of measures

#### *Stunting*

Stunting is defined in terms of HFA. The proportion of children who are more than 2 standard deviation units (z-score) below the median of the international reference population are considered stunted and those who fall more than 3 SD units below are severely undernourished. The z-scores derived using ANTHRO software are based on the NCHS/CDC/WHO international growth reference curves.[25] The data from the US Health Examination Surveys were found to be most representative of the growth reference curves that also closely approximated a normal distribution. This international growth reference, approved by a WHO working group on nutritional surveillance, has been widely used and is also found appropriate for measuring the nutritional status of Indian children.[26] Detailed descriptions of the reference population have been reported elsewhere.[25,27] The NFHS measured height (in centimetres) for each living child born since January 1988. Children aged <2 years were measured lying down and those aged ⩾2 years were measured in standing positions. The anthropometric measurements of children were taken after women's interviews in three phases during 1992–1993. Height was not measured in the states covered under the first phase because height measuring boards were not available at that time.[11] The survey reported that 15.5% of living children were not measured at the all India level. The reasons included were: the mother refused (5.4%), child not present (5.5%), child was sick (1.4%), child refused (2.6%), or other reasons (0.6%). The reasons reported did not differ by states. A negligible proportion (0.2%) of children with grossly improbable measurements are excluded. Children's age in months is derived from a detailed birth history collected in the survey.

#### *Weaning*

In this study, we use the term FB, which may be either truly exclusive or predominant breastfeeding. We define timing of weaning as the age at which FB is concluded by the introduction of either formula, milk other than breast milk, or any other liquids (except plain water), or any solid/mushy foods. Age at weaning was self-reported by mothers for children born since January 1988 until the survey. The NFHS asked the following question. 'Was the child ever given water or anything else to drink or eat other than breast milk?' If children received foods other than breast milk on a regular basis, NFHS recorded the age at introduction of each CF (plain water, formula or milk other than breast milk, any other liquids, any solid/mushy food). Although NFHS made a distinction between plain water and other types of liquids given, it did not collect specific information on the type of other liquids given. In this study, children who were given only plain water along with breast

milk are not considered weaned, but those who were given other liquids, which can be sugar/honey water, tea or juice, are considered weaned. If mothers gave CF to children aged <1 month, NFHS coded those responses as 0. In other words the code '0' indicates the first month of life not yet completed. To be precise, in the survey, 4 months is defined as the end of first 4 months of life. For children aged <1 month (pooled data, selected states), 45% received plain water (median: 1 month), 17% received formula or milk other than breast milk (median: 4 months), 3% any other liquids (median: 8 months) and less than 0.5% received solid/mushy foods (median: 10 months). We found age heaping at the 0th, 6th and 12th months in the data, especially in the states where female literacy is low, for example in Uttar Pradesh (UP) and Bihar. About 1% of children (pooled data; N = 7822) were excluded from the analysis since mothers did not report age at weaning (0.6%) or reported not to have given any CF (0.5%).

### Statistical analysis

Logistic regression models are used with a dichotomized classification of z-scores based on height status as the dependent variable. Stunted children are coded 1 and well-nourished are coded as the reference group. Timing of weaning is classified as an independent variable. We coded weaning at age <6 months as the reference category. This classification is made to understand the effect of weaning on stunting particularly at 6 months and after. We purposefully selected children aged 24–47 months (N = 6285) whose height was measured in order to analyse weaning initiation behaviour without censoring problems. For example, it is possible that some children below 2 years could be under FB at survey. Since the effect of age at weaning on stunting could be influenced by factors such as age or mother's education, we controlled for some important demographic, social and health factors in the regression models. We used weighted data to adjust sampling variations.[11] Multicollinearity problems are considered and variables that are significant in the likelihood ratio tests are included in the regression models.

## Results

Based on the z-scores, the NFHS data indicate that more than one-half of children aged under 4 years in India are stunted and more than a quarter are severely undernourished (Table 1). The northern, the central and the eastern states are particularly disadvantaged in terms of proportion stunted, about 60% each in Bihar and UP. The proportion of undernourished children is comparatively low in the north-eastern states. The position of Kerala and Goa, where health care utilization is high, is different from other states.

The introduction of CF starts quite late among children in India, especially in the central and the eastern regions except West Bengal. It is quite paradoxical to observe that children weaned earlier are comparatively less stunted. One of the least populated states, i.e. Meghalaya in the north-east is an exception; here the prevalence of stunting is high despite the very early introduction of CF. For a detailed analysis, we focus on a selected state from each region based on population size. The selected states that are comparatively disadvantaged with regard to nutritional status of children include UP from central India, Bihar from the east, Assam from the north-east and Karnataka from the south. In contrast, we selected Punjab from the north and Goa from the west to represent states with a comparatively lower proportion of stunted children. The selected states from six regions cover about 38% of total population in India.[28]

Over 60% of children weaned at ⩾6 months of age are stunted and age variations are apparent, though fluctuating, over different age groups (Table 2). The prevalence of stunting is high among children aged 42–47 months who are weaned at ⩾6 months. The sex differences appear to be tenuous in the selected states except Assam and Goa (Table 3). Although stunting is generally a little higher among males, females weaned at age 6 months are comparatively more stunted than males in Punjab and Goa.

The pooled data show that stunting gradually increases as weaning is postponed to age ⩾6 months. On the other hand, stunting shows an upward trend for children weaned between 0 and 2 months, and then decreases sharply at 3 months and increases steadily thereafter (Figure 1). The results of bivariate analysis of the selected factors that influence stunting are shown in Table 4. Maternal age, birth order, and current age of children are the demographic variables. Sex of children is not considered further in the analysis because of negligible differences. Immunization status (susceptibility) refers to children who received full immunization in their first year (BCG, 3 doses each of DPT and OPV and measles). We did not consider birthweight in the analysis; since mothers self-reported this information it could be possibly biased, especially in the states where health services utilization and female literacy are low. Frequency of antenatal care and place of delivery are considered proxy variables for health care utilization. Education, place of residence, standard of living and occupation of mother are the social factors considered.

We estimated several regression models based on the pooled data and results are shown only for selected models (Table 5). In the absence of other control variables, the odds of stunting increased significantly ($P < 0.001$) as weaning is postponed to age 6 months (OR = 1.57, 95% CI: 1.34–1.84), and after 6 months (OR = 1.88, 95% CI: 1.67–2.10). The effect of age at weaning on stunting remained the same when we controlled for demographic variables (not shown). However, it reduced in Model II when we controlled for demographic, susceptibility and health care utilization variables, retaining statistical significance (OR = 1.28 for weaning at 6 months and OR = 1.36 for weaning >6 months). The inclusion of social (with education) and region (state) variables in Model III further attenuated the effects of age at weaning on stunting ($P < 0.05$). Similar effects persisted when the variable education was replaced by standard of living along with other variables in Model III. All the other variables, except place of residence, were found to be significantly associated with stunting. Interactions tested between age at weaning and education/living conditions did not yield any significant result (not shown). In a separate model that controlled for selected variables, we found that the likelihood of stunting is as high as 77% for children weaned at age >6 months, who had not received full immunization in the first year and had lived in poorer conditions (Table 6).

**Table 1** Stunting and timing of weaning among children, India and states, 1992–1993

| | Per cent of children | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Height for age[a] | | | Timing of weaning (in months)[b] | | | | |
| **State** | Stunted | Severely stunted | N | <6 | 6 | >6 | Median | N |
| **India** | 52.0 | 28.9 | 26 982 | 53.5 | 15.6 | 30.9 | 5 | 21 066 |
| **North** | | | | | | | | |
| Delhi | 43.2 | 19.3 | 1464 | 69.6 | 13.6 | 16.8 | 3 | 836 |
| Haryana | 46.7 | 19.3 | 1398 | 62.3 | 15.3 | 22.4 | 4 | 765 |
| Himachal Pradesh | na | na | na | 66.1 | 12.5 | 21.4 | 4 | 664 |
| Jammu & Kashmir[c] | 40.8 | 18.6 | 1139 | 78.2 | 12.3 | 9.5 | 1 | 677 |
| Punjab | 40.0 | 15.7 | 1158 | 77.0 | 10.6 | 12.4 | 2 | 652 |
| Rajasthan | 43.1 | 26.6 | 1754 | 34.4 | 22.8 | 42.8 | 6 | 1219 |
| **Central** | | | | | | | | |
| Madhya Pradesh | na | na | na | 37.5 | 17.6 | 44.9 | 6 | 1475 |
| Uttar Pradesh | 59.5 | 35.6 | 5586 | 48.4 | 14.5 | 37.1 | 6 | 3189 |
| **East** | | | | | | | | |
| Bihar | 60.9 | 39.5 | 2515 | 27.3 | 19.8 | 52.9 | 7 | 1493 |
| Orissa | 48.2 | 25.2 | 1492 | 45.3 | 13.0 | 41.7 | 6 | 981 |
| West Bengal | na | na | na | 66.7 | 13.5 | 19.8 | 2 | 1008 |
| **North East** | | | | | | | | |
| Arunachal Pradesh | 53.9 | 27.9 | 330 | 62.9 | 17.4 | 19.7 | 5 | 264 |
| Assam | 52.2 | 26.3 | 1351 | 64.8 | 11.2 | 24.0 | 4 | 878 |
| Manipur | 33.6 | 16.0 | 432 | 66.0 | 25.2 | 8.8 | 4 | 250 |
| Meghalaya | 50.8 | 38.4 | 354 | 87.7 | 5.2 | 7.1 | 1 | 325 |
| Mizoram | 41.3 | 16.0 | 356 | 58.8 | 19.0 | 22.2 | 5 | 221 |
| Nagaland | 32.4 | 13.2 | 432 | 80.3 | 9.7 | 10.0 | 4 | 238 |
| Tripura | 46.0 | 21.3 | 291 | 64.2 | 12.9 | 22.9 | 2 | 271 |
| **West** | | | | | | | | |
| Goa | 32.5 | 11.0 | 959 | 75.1 | 10.5 | 14.4 | 3 | 547 |
| Gujarat | 48.2 | 25.3 | 1405 | 44.3 | 23.6 | 32.1 | 6 | 792 |
| Maharashtra | 48.5 | 23.5 | 1536 | 40.0 | 15.3 | 44.7 | 6 | 972 |
| **South** | | | | | | | | |
| Andhra Pradesh | na | na | na | 30.0 | 25.6 | 44.4 | 6 | 780 |
| Karnataka | 47.6 | 22.7 | 1677 | 47.0 | 14.1 | 38.9 | 6 | 1035 |
| Kerala | 27.4 | 9.0 | 1353 | 84.4 | 11.8 | 3.8 | 3 | 757 |
| Tamil Nadu | na | na | na | 66.3 | 14.0 | 19.7 | 4 | 777 |

[a] Source: IIPS (1995). Information based on children born 1–47 months preceding the survey.

na denotes not available because the states surveyed in the first phase of NFHS did not measure children's height.

Stunted refers to percentage of children who fall more than two standard deviation units below the median of the international reference population and those who fall below three standard deviation units below the reference median are considered severely undernourished for their ages.

[b] Information on weaning is provided only for children aged 24–47 months as many young children could be currently under full breastfeeding at the time of survey. N refers to the total number of children.

[c] Jammu region of Jammu and Kashmir.

## Discussion

The overall prevalence of stunting is extremely high in India. The introduction of CF below 6 months of age significantly reduces stunting among children aged 24–47 months in India. Sex differentials in relation to timing of weaning and stunting are insignificant. The effect of age at weaning on stunting persisted with higher statistical significance both in the presence and absence of other important control variables. Nevertheless, the inclusion of demographic, health, social and region variables mediated and attenuated the weaning effects on stunting. Contrary to existing policy recommendations, our study suggests that reliance on FB alone to 6 months may not be a good solution for the optimal growth of children. Stunting appears to be comparatively lower for children weaned at completed age 3 months.

Weaning is socially and culturally influenced within and across Indian regions. We found that children born in Punjab or Goa are comparatively well nourished where CF is introduced relatively early. The situation is different in states, for example

**Table 2** Proportion of stunted children by timing of weaning and current age for the selected states of India, 1992–1993

| States/age of child (in months) | Timing of weaning (in months) | | | |
|---|---|---|---|---|
| | <6 | 6 | >6 | N |
| **Combined** | | | | |
| 24–29 | 52.1 (891) | 63.6 (272) | 62.0 (643) | 1806 |
| 30–35 | 58.7 (703) | 69.4 (186) | 74.8 (424) | 1313 |
| 36–41 | 58.6 (850) | 66.2 (237) | 71.3 (616) | 1703 |
| 42–47 | 61.4 (677) | 73.9 (213) | 81.4 (514) | 1404 |
| **Punjab** | | | | |
| 24–29 | 34.7 (121) | 42.1 (19) | 61.1 (18) | 158 |
| 30–35 | 47.3 (112) | 70.0 (20) | 55.0 (20) | 152 |
| 36–41 | 37.8 (90) | 50.0 (8) | 25.0 (12) | 110 |
| 42–47 | 48.9 (92) | 61.5 (13) | 47.6 (21) | 126 |
| **Uttar Pradesh** | | | | |
| 24–29 | 60.6 (353) | 67.6 (108) | 64.6 (285) | 746 |
| 30–35 | 70.7 (263) | 83.1 (77) | 80.5 (185) | 525 |
| 36–41 | 69.6 (362) | 68.6 (118) | 75.8 (302) | 782 |
| 42–47 | 77.0 (252) | 74.0 (77) | 87.2 (188) | 517 |
| **Bihar** | | | | |
| 24–29 | 57.1 (91) | 64.9 (74) | 67.0 (176) | 341 |
| 30–35 | 57.4 (54) | 73.8 (42) | 76.9 (108) | 204 |
| 36–41 | 61.9 (84) | 70.0 (40) | 73.2 (153) | 277 |
| 42–47 | 75.0 (92) | 82.6 (69) | 84.5 (181) | 342 |
| **Assam** | | | | |
| 24–29 | 59.7 (134) | 63.0 (27) | 57.6 (59) | 220 |
| 30–35 | 68.5 (92) | 42.9 (14) | 63.3 (30) | 136 |
| 36–41 | 53.8 (117) | 53.8 (26) | 51.9 (52) | 195 |
| 42–47 | 50.0 (76) | 56.3 (16) | 69.6 (23) | 115 |
| **Goa** | | | | |
| 24–29 | 22.5 (89) | 46.7 (15) | 40.0 (25) | 129 |
| 30–35 | 36.8 (95) | 46.2 (13) | 66.7 (21) | 129 |
| 36–41 | 37.6 (85) | 38.5 (13) | 28.6 (14) | 112 |
| 42–47 | 34.1 (88) | 50.0 (8) | 62.5 (16) | 112 |
| **Karnataka** | | | | |
| 24–29 | 54.4 (103) | 69.0 (29) | 52.5 (80) | 212 |
| 30–35 | 50.6 (87) | 40.0 (20) | 68.3 (60) | 167 |
| 36–41 | 58.0 (112) | 78.1 (32) | 77.1 (83) | 227 |
| 42–47 | 51.9 (77) | 73.3 (30) | 77.6 (85) | 192 |

N refers to total number of children; figures in parentheses denote the total number of children in each category; women who did not report month of weaning are excluded from the analysis.

**Table 3** Proportion of stunted children aged 24–47 months by timing of weaning and sex for the selected states of India, 1992–1993

| States/ sex of child | Timing of weaning (in months) | | | |
|---|---|---|---|---|
| | <6 | 6 | >6 | N |
| **Combined** | | | | |
| Male | 57.9 (1693) | 66.0 (467) | 73.9 (1115) | 3275 |
| Female | 56.8 (1427) | 70.0 (440) | 69.3 (1084) | 2951 |
| **Punjab** | | | | |
| Male | 40.3 (238) | 42.4 (33) | 61.3 (31) | 302 |
| Female | 44.1 (177) | 74.1 (27) | 40.0 (40) | 244 |
| **Uttar Pradesh** | | | | |
| Male | 68.9 (673) | 70.8 (192) | 78.3 (489) | 1354 |
| Female | 68.7 (556) | 74.2 (186) | 72.8 (471) | 1213 |
| **Bihar** | | | | |
| Male | 63.9 (166) | 74.1 (112) | 76.6 (334) | 612 |
| Female | 63.2 (155) | 71.7 (113) | 74.0 (285) | 553 |
| **Assam** | | | | |
| Male | 55.4 (222) | 56.8 (37) | 62.4 (85) | 344 |
| Female | 61.4 (197) | 55.3 (47) | 53.8 (80) | 324 |
| **Goa** | | | | |
| Male | 38.9 (193) | 32.1 (28) | 54.5 (33) | 254 |
| Female | 25.6 (164) | 61.9 (21) | 46.5 (43) | 228 |
| **Karnataka** | | | | |
| Male | 57.7 (201) | 69.2 (65) | 66.4 (143) | 409 |
| Female | 50.0 (178) | 65.2 (46) | 71.5 (165) | 389 |

N refers to total number of children; figures in parentheses denote the total number of children in each category; women who did not report month of weaning are excluded from the analysis.

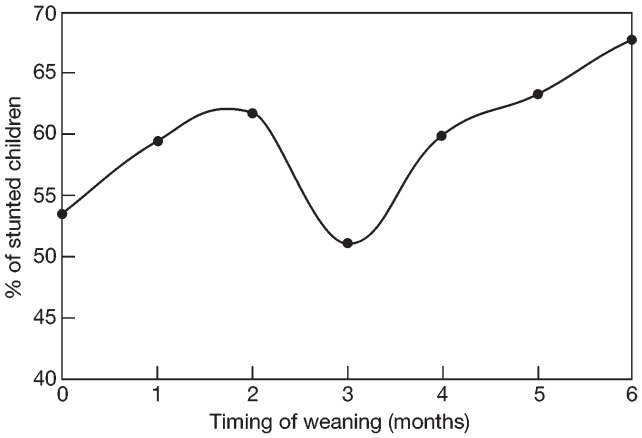


**Figure 1** Proportion of stunted children aged 2–4 years by timing of weaning, pooled data (selected states), India

Bihar and UP, where female education, health care utilization and living conditions are comparatively poorer than in other states. Whilst it concerns poverty, mothers may have less options to initiate early weaning, they rather rely on FB.[29–31] Formula/milk foods that are usually expensive to buy seem to play little role in the states that are still caught up in poverty with large families. An option could be to educate mothers about when and how to start weaning with an emphasis on the use of better home made weaning foods.[32]

This study has some limitations. Unfortunately, we could not derive from the survey whether stunting precedes or follows late introduction of CF. A reverse causality (malnutrition causing late introduction or late introduction causing malnutrition), as found in African studies, might be plausible in India. Moreover, we do not have information in the survey about the type of CF introduced at the time of weaning and in later periods, which could also influence the growth of children. Mothers' response on age at weaning is considered quite reliable since the recall

**Table 4** Summary of selected control variables used in the multivariate logistic regression model

| | Proportion of stunted children aged 24–47 months | | | | | | |
|---|---|---|---|---|---|---|---|
| **Variable** | All N = 6283 | Punjab N = 548 | Uttar Pradesh N = 2596 | Bihar N = 1176 | Assam N = 672 | Goa N = 487 | Karnataka N = 804 |
| **Timing of weaning** | | | | | | | |
| <6 months | 57.4 | 41.9 | 68.8 | 63.6 | 58.2 | 32.8 | 54.1 |
| 6 months | 67.8 | 56.7 | 72.3 | 72.9 | 55.4 | 44.9 | 67.6 |
| >6 months | 71.6 | 49.3 | 75.7 | 75.4 | 58.2 | 50.0 | 69.2 |
| **Demographic** | | | | | | | |
| Mother's age at birth | | | | | | | |
| <20 years | 69.3 | 57.5 | 74.0 | 73.9 | 66.9 | 70.0 | 59.8 |
| 20–27 years | 61.9 | 41.2 | 69.8 | 70.5 | 53.5 | 38.6 | 62.4 |
| ⩾28 years | 65.4 | 49.6 | 74.7 | 72.9 | 58.9 | 32.9 | 61.7 |
| Birth order | | | | | | | |
| 1 | 57.7 | 40.4 | 68.7 | 69.4 | 54.5 | 24.4 | 55.6 |
| 2 | 60.0 | 40.1 | 71.7 | 68.8 | 46.3 | 38.0 | 54.8 |
| 3+ | 68.8 | 50.2 | 73.5 | 73.9 | 62.4 | 49.2 | 69.4 |
| Current age of child | | | | | | | |
| 24–29 months | 57.6 | 38.6 | 63.6 | 64.2 | 59.0 | 29.2 | 55.9 |
| 30–35 months | 65.4 | 51.0 | 75.9 | 71.0 | 65.2 | 43.1 | 56.0 |
| 36–41 months | 64.4 | 37.3 | 72.2 | 69.4 | 53.1 | 37.7 | 67.8 |
| 42–47 months | 70.6 | 50.4 | 80.3 | 81.7 | 54.7 | 39.8 | 65.8 |
| **Susceptible** | | | | | | | |
| Immunization status[a] | | | | | | | |
| Yes | 52.9 | 42.3 | 64.3 | 65.1 | 52.0 | 34.6 | 53.9 |
| No | 70.0 | 49.2 | 74.9 | 73.0 | 59.5 | 44.8 | 70.6 |
| **Use of health care services** | | | | | | | |
| Frequency of antenatal care | | | | | | | |
| None | 74.2 | 54.4 | 75.7 | 76.3 | 64.3 | 69.0 | 75.4 |
| 1–5 times | 58.9 | 43.7 | 68.8 | 62.8 | 52.7 | 51.5 | 60.9 |
| >5 times | 38.0 | 41.2 | 43.2 | 41.5 | 39.5 | 28.1 | 45.9 |
| Place of delivery | | | | | | | |
| Home and other places | 70.2 | 47.7 | 74.6 | 74.8 | 60.5 | 65.2 | 71.3 |
| Public institution | 49.5 | 40.0 | 53.7 | 46.8 | 43.5 | 42.9 | 58.6 |
| Private institution | 35.4 | 29.2 | 52.8 | 55.6 | 25.0 | 23.3 | 33.1 |
| **Social** | | | | | | | |
| Education of mother | | | | | | | |
| None | 72.1 | 53.4 | 76.1 | 76.8 | 63.4 | 54.2 | 71.2 |
| 1–7 years of schooling | 53.8 | 39.0 | 68.9 | 52.6 | 58.2 | 31.7 | 55.6 |
| >7 years of schooling | 39.7 | 32.2 | 51.3 | 48.8 | 28.9 | 26.5 | 35.4 |
| Place of residence | | | | | | | |
| Urban | 54.9 | 43.8 | 67.2 | 64.9 | 44.4 | 35.7 | 49.0 |
| Rural | 66.4 | 44.7 | 73.2 | 72.9 | 59.1 | 38.8 | 67.1 |
| Standard of living | | | | | | | |
| Low | 72.2 | 60.3 | 76.1 | 74.7 | 61.9 | 54.3 | 74.3 |
| Medium | 64.1 | 52.4 | 72.4 | 72.3 | 56.0 | 39.2 | 56.8 |
| High | 38.0 | 30.2 | 55.9 | 46.5 | 17.9 | 21.6 | 25.0 |
| Occupation of mother | | | | | | | |
| Not working | 62.6 | 44.4 | 71.6 | 68.7 | 56.4 | 36.5 | 55.5 |
| Working | 69.6 | 46.2 | 75.1 | 81.7 | 63.6 | 40.2 | 69.4 |

Missing cases are excluded from the analysis.

[a] Restricted to children who received full immunization (BCG, DPT, OPV and measles) in their first year.

**Table 5** Odds ratios (with 95% CI) of stunting associated with timing of weaning, gross effect and effects controlled for selected variables, pooled data of selected states in India, 1992–1993

| | **Odds ratios** | | |
|---|---|---|---|
| **Variable** | Model I | Model II | Model III |
| **Timing of weaning** | | | |
| <6 months | 1.00 | 1.00 | 1.00 |
| 6 months | 1.57*** (1.34–1.84) | 1.28** (1.09–1.51) | 1.18* (1.04–1.32) |
| >6 months | 1.88*** (1.67–2.10) | 1.36*** (1.19–1.50) | 1.17* (1.04–1.32) |
| **Demographic** | | | |
| Mother's age at birth | | | |
| <20 years | na | 1.00 | ns |
| 20–27 years | | 0.73*** (0.61–0.87) | |
| ⩾28 years | | 0.70** (0.56–0.86) | |
| Birth order | | | |
| 1 | na | 1.00 | ns |
| 2 | | 1.02 (0.87–1.20) | |
| 3+ | | 1.31*** (1.11–1.54) | |
| Current age of child | | | |
| 24–29 months | na | 1.00 | 1.00 |
| 30–35 months | | 1.61*** (1.38–1.88) | 1.64*** (1.40–1.92) |
| 36–41 months | | 1.33*** (1.16–1.54) | 1.30*** (1.12–1.50) |
| 42–47 months | | 1.90*** (1.63–2.23) | 1.92*** (1.64–2.25) |
| **Susceptible** | | | |
| Immunization status | | | |
| Yes | na | 1.00 | ns |
| No | | 1.21** (1.07–1.37) | |
| **Use of health care services** | | | |
| Frequency of antenatal care | | | |
| None | na | 1.00 | 1.00 |
| 1–5 times | | 0.67*** (0.58–0.76) | 0.85* (0.74–0.97) |
| >5 times | | 0.43*** (0.35–0.53) | 0.62*** (0.50–0.78) |
| Place of delivery | | | |
| Home and other places | na | 1.00 | 1.00 |
| Public institution | | 0.68*** (0.57–0.81) | 0.72*** (0.59–0.86) |
| Private institution | | 0.46*** (0.38–0.57) | 0.54*** (0.43–0.67) |
| **Social** | | | |
| Education of mother | | | |
| None | na | na | 1.00 |
| 1–7 years of schooling | | | 0.68*** (0.58–0.80) |
| >7 years of schooling | | | 0.47*** (0.39–0.55) |
| Place of residence | | | |
| Urban | na | na | ns |
| Rural | | | |
| Occupation of mother | | | |
| Not working | na | na | 1.00 |
| Working | | | 1.16* (1.00–1.35) |
| **Region (state of residence)** | | | |
| Goa | na | na | 1.00 |
| Punjab | | | 0.82 (0.62–1.10) |
| Karnataka | | | 1.60*** (1.24–2.07) |
| Assam | | | 1.13 (0.85–1.50) |
| Bihar | | | 1.76*** (1.34–2.30) |
| Uttar Pradesh | | | 1.97*** (1.53–2.53) |
| **–2 log likelihood** | 8022 | 7503 | 7348 |
| **Constant** | 0.297*** | 0.547*** | 0.162*** |

na: not applicable; ns: not significant. Note: Results are based on forward conditional logistic regression methods. *** $P < 0.001$; ** $P < 0.01$; * $P < 0.05$.

**Table 6** Predicted probability of stunting associated with timing of weaning and for the effects of selected control variables, pooled data of selected states in India, 1992–1993

| Standard of living | Immunization status | Timing of weaning (months) | Probability of stunting |
|---|---|---|---|
| Low | Yes | <6 | 0.613 |
| Low | Yes | 6 | 0.678 |
| Low | Yes | >6 | 0.693 |
| Low | No | <6 | 0.699 |
| Low | No | 6 | 0.756 |
| Low | No | >6 | 0.769 |
| Medium | Yes | <6 | 0.546 |
| Medium | Yes | 6 | 0.615 |
| Medium | Yes | >6 | 0.632 |
| Medium | No | <6 | 0.638 |
| Medium | No | 6 | 0.702 |
| Medium | No | >6 | 0.717 |
| High | Yes | <6 | 0.332 |
| High | Yes | 6 | 0.399 |
| High | Yes | >6 | 0.417 |
| High | No | <6 | 0.423 |
| High | No | 6 | 0.494 |
| High | No | >6 | 0.512 |

–2 log likelihood: 7699; Constant: 0.459 significant at $P < 0.001$.

period was closer to survey time. It should, however, be noted that since weaning heaps at age 6 months, the weaning effects at age 6 months could be overestimated. More in-depth and longitudinal studies are needed to disentangle the underlying mechanisms and the chain of factors associated with breast-feeding and weaning behaviour and their subsequent influence on the growth of children.

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KEY MESSAGES

- In India, the overall prevalence of stunting is very high and about 47% of children are weaned at age ⩾6 months.
- Weaning at age ⩾6 months significantly increased the likelihood of stunting, even with statistical control of important demographic, health, social and region variables.
- Stunting appears to be comparatively lower among children weaned at age 3 months, and it increases gradually for children weaned from 4 months onwards.

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