Is child undernutrition associated with antenatal care attendance in Madhya Pradesh, India?

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Abstract

Context: There is a paucity of research investigating the association between antenatal care (ANC) attendance and child undernutrition in Madhya Pradesh, India. **Aim:** To determine whether body weight status in children under the age of 5 years is associated with ANC attendance in Madhya Pradesh. **Methods:** A cross-sectional study was carried out using data from India's National Family Health Survey (2005–2006). Bodyweight status (an indicator of undernutrition) was determined using weight-for-age. Descriptive statistics and logistic regression were used to estimate prevalence and obtain adjusted odds ratios (AOR) to investigate associations between ANC indicators and weight-for-age. **Results:** Majority of children were underweight (55.1%). ANC attendance was inadequate, with only 36.8% of women having four or more visits. None of the ANC indicators were associated with body weight status. Increased child age especially an age of 2 years (AOR 2.29; 1.66–3.15), belonging to a scheduled tribe [ST] (AOR 2.36; CI 1.64–3.39), scheduled caste [SC] (AOR 1.75; CI 1.25–2.45) or other backward caste [OBC] (AOR 1.43; CI 1.08–1.89) were associated with being underweight; a birth weight of ≥2.5 kg was associated with lower relative odds of being underweight (AOR 0.43; CI 0.29–0.64). Mothers who had a normal BMI (AOR 0.66; CI 0.53–0.82) or were overweight (AOR 0.42; CI 0.25–0.69) were less likely to have underweight children. **Conclusions:** ANC attendance was not associated with body weight status. Increased child age, low birth weight, poor maternal nutrition status and belonging to SCs, STs or OBCs increased the odds of child undernutrition.

Keywords: Antenatal care, child undernutrition, India, Madhya Pradesh

Introduction

Undernutrition is responsible for almost half the mortality in children under the age of 5 years.[1] The rates of child undernutrition in the state of Madhya Pradesh, India are alarmingly high, in fact, higher than the national average.[2]

ANC may be able to help in the prevention of child undernutrition by identifying at-risk mothers and providing interventions and nutritional counselling.[3] However, empirical evidence regarding associations between ANC and undernutrition in India is limited.

The aim of this study was to determine whether weight-for-age in children under the age of 5 years is associated with ANC attendance rates in Madhya Pradesh.

Methodology

Data

This study used a cross-sectional design. The NFHS-3 survey conducted in 2005–2006 is the third in a series of nationally representative household surveys administered throughout India[4] and represents the latest data available at the time of the study. The 'children's recode' dataset from NFHS-3 was used for the analysis. NFHS-3 collected data from 5,488 households in Madhya Pradesh that were representative of the population at the state level.[5] Children were eligible for analysis if they were de jure (usual) residents of the state, were fully measured in NFHS-3,

were their mother's last-born child and had a singleton birth. Multiple births were excluded, as they could increase the risk of adverse outcomes[6] and may have confounded the analysis.

The following data were used to ensure that the minimum sample size required to establish a statistically significant association was achieved from the available data. Using OpenEpi Version 3 with 95% level, 80% power and estimated odds ratio = 2.0,[7] the ratio of unexposed to exposed = 0.25 (estimated from IIPS and Macro International[5]), percentage of unexposed with the outcome = 48 (estimated from the findings of a cross-sectional study in Nigeria[8]) and the Kelsey *et al.* equation[9], yielded a required sample size of 409. After adding 10% for possible missing data, the minimum sample size required was 450. This indicated that the available sample from the NFHS-3 was adequate.

The NFHS-3 'children's recode' dataset comprises one record for every child born within the 5 years prior to the survey (0–59 months of age). Each record contains the whole of the women's questionnaire, as answered by the mother. Data on weight-for-age, ANC indicators used by IIPS and Macro International[5] and potential confounding variables identified from an extensive literature review were drawn from the dataset. IBM-SPSS for Mac version 24 was used to analyse data.

Analysis

Data were cleaned and cases whose weight or age was improbable or cases whose weight-for-age z-scores were flagged as implausible (6.9%; 123 cases) were excluded, yielding a final sample of 1656 cases for analysis. All 'do not know' responses were treated as missing, as these responses had no informational value to contribute to the study's aim.[10] Values for those 'not weighed at birth' were set to missing. All continuous variables were recoded to be categorical. Categories chosen were justified as being drawn from recommendations of reputed institutions such as the World Health Organisation or prior scholarly research.

It was seen that 62% (1027 cases) were missing birth weight data, mostly because they were 'not weighed at birth'. This was too high and could have subjected the findings to bias, as the majority of cases would have been excluded from the regression model.[11] Birth weight has been found to be one of the most important predictors of undernutrition in children and hence, it was imperative to include this variable in the analysis.[12] Cases with missing birth weight data were initially deleted from the dataset list-wise. However, differences in the characteristics of the population studied were large and could have introduced bias.[13] Also, the aim of this study was the extrapolation of findings to the entire target group and not just to those who had complete birth weight data.[14] Therefore, 'not weighed at birth' was treated as a separate category to prevent the exclusion of these cases from the analysis.[11,15] Nearly 92.6% (1533 cases) were then complete, which was considered acceptable.[16]

A univariate analysis was conducted using logistic regression to assess the independent effect of each predictor variable and potential confounder on weight-for-age. Statistical significance at $P < 0.1$ was considered the criterion for a variable to be included in the multivariate model,[15] as a cut-off of $P < 0.05$ can overlook variables that could potentially be important in the multivariate model.[17]

The multivariate logistic regression model was fitted with all the variables found to be univariately associated with weight-for-age at $P < 0.1$. Variables were then eliminated from the analysis in a backward stepwise manner, that is, all variables with $P > 0.05$ in each model were removed. This was continued until all the variables that remained had statistically significant associations with underweight status.[18]

Ethics

All data used in this study were de-identified at the source. Individuals and households only had a case ID, which did not allow the researcher to identify them. Informed consent had been obtained from each woman prior to commencing the interview.[19]

The Demographic and Health Surveys (DHS) programme consented to the use of the NFHS-3 datasets for this research. Ethics committee approval was obtained from the University of Liverpool. Date: 16-03-2017.

Results

Missing data

There were no missing data for most of the variables and missing data were less than 0.2% for the other few variables. However, birth weight had 83 (5%) missing and the use of iron-folic acid (IFA) supplements had 21 (1.3%) missing. These were mostly due to 'do not know' and 'other' responses.

Characteristics of participants

A total sample of 1656 children under the age of 5 years was studied.

Child level indicators

Majority of children were of age 0 (25.7%; 426/1656) or 1 (25.7%; 425/1656). Over half the children were male (54.5%; 903/1656). The proportion that was 'not weighed at birth' was high (60%; 944/1573). Almost half the children were breastfed only after the first 24 h (40.9%; 678/1656). Most children were from birth orders ranging from 1 to 5 (89.6%; 1482/1656). The frequency of fever or diarrhoea in the past 2 weeks was low at less than 17%.

Maternal level indicators

Large proportions of mothers were uneducated (44.5%; 737/1656) and currently unemployed (64.6%; 1070/1656). Many of them were underweight (39.1%; 647/1653). A sizeable proportion was between the ages of 20 and 29 years at the time of childbirth (70.9%; 1175/1656).

Household level indicators

A vast majority of families were of the Hindu religion (88.4%; 1464/1656) and belonged to scheduled tribes (STs), scheduled castes (SCs) or other backward castes (OBCs) (76.6%; 1267/1655). Over half (54.3%; 899/1656) lived in rural areas. Most households used improved sources of drinking water (80.6%; 1333/1654) but an alarming 56.4% (934/1656) had no toilet facility. A large proportion was concentrated in either the poorest (30%; 496/1656) or richest (23.2%; 385/1656) wealth index. More than half had two or more children under the age of 5 years (53%; 877/1656).

Underweight Status and ANC Indicators

Over half the children sampled were underweight (55.1%; 913/1656). ANC attendance was inadequate, with only 36.8% (608/1652) of women receiving the recommended number of at least four visits during pregnancy. Most of these women had their first visit in the first trimester (57.35%; 804/1402), although a sizeable number did access ANC only in their second trimester (33.24%; 466/1402). Most mothers received the recommended doses of tetanus toxoid (TT) injections during pregnancy (80.7%; 1334/1654) but the proportion that had used IFA supplements for at least 90 days (20.5%; 335/1635) and intestinal parasite drugs (3.8%; 62/1652) were very low. ANC was predominantly provided by a doctor (54.2%; 761/1405), nurse or midwife (40.3%; 566/1405).

Univariate logistic regression analysis

Among the ANC indicators, number of ANC visits, the timing of the first visit, the use of TT injections and IFA supplements and ANC providers were found to have statistically significant associations with underweight status in the univariate analysis. The use of intestinal parasite drugs was not found to be statistically significant.

Age of the child, birth weight, birth order and timing of initiation of breastfeeding were significant factors. The child's gender and whether the child had fever or diarrhoea recently were not found to be associated.

Maternal level factors such as nutritional status, education and whether the mother was currently employed were significant predictors. As this study chose to include variables that were univariately associated at $P < 0.1$ in the multivariate analysis in case they became significant, the mother's age at childbirth was also included. All the household indicators had statistically significant associations with underweight status in the univariate analysis.

Multivariate logistic regression analysis

Table 1 shows the results of the final multivariate model, after the backward stepwise deletion of variables that proved not to be statistically significant ($P > 0.05$) when included in the model. Adjusted odds ratios (AOR) are presented with 95% confidence intervals and the corresponding P values. The analysis

Table 1: Final multivariate logistic regression model showing predictors of underweight status in a sample of children under the age of 5 years in Madhya Pradesh, 2005-2006

	Adjusted OR (95% CI)	*B*	S.E.	Wald	df	Sig.
Child age						
0	1.00					
1	1.65 (1.23-2.20)	0.498	0.147	11.432	1	0.001
2	2.29 (1.66-3.15)	0.828	0.163	25.871	1	<0.001
3	1.74 (1.25-2.41)	0.551	0.168	10.704	1	0.001
4	1.65 (1.15-2.38)	0.502	0.186	7.311	1	0.007
Birth weight						
<2.5 kg	1.00					
≥2.5 kg	0.43 (0.29-0.64)	-0.839	0.201	17.504	1	<0.001
Mother's nutritional status						
Underweight	1.00					
Normal	0.66 (0.53-0.82)	-0.419	0.112	13.910	1	<0.001
Overweight	0.42 (0.25-0.69)	-0.873	0.254	11.810	1	0.001
Caste/Tribe						
SC	1.75 (1.25-2.45)	0.561	0.171	10.789	1	0.001
ST	2.36 (1.64-3.39)	0.857	0.185	21.381	1	<0.001
OBC	1.43 (1.08-1.89)	0.356	0.143	6.161	1	0.013
None of the above	1.00					

Omnibus Tests of Model Coefficients (OMTC) Chi-square 153.738 (df=11) *P*<0.001. Note: SC - Scheduled caste; ST - Scheduled Tribe; OBC - Other backward castes

revealed that none of the ANC indicators were associated with underweight status. However, other predictors were identified. Increased child age especially an age of 2 years (AOR 2.29; 1.66–3.15), belonging to an ST (AOR 2.36; CI 1.64–3.39), SC (AOR 1.75; CI 1.25–2.45) or OBC (AOR 1.43; CI 1.08–1.89) were associated with being underweight; a birth weight of ≥ 2.5 kg was associated with lower relative odds of being underweight (AOR 0.43; CI 0.29–0.64). Mothers who had a normal BMI (AOR 0.66; CI 0.53–0.82) or were overweight (AOR 0.42; CI 0.25–0.69) were less likely to have underweight children.

The Omnibus tests of model coefficients showed a large Chi-square value, indicating that the model was a significant improvement over the constant-only model and was, therefore, a valid predictor of underweight status in this population.[20]

Discussion

The multivariate analysis used in this study found that none of the ANC indicators had any statistically significant effect on underweight status. This was a surprising finding that contradicted most research considered in the literature review. However, the study identified the independent predictors of poor underweight status in Madhya Pradesh as child age, birth weight, mother's nutritional status and caste/tribe suggesting that the univariate associations seen between ANC indicators and underweight status were accounted for by associations with one or more of the independent predictors identified.[7]

A study by Juneja *et al*. in the Indian state of Uttar Pradesh found that low birth weight was associated with a lower

number of ANC visits and the use of IFA supplements for less than 100 days.[21] This study was, however, community-based and hence, not representative at the state level. Further, the authors only conducted bivariate analyses and did not adjust for confounding.[22] However, unlike NFHS-3, this study's prospective design allowed for birth weight to be recorded even for home births. The current study's results may have been limited due to the relatively large proportion of children with missing birth weight data that is apparently not actually weighed at birth.

Cross-sectional evidence by Kumar and Singh showed that SCs and STs had poorer access to ANC services than the rest of the population, due to factors such as poor socioeconomic status, education levels, rural place of residence and lower women's age at childbirth.[23] NFHS-3 reports confirm this finding, as women from STs were the least likely to receive ANC.[5]

An alternate explanation for ANC not being associated in the multivariate analysis is that, in Madhya Pradesh, it may be associated with either acute (wasting) or chronic (stunting) undernutrition in particular, as patterns for these indicators have been known to vary across age groups and settings.[24] Health outcomes are indeed the result of various factors acting together.[25] The individual effects of stunting and wasting may be masked when studied using a composite index like weight-for-age.[24]

The results of the analysis were mostly consistent with other research in similar settings. A cross-sectional study conducted by Gupta, Chakrabarti and Chatterjee in the state of West Bengal discovered that poor maternal nutrition status was a strong predictor of child undernutrition and mother's occupation was not,[26] as found in the current study. Mittal, Singh and Ahluwalia also generated similar results about mother's occupation in their analysis of children aged 1–5 years in an urban slum population.[27] Gupta, Chakrabarti and Chatterjee also found that mother's educational level was a statistically significant predictor of underweight status[26], which contradicts the findings of the current study. However, their study was carried out in a few selected districts and was not representative of the general population. Further, Gupta, Chakrabarti and Chatterjee and Mittal, Singh and Ahluwalia only conducted bivariate analyses.[26,27] The current study may, therefore, present a more representative and valid picture of the associations between these factors and weight-for-age.

This study's finding that children from STs, SCs and OBCs had a higher risk of being underweight (2.36, 1.75 and 1.43 times, respectively) confirms NFHS-3 reports of the gravely high prevalence of underweight children across these groups in Madhya Pradesh.[5] Therefore, a focus on these groups may be beneficial to reduce undernutrition.

Evidence generated by Rahman *et al.* using a large sample of secondary data drawn from the nationally representative Bangladesh Demographic Health Survey (BDHS 2011) showed that low birth weight was an independent predictor of poor underweight status, as the statistically significant association seen was not modified even after adjusting for mother's education, region of residence and wealth index.[28] These findings are consistent with those generated by the current study.

Factors such as wealth index, parental education, birth order of the child and region of residence have been found by authors such as Singh *et al.* to be associated with underweight status.[29] Shah and Bali found the type of toilet facility to be a statistically significant predictor.[30] Yet, these were not found to be statistically significant in this current multivariate analysis. The setting for Singh *et al.* study was rural India while Shah and Bali only studied one urban slum in Madhya Pradesh.[29,30] Therefore, an explanation could be that in this setting, these factors were simply confounding the true relationships seen between underweight status and the independent predictors identified.[7]

The lack of association seen with wealth index could also be explained by the fact that Madhya Pradesh has less wealth inequality when compared with more developed states.[31] For example, the percentage distribution of the population of Madhya Pradesh by the three wealth quintiles (poor, middle, rich) is 64, 13, 26, respectively whereas in Delhi the figures are 3.2, 9 and 89, respectively.[19]

The findings of this study provide data for policymakers to develop interventions to reduce child undernutrition in Madhya Pradesh. Primary care settings are best placed to address the determinants and deliver crucial interventions to prevent and diagnose undernutrition.[32] This will reduce the clinical risks and mortality associated with undernutrition and decrease future healthcare needs in the community.[33]

The use of secondary data were advantageous for this study, as producing a representative sample would have otherwise proven time consuming and expensive.[34] NFHS-3 provided robustly, representative, high-quality data on many demographic and health indicators[35] allowing for in-depth analysis.[36]

Care was taken to reduce potential bias by excluding multiple births. ANC data were only collected for the last-born child so the period of recall was not worryingly large.[37] To ensure the validity of findings,[13] missing data were carefully considered and rigorous methods were employed to reduce the percentage where possible. The resulting percentage of missing data were considered too low to bias findings.[16]

Birth weight data were a concern. Many children (60%) were not weighed at birth, perhaps because three-quarters of children in Madhya Pradesh are delivered at home.[5] Several studies assessed in the literature review did not have access to birth weight data. Nevertheless, ignoring birth weight was not an option because this could have confounded the analysis, as low birth weight is associated with the increased risk of several unfavourable child health outcomes.[38]

This study had a cross-sectional design, which allowed for the study of associations between exposure and outcome. A randomised controlled trial or prospective cohort study would have been useful to determine causation but this was not achievable due to limited time and resources.

Conclusion

This study was the first to investigate the association between ANC attendance and weight-for-age in children under the age of 5 years in Madhya Pradesh. The study found that there was a high prevalence of undernutrition in this population and ANC attendance was inadequate. However, ANC attendance was not associated with body weight status in children under the age of 5 years. Therefore, there was insufficient evidence to recommend a focus on ANC in programmes to fight undernutrition in this population. However, the association of ANC with stunting and wasting warrants future research. Increased child age, low birth weight, poor mother's nutritional status and belonging to STs, SCs or OBCs were found to be strong predictors of child undernutrition. Policymakers in Madhya Pradesh must target primary care settings and prioritise mothers, older children and those from disadvantaged groups (SCs, STs, OBCs) when developing interventions to reduce child undernutrition.

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Conflicts of interest

There are no conflicts of interest.

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