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Original article

Maternal intake of milk and milk proteins is positively associated with birth weight: A prospective observational cohort study[☆]

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SUMMARY

Background: A striking number of low birth weight (LBW) Indian babies are born annually. Previous studies have confirmed the positive association between milk intake and birth weight. However, the relations between protein and vitamin B_{12} from milk and birth weight have not been systematically explored.
Aims: We examined the relations between birth weight and maternal intake of milk, protein from milk and vitamin B_{12} from milk.
Methods: This prospective, observational cohort study was conducted in an urban South Indian hospital. The dietary intakes of milk and milk products were assessed using validated food frequency questionnaire and at delivery birth outcomes were measured. The relations between milk products, milk protein, and vitamin B_{12} from milk with birth weight and gestational weight gain were assessed in 2036 births with first trimester dietary and delivery data.
Results: Median consumption of milk products in the first trimester was 310 $g \cdot day^{-1}$ and average birth weight was 2876 g. Birth weight was positively associated with intake of milk products and of % protein from milk products (%milk protein) in the first trimester [$\beta = 86.8$, 95% confidence interval (CI): 29.1, 144.6; $\beta = 63.1$, 95% CI: 10.8, 115.5; $P < 0.001$ for both]. Intake of milk products and of %milk protein in the third trimester was positively associated with gestational weight gain (GWG) between the second and third trimester (One-way ANOVA, $P < 0.001$ and $= 0.001$, respectively). Neither birth weight nor GWG were associated with %vitamin B_{12} from milk products.
Conclusions: These findings indicate that intake of milk products in the first trimester and especially, protein from milk products is positively associated with birth weight in this South Asian Indian population.

1. Introduction

India has an unacceptable rate of low birth weight (<2500 g) babies born every year [1]. LBW and pre-term babies accounted for 14% of all neonatal deaths in 2005 while neonatal deaths, in turn, were responsible for 43% of deaths under five years of age [2]. Among the modifiable factors affecting birth weight, maternal nutrition has time and again been shown to be intimately related to birth outcomes [3,4].

Though findings from human studies are equivocal in terms of associations between maternal dietary protein intake and birth outcomes, milk consumption has proven important to birth weight

Abbreviations: SGA, small for gestational age; AGA, appropriate for gestational age; LBW, low birth weight.

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[5–7]. Studies in Denmark and Rotterdam have shown that antenatal milk intake is positively related to birth weight—although the mechanisms by which milk intake increased birth weight could be different. The study of the Danish National Birth Cohort—including 50117 mothers and their infants—compared mothers who consumed six or more glasses of milk per day to those who consumed none. It was found that mothers who drank six or more glasses had an increased risk of having a large for gestational age (LGA) baby, but a lower risk of having a small for gestational age (SGA) baby; in fact, the risk of an SGA baby was almost half [8]. The Generation R study in Rotterdam found that consuming more than three glasses of milk per day was found to be associated with an 88 g increase in birth weight in the third trimester as opposed to one glass or none at all [9]. Earlier studies have demonstrated the significant positive association between protein intake and birth weight [10]. Balanced energy and protein intake during pregnancy has been reported to be positively associated with birth weight in 13 controlled trials of a total of 4665 women [11]. Vitamin B_{12} appears to have an important role in the intrauterine development of the fetus—particularly in neurological and other development of the growing baby [12]. In South Indian women, who are predominantly vegetarian, low maternal B_{12} intakes and levels in all three trimesters are associated with a higher risk of intrauterine growth retardation (IUGR) [12].

Cultural and religious norms, as well as impoverished circumstances, dictate that most Indians are strict vegetarians, while the rest have very limited meat consumption [13]. Most protein in Indian diets comes from cereal, legumes, and milk or milk products. Milk assumes a particular importance in Indian diets, because it forms the sole source of vitamin B_{12} in vegetarians and culturally accepted. Milk and milk products are an excellent source of both protein and vitamin B_{12} in vegetarians [14].

While the importance of milk during pregnancy is clear, there remains a need to quantify protein and vitamin B_{12} intakes from milk with regards to their relations with birth weight. Vitamin B_{12} and protein from milk may work together or independently with regard to promoting fetal growth. In this context, the primary objective of this study was to evaluate the relations between birth weight and maternal intake of milk, protein from milk and vitamin B_{12} from milk. The results of this study reach beyond their huge implications for public health in India to hold relevance on India's economic thought and health policy as well.

2. Subjects and methods

2.1. Study design

We used a prospective, observational cohort study design. The study was conducted at the Obstetrics and Gynecology Outpatient Department of St. John's Medical College Hospital (SMJCH) in Bangalore, India, which caters to patients of diverse socio-economic status—from urban slums to high socioeconomic status. The Institutional Ethical Review Board of SMJCH approved the experimental protocols. A written consent was obtained from each study subject at enrollment. The family member or the companion of the study participant was the witnesses and co-signed the consent form.

2.2. Subjects

The current study is a part of an observational prospective ongoing cohort study of pregnant women at St. John's Research Institute and St. John's Medical College and Hospital (SJMCH), Bangalore, India. Pregnant women (17–40 years) attending antenatal screening at the Department of Obstetrics and Gynecology at SJMCH were invited to participate in the study. Women with a clinical diagnosis of chronic illnesses such as diabetes mellitus, heart disease, hypertension, thyroid disease, those with multiple fetuses, those tested positive for HIV/Hepatitis B surface antigen/syphilis infection or those who are anticipating moving out of the city before delivery were excluded from the study. While the study is ongoing, the interim analysis on 2391 subjects consented and continued to be part of the study is represented. There were 196 fetal losses and 2195 live birth outcomes. The subjects lost to follow-up comprised of those wishing to undergo family planning (tubectomy); since SJMCH is run by Catholic Bishops, family planning is not encouraged. Therefore, the subjects who consented and had few visits at the clinic but delivered at another hospital were included in lost to follow-up. Of the 2195 live birth outcomes, first trimester diet data was not available for 159 subjects. Data from the remaining 2036 births was analyzed.

2.3. Anthropometry

Socio-demographic details were collected at baseline (11.3 ± 2.6 weeks of gestation) that included mother's age and obstetric history to classify the parity and education as a surrogate of socio-economic status. Information on maternal anthropometry, dietary intake, clinical status and blood biochemistry as per the routine antenatal care was collected at the second and third trimesters (24.2 ± 1.6 weeks and 34.1 ± 1.5 weeks, respectively) of pregnancy.

A digital balance (Soehnle, Germany) was used to record the weights of all mothers to the nearest 100 g. The digital weighing scale was standardized using the standard weights once every month. Height was measured using a stadiometer to the nearest 1 cm. Mid-upper arm circumference (MUAC) was measured to the nearest 0.1 cm using a plastic measuring tape, and skinfolds were measured at three sites (biceps, triceps and subscapular) using the Holtain Caliper (Crosswell Crymych Pembrokeshire, UK) for the assessment of body composition using prediction equations (Durnin & Womersley 1974). Weekly maternal weight gain during the second trimester ($GWG_{1\text{-}2}$) was calculated as the difference between the body weight at the second trimester and at baseline divided by the difference in the LMP (or gestational age) at the second trimester and at the baseline. Similarly, weekly maternal weight gain during the third trimester ($GWG_{2\text{-}3}$) was calculated as the difference between the weight in the third and second trimesters, divided by the difference between the LMP in the third and second trimesters, respectively. Maternal body mass index (BMI) (kg m^{-2}) was calculated using weight and height.

2.4. Routine antenatal care

Each participant was screened for routine antenatal tests (screening for HIV, VDRL and HBsAg) before enrolling in the study. The obstetrician prescribed antenatal supplements of folic acid, iron and calcium as per the antenatal schedule. Supplement compliance was recorded during the course of pregnancy in the form of tablet count. All subjects were prescribed 5 mg of folic acid per day in the first trimester with ferrous sulphate 150 mg (equivalent to 45 mg iron), folic 0.5 mg and 1000 mg calcium, each per day from the second trimester until delivery. The 1000 mg calcium prescribed per day was consumed as two tablets, each of 1250 mg calcium carbonate (equivalent to 500 mg elemental calcium) with vitamin D_3, IP 250 I.U. None of the subjects were prescribed multivitamins or multi-minerals.

2.5. Dietary intake

The dietary intake during each trimester of pregnancy was assessed using a validated food frequency questionnaire (FFQ).