Maternal anthropometry as a risk predictor of pregnancy outcome: the Nutrition CRSP in Egypt

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The Nutrition Collaborative Research and Support Program (CRSP) is a longitudinal study on food intake and human function, which was carried out in three countries—Egypt, Kenya and Mexico. This article describes the study in Egypt.

Methods

Site selection

Kalama, a village of 1470 households in 1982, was selected by a team of investigators from Egypt and the USA as the research site (*1*). The village, located in the Nile delta, 25 km north-west of Cairo, has been undergoing rapid socioeconomic transformations; occupational diversity is at the heart of these changes. This site was selected because of certain prescribed conditions: a well-defined community with a stable population of ≥700 households, with little emigration to other countries or to neighbouring towns and cities; a representative population with a range of nutritional status from adequate to mild-to-moderately undernourished; absence of endemic nutritional diseases such as goitre; and no current or proposed intensive research projects involving nutrition, agricultural development, or fertility control.

A total of 312 households in Kalama were enrolled for a period of ≥1 year in this large, USAID project which focused on the functional consequences of mild-to-moderate malnutrition (*2*). Village census data, collected by project personnel, were used to identify eligible subjects — women aged between 15 and 45 years, who were in the first trimester of pregnancy and would have infants reaching 6 months of age before the project ended. All who met the eligibility requirements and who consented to participate were enrolled. A total of 121 women continued in the study until delivery. All research procedures and the subject consent form were approved by the Purdue University Committee on the Use of Human Subjects in Research.

Identification of pregnancy

An identification-of-pregnancy questionnaire was administered monthly by the project physicians, and a pregnancy test was given whenever the women agreed. Women known to be pregnant and who were estimated to be <4 months of gestation were invited to enrol in the study. Questionnaires on menstrual history were administered by Egyptian physicians to estimate the date of conception. The first day of the last menses was recorded either by noting the exact calendar date or by referring to a calendar of events.

Anthropometry

All anthropometric measurements of pregnant or lactating women were performed by a team of physicians from the time of a woman's entry into the study (before or at the fourth month of pregnancy). Measurements were scheduled to be performed monthly up to the eighth month of gestation, and then weekly until delivery. The measurements included height, body weight, mid-arm circumference, and skinfold thickness of triceps and biceps.

Pregnancy outcome

Pregnancy outcome data were collected by trained Egyptian dietitians within 48 hours after delivery, whether the pregnancy ended in fetal death, stillbirth, or delivery of a live infant. Information about fetal or infant deaths was sometimes sketchy because mothers were either sensitive about discussing the events or refused to give this information. Weight of newborns was measured by trained dietitians within 48 hours after birth. Dubowitz scoring for the assessment of gestational age of newborns was done by Egyptian physicians within 72 hours after delivery.

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Description of the study population

Women enrolled were between 17 and 45 years of age and were either non-pregnant or in the first trimester of pregnancy at the time of entry. Among these 121 women, 12 pregnancies were terminated due to fetal death and three women who delivered twins were excluded from the study. Reliable birth weight measurements, complete data on reproductive history, education of mothers, household socioeconomic status (SES), and household sanitation–hygiene index were obtained for 101 women who had singleton pregnancies. Of these, longitudinal anthropometric data were available for 63.

Results

Estimate of the risk for small newborns and preterm delivery based on maternal anthropometry

Relative risks for birth weights <2800 g and <3000 g and preterm delivery were estimated by two-way associations between the pregnancy outcome variables and each of the maternal anthropometry (during the pregnancy) predictor variables. Odds ratios were calculated based on the entire sample and on data stratified by maternal height, age and parity. Maternal anthropometry was dichotomized by use of the 25th and 50th percentile values for each measurement. The odds ratios (OR) and confidence intervals (CI) are shown in Table 1.

Women who weighed less than 55 kg in early pregnancy (≤3 months) were at a higher risk by more than sixfold of delivering an infant <2800 g, and the odds were greater than sevenfold for delivering a preterm infant (gestational age <35 weeks) compared with women who weighed 55 kg or more. Furthermore, women who weighed less than 63 kg at 6 months gestation were at a sixfold greater risk of delivering an infant weighing less than 3000 g at birth than women who weighed more.

Examination of mid-upper-arm circumference as a predictor of birth weight showed that women whose measurements were <25 cm at 3 or 6 months were at greater risk (more than threefold) of delivering an infant <3000 g at birth, compared with women with larger arm circumferences.

The Mantel-Haenszel (M-H) procedure was used to control for the potential confounding effects of maternal height, age and parity on the pregnancy outcome variables predicted by maternal weight and MUAC. For example, to eliminate the confounding effect of age when investigating the effect of low maternal weight or arm circumference on birth weight, data were examined in separate strata by age and the M-H procedure was employed. The chi-squared tests indicated that none of the differences was statistically significant ($P > 0.05$).

Relation of BMI in early pregnancy to birth weight

Maternal BMI in early pregnancy was examined relative to infant birth weight and weights at 3 and 6

Table 1: **Significant associations of maternal anthropometry in pregnancy with birth weights <2800 g and <3000 g and with preterm delivery in Egyptian women**

Maternal anthropometry in pregnancy[a]	No.	Outcome variable	%	Quartile cut-off	OR	Estimated 95% CI	Chi-squared *P*
		Birth weight (g)					
Weight (kg):							
≤3 months	74	<2800	<25	<55.0	6.79	1.33–34.66	0.01
	74	<3000	<25	<55.0	3.27	1.00–11.25	0.05
	74	<3000	<50	<59.4	3.96	1.14–13.76	0.02
6 months	44	<3000	<25	<56.4	6.72	1.47–30.76	0.009
	44	<3000	<50	<63.0	6.92	1.29–37.29	0.02
MUAC (cm):							
≤3 months	66	<3000	<50	25.3	3.63	1.02–12.93	0.04
6 months	39	<3000	<50	25.9	4.36	1.00–19.86	0.05
		Gestational age (weeks)					
Weight (kg):							
≤3 months	59	<35	<25	<55.0	7.50	1.09–51.52	0.02

[a] Height and body mass index were not significantly associated with birth weight or preterm delivery; MUAC was not associated with preterm delivery.

months of age (Table 2). For this assessment, mothers were subdivided by BMI into quartiles <1, 1–3, and >3. Mothers in the lowest quartile delivered infants of significantly lower birth weights than mothers in the highest quartile. Infant weights at 3 and 6 months of age were not significantly associated with their mother's BMI in early pregnancy.

Bivariate analysis of maternal anthropometry in lactation with infant weight changes showed that maternal weight changes from 3 to 6 months of lactation were significantly and positively correlated with the infants' weight changes from birth to 6 months (Table 3). Change in arm circumference from 1 to 3 months of lactation was significantly and positively associated with infant weight change during the same period.

Conclusions

Analyses of an Egyptian village database showed that maternal anthropometry measurements made in early pregnancy (<3 months gestation) identified women who were at risk of poor pregnancy outcomes (preterm delivery and/or small newborn). Simple measurements of maternal weight, body mass index and arm circumference, made prior to or in early pregnancy, were particularly useful predictors of women at risk of the pregnancy outcome.

Women whose weight in early pregnancy was less than 55 kg (<25th percentile) were at greater risk by more than sixfold of delivering a newborn weighing less than 2800 g, compared with mothers who were heavier. The risk of delivering preterm infants was more than sevenfold for mothers who weighed less than 55 kg, i.e., below the first quartile (<25th percentile) of weight, in early pregnancy, compared with mothers who weighed more at this time. Also, older mothers who had a previous history of fetal deaths were at greater risk of delivering a small infant than younger mothers who had no history of fetal deaths. Furthermore, weight in early pregnancy and body mass index were associated positively with neonatal behavioural characteristics including orien-

Table 2: **Relation of body mass index in early pregnancy to birth weights and to infant weights at three and six months of age**

BMI at 3 months	Quartile	Infant weight (g)[a]		
		At birth	3 months	6 months
<22.6	<1	3154 ± 386[b]	5450 ± 956	6865 ± 952
		3177[c] (18)[d]	5359[c] (14)	6560[c] (15)
22.6 – 27.4	1–3	3303 ± 419	5653 ± 653	6882 ± 936
		3282[c] (37)	5605[c] (28)	6889[c] (27)
>27.4	>3	3568 ± 362[b]	5842 ± 681	7013 ± 735
		3574[c] (18)	5932[c] (12)	7164[c] (11)

[a] Figures are means ± S.D., except where otherwise indicated.
[b] These means are significantly different (P <0.05) by Tukey and Bonforroni test.
[c] These figures are the median.
[d] Figures in parentheses are the number of subjects.

Table 3: **Associations of maternal anthropometry in lactation with infant weight change from birth to 6 months of age** (NS: not significant)

Maternal anthropometry[a]	Infant weight change (z-score)		
	Birth – 3 months	3–6 months	Birth – 6 months
Lactation[b]			
Weight change at 3–6 months	NS	NS	0.34[c] 0.08[d] (27)[e]
Arm circumference	0.41	NS	NS
Change at 1–3 months	0.02 (31)[e]		

[a] Height, weight, BMI and weight gain during pregnancy were not significantly associated with infant weight changes; sample sizes were small (<30 subjects in each category).
[b] During lactation, maternal anthropometry was not significantly related to infant weight change except for weight and arm circumference changes at 3–6 months; in all categories tested, sample sizes were small (≤31 subjects).
[c] Correlation coefficient (r).
[d] Trend, P <0.10.
[e] Number of subjects.

tation behaviour, i.e., response of neonates to animate and inanimate visual and/or auditory stimuli. These behaviours are postulated by some researchers to reflect the earliest information processing by infants.

Body mass indices in early pregnancy were not significantly associated with anthropometric changes observed in later pregnancy or the first six months of lactation. Maternal body mass index in early pregnancy was significantly related to infant birth weight but was not significantly associated with infant weights at 3 and 6 months of age.

In summary, maternal anthropometry during early pregnancy was a significant indicator of pregnancy outcomes, i.e., birth weight, preterm delivery and neonatal behaviour, but was not significantly related to maternal anthropometric changes observed in later pregnancy and/or early lactation or to infant weights during the first 6 months after birth.

References

1. *Egypt Project. The Collaborative Research Support Program on Food Intake and Human Function. Final report on food intake and function.* Washington DC, USAID, 1987.
2. **Kirksey A et al.** *The human costs of moderate malnutrition in an Egyptian village. Final report.* Washington DC, USAID, 1992.