Maternal anthropometry predictors of intra-uterine growth retardation and prematurity in the Malawi Maternal and Child Nutrition study

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The Malawi Maternal and Child Nutrition (MMCN) study is a longitudinal, community-based investigation of the influence of maternal health and nutritional status on prenatal and postnatal growth and infant survival. It was carried out in three districts (89 villages) of northern Malawi from December 1986 till December 1989.

Methodology

A baseline census was conducted of all households in the study villages, from December 1986 till June 1987, to identify prospective study women and obtain baseline anthropometric measurements. Women who informed the local enumerators that they were pregnant were recruited into the study over the next 18 months; they were then visited each month to obtain measurements and answers to questionnaires. It is estimated that 89% of all live births were covered by the study. Two birth outcomes — prematurity (<37 weeks) and intrauterine growth retardation (<10th percentile of weight for gestational age) — were examined and the maternal anthropometric predictors considered were weight, body mass index (BMI), and mid-upper-arm circumference. The predictive ability of these indicators was examined at baseline (pre-pregnancy period). In addition, the predictive ability of changes in these variables during pregnancy was also examined. The general analytical strategy was to divide each of the maternal anthropometric variables into quartiles and compare the incidence of IUGR or prematurity in each of the lower three quartiles to the highest (fourth) quartile using odds ratios.

The MMCN Study includes information on 1129 livebirths occurring to 954 women. The present analysis is restricted to singleton livebirths. Only the first birth was used when a woman gave birth to more than one child during the study period. In addition to the above exclusions, the actual sample available for a given analysis was reduced further, depending upon the extent of missing data in the relevant maternal variables. The potential bias due to missing data was examined by comparing the anthropometric characteristics of women with more complete data to those for women with less complete data. Women with relatively complete data tend to be lighter (by 1–1.5 kg) at baseline and at selected stages of pregnancy, but had a higher weekly rate of weight gain in the second half of the pregnancy and had heavier infants. Similar results were obtained with BMI, but not with arm circumference. This suggests that the women with complete data may have had a slightly different pregnancy experience, but it is not clear how this could influence the relationship between maternal characteristics and neonatal characteristics. In addition, any cases with unusual values were screened, examined and corrected when possible.

Pre-pregnant anthropometry was estimated from the baseline census conducted prior to enrolment of the pregnant women into the study. Enrolment occurred continuously over a period of two years, whereas the census took place in a six-month period (mostly in the rainy season). Thus, the "pre-pregnant" state as used here may be separated from conception by up to two years and may have a component of variation due to seasonality. However, the total weight gain (about 6.5 kg) is likely to be an overestimate and has no significant impact on these analyses since weekly rates of weight gain were used. The stage of pregnancy was based on the estimation of gestational age of the infant at birth (from Dubowitz), and was calculated by subtracting this from the date of birth. It is estimated that the 95% confidence interval for MMCN estimates of gestational age was ±3 weeks.

Results

Predictors of IUGR

There are statistically significant associations with all three maternal variables at baseline (weight, BMI, MUAC), all in the expected direction (i.e., more

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IUGR among women with low anthropometric values). The odds ratios were highest in the third trimester for all the indicators especially weight, followed by BMI and arm circumference respectively. However, even the latter does approach a value of 2.0 (lowest quartile in the third trimester) and may still serve as an useful tool for screening. When stratified by height the predictive ability of BMI is much better among tall women than short. The results for arm circumference remain unaltered. Similar results were obtained using head circumference as a proxy for maternal size, but the strength of the odds ratios were lower.

The results pertaining to weight and BMI may have considerable practical utility. The combined use of both weight and height and BMI and height effectively doubles the sensitivity (47%), while still maintaining fairly high specificity (70%). The practical protocol suggested by this would be to screen initially by height, and then short women would be screened based on their weight and tall women would be screened based on their BMI.

There does not appear to be any particular advantage to screening on the basis of changes in anthropometry during pregnancy. As expected, changes in weight during the second semester are strongly associated with IUGR, but only among women who entered pregnancy with an initially low BMI. A similar pattern is seen for total pregnancy weight gain and gain during months 5 to 7 and when pre-pregnancy arm circumference was used for stratification. Nevertheless, the odds ratios for these combinations of indicators are still weaker, compared with the one-time measurements which would have been better for screening as well as being more practical.

Predictors of prematurity

The prediction of prematurity from maternal anthropometry is weaker than the prediction of IUGR. The most promising predictors of prematurity are related to arm circumference (especially early in pregnancy), rather than weight or BMI. The results are largely unchanged when stratified by height, except that both low weight or BMI in the third trimester among tall women is predictive of prematurity. Stratification by head circumference does significantly improve the predictive ability of weight, BMI and arm circumference. In all cases, the overall association between prematurity and maternal anthropometry is entirely attributable to effects among the large-headed women (greater than the median). The prediction of prematurity by changes in weight and BMI during pregnancy does not appear promising. Stratification by maternal height or head circumference indicates that there is no convincing evidence that any of these "change" indicators can be used to predict prematurity.

The only promising finding with important practical advantages is the highly significant association (OR, 7.1) of pre-pregnant arm circumference among large-headed women with prematurity, in that screening could take place without scales or height-measuring devices. Future analysis should be directed towards identifying optimal cut-off points for head and arm circumferences, and towards examining the consistency of this finding across populations. It is worth noting that the strongest predictors for prematurity may not be anthropometric variables at all. There is a highly significant association between parity and prematurity (P=0.006) and these kinds of indicators would be easier to collect.

Concluding remarks

The ultimate utility of any of these indicators should be based not only on the strength and consistency of the relationship but also on the sensitivity–specificity. It seems that the performance of maternal anthropometry may be rather weak in this area especially, because the only way to achieve high sensitivity would be to accept low specificity. This situation is likely to be unacceptable unless the cost per recipient of the interventions is very low. It is important to clarify whether the purpose of screening is to prevent IUGR and prematurity themselves or to prevent the consequences of IUGR and prematurity (e.g., neonatal morbidity and death). The need for this distinction is illustrated by considering the poor performance of maternal anthropometry for predicting IUGR and prematurity, compared with the very high performance of simple clinical observations and measurements made on the neonate itself. If the objective is to prevent the consequences of IUGR and prematurity, then it may be far more cost-effective to ensure that local midwives can determine which neonates require special care, and to ensure that these interventions are made available to the neonates in a timely fashion. These considerations highlight the importance of distinguishing the use of maternal anthropometry for screening versus its use for monitoring and promoting adequate levels of nutritional status in all women. The latter does not rely on critical cut-off points or sensitivity–specificity performance, but requires a normative reference for maternal anthropometry which would lead to community-based programmes designed to create awareness and promote actions by households and communities to improve maternal nutritional status.