Research Roundtable Summary

22

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Research Projects

Maternal Factors Determining Birthweight

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About This Series

The Research Roundtable Series, sponsored by the Maternal and Child Health Bureau (MCHB), disseminates the results of MCHB-funded research to policymakers, researchers, and practitioners in the public and private sectors. The results of these projects influence future service, research, and policy development. The Research Roundtable sessions provide an opportunity for researchers to discuss their findings with policymakers, MCH program directors, service providers, and other health professionals.

The MCHB Research Program is directed by Dr. Gontran Lamberty and administered through the Division of Systems, Education and Analysis, MCHB, Health Resources and Services Administration (HRSA), U.S. Department of Health and Human Services. The purpose of the MCHB Research Program is to support applied research that shows promise of substantial contribution to the advancement of maternal and child health services.

Introductions

Dr. Gontran Lamberty introduced the speakers for the Research Roundtable. Sally A. Lederman, Ph.D., is a research scientist at Teachers College, Columbia University. She is well known for her research on body composition and pregnancy weight gain. She has published extensively in such medical and nutritional journals as the *American Journal of Obstetrics and Gynecology* and the *American Journal of Clinical Nutrition*. She is an elected member of the American Society for Nutrition. She received her doctorate from Columbia University.

Roy M. Pitkin, M.D., is a professor emeritus at the University of California, Los Angeles. He is editor of *Obstetrics and Gynecology*, a position he has held for 13 years. He also serves as editor for *Clinical Obstetrics and Gynecology*. Dr. Pitkin has served as president for several professional associations, including the American Gynecological and Obstetrical Society and the Society of Perinatal Obstetricians. Dr. Pitkin received his M.D. from the University of Iowa.

Presentation of Research and Relevant Findings

Statement of the Problem

Although birthweights over 2,500 g are considered "normal," recent studies have confirmed that optimal birthweight is much higher. In the United States, minimum mortality occurs at 3,500–4,500 g for infants of white adult women and 3,000–4,000 g for infants of black women. The infant mortality rate rises less rapidly above these ranges than below these ranges. Yet 5 to 10 times as many infants are born in the higher risk weight range of 2,500–3,000 g than in the lower risk weight range of 4,500–5,000 g (for whites) or 4,000–4,500 g (for blacks). Thus, raising birthweights across most of the birthweight spectrum is a desirable goal.

To achieve this goal, researchers need to understand the factors that control or limit birthweight. For many decades, researchers have known that both maternal weight before pregnancy and maternal weight gain during pregnancy are closely associated with infant birthweight.[1–3] It is also clear that women who have the same prepregnancy weight can deliver infants with the same birthweight while gaining very different amounts. The maternal physiological factors in the relations among prepregnancy weight, weight gain during pregnancy, and birthweight have not been fully identified. These factors may be crucial in determining the relationship between maternal weight and infant birthweight.

Research Question

The aim of this study was to identify which components of maternal weight are responsible for the associations among maternal prepregnancy weight, pregnancy weight gain, and birthweight. The study examined the influence of gains in maternal weight and net weight, fat and net fat, and water and net water on birthweight. The researchers also examined the possible influences of maternal pelvic size and the timing of gestational weight gain on birthweight.

Population Description and Sampling Plan

The study was a prospective examination of maternal body composition and infant birthweight among 200 pregnant women.[4] Most of the women were recruited at four prenatal care sites in New York, NY. Women were eligible for the study if they were 18–35 years of age; nonsmokers throughout pregnancy; not infected with HIV (to their knowledge); free of major medical concerns; not regular users of alcohol or drugs during their pregnancy (self-reported); and available for their first visit at 12–16 weeks' estimated gestation. Approval for the study was obtained from the human investigational review board of each participating site.

The researchers obtained demographic data, reproductive history, and infant gestational age and birthweight by interviewing the mother and/or abstracting her medical record after delivery. Body fat was determined with a multicompartment model. Laboratory visits to determine body composition were scheduled for between 12 and 16 completed weeks of gestation and at or after 37 weeks, based on each woman's estimated stage of gestation in early pregnancy.

At these laboratory visits, each woman was weighed and her body density was determined by underwater weighing with a 4-point platform scale system. Residual lung volume was determined by nitrogen washout prior to underwater weighing. Total body water was determined by the dilution of a 10-g dose of orally administered deuterated water, estimated from predose and postdose blood samples.

A third laboratory visit was scheduled at around 3 weeks postpartum. At this visit, total body bone mineral content was measured with dual energy absorptiometry. The relation between maternal pregnancy weight gain and fat gain in these women was reported.

Research Findings

The study controlled for race (black or white) and ethnicity (Hispanic or non-Hispanic); maternal height, age, and parity; and the sex and gestational age of the infant. A key finding was that maternal fat gain (total or net) is not positively associated with birthweight, but maternal body water gain (total or net) is. The mother's pelvic size and shape may also contribute to variations in birthweight.

The researchers noted that pregnancy weight gain is due to increases in both fat and nonfat tissues. At week 37, both fat and water are highly correlated with weight. The major increase in nonfat tissue is due to a 6- to 7-liter increase in water, which was measured directly. Pregnant women experience little or no increase in bone mass or carbohydrates and an increase in protein of less than 1 kg; nonbone mineral increases are much less. Therefore, the measurement of body water captured nonfat tissue.

Results from the study's analysis of the effect on birthweight of maternal weight and net weight in early and late pregnancy were consistent with data reported in previous studies. The study found a positive effect on birthweight of week-37 total weight and a negative effect of week-37 total fat in exploratory regression analyses that included both variables. When the researchers used net water and fat values or net maternal weight as predictors, the ß coefficients reflecting their relation to birthweight were reduced—often markedly—compared with analyses using total weight, water, and fat.

Studies on the relationship of maternal fat or nonfat tissue to birthweight are more conflicting than studies on maternal weight and birthweight alone. Earlier studies generally suffer from small samples and crude methods of assessing body composition. The strengths of the current study were the sample population of 200 women and the use of a multicompartment model that provided a much more precise estimate of body composition in pregnant women.4 The study's limitations included the selection of healthy adult volunteers delivering after 37 weeks' gestation, which may prevent the findings from being generalized to more heterogeneous groups. Lederman et al. also estimated placental weight and composition and derived estimates of fetal weight and composition using published standards for rates of fetal growth that may not be followed exactly by every fetus. These estimates were used in computing net body composition variables. However, most of these approximations were small, and the even smaller projected errors in the estimations (e.g., of placental weight or fetal weight) would be expected to have a minimal effect on the final results.

Finally, the researchers had no information on dietary behaviors, weight gain recommendations by the women's health care providers, or which women experienced edema. Therefore, they did not know whether or how these factors contributed to variability in weight, fat, water, or birthweight. Despite these limitations, the study's key findings—that maternal fat does not significantly increase birthweight but that maternal water at term has a significant and positive association—were robust. These findings are consistent in models examining either total maternal body composition or net composition.

It is essential to recognize that weight gain is necessary for water gain and that fat gain also occurs with weight gain. One question raised by this research is whether the full benefit usually associated with a given weight gain could be achieved at a lower weight gain by limiting the increase in fat that would normally occur. If so, mothers might be able to optimize fetal growth without increasing their risk of obesity. This would require an understanding of the factors determining the partitioning of nutrients between maternal and fetal tissues. The association of fetal growth with increased maternal weight and body water or nonfat tissue at term supports the importance of adequate weight gain, despite the likely concomitant increase in maternal body fat. However, this group's finding that women who gained more weight also gained more fat—despite a lack of benefit for the mother or the infant from either type of gain—underscores the importance of encouraging women not to exceed pregnancy weight-gain recommendations.

Reactor Response

The significant relationships between maternal weight and birthweight have probably been recognized for many years, but the first clear articulation was by Eastman and Jackson in 1968.3 Research over the ensuing 30 years has clearly established that maternal weight before pregnancy and gain in weight during pregnancy are independent, additive influences on birthweight and therefore on infant outcome. Until quite recently, however, we have known about maternal weight only in the grossest sense. Now, largely through the work of Dr. Lederman, we are beginning to understand the relationship of the different components that make up what we read on the scales.

Dr. Lederman's research, some of which she has summarized for us today, is characterized by methodological rigor and technical meticulousness. These qualities are essential in this type of investigation because of the risk of magnifying seemingly small errors into distorting conclusions. The difficulties attendant on this type of research can hardly be overstated, and overcoming them requires enormous effort. In a word, the science here is impeccable, and it will form the foundation for rational clinical management.

Discussion

The discussion focused on how to determine the ways that maternal weight gain influences infant birthweight. Several participants raised issues about which type of weight should be gained: water or fat? Dr. Lederman's research suggests that water weight gain is more beneficial to birthweight; however, the reason for this is unclear. Although several participants suggested theories, it was concluded that more research is needed to examine the association between different types of maternal weight gain and birthweight.

Publication

Lederman SA, Paxton A, Heymsfield SB, Wang J, Thornton J, Pierson RN Jr. 1997. Body fat and water changes during pregnancy in women with different body weight and weight gain. *American Journal of Obstetrics and Gynecology* 90:483–488.

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