

A New Definition of Maternal Depletion Syndrome

ABSTRACT

Background. Although the term "maternal depletion syndrome" has been commonly used to explain poor maternal and infant health, whether such a syndrome actually exists remains unclear. This uncertainty may be due to the lack of a clear definition of the syndrome and the absence of theoretical frameworks that account for the many factors related to reproductive nutrition.

Methods. We propose a new definition of maternal depletion syndrome within a framework that accounts for potential confounding factors.

Results. Our conceptual framework distinguishes between childbearing pattern and inadequate diet as causes of poor maternal health; hence, our definition of maternal depletion syndrome has both biological and practical meaning. The new definition is based on overall change in maternal nutritional status over one reproductive cycle in relation to possible depletion and repletion phases and in relation to initial nutritional status.

Conclusions. The empirical application of this approach should permit the testing of the existence of maternal depletion syndrome in the developing world, and the distinction between populations where family planning will alleviate maternal depletion and those in which an improved diet is also necessary. (*Am J Public Health*. 1992;82:691-694)

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Introduction

The term "maternal depletion syndrome" (MDS) is commonly used to explain poor maternal and infant health in developing countries.¹⁻⁶ The syndrome has been attributed to the nutritional stresses of successive pregnancies and lactations and includes osteomalacia, goiter, anemia, edema, and inadequate pregnancy weight gain, as well as low infant birthweight.⁷⁻⁹ Unfortunately, whether these features are related solely to women's childbearing patterns or whether they result from a combination of childbearing and lifelong poverty and inadequate diet remains unclear, especially as most studies in human subjects and animal models have been unable to demonstrate MDS.

Two testable hypotheses have been proposed for use in investigating the existence of MDS: (1) women of high parity have poorer nutritional status than do women of low parity, and (2) short interbirth interval is associated with poor maternal health as well as poor pregnancy outcome. A few studies have found an association between high parity and low maternal weight,¹⁰⁻¹² but of these only one controlled for the possible confounding effect of maternal age.¹² Many studies have instead found an association between high parity and improved nutritional status, or no association at all.^{5,13-16} It may be that parity is not an accurate indicator of reproductive stress—parity does not provide information about miscarriages, abortions, or stillbirths, and the spacing of pregnancies as well as the length of breastfeeding are not taken into account. Also, if women of poor health are unable to bear more children, high-parity women may include only the healthiest individuals.⁴ Clearly, the first hypothesis does not ad-

equately account for the multitude of factors related to MDS.

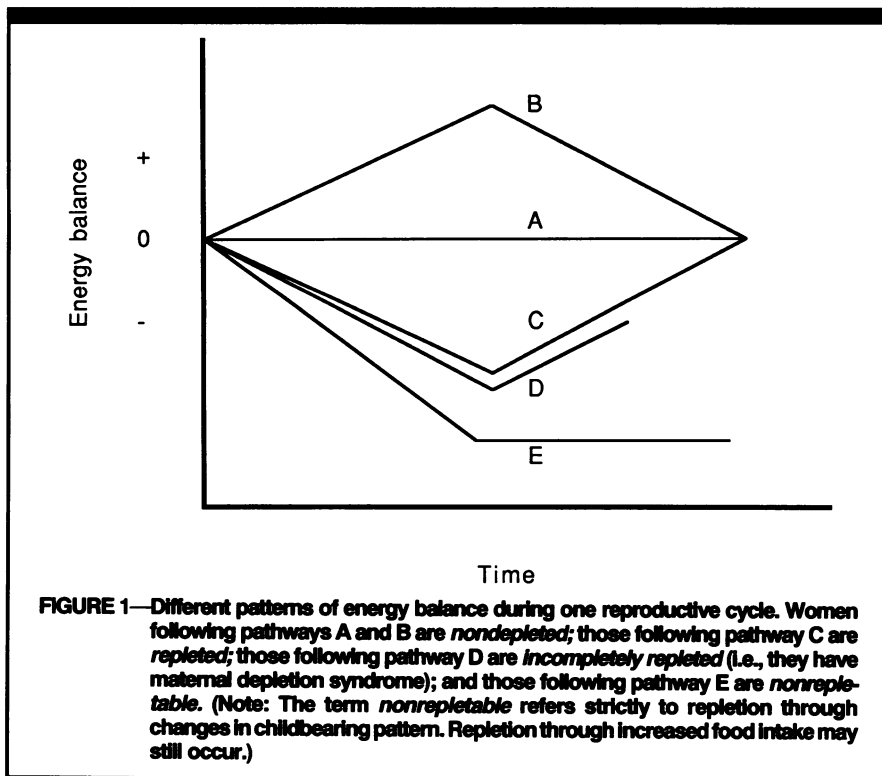
Plausible associations of short interbirth interval with increased infant mortality and morbidity have been reported.^{2,17-20} However, such associations provide only indirect evidence for the existence of MDS, because, in this conceptualization, maternal nutrition is simply assumed to be a mediating variable. A few studies have investigated the effect of short interbirth interval on maternal nutrition. One study found an association between long periods of nonpregnancy/nonlactation (NPNL) and low subsequent prepregnant weight²⁰; another study, using a stricter definition of NPNL, found an association between long periods of NPNL and large subsequent prepregnancy thigh fat-folds as well as decreased intake of a nutritional supplement.^{20,21}

MDS is obviously more complex than previously perceived. Inasmuch as most existing studies lack a clear definition of the syndrome and its outcomes, it is possible that the correct outcome variables have not been measured. We offer a new definition of MDS that is both biologically and practically meaningful. This definition of MDS goes beyond the existing concepts of malnutrition and birth spacing and hence can improve our ability to design cost-effective interventions to alleviate poor maternal and infant health worldwide.

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Hypothesis

Men, infertile women, and fertile women are treated differently in most societies; hence, the weight patterns of the former two groups will not reflect the pattern of weight change that might have been observed among childbearing women had they not experienced pregnancy and lactation. Therefore, we have no “control group” available for studying the isolated effect of childbearing on women’s health. Instead, we define four groups of fertile women, each representing one pattern of weight change in relation to diet and childbearing. We hypothesize that only one pattern represents MDS. The four patterns cover all fertile women except those who experience weight gain between pregnancies, because these women are not of interest to this discussion.

A reproductive cycle is made up of four phases: pregnancy, full lactation, partial lactation, and NPNL. Depending on many factors, including caloric intake and workload, women may experience a positive or negative energy balance during these four phases. Women may become pregnant again while lactating, and these “overlapping” cycles^{21,22} certainly increase the nutritional stress of childbearing.

Weight change is used here as an indicator of change in energy stores. Weight change may be a less accurate indicator

for stores of other nutrients; therefore, we restrict this discussion to energy stores. Overall weight change for one reproductive cycle is referred to as ΔW . Theoretically, ΔW could be measured between any two corresponding points in time, but points such as conception or childbirth offer precise definitions; the latter also offers a convenient time for measurements.

Well-nourished women who change their food intake and activity appropriately will maintain energy equilibrium throughout the reproductive cycle, and $\Delta W = 0$ (see Figure 1, pathway A). Many women in the Western world actually experience positive energy balance across pregnancy and full lactation; for these women partial lactation and NPNL are periods of conscious weight loss (Figure 1, pathway B). We categorize women following either of these pathways as *nondepleted*.

Many studies have found that women who cannot substantially increase their food intake give birth to surprisingly healthy infants and produce adequate amounts of milk without losing weight over time ($\Delta W = 0$).^{23–26} These women may gain less weight during pregnancy and lose more weight during lactation than do women in the nondepleted group, but may still maintain $\Delta W = 0$ if the potential repletion phase (PRP)—consisting of the periods of partial lactation, NPNL, and, in

some cases, early pregnancy—is used for repletion (Figure 1, pathway C). Rats subjected to chronic food restriction before and during the reproductive cycle have been shown to become replete during NPNL and early pregnancy,²⁷ and recent studies indicate that women may metabolically adapt to low energy intake during pregnancy.^{23,28} Hence, as a result of increased metabolic efficiency, repletion may be possible among women during PRP without extra food intake. We categorize such women as *repleted*.

The third pattern is characterized by a marginally inadequate diet combined with a very short PRP, too short to allow for full weight recovery; as a result, $\Delta W < 0$ (Figure 1, pathway D). In this case, the childbearing pattern is the primary cause of the weight loss and these women, whom we refer to as *incompletely repleted*, have experienced MDS. As we mentioned above, negative effects of short interbirth interval on infant mortality and morbidity have been plausibly demonstrated; the effects on maternal mortality, morbidity, and future fecundability have yet to be investigated.

Women with extremely inadequate diets gain even less weight during pregnancy than do those we categorize as *incompletely repleted*; they lose more weight during lactation and, because of food shortage, are unable to become replete during the PRP even with lengthy interbirth intervals. For these women, $\Delta W < 0$ (Figure 1, pathway E). These women suffer from malnutrition but not from MDS, because their childbearing pattern is not the primary cause of their overall weight loss. If they had had even marginal diets, they could have accommodated the cost of childbearing by means of weight fluctuations similar to those of repleted women. Instead, their weight loss is primarily the result of poor intake, and it is likely to parallel that of the rest of the population. Their children are likely to be affected in utero (prematurity and intrauterine growth retardation) as well as after delivery (poor survival and growth). We categorize these women as *nonrepletable*. It is possible for these women also to have a very short PRP; however, because repletion does not occur during this period, ΔW will not improve with length of PRP. It is important to note that the term *nonrepletable* refers strictly to repletion through changes in childbearing pattern; if provided with adequate dietary intake these women would most certainly replenish their stores as well.

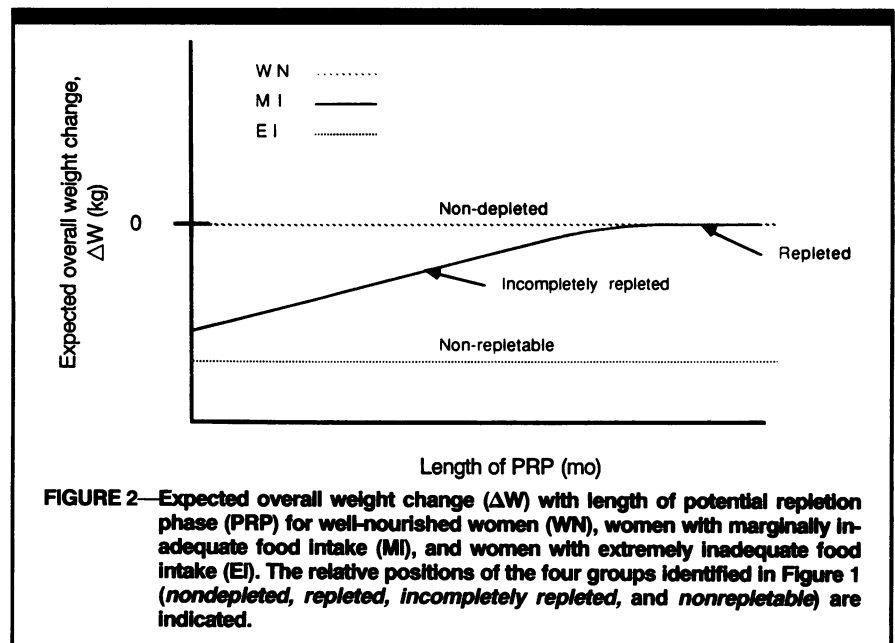
In short, we have defined four mutually exclusive groups with different levels of energy balance. The relationship between length of PRP and ΔW , given these different levels of energy balance, is illustrated in Figure 2. Only for incompletely repleted women does ΔW increase with increased PRP.

Discussion

Traditionally, the term "maternal depletion syndrome" has been used to explain the weight loss of both nonrepletable women and women with MDS. However, to distinguish between the different mechanisms for weight loss in the two groups, we suggest that the term not be used for women in the nonrepletable group. The term "maternal malnutrition" applies to both groups, but its failure to distinguish between mechanisms should be recognized. Also, the term "short interbirth interval" is inadequate in characterizing women with MDS because it does not account for prolonged breast-feeding followed by a short PRP, or for whether or not repletion actually occurs in any women during PRP. The latter point is supported by the observation that short interbirth interval among Malaysian women had a negative effect on infant mortality only when maternal nutritional status was inadequate.²⁹

The original definition of MDS referred to the cumulative effect of successive pregnancies and lactations⁷; hence a pronounced effect at higher parities was expected. However, MDS is not necessarily either absent or present during a woman's lifetime, and therefore the correlation between parity and maternal weight might be low. Only if MDS has persisted throughout many reproductive cycles for all women who ever experienced MDS would parity be a sensitive lagged indicator. Instead, we should identify women who experience reproductive stress or inadequate diet or both across a reproductive cycle, and the correct outcome variable is change in nutritional status, for example, ΔW .

Interventions to prevent maternal malnutrition among nonrepletable and incompletely repleted women will differ. An increased PRP alone will not affect ΔW (see Figure 1) for nonrepletable women, whereas increased food intake will help them to accommodate the cost of pregnancy and lactation without an overall weight loss. Thus, interventions are needed to improve their nutrition (e.g., by increasing income, changing intrahouse-



hold food distribution, or improving women's prestige in the society). On the other hand, women with MDS have the potential to become replete if their PRP is lengthened. However, these women now experience repletion periods too short to make up for depletions as a result of changes associated with modernization (e.g., the breaking down of traditional taboos against sexual intercourse during breast-feeding, and the trend toward shortened breast-feeding) that lead to an earlier return of fecundability and a subsequent pregnancy.³⁰ This situation is exacerbated by a high infant mortality rate, which also results in curtailed breast-feeding. Effective interventions are the promotion of breast-feeding and family planning, as well as interventions to increase infant survival, such as improved prenatal care and, again, the promotion of breast-feeding.

Finally, our aim in developing this new definition of MDS was to enable the testing of its actual existence in the developing world. A nutritional effect of reproductive stress has been indicated by some studies^{20,21}; however, it remains uncertain whether this really represents a "syndrome" in the clinical sense. Hence, we support the use of the term "maternal depletion," rather than the term "maternal depletion syndrome," at this stage.

Conclusions

We suggest a new conceptual framework for the study of maternal depletion. Within this framework, maternal deple-

tion is defined as follows: (1) It is a condition that should be evaluated over one reproductive cycle at a time. (2) It is characterized by a negative change in maternal nutritional status during the reproductive cycle, and the change is more negative the longer the periods of potential depletion and/or the shorter the periods of potential repletion. (3) It most likely occurs only among women with marginally inadequate food intake, because these are the women for whom the balance between the potential depletion and potential repletion phases has an important functional role.

With this new definition, maternal depletion finally has both a biological and a practical meaning, and we can conceptually distinguish between childbearing pattern and inadequate diet as causes of poor maternal health. The empirical application of this approach should permit the practical identification of populations in which family planning will alleviate maternal depletion, and in which only the provision of more food will alleviate malnutrition among the women. □

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