

ordinarily used to describe quantitative differences on a single construct when the authors actually meant one or more comorbid conditions, was misleading.

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Dr. Liu and Colleagues Reply

TO THE EDITOR: We appreciate the thoughtful comments of Dr. Galler et al. regarding our recent work on malnutrition and externalizing behavior problems. They point out that we did not test for the effects of acute versus chronic malnutrition on long-term behavior, that we measured malnutrition at only one time point, and that the effect of malnutrition may be prenatal rather than postnatal. In response, we refer the reader to the limitations section of our article, where we acknowledged all of these issues. The important study of Neugebauer et al. (1), demonstrating a link between prenatal malnutrition and, later, antisocial personality disorder, clearly demonstrates the significance of prenatal nutrition on later externalizing behavior. Our research took this further by demonstrating that malnutrition assessed at age 3 years has long-term effects on children's externalizing behavior (aggression, hyperactivity, and conduct disorder) across 14 years, as assessed at three age points. We believe our study is the first to demonstrate a link between malnutrition assessed postnatally and later externalizing behavior. Furthermore, although malnutrition was not assessed after age 3, the important practical and intervention implication is that the children who showed external, observable signs of malnutrition at age 3 are at risk for developing externalizing behavior. If we assume that this link is causal, better nutrition postnatally could help prevent such problems. In support of this, we recently demonstrated that a multimodal postnatal enrichment

that included better nutrition significantly reduced conduct disorder at age 17 and criminal behavior at age 23 (2), and furthermore, these beneficial effects on conduct disorder were potentiated in children with signs of malnutrition at entry into the prevention program. This finding and work on the effects of nutritional supplements in reducing antisocial/aggressive behavior in prisoners (3) are not consistent with the claim of Dr. Galler et al. that the negative effects of prenatal malnutrition are permanent and instead suggests that whether prenatal or postnatal, the deleterious effects of early malnutrition can be addressed. We fully agree that future studies that elucidate the relative roles of prenatal and postnatal malnutrition in the development of children's externalizing behavior are important.

Dr. Galler et al. suggest that our definition of malnutrition was unconventional and that height and weight were not used. In response, there are at least two types of malnutrition: macro-malnutrition, which often refers to protein-energy malnutrition, and micromalnutrition, which usually refers to mineral and vitamin deficiency (e.g., zinc, iron, vitamin A). Although assessment of the former often includes height and weight, the latter can be assessed by signs and symptoms in addition to laboratory measurements. In our article, we emphasized that the indicators of malnutrition reflect deficits not only of protein (red hair, sparse/thin hair) but also of iron (low hemoglobin level) and zinc (red hair, sparse/thin hair). A deficiency in iron and zinc could negatively affect brain growth and development and result in antisocial behavior. In our study, anemia indicated by a low hemoglobin level, which reflects iron deficiency, was the most common indicator of malnutrition; this cannot be viewed as an unconventional measure. Furthermore, unlike the indicators we used, height and weight are strongly influenced by genetic factors unrelated to malnutrition. The fact that we previously found that children at age 3 who are taller and weigh more (hypothesized to reflect increased testosterone and/or a physical advantage that predisposes to aggression through social learning) illustrates both the importance of recognizing different forms of malnutrition and also the fact that multiple etiological factors are at play in shaping externalizing behavior (Raine et al., 1998, reference 6 from previous letter).

Finally, Dr. Galler et al. felt that our use of the term “dose-response” was misleading. The empirical fact remains that the more indicators of the single construct of malnutrition that a child has, the greater the level of later externalizing behavior.

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