Letter to the Editor: Response to Primack's Comment: Mother's Milk

In our recent article (Fujita et al., 2012), we reported a test of the Trivers–Willard hypothesis on both behavioral and biological parental investment by evaluating breastfeeding frequencies and breastmilk fat concentrations using data from northern Kenya. We did this by testing two specific hypotheses: (1) economically sufficient mothers will breastfeed sons more frequently than daughters, whereas poor mothers will breastfeed daughters more frequently than sons, and (2) economically sufficient mothers will produce breastmilk with higher fat concentrations for sons than daughters, whereas poor mothers will produce breastmilk with higher fat concentrations for daughters than sons. We applied multiple linear regression models to test these hypotheses and found support for the latter hypothesis on milk fat.

As reported in the article, the regression model for milk fat estimated that, after controlling for covariates, economically sufficient mothers would produce milk with substantially higher fat concentrations for sons than daughters whereas poor mothers produce milk with higher fat concentrations for daughters than sons. For illustrative purpose, we described the model estimates for hypothetical mothers having mean values for covariates.

In his letter, Dr. Primack suggests that our results are questionable for the reasons that (1) statistical models should not estimate a value beyond the observed range, (2) human milk should not vary beyond a factor of 4 based on the infant's sex, and (3) human infants should not thrive on low fat milk. He further notes that (4) the title of our article misrepresents our results which are about an interaction factor involving mainly well-off mothers, rather than about poor mothers. He suspects that the log-transformation may have caused an error in our results and requests that we report descriptive statistics for milk fat so that the reader can evaluate the validity of our results.

We express our sincere appreciation for Dr. Primack for taking the time to lay these concerns out in his Letter. After going through the statistical models and data carefully to examine these issues, we found that there was no problem in our statistical model or data. We found instead that there was an error in our calculation of predicted value that artificially lowered the value for just one group—economically sufficient mothers with daughters. We corrected this error and found that the predicted value for this group was 1.74 g/dl instead of 0.6 g/dl after controlling all other covariates the same as the other groups. The predicted values for each group were reported in the original article in order to explain the effect of the interaction of socioeconomic status and offspring sex testing the hypothesis 2. We indeed used log-transformed milk fat values during data analysis to fulfill the normality assumption, but this transformation did not contribute to the error because we reported exponential values of the estimated ones to convert to the original unit (g/dl). The error was rather caused by our failure to add the constant ($\beta_0 = 1.127$) to the contributions from the independent variables and covariates in the regression model to calculate the predicted value prior to taking the exponential values of log-transformed milk fat. This error contributed to the abnormally low milk fat prediction for economically sufficient mothers with daughters which in turn produced an impression that the interaction is driven primarily by this particular group. Figure 1 displays the nature of the interaction after correcting for the above error. The value for the economically sufficient with daughters group now falls within the observed range while our overall patterns of interaction remain intact. The interaction still shows that milk fat for poor mothers with daughters is greater than that for poor mothers with sons while milk fat for economically sufficient mothers with sons is greater than their counterparts with daughters. With this correction, the differences in milk fat concentrations based on offspring sex are more consistent with published sources and biologically plausible.

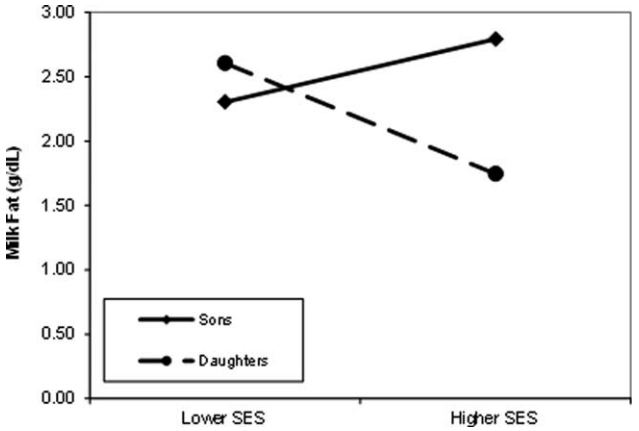

Fig. 1. Interaction between socioeconomic status (SES) and offspring sex. The figure based on predicted values calculated with all covariates fixed at the mean values: 2.79 g/dl for higher SES with sons, 1.74 g/dl for higher SES with daughters, 2.30 g/dl for lower SES with sons, 2.61 g/dl for lower SES with daughters.

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TABLE 1. Descriptive and adjusted characteristics for milk fat concentrations (g/dl) by socioeconomic status (SES) and offspring sex (n = 72)

	Lower SES		Higher SES	
Milk Fat (g/dl)	Sons ($n = 13$)	Daughters ($n = 10$)	Sons ($n = 30$)	Daughters ($n = 19$)
Raw mean (SD)	2.13 (0.86)	2.98 (1.51)	2.56 (1.12)	1.91 (1.10)
Range	1.11, 4.08	0.93, 5.52	1.29, 5.97	0.93, 4.80
Adjusted[a] Mean (SD)	2.00 (0.19)	2.65 (0.44)	2.38 (0.33)	1.71 (0.28)
Range	1.70, 2.44	2.10, 3.49	1.71, 3.17	1.11, 2.30

[a]Values are based on predicted values of the regression model for individuals.

We present descriptive statistics for milk fat concentrations for the four groups of mothers in Table 1, including both raw and adjusted means. Adjusted means are calculated by obtaining individual predicted values from the regression model. Table 1 indicates that, on average, milk of poor mothers was higher in fat for daughters (2.98 vs. 2.13 g/dl raw means, 2.65 vs. 2.00 g/dl adjusted means) while milk of economically sufficient mothers was higher in fat for sons than daughters (2.56 vs. 1.91 g/dl raw means, 2.38 vs. 1.71 g/dl adjusted means). These results lead us to disagree with Dr. Primack that the title of our article misrepresents our results.

We hope that the above discussion will clarify all the concerns raised in the *Letter to the Editor*. Despite the limitations of our data owing to the use of foremilk samples and the lack of milk volume information, we believe that, with this additional analysis, our study provides an empirical example supporting the Trivers–Willard hypothesis. What was striking in this study was that milk fat showed a very wide range of variation, spanning from 0.93 to 5.97 g/dl overall. This underscores the increasingly appreciated notion that human milk is a highly variable fluid (Miller et al., 2013), particularly in its fat concentration (Mitoulas et al., 2002). We hope that our study has contributed to an increased attention to this aspect of human milk.

Finally, we express our appreciation to the reviewers of this response letter who provided us with careful and constructive suggestions for the reevaluation of our original analysis which helped us discover the calculation error. The primary author is solely responsible for the error. She expresses appreciation for this opportunity to report the correction and additional analyses on milk fat.

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LITERATURE CITED

Fujita M, Roth EA, Lo Y, Hurst C, Vollner J, Kendell A. 2012. In poor families, mothers' milk is richer for daughters than sons: a test of Trivers–Willard hypothesis in agropastoral settlements in Northern Kenya. Am J Phys Anthropol 149:52–59.

Miller EM, Aiello MO, Fujita M, Hinde K, Milligan L, Quinn EA. 2013. Field and laboratory methods in human milk research. Am J Hum Biol 25:1–11.

Mitoulas LR, Kent JC, Cox DB, Owens RA, Sherriff JL, Hartmann PE. 2002. Variation in fat, lactose and protein in human milk over 24 h and throughout the first year of lactation. Br J Nutr 88:29–37.