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The Mediating Effect of Maternal Nutrition Knowledge on the Association between Maternal Schooling and Child Nutritional Status in Lesotho

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The present study tested whether maternal nutrition knowledge was a mediating factor in the association between maternal schooling and child nutritional status, and whether the mechanism involved differed according to socioeconomic status. The data were collected in Lesotho on 921 mother–child pairs and included scores from a nutrition knowledge test, socioeconomic and demographic information, and the child's anthropometric data. A wealth factor derived from a factor analysis was used to stratify the sample into two socioeconomic groups. Two-stage least-squares estimation was used to test the mediating role of nutrition knowledge between maternal schooling and child weight-for-age. Results showed that both the importance of maternal schooling and the mechanism by which it affects the child's weight-for-age are contingent upon the family's socioeconomic status. While maternal schooling was positively associated with weight-for-age for both wealthier and poorer households, the size of the effect was much larger for the latter group. The effect of maternal schooling on weight-for-age was mediated by the mother's nutrition knowledge only among wealthier households. These results imply that, in Lesotho, nutrition education for mothers could contribute to improving children's growth, but only in households that have access to a minimum level of resources. For poorer households, nutrition education would not be sufficient. *Am J Epidemiol* 1992;135:904–14.

educational status; health education; nutritional status; socioeconomic factors

Maternal schooling has been consistently associated with positive child health outcomes in developing countries, be it through decreased mortality (1–4), decreased morbidity (5–8), or improved nutritional status (9–15). The mechanisms by which maternal schooling affects child health and nutritional status, however, are still poorly understood (1, 16). Various hypothetical pathways have been proposed (4, 10, 17, 18), although little research has been done to test these hypotheses. A recent study done in the Phil-

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ippines (8) identified various health- and nutrition-related behaviors through which maternal schooling affects the prevalence of diarrhea in 6-month-old children. Socioeconomic factors were controlled for in the analyses, thereby reducing the possibility that maternal schooling acted as a proxy for socioeconomic status. Other studies have also shown that after income was controlled for by multivariate analysis, maternal schooling was of greater importance and statistical significance than the income effects (10, 11, 19–21).

The present study tested whether greater knowledge of nutrition is one possible mechanism by which maternal schooling may affect child nutritional status, independent of socioeconomic factors. This mechanism is suggested by the empirical evidence of an association between maternal schooling and nutrition knowledge in this population (22) and in others (23–27).

A related issue that has received little attention to date and that was also tested in the present study is the potential interaction between maternal schooling and socioeconomic factors. Two studies from developing countries have examined this question and have shown that the magnitude of the impact of maternal schooling on child nutritional status differs markedly between socioeconomic groups (12, 28). In both studies, the stronger association between maternal schooling and child nutritional status was found in households whose income was above a certain minimum threshold. Below this point, maternal schooling had little effect, probably because of the overwhelming constraint on resources.

The objectives of the present study were twofold: 1) to ascertain whether maternal schooling is an important determinant of child growth in rural Lesotho, after controlling for other socioeconomic factors, and whether this effect is mediated by maternal nutrition knowledge; and 2) to determine whether maternal schooling is equally important for poorer and wealthier Basotho households and if the effect is mediated by nutrition knowledge in both groups. Figure 1 illustrates the hypothesized mechanisms that were tested.

MATERIALS AND METHODS

Study sample and data used

The data were collected in 1985–1986 in Lesotho, a small, mountainous country surrounded by the Republic of South Africa. Lesotho is a poor country with a population of 1.7 million. In 1986, its gross national product per capita was US$370, infant mortality ranged from 103 to 122 per thousand live births, and life expectancy was 57 years (29). Lesotho is economically highly dependent on the Republic of South Africa: about 40 percent of its male labor force earns income from working in the mines and in other industries in the Republic of South Africa, and their remittances constitute about 52 percent of Lesotho's gross national product (30).

A sample of 921 mothers and their youngest child (0–24 months old) from nine primary health care clinics of rural Lesotho was included in the study (31). Clinics were chosen on the basis of their accessibility by road and their high attendance rates. All mothers who had a child 24 months of age or younger and who attended the clinics during the 9-month enrollment period were included in the study. A summary of the socioeconomic and demographic characteristics of the sample is presented in table 1.

The child's weight and length were measured and the mother's nutrition knowledge was tested. Nutrition knowledge was defined in a wide sense to include knowledge of breast-feeding, timing of introduction of foods into the child's diet, use of oral rehydration salts, and withholding of food during episodes of diarrhea (22). A nutrition knowledge score was derived by giving one point for each correct answer and zero for an incorrect or uncertain answer (maximum score, 50 points).

Analytical methodology

Factor analysis. Factor analysis was used to reduce the number of socioeconomic vari-

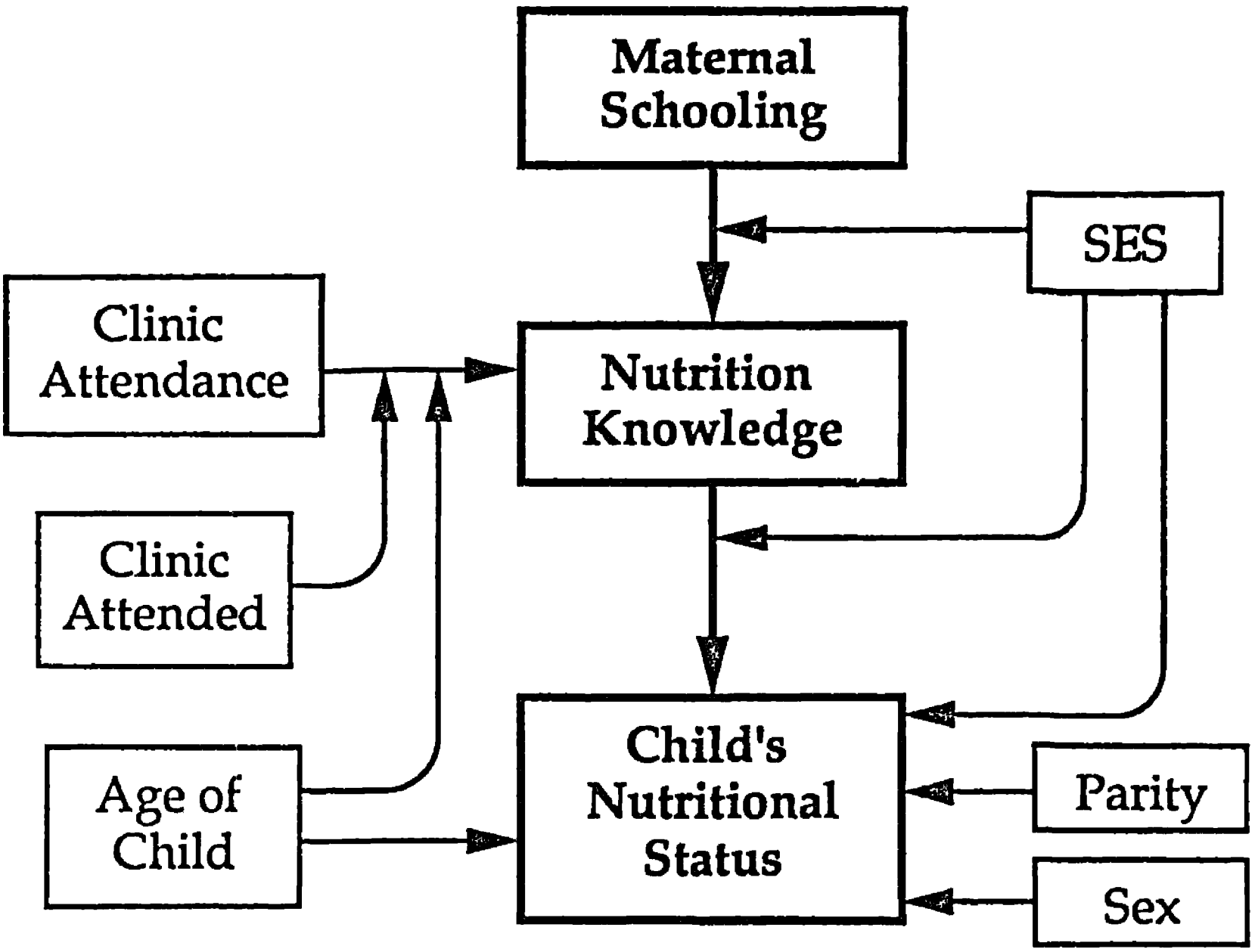

FIGURE 1. Hypothesized mechanisms by which maternal schooling affects child nutritional status, Lesotho, 1985–1986. Only the variables available in the data set are reproduced in this figure. Arrows meeting a second arrow represent hypothesized interactions. SES, socioeconomic status.

ables to five factors: demographics, involvement in agriculture (land, assets, and animals possessed), sources of income (agriculture, mine work, other wage work, etc.), wealth (housing quality, possessions, source of water), and environmental conditions (crowding, quantity of water used daily) (32). Principal components was chosen for factor extraction and the varimax (orthogonal) rotation was used in the final modeling (33).

Multivariate analysis. The overall prediction equation for the child's weight, considering only the main effects, was as follows:

$$\text{Weight} = a_0 + a_1K + a_2S + a_3CA + a_4C + a_5M + a_6SES + e_1, \quad (1)$$

where, K is maternal nutrition knowledge (test scores); S is maternal schooling; CA is previous clinic attendance; C is the vector of the child's characteristics (age and sex); M is the vector of maternal characteristics (working status, parity); SES is the vector of the five socioeconomic factors; and e is the error term. As shown in a separate publication (22), the prediction equation for maternal nutrition knowledge (K) was

$$K = b_0 + b_1S + b_2CA + b_3A + b_4CA*S + b_5CA*A + b_6CA*CAE + e_2, \quad (2)$$

where A is the age of the child (0, <6 months: 1, 6–24 months); $CA*S$ is the interaction between clinic attendance and schooling; $CA*A$ is the interaction between clinic attendance and the child's age; and $CA*CAE$ is the interaction between clinic attendance and the clinic attended.

It can be seen from these two equations

TABLE 1. Summary of demographic and socioeconomic characteristics of 921 Basotho mothers: Lesotho, 1985–1986

Characteristic	Value
Demographics	
Mother's age (mean, years)	26 5
Parity (mean)	2.7
Household size (mean)	5 1
Schooling (%)	
Mothers	
None	3 3
Primary not completed	42 9
Primary completed	37 0
Higher level	16 7
Fathers	
None	12 9
Primary not completed	19 4
Primary completed	40 5
Higher level	27 2
Main sources of income (%)	
Mine remittances from the RSA*	72 7
Agriculture	5 1
Other socioeconomic characteristics	
Do not own land (%)	31 6
Have a latrine (%)	66 4
Crowding (mean, persons room)	3 8
Unprotected water source (%)	47 6

* RSA, Republic of South Africa

that some of the determinants of maternal nutrition knowledge (equation 2) are also hypothesized to be determinants of the child's nutritional status (equation 1), namely, maternal schooling and previous clinic attendance (see also figure 1). Because the variable "maternal knowledge" is determined within the system (i.e., by variables included in the equation), this intermediary variable is "endogenous," and thus, the errors of this variable are correlated with the error term of the equation (34). The use of ordinary least-squares regression analysis in this situation provides biased and inconsistent estimates of the coefficients (35). Two-stage least squares is a method widely used for the estimation of models in which one or more of the predictor variables is thought to be correlated with the error term (8, 35–39). This method consists of 1) regressing the endogenous variable on all its predictors, and 2) using the predicted values obtained to replace the observed values for this variable in the overall equation. Equation 1 then becomes

$$\text{Weight} = c_0 + c_1\hat{K} + c_2S + c_3CA + c_4C + c_5M + c_6SES + e_3, \quad (3)$$

where, $\hat{K}$ equals the predicted values for knowledge.

Thus, two-stage least-squares regression was used here to test whether schooling was a significant determinant of the child's nutritional status once its effect, as mediated through maternal nutrition knowledge, was taken into account. The results of the two-stage least-squares estimation were compared with those obtained using ordinary least squares, to illustrate the differences. The statistical package SPSS/PC+ (version 3.1) was used for all analyses (33, 40), and main effects and interactions were considered significant at the $p \leq 0.05$ and $p \leq 0.10$ levels, respectively (41).

RESULTS

Figure 2 shows the mean weight-for-age Z scores of the sampled children, by sex. Similar patterns were observed for both sexes: weight-for-age was above zero during the first two months of life, but a marked drop was observed as early as the third month and persisted until the age of 9–11 months. A plateau was then reached at a low mean Z score of approximately −1.5.

In a multivariate analysis of weight-for-age that included maternal characteristics as well as demographic and socioeconomic variables, the two-way interactions between the child's age and maternal schooling and between the child's age and the socioeconomic factors were not statistically significant. However, a statistically significant interaction was found between maternal schooling and the wealth factor. Hence, this factor was used to divide the sample into two socioeconomic groups: the "poorer" (wealth factor score below or equal to the mean) and the "wealthier" (wealth factor score above the mean). Subsequent analyses were done separately for each group.

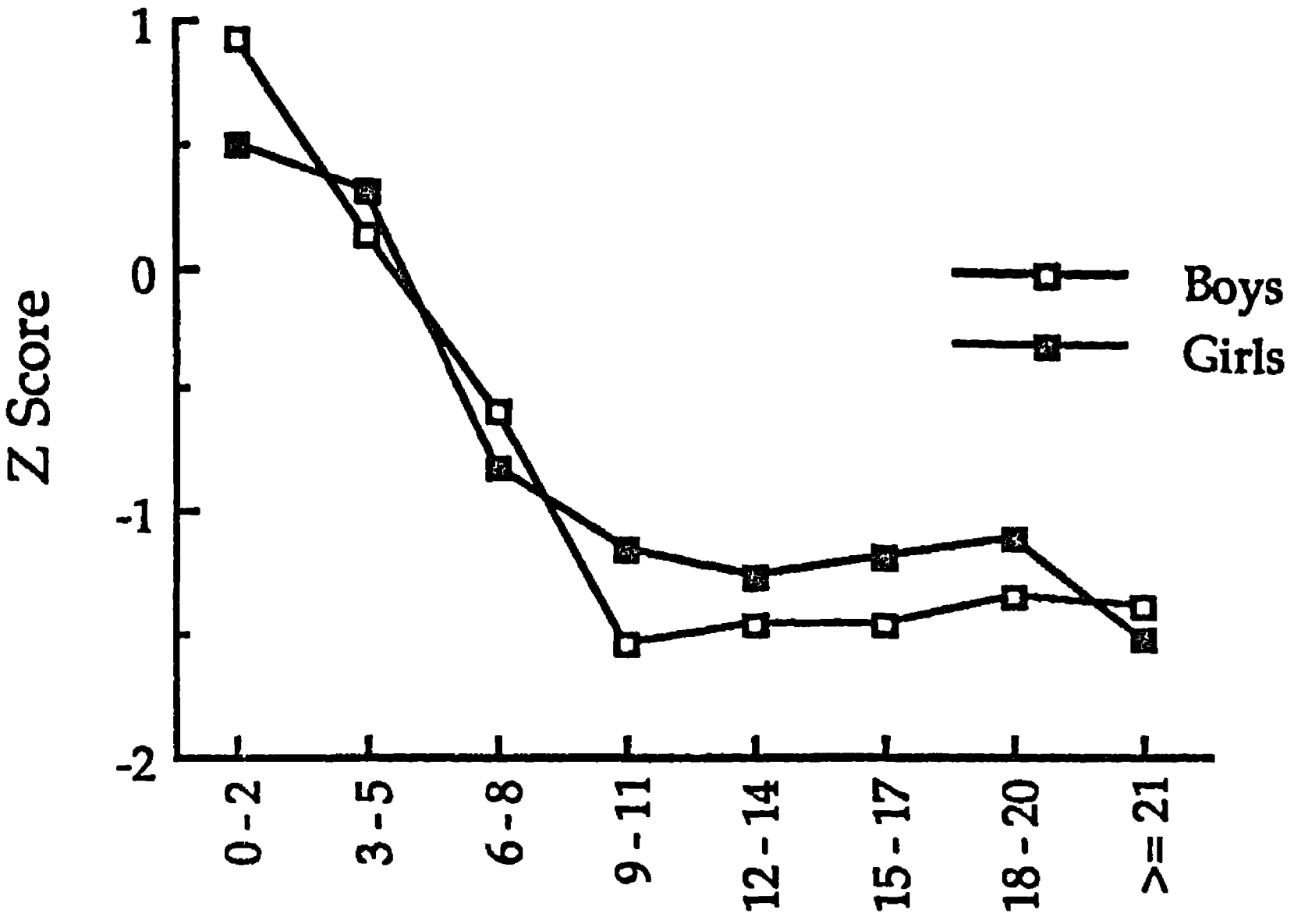

FIGURE 2. Mean weight-for-age *Z* scores of 921 Basotho children by age and sex, Lesotho, 1985–1986 *Z* scores were computed using the reference population of the National Center for Health Statistics (42). The child's weight was compared with the 50th percentile value of the reference population and divided by the standard deviation of the references at that age (43) A *Z* score of zero means that the child's weight is equal to the 50th percentile of the reference population

Table 2 presents the results of the multivariate analysis of weight-for-age by socioeconomic group, comparing the ordinary least-squares and two-stage least-squares estimation methods. The coefficients of the knowledge equations (i.e., the first stage of the two-stage least-squares estimations) are presented in the Appendix. Table 2 shows that among the poorer group, the two estimation methods (ordinary least squares and two-stage least squares) provided very similar coefficients for all the variables included in the model, particularly for the variables of interest (knowledge and schooling). Only schooling was associated with weight-for-age. Nutrition knowledge had no effect. For the wealthier group, the coefficients for maternal nutrition knowledge and schooling differed markedly between the ordinary least-squares and the two-stage least-squares estimations. The interpretation of these results is that for the poorer group, two-stage least squares did not provide results different from ordinary least squares because maternal nutrition knowledge was not a mediating factor in the association between schooling and weight-for-age. For the wealthier group, however, the use of two-stage least squares highlighted the importance of maternal nutrition knowledge as a mediating factor between schooling and weight-for-age. Schooling was also shown to have no remaining effect on weight-for-age, once its effect on nutrition knowledge was taken into account.

TABLE 2. Comparison of results of equations for child's weight* using ordinary least-squares and two-stage least-squares estimations, by socioeconomic group: Lesotho, 1985–1986

Independent variables	Socioeconomic group†							
	Poorer families (n = 438)				Wealthier families (n = 412)			
	Ordinary least squares		Two-stage least squares		Ordinary least squares		Two-stage least squares	
	β‡	p	β	p	β	p	β	p
Nutrition knowledge§	0 00	0 40	0 01	0 86	0 00	0 91	0 10	0 03
Schooling‖	0.44	0 01	0 43	0 01	0 05	0 75	−0 05	0 75
Family composition¶	−0.08	0.34	−0 09	0.31	0 00	0 94	−0 08	0 45
Agricultural involvement¶	−0 05	0 32	−0 05	0 31	−0 04	0 47	−0 09	0 22
Sources of income¶	−0 03	0 65	−0.03	0 64	0 03	0 58	0 04	0 57
Wealth¶	0 17	0 08	0.17	0 08	0 23	0 03	0 31	0 01
Environmental conditions¶	−0 08	0 11	−0 07	0 17	−0 21	0 00	−0 22	0 00
Parity**	0 40	0 01	0 42	0.02	0.11	0 52	0 18	0 38
Age (months)	0 19	0 00	0 19	0 00	0 20	0 00	0 19	0 00
Sex	−0 45	0 00	−0 46	0 00	−0 47	0 00	−0 47	0 00
Clinic attendance††	0.07	0 62	0 03	0 87	0 22	0 25	−0 13	0 63
Working‡‡	−0 07	0 62	−0 08	0 49	−0 10	0 39	−0 07	0 63
Constant	6 73	0 00	6 31	0 00	6 30	0 00	2 57	0 15
Standard error	1 10		1 12		1.18		1 36	
df	437		437		411		411	
R^2	52 53%		51 47%		55 15%		48 00%	

* The outcome variable of these equations is the weight of the child in kilograms

† The sample was divided into two socioeconomic groups using the "wealth" factor. Families for whom the values of some of the variables were missing were excluded from the multivariate analysis "Poorer" families had a wealth factor score below or equal to the mean and "wealthier" families had a wealth factor score above the mean Note that factor scores are standardized variables, and thus their mean is zero

‡ β, regression coefficient

§ Score derived by giving one point for each correct answer and zero for an incorrect or uncertain answer; maximum score 50 points

‖ 0, primary school or less, 1, more than primary school

¶ Factor score extracted from principal components analysis (Ruel MT. The role of maternal nutrition knowledge and formal education as determinants of child s nutritional status in Lesotho Unpublished Ph D dissertation Cornell University, Ithaca NY, 1990) Scores derived from this analysis are standardized variables and are unitless, they were used as continuous variables in this analysis

** 0 first child, 1, second child and subsequent children

†† 0 <3 months, 1, ≥3 months

‡‡ 0, no, 1, yes

Table 3 presents the parsimonious two-stage least-squares models for both socioeconomic groups. Among poorer households, none of the socioeconomic factors were associated with weight-for-age. Besides the age and sex of the child, only maternal schooling and parity were significantly associated with weight-for-age among this group. For wealthier households, wealth and maternal nutrition knowledge were positively associated with weight-for-age, and the worst environmental conditions were associated with poorer nutritional status.

Figure 3 illustrates the interaction between maternal nutrition knowledge and socioeconomic status on the estimated weight of 12-month-old male children. It shows that as maternal nutrition knowledge scores increase, the weight of children from the wealthier group also increases. In contrast, the weight of children from the poorer group remains constant.

DISCUSSION

Main findings

In Lesotho, as in most developing countries, maternal schooling is positively associated with child nutritional status. The present study, however, suggests that both the importance of schooling and the mechanism by which it affects child nutritional status

TABLE 3. Results of two-stage least-squares equations for child's weight* (parsimonious models), by socioeconomic group: Lesotho, 1985–1986

Independent variable	Socioeconomic group†			
	Poorer families (n = 438)		Wealthier families (n = 412)	
	β‡	p	β	p
Nutrition knowledge§	0 00	0.90	0 08	0 01
Schooling‖	0.46	0 01		
Wealth¶			0 29	0 01
Environmental conditions¶			−0 19	0 00
Parity**	0 31	0 00		
Age (months)	0 19	0.00	0 20	0.00
Sex	−0 48	0 00	−0 51	0 00
Constant	6 35	0 00	3 63	0 00
Standard error	1.10		1 29	
df	437		411	
R^2	52 31%		51 30%	

* The outcome variable of these equations is the weight of the child in kilograms.

† The sample was divided into two socioeconomic groups using the "wealth" factor. Families for whom the values of some of the variables were missing were excluded from the multivariate analysis. "Poorer" families had a wealth factor score below or equal to the mean, and "wealthier" families had a wealth factor score above the mean. Note that factor scores are standardized variables, and thus their mean is zero.

‡ β, regression coefficient.

§ Score derived by giving one point for each correct answer and zero for an incorrect or uncertain answer, maximum score 50 points.

‖ 0, primary school or less; 1, more than primary school.

¶ Factor score extracted from principal components analysis (Ruel MT. The role of maternal nutrition knowledge and formal education as determinants of child's nutritional status in Lesotho. Unpublished Ph D dissertation. Cornell University, Ithaca NY, 1990). Scores derived from this analysis are standardized variables and are unitless; they were used as continuous variables in this analysis.

** 0, first child; 1, second child and subsequent children.

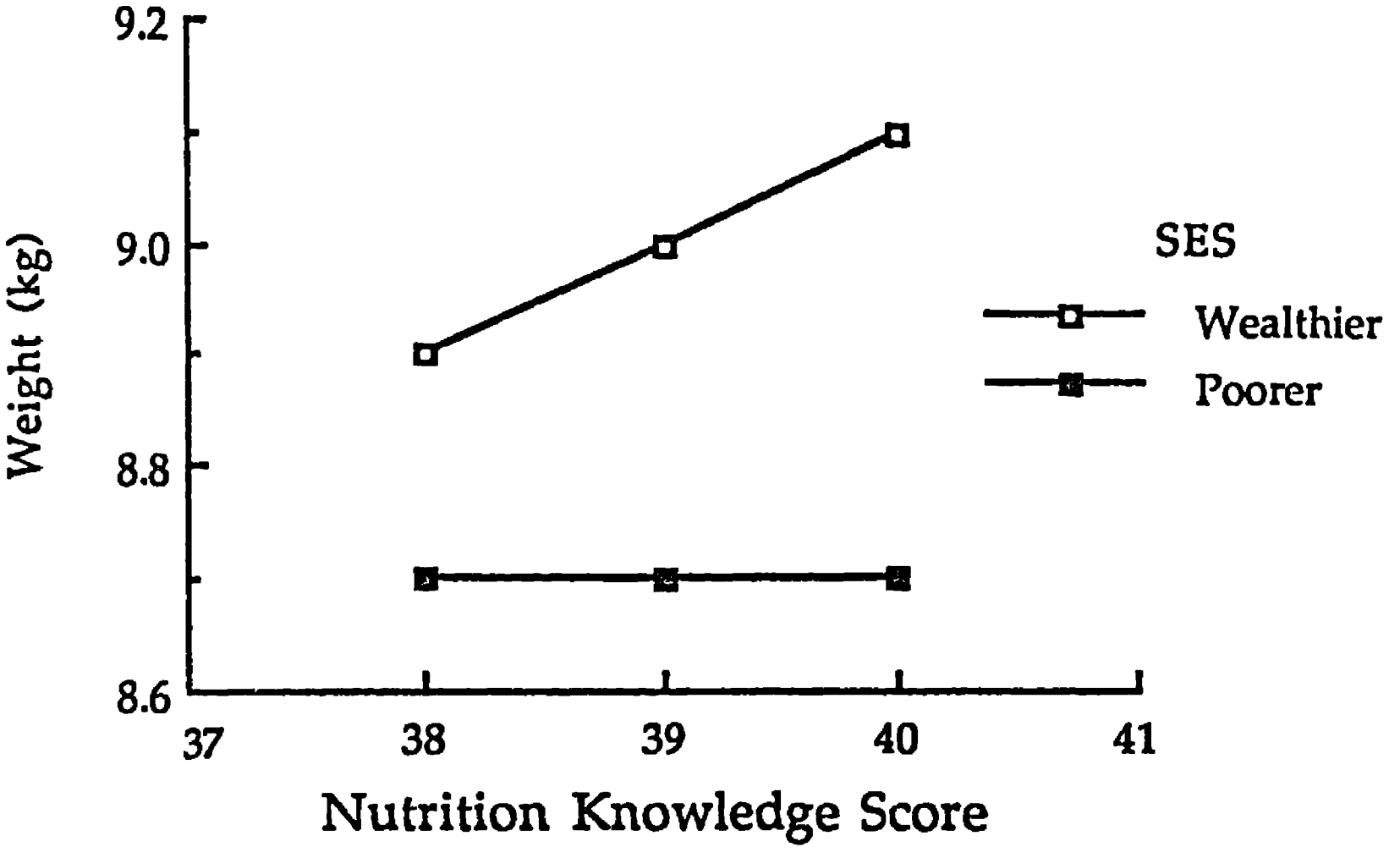

FIGURE 3. Interaction between maternal nutrition knowledge and socioeconomic status, Lesotho, 1985–1986. The weights of 12-month-old male children were estimated, using the coefficients from the two-stage least-squares complete model (table 2) for each socioeconomic group and for different maternal nutrition knowledge scores. SES, socioeconomic status.

differ according to socioeconomic status. Among the wealthier households of the sample, the association between maternal schooling and child nutritional status was mediated by increased nutrition knowledge. For poorer households, nutrition knowledge was not associated with child nutritional status, although maternal schooling had a large and statistically significant positive effect. Among this group, the association between schooling and child nutritional status was independent of maternal nutrition knowledge, and was probably related to other benefits of schooling not reflected in knowledge of the issues examined.

External validity

It is worth mentioning that the sample used in the present study may not be representative of the entire Basotho population. Because of the clinic-based nature of the study, the sample was self-selected, in that it included only mothers who chose to attend the clinics. To reduce potential self-selection biases, clinics with high coverage rates were chosen, and the sample was found to be representative of Lesotho's typical population of clinic attenders (32). Thus, the findings and implications of the present study are relevant for ongoing, clinic-based nutrition education programs, and should be used to increase their effectiveness. For national community-based programs, however, similar analyses of a representative sample of the Basotho population would need to be done.

Analytical approach

The present study applied the method of two-stage least squares to model the mediating effect of maternal nutrition knowledge in the association between maternal schooling and child nutritional status. The Philippines study (8) provides a thorough discussion of a similar application of two-stage least squares to the modeling of intermediary mechanisms in epidemiologic research. Using two-stage least squares regression to control for endogenous variables, the authors developed a methodology to assess the effects of "underlying" social factors and "proximate" behavioral and biomedical factors on infant morbidity, growth, and mortality. The implications of ignoring endogenicity are clearly demonstrated by comparing the results of the ordinary least-squares and the two-stage least-squares estimations. A similar demonstration had been made earlier by Schultz (37) in an analysis of the association between the use of prenatal care and infant mortality. When endogenicity was ignored, the use of prenatal care was associated with increased infant mortality, while in fact, prenatal care was shown to have a strong protective effect when appropriate statistical techniques were used.

Comparison with other studies

Our findings regarding the interaction between maternal schooling and socioeconomic status on child growth seem to contradict results from previous studies (12, 28). Contrary to our findings, these studies showed no effect of maternal schooling on child growth among the poorest strata of society. This apparent inconsistency can be explained by a combination of three factors. First, the level of relative poverty and its implications in terms of access to resources was probably not comparable among the three settings (Lesotho, Jordan (12) and Bangladesh (28)). Second, the variables and cutoff points used to classify the population into socioeconomic groups and schooling categories differed among the studies. Third, different analytical approaches and statistical modeling were used, which makes comparisons difficult to interpret. Such differences in results reaffirm the importance of conducting context-specific analyses before deciding upon intervention strategies.

The literature on the association between maternal nutrition knowledge and child nutritional status also shows inconsistent results. Both positive correlations (23, 24, 27, 44) and the absence of association (45–47) have been found. There are two major problems, however, with the interpretation of these studies. First, the testing instruments

used to evaluate nutrition knowledge and the subject matter assessed vary widely. On occasion, mothers were tested on issues that may not be directly associated with child growth. For instance, a study that reported a lack of association between maternal nutrition knowledge and child nutritional status in the Philippines (45) tested mothers on their knowledge about the nutrient content of foods (iron, calcium, vitamins A and C). Since knowledge of these issues is not directly related to the feeding and weaning practices likely to affect the nutritional status of preschoolers in the Philippines, it is not surprising that no association was found between maternal nutrition knowledge and child growth.

Secondly, the relative importance of maternal knowledge and schooling is likely to vary according to the age of the child. Previous studies showed that maternal schooling was a stronger determinant of the nutritional status of younger children, namely, those between the ages of 0 and 2 years (10, 11). Nonetheless, research in this area is usually done on samples of children between the ages of 0 and 5 years, without stratifying by age in the analysis nor testing the interaction between the mother's schooling (or knowledge) and the child's age. The children included in the present study were all younger than 24 months, and the interaction between age and either socioeconomic factors or maternal schooling was not statistically significant. Moreover, mothers were tested on their knowledge of specific practices related to weaning and feeding during diarrhea and illnesses (22), which were thought to be associated with childhood malnutrition in Lesotho (48).

CONCLUSIONS

Our results suggest that, in Lesotho, maternal nutrition knowledge is a positive asset and is associated with improved child nutritional status, but only in households that have access to a minimum level of resources. Thus, only among this group does nutrition education have the potential to improve child growth. For poorer households, other types of interventions must precede or accompany educational efforts if an impact on child health and nutrition is to be expected. Other authors also claim that the effectiveness of nutrition education in combating childhood malnutrition depends on the availability of a minimum amount of food and resources at the household level (49, 50). Whereas previous statements to this effect were based on common sense, our results suggest that they are empirically sound and fundamental to nutrition education policy and planning.

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APPENDIX

Coefficients Obtained for Knowledge Equations

The coefficients obtained for each socioeconomic group in the first stage of the two-stage least-squares analysis are as follows:

Poorer households

$$\begin{aligned}\text{Knowledge} = {} & 30.42 + 5.85\ (\text{clinic attendance}) + 2.31\ (\text{age of child}) \\ & + 3.23\ (\text{maternal schooling}) - 2.55\ (\text{clinic attendance} \times \text{schooling}) \\ & - 2.55\ (\text{clinic attendance} \times \text{age of child}) \\ & - 0.66\ (\text{clinic attendance} \times \text{clinic attended}).\end{aligned}$$

Wealthier households

$$\begin{aligned}\text{Knowledge} = {} & 30.09 + 8.39\ (\text{clinic attendance}) + 4.23\ (\text{age of child}) \\ & + 6.14\ (\text{maternal schooling}) - 7.05\ (\text{clinic attendance} \times \text{schooling}) \\ & - 3.71\ (\text{clinic attendance} \times \text{age of child}) \\ & - 0.25\ (\text{clinic attendance} \times \text{clinic attended}).\end{aligned}$$