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Self-report vs. direct measures for assessing corn soy blend porridge preparation and feeding behavior in a moderate acute malnutrition treatment program in southern Malawi

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ABSTRACT

This analysis assessed whether caregivers' reports about the amount of oil added to corn soy blend (CSB) porridge were consistent with lab analysis and whether reported sharing of CSB porridge was consistent with direct observation. This was a secondary analysis of a feasibility study assessing 2 programmatic changes in a supplementary feeding program for treatment of moderate acute malnutrition (MAM) in southern Malawi. Intervention groups received standard monthly rations of CSB with increased oil along with social behavior change communication (SBCC) to increase the amount of oil added to CSB porridge and reduce sharing. A control group received the standard CSB and oil ration. Self-reported data collected through structured interviews with caregivers were compared with laboratory analysis of CSB porridge samples and in-home observation over a 5-day period. On average, participants over-reported the amount of oil used in prepared CSB porridge; self-report tended to be closer than the lab-assessed values to the amount recommended in the SBCC. Self-reported and observed sharing appeared consistent across groups. Overall, the self-reported and direct measures showed the same relationships among the groups. Self-report and objective measures were inconsistent but conveyed the same overall message.

KEYWORDS

Food aid; corn soy blend; supplementary feeding; moderate acute malnutrition; self-report; in-home observation; sharing; Malawi

Introduction

The success of supplementary feeding programs to treat children with moderate acute malnutrition (MAM) partly depends on whether caregivers adhere to proper food preparation and feeding practices as instructed.[1] Participant compliance also affects the validity of research conclusions.[2] Assessing participants' behaviors, however, is challenging and may require

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direct, objective methods that are not consistently used in randomized controlled trials.[2,3] Self-report is commonly used to assess compliance in many studies; however, its reliability remains an important research question. In the context of international food assistance programs, it is not well understood how self-report compares to other, more direct forms of measurement. In order to better evaluate the effectiveness of supplementary feeding programs, there is a need for more information on the reliability of self-report in comparison to objective measures.

This article compares self-report and objective measures of 2 specific behaviors—amount of fortified vegetable oil added to corn soy blend (CSB) porridge and sharing of prepared porridge. This was a secondary analysis of data from a study in southern Malawi that evaluated the effectiveness of 2 interventions designed to increase the amount of fortified vegetable oil added to CSB porridge prepared by caregivers of beneficiary children with MAM (main findings published in a separate paper).[4] The recommendation to add more fortified vegetable oil to CSB porridge came from a review of research on supplementary feeding, as part of an effort to improve food aid products and programs delivered to vulnerable communities in food insecure settings. This recommendation aimed to better address the nutritional needs of children with MAM by increasing calorie density and essential fatty acids content to improve absorption of fat-soluble vitamins.[5]

Adding more oil requires that caregivers adhere to proper treatment instructions and not divert it for other uses. In this study, social behavior change communication (SBCC) given by health care workers and care group volunteers to caregivers of beneficiary children emphasized preparation of CSB porridge with a ratio of 30 g added oil (fortified vegetable oil) per 100 g of CSB flour. Additionally, the SBCC directed caregivers to feed the CSB porridge to the beneficiary child only.[5] We assessed whether caregivers' reports about the amount of oil added to CSB porridge were consistent with lab analysis and whether reported sharing of CSB porridge appeared to be consistent with direct observation. In-home observations were conducted over several consecutive days, allowing us to explore whether households had a tendency to *always* share (i.e., on all days of observation). The methods of collecting these data, challenges encountered, and lessons learned are discussed. This information helps better understand the effectiveness of supplementary feeding programs for treatment of MAM in food insecure settings.

Methods

Study design

This was a secondary analysis of data from a feasibility study assessing 2 programmatic changes in a MAM treatment program. Figure 1 describes the cross-sectional design and data collection techniques. Consent was obtained

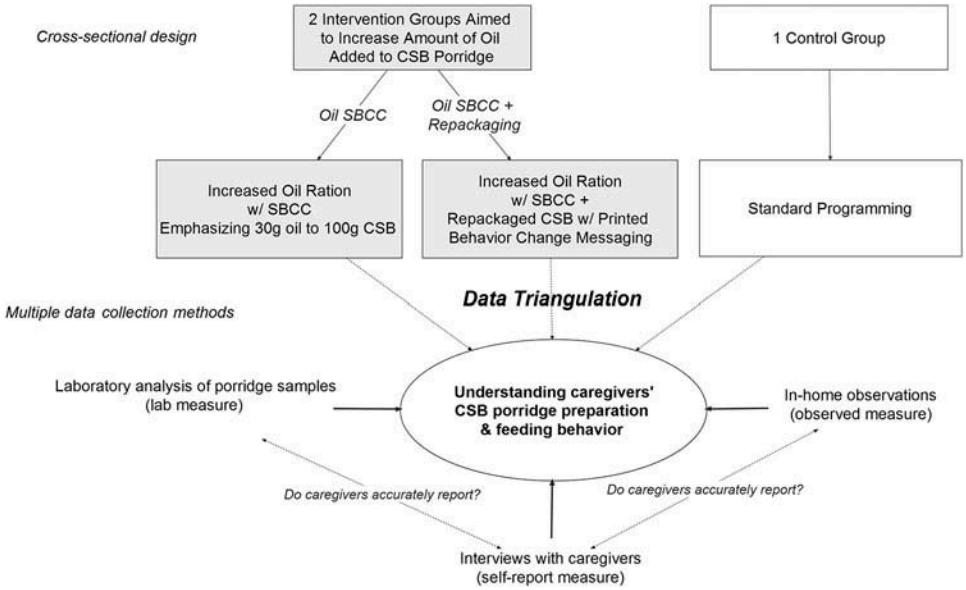

Figure 1. Cross-sectional design and data triangulation method to understand caregivers' CSB porridge preparation and feeding behaviors.

prior to participation in the research. The study protocol was approved by the Health Sciences Institutional Review Board at Tufts University in Boston, Massachusetts, and by the National Health Sciences Research Committee of the Malawi Ministry of Health in Lilongwe, Malawi. Intervention groups received SBCC emphasizing the need to meet the added oil target in prepared CSB porridge (30 g oil per 100 g CSB flour). They also received increased rations of 2.6 L fortified vegetable oil (a sufficient quantity to achieve the target oil : CSB ratio) and 8 kg CSB flour per month provided either in bulk (group 1) or in separate 2-kg packages with printed messages (group 2). The control group received the standard monthly ration of 1 L fortified vegetable oil and 8 kg CSB flour in bulk and standard health education with no emphasis on the quantity of oil to be added. All study groups were instructed to feed the porridge only to the target child, but the intervention groups received stronger messaging. This study was conducted in the context of an existing supplementary feeding program through 16 food distribution points. The study's methods are described in detail in the primary paper.[4]

Data collection

In order to determine caregivers' adherence to porridge preparation and feeding instructions, data were collected through in-depth interviews with caregivers and 2 objective measures: (1) laboratory analysis of porridge samples to assess the amount of oil used and (2) in-home observation to

assess porridge consumption behaviors. In the in-depth interviews, participants were asked questions about the oil and CSB ration, including sharing and leakage, CSB porridge preparation, instructions they received, and CSB porridge consumption. To assess the quantity of oil used in the CSB porridge, participants were asked to give demonstrations of the most recent time they prepared CSB porridge using food models (water for liquid and raw rice for the CSB flour), showing quantities using their own utensils. Enumerators then transferred the models to graduated beakers and recorded the ingredient amounts (in milliliters) on the data collection form. Quantities were converted from milliliters to grams using standard conversions. Participants were asked to whom they served the CSB porridge on that same day.

A small (approximately 1 tablespoon) sample of prepared CSB porridge was collected from participants at the end of each interview in order to determine the amount of added oil in prepared CSB porridge. This porridge sample was collected from a batch of prepared porridge and not from the demonstrations. If there was no prepared porridge at the time of the interview, enumerators attempted to collect a sample on a different day. CSB porridge samples were then taken to a local laboratory to be analyzed for total fat and dry matter contents after eliminating water. (Porridge samples were analyzed by Chancellor College Laboratory at University of Malawi, Zomba, for oil content determination: 10-g samples were quantitatively weighed and dried to constant weight at 105°C; 3- to 5-g dried samples were then weighed and transferred to a Soxhlet thimble. Extractions were done with petroleum ether 40-60 (a laboratory solvent) for 3 hours in a DET GRAT semi-automated extractor. Before analyzing CSB porridge samples, dummy samples containing no added oil were analyzed to determine the intrinsic fat content of the CSB, which was then subtracted to calculate the amount of *added* oil.

In-home observations were piloted during a baseline phase of data collection and adapted into a structured data collection form on which specific activities were recorded in 30-minute time intervals. Following baseline, a subsample of participants was randomly selected for the in-home observations. A sample size of 45 was planned based on logistics and feasibility. Enumerators visited each household during waking hours (about 12 hours a day) for 5 consecutive days. Multiple days of observation were intended to allow for household members to adjust to the presence of the enumerator, on the assumption that they might initially alter their behavior due to being observed (i.e., the Hawthorne effect). Information was collected on aspects of CSB preparation and consumption and on other observable behavior, including how many times a day the CSB porridge was made; who prepared the CSB porridge; ingredients used; who ate the CSB porridge; and how leftovers were handled.

Outcomes

The amount of added oil in CSB porridge, defined as oil grams per 100 g CSB flour, was assessed by porridge demonstrations (the self-reported added oil measure) and laboratory analysis of prepared CSB porridge samples (the direct added oil measure). Sharing, defined as consumption of CSB porridge by anyone other than the beneficiary child, was determined through participants' responses about the most recent day the CSB porridge was served (the self-reported sharing measure) and in-home observation (the direct sharing measure). Direct sharing was described as the percentage of household-days where any sharing was observed. Additionally, sharing was summarized over the total number of CSB porridge-eating occasions observed and by the total number of days where any sharing was observed for each household.

Data analysis

Self-reported amounts of added oil in CSB porridge were compared to amounts derived from lab analysis within each study group using paired *t* tests. When appropriate, the nonparametric Wilcoxon matched-pairs signed rank test was used. Among the study groups, the mean difference between reported and lab values (self-report minus lab value) was assessed using analysis of variance. Statistical significance was determined at the 0.05 level. Bland-Altman plots—a descriptive method by which the difference of 2 measures is plotted against the mean—revealed any discrepancies between reported and lab values.[6] Descriptive statistics only are presented for reported and observed sharing. Data were analyzed using SAS 9.3 (SAS Institute Inc., Cary, NC) and Stata 13 (StataCorp, College Station, TX). Bland-Altman plots were created using R 3.2.1 (R Foundation for Statistical Computing, Vienna, Austria).

Results

A total of 584 caregivers participated: $n = 192$ in the oil SBCC group; $n = 196$ in the oil SBCC plus repackaging group; $n = 196$ in the control group. Of these, a total of 144 (25%) had missing values for either the self-report or lab measure and were excluded from the analysis of added oil. No statistical differences were noted between the omitted and included caregivers with regard to demographic and household characteristics. Additionally, there was a cluster of outliers in the intervention groups with high lab-assessed added oil values. Upon further examination, it was noted that these outliers ($n = 95$) came from the same 3 food distribution points. Results are presented both with and without these outliers included (Table 1 and Figure 2).

Mean grams of added oil from self-report and lab analysis are displayed in Table 1 and Figure 3. Within each group, the mean self-reported amount of

Table 1. Comparison of self-reported and lab-assessed oil measures, presented as grams of added oil per 100 g CSB.[a]

	Full sample			Outlier clusters removed		
	Oil SBCC	Oil SBCC + repackaging	Control	Oil SBCC	Oil SBCC + repackaging	Control
	n = 192	n = 196	n = 196	n = 129	n = 164	n = 196
Mean (SD), median						
Reported	30 (9), 30	30 (9), 30	15 (9), 14	31 (9), 32	30 (9), 30	15 (9), 14
Lab	28 (16), 25	25 (15), 23	12 (10), 10	22 (12), 22	22 (12), 22	12 (10), 10
Difference (reported − lab)	3 (19), 5	5 (17), 6	4 (12), 4	9 (14), 10	8 (15), 9	4 (12), 4
p Value (reported vs. lab within study arms)	0.03[b]	<0.01[b]	<0.01	<0.01	<0.01	<0.01
p Value (across study arms)	0.56			<0.01[c]		
Freq. missing	53	43	48	20	28	48

[a]CSB indicates corn soy blend; SBCC, social behavior change communication. The target ratio was 30 g oil to 100 g CSB.
[b]Wilcoxon matched-pairs signed rank test used.
[c]Pairwise comparisons using Bonferroni method: Oil SBCC and Oil SBCC + repackaging groups both significantly different than control (p = 0.003, p = 0.029, respectively).

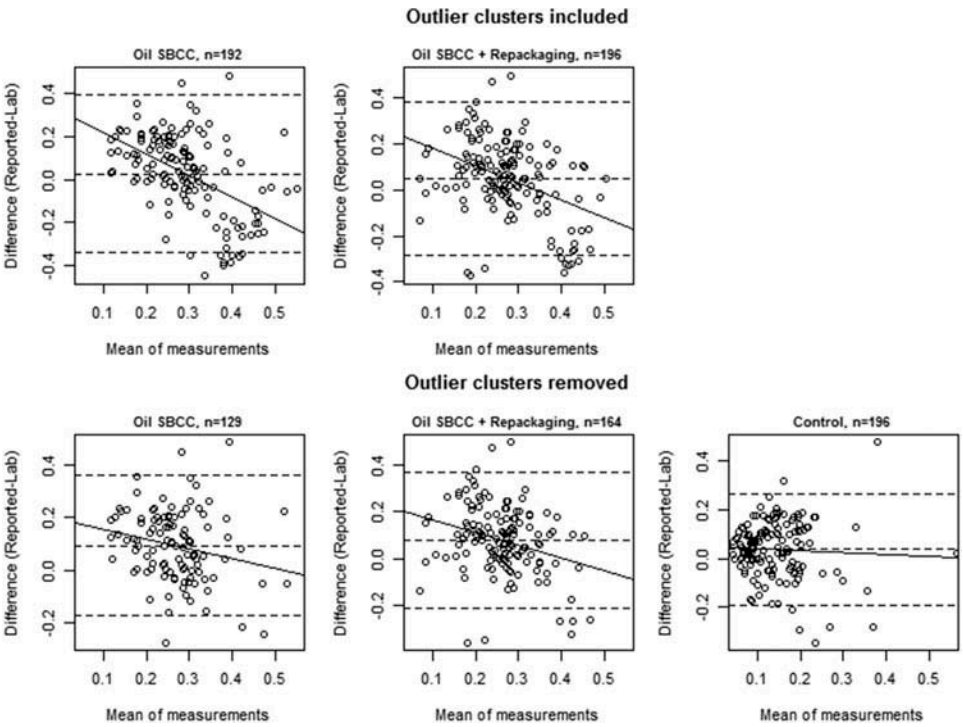

Figure 2. Bland-Altman plots revealing bias between reported and lab measures of added oil in the intervention groups.

added oil was significantly higher than the mean lab value. Mean differences between the reported and lab measures of added oil among the 3 study groups were not significant; however, sensitivity analysis excluding the food

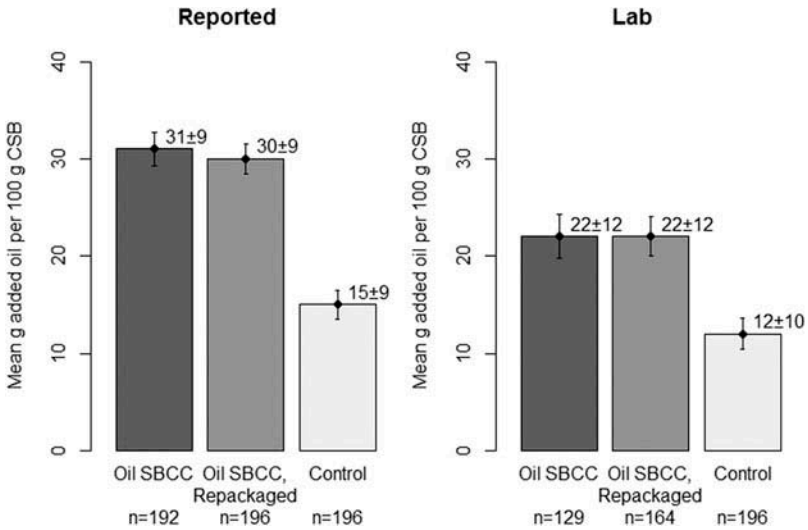

Figure 3. Reported and lab measures (outliers removed) of added oil in prepared CSB porridge with error bars showing 95% confidence intervals of the means.

distribution points with outlier values reduced the mean lab values of added oil in both intervention groups, causing differences between the 2 measures to become significantly larger in the intervention groups than in the control (p = 0.002; Table 1).

Bland-Altman plots revealed bias between the reported and lab measures in the intervention groups but not in the control group (Figure 2). On average, participants overreported the amount of oil used, but there was a shift toward underreporting as the lab-assessed values of added oil increased. That is, self-report tended to be closer than the lab-assessed values to the amount recommended in the SBCC. When the outlier clusters were removed, the bias was less pronounced but still observable. Both self-report and lab-assessed values showed the same relationships among the study groups: intervention groups added more oil than the control by either measure (Figure 2).

A total of 30 households were observed over 143 household-days (n = 11 households in the oil SBCC group, n = 12 households in the oil SBCC plus repackaging group, and n = 7 households in the control group). Of the 30 households, 25 had a full 5 days of observation, 4 households had 4 days of observation, and 1 household had 2 days of observation. Figure 4 displays self-reported and observed sharing by study group. According to both measures, sharing was highest in the control group. According to self-report, in the 2 intervention groups, about 45% of participants reported that they shared the CSB porridge with someone other than the target child on the last day they prepared it. In the control group, 70% reported sharing the last time CSB porridge was prepared. By in-home observation, the percentage of household-days in which sharing was observed was higher in the repackaging intervention group and in the control group than it

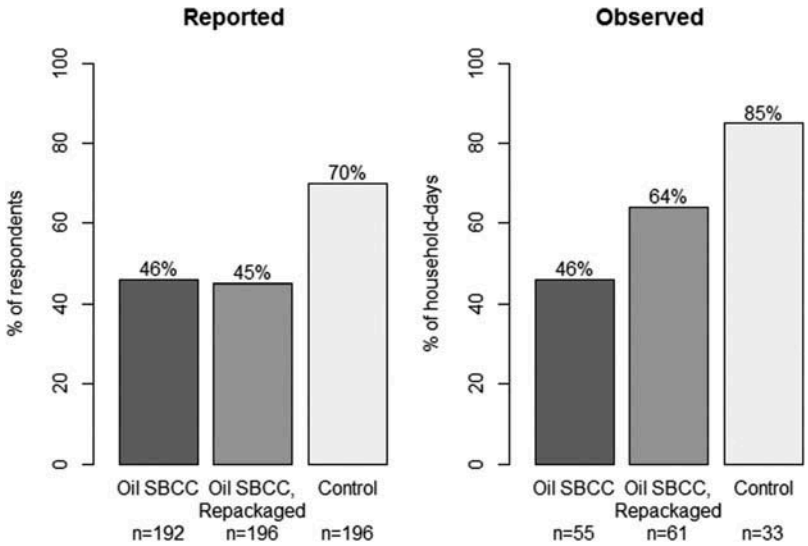

Figure 4. Reported and observed measures of sharing.

was by self-report. Note that this is not a direct comparison, because self-report refers to a single day, and in-home observations counted a household as sharing if they shared on any day of the observation, giving each household more opportunities to share.

In-home observations showed that households did not have consistent sharing behavior. Of the 143 total household-days of observation, CSB porridge eating was observed on 118 (83%) of the days, with sharing occurring on 88 (62%) of the 118 days. Of the 118 household-days when CSB porridge eating was observed, the total number of CSB porridge-eating occasions was 183. During these eating occasions, sharing was observed a total of 110 (60%) times. Of the 30 households, 4 never shared. Of the 26 households that did share, some (6 out of 26, 23%) were observed to share on all days of observation. Most (20 of the 26, 77%) did not share consistently on all days of observation but shared only on some days. When stratified by day of observation, a higher percentage of sharing was observed on the last day compared to the first day of observation (Table 2).

Table 2. Observed sharing by day of observation.[a]

	Number of CSB porridge-eating occasions	Number of times sharing observed	Percentage sharing
Day of observation			
First	46	25	54
Second	33	20	61
Third	39	22	56
Fourth	35	21	60
Fifth	30	22	73
Overall	183	110	60

[a]CSB indicates corn soy blend.

Discussion

This study provided the opportunity to compare participant self-report with 2 objective measures: lab analysis and in-home observation. In both cases, there was inconsistency between self-report and the more objective measure. In the case of added oil, participants reported using more oil than was revealed in the lab analysis; further, the quantities of oil that were self-reported were closer to the amounts recommended in the SBCC than the amounts measured in the CSB porridge. The systematic bias in reporting that was observed in the intervention groups suggests that participants had a tendency to report what they were told to do. Some of the inaccuracy in self-report could be due to the intensive SBCC, specifically with respect to the amount of oil to be added to CSB porridge. Other studies that include observations have diverse methodologies, making it difficult to compare findings. In one study of handwashing behaviors among nurses in Kuwait, there were similar results: self-report was skewed toward desired behaviors, whereas direct observation found a lower rate of compliance.[7] Both measures in our study, however, conveyed the same overall finding about the effectiveness of the intervention in increasing the amount of oil used in CSB porridge: results were consistent by either measure.

Assessment of sharing behavior also differed between self-report and observation in our study. All groups (both intervention and control) were instructed to feed the CSB porridge only to the target child—an instruction difficult to follow where sharing, especially among children in a family, is a cultural norm. In another study examining sharing of small-quantity lipid nutrient supplements, self-report and direct observations were used to determine sharing practices. This study found high rates of sharing of a product that previous literature has found to be minimal, possibly due to sharing data being self-reported in other studies.[8] The inconsistency between reported and observed sharing in our study possibly reflected a tendency to report behavior that was promoted by the intervention. However, self-report referred only to a single day, whereas observation reflected up to 5 days, which means that by direct observation, households had more opportunities to be defined as a sharing household. Direct observation revealed that sharing varies from day to day: 1 day's observation is not an accurate reflection of a household's general tendency to share, and the majority of those households observed to share on any day did not share on all days of observation. A single day does not necessarily represent a household's sharing behavior. Based on this study, it is not possible to conclude that multiple days of observation result in a more valid measure of a household's usual behavior (because the household members may adjust to the presence of the enumerator). Still, we did find that sharing (a behavior discouraged in the intervention) was observed more frequently on the last than on the first day of in-home observation.

Some of the limitations of this study suggest future directions for further research. We identified what might be inaccuracies in a small subset of the CSB porridge samples analyzed in the lab. These outliers raised concerns, but we could not affirm that they were the result of lab error. In future studies, every batch of CSB porridge samples sent to the lab should contain some blinded dummy samples with known quantities of oil added, in order to check for accuracy.

There were a substantial number of missing values in the lab analysis of added oil. This may have been due to households' inability to provide a CSB porridge sample at the time of the interview. Though no statistical differences were seen in the demographic characteristics of those with and without missing lab data, there is the possibility that the sample without lab data might be biased in some way.

Collecting in-home observation data posed a challenge. Simultaneously observing and recording multiple activities on a paper form, unobtrusively, was difficult for enumerators. Future studies should consider tablet-based data collection for direct observations, so that activities can be automatically time-stamped. The small number of households included in the in-home observations was a limitation in our study. Allocating an enumerator to a single household to conduct multiple days of observation is costly; however, our results suggest that multiple days of observation does have benefits in terms of characterizing the household's behavior and, possibly, in reducing the household's tendency to adjust behavior due to the presence of the observer. Sufficient resources, therefore, should be devoted to in-home observations, in order to achieve a sufficient sample of households observed over multiple days, if such observations are planned.

Conclusion

We found that among caregivers of children in a MAM treatment program in southern Malawi, self-reported measures of added oil in CSB porridge and sharing of CSB porridge differed from objective measures. Though self-report was less accurate compared to objective measures, the overall trends across study groups were similar. Future studies may find it useful to include objective measures as a comparison to self-report, which can aid in evaluation of effectiveness of food supplementation programs, but further research is needed on the best methods for direct observation. With regard to defining sharing, future studies should consider recharacterizing the practice of sharing based on consistent, habitual behavior versus that of a single day.

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Author contributions

B.R. conceived the research questions and has primary responsibility for the study as a whole. S.W. coordinated the research project. K.H.C., D.S., and L.W. advised on data analysis. B.L. conducted the data analysis. B.L., D.S., and B.R. wrote the article. K.R.C. conducted the literature review. S.W., L.W., K.R.C., and K.H.C. reviewed and edited the article for intellectual content. All authors have read and approved the final article.

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