Integrating Registered Dietitian Nutritionists Into Primary Care Practices to Work With Children With Overweight

Abstract: *Despite increased reimbursement for registered dietitian nutritionists (RDNs), few studies have assessed the potential of integrating them into primary care clinics to support pediatric weight management. To assess the feasibility and effectiveness of this approach, RDNs were introduced into 8 primary care practices in North Carolina. This mixed-methods study combined (1) interviews and focus groups with RDNs and clinic personnel, (2) comparison of change in body mass index (BMI) z-score in study practices to change in historical comparison groups, and (3) analysis of behavior and BMI change for RDN utilizers. Qualitative data were coded thematically, and McNemar's and Wilcoxon signed-rank tests were used for quantitative data. RDN integration was good, but average referral rate for eligible children was 19.4%; 48.4% of those referred utilized the RDN (most fewer than 3 times). Using the full analysis set, there was no difference in change in BMI z-score for intervention and comparison groups. For RDN utilizers, the average change in BMI z-score was –0.089 ($P < .001$), and there was statistically significant improvement in 7 of 8 health behaviors. Integrating RDNs into primary care practices was feasible and possibly effective for utilizers. Reaping potential benefits of RDN co-location would require increasing low referral and utilization rates.*

Keywords: outpatient medical nutrition therapy; co-location; pediatric overweight and obesity; primary care; BMI

Introduction/Background

The prevalence of overweight and obesity has increased significantly in children over the past 30 years.[1-3] Although randomized controlled pediatric weight management trials demonstrate the efficacy of medium- to high-intensity behavioral interventions, there have been few studies to assess the effectiveness of real-world, practice-based interventions for overweight and children with obesity, particularly interventions integrated into primary care.[4-8] Findings from existing studies suggest that primary care–based interventions of relatively low intensity can improve body mass index (BMI) and nutrition, physical activity, and sedentary behaviors, at least in the short term.[9,10]

> . . . even pediatric patients with overweight and without comorbidities require serious attention because they are at high risk for adult obesity and chronic disease.

Although primary care providers (PCPs) recognize the health effects of decreasing the prevalence of overweight and obesity

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among their pediatric patients, they encounter multiple barriers in identifying and counseling children with overweight and obesity and their families.[11-19] Experts recommend that health teams bring together PCPs and registered dietitian nutritionists (RDNs), who are experts in nutrition counseling and behavior change.[20] Pediatric patients with weight-related comorbidities are often sent to specialized clinics for medical nutrition therapy (MNT), which includes tailored diet and physical activity plans designed with and monitored by RDNs. However, these services are unavailable in most rural and suburban settings, and even pediatric patients with overweight and without comorbidities require serious attention because they are at high risk for adult obesity and chronic disease.[21] With the anticipated shortage of PCPs in the near future and the drive for patient-centered medical homes that utilize team-based care, new models of care are needed in which RDNs assist PCPs in treating children with overweight and obesity.[22-25] Reimbursement for pediatric MNT is improving, with initiatives from Blue Cross and Blue Shield of North Carolina and the efforts of the Alliance for a Healthier Generation.[26]

The IN4Kids (Integrating Nutrition for Kids) study was designed in response to these trends and carried out by researchers from North Carolina's academic medical centers (AMCs); researchers were not affiliated with study sites. This article addresses the study's 3 primary questions:

- Is it feasible for primary care practices to integrate a RDN into their practice?
- To what extent does access to the RDN improve weight management of the eligible children at the practice overall?
- How do health behaviors and weight status change for those children treated by the RDN?

Methods

Overview

IN4Kids was a mixed methods study of the integration of RDNs into primary care practices in North Carolina (NC). Three study components are reported here: (1) interviews and focus groups with RDNs, PCPs, and clinic staff designed to assess integration of RDNs into the practices and identify facilitators and barriers to integration, (2) a 2-arm design comparing change in BMI *z*-score for pediatric patients with overweight in the study practices with change in a historical comparison group at those same practices, and (3) a 1-arm study of behavior and BMI *z*-score change among patients who utilized the study RDNs. Institutional review board approval was received for this study from all 4 AMCs; informed consent, guaranteeing confidentiality, was administered for interviews and focus groups; quantitative data collection was exempted from the requirement of patient consent.

Practice Inclusion Criteria

Practice inclusion criteria were the following: at least 2 PCPs serving a minimum of 2000 children; affiliation with 1 of the AMCs in NC; not being staffed primarily with AMC faculty and/or residents; and commitment to the study. Rural locations were given priority because of the paucity of weight management resources in those communities. A total of 8 practices were selected: 2 family practices (including 1 federally qualified health center) and 6 pediatrics practices. Among them, 6 were rural and 2 suburban.

Intervention

Half-time RDNs were placed in each practice beginning in 2009. The study paid the RDN's salary and 5% of a scheduler at each practice. RDN services were available to patients free of charge. Patients received standard of care from the PCPs and RDNs. Deidentified study-relevant administrative and encounter data, obtained via chart audit or electronic record, were sent by practice personnel to the study team. Although the RDN provided care to any referred patient, the focus of the study was on pediatric patients with overweight or obesity. All providers were informed of the RDN's presence in the clinic by clinic leadership.

RD, PCP, and Staff Perceptions Component of Study

From July to September 2010, all RDNs were interviewed in person or by phone, and lunchtime practice-based focus groups (with food provided by the study team) were conducted with all available PCPs and practice staff, comprising most personnel at each site. RDNs were asked for perceptions of the following: their impact on the practice, patients, and families; being part of the practice team; difficulties in the work environment; what was best about working in the practice; and the challenges and barriers to helping families. PCPs and practice staff were asked for perceptions of the extent and experience of RDN integration, utilization, and referral; barriers to referrals and utilization; and patient response/impact. RDN, PCP, and staff perceptions were coded by 2 study investigators and analyzed thematically using ATLAS-ti. The 2 investigators shared and modified their coding until their approaches converged.

Two-Arm Component

To understand whether access to the RDN was effective in improving weight management for the patient population as a whole, we compared weight change for eligible patients in the intervention and historical comparison groups who had both baseline and 1-year data (ie, the full analysis set). Eligibility criteria were as follows: 2 to 18 years of age; with overweight/obesity (≥85th BMI-for-age percentile); and not diagnosed with any significant weight-related comorbidities or clinical mental health issues (including diabetes, hypertension, hypertension with end-organ damage, obstructive sleep apnea, depression or bipolar disorders, or familial hyperlipidemia). Children with weight-related comorbidities or mental health issues were excluded from the study for 2 reasons. First, the primary goal of the model we were testing was to provide RDN services for children without significant weight-related comorbidities because children with these comorbidities often receive nutritional services through specialty

care. Second, we believed that their use of and benefit from the RDN would differ from that of children without these conditions, making it problematic to analyze results for these groups together; at the same time, we anticipated that the numbers of children with these conditions would be too small to allow for separate analysis. The intervention group was defined as eligible patients who completed well-visits at the participating clinics in 2009 during the first 6 months when the RDN was on-site. The historical comparison group was eligible patients seen for well-visits during the same period of 6 months but in 2007 when there was no in-practice RDN. Both groups were identified through chart audits of baseline well-visits.

Sample size was based on a difference of −0.64 in mean change in BMI *z*-score assuming no BMI change in the comparison group. Each practice needed complete data for approximately 100 children in the intervention group and 100 in the historical group, for a total of 1600 for the study. Based on practice estimates that 50% to 55% of patients would not return for a PCP visit at 1 year, the goal was 225 eligible patients per group per practice at the start of the study.

Deidentified demographic, anthropometric, diagnostic, RDN referral, and basic encounter data (Table 1) from patient charts were exported monthly to Duke. For both eligible intervention and historical comparison groups, patient data were audited from all encounters for up to 13 months from the baseline visit.* The same data were collected for both groups with the exception of data for RDN encounters, which were available only for the intervention group.

The outcome for this component of the study was effectiveness in weight change, measured as a modified BMI *z*-score.† Because only deidentified data were provided and month of birth is considered an identifier, the modified *z*-scores assumed patients' ages to be whole years at baseline. Age at follow-up visits was based on the number of days since baseline. We compared change in BMI *z*-score for the intervention group with that for the comparison group using McNemar's test of differences and adjusting for baseline BMI *z*-score, age, and gender. The threshold for statistical significance for this and all other such analyses was set at $P < .05$. All quantitative analyses were done in SPSS 17.0.

In addition to measuring effectiveness, we measured the process by which patients were referred to and received care, including percentage of eligible patients receiving referrals to the RDN and utilization of RDN services among those receiving referrals, as documented in the clinical data. Referral rates for the intervention group were compared with those for RDNs from outside the clinic for the historical comparison group. We also assessed whether referrals were more likely for some patient groups than others. Bivariate associations between patient characteristics and referral were tested using Pearson's χ^2 tests for categorical variables. Variables associated with referral in these analyses were included in a logistic regression model predicting referral and controlling for age, gender, insurance, and so on. The same process was used to assess whether there were patient characteristics that predicted utilization of the RDN (operationalized as a dichotomous outcome of any visits vs none) from among those patients referred.

One-Arm Study of Change Among Patients Utilizing the RDNs

For those patients who saw the RDN, we collected nutrition and physical activity behaviors assessed by the RDN using an instrument developed by the Physical Activity and Nutrition Branch of the North Carolina Department of Health and Human Services, with funding from the Centers for Disease Control. There was one version for patients in middle or high school and a second version for the parent to complete for younger patients. Both versions of the survey were translated into Spanish. Although it was not a validated tool, this instrument has been used statewide, was designed specifically to target behaviors that affect weight status, and was recommended by an expert advisory committee for the project.

Change among those who saw the RDN was assessed from baseline to the final visit for patients who received MNT within a 3- to 12-month period, no matter how many visits occurred during the time period. Change in categorically measured health behaviors (6 nutrition items plus screen time) was assessed using McNemar's test of agreement. Change in continuously measured health behaviors (physical activity and BMI *z*-score) was assessed using the Wilcoxon signed-rank test.

Two additional analyses were conducted to explore the relationship between RDN use and BMI change. We examined whether there was a dose-response relationship between the number of visits patients completed in 1 year and weight change among the sample of 100 eligible patients who saw the RD and had baseline and 1-year data. The mean number of visits to the RD in 12 months was 5.7, with a range of 1 to 13 visits. We conducted the dose-response analysis in 2 ways: by differences in weight loss for those above and below the average number of visits (1-5 vs 6 and above) and comparing 3 policy-relevant groupings—namely, people with 1 to 5 visits, people with 6 visits (the recommended number of MNT visits in a year), and people with more than 6 visits. Both analyses used ANOVA test of differences in mean change in BMI *z*-scores by number of visits, controlling for BMI *z*-score at baseline, gender, health insurance type, and age. In addition, we assessed whether any specific behavior changes were associated with change in BMI *z*-score, using linear regression models, which included patient characteristics as control variables.

*There was no imputation of missing data.
†BMI *z*-scores are an appropriate measure of pediatric weight for studies of weight change.[27]

Table 1.

Data Elements Exported From Primary Care Practices for IN4Kids Study.

Category	Variables	
Patient indicator data	• Study ID • Clinic ID	• Provider ID • Days since baseline visit
Demographic data	• Age (years) • Gender • Race/ethnicity (where applicable)	• Need for an interpreter • Health insurance
Medical diagnoses and referral data	• ICD-9 codes for medical diagnoses	• Patient referred to IN4Kids RDN or outside management services
Anthropometric and clinical data	• Height • Weight • BMI • BMI-for-age percentile • Blood pressure (when measured)	• Lab values ○ Total cholesterol ○ HDL ○ LDL ○ TGL ○ Glucose ○ Insulin ○ ALT/AST ○ HbA1c ○ Urine MA, TSH ○ Hematocrit ○ Hemoglobin
Health habit data (intervention group RD utilizers only)	• Sweet drinks times/d • Vegetables servings/d • Fast food times/wk • Screen time ≥2 h/weekend day	• Glasses milk/d • Fruits servings/d • French fries or chips/d • Physical activity number of days with ≥20 min/d

Abbreviations: ALT, alanine aminotransferase; AST, aspartate aminotransferase; BMI, body mass index; HbA1c, glycated hemoglobin; HDL, high-density lipoprotein; LDL, low-density lipoprotein; MA, microalbumin; RDN, registered dietitian nutritionist; TSH, thyroid stimulating hormone; TGL, triglycerides.

Results

Integration and Utilization

RDN, PCP, and Staff Perceptions of Integration. Integration was determined to be high when RDNs reported being well utilized to help patients and assist providers. Based on this criterion, integration of the RDNs in 5 of the 8 practices was high. In addition to working with patients, these RDNs also reported being utilized to answer questions for providers and assist providers and staff with their personal nutritional needs. They also described being invited to social events, provider meetings, and/or team-building exercises. They perceived provider enthusiasm for their services, and in some cases, staff support was provided for scheduling their appointments and/or reminder calls. Focus groups with staff and with providers at these practices supported these perceptions. PCPs at these practices saw the RDN as a necessary addition to the practice in order to meet the needs of their patients, and staff and PCPs often reported working with the RDNs to support their personal nutrition and weight management goals as well.

We classified integration as moderate in 2 of the remaining practices and low in one. Based on the interviews and focus groups, RDN integration was challenging when the existing practice was not already operating as a team or was characterized by poor communications systems, high workloads, low staff morale, high staff turnover, and/or part-time providers/staff. RDNs also found that they were less well integrated into the practice when the RDN office was not centrally located relative to the providers and patient care. When a competing weight loss program was accessible to practice patients, RDNs also perceived that they were less valued.

Providers and staff focus groups also suggested that integration was affected by the extent to which providers perceived that the RDN had unique skills in weight management and other areas as well as the amount of interaction between the staff/PCPs and the RDN. RDN behavior also seemed to affect integration, with RDNs more readily accepted when they provided informal education to staff or explained to the

Table 2.

Eligibility for RDN Services, RDN Referral, and Utilization Patterns in 8 IN4Kids Practices With Co-located RDNs.

Practice	Number Eligible	Percentage of Total Population of Pediatric Patients 2-18 Years Old Who Were Eligible[a]	Percentage of Eligible Patients Referred to RDN	Percentage Referred Who Completed an RDN Visit
Total	1555	31.8%	19.4%	48.3%
1	204	29.7%	11.8%	38.5%
2	236	33.7%	11.9%	63.0%
3	170	22.1%	18.2%	55.2%
4	131	39.1%	16.0%	41.7%
5	237	43.4%	23.6%	49.1%
6	178	34.2%	11.8%	59.1%
7	238	31.2%	33.2%	25.3%
8	161	28.1%	26.1%	54.5%

Abbreviation: RDN, registered dietitian nutritionist.

[a]IN4Kids eligible patients are 2 to 18 years old, have a BMI-for-age percentile at or above the 85th percentile, and do not have significant weight-related comorbidities or clinical mental health issues.

providers what services they could offer. Finally, while having a large Spanish-speaking patient population was not perceived as a barrier to integration, it was observed to raise the costs of integration because 30- to 60-minute RDN visits strained interpreter availability.

Utilization of RDN Services. On average, 31.8% of 2- to 18-year-olds examined for well visits had overweight or obesity, with a range among practices of 22.1% to 43.4% (Table 2). Of those eligible for RDN services, 19.4% were referred to the RDN, with referral rates at the individual practices varying between 11.8% and 33.2% of eligible patients. In comparison, the average referral rate to outside RDN services for the historical comparison group was 2.0%.

The average utilization rate among patients referred to RDN services was 48.3%, and the range among practices was 25.3% to 63.0% (Table 2). Among those who went to the RDN, visit numbers were low; 39.2% had 1 visit, 23.8% had 2 visits, 29.1% had 3 to 5 visits, and 7.9% had more than 5 visits.

Interviews and focus groups provide insight into these numbers. PCPs indicated that they thought having an RDN on-site increased the likelihood of RDN utilization, commenting that prior to having a co-located RDN, they rarely referred patients to RDNs and that families rarely followed through if they had to drive a long distance to get nutrition services. However, challenges for referral to—and use of—on-site RDNs were discussed as well. PCPs reported that many families felt offended by the suggestion that their children had overweight or for other reasons were resistant to addressing weight issues. When families were perceived as resistant, the providers said they would drop or avoid the subject and plan to ask again at the next visit. RDNs and staff noted that not all providers were attuned to weight issues or to the RDN's availability. Some providers acknowledged that they could be uncomfortable discussing weight issues or were not always aware of who had overweight. Some said they occasionally thought the patient looked fine despite elevated BMI percentile. RDNs speculated that some providers presented MNT as "optional." Conversely, patient/family satisfaction and success appeared to encourage additional referrals to the RDN. Respondents believed that parents having to miss work or take children out of school to see the RDN were sometimes obstacles to utilization when a referral was made.

Given the low rate of referrals to the RDN, we explored whether referral rates varied by patient characteristics. Based on multiple regression, BMI-for-age percentile category and BMI *z*-score were significantly associated with referral to the RDN. Both children who had obesity and children with severe obesity were much more likely to be referred to the RDN than were children with overweight. Children 5 years of age and older were more likely to be referred to the RDN than were younger children; girls were more likely to be referred than boys; and children of Latino ethnicity were more likely to be referred than either whites or African Americans. We found that no measured patient characteristics predicted which

Table 3.

Demographics and Baseline Weight for Eligible Patients With Baseline and 1-Year BMI Data in the Intervention and Historical Comparison Groups at IN4Kids Practices.[a]

Characteristic	Intervention, n (%)	Comparison, n (%)
n	482	338
Age (years)		
2 to 4	177 (36.7)	134 (39.6)
5 to 10	157 (32.6)	124 (36.7)
11-18	148 (30.7)	80 (23.7)
Gender		
Male	263 (54.6)	178 (52.7)
Female	219 (45.4)	160 (47.3)
Race/Ethnicity		
Caucasian	190 (39.4)	141 (41.7)
African American	90 (18.7)	54 (16.0)
Hispanic/Latino	84 (17.4)	42 (12.4)
Other	20 (4.1)	12 (3.6)
Missing (routinely collected)	9 (1.9)	11 (3.3)
Missing (not routinely collected)	89 (18.5)	78 (23.1)
Need for an interpreter		
No	368 (76.3)	257 (76.0)
Spanish	30 (6.2)	7 (2.1)
Other	1 (0.2)	—
Missing	83 (17.2)	74 (21.9)
Health insurance		
Uninsured	10 (2.1)	9 (2.7)
Private insurance	237 (49.2)	156 (46.2)
Public insurance (Medicaid or NC Health Choice)	235 (48.8)	173 (51.2)
BMI-for-age percentile		
Overweight (85th to <95th percentile)	229 (47.5)	181 (53.6)
Obese (95th to <99th percentile)	183 (38.0)	109 (32.2)
Severely obese (≥99th percentile)	70 (14.5)	48 (14.2)

Abbreviation: BMI, body mass index.

[a]IN4Kids eligible patients are 2 to 18 years old, have a BMI-for-age percentile at or above the 85th percentile, and do not have significant weight-related comorbidities or clinical mental health issues.

Table 4.

Difference in Mean Change in BMI *z*-Score From Baseline to 12 Months Between Eligible Patients in Intervention and Historical Comparison Groups at IN4Kids Practices.

Group	n	Mean Change BMI *z*-score	SD	*P* Value,[a] Crude	*P* Value,[b] Adjusted
Intervention	482	−0.068	0.462	.768	.704
Comparison	338	−0.069	0.488		

Abbreviation: BMI, body mass index.
[a]Wilcoxon Mann-Whitney test of differences in mean *z*-scores.
[b]Multivariable linear regression of change in BMI *z*-score from baseline to 12 months, adjusted for age group, gender, and BMI *z*-score at baseline. BMI *z*-score at baseline was statistically significant in this analysis of all eligibles ($P < .001$).

individuals from among those referred utilized RDN services.

The Impact of RDN Access on Weight Management

Patient Sample. Table 3 presents the patient sample for the 2-arm component of the study, comprising 482 patients in the intervention group and 338 in the comparison group. There were no significant differences in age, sex, race, health insurance, or BMI status between the intervention and comparison groups. The children were roughly evenly male and female, and most had private insurance and Medicaid, with few uninsured. About two-thirds were younger than 11 years of age. Race/ethnicity was missing for about 1 in 5 children; the majority of the remainder were Caucasian, with sizable African American and Latino populations as well. Approximately half had overweight, one-third had obesity, and one-sixth had severe obesity.

Table 4 shows that mean change in BMI *z*-score from baseline to 1 year was similar for intervention and comparison groups. Multivariate analyses indicated no effect of RDN access on weight change.

Weight Management and Behavior Change for Patients Utilizing the RDN

RDN Visits. There were 1555 children in the intervention group who were seen by the RDN at least once. Of these, 373 had a follow-up visit 3 to 12 months from baseline and constitute the sample for this component of the study. For the 373 patients, the mean number of visits to the RDN within 1 year was 4.6 (median = 4 visits; range = 2-13 visits), with most patients completing their final visit within the first half of the year.[‡]

BMI z-Score Outcomes. At baseline, average BMI *z*-score for these 373 patients was 2.50. From baseline to final measurement, the BMI *z*-score decreased for 67% of the children and increased for 26%, with 7% experiencing no change (defined as a change of less than 0.01 in absolute value). Average BMI *z*-score changed by −0.089 ± 0.27 ($P < .001$, Wilcoxon signed-rank test). Our analysis showed no relationship between number of RD visits and change in BMI *z*-score.

[‡]To assess the appropriateness of combining samples with different final data points, we broke the patients into 4 groups (final data point ±60 days from 3, 6, 9, and 12 months) and examined differences in the change in BMI *z*-score and the change in sweetened drink consumption across these groups; the mean decrease in BMI *z*-score was similar, with a range of −0.073 to −0.111. Similarly, in all 4 groups, the majority of study participants showed decreased sweetened drink consumption, although differences among the groups were larger than for BMI *z*-score, with the greatest proportion decreasing among those with a 12-month data point (range = 51.9%-74.6%).

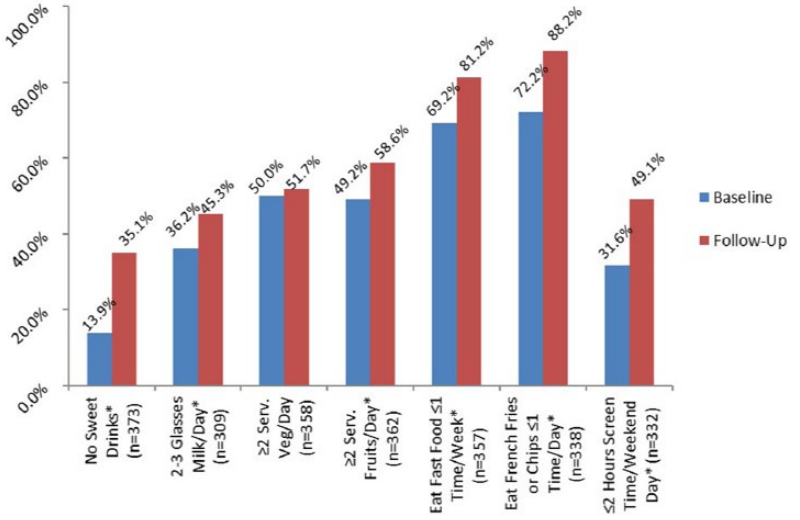
Health Behaviors. Baseline and follow-up results for categorically measured health behaviors are shown in Figure 1. At baseline, the majority of patients were not meeting guidelines for several different health behaviors. From baseline to follow-up, we found statistically significant improvement for 7 out of 8 health behaviors. These improvements included numbers of patients reporting not consuming sweetened drinks, drinking 2 to 3 glasses of milk/d, having ≥2 servings of fruit/d, eating at fast food ≤1 time/wk, eating french fries/chips ≤1 time/d, and spending ≤2 weekend h/d in screen time (based on McNemar's test of agreement from baseline to follow-up). Changes in physical activity were analyzed by comparing mean number of days with ≥20 minutes of physical activity at baseline and follow-up. At baseline, the mean was 3.2 d/wk, and at follow-up, 4.1 (n = 340, $P < .001$, Wilcoxon signed-rank test). No significant changes were observed for eating ≥2 servings/d of vegetables. Individual health behavior changes were not associated with change in BMI *z*-score.

Discussion

Based on the findings of this 8-site study, integration of a RDN into primary care practices to work with children with overweight and without significant weight-related comorbidities or mental

Figure 1.

Improvements in Health Behaviors among Eligible Patients Seen by RDNs at 8 IN4Kids Practices (n = 373).



Abbreviation: RDN, registered dietitian nutritionists.

health conditions is feasible and may be effective for those who visit the RDN. Acceptance of the RDNs was high in most practices, and integration into practice flow was generally smooth, despite some variation. The data suggest some key factors in the extent of integration: the degree to which there was an existing culture of team work and communication patterns at the practice; the extent to which practice staff and providers understood the RDN's role and skillset and spent time interacting with her; RDN office location; and whether there was another weight loss program accessible to patients. Having a large Spanish-speaking population at the practice strained resources in the form of interpreters, particularly because RDN visits are lengthy.

Referral rates to the RDN for the intervention group were higher than the 2% referral rate for outside RDN services in the historical comparison group, but at 19.4% on average, they were still low. We were concerned that this low rate might be an artifact of referrals not being documented, so early in the study, we (1) communicated with the practices about the importance of consistent documentation of RDN referrals and (2) added a referral field to the RDN database. By matching these data to the well-visit data, we found that almost all referrals resulting in an RDN visit were documented by the PCP, indicating that our finding was not a result of poor documentation. Clearly, the low RDN referral rates and completed RDN visits limited the impact that the RDN could have at the population level. With only a small percentage of eligible patients using the RDN, and most of the utilizers having only 1 to 2 visits, we would not expect significant weight change across the eligible population in the intervention group; in fact, the 2-arm study showed no difference in weight change for the intervention and comparison groups.[§]

[§]Because of misestimate by practices of their obesity rates and low return rates for annual physicals, the sample for this analysis was 51.3% of the estimated 1600 patients needed to test for effectiveness. However, given the lack of any mean difference in change in BMI *z*-score between the intervention and comparison groups, along with the low referral and utilization rates, this would seem to be irrelevant to the outcome.

Low referral rates could be related to the fact that neither the practices nor the RDNs were at risk for the RDN salaries. However, this study indicates a mix of patient, provider, and practice factors that would likely limit referrals and utilization even if financial viability were at stake. Many patients/families were reportedly resistant to visiting the RDN, and providers said that they would put off referral in that situation. It may be that with time, referral rates would have increased. However, variations in provider and practice referral rates make it clear that family resistance was not the only factor. Providers varied in their enthusiasm and comfort in referring patients in need of MNT services, suggesting a need to train providers in having these conversations. Finally, referral rates varied by patient characteristics and were higher for those at higher BMI-for-age percentiles, elementary school–aged children, girls, and children of Latino ethnicity. The small number of children with overweight (as opposed to obesity) who were referred to the RDN is particularly of interest, given the many benefits of preventing health problems rather than treating them after they develop.

Rates of completion of an RDN visit were higher than referral rates. On average, about half of the eligible children referred to the RDN saw her at least once. However, among those who saw the RDN, the average number of visits was considerably less than the protocol of 6 visits per year. Clearly, the low RDN referral rates and low completed RDN visits limited the population impact of the RDN.

Did the RDNs make a difference for the subpopulation who used them? The results of the qualitative study and the high average reduction in BMI *z*-score for RDN users are suggestive but not conclusive. There were significant reductions in BMI *z*-score and significant improvements in health behaviors related to consumption of sweetened drinks, milk, fruit, fast food, chips, and fries as well as screen time and physical activity.

These findings are similar to those of other pediatric behavioral interventions conducted in primary care settings, suggesting that primary care–based interventions of relatively low intensity can modestly improve BMI as well as change dietary behavior and physical activity.[4-6,27,28] Of course, given the lack of a control group in this study, we cannot conclude that the RDN caused the observed behavior and weight changes, nor do we know how long the observed changes were maintained. There was no relationship between number of RD visits and change in BMI, possibly because of differences in patient characteristics predicting RD use that were unmeasured (eg, family dynamics or attitudes) and, therefore, could not be controlled for in the analysis. No individual health behavior change was associated with change in BMI.

What is clear is that maximizing the potential benefits from having an RDN on-site requires that practices increase their referral and utilization rates. Our research suggested some potential strategies for increasing referrals. First, because some providers have trouble recognizing overweight in their patients, make it easy to identify the patients who need services by charting BMI-for-age percentiles and trends and use health information technology to support charting.[21,22] Second, identify key diagnoses among eligible patients and explore making referrals to the RDN standard of care for these diagnoses, possibly by using electronic systems to trigger or automate the referral.

Third, given the high rate of childhood overweight and the predominance of poor nutritional behaviors overall, consider the possibility of making 1 RDN visit standard of care for all pediatric patients, thereby meeting prevalent health needs and reducing the stigma of treatment by the RDN. Fourth, keep the referral process simple and consistent for providers and have the front desk staff schedule the patient's first visit with the RDN at check-out. Then, regularly review referral patterns to ensure targets are met.

Variations in the rates of completed initial RDN visit rates and the qualitative data suggest that RDN utilization rates could be increased once referrals are made. Strategies include the following: (1) framing the RDN visit in terms of health, not weight; (2) having the PCP enthusiastically encourage RDN visits; (3) when possible, having the patient see the RDN at a PCP visit and/or having PCPs introduce patients to the RDN during the visit at which the referral is made; and (4) having the RDN provide evening and/or weekend hours to facilitate use by school-aged children and working parents.

Conclusions

This study suggests that integrating RDNs into primary care practices is feasible. The qualitative data and the 10-fold increase in referrals for RDN services compared with the period before the RDN was on-site indicate benefits for practices in the form of heightened attention to issues of nutrition and overweight, increased referrals to RDN services, an increased capacity to serve patients, and support for staff and providers' own health goals. However, reaping the potential benefits of having an RDN on-site clearly would require increasing the low referral and utilization rates for RDN services observed in this study. Making the case for enhanced coverage for and implementation of RDN integration into primary care practices requires additional evidence on the benefits of integration and evidence-based guidelines to promote effective practice use of RDNs. Suggested next steps for research include assessing strategies for increasing referrals and RDN visit completion, including those suggested above; evaluating making an initial RDN visit standard of care for all patients; and longer-term studies of the effects of RDN access on weight management.

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Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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