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Abstract

Background. Rates of body mass index (BMI) calculation and plotting remain low. We examined whether providing a BMI wheel and brief education to pediatric residents and attendings would increase rates of “BMI recognition” and obesity-related counseling. **Methods.** A delayed-control design was used to evaluate a 20-minute intervention. A total of 1640 records of well-child visits were reviewed to determine the proportion of records in which BMI was calculated and plotted and counseling provided. **Results.** In clinic A, there was a significant increase in the proportion of records in which BMI was recognized from pre- to postintervention ($P < .01$). No changes in clinic B occurred until after the delayed intervention. Obesity-related counseling was more likely to occur if BMI was recognized. **Conclusion.** Brief education and BMI wheel increased rates of BMI recognition. BMI recognition was associated with increased obesity management. Additional efforts should be incorporated to further increase BMI recognition and assist providers in treating these children.

Keywords

Body mass index (BMI), growth charts, obesity management, patient care, pediatric obesity, physician behavior

Abbreviations: BMI = Body Mass Index; AAP = American Academy of Pediatrics; HEDIS = Healthcare Effectiveness Data and Information Set; CDC = Centers for Disease Control and Prevention

Background

Currently, 32% of children in the United States are overweight (body mass index [BMI] ≥ 85 th percentile and < 95 th percentile) or obese (BMI ≥ 95 th percentile).¹ Being overweight has many medical and social consequences for children, including dyslipidemia, high blood pressure,^{2,3} impaired glucose tolerance,⁴ sleep apnea,⁵ and depression.⁶ Furthermore, it is well documented that overweight children carry a higher risk of becoming overweight adults,³ affecting lifelong morbidity and mortality^{7,8} as well as exacting great economic burdens.⁹

To address this issue, many organizations identify the primary care provider as a key player in the treatment and prevention of childhood obesity. As a first step, the American Academy of Pediatrics Committee on Nutrition,¹⁰ the Expert Committee on Pediatric Obesity,¹¹ and the National Initiative for Children's Healthcare Quality¹² recommend the routine use of BMI growth charts and the discussion of healthy lifestyle habits during all health supervision visits. Subsequently, the

Healthcare Effectiveness Data and Information Set 2009 incorporated BMI assessment and nutrition and physical activity counseling as quality measures that may be used by insurers to determine reimbursement in pay-for-performance programs, particularly if they have prevented the development of later disease.¹³ Nevertheless, several studies document that rates of overweight and obesity identification in pediatric primary care clinics are low,^{14,15} with less than 30% of overweight children being identified by their primary care provider,^{16–18} and

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less than 10% receiving an actual diagnosis of overweight on billing forms.¹⁹

In 2003, a Cochrane review stated that further investigations are needed to identify ways to improve provider assessment and management of pediatric obesity.²⁰ Overcoming provider lack of knowledge and comfort around providing nutrition and physical activity counseling may help in this matter.²¹ To do this, training around childhood obesity should start earlier, that is, in medical school and residency.²² Several efforts have focused on training residents to interpret BMI charts and deliver obesity-related counseling.²¹⁻²³ Two interventions included the addition of a color-coded BMI chart into the patients' records.^{22,23} Others included more intensive training on how to communicate weight status to families and deliver healthy eating and activity counseling with²² or without²¹ the use of a tool. These efforts demonstrated improvement in weight status recognition²¹⁻²³ and perceived self-efficacy around counseling.²¹ However, they were unable to show actual changes in counseling behavior.²³ Only the more intense intervention that included training around counseling and the use of a tool resulted in greater documentation of obesity-related counseling.²²

Our study examines the efficacy of a 20-minute intervention focused on measuring and interpreting BMI results. The intervention targeted pediatric residents in an academic primary care setting. Residents were given a tool, a BMI wheel, to help determine BMI percentiles for girls and boys. We hypothesized that the intervention would lead to an increase in the proportion of medical records with BMI "recognition," which includes calculating and plotting on Centers for Disease Control and Prevention (CDC) growth charts. Whether or not recognition of weight status results in greater obesity-related counseling is unknown. Therefore, as a secondary aim, we examined the relationship between BMI recognition and subsequent obesity management, including nutrition, physical activity, and screen time counseling.

Methods

Study Design and Residency Setting

A brief intervention highlighting the importance of pediatric BMI identification was conducted in an inner-city-based resident clinic at an academic hospital. The clinic is physically divided into 2 sections: Clinic A consists of 23 categorical pediatric and 12 psychiatry/child psychiatry/pediatric residents (all who attend clinic on the same day) and is supervised by 7 attending level physicians and clinic B consists of 31 categorical pediatric residents and is supervised by 7 attendings. Each resident is

randomly assigned to either clinic A or B for the duration of their training. Attendings work in one clinic or the other and do not float between them. Each clinic has its own staff of nurses and is physically separated from each other. To ensure that all residents receive education on the importance of BMI charting, we used a delayed-control design where clinic A was chosen to receive the intervention in January 2008 and clinic B was chosen to receive the intervention in June 2008. Residents were not aware that BMI and weight-counseling documentation would be monitored. This study was approved by the institutional review board of Rhode Island Hospital.

Intervention

A 20-minute presentation was delivered by a board-certified pediatrician every day for a week to clinic A from January 28 to February 1, 2008. The presentation was given prior to the start of each afternoon clinic so that every resident would receive the same information. The presentation focused primarily on the epidemiology of childhood obesity, different methods available for measuring body fat, and the importance of calculating BMI and then plotting BMI percentile given that norms for percent body fat vary by age and gender. The presentation highlighted the importance of recognizing a child's BMI percentile as a first step before treatment or prevention can begin. Current definitions of overweight (BMI ≥ 85 th percentile and < 95 th percentile) and obese (BMI ≥ 95 th percentile) were clarified. An *EZ PLOT* pediatric BMI wheel²⁴ was given to each resident and attending in the clinic to help calculate BMI and determine the child's BMI percentile. The intervention and tool were solely targeted to providers since nurses and medical assistants were not responsible for calculating and plotting BMI. Providers in clinic B received the same presentation and the *EZ PLOT* pediatric BMI wheel in June 2008. Since there is no crossover among residents and attendings between clinics and the BMI wheels were kept in the clinic setting, there was minimal risk of cross-contamination of the intervention and materials. However, any communication between residents regarding the intervention in other settings could not be prevented. No other nutrition or physical activity counseling training was provided during the study period.

Chart Review

At the time of the intervention, all medical records were paper charts. All well-child visit charts for children aged 2 to 18 years old with an even-numbered medical record number were reviewed within each time period. A protocol was developed to standardize the chart review.

Reviewers were blinded as to which clinic was the intervention clinic and which clinic was the delayed intervention clinic. No child was entered more than once. Sick visits or follow-up visits were excluded. In clinic A, medical records from October 1 to November 16, 2007 were reviewed to determine the preintervention rate of BMI calculation and plotting of BMI on CDC growth charts. Postintervention medical records were reviewed from March 3 to August 29, 2008 to determine if there were any changes in the rate of BMI calculation or plotting on CDC growth charts. Medical records from clinic B were also reviewed during the same time periods to assess if any changes occurred prior to and after their intervention on June 16 to 20, 2008.

Measures

The primary outcome of interest was “BMI recognition,” which included the rate of BMI calculation and plotting of BMI on CDC growth charts. At the time, space for BMI documentation was provided next to the height and weight measurements along with the other vital signs on the Physical Exam form. In both clinics, nurses and medical assistants measured and weighed each child and entered this information on the paper chart. Physicians were then responsible for calculating a BMI and plotting this information on the growth chart. During the chart review, actual BMI was calculated and BMI percentile derived for all patients using the documented height and weight in the medical record and based on norms from the National Center for Health Statistics growth curves.²⁵ Growth charts were checked to determine if BMI was plotted for the visit and only accurately plotted BMIs were counted as plotted.

Secondary outcomes included rate of nutrition, physical activity, screen time, and weight control counseling with patients and families; scheduled follow-up appointments for obesity management; referrals to relevant subspecialists; and obesity-related lab work. This information was abstracted from the medical record either in the anticipatory guidance section (indicated by checking a box next to the topic of discussion or abstracted from information recorded in the free-text boxes) or the assessment and plan (where additional mention of obesity-related discussions, follow-up appointments, referrals, and lab work were documented). Demographics included age, gender, race/ethnicity (categorized as white, African American, Hispanic, and other), and insurance status of the child.

Analysis

Analyses were performed using SASv9.2 (SAS Institute, Cary, NC). Bivariate statistics were performed using

Student's *t* test (for continuous variables) and Fisher's exact or χ^2 tests (for categorical variables). Given that there were baseline differences in the proportion of records with BMI recognition between clinics (clinic A = 35.6%, clinic B = 19.9%, $P < .01$), all subsequent analyses were performed on the clinics separately. First, simple proportions were compared before and after the intervention using Fisher's exact test. To assess for sudden changes in levels of BMI recognition and changes over time, time trend analysis was performed using logistic regression modeling fitted to the data from each clinic separately. The outcome was BMI recognition (dichotomous variable) and the independent variables were intervention period (0 for preintervention and 1 for postintervention) and time expressed in weeks. The interaction of intervention period $\times$ time tested the hypothesis that trend varied with intervention status.

Chi-square tests were used to compare obesity management behaviors before and after the intervention in clinics A and B combined. Multivariate logistic regression was used to examine the relationship between BMI recognition and each obesity management behavior (nutrition, physical activity, screen time, and weight control counseling; scheduled follow-up appointments for obesity management; referrals to relevant subspecialists; and obesity-related lab work). Standard demographic variables were included in all models, including child age, gender, race/ethnicity, weight status, and insurance status. Intervention period, dichotomized into pre- and postintervention, was included in the model. The interaction between BMI recognition $\times$ intervention period was tested in each model. In models where there was a significant interaction, results are presented stratified by intervention period. An α level of .05 was used to determine significance.

Results

Provider and clinic characteristics are shown in Table 1. In clinic A, 23 out of 35 residents (65.7%) and 6 out of 7 (85.7%) attending level physicians attended the intervention training. In clinic B, 21 out of 31 residents (67.7%) and 6 out of 7 attendings (85.7%) attended the intervention training. All providers received the *EZ Plot* wheel whether they attended the lecture or not. Providers in clinic A and B were otherwise similar across demographic variables except that all triple board residents were in clinic A. There were no differences between clinics regarding their patient population (see Table 1). A total of 920 medical records were extracted from clinic A ($n = 194$ preintervention and 726 postintervention) and 720 medical records from clinic B ($n = 528$ preintervention and 192 postintervention). Both clinics

Table 1. Characteristics of Providers and Clinics.

	Clinic A	Clinic B	P
Provider demographics	n = 42	n = 38	
Age in years, mean (SD)	32.1 (2.0)	32.1 (7.5)	NS
Gender, (%)			NS
Male	31.0	29.0	
Female	69.0	71.0	
Race/ethnicity (%)			NS
White	71.4	89.5	
African American	4.8	0.0	
Asian	19.0	7.9	
Hispanic	4.8	2.6	
Resident training	n = 35	n = 31	
Categorical pediatrics	65.7	100	N/A
Triple board (pediatrics, psychiatry, child psychiatry)	34.3	0	
Clinic demographics	n = 920	n = 720	
Age in years; mean (SD)	8.8 (4.5)	9.1 (4.6)	NS
Gender (%)			NS
Male	50.7	51.5	
Female	49.3	48.5	
Race/ethnicity (%)			NS
White	42.0	47.0	
African American	36.2	37.9	
Hispanic	18.6	12.5	
Other	3.2	2.6	
Insurance (%)			NS
Medicaid	79.1	77.1	
Private	17.9	20.3	
None	2.9	2.6	
WIC (%)	12.8	10.1	NS
Weight status (%)			
Normal weight	54.9	59.8	NS
Overweight	21.0	17.4	
Obese	24.1	22.8	
BMI percentile; mean (SD)	73.2 (26.2)	71.2 (26.7)	NS
BMI z score; mean (SD)	0.87 (1.15)	0.79 (1.10)	NS

Abbreviations: WIC, Women, Infants, and Children; BMI, body mass index; NS, not significant; N/A, not applicable.

primarily served a lower income population and more than one third of the children were overweight or obese. Clinic demographics were stable over time except for an increase in the proportion of Hispanic patients seen in both clinic A ($P < .01$) and clinic B ($P = .05$). There was also an increase in the proportion of patients who had private insurance (clinic A, $P < .01$; clinic B, $P = .13$). However, the overall proportion of insurance type between clinics was not statistically different. A random sample of 10% of the records was reviewed independently by 2 reviewers. Interrater agreement was >98% for the primary outcome, BMI recognition.

In clinic A, there was a significant difference in the proportion of records with BMI recognition from before

to after the intervention (35.6% vs 47.8%, $P < .01$). When examining the trend in clinic B during the time that clinic A received their intervention but before clinic B received their intervention (clinic B preintervention period), there were no significant changes in trend or proportion of records with BMI recognition. In the logistic regression model, there was a significant difference in level of BMI recognition in clinic A from the pre- to postintervention period (odds ratio [OR] = 1.66, 95% confidence interval [CI] = 1.19-2.30, $P < .01$). However, there were no significant differences in trend over time or in the pre- and postintervention period (Figure 1). In clinic B, there was a significant difference in the logistic regression model in level of BMI

Figure 1. Proportion of charts in intervention clinic (clinic A) with body mass index (BMI) recognized pre- and postintervention. (♦) Preintervention, (•) postintervention; (I) intervention in clinic A, (//) intervention in clinic B.

recognition between intervention periods (OR = 2.62, 95% CI = 1.36-5.03, $P < .01$; Figure 2). There was also a slight increase in trend over time (OR = 1.07, 95% CI = 1.04-1.11, $P < .01$).

After the intervention, there was an increase in counseling on obesity-related topics. Combining data from clinics A and B, 95.2% of charts documented nutrition counseling and 45.7% of charts documented screen time counseling prior to their intervention (indicated either by checking a box or abstracted from the assessment and plan). Postintervention, 97.8% of charts documented nutrition counseling ($P < .01$) and 50.4% of charts documented screen time counseling ($P = .04$). Although non-significant ($P = .15$), physical activity counseling increased from 51.8% to 55.3%.

Using multivariate analysis, we examined the relationship between obesity management behaviors and BMI recognition. There was a significant interaction between BMI recognition and intervention time in relation to lab ordering. Prior to the intervention, there was no relationship between BMI recognition and lab ordering. In the postintervention period, there was an increased odds of ordering labs if BMI was recognized ($P < .01$; Table 2). For all other behaviors there was no

interaction between intervention time and BMI recognition. Overall, BMI recognition was related to greater odds of discussing dietary behaviors, physical activity behaviors, and screen time behaviors, making follow-up appointments, and referring to a subspecialist (Table 3). The odds of discussing weight control behaviors were higher in the postintervention period.

Discussion

Body mass index growth charts are known to be useful,²⁶ but underutilized.¹⁹ Simple, systematic efforts are needed to improve the use of these charts, particularly among physicians in training. In this study, we tested the impact of a brief intervention to improve BMI calculation and plotting among pediatric residents. We found that the delivery of a 20-minute intervention and BMI wheel was associated with greater BMI recognition. We also found that BMI recognition was associated with greater obesity management behaviors. Although these behaviors were not addressed in the intervention, the act of recognizing a child's BMI and weight status appears to trigger providers to engage in further counseling. Other interventions that focused primarily on BMI

Figure 2. Proportion of charts in delayed-control clinic (clinic B) with body mass index (BMI) recognized pre- and post-delayed intervention. (♦) Preintervention, (•) postintervention; (/) intervention in clinic A, (//) intervention in clinic B.

Table 2. Multivariate Logistic Regression of Obtaining Labs if BMI Was Recognized Stratified by Intervention Period.^a

	OR of Obtaining Labs (95% CI)
BMI recognized	
Postintervention	8.88 (2.48-31.81)**
Preintervention	1.44 (0.62-3.36)
Age	1.27 (1.11-1.44)**
Gender	2.05 (0.73-5.78)
BMI percentile	1.03 (1.00-1.06)*
Insurance	1.42 (0.49-4.13)
Race/ethnicity	1.21 (0.88-1.65)

Abbreviations: BMI, body mass index; OR, odds ratio; 95% CI, 95% confidence interval.

^aAnalysis controlled for age, gender, BMI percentile, insurance status and race/ethnicity.

* $P \leq .05$, ** $P \leq .01$.

charting did not have similar results.^{23,27} These studies may have been limited by their smaller sample sizes or reflect a lack of provider self-efficacy to engage in counseling.^{15,28,29} Although a few large studies have shown a relationship between weight status identification and delivery of further weight management care,^{17,18} only one study has been able to demonstrate that obesity

training resulted in greater counseling.³⁰ Our study demonstrated greater ordering of lab studies in the postintervention period when BMI was recognized and an overall increase in discussion about weight control behaviors. The fact that providers were more likely to order labs in the postintervention period may reflect their preexisting comfort with ordering labs. The extent of additional training needed to increase provider behaviors in other areas of obesity counseling is yet to be determined.

Although statistically significant changes were observed, BMI calculation remained relatively low with room for improvement. One could argue that with the growing prevalence of electronic medical records that automatically calculate and plot BMI, there is no need to train residents and physicians to do this. However, automatic calculation of BMI may not result in improved counseling and obesity management. There is some evidence to show that even when providers are alerted to an abnormal test result³¹ or the need for vaccination,³² these alerts are ignored and only modest improvements in behavior occur. Additional strategies, such as computer-based generation of decision support, recommendations for action, and the provision of reasoning for specific recommendations may assist in generating provider action.³³ Training in the basic understanding of how to

Table 3. Multivariate Logistic Regression of the Odds of Physician Behaviors/Discussion Topics if Body Mass Index (BMI) Was Recognized.^a

	Discussed Dietary Behaviors	Discussed Physical Activity	Discussed Screen Time	Discussed Weight Control Behaviors	Made Follow-up Appointment	Refer to Subspecialist
BMI recognized	3.22 (1.31-7.94)**	1.66 (1.18-2.33)**	1.55 (1.17-2.04)**	1.33 (0.90-1.95)	4.84 (2.14-10.95)**	1.75 (1.12-2.74)**
Intervention period	0.96 (0.48-1.91)	0.94 (0.67-1.30)	0.82 (0.63-1.07)	1.52 (1.03-2.24)*	1.10 (0.54-2.25)	0.39 (0.25-0.60)**
Age	0.89 (0.83-0.96)**	1.39 (1.34-1.45)**	0.99 (0.97-1.02)	1.53 (1.45-1.62)**	1.12 (1.04-1.21)**	1.02 (0.98-1.07)
Gender	1.17 (0.60-2.28)	1.09 (0.80-1.49)	0.88 (0.69-1.14)	0.74 (0.51-1.07)	0.46 (0.24-0.91)*	1.02 (0.66-1.56)
BMI percentile	0.99 (0.97-1.01)	1.01 (1.00-1.01)*	1.00 (0.99-1.01)	1.01 (1.00-1.02)*	1.10 (1.05-1.14)**	1.00 (0.99-1.01)
Insurance	0.58 (0.33-1.02)	1.08 (0.78-1.49)	1.01 (0.78-1.30)	1.29 (0.89-1.88)	0.87 (0.39-1.92)	1.03 (0.68-1.60)
Race/ethnicity	0.92 (0.75-1.12)	1.03 (0.94-1.13)	1.02 (0.95-1.09)	0.94 (0.84-1.05)	1.00 (0.83-1.21)	1.05 (0.93-1.19)

^aAnalysis controlled for intervention period, age, gender, BMI percentile, insurance status, and race/ethnicity.

* $P \leq .05$, ** $P \leq .01$.

calculate and interpret BMI numbers and plots would complement these strategies and therefore not make this intervention obsolete in the era of electronic medical records. Additional efforts, however, may be needed to train providers on how to engage in nutrition and physical activity counseling.³⁰

This study had several strengths and limitations. We were able to conduct this study during a time when no other weight-related interventions were occurring and we were able to review more than 1000 charts. However, it was conducted in one academic clinical setting and the generalizability of these results may be limited. Clinic A is unique in that a third of the residents were triple board residents in psychiatry, child psychiatry, and pediatrics and whether or not these residents were more inclined to provide counseling and engage in BMI calculation and plotting cannot be determined since our data are not provider-level data. In addition, we were unable to determine whether the impact of the intervention was because of education or receipt of the tool since both were given simultaneously. Dunlop et al³⁴ found significant increases in provider documentation of BMI and nutrition counseling only after the distribution of tools, which may have acted as a reminder to engage in these activities. In addition, although there was an increasing trend in BMI recognition, there was still room for improvement. Examination of other reminder systems or system-wide changes to increase BMI screening (such as the use of an electronic alert system with decision support) are warranted to determine the best way to improve provider behavior in this area. Finally, we were dependent on chart review and provider documentation to determine actual practices. However, at no time did we emphasize the need to engage in greater documentation of weight management behaviors beyond the calculation and plotting of BMI. Thus, our findings regarding obesity-related counseling are likely valid and may be an underestimation of the impact of the intervention since formal documentation of all the behaviors and discussion topics during a well-child visit can be challenging.

In summary, this study demonstrated that the delivery of a 20-minute intervention and tool can improve BMI documentation and impact provider behaviors around obesity screening and counseling. In this day and age, with increasing awareness of childhood obesity and its overwhelming consequences, simple interventions and tools may be sufficient to act as a reminder for the provider and improve the quality of care around obesity recognition and management. Given its brief nature, this intervention could also easily be implemented in a pediatric residency curriculum, and result in greater, more consistent screening of BMI among children. Whether or not this is sufficient to cause parents and children to change their eating and activity behaviors remains to be seen. At this time, only more intense interventions that provide training and tools in counseling seem to result in changes in patient behaviors.³⁰ Providing pediatric providers with brief but effective strategies regarding weight control behaviors may be necessary to further increase the quality of obesity management in the primary care setting.

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