Health Information Technology in Screening and Treatment of Child Obesity: A Systematic Review

BACKGROUND AND OBJECTIVES: Childhood obesity is a major problem in the United States, yet screening and treatment are often inaccessible or ineffective. Health information technology (IT) may improve the quality, efficiency, and reach of chronic disease management. The objective of this study was to review the effect of health IT (electronic health records [EHRs], telemedicine, text message or telephone support) on patient outcomes and care processes in pediatric obesity management.

METHODS: Medline, Embase, and the Cochrane Registry of Controlled Trials were searched from January 2006 to April 2012. Controlled trials, before-and-after studies, and cross-sectional studies were included if they used IT to deliver obesity screening or treatment to children aged 2 to 18 and reported impact on patient outcomes (BMI, dietary or physical activity behavior change) or care processes (BMI screening, comorbidity testing, diet, or physical activity counseling). Two independent reviewers extracted data and assessed trial quality.

RESULTS: Thirteen studies met inclusion criteria. EHR use was associated with increased BMI screening rates in 5 of 8 studies. Telemedicine counseling was associated with changes in BMI percentile similar to that of in-person counseling and improved treatment access in 2 studies. Text message or telephone support was associated with weight loss maintenance in 1 of 3 studies.

CONCLUSIONS: To date, health IT interventions have improved access to obesity treatment and rates of screening. However, the impact on weight loss and other health outcomes remains understudied and inconsistent. More interactive and time-intensive interventions may enhance health IT’s clinical effectiveness in chronic disease management. *Pediatrics* 2013;131:e894–e902

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KEY WORDS review, child, obesity, BMI, information technology, electronic health records, telemedicine, text messaging, decision support systems

ABBREVIATIONS CI—confidence interval

EHR—electronic health records

IT—information technology

RCT—randomized controlled trial

Ms Smith conceptualized and designed the study, carried out analysis and interpretation of data, drafted the original manuscript, and approved the final manuscript as submitted; Ms Skow assisted with the design of the study, carried out analysis and interpretation of data, critically revised article drafts, and approved the final manuscript as submitted; Dr Bodurtha assisted with the conceptualization of the study and data acquisition, critically revised article drafts, and approved the final manuscript as submitted; and Dr Kinra assisted with the design of the study, critically revised article drafts, and approved the final manuscript as submitted.


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More than one-third of children in the United States are now overweight or obese. However, childhood obesity remains underrecognized and undertreated. Of children who see a physician, surveys indicate that less than half of them receive BMI screening and/or preventive counseling about diet and physical activity as recommended by the American Academy of Pediatrics. A minority of overweight and obese adolescents are referred to dietitians or behavioral counseling for treatment, and adherence to treatment is often poor. Additionally, many weight management programs are concentrated in academic medical centers, typically located far from the medically underserved rural and urban areas where obesity is more common.

Information technology (IT) has the potential to improve the quality, consistency, and availability of health care. Common forms of health IT are electronic health records (EHRs), computerized decision support systems, telemedicine, and text message or telephone support. In adults, EHR adoption and telemedicine have been associated with small improvements in physician behavior (BMI screening) and patient outcomes (weight loss), respectively. In pediatrics, the 2009 US Congressional Act, Health Information Technology for Economic and Clinical Health, is rapidly expanding the use of electronic health records and telemedicine. This act includes specific incentives for IT-facilitated delivery of BMI screening and counseling on diet and physical activity, such as computerized growth charts. However, little is known about the clinical effectiveness of IT for pediatric obesity management. Despite some success in adults, health IT may be complicated by the lack of pediatric-specific EHR systems and the different stages of child development and family involvement. Pediatric IT interventions for other chronic diseases have reported issues with age-appropriate messaging, pediatrician uptake, and minor confidentiality.

Developing a clinical evidence base for health IT is an important step for delivering effective chronic disease management and leveraging new federal funding for IT. We performed a systematic review of the impact of health IT on patient outcomes and care processes in childhood obesity management.

METHODS

Search Strategy

Given rapid advancements in technology, the literature review was limited to English-language articles from 2006 to April 2012. Three databases were searched: Medline, Embase, and the Cochrane Registry of Controlled Trials. Table 1 shows search terms used for Medline, which were modified where necessary for Embase and Cochrane Registry of Controlled Trials. Terms for “child,” “obesity,” and “IT” were adapted from previous reviews of obesity prevention, mobile technologies, and IT. Reference lists of included articles were also searched.

Inclusion/Exclusion Criteria

Randomized controlled trials (RCTs) and nonrandomized controlled trials, before-and-after studies, and cross-sectional studies were considered. Studies were included if they (1) used IT to deliver obesity screening or treatment in children 2 to 18 years of age, (2) were clinic based or involved data communication with child health professionals; and (3) reported measures of clinical effectiveness (BMI, dietary or physical activity behavior change, treatment adherence) or care processes (BMI screening, comorbidity testing, counseling on diet or physical activity).

Studies of obesity treatment outside clinical care, such as internet-only or videogame-based interventions, and studies without a comparison group were excluded. Telemedicine was defined as the remote diagnosis and/or treatment of patients using IT.

Two independent reviewers screened all abstracts and titles for initial assessment of eligibility. After abstract screening, both reviewers reviewed full-text articles to make final inclusion/exclusion decisions. Disagreements were resolved by consensus.

TABLE 1 Search Terms in Medline

<table>
<thead>
<tr>
<th>Search Term</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>exp child/</td>
<td>child/</td>
</tr>
<tr>
<td>exp adolescent/</td>
<td>adolescent/</td>
</tr>
<tr>
<td>exp juvenile.mp</td>
<td>juvenile</td>
</tr>
<tr>
<td>exp child$.mp</td>
<td>child</td>
</tr>
<tr>
<td>exp teen$.mp or adolescent$.mp</td>
<td>teen or adolescent</td>
</tr>
<tr>
<td>exp electronic health record$.mp</td>
<td>electronic health record</td>
</tr>
<tr>
<td>exp BMI</td>
<td>BMI</td>
</tr>
<tr>
<td>exp weight gain/loss</td>
<td>weight gain or loss</td>
</tr>
<tr>
<td>exp body wt/</td>
<td>body weight</td>
</tr>
<tr>
<td>exp obes$</td>
<td>obesity</td>
</tr>
<tr>
<td>exp wt gain or wt loss</td>
<td>weight gain or weight loss</td>
</tr>
<tr>
<td>exp body wt changes</td>
<td>weight change</td>
</tr>
<tr>
<td>exp overweight or over wt or overeat$</td>
<td>overweight</td>
</tr>
<tr>
<td>exp overeat$</td>
<td>overweight</td>
</tr>
<tr>
<td>exp body mass-index</td>
<td>body mass-index</td>
</tr>
<tr>
<td>exp BMI-for-age or wt-for-height</td>
<td>BMI for age or weight for height</td>
</tr>
<tr>
<td>exp medical informatics</td>
<td>medical informatics</td>
</tr>
<tr>
<td>exp educational technology</td>
<td>educational technology</td>
</tr>
<tr>
<td>exp telemedicine</td>
<td>telemedicine</td>
</tr>
<tr>
<td>exp cellular phone</td>
<td>cellular phone</td>
</tr>
<tr>
<td>exp text messaging</td>
<td>text messaging</td>
</tr>
<tr>
<td>exp computer-assisted therapy</td>
<td>computer-assisted therapy</td>
</tr>
<tr>
<td>exp user-computer interface</td>
<td>user-computer interface</td>
</tr>
<tr>
<td>exp personal digital assistant</td>
<td>personal digital assistant</td>
</tr>
<tr>
<td>exp computer, handheld</td>
<td>computer, handheld</td>
</tr>
<tr>
<td>exp electronic medical record</td>
<td>electronic medical record</td>
</tr>
<tr>
<td>exp electronic health record$</td>
<td>electronic health record</td>
</tr>
<tr>
<td>exp personal health record$</td>
<td>personal health record</td>
</tr>
<tr>
<td>exp Diagnosis, Computer-Assisted</td>
<td>Diagnosis, Computer-Assisted</td>
</tr>
<tr>
<td>exp Decision Support Systems</td>
<td>Decision Support Systems</td>
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<tr>
<td>exp Clinical/</td>
<td>Clinical/</td>
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<tr>
<td>exp 23-34</td>
<td>23-34</td>
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<tr>
<td>exp 10 and 22 and 35</td>
<td>10 and 22 and 35</td>
</tr>
<tr>
<td>exp 2006 to current and</td>
<td>years 2006 to current and</td>
</tr>
<tr>
<td>exp English-language and human</td>
<td>English-language and human</td>
</tr>
</tbody>
</table>
Results and Discussion

Quality Assessment

Reviewers assessed study quality by using a tool developed for health IT studies. Studies were scored for methodological quality on a 10-point scale, including the method of allocation to study group (random: 2, quasi-random: 1, concurrent or no controls: 0), unit of allocation (cluster: 2, health professional: 1, patient or not applicable: 0), baseline differences between groups that may be linked to study outcomes (no baseline differences or differences adjusted with appropriate statistical methods: 2, baseline differences reported and no statistical adjustment: 1, baseline characteristics not reported: 0), outcome objectivity (objective outcomes or subjective outcomes with blinding: 2, validated subjective outcome: 1, subjective outcomes poorly defined: 0), and attrition (<10%: 2, 10–20%: 1, >20% or not applicable: 0). On this scale, the maximum score for a before-and-after study was 4, and the maximum score for a cross-sectional study was 3 because of the lack of concurrent controls and group allocation. Both reviewers assessed quality independently, and disagreements were resolved by consensus.

Data Extraction and Synthesis

For a given study, we extracted all outcomes relating to patient outcomes or care processes. Both reviewers used a standardized form to extract data independently; data were compared for concordance. Random-effects meta-analysis was performed by using Stata (version 12; StataCorp, College Station, TX) when two or more similarly designed studies reported comparable outcomes. Results are presented by IT application: electronic health records, telemedicine, and text message or telephone support.

Methodological Quality Assessment

Of the 13 included studies, 4 were RCTs, including 1 cluster-randomized trial, and 5 were before-and-after studies performed by using chart reviews of EHR data. Five were before-and-after studies performed by using chart reviews of EHR data, and 4 were cross-sectional studies. The trials reported participation rates ranging from 61% to 100%, and 3 of 4 reported no baseline differences considered relevant to study outcomes. For the 3 surveys, response rates ranged from 36.9% to 62%. All RCTs and before-and-after studies reported objective outcomes, although only 1 study used blinded outcome assessors. One RCT had 1-year attrition of <10%, whereas the remaining trials had attrition of 18%, 18%, and 30%, respectively. On the 10-point quality scale, the mean score was 3.7 (SD 2.8), with a range of 1 to 10 (Tables 2 and 3).

EHRs

One study examined the impact of EHRs on patient outcomes (Table 2), and 8...
studies evaluated care processes (Table 3). Impacts on care processes were inconsistent but indicated that EHRs have the potential to improve physician documentation of child BMI and comorbidity screening.

Taveras et al26 randomized obese children to enhanced weight management, including EHRs with decision support, increased insurance reimbursement, telephone support, and motivational interviewing, or usual care. At the 1-year follow-up, Taveras et al reported no significant differences in BMI (−0.21; 95% confidence interval [CI], −0.50 to 0.07; \( P = .15 \)) or BMI z-score (−0.05 unit; 95% CI, −0.14 to 0.04; \( P = .28 \)) between groups, and a slightly greater decrease in television viewing (−0.36 h/day; 95% CI, −0.64 to −0.09; \( P = .01 \)) and fast food intake (−0.16 servings/week; 95% CI, −0.33 to 0.01; \( P = .07 \)) in children randomized to enhanced weight management.

Gance-Cleveland et al30 introduced a computerized decision support system in a school-based health center and reported significant increases in documentation of BMI and blood pressure. The year after implementation, 76% of children had a BMI percentile documented and 35% had a blood pressure percentile documented compared with 31% and 1% before, respectively (\( P < .01 \) for both).

Benson et al29 reported no change in diagnosis of overweight, obesity, or severe obesity after the introduction of a BMI flag in EHRs that displayed, in red, BMIs \( \geq 85 \text{th} \) or \( \leq 10 \text{th} \) percentile. During the 4-year period of study, overweight children were less likely to be diagnosed than obese children (\( P = .001 \)).

Shaikh et al32 found no change in documentation of BMI, weight, or height after the addition of an automatic BMI calculator to EHRs. Children with higher BMI percentiles and older children were more likely to be screened for BMI before and after EHR implementation (\( P < .001 \)). Counseling rates for physical activity increased from 9% to 32% (\( P < .001 \)), and counseling on nutrition increased from 38.3% to 69.2% (\( P < .001 \)). Because the EHR did not include decision support, the study authors suggested that changes were caused by undocumented discussion of weight concerns.32,36

Keehbauch et al31 compared the effects of an EHR upgrade, from basic BMI calculation to calculation of an age- and gender-specific BMI percentile, on rates of documenting weight status, screening for lipids, and providing nutrition and physical activity counseling.31 The 2 study sites both upgraded their EHRs, but 1 site received extra training on how to document and treat pediatric obesity using BMI percentiles. One year after the upgrade, documentation of children as overweight or obese increased from 24.2% to 33.6% (no \( P \) value given). Diet and

### TABLE 2: Studies of the Impact of Health IT on Patient Outcomes in Childhood Obesity Treatment

<table>
<thead>
<tr>
<th>Source</th>
<th>Study Design (n)</th>
<th>Quality Score</th>
<th>Intervention/Change</th>
<th>Patient Outcome(s)</th>
<th>Improvement in Patient Outcome(s)*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Telemedicine</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Davis et al 2011</td>
<td>RCT (17)</td>
<td>5</td>
<td>Group counseling treatment via telemedicine</td>
<td>BMI percentile</td>
<td>No(^b)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Nutrition</td>
<td>No</td>
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<td></td>
<td></td>
<td></td>
<td>Physical activity</td>
<td>No</td>
</tr>
<tr>
<td>Irby et al 2012</td>
<td>Before-and-after study (284)</td>
<td>3</td>
<td>Individual counseling via telemedicine</td>
<td>BMI z-score</td>
<td>No(^b)</td>
</tr>
<tr>
<td><strong>Text message and telephone support</strong></td>
<td></td>
<td></td>
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<tr>
<td>Estabrooks et al 2009</td>
<td>RCT (220)</td>
<td>6</td>
<td>Automated telephone messages to parents after group treatment</td>
<td>BMI z-score</td>
<td>Yes(^c)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Nutrition</td>
<td>No</td>
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<td>Physical activity</td>
<td>No</td>
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<td></td>
<td></td>
<td></td>
<td>BMI</td>
<td>No</td>
</tr>
<tr>
<td>Kornman et al 2010 and Nguyen et al 2012</td>
<td>RCT (151)</td>
<td>8</td>
<td>Text messages, emails, and phone messages during group treatment</td>
<td>BMI z-score, Waist circumference</td>
<td>No</td>
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<td></td>
<td></td>
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<td></td>
<td>Nutrition</td>
<td>No</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Physical activity</td>
<td>No</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>BMI</td>
<td>No</td>
</tr>
<tr>
<td>Taveras et al 2011</td>
<td>RCT (475)</td>
<td>10</td>
<td>Multicomponent obesity treatment including motivational phone calls, a television monitoring device, and EHRs with clinical decision support</td>
<td>BMI z-score</td>
<td>No</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Nutrition</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Reduced television time</td>
<td>Yes</td>
</tr>
</tbody>
</table>

* Improvement was defined by conventional levels of statistical significance (\( P < .05 \)).

\(^b\) Lack of improvement in patient outcomes for a telemedicine intervention indicates that the intervention was comparable to in-person care.

\(^c\) Only for children of parents who completed a majority of counseling calls.
exercise counseling rates for these children also improved. Rates of weight status documentation and lipid assessment were significantly higher at the site that received education ($P < .05$ for both). The EHR upgrade did not affect initiation of obesity treatment, which remained low at all sites ($P = .36$).

Four surveys of pediatricians and primary care providers reported that pediatricians with EHR access reported higher rates of BMI screening than those without EHRs.$^{24,35-33}$ In a random effects meta-analysis of the 3 surveys reporting percentage of children screened (Fig 2), the odds of BMI screening were more than twice as high among pediatricians with EHRs compared with those without (pooled odds ratio: 2.53; 95% CI: 1.39–4.62).$^{33-35}$ However, overall screening rates remained low, ranging from 39% to 70%. In Klein et al$^{34}$ and Adhikari et al,$^{33}$ availability of clinic resources for weight management, such as a dietitian or group counseling, appeared to be greater predictors of BMI screening than access to EHRs. Adhikari et al found no difference between respondents with and without EHRs with respect to rates of blood pressure, lipid, and glucose testing for overweight or obese children.

### Telemmedicine

Two studies (1 RCT and 1 before-and-after study) evaluated patient outcomes of obesity counseling delivered via telemedicine.$^{25,27}$ Davis et al$^{25}$ found no significant difference in BMI percentile, nutrition, or physical activity behavior in children whose parents attended 4 sessions of telemedicine group counseling at a school health center compared with children whose families attended 1 in-person counseling visit. At 1 year, neither group showed any change from baseline. However, parents reported high levels of satisfaction with telemedicine, primarily because it minimized health care–related travel, and counseling attendance was 100%.

Irby et al$^{27}$ found reductions in BMI percentile for children enrolled in a weight management program where families were seen via telemedicine or in person every 2 to 4 weeks; the difference between groups was not significant. Sixty-four percent of children seen via telemedicine decreased BMI percentile compared with 69% of children seen in person at 1 year. Enrollment of rural families increased, and treatment attrition was similar in both groups (30% for telemedicine versus 32% for in person; no $P$ value given).
Three studies examined effects of text message and telephone support on BMI and other clinical outcomes.\textsuperscript{23,28} Findings suggest that phone-based support may affect change, but only if it is high intensity. Estabrooks et al\textsuperscript{28} reported that children whose families completed group counseling sessions plus an additional 6 to 10 maintenance sessions using automated telephone counseling experienced larger decreases in BMI z-score at 1 year than children whose families received group counseling alone. No improvement from baseline to 1 year was seen in children whose families completed only 0 to 5 sessions (10 were offered to all in the intervention group), which the study authors attributed to low parental motivation and insufficient skill building.

Nguyen et al and Kornman et al\textsuperscript{23,37} compared adolescents who received group counseling followed by text message, telephone, or e-mail every other week to adolescents who received group counseling alone and found no difference in mean changes in BMI, waist circumference, or blood pressure at 1 year. In a process evaluation of the trial, low adolescent engagement was reported: adolescents responded to <22% of the messages marked “please reply.”\textsuperscript{37}

Taveras et al\textsuperscript{26} reported no difference in BMI or BMI z-score between children who received enhanced weight management, including 3 15-minute phone calls, and usual care at 1 year. Although 3 telephone calls and 3 clinic visits were offered to all intervention participants, less than half of families completed \(\geq 2\) calls or visits.

**DISCUSSION**

**Assessment of the Literature**

Improving pediatric obesity screening and treatment is vital to addressing the US obesity epidemic and associated burdens of chronic disease and health care costs.\textsuperscript{38,39} As far as we are aware, this is the first review to evaluate the effect of using health IT in pediatric obesity management. This review illustrates that, although health IT may improve screening rates and access to treatment, it has had little to no impact on behavior change and weight loss thus far. EHRs have had small positive effects on care processes. Of included studies, computerized decision support showed the largest magnitude of improvement in BMI and comorbidity screening rates; this is consistent with other studies suggesting that interactive EHRs are more effective at changing physician behavior.\textsuperscript{30,40} Other EHRs in this review involved passive notification of weight status, such as color-coding BMIs over the 85th percentile or displaying BMI among a child’s vital signs, which physicians may not notice.\textsuperscript{32}

Regardless of the EHR technology used, the American Academy of Pediatrics’s recommendations for universal BMI, blood pressure, and lipid screening were not met in any of the included studies.\textsuperscript{4} Making clinic resources available for weight management or continuing medical education on pediatric obesity may enhance rates of BMI documentation and lifestyle counseling to a greater extent than EHR use.\textsuperscript{31,33,34}

Counseling delivered via telemedicine had comparable clinical outcomes to in-person counseling and improved rural families’ access to obesity treatment. One trial’s null findings may be because of the fact that the frequency of counseling sessions was less than that recommended by clinical guidelines.\textsuperscript{4,25} Given the US government’s investment in the telemedicine infrastructure, telemedicine is likely an effective way to expand access to obesity treatment. Telemedicine may be cost-effective if it minimizes travel costs to families and/or promotes earlier initiation of effective treatment.

Text message– or telephone-based support showed some positive effects on weight maintenance in young children but not in adolescents. Greater frequency of contact may increase impact. However, as some contact is patient initiated, this association may be non-causal and reflect differential patient motivation.

Strengths of this review include the comprehensive search strategy and
The review has several limitations. We limited the search strategy to medical databases and English-language articles and did not contact study authors for unpublished data. Reliance on EHR documentation may underestimate screening and counseling rates, depending on ease of EHR data entry and provider incentives to document screening and counseling provided. Information on IT implementation (staff trainings, provider satisfaction, cost, and computer systems) is important to generalizability and cost-effectiveness but was poorly described in most studies. Meta-analysis was possible for only 1 outcome, given the heterogeneity of included study designs and outcomes measured.

Future Directions

The US government will invest more than $29 billion in health IT by 2020. Despite this, very few studies have demonstrated positive effects of health IT on patient outcomes. Notably, in this review, the majority of included studies did not measure patient outcomes, but rather evaluated impacts on care processes. This focus was expected: EHRs are designed primarily to assist clinician decision-making and record-keeping. Nonetheless, improvements in care processes may lead to positive behavioral changes. For example, improving BMI screening rates in children will lead to clinicians and parents being informed when a child is overweight or obese. Parents who recognize their child is overweight and are aware of the associated health risks are more likely to make lifestyle changes. Further research is needed to understand how improved quality and consistency of care influences patient outcomes.

On the other hand, some interventions, such as text message support, have not been associated with improved patient outcomes thus far. Because these applications are new, their design and implementation have room for improvement. IT interventions that have been effective for other conditions could be tried for childhood obesity. Text message reminders increase attendance for pediatric appointments and could reduce obesity treatment dropout. Personalized daily text messages have been shown to increase smoking cessation in young adults; messages about diet and nutrition might augment group counseling if delivered at a similar intensity. Pop-up alerts for BMI above healthy thresholds have been used effectively in adult weight management. Although the review found no studies on electronic prescribing, the use of drugs, such as orlistat and statins, is increasing in childhood obesity treatment. EHRs that integrate prescribing and decision support could play an important role in ensuring safe prescribing and appropriate treatment. To maximize accessibility, telemedicine could be used to deliver obesity screening or treatment in children’s homes. Many of these strategies, if successful, could be expanded to management of other pediatric chronic diseases.

CONCLUSIONS

In childhood obesity, studies show promise for telemedicine to expand treatment access and for EHRs to assist physicians in adhering to clinical guidelines for screening. To date, the effect on weight loss and behavior change remains understudied and inconsistent. Further research is necessary to evaluate if changes in care processes affect clinical outcomes and if additional IT applications could enhance the quality and availability of screening and treatment. Understanding the benefits, and limits, of health IT will enable pediatricians to design and implement IT programs that fit their patients’ needs and maximize its value in pediatric obesity management.

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REFERENCES


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