The Prevalence and Health Care Use of Overweight Children in an Integrated Health Care System

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Objective: To determine the prevalence, health care use, and costs of overweight children when compared with healthy-weight children.

Design: Longitudinal cohort.

Setting: Kaiser Permanente Colorado is an integrated, nonprofit health care system.

Patients: Eleven thousand six hundred thirty-six children who completed at least 1 body mass index (calculated as weight in kilograms divided by height in meters squared) assessment between 2000 and 2004.

Main Exposure: Overweight.

Main Outcome Measure: Health care use. Based on previous research that demonstrated a higher cost for obese adults when compared with healthy-weight adults, we hypothesized that, when compared with healthy-weight children, overweight children would have higher health care use patterns.

Results: Thirteen percent and 14% of the sample, respectively, were classified as overweight or at risk of becoming overweight. At both year 1 (rate ratio [RR] = 1.11 [95% confidence interval (CI), 1.06-1.17]) and year 3 (RR = 1.06 [95% CI, 1.01-1.11]), overweight children had significantly more internal Kaiser Permanente Colorado medical visits, although the magnitude of the relationship was relatively small. Of particular note was the relationship between being overweight and increased use of mental health resources at both points (year 1 RR = 1.47; year 3 RR = 1.48). The calculated additional annual cost of use for 1000 overweight children (regression adjusted to control for comorbidities) was approximately $42,000 for primary care sick visits and $32,000 for mental health visits.

Conclusion: There is potential for cost savings or cost realignment with weight-management interventions from dollars that could be saved through the reduction of childhood overweight.

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HE PREVALENCE OF OVER-weight children has increased significantly over the past 3 decades.1 For children aged 2 to 5, 6 to 11, and 12 to 19 years, prevalence has increased, respectively, from approximately 5%, 4%, and 6% to 10%, 15%, and 16%.1 A recent report by the Institute of Medicine highlighted the personal and societal cost of overweight children.2 First, childhood obesity is related to a wide variety of adult-onset physical health issues such as hypertension, dyslipidemia, sleep apnea, and orthopedic problems.2 Much attention has also been given to the increasing prevalence of type 2 diabetes mellitus among American children3,4 and the evidence that the comorbid conditions associated with diabetes—retinopathy, nephropathy, neuropathy, and cardiovascular disease—will become issues associated with early adulthood rather than the senior years of life.5 Second, although the physical health symptoms of childhood obesity may not present themselves until later in life, there are immediate negative social and emotional health consequences in a society where those with weight-management problems are stigmatized.6 These issues range from low self-esteem, negative body image, and depressive symptoms that can be produced from interactions with peers, parents, teachers, and health care professionals.2 Third, a number of studies have demonstrated that the body mass index (BMI) and obesity status during childhood is a strong predictor of adolescent and adult obesity.6 This relationship is consistent in the United States and across a variety of industrialized countries.7-13

An additional concern that emanates from the prevalence, tracking, and adverse health outcomes of overweight children is the related personal and economic burden.14 A recent US Preventive Services
Task Force recommendation for future research related to screening of overweight children suggests that there is a need to understand the costs associated with overweight children as a first step in determining cost-effective treatment and prevention interventions. For example, the identification of disparate health care use patterns of overweight, when compared with healthy-weight, children could provide information related to the potential savings that could be achieved through pediatric weight-management interventions—or at minimum determine the resources that could be made available for treatments to be cost neutral. Although there are studies that have demonstrated a higher health care use for obese adults, there is limited information on use patterns of overweight children. Wang and Dietz demonstrated that the hospital costs associated with pediatric obesity nearly tripled between 1981 and 1999. More recently, a report that highlighted the disparities between Medicaid and privately insured children with an obesity diagnosis supported the increased hospitalization costs and increased health burden associated with obesity. The purpose of our study was to extend previous research by determining the prevalence of overweight and at-risk children between 3 and 17 years of age within an integrated health care system and examine if use of system resources differed based on weight status (ie, healthy, at risk, or overweight). A secondary purpose was to provide cost information on any use patterns that may differ based on child weight status.

METHODS

We identified children at risk of becoming overweight (BMI [calculated as weight in kilograms divided by height in meters squared] in the 85th-94th percentile) and those already overweight (BMI ≥ 95th percentile) using sex- and age-specific BMI cut points obtained from the 2000 Center for Disease Control and Prevention BMI-for-age tables. Body mass index calculations were based on weight and height entries from electronic medical records of children aged 3 to 17 years who received health care from Kaiser Permanente Colorado (KPCO). This study was approved by the KPCO institutional review board to ensure compliance with the appropriate protection of human subjects.

In 2000, there were 60,587 members aged 3 to 17 years with at least 1 year of membership (those with <1 year of membership were excluded from the study). Among these members, 73% (n=44,252) had a primary care visit during which BMI could have been measured. Visits were more common among youngest members (85% of 3- to 4-year-olds had a visit) and less common among teenagers (66% of 13- to 17-year-olds had a visit). Girls were slightly more likely to have had a visit than boys (74% vs 72%, respectively).

Body mass index measurements were available for 11,857 children (26% of those with visits). Availability varied by age, but at its highest level, among 3- to 4-year-olds, it was still only 32.4% of eligible members. Despite this relatively low capture, we are confident children with BMI measurements were representative of users of our clinic system for several reasons. First, initiatives to more consistently record height measurements in the electronic record, particularly on well-care visits, produced steady increases in BMI measurement availability to 64% in 2004 (with >95% capture on well-care visits). Despite this large increase, the proportion of children with a high BMI remained closely aligned to the estimates from 2000. For example, the overall proportion with a BMI in the 95th percentile or higher was 13.5% in 2000 and 13.3% in 2004. Second, missing BMI measurements were primarily because of height being less frequently measured than weight, which was measured at nearly every visit. Average weights for persons with height measured differed by less than 5% compared with persons with heights not measured and were not consistently higher or lower by age. These data investigations did not find subject characteristics differing markedly by BMI measurement availability and confirmed this sample was a reasonable representation of our clinic users.

For the analytic sample, we excluded girls who became pregnant at any time during the period 2000 to 2003, which left 11,636 members. A subset of 8232 remained members for at least 3 years and their use was evaluated over a longer period. In contrast to the analyses for the primary aim of determining use, prevalence was documented using cross-sectional records for all KPCO child members with BMI measurements from 2000 to 2004. This cross-sectional sample included 86,868 children with at least 1 BMI measurement between 2000 and 2004; only 1 measurement was randomly selected for inclusion for each child if multiple measures were available (Figure).

ASSESSMENT OF USE

Kaiser Permanente Colorado is an integrated, nonprofit health maintenance organization health care system. Members’ visits for primary care and most specialty needs are completed with KPCO health care professionals. For use of KPCO resources, dates and visit details were available and obtained from KPCO electronic medical records. Hospitalizations, emergency department visits, and specialty visits with non-KPCO professionals were identified through billing records. Each method has been used previously and demonstrated reasonable accuracy.

Annual cost estimates were drawn from KPCO’s Decision Support System. This system, started in 2001, aligns costs from the general ledger with use histories of members to produce cost estimates for visits that include both direct costs for physicians, nurses, supplies, and other costs of care as well as distributing indirect costs for facilities, malpractice insurance, in-
A longitudinal design was used that included the assessment of BMI in 2000 and captured use over the following 1 to 3 years. Following weight status classification based on the Centers for Disease Control and Prevention growth charts, the proportion of child members who were overweight or at risk for overweight was calculated. Crude visit rates were calculated for each weight category and confidence intervals (CIs) estimated using the Fisher exact test method. Negative binomial models were used to estimate use rate ratios (RRs) contrasting overweight vs nonoverweight children. These models excluded rare diseases that would be associated with high-use patterns (eg, kidney dialysis, cancer, cerebral palsy, epilepsy). Only 81 children with 1 year of membership and 62 with 3 years of membership had any of the selected rare diseases (<0.8% of the analytic samples for all combined). Two models were used to determine the relationships between weight status and use. First, a simple model adjusting for age and sex was used. Second, a model that adjusted for 3 more common diseases in the sample, asthma, diabetes, and attention-deficit disorder, was used. The rationale to control for these conditions was to allow for the parsing out of the influence of these disease states when examining the relationship between overweight status and use. Asthma was the most common disease, affecting 17% to 19% of these children; attention-deficit disorder was noted on medical records of 7% to 8%; and diabetes was relatively rare at 0.3%. Presence of disease was identified by International Classification of Diseases, Ninth Revision codes located on medical records for visits during the study period.

The Figure highlights the prevalence of at-risk and overweight children, using cross-sectional data between 2000 and 2004. Specifically, 72% of children who completed a BMI assessment were classified as having a healthy weight, while 13% and 14%, respectively, were classified as overweight or at risk of becoming overweight.

In 2000, the baseline year for the use analyses, boys and older children were significantly more likely to be overweight (Table 1). Approximately 82% and 98% of study participants completed at least 1 internal clinical visit, respectively, at year 1 and year 3 following BMI assessment. Conversely, approximately 80% of children did not have an outside referral, emergency department visit, or hospitalization over the 3-year period. Table 1 provides visit rate estimates and 95% CIs by visit type across healthy, overweight, and at-risk children.

Rate ratios in Table 2 control for age, sex, and disease status. At both year 1 (RR=1.11 [95% CI, 1.06-1.17]) and year 3 (RR=1.06 [95% CI, 1.01-1.11]), overweight children had significantly more internal KPCO medical visits, although the magnitude of the relationship was relatively small. At year 3, overweight children completed fewer well-child visits (RR=0.85 [95% CI, 0.80-0.91]) but a higher number of sick-child visits (RR=1.08 [95% CI, 1.02-1.13]) when compared with healthy-weight children. Of particular note is the relationship between being overweight and increased use of mental health resources at both points (year 1 RR=1.47 [95% CI, 1.08-1.99]; year 3 RR=1.48 [95% CI, 1.14-1.92]). There were few differences between children at risk of being overweight and those who were a healthy weight.
Table 2. Use Rate Ratios for BMI in the 95th Percentile or Higher and BMI Between the 85th and 94th Percentile Compared With BMI Lower Than the 85th Percentile

<table>
<thead>
<tr>
<th></th>
<th>Year 1 (n = 11 636)</th>
<th>Year 3 (n = 8282)</th>
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<tbody>
<tr>
<td></td>
<td>RR (95% CI)</td>
<td>RR (95% CI)</td>
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<tr>
<td>BMI 95th Percentile</td>
<td>Model 1†</td>
<td>Model 2†</td>
</tr>
<tr>
<td>Primary care</td>
<td>1.02 (0.97-1.08)</td>
<td>1.11 (1.06-1.17)</td>
</tr>
<tr>
<td>Well visits</td>
<td>0.98 (0.92-1.05)</td>
<td>0.96 (0.90-1.03)</td>
</tr>
<tr>
<td>Sick visits</td>
<td>1.09 (1.04-1.15)</td>
<td>0.96 (0.90-1.03)</td>
</tr>
<tr>
<td>Urgent care visits</td>
<td>0.96 (0.80-1.15)</td>
<td>1.12 (1.06-1.18)</td>
</tr>
<tr>
<td>Mental health visits</td>
<td>0.95 (0.89-1.32)</td>
<td>1.23 (1.04-1.46)</td>
</tr>
<tr>
<td>Hospitalizations</td>
<td>0.94 (0.74-1.19)</td>
<td>1.13 (1.01-1.26)</td>
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<table>
<thead>
<tr>
<th>BMI 85th-94th Percentile</th>
<th>Model 1‡</th>
<th>Model 2‡</th>
<th>Model 1‡</th>
<th>Model 2‡</th>
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<tbody>
<tr>
<td>All internal clinic visits</td>
<td>1.02 (0.97-1.08)</td>
<td>1.15 (1.09-1.21)</td>
<td>1.11 (1.06-1.17)</td>
<td>1.03 (0.98-1.08)</td>
</tr>
<tr>
<td>Primary care</td>
<td>0.98 (0.92-1.05)</td>
<td>0.96 (0.90-1.03)</td>
<td>0.94 (0.89-0.99)</td>
<td>0.93 (0.88-0.99)</td>
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<tr>
<td>Sick visits</td>
<td>1.09 (1.04-1.15)</td>
<td>1.16 (1.10-1.22)</td>
<td>1.12 (1.06-1.18)</td>
<td>0.94 (0.89-0.99)</td>
</tr>
<tr>
<td>Urgent care visits</td>
<td>0.96 (0.80-1.15)</td>
<td>1.27 (1.07-1.51)</td>
<td>1.23 (1.04-1.46)</td>
<td>1.00 (0.87-1.16)</td>
</tr>
<tr>
<td>Mental health visits</td>
<td>0.95 (0.89-1.32)</td>
<td>1.36 (0.98-1.80)</td>
<td>1.47 (1.08-1.99)</td>
<td>0.94 (0.71-1.23)</td>
</tr>
<tr>
<td>Hospitalizations</td>
<td>0.94 (0.74-1.19)</td>
<td>1.19 (1.06-1.34)</td>
<td>1.13 (1.00-1.27)</td>
<td>1.03 (0.93-1.15)</td>
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<thead>
<tr>
<th></th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 1</th>
<th>Model 2</th>
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<tbody>
<tr>
<td>External, referred clinic visits</td>
<td>1.09 (0.87-1.38)</td>
<td>1.15 (0.90-1.46)</td>
<td>1.28 (1.01-1.62)</td>
<td>0.95 (0.76-1.19)</td>
</tr>
<tr>
<td>ED visits</td>
<td>1.13 (0.97-1.32)</td>
<td>1.12 (0.96-1.30)</td>
<td>1.19 (1.02-1.53)</td>
<td>1.04 (0.92-1.18)</td>
</tr>
<tr>
<td>Hospitalizations</td>
<td>1.27 (0.79-2.02)</td>
<td>1.07 (0.97-1.19)</td>
<td>1.66 (1.07-2.59)</td>
<td>0.79 (0.54-1.18)</td>
</tr>
</tbody>
</table>

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); CI, confidence interval; ED, emergency department; RR, rate ratio.

*Model 1 adjusts for age and sex.
†Model 2 adjusts for age, sex, asthma, diabetes mellitus, and attention-deficit disorder.

Table 3. Estimated Annual Costs of Extra Primary Care Sick Visits and Mental Health Visits Among Overweight Children After 1 Year of Follow-Up

<table>
<thead>
<tr>
<th></th>
<th>Primary Care Sick Visits</th>
<th>Mental Health Visits</th>
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<tbody>
<tr>
<td>Visits per year for a healthy-weight child,* mean</td>
<td>2.14</td>
<td>0.20</td>
</tr>
<tr>
<td>Extra visits for overweight child,†% (95% CI)</td>
<td>12 (6-18)</td>
<td>47 (8-99)</td>
</tr>
<tr>
<td>Calculated extra visits for an overweight child in 1 y, No. (95% CI)</td>
<td>0.257 (0.128-0.385)</td>
<td>0.094 (0.016-0.198)</td>
</tr>
<tr>
<td>Visit cost (direct + indirect), $, median</td>
<td>164</td>
<td>339</td>
</tr>
<tr>
<td>Extra visit costs for 1000 overweight children, $, mean (95% CI)</td>
<td>42 148 (20 992-63 140)</td>
<td>31 866 (54 244-67 122)</td>
</tr>
</tbody>
</table>

Abbreviation: CI, confidence interval.
*From Table 1; single person rather than 100 person-years.
†Based on adjusted rate ratio estimates from Table 2.

Year 1 cost estimates are provided in Table 3 for primary care sick visits and mental health visits, which were the use elements that showed consistent, significant differences by BMI. Based on the number of extra visits of overweight children when compared with healthy-weight children and the median visit cost across these services, the calculated additional annual cost of use for 1000 overweight children is approximately $42 000 for primary care sick visits and $32 000 for mental health visits.

Our study found that the prevalence of overweight children (13%) within this integrated health care system reflected recent data on national prevalence and was consistent across the 4 years of data collection. We used 2 models to determine the relationships between weight status and use. Both models found that, with the exception of well-care visits over 3 years, use was similarly higher for overweight when compared to healthy-weight children. Also, although shifts in significance occurred for hospitalizations, emergency department visits, and mental health visits, the magnitude and the direction of these relationships are more consistent than the simple P value cut points indicate. Because there is little evidence that asthma and attention-deficit disorder are on the causal pathway between weight status and use and because the prevalence of diabetes was so low in the sample, we concluded that the disease-adjusted model was appropriate for parsing out the use related to disease-specific issues from those related to weight status.

After controlling for age, sex, and disease status, an overweight child was likely to participate in more primary care sick visits and mental health-related visits over a 1-year period when compared with healthy-weight children. This difference had a cost of approximately $72 (sick plus mental health visits costs) more per year than a child with a healthy weight. Total cost estimates will vary based on organization size. For example, KPCO currently has more than 50 000 pediatric members. The prevalence data reported herein suggest that approximately 6500 of the child members of KPCO are overweight. When combined, the cost and prevalence data suggest that overweight children account for almost half of a million dol-
lars annually when compared with healthy-weight children in the KPCO system.

After 3 years, the estimated percentage of extra visits for an overweight child was lower (8%) and there were significantly fewer well visits among overweight children. For this time frame, the calculated annual estimate shows a much lower burden based on overweight children. However, this comes with 2 notable caveats. First, the reduced burden comes at the price of fewer well visits for overweight children, which in this population may not be ideal when considering the potential gaps in preventive and weight-management care that could be provided. Second, the models are estimating costs over a 3-year span so this annual cost is expected to persist.

There is a strong call across medical and scientific groups to develop and translate evidence-based obesity treatment and prevention strategies into practice, yet it is also acknowledged that the clinical resources of most health systems are already stretched thinly. This longitudinal cohort study does not provide evidence for causation, but the findings from our study provide some indication of the financial savings that might be achieved if overweight children were supported to achieve a healthy weight. This information, combined with findings demonstrating increased hospital use for overweight children, could be used to resource pediatric weight-management initiatives so that they would be cost-neutral to a health care organization, thereby allowing improved care for pediatric patients without an increase in cost to the health care setting.

Our finding that overweight children are at a greater risk of using mental health services is a particularly interesting finding given the documented psychosocial outcomes related to being an overweight child. The consistency of this relationship in both magnitude and over time suggests that there are some mental health issues that may disproportionately affect overweight children or, conversely, contribute to an unhealthy weight status. This finding is consistent with previous research that determined that children treated for obesity were far more likely to be diagnosed with mental health disorders. By using administrative data to determine use, we were not able to review medical records to determine the specific reasons for mental health visits in this population, but our data do suggest that such a determination would be a valuable and important step in future research.

Interestingly, over a 3-year period, overweight children show significantly fewer well-child visits. This could indicate that overweight children receive well-child visit care during sick visits that occur at a time that is proximal to a future well-child visit. It could also indicate that parents of overweight children feel that well-care visits are not necessary as a result of a higher frequency of sick visits. Finally, it could also indicate that overweight children avoid well-care visits as a method to avoid receiving advice about their weight.

This preliminary study of differences in child health care use based on weight status has its limitations. First, the health care system that was investigated does not collect racial, ethnic, or economic status on patients, and therefore, we could not examine these variables as potential covariates or moderators of the relationship between weight status and use. We did, however, compare the prevalence of overweight of our sample with a nationally representative sample and found the proportion of overweight children to be similar, albeit slightly lower in our study population (ie, 13.5% compared with 16%). Second, total health care costs estimated for the follow-up period were not available. The preliminary cost estimates used in this study indirectly estimated costs for primary care sick and mental health visits but did not include the costs associated with care that was received through hospitalizations, emergency department visits, or other external specialty care sessions. Future studies should include examining changes in the costs of use within an experimental design that targets the treatment of childhood obesity and changes in cost and provides more detailed sensitivity analysis.

In summary, our study demonstrates that the economic burden of obesity from the frame of health care use may be consistent between children and adults in that those with an unhealthy weight status have a higher cost to the health care system. There may also be potential for cost savings or cost realignment with weight-management interventions. Finally, future research is necessary to determine if change in weight status causes a reduction in the use patterns reported in this article.

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**Author Contributions:** Study concept and design: Estabrooks. Acquisition of data: Shetterly. Analysis and interpretation of data: Estabrooks and Shetterly. Drafting of the manuscript: Estabrooks and Shetterly. Critical revision of the manuscript for important intellectual content: Estabrooks and Shetterly. Statistical analysis: Shetterly. Obtained funding: Estabrooks. Administrative, technical, and material support: Estabrooks and Shetterly. Study supervision: Estabrooks.

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**REFERENCES**


Announcement

Submissions. The Editors welcome contributions to Picture of the Month. Submissions should describe common problems presenting uncommonly, rather than total zebras. Cases should be of interest to practicing pediatricians, highlighting problems that they are likely to at least occasionally encounter in the office or hospital setting. High-quality clinical images (in either 35-mm slide or electronic format) along with parent or patient permission to use these images must accompany the submission. The entire discussion should comprise no more than 750 words. Articles and photographs accepted for publication will bear the contributor's name. There is no charge for reproduction and printing of color illustrations. For details regarding electronic submission, please see: http://archpedi.ama-assn.org.