Do Parents Understand Growth Charts? A National, Internet-Based Survey

WHAT'S KNOWN ON THIS SUBJECT: Literature reviews revealed that, although growth charts are widely used to teach parents about their children's growth, very little research has been done to ascertain whether parents understand growth chart data and whether growth charts are effective as educational tools.

WHAT THIS STUDY ADDS: This is the largest, nationally representative study to explore parental understanding of growth charts and attitudes toward the use of growth charts as educational tools. The results can facilitate development of more-effective strategies for counseling parents about children's growth.

abstract

OBJECTIVE: The objective of this study was to assess parental knowledge and understanding of growth charts.

METHODS: An online survey was conducted with 1000 parents selected to be demographically representative of the US population. Questions explored awareness of, knowledge of, and attitudes toward growth monitoring, as well as the ability to interpret growth chart data.

RESULTS: Seventy-nine percent of parents surveyed claimed to have seen a growth chart before, with the majority thinking that they understood it well. Sixty-four percent of parents thought it was important to be shown growth charts to see how their child was growing, and 40% expressed the need to see their child's growth chart as confirmation of their health care provider's verbal interpretation. However, when provided with multiple-choice questions and answers, only 64% could identify a child's weight when shown a plotted point on a growth chart. Ninety-six percent had heard of the term "percentile," but only 68% identified the percentile of the plotted point, and only 56% could identify the definition of percentile. Up to 77% interpreted incorrectly charts containing height/weight measurements in tandem.

CONCLUSIONS: Although growth charts are used frequently as visual aids to educate parents about their children's growth, many parents cannot comprehend the data. This finding is significant because many parents prefer to be shown growth charts by their health care provider, and many parents report recording their children's measurements on growth charts at home. *Pediatrics* 2009;124:1100–1109

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KEY WORDS

child, growth, height, parents, weight, growth chart, obesity, BMI, health literacy, numeracy

ABBREVIATION

CDC—Centers for Disease Control and Prevention

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Growth charts were developed to help health care providers track children's growth and identify potential health problems.[1] Their use, however, is no longer restricted to the realm of health care professionals. Parents often are shown the charts at routine health care visits, and the growth pattern or percentile becomes a focal point for discussion.

In the context of the current childhood obesity epidemic, parents are being asked to become more aware of their children's growth measurements, growth patterns, and indices such as the BMI. Many health organizations throughout the world, including the Centers for Disease Control and Prevention (CDC), the World Health Organization, and a coalition of key pediatric health care organizations in Canada, are encouraging parents to use the growth charts as monitoring tools.[2–4] For parents to accept and to use growth charts as educational tools, they must understand the charts. But do they?

Little research has been performed to ascertain whether parents understand growth charts and whether growth charts are practical teaching tools. Two recent literature reviews examined current knowledge about the public's comprehension of growth charts, but the analyses were based mainly on data from studies conducted in developing countries and were not applicable globally.[5,6] Two smaller qualitative studies conducted in the United States explored maternal perspectives on growth counseling.[7,8] One study showed that many parents did not think that population-based growth standards were relevant to their children's weight assessments,[7] whereas another study found that growth chart use and findings were memorable to mothers but frequently were misunderstood.[8]

Understanding a growth chart requires the ability to understand several concepts, including trending over time, proportionality (height compared with weight), and graphical presentation. Health care providers may mistakenly assume that parents understand these concepts. The capacity of the general public to understand and to act on graphically presented health information to make health decisions has not been studied adequately.[9] Although it is now acknowledged that many individuals in the United States do not have the literacy and numeracy skills to function effectively in today's health care environment,[10–12] the details of such deficits and their impact are only beginning to be explored. In this study, we assessed knowledge and understanding of growth charts in a representative sample of US parents.

METHODS

Subjects and Design

An online survey was conducted from January 4 to January 22, 2007. One thousand parents with sole or shared responsibility for their child's health care and with ≥1 child <18 years of age in the household were recruited through e-mail invitations. A third-party vendor (Survey Sampling International, Shelton, CT) that uses opt-in, e-mail–based, recruiting methods was hired to provide a panel of potential respondents. Invitations were sent to 60 313 parents at a graduated rate over the course of 2 weeks, to avoid early-respondent or nonrespondent bias, and participants were selected on the basis of answers to preliminary demographic questions (to ensure a sample representative of the US population).

One thousand of the 1163 parents who completed the survey were chosen to match the US Census findings with respect to region, race, household income, ages of children, number of children in the household, and marital status. This sample size was chosen to provide an acceptable error rate at both the population and subgroup levels. The sampling error, which is the largest degree to which this sample might differ from the US population, was ±3.10 percentage points at the 95% confidence level. Study participants received compensation for their participation ($3 cash incentives and entry into a $25 000 prize pool), to maximize response rates and to minimize nonparticipation bias. The study was approved by the Nemours Institutional Review Board at the Alfred I. DuPont Hospital for Children (Wilmington, DE).

Survey Instrument

The survey instrument was created by the pediatrician authors at the Nemours Center for Children's Health Media (KidsHealth) and research consultants at Cogent Research. Focus group testing and in-depth interviews were conducted to assess parental awareness and baseline knowledge of growth charts, as well as attitudes toward growth-monitoring methods.

After the focus group testing, a 98-question survey was developed (www.kidshealth.org/misc/surveys/GrowthChartSurvey.pdf). Although the format included both closed-ended and open-ended questions, as well as growth chart images (Figs 1 and 2), only the closed-ended question results are reported in this article. Table 1 describes the topics that were explored.

Data Analysis

In preparation of the data for analysis, tests on all data were conducted by using SPSS 15.0.0 (SPSS Inc, Chicago, IL). Tests ranged from simple tests (frequency distribution) to ensure that all variables had valid values to more-complex tests (cross-tabulation) of the

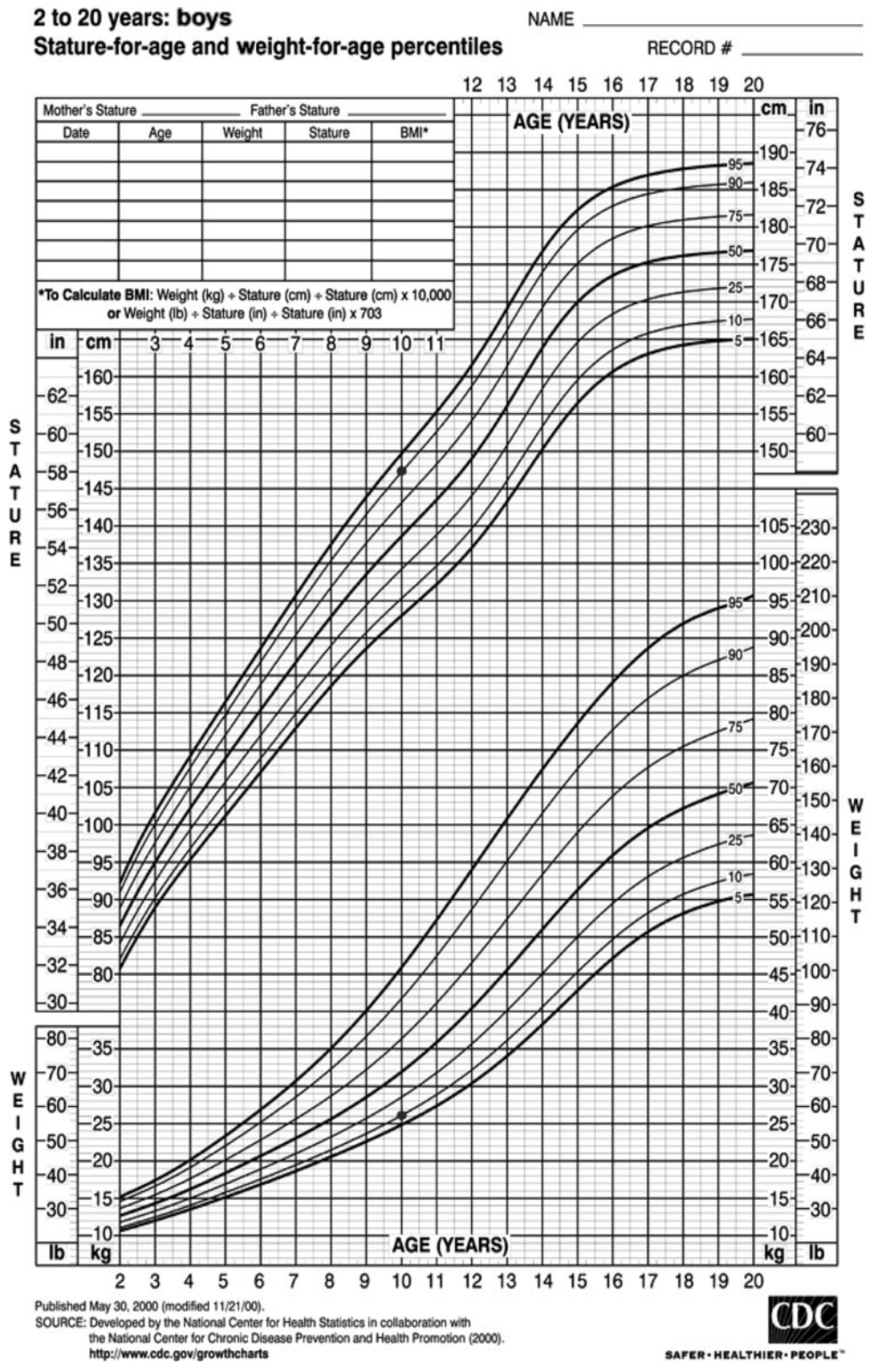

FIGURE 1
Example of a growth chart with stature plotted at the 90th percentile and weight plotted at the 10th percentile.

relationships between variables. After data preparation, an array of data tables, including every survey question cross-tabulated with a key set of demographic and attitudinal variables, was created by using WinCross (The Analytical Group, Glenview, IL). A full range of significance testing at the 95% level was conducted.

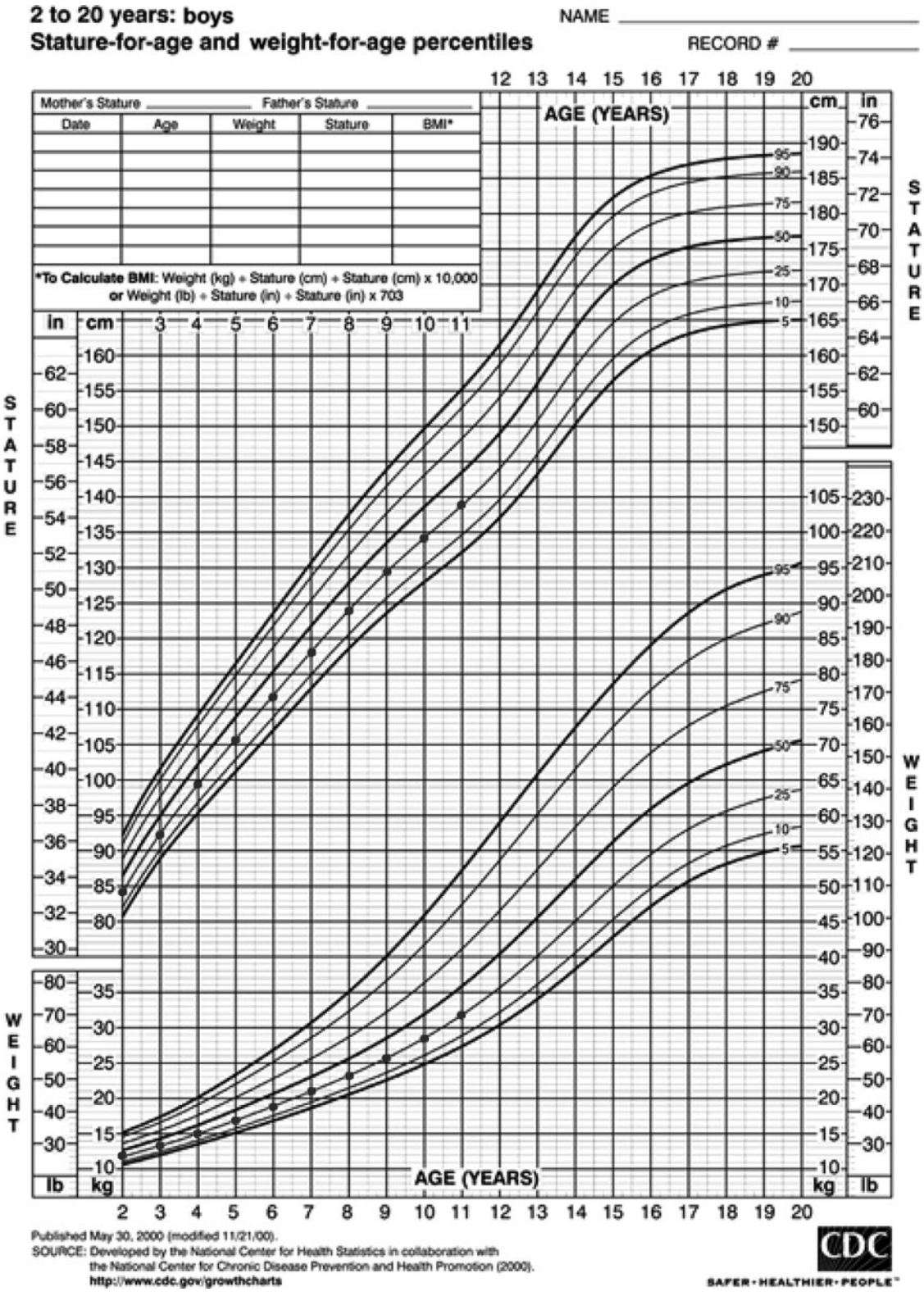

FIGURE 2
Series of points plotted along the 25th percentile for both stature and weight.

To determine the extent to which demographic features (race/ethnicity, income, education, and gender) predicted graph comprehension, data were analyzed by using a direct-entry (standard), multivariate regression analysis.[13] Specifically, the criterion of graph comprehension was regressed with respect to the following series of

TABLE 1 Survey Topics

Category	Question Topics
Demographic data	Number and ages of children in household; total annual household income; race; region of residence; educational attainment; gender; age; marital status; employment status; type of physician providing routine child health care; parental height and weight status; type of health care coverage; primary spoken language
Basic knowledge and attitudes toward children's health care and the growth-monitoring process	Sources of health information; satisfaction with health care child receives; understandability of health care provider; viewing growth chart helpful?; other indicators that child is "growing well"
Awareness and basic knowledge of growth charts (when shown example of CDC growth chart)	Past exposure to growth charts; level of familiarity with growth charts; level of explanation received about growth charts; understandability of growth charts; use of growth charts at home
Ability to interpret point or series of points on growth chart	Ability to identify child's age and weight on growth chart with 1 plotted point; familiarity with term percentile and ability to identify percentile and correct definition; ability to identify child's weight status (overweight, underweight, or neither) by using tandem points on 4 different charts, each containing 2 plotted points (weight and height) (Fig 1), and level of concern about weight status; ability to understand trend on growth chart with series of points plotted at 25th percentile (Fig 2)
Basic awareness and comprehension of BMI	Knowledge level for BMI; attitudes toward BMI screening in schools

dummy-coded predictors: (1) race (2 codes were created, for black and other, with white serving as the base group), (2) income ($25 000 or less, $26 000–34 000, $35 000–49 000, $50 000–74 000, or $75 000–99 000, with $100 000 or more serving as the base group), (3) education (high school or less or 1–3 years of post–high school training, with college education and beyond serving as the base group), and (4) gender (with female serving as the base group).

RESULTS

Respondent Characteristics

The sample of survey respondents was nationally representative. Selected demographic characteristics are presented in Table 2.

Attitudes Toward Children's Health Care and Information From Providers

Although almost all respondents (90%) said they would visit their child's health care provider immediately if they thought something was wrong with their child, only 62% stated they were comfortable relying only on verbal information from their child's doctor or nurse. In fact, 83% said they would seek information online or in print if they thought their child had a medical problem.

Awareness of Growth Charts

Seventy-nine percent of respondents reported having seen a CDC-type growth chart, with most (98%) indicating they had seen it in a doctor's or nurse's office. Other places parents

TABLE 2 Demographic Characteristics ($N = 1000$)

Demographic Characteristic	Proportion, %
Gender	
Male	11
Female	89
Age	
18–24 y	1
25–34 y	33
35–44 y	40
45–54 y	23
55–64 y	3
65–74 y	0
Region[a]	
South	36
Midwest	24
West	23
Northeast	18
Race/ethnicity[b]	
White	77
Black	14
American Indian/Alaskan Native	2
Asian/Pacific Islander	2
Native Hawaiian	0
Other	5
Prefer not to answer	2
Hispanic	16
Marital status[a]	
Married	73
Single	12
Divorced	10
Widowed	1
Other	5
Prefer not to answer	0
Employment status	
Employed full-time	44
Employed part-time	15
Not currently employed	31
Other	9
Prefer not to answer	1
Total annual household income[a]	
Less than $25 000	19
$25 000–34 999	12
$35 000–49 999	16
$50 000–74 999	21
$75 000–99 000	15
$100 000–149 999	11
$150 000–199 999	2
More than $200 000	1
Prefer not to answer	4
Educational attainment[a]	
Less than high school	2
Graduated high school	16
Some college (no degree)	32
Associate's degree	18
Bachelor's degree	19
Some graduate/professional school (no degree)	5
Graduate/professional school	9
Prefer not to answer	0
No. of children living with caregiver	
1	41
2	38
3	14
≥4	7
Ages of children living with caregiver[b]	
0–2 y	24
3–5 y	29
6–11 y	50
12–17 y	46

[a] Total does not add up to 100% because of rounding.
[b] More than 1 choice could be selected.

had seen a chart were on a Web site (11%), in their child's school (5%), or in a newspaper or magazine (2%). Parents whose children received their health care from a pediatrician, rather than a family practitioner, were more likely to have seen a growth chart (84% vs 67%).

Familiarity With Growth Charts

Seventy-one percent of respondents recalled having had the growth chart explained to them by their health care provider, but only 56% thought that the explanation had been very clear. Despite the reported lack of clarity, 65% of respondents thought that they understood properly the information conveyed by the growth chart, and 64% wanted to be shown a growth chart in the clinical setting. Forty percent of respondents thought that they needed to see a growth chart as visual verification of their health care provider's verbal statements. Thirty-one percent reported plotting their children's measurements on CDC-type growth charts at home.

Understanding of Growth Charts

When shown a growth chart with 1 plotted point, 85% of respondents could identify correctly the child's age on the x-axis of the chart when provided a list of options; in contrast, only 64% identified correctly the weight on the y-axis. Although the majority (96%) of respondents reported having heard the term "percentile," only 68% were able to identify the percentile of the plotted point, and only 56% could select the definition of percentile from a list of choices. Fifty-three percent of respondents were able to identify all chart features (age, weight, and percentile), but only one third could identify all chart features and the definition of percentile.

Charts with plotted points for both height and weight (Fig 1) proved to be even more difficult for the respondents. Charts that contain both height and weight plotted points on the same page allow for direct comparison of weight percentile and height percentile at a given age. Thirty-six percent of respondents did not interpret correctly as normal a chart for a child in the 90th percentile for both height and weight; 77% did not interpret correctly a chart for a child in the 10th percentile for height and weight, with more than one half being concerned that the child was underweight. Fifty-one percent did not understand that a child with height and weight in the 10th and 90th percentiles, respectively, is overweight, and 40% did not understand that height and weight in the 90th and 10th percentiles, respectively, represent an underweight child. Only 8% were able to interpret correctly all 4 of the paired height/weight points on the charts.

Parental concern regarding a proportionately small child (short stature and low weight) was extremely high. Eighty percent of parents reported that they would worry if a child's measurements were in the 10th percentile for both weight and height, although a clinician might not be concerned about such a child if all else was well. This proportion of concerned parents was consistent with the proportions of parents who reported concern about extremely disproportionate children; 87% reported worrying about height/weight measurements of 90th/10th percentiles, and 82% reported worrying about height/weight measurements of 10th/90th percentiles.

Many respondents misinterpreted the implications of normal growth velocity for a small-average child. When shown a growth chart with the child's height and weight curves both following the 25th percentile (Fig 2), many respondents thought this represented a health problem. Sixteen percent said they would encourage the child to eat more, and 18% reported being unsure what to do with the trend information.

When asked about different methods of determining whether their child is growing normally, respondents preferred speaking to a health care provider or comparing their child's size with that of peers, compared with looking at a child's growth chart. A sizeable proportion (30%) of respondents did not think that height and weight measurements could help show how healthy a child is.

Characteristics Correlated With Poorer Growth Chart Comprehension

On the basis of multivariate regression analyses of the data, respondents who were more likely to have difficulties comprehending the growth charts included respondents with low income (total annual household income of less than $25 000), respondents who had not completed a college degree, black respondents, and male respondents (Table 3). Each of these variables was independently associated with the outcome (poor growth chart comprehension), controlling for all other variables. In comparisons of the relative predictive strengths of these variables, poor comprehension of growth charts was correlated more strongly with a lower education level than with race (1.6 times more predictive), gender (2.7 times more predictive), or income level (6.6 times more predictive).

DISCUSSION

Pediatric growth charts, which were developed originally for use by health care providers as a tool for assessing and tracking the physical growth of infants, children, and adolescents, have acquired an additional role. Providers now use them routinely as visual aids to educate parents about their children's growth, and parents use them frequently at home.

This expanded role has been endorsed by many health organizations. For ex-

TABLE 3 Regression Analysis Summary of Variables Predicting Growth Chart Comprehension

Variable	*B*, Estimate ± SE	β	sr^2	f^2
Black	−0.899 ± 0.17	−0.168[a]	0.026	.03
Other	−0.293 ± 0.18	−0.05	0.003	
Income of less than $25 000	−0.553 ± 0.21	−0.120[b]	0.006	.007
Income of $26 000–34 000	−0.218 ± 0.229	−0.039	0.001	
Income of $35 000–49 000	−0.257 ± 0.209	−0.052	0.005	
Income of $50 000–74 000	−0.129 ± 0.194	−0.029	0.001	
Income of $75 000–99 000	0.125 ± 0.208	0.024	0.001	
Education of high school or below	−1.021 ± 0.178	−0.248[a]	0.042	.048
Education of 1–3 y after high school	−0.442 ± 0.135	−0.121[a]	0.01	.013
Male	−0.273 ± 0.179	−0.126[a]	0.015	.017

Constant = 5.185 ± 0.16; $R^2 = 0.231$ ($N = 380$, $P = .001$); sr^2 is the semipartial coefficient squared; f^2 is presented only for statistically significant predictors and represents Cohen's effect size statistic for multivariate regression analyses.

[a] $P = .001$.

[b] $P = .01$.

ample, the CDC recommends that "parents should partner with pediatricians to track their child's growth,"[2] and the World Health Organization states that "parents should use growth charts as a tool to better monitor the growth of their child, and "to understand and follow nutritional recommendations, and to seek timely health care for their children."[3] A policy statement from key pediatric health care organizations in Canada encourages health care providers to "teach children and their caregivers how to interpret the growth chart and what the target growth pattern should be."[4] Similar recommendations have been made by the World Federation of Public Health Associations[14] and the Human Development Department of the World Bank.[15]

Indeed, using a chart as a visual aid has certain theoretical advantages. Tversky and Morrison[16] suggested that graphic images facilitate communication by showing things that would require many words to describe, and they suggested that combinations of words and images are better than either alone. This is true, however, only if the intended audience can understand the data. Quantitative information, in the form of numbers, numerical concepts such as risks and probability, or graphs and charts, often is not adequately understood.

Therefore, it is not surprising that the majority of this survey's respondents were not able to comprehend growth chart data fully. The concept of percentile seemed particularly difficult for respondents to understand. Although most reported having heard of the term, many could not identify the percentile of a point shown on a growth chart, and an even larger number could not identify the definition of the term percentile.

Proportionality of a child's height and weight percentiles posed another challenge; many respondents had difficulty interpreting a growth chart that contained both. A significant number of respondents were mistakenly concerned about a proportionate child who is smaller (shorter and lighter) than average but growing normally, and they thought that it would be healthier for the child to be at higher percentiles. This confirms the findings of a recent study in which mothers misinterpreted percentile as indicating the percentage of children at that height or weight and thought that growth curves were more satisfactory at higher percentiles.[8] Most respondents expressed concern if a child's growth was shown to measure in the 10th percentile for both height and weight, whereas significantly fewer showed concern about the health of a child who was in the 90th percentile for height and weight. Also, respondents showed much greater concern about a child's absolute weight, compared with a child's height or height/weight proportionality.

The difficulties experienced by the respondents in understanding a graph paralleled the results of 2 nationwide literacy assessments, conducted in 1992 and 2003.[17,18] In those assessments, nearly one fourth of US adults performed at a level such that they would not be expected to understand a line graph such as a growth chart. In 2004, the Institute of Medicine, the Agency for Healthcare Research and Quality, and the American Medical Association issued reports on health literacy (the degree to which individuals have the capacity to obtain, to process, and to understand basic health information and services needed to make appropriate health decisions), which stated that as many as one half of US adults lack the literacy skills needed to function adequately in a health care environment.[10–12]

A number of studies have focused on numeracy (the ability to understand basic mathematical concepts) and have examined the impact of poor numerical skills on patient decision-making in diseases such as diabetes mellitus, asthma, and clotting disorders, which often require the comprehension of quantitative concepts for proper disease self-management.[19–21] Another aspect of numeracy that has been explored is the relationship between a patient's quantitative literacy level and the ability to understand risk-benefit information.[22–30] The findings of our survey add to the concerns regarding the impact of poor numeracy raised by previous studies.

A number of parental demographic characteristics were independently associated with poorer understanding of growth charts. Having a household income of less than $25 000 per year, not being a college graduate, being black, and being male were all associ-

ated with poorer growth chart comprehension. The reasons for these correlations were not investigated specifically in this study, and the possible contributions of other factors would need to be considered for better understanding.

For example, an Institute of Medicine report addressing racial and ethnic disparities in health care pointed out the lower quality of health care received by minority groups regardless of access-related factors such as insurance status and income.[31] Differences in care resulting from biases, prejudices, stereotyping, and physicians' uncertainties when interacting with minority patients have been shown to affect health outcomes[31] and may be a source of some of the differences in comprehension found in this survey. Efforts to eliminate racial and ethnic disparities in health care may be necessary to mitigate this effect.

This study had several possible limitations. First, the survey was not a thorough assessment of growth chart comprehension but was focused on the basic growth chart components. However, it assessed many of the skills and knowledge elements needed to understand growth curves for both healthy and sick children. The Internet-based survey technique required that participants have Internet access. This undoubtedly introduced some sampling bias, but data suggest that this is no longer a major issue, compared with the Internet survey environment in the early years of the Internet.[32] It may be reasonable to assume that potential participants who were not included because they did not have Internet access would likely have had even lower numeracy levels than those surveyed. The low response rate may limit the generalizability of our results. However, we attempted to address this limitation by matching the study sample demographically to national Census data. This study did not test specifically the numeracy levels of respondents, and their ability to understand growth charts could not be correlated with numeracy, although it seems logical to infer that low numeracy levels would be associated with poorer comprehension.

CONCLUSIONS

The findings of this survey demonstrate that the current trend of clinicians sharing growth chart data with patients, although well intentioned, does not seem to be effective. Most parents in this study recalled having seen growth charts, and many claimed to have used them at home. It is likely that patient exposure to growth charts will increase further with the burgeoning use of patient-accessible electronic medical records and Internet health sites. However, few parents understand growth charts and the implications of the data they present.

The results of this survey raise questions not only about how to maximize the effectiveness of growth chart use in clinical settings but also about whether growth charts should be used routinely for this purpose without determination of whether parents actually understand them. Clearly, better strategies for educating and counseling parents about their children's growth need to be developed, which likely will require thinking beyond the boundaries of traditional health education tool design. This might involve continued use of growth charts with improved methods of teaching about them or the redesign of currently used growth charts with the goal of making them more understandable, keeping in mind cultural factors and other influences on the acceptability of growth chart data.

Furthermore, non–growth chart-based approaches to teaching parents about their children's growth should be considered, because our results reveal that many parents clearly lack knowledge about the growth process and are uncertain about the best ways to assess a child's growth or, indeed, whether tracking a child's growth is even important. For example, our results indicate that parents typically rely on comparisons they make with other children of similar age, rather than growth charts, to judge their child's physical development, which can be deceiving when a large proportion of children in a community are overweight.

Parents do want a method to help them understand how their child is growing, as indicated by their desire to be shown a growth chart in the clinical setting and by their frequent use of growth charts at home. The most common "official" method that is currently available is the CDC growth chart, which is not working as well as might be hoped.

Future considerations and research on which communication and teaching methods are most effective will require the input of parents and caregivers. Rather than devising methods for teaching parents complicated mathematical concepts, clinicians and health educators would be wise to let parents be the teachers, by inviting parents to assist in developing the best methods to facilitate understanding of complex health concepts such as growth.

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