Evidence Brief: Comparing self/proxy report versus direct measures of height, weight and BMI in 0–18 year olds

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Issue and Research Question

Childhood obesity is an important public health priority. According to the Canadian Health Measures Survey (CHMS), one third of Canadian children and adolescents were overweight or obese in 2009–11.[1] In a study monitoring the prevalence rates of overweight and obesity, it was found that between 1978–79 and 2004, the prevalence of both overweight and obesity increased significantly among Canadian children and adolescents.[2] In order to appropriately develop and evaluate interventions aimed at reducing childhood obesity, routine population monitoring of weight status is necessary.[1]

Body mass index (BMI) is a commonly used classification method that estimates weight status based on weight relative to height.[1] It is one of several useful indicators of overweight and obesity in children and adolescents.[3,4] In order to generate accurate population-level estimates of BMI-for-age (discussed further below), height and weight measures must be accurate. These measures can be collected by self or proxy report or by direct measurement. For the purpose of this evidence brief, self/proxy report includes weight and height information provided by the child or adolescent themselves (self report), or by a parent on behalf of the child/adolescent, based on their own estimates or knowledge of previous measurements (proxy report). Direct measures are defined as height and weight data typically collected by practitioners or researchers using appropriate equipment and measurement protocols. For the purpose of this evidence brief, direct measures do not include height and

weight data collected and reported by parents of the child or adolescent for whom obesity/overweight status is being determined.

Although self/proxy report is economically and logistically appealing, direct measures of height and weight are considered the gold standard for the calculation of accurate BMIs; however, direct measures are not always feasible.[4] It is therefore important to examine the potential of both self/proxy-reported and directly measured height and weight data for generating accurate population-level estimates of overweight and obesity based on BMI calculations.

This evidence brief asks: What is the accuracy of self/proxy report as compared to direct measures of height, weight and BMI in 0–18 year olds?

Methods

Four databases (MEDLINE, Cochrane, CINAHL, and Embase) were searched by PHO Library Services on June 25, 2014 for relevant articles published between 2004 and 2014. Articles retrieved by this search were assessed for eligibility by two reviewers. Only primary studies, written in English, comparing self/proxy report and direct measures of height, weight, and/or BMI in children or adolescents aged 0–18 were included. Studies that sampled specific sub-populations (e.g., underweight females only, lesbian, gay, bisexual, transgender, transexual, or queer (LGBTQ) youth, etc.), non-English articles and other study types, including review articles were excluded. Additional articles were referred to the study team by experts in the field, and these were assessed for eligibility using the criteria above. Reference lists of referred review articles were searched to identify any additional relevant primary studies. Full text articles were retrieved, reviewed, and relevant information was extracted. The detailed search strategy can be obtained from Public Health Ontario.

Main Findings

The search identified 1465 articles, of which 26 unique primary studies met inclusion criteria. An additional four articles were identified through expert referrals and reference list searches. This resulted in a total of 30 primary studies analyzed in this evidence brief. Studies were highly variable in terms of study types, study populations and outcomes reported including the ways in which outcomes were reported, therefore outcomes were carefully categorized and coded in order to be deemed comparable data points.

Of the included studies, 19 compared child/adolescent self report to direct measures,[24-33] whereas 10 compared parent report to direct measures[24-33] and one study compared direct measures to reports by either the child/adolescent or the parent.[34] In this study, it was not possible to determine whether it was the child/adolescent or parent making the report; therefore it is not included in the analysis below.

Studies endeavoured to assess the accuracy of self/proxy reports relative to direct measurement in estimating BMI at the individual level, as well as the mean BMI and prevalence of overweight and obesity in the study population. Outcomes included: 1) individual BMI estimates calculated from self/proxy report and directly measured height and weight; 2) population overweight or obesity prevalence calculated from BMI generated by both self/proxy report and directly measured height and weight; and/or, 3) the sensitivity and specificity of self/proxy report for estimating true BMI, as calculated using the gold standard of direct measurement.

Studies were categorized by whether weight status was parent (proxy) or child/adolescent (self) reported. Outcomes were then subcategorized by age groups by the research team. As age groups differed between parent and child reported studies, separate age

categories were developed based on the type of report. Specifically, age group categories chosen within parent-reporting studies were 2–7 years old, 7–11 years old and 11–17 years old, whereas age group chosen categories within child/adolescent reporting studies were 5–11 years old, 11–14 years old and 14–18 years old. For studies in which outcomes were reported in broad age ranges that did not fit into the categories above, an overall category of 5–18 years old was added.

Due to the variability in reporting, any one study may have reported multiple instances of overestimation or underestimation of BMI or obesity/overweight prevalence, depending on how age/sex groups were categorized in the reported results. To account for this, we report all instances of overestimates and underestimates across all studies, as well as the total number of studies reporting these instances.

Lastly, there was variability among included studies with regards to the BMI-for-age-cut-offs used by different authors. In children, to account for ongoing growth and development, BMI-for-age standards are used. Thirteen studies [8,9,10,12,14,15,16,17,20,27,28,29,31,] used cut-offs identified by the International Obesity Task Force (IOTF),[35] six studies [5,18,24,26,32,33]used Center for Disease Control and Prevention cut-offs (CDC),[36] and three studies [22,31,33]used those from the World Health Organization (WHO).[37] Other studies used national cut-offs specific to their respective countries[6,11,23,25,34] or did not report the cut-off used[21]. BMI-for-age cut-offs define overweight and obesity in children and adolescents relative to age and sex, and one cut-off may yield more conservative estimates than another.[38] In other words, depending on which BMI-for-age cut-off is used, more or fewer children may be identified as overweight or obese. We did not limit included studies by specific BMI-for-age cut-offs used.

Self-reported BMI estimates and the overweight/obesity prevalence

Child/Adolescent Self Report of Height and Weight

Children and adolescents tend to underestimate BMI when self-reporting height and weight. In the 19 studies comparing child and adolescent self report to direct measures, in the 5–11 year old age group there were five instances of BMI underestimation in three studies[5,14,16] (versus two overestimates),[5,10] in the 11–14 year old age group we found 10 instances of BMI-underestimation in six studies[10,11,13,17,18,21] (versus one overestimate[5]), and in the 14–18 year old age group we found 22 instances of BMI-underestimation in seven studies[8,11,12,16,19,20, 21] (versus no overestimates). Finally, among the 5–18 year old age group, encompassing studies that reported wide age ranges, we found one BMI-underestimation[15] and no overestimates. Underestimates ranged from -2.90 BMI-units to -0.22 BMI-units. There were only three instances of BMI overestimation through self report (range: 0.10 to 6.45 BMI-units)[3,5,10] and these overestimates were more common in the younger age groups. Almost no differences were seen by sex, with 16 instances of BMI underestimation by males in seven studies (range: -2.40 to -0.29 BMI-units)[8,11,12,14,16,19,20] and 18 instances of BMI underestimation in females in ten studies (range: -2.50 to -0.28 BMI-units).[8,11,12,13,14,15,16,19, 20,21] There were no overestimates reported among studies that reported on differences by sex.

Prevalence of both overweight and obesity were more likely to be underestimated when based on child and adolescent self report data, with a total of 10 instances of underestimation of overweight prevalence in nine studies [9,10,12,13,15,16,17,18,20] as well as two instances of overestimation[12,13] and 14 instances of underestimation of obesity prevalence in eight studies[7,9,11,12,13,15,16, 20] with no instances of overestimation. In addition, there were five

instances of underestimation in three studies [6,7,34] reported as a combined overweight/obese category, as well as two instances of overestimation[5,34] in this combined category. Underestimates of the population prevalence of overweight or obesity ranged from less than 1% to over 15% of the true value.

Parent Report of Child/Adolescent Height and Weight

Ten studies compared parent report of child height and weight to direct measures[24-33]. When BMI was calculated based on these reports, the overall trend was again toward underestimation. In the 2–7 year old age group there were five instances of BMI-underestimation in four studies[25, 27,30,32] (versus one overestimate[32]), in the 7–11 year old age group there were two instances of BMI-underestimation in one study[25] (versus two overestimates from one study[31]) and in the 11–17 year old age group there were two instances of BMI-underestimation in one study[25] (versus no overestimates). Underestimates ranged from -0.79 to -0.50 BMI-units. No differences were seen by sex, with four instances of parent-reporting underestimation in males in two studies (range: -0.52 to -0.05 BMI-units)[25,28] versus one overestimate[29] and three instances of underestimation in females in one study (range: -0.79 to -0.26 BMI-units)[25] versus two overestimates.[28,29]

When parent-reported height and weight were used to calculate prevalence of overweight and/or obesity, some overestimation occurred, particularly in the younger age groups.[11,25] In the 2–7 year old age group there were ten instances of underestimation of overweight/obesity prevalence in three studies[27,30,29] (and five instances of overestimation in three studies[24,25,32]), in the 7–11 year old age group there was one instance of underestimation of overweight/obesity prevalence[25] (and five instances of overestimation[24,28, 31]) and in the 11–17 year old age group there were three instances of underestimation (with no overestimates).[24,25]

In summarizing the effects of age on the accuracy of self reports by children, study authors note that at a population level children on the whole appear to become better at correctly reporting heights and weights as they grow older.[5,12] In other words, although children and adolescents typically continue to misreport their heights and weights most commonly leading to underestimation of BMI, they appear to do so to a lesser degree as they age. However, two reports suggest that parent reports have a higher degree of error as children grow older.[24,26] It is important to note that there was some variability in conclusions made with regard to age and that these findings were not confirmed by all studies. For example, it was also found that younger children are less likely to underreport their weight than older children.[14,16]

Other variables which may affect the accuracy of self/proxy report

Authors of included studies analyzed a variety of factors that may influence the accuracy of self reports, such as sex, socioeconomic status, race, and weight status.

Although trends in underestimation and overestimation of height and weight in boys and girls were variable, the overall effect was predominantly an underestimation of BMI and overweight/obesity prevalence in both sexes. Some studies showed a greater degree of misreporting in girls than boys,[10,13,23] which may be explained by variability in body image perceptions or social desirability bias,[11] but this was not supported by all studies.

Few studies (n = 5) reported on accuracy of BMI estimation by socioeconomic status (SES).[21,22, 24,25 39] Of these, no differences by SES were seen in child self report; however, there may be some potential for misclassification of BMI based on parent report in low-income sub

groups.[24,39] However, studies reported different explanations for inaccurate estimations by SES, with one citing that, "this may be related to the fact that children from low-income families are heavier and if these children are near the cut off between normal weight and overweight, then a misclassification will be more likely, even if the difference between BMI based on parent-reported versus measured values is small."[25] Another report stated that, "authors speculate that for low-income parents, reduced access to and utilization of health care (in which height and weight are routinely assessed) may exacerbate parents' difficulties keeping up with children's height gains."[24]

Three studies looked at race and ethnicity as a variable, of which only one found that BMI was "more likely to be underestimated in African American ($p < 0.001$) and white ($p < 0.01$) students compared to other race students,"[18] while the others did not note any significant differences.[21,26]

The only variable consistently affecting weight and height reporting was the child's current weight status. In all twelve studies reporting on this variable, BMI was more likely to be underestimated in children who were overweight or obese, compared to those who were normal weight.[7,11,14,17,18,19,22,23,24,26,30,33] This was true of both child[7,11,14,17,18,19,22,23] and parent[24,26,30,33] reports. This may have implications for prevalence estimates in populations with different underlying distributions of overweight and obesity.[4]

Sensitivity and specificity of self/proxy reports

Twelve studies reported the sensitivity and specificity of self/proxy report to correctly classify children or adolescents as normal weight, overweight, or obese.[11,13,14,15,17,20,25,26,27,30,31,34] In this context high sensitivity of self/proxy report would indicate that this measure is good at identifying those who are overweight or obese, while high specificity would indicate that the test is good at identifying people who are of normal weight.[40]

Of the twelve self-reported studies by children/adolescents that reported sensitivity and specificity, it was found that sensitivity was frequently low, ranging from 27.8% to 64.6%, with a calculated average of 52.5% . Specificity was frequently high, ranging from 91.3% to 99.8%, with a calculated average of 93.7% . The same was true for parent reports for which sensitivity was also low, averaging 63.0% and ranging from 22.0% to 83.0%, and specificity was high, averaging 93.7% and ranging from 79.0% to 100.0%.

Low sensitivity observed for calculated BMI based on both child or parent reported height and weight, indicates that self reports may misclassify those who are overweight or obese as normal weight. The high specificity seen for calculated BMI based on both child or parent-reported height and weight, indicates that self/proxy reports are less likely to misclassify those who are normal weight compared to those who are overweight or obese. A low sensitivity, or frequent misclassification of those who are truly overweight or obese as normal weight, is problematic for intervention design, evaluation, and epidemiological studies that aim to document childhood obesity, and may miss important changes in population weight status over time.[6]

Discussion and Conclusions

The results of this evidence brief demonstrate that biases in self/proxy-reported height and weight among children and adolescents result in frequent inaccurate estimation of BMI, and consequently, misclassification and inaccurate estimation of true overweight/obesity prevalence. Biases may stem from current weight status, body image perceptions, social desirability bias, socioeconomic status or other factors.

Although there are advantages to using self/proxy-reported data, the overall balance of opinion from study authors shows a strong preference for using direct measures of height and weight in order to achieve the most accurate estimation of child BMI and population overweight/obesity prevalence. Nineteen of the 30 included studies advised against the use of self/proxy-reported data, [4,5,6,9,10,11,12,13,14,16,17,18,20,21,23 25,26, 28, 31] especially within a clinical setting where diagnostic or therapeutic decisions are made,[21,23] or for interventions where accurate estimation of BMI or classification into weight categories are required.[14] Many studies caution against interpretation of self/proxy-reported data, highlighting the potential for BMI underestimation and potential misclassification of individuals in overweight and obese categories. While some studies discuss statistical methods for adjusting self/proxy-reported data to maximize accuracy[31] this was not the focus of this evidence brief. While not the focus of this brief, two studies did note that accuracy of self/proxy report can be improved if weights and heights are measured at home, prior to providing this data.[27,30]

One author nicely summarized the state of the literature: "The biases in self reports are entangled in idiosyncratic differences among samples in gender, age, underlying distributions of BMI, and perhaps race, mental health, and socioeconomic status. Prevalence of overweight and obesity based on self-reported BMI data will almost certainly be underestimates of the true prevalence, although to an unknown degree."[4] Future research could look more closely at these differences in samples, in order to better understand reporting biases.

Implications for Practice

Based on this review, direct measures are the preferred method for generating accurate estimates of BMI and overweight/obesity prevalence. In practice, this may not always be feasible, as the size, complexity, or cost of a study or intervention could make direct measurements impractical. If self/proxy report must be used, it is possible that encouraging home measurement prior to collecting self-reported data could mitigate the degree of misreporting.[27,30]

The decision of whether to rely on self/proxy report or take direct measurements depends on several factors, such as the underlying distribution of weight status in the population, and the purpose of data collection. Ultimately, if self/proxy report is used, this should be with an understanding of its limitations and biases and the interpretation of findings must be couched accordingly.[4]

Specifications and Limitations of Evidence Brief

This Evidence Brief presents key findings from the scientific literature. Its purpose is to investigate a research question in a timely manner in order to help inform decision making. This report is not a comprehensive review of the literature, but rather a rapid assessment of the best available research evidence. There may be relevant pieces of evidence that are not included and these may alter the conclusions drawn from the document.

Quality appraisal of individual studies was not conducted for this evidence brief and results of all included studies were weighed equally.

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