Mini Review

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Childhood obesity: how long should we wait to predict weight?

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Abstract: Obesity is highly prevalent in children under the age of 5 years, although its identification in infants under 2 years remains difficult. Several clinical prediction models have been developed for obesity risk in early childhood, using a number of different predictors. The predictive capacity (sensitivity and specificity) of these models varies greatly, and there is no agreed risk threshold for the prediction of early childhood obesity. Of the existing models, only two have been practically utilized, but neither have been particularly successful. This commentary suggests how future research may successfully utilize existing early childhood obesity prediction models for intervention. We also consider the need for such models, and how targeted obesity intervention may be more effective than population-based intervention.

Keywords: intervention; model; obese; overweight; prediction; prevention; risk.

Introduction

The prevalence of obesity in children and adolescents rose throughout the world between 1975 and 2016 [1]. Obesity is also a major issue in younger children; worldwide, 41 million children under the age of 5 years are estimated to be overweight [2]. However, determining obesity prevalence among infants under 24 months of age is more difficult. At present, only the World Health Organization (WHO) Child Growth Standards [3] supply guidelines for the detection of overweight and obesity in those under 2 years of age. Although the International Obesity Task Force (IOTF) included data from infants aged 0–2 years when determining cut-off points for overweight and obesity in children, the resulting recommended cut-off points were not applied to infants under 2 years of age [4]. Other nationally representative growth references such as the 2000 Center for Disease Control and Prevention (CDC) Growth Charts for the United States also do not provide any guidelines for the identification of overweight or obesity in infants [5].

There is clearly a reluctance to label infants under the age of 2 years as overweight or obese. Variability in infant growth patterns and lack of evidence for meaningful cut-offs in infants are suggested reasons to avoid such categorization [6, 7]. However, there are data showing that obesity tracks from infancy into early childhood, and from early childhood into adulthood, underpinning the importance of obesity in these periods. For example, being above the 85th percentile for body mass index (BMI) at 6, 12 or 18 months of age was a strong predictor of severe obesity (being above the 99th percentile) at 6 years of age [8]. Differences in BMI trajectories in children who were normal weight at 6 years, compared to those with severe obesity, were apparent as early as 4–6 months of age [8]. Other smaller studies have indicated that around one-third of infants deemed to be obese at 2–6 months, remain so at 24 months of age [9, 10]. Although longer-term longitudinal studies are rare, the seminal study by Guo et al. [11] demonstrated that obesity at 3 years of age was associated with the risk of overweight well into adulthood. These results suggest that obesity in infants under 24 months can track into later childhood and should therefore be considered.

What are the early factors associated with childhood obesity?

Numerous factors have been consistently found to be associated with obesity in childhood, such as maternal BMI
Can childhood obesity be predicted early?

Worldwide, several models have been created for predicting the risk of overweight/obesity at ages ranging from 2 to 8 years based on known risk factors identified during gestation and infancy [6, 23–30]. The strategies to identify those at risk vary considerably, as does the predictive capacity of the models: sensitivity (of those who were actually obese in childhood, how many were predicted to be so in infancy) ranging from 12 to 96%; specificity (of those who were non-obese in childhood, how many were predicted to be so in infancy) from 37 to 98%; positive predictive values of 4–95% and negative predictive values ranging from 41 to 99.5% [6, 23–25].

Importantly, there is little consensus as to what the optimal risk threshold is for childhood obesity prediction. The risk threshold is the level of risk an individual needs to have of developing the outcome for the model to classify them as at risk of doing so [31]. Risk thresholds should be set after careful consideration of the likely benefits of treating an individual who will need treatment versus the potential harm of treating an individual who will not need treatment [32]. Morandi et al. [24] reported the results of their prediction model using an arbitrary risk threshold, while others have reported their results without pre-determined thresholds or any discussion on their appropriate selection [25, 28]. In the development of their infant growth phone application, Santorelli et al. [26] chose to use a 10% risk threshold as it was reflective of the numbers of children with obesity in their model development and validation samples. Redsell et al. [30] chose to use the net reclassification index (NRI) as a method to determine their optimal risk threshold. They defined this as the “net change in percentage of children correctly reclassified from an initial baseline risk threshold of 2.5%”. However, the use of the NRI still does not take any potential clinical consequences into account [33, 34].

There often appears to be little consideration given to the practical applications of obesity prediction models. An exception to this is Graversen et al. [35], who chose a 10% upper limit risk threshold as they felt this would be clinically manageable. No further background information was given for this decision. It has been argued that sensitivity is more important than specificity in obesity prediction because obesity interventions are unlikely to be harmful to infants incorrectly classified as being at risk [29]. While we agree that sensitivity is more important than specificity, the financial cost of the intervention should also be considered. Conversely, a model that has very low levels of specificity is not particularly useful; if the specificity is low enough to generate large amounts of false-positives, why use the model at all? Therefore, the decision about where to place the risk threshold should be based on a consideration of potential risks and harms, financial costs, as well as the capacity of the model to accurately predict overweight/obesity without producing so much noise that the predictive power is questionable.

Can prediction models be successfully utilized for childhood obesity prevention?

Currently, several childhood obesity prediction models exist, but no agreed risk threshold has been identified as of yet. This makes the utilization of a childhood obesity prediction model for intervention difficult, particularly when it comes to evaluating the intervention’s success. Of the models that have been developed, only two have been utilized for intervention and without evidence of success. Santorelli et al. [26] developed their prediction model into a smart phone application called “Healthy Infant Weight?” but the application has since been discontinued due to lack of funding (G. Santorelli, personal communication, 5/12/2017). No published research exists on the uptake or efficacy of the application. Redsell et al. [36] developed the Proactive Assessment of Obesity Risk during Infancy (ProAsk) tool. ProAsk is an interactive digital tool that calculates an infant’s risk of obesity and provides information about preventive behavioral changes, which could be made to reduce the infant’s risk. However, a feasibility study into the use of ProAsk by UK Health Visitors had low uptake and high attrition rates; of 226 parents invited to participate, only 15% went on to complete the trial and return their 6-month follow-up questionnaire [36].
The previously mentioned study demonstrates the need for such an intervention to be delivered in a manner that is engaging to parents. A qualitative study into parental views about obesity risk communication for infants found that parents are not concerned about their infant’s weight status until they have started to walk [37]. Parents may need sensitive, tailored communication about the likelihood of their young infant growing into an obese child or adolescent as well as an explanation of potential later health risks in order for them to participate in an intervention so early in the infant’s life. The health belief model (HBM) states that the likelihood of an individual taking action to prevent a disease or illness is based on their belief in their perceived susceptibility, severity of the disease or illness, as well as perceived benefits of taking action weighed against barriers to action [38]. Thus, if applying the HBM to childhood obesity prediction, in order for parents to participate in an intervention, they would need to believe that their infant is susceptible to obesity, there would be severe health consequences for their child if they became obese and the benefits to early intervention outweigh any potential barriers to participation.

Obesity prediction models may be used alone, but are likely to be more effective when provided in combination with tailored lifestyle education. However, at present, there are no data on the comparative efficacy of these methods. Risk information from the prediction model alone may be useful for childhood obesity prevention, as many parents fail to recognize that their child is overweight or obese [39, 40]. Gomes et al. [41] reported that Portuguese parents who recognized their child as overweight were over 30 times more likely to be concerned about their child’s weight status than those who did not recognize their child as overweight. However, it is well known that information alone is usually insufficient to produce effective behavior change; a UK study reported that while 87.2% of parents found the feedback regarding their child’s weight to be helpful, there was limited effect on behavior change [42]. As the HBM states that individuals need to recognize benefits to behavior change as outweighing perceived barriers [38], interventions may be more successful if they educate parents about the likely benefits and provide support to overcome barriers. In the US, overweight African-American mothers who were enrolled in a gestational weight management program reported that the loss of support from the program postpartum was a barrier to sustained weight management [43]. Discontinuation of support initiatives continues to be a major barrier to producing effective weight change long term as evidenced by other childhood obesity programs [44].

Do we need a childhood obesity prediction model?

The use of an accurate risk prediction tool allows for a more targeted approach to preventative healthcare. Zulman et al. [45] considered population-based versus targeted prevention strategies for cardiovascular disease. They concluded that targeted preventative treatment of individuals at high risk for cardiovascular disease (identified through use of a risk prediction tool) was more effective than using a low-intensity population-based approach. The authors also suggested that this finding may apply to other health conditions [45]. Resnicow showed that obesity interventions targeting school children and adolescents at high risk of obesity produced better treatment effects than school-wide interventions [46]. That study was conducted before any childhood obesity risk prediction tool existed, but it is reasonable to propose that the use of an obesity prediction model could further enhance the effectiveness of childhood obesity interventions.

It has been recognized for some time that childhood obesity is a risk factor for obesity in adulthood [11, 47, 48]. Once established, obesity is difficult to treat [49, 50]. Childhood/adolescent overweight and obesity are also associated with long-term health consequences, including greater risk of premature mortality [51]. Adult obesity and the associated comorbidities (e.g. diabetes and cardiovascular disease) create significant economic burden worldwide, not just in terms of healthcare costs, but also through indirect costs such as loss of productivity and premature mortality [52]. In Australia, obese children aged 2–5 years have been shown to have higher healthcare costs than their healthy weight peers [53]. Early intervention for non-communicable diseases produces better outcomes than intervention later in life [54]. Given that later obesity is often underpinned by potentially modifiable risk factors early in life, it is preferable to predict obesity in younger, rather than older children.

The pertinent question is not “Do we need a childhood obesity prediction model?” but rather, “What do we need a childhood obesity prediction model to do?” Childhood obesity prediction models that are published but not implemented in practice will do little to reduce the prevalence of childhood obesity. There has been limited success in developing two of these models into tools for utilization by parents and practitioners [26, 36]. Future studies can build on the findings of Redsell et al. [36] and Santorelli et al. [26] and continue to develop prediction models into clinically useful intervention tools. Importantly, consistent risk thresholds are needed to underpin obesity.
prediction models that are clinically useful. Once this has been agreed upon, childhood obesity prediction models can be translated into intervention tools that will be tested so that we will no longer need to wait to predict weight.

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