



Community Pædiatric Review

A NATIONAL PUBLICATION FOR COMMUNITY CHILD HEALTH NURSES AND OTHER PROFESSIONALS

www.rch.org.au/ccch

VOL 15 NO 1 MAY 2006

An initiative of the
Centre for Community
Child Health,
Royal Children's
Hospital, Melbourne

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Body Mass Index (BMI) for children

Introduction

Body Mass Index (BMI) has been used for many years with adults to assess overweight and obesity. However, overweight and obesity is not only a problem for adults. An estimated 20-25% of children and adolescents in Australia are overweight and a quarter of this group are obese. Being overweight or obese has a negative impact on both physical and psychosocial health in the short and long term.

The National Health and Medical Research Council (NHMRC) in the "Clinical Practice Guidelines for the Management of Overweight and Obesity in Children and Adolescents (2003)" has recommended that the 2000 US Centre for Disease Control (CDC) BMI percentile be used to assess adiposity in children and adolescents between the ages of 2-18 years. The 85th percentile and above is indicative of overweight and the 95th percentile and above is indicative of obesity. These percentile cut offs should be used as a reference or a guide.

The importance of identifying overweight in children

The first step is to identify children who are overweight or obese, or those that are likely to become that way. It is particularly important a health care professional undertakes this role when "parents do not often recognise overweight in themselves or their children". (Jeffery, et al, 2005).

In a study involving four year old children and their parents it was found that "... despite the

high rate of overweight and obesity in the four year olds in this study, only 5% of mothers expressed concern that their child was currently overweight... Stereotypes of overweight children portrayed in the media tend to be at the severe end of the spectrum and may also distort the lay perception of overweight. In fact most overweight and obese young children in the community do not stand out in the crowd... Health professionals can help improve recognition of childhood overweight. The charting of child BMI could be encouraged as part of normal practice, not only to provide an objective measure of weight status, but also to reassure parents who are anxious about underweight, and to start discussion." (Campbell, et al, 2006).

Calculating a child's BMI

The following equation is how BMI is calculated:

$$\text{BMI} = \frac{\text{Weight in Kilograms}}{(\text{Height in Metres}) \times (\text{Height in Metres})}$$

"Height is measured standing in children over the age of 2 years. There should be a fixed wall stadiometer and the measurement should be to the nearest millimetre. Weight is measured by standing on scales; measurement should be to the nearest 0.1 kilogram." (NHMRC "Clinical Practice Guidelines for the Management of Overweight and Obesity in Children and Adolescents", 2003 p7).

Since height is commonly measured in centimetres, to make it easier to complete the

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calculation you can use the following formula:

$$\text{Weight (kg)} \div \text{height (cm)} \div \text{height (cm)} \times 10,000 = \text{BMI}$$

For example: Kurt weighs 16.9 kg and his height is 105.4 cm (1.054m). To calculate his BMI is: $16.9 \div 105.4 \div 105.4 \times 10,000 = 15.2 \text{ BMI}$

When the child's BMI is calculated, this information can be transferred to the age – gender specific BMI percentile charts. Percentiles are the most commonly used clinical indicator to assess the size and growth patterns of individual children. Percentiles rank the position of the individual by indicating what percent of the reference

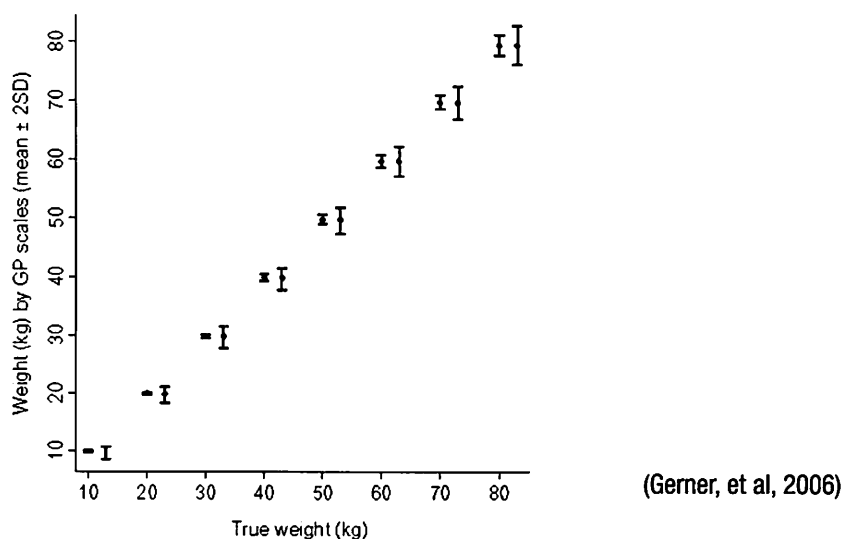
population the individual would equal or exceed. The 85th percentile and above is indicative of overweight and the 95th percentile and above is indicative of obesity.

It is important to understand that the accuracy of BMI will depend upon the skill of the measurer and the precision of the equipment. This is supported by the findings reported by Gerner et al, "Are general practitioners equipped to detect child overweight/obesity? Survey and audit" (Journal of Paediatrics and Child Health, 2006) as outlined below. Whilst it is noted that this study related to GPs, the accuracy of weighing and measuring equipment in any primary health care setting is vital.

"Equipment servicing was rare; only four scales (11.8%) had ever been serviced, and two stadiometers (8.7%) had been serviced 1 and 7 years, respectively, prior to the audit... The mean measured height for the short pole (true height 92.68cm) was 92.52cm (SD = 0.8, range = 89.0-94.1), 0.16mm shorter than the true pole height. The tall pole (true height 157.64cm) on average measured 157.55cm (SD = 0.9, range = 154.2-159.2), just 0.09mm shorter than the true pole height... Some GPs noted that carpet had been removed or put in since the stadiometer was installed, resulting in an alteration of the original floor to stadiometer distance. In none of these instances had the stadiometer been adjusted accordingly. The nine [GPs] using a fixed tape/chart stadiometer said they placed a book or a similar object on the child's head to create a 90-degree angle with the wall (which would introduce potential additional error to height measurement)..."

Figure 1 shows the mean values plus/minus two SDs obtained by the GP scales against the calibration weights, for digital (n = 8) and non-digital (n = 36) scales separately. Non-digital scales were more inaccurate, demonstrating a greater degree of underweighing than digital scales and having wider error bands. Twelve scales (28%) were used on a soft surface, possibly introducing further inaccuracy."

Figure 1. Accuracy of general practitioner (GP) scales against calibration (true) weights, shown as mean $\pm$ 2SD error bars against each true weight. Digital (left of each pair) and non-digital (right of each pair) scales results are shown separately.



An overstating of height or weight, or both, will lead to an incorrect BMI result and potentially put a child on an incorrect percentile. The following examples in Table 1 show how an inaccuracy in height/weight can affect BMI.

Jenny is 4 years old. She weighs 18.5 kg and her height is 102.4 cm. Using these figures her BMI is 17.6 – which is in the 90th percentile and classifies Jenny as overweight.

Table 1

Variation details	Calculation	BMI	Percentile	Classification
Weigh overstated by 0.5kg	$19 \div 102.4 \div 102.4 \times 10,000$	18.12	95th	obese
Height understated by 1.2cm	$18.5 \div 101.2 \div 101.2 \times 10,000$	18.06	95th	obese
Weight understated by 1.5kg	$17 \div 102.4 \div 102.4 \times 10,000$	16.21	75th	normal
Height overstated by 2.5cm	$18.5 \div 104.9 \div 104.9 \times 10,000$	16.81	75th	normal

A separate “tip” sheet has been included in this publication to support you in weighing and measuring children accurately and calculating their BMI.

Why is BMI for children age and gender specific?

For children BMI is gender specific and age specific. BMI changes substantially with age, as children are still growing and the amount of body fat changes. BMI usually rises steeply in infancy and decreases during preschool years, reaching a minimum at about 4 to 6 years of age. After this age BMI begins to gradually increase through adolescence into adulthood. The example below in Table 2 demonstrates how BMI changes with age and differs by gender.

Table 2

Age	Boy BMI on the 50th percentile	Girl BMI on the 50th percentile
2 years old	16.6	16.4
4 years old	15.7	15.4
6 years old	15.4	15.2
9 years old	16.2	16.3

The rebound or increase in BMI that occurs after a child reaches the lowest BMI point is referred to as “adiposity rebound”. This is a normal pattern of growth that occurs in all children. Recent research has shown that the age when adiposity rebound occurs may be a critical period in childhood in the development of obesity as an adult (Whitaker, et al, 1998).

BMI as a screening tool

BMI should be used as a screening tool not a diagnostic tool. BMI is a weight to height ratio that is significantly associated with body fatness. BMI is not a direct measure of body fatness. “The accuracy of BMI as a screening test in children has been compared with that of a more direct measure of adiposity, dual-energy X-ray absorptiometry (DEXA). The correlation between BMI and more direct measures is variable, ranging from 0.5 to 0.85 (Sardinha 1999; Pietrobelli et al 1998; Himes et al 1994). The specificity, or false positive rate, ranges from 0.03 to 0.13. Although some overweight children would be wrongly classified as being of normal weight when BMI is used as a screening test, very few children would be classified as overweight when they are not.” (NHMRC “Clinical Practice Guidelines for the Management of Overweight and Obesity in Children and Adolescents”, 2003 p8).

“A single time point on the growth chart may not be all that useful. Changes over time will provide meaningful information. Height and weight should be measured at least twice a year in all children as part of primary care. If the position on the BMI percentile is marginal, the child should be reviewed over six months before making any definitive decision. Be alert to an upward change in BMI

such as their own neglect or ambivalence about the baby, the caregiver may find it difficult to be emotionally involved with the infant.

Table 2: Risk-factors in early parenting

- Carer mental health problems – depression, anxiety
- Carer history – history of neglect or abuse; history of difficulties in relationships
- Current stressors – difficult birth; lack of support; domestic conflict
- Infant factors – unwanted baby or “special baby” (eg IVF; previous loss of infant); neonatal illness or developmental problems

Early Communication Disturbances

Disturbance of infant-parent interaction can take several forms, as outlined in Table 3: “Early communication disturbances”. All these patterns are significant as they can result in the infant being insecurely attached to the caregiver. The most serious interactive disturbances are highly stressful for the infant and result in high levels of stress hormones, such as cortisol. Stress hormones are thought to have a negative impact on brain development in cases of prolonged exposure.

Distorted interactions of all types may have long-term effects on infant development. Insecure infants are more likely to have difficulties in regulating and controlling their own feelings and may be less socially competent, when compared to secure infants.

Table 3: Early communication disturbances

- Avoidance – caregiver may reject the infants overtures or withdraw from interaction
- Intrusion – caregiver may have unrealistic expectations of the infant and impose their own needs
- Inconsistent – caregiver may be unable to maintain a consistent focus on the infant
- Confusing – caregiver may be unpredictable or self-preoccupied in a puzzling way for the infant
- Frightening/Hostile – caregiver may be easily angered by the infant and have difficulty managing their own feelings

Early Intervention

Intervention in infancy is likely to have long-term benefits. Support for “high-risk parents” is important and identification of risk factors in the ante-natal period (psychosocial screening) is now being adopted.

Infant-parent interaction should be observed at routine infant reviews. There are several rating scales for describing infant-parent interaction ie. Emotional Availability scale (Bringen et al 1995). Most require training.

Interventions in infancy range from education approaches to longer-term psychological support. Many parents are keen to learn more about their infants capacities and interaction skills. A useful educational video is “Getting to Know You” which looks at infants 0-3 months. (Available from www.nswiop.nsw.edu.au).

More complex problems in infancy may need referral to a mental health service or to a General Practitioner. Any concerns about risk to the child such as neglect or abuse are required to be reported.

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Reflection Questions

1. How do you currently assess infant-parent interaction at the time of routine visits?
2. Based on the “infant competencies”, what suggestions would you give parents?
3. Do you know where to refer a parent if attachment issues are evident?



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percentile particularly if it occurs early (4 to 5 years of age) and in children with overweight parents." (NHMRC "Overweight and obesity in children and adolescents: A guide for General Practitioners", 2003 p4).

It is important when examining BMI for children that this is compared with the appropriate weight and height charts. "BMI may not be as sensitive a measure of body fatness in children and adolescents who are particularly short or tall for their age or have an unusual body fat distribution. It may also misclassify children and adolescents who have highly developed muscles." (NHMRC "Clinical Practice Guidelines for the Management of Overweight and Obesity in Children and Adolescents", 2003 p8).

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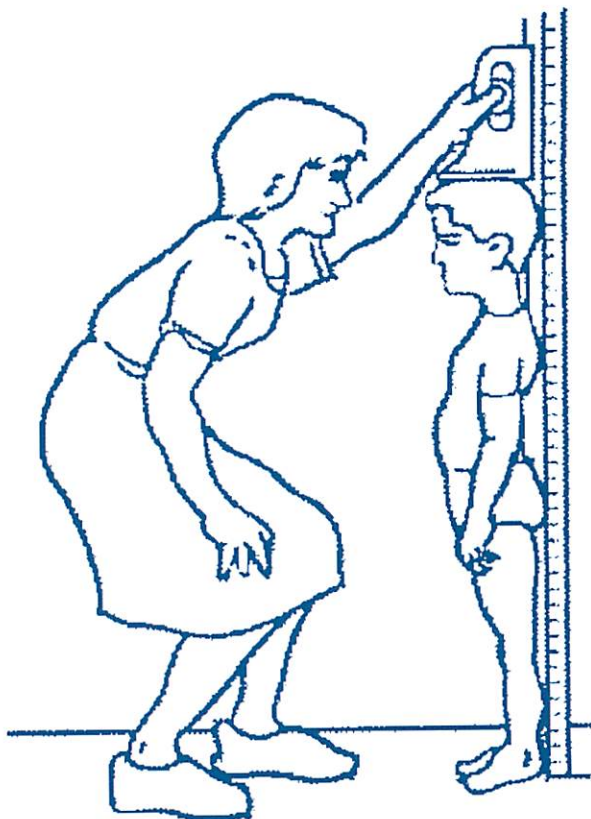
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Reflection Questions

1. Do you believe you are weighing and measuring children accurately?
2. When was the last time you had your weighing and measuring equipment calibrated?
3. Do you have a fixed wall stadiometer?
4. Do you move your scales around?
5. Have you had training in how to calculate BMI?
6. What information and strategies are used in your practice to advise parents about overweight and obesity?



Infant-Parent Interaction: The Beginnings of Attachment

Infants are born primed for social and emotional communication. From birth, infants begin the process of coming to know their caretakers and expressing their own feelings. The human infant is born with complex neurological capacities which allow them to engage with the social world as active participants. Infants are social beings and their social, emotional and psychological development, and physical growth, occurs in a social context. This article will review current understanding of the capacities of infants and discuss the importance of communication for development.

The Social Baby

Traditional models of infancy described infants as passive, largely unaware of the environment and minimally interactive. This view has been challenged by developments in infant research and observation which point to the innate capacities of infants for social interaction. Daniel Stern has described infants as having a “pre-wired knowledge of the world”, meaning a neurological ability to engage with and learn about the social environment from birth.

As shown in Table 1 “Infant Competencies”, infants begin to actively communicate from birth and are capable of complex interactions. The response of the caregiver is crucial for infant development, including the growth of the brain and neurological functions. Infant development is optimal when the caregiving environment is responsive and sensitive to the infant’s communication.

Table 1: Infant Competencies

• <i>Infants are programmed for social interaction.</i> Infants are sensitive to changes in their carer’s emotional state. From birth infants show preferential attention to shapes resembling a human face, respond to voices, and can recognise the smell of their own mother. They imitate facial expressions and focus on the carer’s eyes. • <i>Infants have the ability to communicate emotional experience.</i> Infants communicate basic emotions which can be recognised by carers. They are sensitive to non-response carers and show distress. • <i>Infants engage in Affective Interaction.</i> By eight weeks infants engage in early or “proto-conversation” and “talk” to the carer. By twelve weeks infants engage in joint attention with the carer and enjoy playing with objects. • <i>Infants have an inborn move towards self-regulation.</i> Infants learn about their own feelings states and those of others, through the caretaking relationship. The carer initially organises and regulates the infant’s emotional states, but gradually the infant comes to regulate their own states.
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Early Parenting

Interpreting and responding to the infant’s communication is a crucial task of early parenting. Parents learn to recognise their particular infant’s communications and needs and how best to manage infant stress. Temperamental and neurological differences influence infant behaviour but the majority of parents adapt to the specific needs of their infant. “Good enough” early parenting involves the parent being sensitive and responding to infant cues and being able to manage their own anxiety or frustration.

Sensitive parenting refers to the capacity to understand or “read” the infant’s emotional state and to help the infant stay within an optimal range of neurophysiological arousal. Being either overstimulated or understimulated is stressful for the infant and if persistent may have long-term effects on growth and development.

Not all parents find it easy to understand and respond to their infants. Parents with high levels of anxiety, depression or histories of poor parenting may find it particularly difficult to respond in a consistent way to their infant and may be overwhelmed by the infant’s demands. It is important to recognise factors that may interfere with early parenting as early intervention is effective. Refer to Table 2: “Risk-factors in early parenting”.

All these factors can potentially impact on the caregivers expectations, ideas and feelings about the infant. Where there are unresolved issues in the mind of the caregiver,

Body Mass Index (BMI) for children

Calculating BMI

$$\text{BMI} = \frac{\text{Weight in Kilograms}}{(\text{Height in Metres}) \times (\text{Height in Metres})}$$

To complete the calculation you can use the following formula:

$$\text{Weight (kg)} \div \text{height (cm)} \div \text{height (cm)} \times 10,000 = \text{BMI}$$

Weighing and measuring children accurately

Equipment to be used for weighing and measuring children should be serviced and checked for accuracy.

Remove from the child:

- Shoes
- Any hair ornaments that may impede measurement
- Heavy outer garments – eg coats, jackets, big jumpers
- Any heavy articles in their pockets

To ensure correct weight measurements:

1. After pressing the “on” button, wait until the scales show “0.0”
2. Ask the child to stand:
 - Centred on the scales
 - With their feet evenly apart
3. Ask the child to look straight ahead and stand still
4. Record weight to the nearest 0.1kg

To ensure correct height measurements:

1. Ask the child to stand:
 - Up straight
 - With feet and heels together
 - Heels back against the upright section of the stadiometer
 - Arms relaxed by their side, with palms facing inwards
2. Gently position the head. Hold your hand around the jaw, so that the top of the head and stadiometer form a right angle and the chin is not pointing down towards the chest
3. Ask the child to look straight ahead, eg at a marker on a wall
4. Check that their head is still positioned correctly and their heels are still flat on the floor
Bring the set square down to rest on the child's head
5. Record height to the nearest 0.1cm.

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