Section 2: Identification and classification

Identification and classification

5.1 A: Clinical

5.1.1 Evidence statements

5.1.1.1 Children (Table 5.1)

Table 5.1 Evidence statements and grading

No.	Evidence statement	Grade
Body mass index (BMI)		
1	BMI is a widely accepted and practical estimate of general adiposity in children	2++
2	Different classifications using BMI centile cut-offs have been proposed for children, but there is no evidence on which are the most appropriate in practice	2++
3	There is limited evidence on which BMI measure (BMI, percentage change BMI, BMI z-score or BMI centile) is best at measuring adiposity change	3
4	Some evidence suggests that the IOTF/Cole and the WHO BMI-based systems have high specificity which can lead to fewer non-overweight adolescents being classified as overweight	3
5	There is no evidence on ethnicity differences in the association of proxy measures of obesity with morbidity in children in UK populations	N/A

No.	Evidence statement	Grade
Waist circumference		
6	There is limited evidence on the utility of waist circumference compared with BMI in children, but its use is not widely accepted. Expert consensus is that waist circumference alone is not recommended in children, due to problems with measurement validity and reliability	4 (expert opinion)
1.1.7	There are no proposed evidence-based cut-offs for waist circumference measurements in children	2++
Bioimpedance		
8	There is no evidence on the utility of bioimpedance compared with BMI in children	N/A

IOTF, International Obesity Taskforce; NA, not applicable; WHO, World Health Organization.

5.1.1.2 Adults (Table 5.2)

Table 5.2 Evidence statements and grading

No.	Evidence statement	Grade
Body mass index (BMI)		
1	BMI is a widely accepted measure of general adiposity in adults	2++
2	Adults with a BMI of 25 kg/m^2 or over are overweight. Adults with a BMI of 30 kg/m^2 or over are obese	2++
3	Further classifications of obesity by BMI in adults are as follows: Obesity, class I 30–34.9 Obesity, class II 35–39.9 Obesity, class III ≥40	4

No.	Evidence statement	Grade
4	There is no accepted definition for classification using BMI in older people.	2++
Waist circumference		
5	Waist circumference is a useful measure of central adiposity in adults	3
6	Men with a waist circumference of 94 cm or more are at increased risk of health problems. If their waist circumference is 102 cm or more, even at a healthy weight (BMI 18.5–25 kg/m^2) they are at increased risk	2++
7	Women with a waist circumference of 80 cm or more are at increased risk of health problems. If their waist circumference is 88 cm or more, even at a healthy weight (BMI 18.5–25 kg/m^2) they are at increased risk	2++
Other measurements *[The Guidance Development Group (GDG) wanted evidence on the diagnostic accuracy of other anthropometric measurements and bioimpedance compared with the gold standard of BMI.]*		
8	Waist-to-hip ratio is a useful measure of central adiposity in adults, but is more difficult to measure	3
9	There is no evidence on the utility of bioimpedance compared with BMI in adults	N/A
Opportunistic screening		
10	There is no evidence on the effectiveness of opportunistic screening	N/A
Different cut-offs in different ethnic groups		
11	In first generation migrants from Pakistan to the UK, a given BMI is associated with greater truncal adiposity than in the white population	3

No.	Evidence statement	Grade
12	In South Asians (of Pakistani, Bangladeshi and Indian origin) living in England, a given waist circumferences tends to be associated with more features of metabolic syndrome than in Europeans (for example, higher triglycerides and lower HDLs in females and higher serum glucose in males)	2
13	In South Asians living in South Asia, a given BMI tends to be associated with higher percentage body fat than in European populations	3
14	In black populations, for a given BMI, percentage body fat tends to be higher in those living in the USA than in Jamaica. It also tends to be higher in Jamaicans compared with rural Nigerians	2

HDL, high-density lipoprotein; NA, not applicable.

5.1.2 Methodology

We searched for high-quality systematic reviews of the evidence, and these are summarised below. We also searched for evidence published since the cut-off dates of the included reviews and evidence to answer key clinical questions not addressed in the reviews. Where appropriate, expert opinion is cited. Details can be found in the evidence review for each section. We did not retrieve any study from the update searches that modified any of the recommendations.

5.1.3 Evidence review on different anthropometric measures for the identification of individuals who are overweight or obese

There is growing evidence that links body composition, specifically the levels of fat tissue in the human body, with increased health risks and the development of certain diseases (see also section 5.1.5). The amount of body fat in the human body is called adiposity. Adiposity is defined as the amount of body fat expressed as either the absolute fat mass (in kilograms) or as the percentage of total body mass. Absolute adiposity is highly correlated with body mass, but percentage adiposity is relatively uncorrelated with body mass.[1]

There are many methods of **directly** measuring the amount of fat in the human body. These usually involve complicated procedures that can only be carried out in specialist laboratories.

Indirect methods, based on the relation between height and weight, can be used in everyday clinical practice to estimate adiposity. The most common and accepted, at least in adults, measures are those of body mass index (BMI) and waist circumference.

BMI is calculated as the weight (in kilograms) divided by the height (in metres) squared. For example, an individual who weighs 95 kg and is 180 cm tall has a BMI = 95/(1.80 $\times$ 1.80) = 95/3.24 = 29.32 kg/m^2. So the person's BMI is approximately 29 kg/m^2.

A simple measure of fat distribution is waist circumference. This can be related to the overall body shape of the individual by calculating the ratio of the waist to the hip (waist-to-hip ratio).

Different methods may be appropriate in different circumstances. For example, waist-to-hip ratio may be the most accurate predictor of risk of myocardial infarction,[2] and waist circumference may be the most accurate predictor of risk of type 2 diabetes.[3]

5.1.3.1 Identification and measurement of children who are overweight or obese

We were not able to find any other systematic reviews that addressed the accuracy of anthropometric measures or bioimpedance to diagnose obesity compared with the use of BMI in children.

The National Health and Medical Research Council (Australia) (NHMRC)[4] stated that although there was no evidence to recommend specific cut-offs, it recommended that BMI should be the standard measure for children. BMI is a measure of weight adjusted for height and is highly correlated with adiposity.

Limitations of the BMI, include: not being able to distinguish between fat or lean mass, not necessarily reflecting fat distribution (which may or may not be associated with age), and not necessarily describing the same levels of body fat in different populations because of different body proportions. Both the United States Preventive Services Task Force (USPSTF) 2005[5] and Freedman and coworkers[6] reiterated these limitations. Freedman and coworkers[6] pointed out pitfalls in their assessment of the relation of BMI to levels of fat mass and fat-free mass among healthy 5–18-year-olds. By measuring fat and fat-free mass by dual-energy X-ray absorptiometry they found that the correlation of BMI to fat mass was clearly non-linear, and that substantial differences in fat mass were only observed at BMI levels equal to or more than the 85th percentile. Thus, the authors contended that despite BMI-for-age being a good estimate of excess fat mass, BMI differences among thinner children can be partly associated with fat-free mass.[6]

For measurement of central adiposity, waist circumference was recommended but, as for BMI, no cut-offs were specified. The role of bioimpedance was reviewed and several limitations were highlighted: equations used to convert resistance to body fat should be population specific but these may not always be available; it may add little to anthropometric measures; hydration status can affect results; results can be unreliable at extremes of body weight. Concern was also raised that bioimpedance may be used by operators who are not aware of these limitations.[4] The USPSTF also stated that 'indirect measures of body fat, such as skinfold thickness, bioelectrical impedance analysis, and waist-hip circumference, have potential for clinical practice, treatment, research, and longitudinal tracking, although there are limitations in measurement validity, reliability, and comparability between measures'.[5]

The Scottish Intercollegiate Guidelines Network (SIGN) guidelines[7] only considered the use of BMI as 'there is no clear threshold for waist circumference associated with morbidity outcome in children'. However, the strict use of BMI in children can underestimate the prevalence of obesity in young people. McCarthy and coworkers[8;9] compared changes in waist circumference and BMI in British youth through cross-sectional surveys in 1977, 1987 and 1997. They found that trends in waist circumference significantly exceeded the figures for BMI in the past 10–20 years. Another study published by Rudolf and coworkers,[10] followed a cohort of British schoolchildren for 6 years, and found that both BMI and waist circumference increased significantly.

The clinical practice guidelines of the Ministry of Health of Singapore recommended BMI-for-age and gender charts to be used in children.[11]

A recent study published by Neovius and coworkers[12] in which a cross-sectional analysis was performed in 474 healthy adolescents aged 17 years, showed that both BMI and waist circumference had strong correlation with percentage body fatness in both girls and boys, but that the correlation was not so apparent for waist to hip ratio. Moving on from this the authors contended that for BMI and waist circumference, sensitive and specific cut-offs of obesity can be derived, whilst larger trade-offs were required to detect overweight in girls.

5.1.3.2 Identification and measurement of adults who are overweight or obese

The NHMRC[13] reviewed the evidence for different anthropometric measures in the identification of overweight or obesity in adults.

On the basis of the evidence, the NHMRC concluded that:

- BMI was highly, but not perfectly, correlated with adiposity
- limitations of the BMI included not being able to distinguish between fat or lean mass, not necessarily reflecting fat distribution (which may or may not be associated with age), and not necessarily describing the same levels of body fat in different populations because of different body proportions.

Because of these limitations, they recommended that:

> 'BMI is an acceptable approximation of total body fat at the population level and can be used to estimate the relative risk of disease in most people. However, it is not always an accurate predictor of body fat or fat distribution, particularly in muscular individuals, because of differences in body-fat proportions and distribution.'[13]

The evidence on waist circumference showed a positive correlation with risk of disease. However, when the BMI was greater than 35 kg/m^2, waist circumference did not add to the absolute measure of risk. The conclusions reached were:

> ‘waist circumference is a valid measure of abdominal fat mass and disease risk in individuals with a BMI less than 35. If BMI is 35 or more, waist circumference adds little to the absolute measure of risk provided by BMI.’[13]

No evidence on the use of bioimpedance was reported.

Similarly, the National Institutes of Health (NIH) guidelines[14] found that BMI gave a reasonable approximation of adiposity in most people and that waist circumference was the most practical measurement for assessing abdominal fat. Again, bioimpedance was not considered.[14]

In older people,[15] the evidence was summarised as follows:

> ‘Primary limitations to use of BMI in diagnosing obesity in the elderly include a lower correlation with percentage body fat in the old than in the young, and a weaker association with cardiovascular mortality, as well as several intermediaries of cardiovascular morbidity than measures of central adiposity (waist circumference or waist-to-hip ratio).
>
> While the correlation between BMI and body fat percentage drops with age, most data show a reasonable correlation persists. In addition, body fat percentage is generally more closely correlated with BMI or waist circumference than other common obesity diagnostic tests in the elderly. Likewise, BMI is the diagnostic measure linked with the broadest range of subsequent health states. Some of these outcomes (e.g., incident functional disability) have not been evaluated by waist-to-hip ratio or waist circumference; others (e.g., hip fracture incidence in women) are linked with BMI, but not with waist-to-hip ratio or waist circumference (likely reflecting that generalized, not central, obesity is important in their aetiology).’[15]

We were not able to find any other systematic reviews that addressed the accuracy of anthropometric measures or bioimpedance to diagnose obesity compared with the gold standard of BMI in adults.

We found several primary studies that assessed the utility of waist circumference and/or waist-to-hip ratio to classify people as obese or overweight compared with classification by BMI.[16-26]

None of the included studies scored highly when quality assessed (using diagnostic study criteria), as blinding was not done, which was assumed to be a practical problem with this type of measurement. This may have affected the accuracy of the measurements, particularly with waist circumference. However, most studies did report that the assessors were trained, and in some cases, the results were validated.

Overall, the utility of other measures compared with BMI varied, particularly with sex and age. In general, the use of measures such as waist circumference or waist-to-hip ratio only would not classify someone as overweight or obese who was not. However, the use of these measures would miss a proportion of people who were at increased risk if assessed using BMI alone. The use of waist-to-hip ratio appeared to be less useful than waist circumference.

Since we initially reviewed the evidence, the National Guideline Clearing House has produced a synthesis of guidelines relating to obesity in adults,[27] and a comparison of the different recommendations relating to measurement can be seen in Table 5.3.

Table 5.3 Comparison of recommendations in the key measures (weight, body mass index (BMI), waist circumference)[a]

ACP (2005)	No recommendations offered. ACP refers to the USPSTF guidelines for screening for obesity in adults
ACPM (2001)	Periodic measurement of BMI (weight in kilograms/height in metres^2) is recommended for all adults

AGA (2002)	A medical evaluation is needed to identify patients who either have, or are at risk for, obesity-related medical complications. This assessment should include a careful history, physical examination (including determination of BMI), and laboratory tests to identify eating and activity behaviours, weight history and previous weight loss attempts, obesity-related health risks, and current obesity-related medical illnesses
BWH (2003)	*BMI*. The BMI is the recommended approach for assessing body size in the clinical setting, providing a more accurate measure of body size than weight alone. However, it can overestimate body fat in people who are very muscular, very short, or who have oedema, and it underestimates it in people who have lost muscle mass, such as the elderly. *Waist circumference*. Excess abdominal fat carries particularly elevated health risks. Waist circumference is the most practical marker of abdominal fat. (Many patients understand this concept as 'apple' versus 'pear' shaped.) A waist circumference greater than 88 cm (> 35 inches) raises cardiovascular disease risk in women Ethnic and age-related variations in distribution of body fat affect the predictive value of waist circumference. Waist circumference may be a better indicator of risk than BMI for estimating obesity-related disease risk among certain populations, such as Asian–Americans and older people. Waist cut-offs designed for the general population may not apply to very short women (under 1.5 m [5 feet])

Singapore MOH (2004)	BMI is the recommended index to define overweight and obesity. It is minimally correlated with height and highly correlated with body fat percentage and levels of disease risk of comorbidities. Body weight alone can be used to follow weight loss and to determine efficacy of therapy (grade B, level III) Waist circumference is the most practical anthropometric measurement for assessing a patient's abdominal fat content before and during weight loss treatment. Gender-specific waist circumference cut-offs should be used in conjunction with BMI to identify increased disease risk (grade B, level III)
USPSTF (2003)	The USPSTF found good evidence that BMI, calculated as weight in kilograms divided by height in metres squared, is reliable and valid for identifying adults at increased risk for mortality and morbidity due to overweight and obesity Central adiposity increases the risk for cardiovascular and other diseases independent of obesity. Clinicians may use the waist circumference as a measure of central adiposity. Men with waist circumferences greater than 102 cm (> 40 inches) and women with waist circumferences greater than 88 cm (> 35 inches) are at increased risk for cardiovascular disease. The waist circumference thresholds are not reliable for patients with a BMI greater than 35 kg/m^2

[a] Adapted from the National Guideline Clearinghouse guideline synthesis on the assessment and treatment of obesity and overweight in adults.[27]

ACP, American College of Physicians; ACPM, American College of Preventive Medicine; AGA, American Gastroenterological Association; BWH, Brigham and Women's Hospital; MOH, Ministry of Health; USPSTF, United States Preventive Services Task Force.

5.1.3.3 Effectiveness of opportunistic screening on health outcomes

We did not find any guidelines that issued recommendations on the effectiveness of opportunistic screening in the identification of people who are overweight or obese.

We identified randomised controlled trials (RCTs) from the Cochrane review[28] on improving management for people who are overweight or obese that may have had an element of opportunistic screening in the intervention arm of the trial. Only one was considered relevant, but follow-up was less than our inclusion criteria of 12 months so was subsequently excluded.[29] We also searched for RCTs citing a Little 1998 paper,[30] which concluded that measurement of obesity in the general population was not likely to improve risk assessment or patient knowledge significantly. Again, no RCTs were identified that evaluated the effectiveness of opportunistic screening.

Other policy initiatives

GMS2 contract

Two indicators in the Quality and Outcomes Framework[31] (QOF) of the revised contract for general practitioners (GMS2) require an assessment of obesity:

OB1: The practice can produce a register of patients aged 16 and over with a BMI greater than or equal to 30 in the previous 15 months.

DM 2 The percentage of patients with diabetes whose notes record BMI in the previous 15 months.

The rationale given for DM 2 was that:

> ‘Weight control in overweight subjects with diabetes is associated with improved glycaemic control. There is little evidence to dictate the frequency of recording but it is general clinical practice that BMI is assessed at least annually.’[31]

National Service Frameworks

The National Service Framework for Coronary Heart Disease (www.dh.gov.uk) stated that general practitioners and primary care teams should identify all people with established cardiovascular disease and offer them appropriate advice and treatment to reduce their risks.

The National Service Framework for Diabetes (www.dh.gov.uk) stated that the opportunistic screening of people with multiple risk factors for diabetes can lead to the identification of some individuals with previously undiagnosed diabetes.

The rationale given for this was that:

> ‘People who have multiple risk factors for diabetes – family history, obesity, ethnic background, increasing age – also require advice and support to decrease their risk of developing diabetes and information about the symptoms and signs of diabetes. Moreover, opportunistic screening will identify those who are unaware of their condition. Opportunistic screening can help, although there is the need for a more systematic approach to administer screening.’

National Screening Committee

The National Screening Committee (www.nsc.nhs.uk) does not currently recommend screening for obesity for children or adults.

5.1.4 Evidence review on the classification of overweight and obesity

[This is intended as a discussion paper to highlight any areas where there is disagreement or controversy in the defined cut-offs used to classify people who are overweight/obese. Because the associated key clinical question does not lend itself easily to an evidence-based approach, we have referred to key references which are mainly expert opinion and authoritative statements.]

5.1.4.1 Classification of overweight or obesity in children

Despite the rising problem of weight and weight-related problems among children, there is no universally accepted classification system for childhood obesity. Thus, the absence of a universally accepted measure causes difficulties in monitoring the development of the obesity epidemic and for comparing between studies.[32]

Several attempts have been made to establish BMI-based classification systems, although such systems are difficult to define with any precision. This problem is related to children having less obesity-related disease than adults (in the short term) and that the dose–response curve connecting obesity and outcome is linear over a wide range of adiposity in children (Cole and Rolland-Cachera cited by Neovius et al., p107[32]).

The evidence reviews below report how BMI and waist measurements can be used to classify the weights and body shapes of individuals into groups at increased risk of health problems (Table 5.4).

Table 5.4 Classification of overweight and obese (BMI) from key references

Source	Classification	Definition and notes	
RCPCH/NOF 2002[33]	Overweight	British childhood BMI charts show 91st, 98th and 99.6th centile lines	'Body mass index (BMI) is the most practical measure of obesity/overweight, provided values are related to reference standards for age'
	Obese	The 2002 charts show IOTF cut-offs corresponding to adult definitions of overweight and obesity	
NHMRC 2003[4]	Overweight	> 85th centile (CDC 2002)	CDC BMI percentile charts recommended for use (in the clinical setting) until local BMI charts are developed (Australia)
	Obese	> 95th centile (CDC 2002)	
SIGN 2003[7]	Overweight	≥ 91st centile (UK 1990)	'Despite … limitations, there is widespread international support for the use of BMI to define obesity in children, expressed in non-systematic reviews and consensus statements'
	Obese	≥ 98th centile (UK 1990)	

Source	Classification	Definition and notes	
AAP 2003[*]	At risk of overweight	BMI between 85th and 95th percentile for age and sex	
	Overweight or obese	BMI ≥ 95th percentile	
Singapore MOH 2004	'BMIs-for-age and gender equivalent to adult WHO BMI cut-offs for obese and overweight (at ≥ 30.0 or ≥ 25.0 kg/m^2) respectively can be used as thresholds, although BMI cut-offs for action among Asians of 27.5 kg/m^2 and 23.0 kg/m^2 respectively may be eventually used'		
AHA 2005	Overweight	≥ 95th percentile (CDC age- and sex-specific nomograms for BMI)	'By late adolescence, these percentiles approach those used for adult definitions; the 95th percentile is approximately 30 kg/m^2'
RNAO 2005	Overweight	BMI > 85th percentile and < 95th percentile	'Research studies often use recommended international cut-offs corresponding to a BMI of 25-29.9 used in adults'

[*] The AAP 2003, Singapore MOH 2004, AHA 2005, RNAO 2005 and USPSTF 2005 are all adapted from the National Guideline Clearinghouse guideline synthesis on the assessment and treatment of obesity and overweight in children and adolescents.

Source	Classification	Definition and notes	
	Obese	BMI for age and sex above 95th percentile using CDC growth curves	'There is no direct measure of body fat in childhood that is readily applicable in the clinical setting …. A new international cut-off for BMI which corresponds to the adult levels of 25 and 30 for overweight and obesity respectively are recommended for population studies'
USPSTF 2005	At risk of overweight	BMI between the 85th and 94th percentile for age and sex	'BMI percentile for age and sex is the preferred measure for detecting overweight in children and adolescents because of its feasibility, reliability, and tracking with adult obesity measures'
	Overweight	Overweight as a BMI at or above the 95th percentile for age and sex	

AAP, American Academy of Pediatrics; AHA, American Heart Association; CDC, Centers for Disease Control and Prevention; MOH, Ministry of Health; NOF, National Obesity Forum; NHMRC, National Health and Medical Research Council (Australia); RCPCH, Royal College of Paediatrics and Child Health; RNAO, Registered Nurses Association of Ontario; SIGN; Scottish Intercollegiate Guidelines Network; USPSTF, United States Preventive Services Task Force.

In children, weight must be adjusted for height. These adjustments are made by comparing the child's measurements with reference standards. BMI varies with body proportions, age and puberty status. To assess individual children, measurements need to be adjusted to compare them with those of other children of the same age.

There are different ways of making these adjustments and they are all made with the same aim: to strengthen the relation between weight and adiposity.

Concern surrounding issues of sensitivity and specificity of classification systems were also explored in Neovius and coworkers'[34] assessment of the International Obesity Taskforce (IOTF/Cole) and the World Health Organization BMI-based systems. The results were then compared with a national (Swedish) BMI reference, and BMI cut-offs maximising the sum of sensitivity and specificity were also derived from the group. The results suggested that, on the one hand the international classification systems have high specificity, resulting in few cases of non-overweight adolescents being classified as overweight. On the other hand, the sensitivity was very low in adolescent girls, thus illustrating how overweight girls would be missed in intervention programmes that use BMI as inclusion criteria.

The authors concluded that:

> 'an international reference is a compromise to obtain acceptable, comparable prevalence estimates at the global level. At the national level, given the probable population differences in relative risks at certain BMI values, the seriousness of the adolescent obesity problem, and its character as a major cost driver through obesity-related illnesses, customized systems derived from national data are likely to be more efficient'.[34]

Different growth reference charts can be used to assess the degree of overweight or obesity of a child. These are calculated to allow for age, sex and height.

The Growth Reference Review Group, a working group convened by the Royal College of Paediatrics and Child Health concluded that for most clinical purposes the UK 1990 charts were superior and recommended that:

- For children under the age of 2 years, the UK 1990 reference charts are the only suitable reference charts for weight, length and head circumference.
- For children over the age of 2 years, both the UK 1990 and the Buckler–Tanner references are suitable for assessing cross-sectional height in

isolation, but the UK 1990 charts should be used where both weight and height are being evaluated. The UK 1990 BMI reference is the only suitable reference for assessing weight relative to height.[35]

The NHMRC guidelines for children[4] highlighted several difficulties with the BMI-for-age percentile cut-offs:

- Data are derived from a reference population.
- Classifying a child as overweight or obese on the basis of BMI being above a certain percentile is an arbitrary decision and not based on known medical or health risk.

These difficulties have resulted in different BMI centiles being used. For example, the Centres for Disease Control and Prevention define the cut-offs as over 95th percentile as overweight, the 85–95th percentile as risk of overweight, and under the 5th percentile as underweight. The NHMRC guidelines[4] recommended that BMI above the 95th percentile (on the CDC charts) is indicative of obesity and a BMI above the 85th percentile is indicative of overweight. Again, the guidelines stressed that these classifications are arbitrary. The SIGN guidelines[7] used yet another classification, with obese children with a BMI at the 98th percentile or over (on the UK 1990 charts), and overweight children with BMI at the 91st percentile or over. The authors of the evidence review on which these guidelines were based stated that:

> ‘A BMI cut off in the upper end of the BMI range (for example, above the 85th centile) was specific for obesity (low false positive rate). This avoids problems associated with stigmatising children or providing unnecessary treatment.
> When using BMI > 91st centile on the UK 1990 charts for British children, sensitivity is moderately high and specificity high. In practice, clinical assessment of obesity in British children using British BMI centile charts will be robust provided that an appropriate cut off (for example, BMI > 98th centile) is used. Serial measures of BMI, plotted on the chart, can assess changes over time.[36]

> ‘One British study reported improved screening ability (higher sensitivity; high specificity) when national (UK) reference data were

> used, compared to use of the international reference data. Sensitivity of the definition of obesity using the international reference data differed significantly between the sexes, with low sensitivity in girls and extremely low sensitivity in boys. International BMI cut offs for BMI in children have not been related to obesity related morbidity in childhood.'[37]
>
> 'They require further testing, with evidence of external validity, before they are adopted.'[36]

The Growth Reference Review Group, a working group convened by the Royal College of Paediatrics and Child Health, published a review of growth reference charts for use in the UK.[35] The Group considered the data on which the references were based and their current validity, and made recommendations about which reference was to be used in defined settings.

Viner and Nicholls[38] made clear their use of the IOTF cut-offs to identify obesity. As there is no accepted definition of obesity they considered those with a BMI of greater or equal to 3 standard deviations (SD) above the mean (≥ 99.86th centile) as extremely obese and at potential high risk. Moreover, they acknowledged the use of waist circumference as an additional indicator of potentially high risk of abdominal obesity.[38]

Cole and coworkers[39] aimed to identify the best possible BMI measure for change (BMI, BMI%, BMI z-score or BMI centile) for children across a range of adiposity. To do so, they measured BMI three times over a period of 9 months in 135 Italian preschool children aged 29–68 months.

The authors concluded that BMI centile is (i) useful for classifying children's adiposity, although poor at quantifying change in adiposity and (ii) sensitive to changes in the middle of the adiposity range but insensitive to changes at the extremes. BMI z-score is also useful for assessing adiposity cross-sectionally, and, unlike BMI centile it can be summarised across populations for statistical purposes. Despite these, disadvantages appear as its variability gets progressively smaller the more obese the child.[39]

Cole and co-workers also analysed percentage change in BMI, stating that it performs better than BMI centile or z-score. They stated that, in practice, adiposity change over time is virtually equivalent when measured either with percentage change BMI or BMI. Thus, both can be used interchangeably. To conclude, Cole and co-workers contended that adiposity change should be measured in BMI (kg/m^2) or BMI (%). Nevertheless they acknowledged that this should be qualified, as the adiposity measures for change over time are all highly associated and the advantage of BMI or BMI% over BMI z-score is tenuous.[39]

In 2002, the 'Health survey for England'[40] focused on the health of children and young people, and on the health of infants (aged under 1 year) and their mothers. One of the 'core topics', which is included in all health surveys, was anthropometry.

Emmanuel Stamatakis produced a chapter for 'Health survey for England' on the anthropometric measurement of overweight and obesity in children.[41] He discussed the establishment of a standard definition for child overweight and obesity using BMI reference data from six different countries around the world.[42] This linked childhood and adult obesity/overweight standards using evidence of clear associations between the adult BMI cut-off values of 25 kg/m^2 and 30 kg/m^2 and health risk. However, Stamatakis reported that a re-analysis of children's BMI data using similar methods to the international classification but UK-only reference data showed that the international BMI cut-offs exaggerated the differences in overweight and obesity prevalence between boys and girls by underestimating prevalence in boys. Other possible limitations of the international classification included concerns about its sensitivity (ability to identify all obese children as obese), the limited sample size of the reference population and the lack of BMI cut-off points for underweight. However, in summary, the report concluded that 'the issue of childhood obesity definition is far from resolved and there is an urgent need for further work'.[41]

5.1.4.2 Classification of overweight and obesity in adults

This section describes how BMI and waist measurements can be used to classify the weights and body shapes of individuals into groups at increased risk of health problems (Tables 5.5 and 5.6).

Table 5.5 Classification of overweight and obese (body mass index [BMI][a]) from key references

Source		**Classification (BMI[a])**
		Adult
NOF 2002[43]	Overweight	≥ 25
	Obese	≥ 30
NHMRC 2003[13]	Overweight	≥ 25
	Obese	≥ 30
		(≥ 40 severely obese)
NIH 1998[14]	Overweight	≥ 25
	Obese	≥ 30

[a] BMI unit of measurement: kg/m^2.

NOF, National Obesity Forum; NHMRC, National Health and Medical Research Council (Australia); NIH, National Institutes of Health.

Table 5.6 Classification of overweight and obese (waist circumference) from key references

Source	Classification (waist circumference)	Additional comments
	Adult	
NOF 2002[43]	Men > 102 cm	Associated with 'substantially increased health risk'
	Women > 88 cm	
NHMRC 2003[13]	Men ≥ 102 cm (≥ 94 cm increased risk)	Associated with 'substantially increased' risk of metabolic complication Waist circumference is a valid measure of abdominal fat mass and disease risk in individuals with a BMI less than 35 kg/m^2. If BMI is 35 or more, waist circumference adds little to the absolute measure of risk provided by BMI
	Women ≥ 88 cm (≥ 80 cm increased risk)	
NIH 1998[14]	Men > 102 cm	Associated with high risk to health
	Women > 88 cm	Although waist circumference and BMI are interrelated, waist circumference provides an independent prediction of risk over and above that of BMI. It is particularly useful in patients who are categorised as normal or overweight on the BMI scale

BMI, body mass index; NOF, National Obesity Forum; NHMRC, National Health and Medical Research Council (Australia); NIH, National Institutes of Health.

As for measurement above, the National Guideline Clearing House synthesis of adult guidelines summarised classification as follows (Table 5.7).

Table 5.7 Classification of obesity in adults

ACPM (2001)	By criteria of the International Obesity Taskforce, overweight is classified as BMI > 25 kg/m^2 Obesity is categorised as class I (BMI 30–34.9), class II (BMI 35–39.9) and class III (BMI ≥ 40)
AGA (2002)	A BMI of 25.0–29.9 is classified as overweight. Obesity is categorised as class I (BMI 30–34.9), class II (BMI 35–39.9) and class III (BMI ≥ 40)
BWH (2003)	The National Heart, Lung, and Blood Institute Overweight and Obesity Classification by BMI (in kg/m^2): Normal weight 18.5–24.9 Overweight 25.0–29.9 Obesity class 1 30.0–34.9 Obesity class 2 35.0–39.9 Obesity class 3 ≥ 40.0 *Waist circumference*. A waist circumference > 88 cm (> 35 inches) raises cardiovascular disease risk in women. Waist cut-offs designed for the general population may not apply to very short women (under 1.5 m [5 feet])

Singapore MOH (2004)	Current World Health Organization and international guidelines recommend BMI cut-offs of 25 kg/m^2 and 30 kg/m^2 to define overweight and obesity, respectively. Based on body fat equivalence and comorbid disease risk, BMIs of 23 kg/m^2 and 27.5 kg/m^2, respectively have been recommended as cut-off points for public health action in Asians (grade C, level IV). *Note*: BMI cut-off points are currently being reviewed in the light of new data Current international guidelines recommend waist circumference cut-offs of 102 cm and 88 cm to define excess risk in males and females, respectively. Based on an Asian-Pacific consensus and our national health survey and comorbid disease risk, cut-offs of 90 cm and 80 cm, respectively, are probably more appropriate for Asians (grade C, level IV)
USPSTF (2003)	The USPSTF found good evidence that BMI, calculated as weight in kilograms divided by height in metres squared, is reliable and valid for identifying adults at increased risk for mortality and morbidity due to overweight and obesity Persons with a BMI between 25 kg/m^2 and 29.9 kg/m^2 are overweight, and those with a BMI of $\geq$ 30 kg/m^2 are obese. There are three classes of obesity: class I (BMI 30–34.9), class II (BMI 35–39.9) and class III (BMI 40 and above). Men with waist circumferences > 102 cm (> 40 inches) and women with waist circumferences > 88 cm (> 35 inches) are at increased risk for cardiovascular disease. The waist circumference thresholds are not reliable for patients with a BMI > 35 kg/m^2

ACPM, American College of Preventive Medicine; AGA, American Gastroenterological Association; BMI, body mass index; BWH, Brigham and Women's Hospital; MOH, Ministry of Health; USPSTF, United States Preventive Services Task Force.

BMI

There is little disagreement about the classification of overweight and obese using BMI in adults; a BMI between 18.5 kg/m^2 and under 25 kg/m^2 is accepted to be within normal ranges, whereas a BMI of between 25 kg/m^2 and under 30 kg/m^2 is classified as overweight and a BMI of 30 kg/m^2 and over as obesity. Further classifications, linked with morbidity, can be seen in Table 5.8.

Table 5.8 Classifications of obesity[44]

Classification	BMI (kg/m^2)	Risk of co-morbidities
Underweight	< 18.5	Low[a]
Healthy weight	18.5– 24.9	Average
Overweight (or pre-obese)	25–29.9	Increased
Obesity, class I	30–34.9	Moderate
Obesity, class II	35–39.9	Severe
Obesity, class III	≥ 40-	Very severe

[a] Other health risks may be associated with low body mass index (BMI).,

These cut-offs are based on epidemiological evidence of the link between mortality and BMI in adults.

Waist circumference and waist-to-hip ratio

This agreement on classification is also reflected in the cut-offs used for waist circumference: a waist circumference of 102 cm or over in men and 88 cm or over in women is associated with substantially increased health risks (Table 5.9).

Table 5.9 Classification using waist-to-hip ratio and waist circumference[44;45]

At increased risk	Men	Women
Waist-to-hip ratio	> 1.0	> 0.85
Waist circumference (increased risk)	≥ 94 cm	≥ 80 cm
Waist circumference (greatly increased risk)	≥ 102 cm	≥ 88 cm

BMI and waist circumference

The WHO recommended that an individual's relative risk could be more accurately classified using both BMI and waist circumference. These can be seen in Table 5.10.

Table 5.10 Combining body mass index (BMI) and waist measurement to classify the risks of type 2 diabetes and cardiovascular disease[13;44]

		Waist circumference (cm)		
Classification	**BMI (kg/m^2)**	**Men**	94–102	> 102
		Women	80–88	> 88
Underweight	< 18.5		–	–
Healthy weight	18.5–24.9		–	Increased
Overweight	25–29.9		Increased	High
Obesity	> 30		High	Very high

The Agency for HealthCare Research and Quality (AHRQ) undertook a systematic review of the diagnosis and treatment of obesity in older people.[15] The review addressed the following questions:

- Are there limitations in diagnosing obesity in the elderly[†] with BMI?
- Should another measurement be used with BMI or in place of BMI for diagnosing obesity in the elderly?

The review concluded that:

> 'Overall, among office-based diagnostic tests for obesity, BMI and WC showed very similar correlation with body fat percentage in men and women.… While WC correlates closely with body fat percentage and aims to measure central adiposity, it showed low sensitivity when used as a single tool to identify older patients with either generalized (by BMI) or central (by WHR) obesity. Gender did not appear to strongly affect these analyses' diagnostic accuracy, but the utility of diagnostic measures may differ across ethnic/racial groups.'

[†] Defined as people aged 60 years or older.

However, no specific cut-offs were suggested for any of the measures evaluated in this group of people.

One systematic review assessed the link between BMI and risk in older people.[46] In studies where an association was found, a BMI of 27 kg/m^2 or over was associated with increased all-cause and cardiovascular mortality among people aged 65–74 years. For people aged 75 years or over, a BMI of 28 kg/m^2 or over was associated with an increased all-cause mortality. The authors suggested that future guidelines may wish to consider the evidence for specific groups when establishing standards for healthy weight.

5.1.5 How do BMI and waist circumference correlate with morbidity and mortality in different ethnic groups?

5.1.5.1 Classification of obesity in children from different ethnic groups

Background

BMI, besides not being able to distinguish between fat mass and lean (or muscle) mass, does not reflect body fat distribution or differences in body fat associated with different body proportions in different ethnic groups.[47]

The concept of different cut-offs for different ethnic groups has been proposed by the WHO, but there is ongoing debate[48-51] and at present, there are no commonly accepted cut-offs or indeed, methods to determine specific cut-offs.[52]

In the UK, a secondary analysis[53] of the 1999 health survey for England found that Afro-Caribbean and Pakistani girls (aged 2–20 years) were more likely to be obese than girls in the general population (odds ratio [OR] 2.74, 95% confidence interval [CI] 1.74 to 4.31 and OR 1.71, 95% CI 1.06 to 2.76, respectively), with Afro-Caribbean girls also more likely to be overweight (OR 1.73, 95% CI 1.29 to 2.33). Indian and Pakistani boys were more likely to be overweight (OR 1.55, 95% CI 1.12 to 2.17 and OR 1.36, 95% CI 1.01 to 1.83), but not obese. Conversely, Chinese girls were less likely to be overweight or obese and Chinese boys less likely to be overweight. The degree of overweight or obesity was assessed using the IOTF standard definition for international use[42](see International evidence below).[53]

In another study of UK adolescents aged 11–14 years,[54] the prevalence of overweight and obesity was found to be highest for black African girls and lowest for Bangladeshi and Pakistani girls. In boys, the prevalence of overweight and obesity was highest for Indian boys and lowest for black African and Pakistani boys. But the differences between ethnic groups were not significant overall. There were some significant differences between the white British population and the different ethnic groups. Indian boys were significantly more likely to be overweight and Pakistani and black African boys were significantly less likely to be overweight (using the IOTF international cut-offs[42]). One limitation of this study is that the survey was not a national one, but restricted to East London. However, the response rate was high and the authors felt that that sample was representative.

Studies have found that Asian Indian children have higher body mass adjusted pressure levels than white children,[55] and are predisposed to insulin resistance syndrome (IRS),[56] which is associated with excess body fat, abdominal adiposity, and excess truncal subcutaneous fat.[57] This association between IRS and ethnicity was also found in a cross-sectional study of 3642 children in the UK.[58]

However, it is not yet clear how influential maternal nutrition and intergenerational effects will be on the relation between ethnicity and obesity over time.

Methods

The evidence review is based on relevant, identified systematic reviews and primary studies that assessed whether the association between BMI, waist circumference and bioelectrical impedance and morbidity is different between different ethnic groups in UK populations.

Owing to the lack of evidence and ongoing international debate on this topic, we asked experts[‡] in the area to suggest any additional references. These were scanned and included as appropriate.

[‡]Professor Philip James and Dr Kamlesh Khunti.

UK evidence

No studies investigating ethnicity differences in the association of proxy measures of obesity with morbidity in children in UK populations were found. However, there is evidence that young adult South Asians tend to have greater truncal adiposity than their European counterparts.

One study developed body mass reference curves based on a representative sample of the UK population from birth to 23 years.[59] However, it was not stated if ethnicity was considered in ensuring the sample was representative.

International evidence

The WHO review of obesity in the Asia-Pacific region published in 2002 stated that the international standard for BMI-for-age chart[42] was unlikely to be appropriate for Asian and Pacific children.[60]

Summary

Some evidence appears to suggest that Afro-Caribbean and black African girls might be at greater risk of overweight and obesity. This is also observed in some Indian boys. Evidence also suggests that Indian children have higher body mass adjusted pressure levels than white children, and are predisposed to IRS, which is associated with excess body fat, abdominal adiposity and excess truncal subcutaneous fat.

5.1.5.2 Classification of obesity in adults from different ethnic groups

Background

It is now generally accepted that the different ethnic groups have higher cardiovascular and metabolic risks at lower BMIs, and this may be because of differences in body shape and fat distribution.

In 2001, an international meeting of researchers discussed the simplified use of anthropometry to assess the risk of chronic disease associated with overweight and body fat distribution in adults.[61] The researchers concluded that:

> ‘for its potentially important role in health promotion and primary health care activities, WC [waist circumference] should be adopted as

> a valuable tool for assessing the health risks of overweight**, provided that appropriate cut-off points are established'**.[61] (Our emphasis)

Although ethnicity was discussed, the main groups were those not directly applicable to the UK. Although the UK data included in the pooled evidence presented at the meeting did include people of South Asian ancestry, no detailed discussion of this group was reported.

The concept of different cut-offs for different ethnic groups has also been proposed by the WHO, but there is ongoing debate[62-66] and at present, there are no commonly accepted cut-offs or indeed, methods to determine specific cut-offs.[66;67] However, research is currently being undertaken,[68] and any update of this guidance will consider this new evidence as appropriate. For this guidance, we have therefore looked for evidence on how different cut-offs are associated with mortality and morbidity in ethnic populations (appropriate to the UK) both in the UK and in the countries of origin.

The Newcastle Heart project[69] compared coronary heart disease (CHD) risk factors in Indians, Pakistanis and Bangladeshis, and also compared South Asians (as a group) with people of European origins. The participants were aged between 20 and 74 years, and lived in Newcastle, UK. Measurements included biochemical markers (including fasting insulin, lipids, blood glucose) and anthropometry, and other clinical factors (including blood pressure and electrocardiograms). Another aim of the project was to determine the association between ethnic and socioeconomic inequalities, physical activity, social networks and cardiovascular risk factors.[70-74]

The authors reported (in several papers) that:

- The risk of CHD was not uniform among South Asians but that, overall, South Asians had a higher level of CHD than Europeans.[69]
- South Asians did not appear to have higher levels of lipoprotein (a) levels (which, in combination with high insulin resistance, was hypothesised to explain the increased level of heart disease).[74]

- South Asians had lower levels of habitual physical activity than Europeans, and this was likely to contribute to the higher levels of diabetes and cardiovascular risk.[72]

The authors suggested that for South Asians living in Newcastle, the European pattern of inequalities (where social class, education and deprivation were associated with disease and risk factors) were becoming established, with different rates of establishment occurring in different ethnic groups.[70] When different models of predicting cardiovascular disease were applied to the different ethnic groups, a variety of results were seen. However, overall, the authors concluded that 'the potential gains from controlling major established risk factors could be substantial in South Asians and greater than in Europeans'.[75]

There remains uncertainty about how ethnic, migrant populations may or may not adapt over time to the patterns of risk of the indigenous population. Lean and co-workers compared anthropometric measures and behavioural associations in migrant and British-born South Asians and Italians and the general population of British women living in the west of Scotland. No differences were found in anthropometry between the British-born South Asian women and the general population women. The authors concluded that these results offered 'hope that some of the high cardiovascular risks in South Asians in Britain may be overcome by lifestyle modification, and that the risks may reduce over generations through acculturation'.[76] The influence of maternal nutrition, birth weight and initial weight gain on future health and risk of obesity in adulthood is also unclear (although evidence is emerging).[77-79]

Methods

The evidence review was based on relevant, identified systematic reviews and primary studies assessing whether the association between BMI and waist circumference and morbidity is different between different ethnic groups in UK populations. This review considered only Asian and black populations. Due to the lack of evidence and ongoing international debate on this topic, we asked experts[§] in the area to suggest any additional references. The suggested references were scanned and included as appropriate.

Asian population

UK evidence

Five studies were identified that investigated the measurement of obesity in ethnic groups in the UK population. Three of these associated proxy indicators of obesity with morbidity[80-82] and the remaining two investigated the correlation between BMI and skinfold thickness.[83;84] The key findings were as follows:

- For equivalent BMIs, Pakistani adult males were found to have significantly more truncal adiposity and total adiposity than white males as measured by skinfold thickness.[83;84]

- Significant differences were found in associations between proxy measures of obesity and features of the metabolic syndrome with regard to:

    - waist-to-hip ratio and triglycerides in European and Chinese women

    - waist circumference, waist-to-hip ratio and waist-to-height ratio and triglycerides and HDL cholesterol in European and South Asian (Indian, Pakistani or Bangladeshi origin) women

    - waist circumference and waist-to-hip ratio and serum 2-hour glucose in European and South Asian males.[81]

- For equivalent waist-to-hip ratios, South Asian males (Sikh, Punjabi Hindu, Gujarati Hindu and Muslim) were found to have significantly higher diabetes prevalence and serum insulin (excluding people with diabetes) but not significantly different HDL cholesterol, triglyceride and systolic blood pressure.[80]

- However, another study found no relation between central or generalised adiposity and plasma triacylglycerol (TAG) in Sikh men. Although there was a

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[§] Professor Philip James and Dr Kamlesh Khunti positive association between central body fat and insulin resistance, this was less strong for Sikh men than for white men.[82]

- Waist circumference and waist-to-height ratio were more consistently associated with features of metabolic syndrome than waist-to-hip ratio when comparing across European, Chinese and South Asian groups.[81]

In another series of papers,[85;86] the health and coronary risk of a British Punjabi population was compared with that of the general population in Glasgow. However, this was a cross-sectional survey with physical measures, and was not a study to determine the level of association between the different anthropometric measures and risk, so was not included in the detailed review.

International evidence

These findings are broadly consistent with studies and reviews of studies of Asian population groups outside the UK.[87-93] In 2004, a WHO expert consultation[94] reviewed the scientific evidence relevant to recommending BMI cut-off points for determining overweight and obesity in Asian populations. Combining 11 data sets for Asian populations (China, Hong Kong, India, Indonesia, Japan, Republic of Korea, Malaysia, Philippines, Singapore, Taiwan and Thailand) the consultation found that for the same age and percentage of body fat, BMI was 1.3 kg/m^2 (±0.1) lower in females and 1.4 kg/m^2 in males compared with their European counterparts. However, these differences varied substantially between different Asian populations.

> ‘From the analyses undertaken, Hong Kong Chinese, Indonesians, Singaporeans, urban Thai, and young Japanese had lower BMIs at a given body fat compared with Europeans, whereas Beijing (northern) Chinese and rural Thai had similar values to those of Europeans. These differences across Asian groups might be because of the methods used, but might also reveal real differences among the ethnic groups’[94]

The key conclusions were that:

- On the basis of available data in Asia, Asians generally have a higher percentage of body fat than white people of the same age, sex and BMI.
- The proportion of Asian people with risk factors for type 2 diabetes and cardiovascular disease was substantial even below the existing cut-off point of 25 kg/m^2.
- Current (WHO) cut-off points do not therefore provide an adequate basis for taking action on risks related to overweight and obesity in many populations in Asia.

However, the available data do not necessarily indicate one clear BMI cut-off point for all Asian population groups for overweight or obesity. Cut-offs for observed risk varied from 22 kg/m^2 to 25 kg/m^2 and for high risk from 26 kg/m^2 to 31 kg/m^2.

Two key recommendations were as follows:

- Trigger points for public health action should be 23 kg/m^2 (increased risk) and 27.5 kg/m^2 (high risk).
- Where possible, in populations with a predisposition to central obesity and related increased risk of developing the metabolic syndrome, waist circumference should also be used to refine action levels on the basis of BMI.

There is some limited evidence that for a given BMI or waist circumference, morbidity risk in South Asian populations (of Pakistani, Bangladeshi and Indian origin) resident in the UK may be higher.

Black population

UK evidence

Only one UK-based study was found that investigated the measurement of obesity in the male black population.[80] However, the focus of this study was on differences in the relation of central obesity with cardiovascular risk, insulin resistance and diabetes prevalence between European and South Asian populations. The sample size of the Afro-Caribbean group was considerably smaller (European = 1515, South Asian = 1421, Afro-Caribbean = 209). Unlike the European and South Asian groups, data on risk factors for the Afro-Caribbean group were not controlled for waist-to-hip ratio so it is difficult to say whether the findings have a bearing on appropriate cut-offs for Afro-Caribbeans. However, a general comparison of the Afro-Caribbean population sample with the European population found that:

- waist-to-hip ratio was not significantly different but BMI was significantly higher
- diabetes prevalence was significantly higher but serum insulin levels were not significantly different
- median systolic and diastolic blood pressures were significantly higher
- plasma triglyceride was significantly lower and HDL cholesterol significantly higher.

International evidence

Elsewhere, a large-scale study[95] of the relation between BMI and body fat in black populations in Nigeria, Jamaica and the USA concluded that within populations bioelectrical impedance analysis as a measure of percentage body fat was not a better predictor of blood pressure, or waist or hip circumference. However, for similar levels of BMI, body fat varied substantially. Nigerians had a greater fat-free mass than Jamaicans and Jamaicans had a greater proportion than African Americans. The study did not make comparisons with white populations.

A smaller-scale study[96] set in the USA compared the association between upper body obesity and cardiovascular and diabetic risk in white and black pre-menopausal women. This found that upper body obesity (as assessed by waist-to-hip ratio) is not as potent a risk factor for diabetes and coronary heart disease in black women as it is in white women. Also, whereas in white women upper body obesity was associated with significantly greater glucose intolerance, hyperinsulinaemia and insulin resistance, this was not significant in black women (that is, upper body fat distribution has less impact on carbohydrate metabolism). The sample size for this study was small (black women = 22, white women = 20).

Summary

In summary, the evidence base for differences in the association of BMI, waist circumference and bioimpedance with morbidity is limited, particular in black ethnic groups. Available evidence for South Asian groups was consistent with findings from studies in populations living in South Asia. This may not be surprising as UK studies have focused particularly on first generation migrants.

The findings on South Asian populations in the UK were consistent with those from the WHO expert consultation which assessed populations living in South Asia (although these also included a wider range of populations).

Therefore, there is probably insufficient evidence to make any clear recommendations about separate cut-offs for ethnic groups in the UK, as distinct to the cut-offs recommended for Asian populations by the WHO.

5.2 B: Public health

The following is based on an evidence review produced by Cardiff University.

Detailed evidence tables and supporting information are in Appendix 3.

5.2.1 Evidence statements (Table 5.12)

Table 5.12 Evidence statements and grading

No.	Evidence statement	Grade	Evidence
Observational longitudinal studies			
Children			
1	Limited evidence suggests that attempting to identify children at risk of obesity before 2 years of age has poor predictability	3	One longitudinal study (3) (Toschke et al. 2004[97])
2	Children at risk of becoming overweight or obese may be identified from opportunistic monitoring using growth charts after 2 years of age	3	Two longitudinal studies (both 3) (Guo 2002,[98] He and Karlberg 2002[99])
3	There is some evidence that children at risk of overweight or obesity may be identified by assessing measures of habitual activity levels and diet	3	Two longitudinal studies (both 3) (Barba 2001[100] as addition to anthropometric measures, Metcalf et al. 2002[101])
4	There is some evidence that measures in addition to BMI – height and waist circumference – may aid the identification of children at risk of overweight and obesity	3	Three longitudinal studies (two of which linked; all 3) (Maffeis et al. 2001,[102] Freedman et al. 2001,[103] Freedman 2002 et al.[104])
5	Based on two studies, schools may provide an opportunity for monitoring the growth and activity levels of children	3	Two longitudinal studies (both 3) (Barba et al. 2001,[100] Metcalf et al. 2002[101])
Adults			
6	There is some evidence that considering an individual's weight history (for example, previous weight gain or loss, previous attempts at dieting) and monitoring more recent weight gain may help identify adults	3	Two longitudinal studies (both 3) (Kroke et al. 2002,[105] St Jeor et al. 1997[106])

No.	Evidence statement	Grade	Evidence
	at risk of becoming overweight or obese in the future		

Existing guidance and recommendations

UK based			
7	There is no existing UK guidance on the identification of children and adults at risk of obesity	N/A	N/A
8	There is a lack of consensus in existing UK-based 'recommendation' papers on whether to regularly monitor or screen BMI, particularly in children	4	No clear link to evidence or low quality; expert opinion
9	Two of the three UK-based recommendation papers have suggested schools as an appropriate setting if regular monitoring is considered	4	No clear link to evidence or low quality; expert opinion
Non-UK based			
10	The majority of non-UK guidance and recommendation documents suggest that periodic monitoring of weight status and BMI and waist circumference measurements should be routinely undertaken	4	No clear link to evidence or low quality; expert opinion

BMI, body mass index; N/A, not applicable.

See Appendix 3 for associated evidence tables.

5.2.2 Methodology

Database searches were carried out in June/July 2005 for papers published from 1990 onwards (1995 onwards for systematic review level evidence). An additional range of databases were searched for guidelines (see Appendix 3). A final update search was completed on 1 December 2005 on a reduced number of databases. From an initial 1404 hits, 114 papers were assessed in detail, of which 10 papers met the critical appraisal criteria for inclusion in evidence tables. An additional 561 guidelines were identified, of which 44 were assessed in detail and of which 14 met the criteria for inclusion (5 clinical practice guidelines, 2 recommendation statements, 4 policy statements, 2 reports and 1 briefing paper).

The inclusion and exclusion criteria for the review adhered to the standard public health review parameters for interventions. In addition, it was agreed with the Guidance Development Group (GDG) that studies should only be included in this review if:

- the paper reports an intervention to identify adults and/or children who are potentially at risk for developing obesity and who would benefit from participation in a prevention/public health intervention to manage weight
- the paper is a recommendation or guideline for identifying adults and/or children who are potentially at risk for developing obesity and who would benefit from participation in a prevention/public health intervention to manage weight
- the paper concludes that the tools evaluated have the potential for use in identification interventions.

Tooth et al 2005[107] was used to appraise observational longitudinal studies and the AGREE instrument (www.agreecollaboration.org/instrument) was used to appraise guidelines and recommendation documents. For the purposes of this review a clinical or practice guideline was defined as a document that aimed to identify, summarise and evaluate the best evidence and was based on a systematic review of the current research evidence. Public/policy statements and recommendations were defined as documents that aimed to provide advice or recommendations and were likely to have been developed based on consensus agreement by an expert panel.

Please note that the Department of Health (DH) has recently issued ‘Measuring childhood obesity: guidance to primary care trusts’. However as this was published in January 2006 (that is, after the agreed search dates) it has not been appraised for this version of the review. The DH guidance will be appraised before final publication of this NICE guidance.

5.2.3 Identification of individuals who may benefit from participation in public health interventions to manage weight

There is limited evidence on the effectiveness of interventions to identify children and adults who are likely to become overweight or obese and would benefit from interventions. This is particularly the case in adults. All studies had some confounders. Only one study[101] was carried out in the UK. No UK-based corroborative data were identified other than one accelerometer study, but it is likely that the findings are applicable to the UK. No cost-effectiveness data were identified.

5.2.3.1 Children

Eight moderate quality observational longitudinal studies in children[97–104] suggest that those at risk of becoming overweight or obese may be identified from opportunistic monitoring of growth charts after 2 years of age (including larger than expected weight gain and early 'rebound'),[98,99] potentially using anthropometric measures in addition to BMI (height and waist circumference) and from assessing measures of habitual activity levels (for example, through an accelerometer) and diet.[101] Attempting to identify children at risk before 2 years of age had poor predictability.[97] Of the four studies measuring anthropometric measures, one[102] concluded that measurement of waist circumference at age 8 may be a promising index to predict overweight at puberty, and two linked studies[103,104] concluded that a measurement of height at age 7–8 could be used to identify more accurately children who are likely to become overweight adults, although this may only be true for those children already overweight. A further study,[100] which measured anthropometric measures and examined lifestyle factors such as diet and physical activity, concluded that large-scale involvement of primary schools in screening programmes could identify those children at risk of being overweight and obese in adulthood and for whom strategies to prevent overweight and obesity would be most effective. No studies were found which considered identifying children by their parent's weight/obesity.

5.2.3.2 Adults

Two studies with some confounders,[105,106] one large retrospective cohort study and one relatively small ongoing prospective study, examined interventions to identify adults at risk of overweight and obesity. The results suggest that considering an individual's weight history (for example, previous weight gain or loss, previous attempts at dieting) and monitoring more recent weight gain (for example over 2.3 kg) may help identify adults at risk of becoming overweight or obese in future.

5.2.4 Existing guidelines and recommendations

There is currently no available formal guidance in the UK and there is a lack of consensus in the existing 'recommendation' papers on whether to regularly monitor or screen BMI, particularly in children. No corroborative data were identified, but it is likely that the findings are applicable to the UK. No cost data were identified.

5.2.4.1 UK-based guidance and recommendations

No usable UK guidelines were identified. Following the advice of SIGN, the existing SIGN guidelines for adults[108] were not considered due to methodological problems. These guidelines will be updated in the future. SIGN guidance for children[7] was considered, but excluded as it discussed identification of overweight and obesity only.

The conclusions of three UK recommendation papers suggest that there is currently no consensus available for the screening of children for unhealthy weight gain. A policy statement form the UK's National Screening Committee in 2005,[109] based on expert consensus opinion, recommended that screening should not be offered whereas the evidence from a briefing paper prepared by the Child Growth Foundation[110] firmly recommended universal serial BMI assessments for children at least until the end of primary school. One further report from the House of Commons Select Committee on Health in 2004,[111] supported the guidance suggested by the Child Growth Foundation and suggested that BMI measures should be recorded annually for school-aged children.

The evidence underpinning the identified recommendations is not available or is of lower-level quality. According to the AGREE instrument for the appraisal of guidelines only two publications would be recommended (National Screening Committee 2005,[109] Child Growth Foundation 2004[110]), one with provisos (National Screening Committee[109]).

5.2.4.2 Non-UK-based guidance and recommendations

Of the 11 identified non-UK guidance documents, overall evidence from nine recommendations suggests that periodic monitoring of weight status and BMI and waist circumference measurements should be routinely undertaken.

Five clinical practice evidence-based guidelines were identified, of which four recommended recurrent screening for weight gain. Three of these were from the USA, one from Canada and one from Australia. Of the US-based recommendations, one recommended that height, weight and BMI measurements be taken annually for mature adolescents and adults,[112] one) recommended that adults who are not overweight or who have no history of overweight should be screened for weight, BMI and waist circumference every 2 years,[113] and one firmly recommended against screening for obesity for asymptomatic adults.[114] The Canadian guidance, based on expert opinion, advocated the inclusion of monitoring and surveillance data on nutrition, physical activity and measures of adiposity for children in public health policies.[115] The Australian guidance recommended recurrent measurement of height and weight in a nationally representative sample of children and adolescents.[116] Supporting evidence for clinical practice guidelines was obtained from controlled comparative studies, observational data and expert judgement from clinical experience. According to the AGREE appraisal criteria all five clinical practice guidelines would be strongly recommended.

Two recommendation statements, one US-based and one from Canada, gave conflicting advice. The Canadian evidence-based statement concluded that there was insufficient evidence to recommend for or against BMI measurement in the periodic health examination of the general public,[39] whereas the US-based statement proposed an algorithm to determine a child's BMI at health visits.[117] No supporting evidence for the US statement is available and the frequency for health visits is not indicated.

Three policy statements all supported serial assessments for weight monitoring. Two US-based statements recommended recurrent measurement of BMI, one of which[118] recommended annual routine assessments to calculate and plot BMI measurements for children and the assessment of eating and activity patterns for excessive weight gain relative to linear growth. The other US-based statement[119] recommended periodic BMI measurement for all adults, independent of weight or BMI, along with consistent counselling about healthful dietary and physical activity patterns from general practitioners. There are no apparent links to supporting evidence for either of these statements. One evidence-based collaborative policy statement from Canada suggested that repeated height and weight measurements be part of scheduled well-baby and well-child health visits and that health maintenance visits for children be organised according to a child's immunisation schedule.[120] Continued growth monitoring on an annual basis at primary care visits for older children and adolescents was also recommended. These recommendations were based on expert opinion only. BMI-for-age screening from age 2 onwards to track and predict future risk of being overweight was also advised.

According to the AGREE appraisal criteria the five recommendation and policy statements are broadly recommended with provisos although one[117] is an identification algorithm only for children and adolescents and would not be recommended as a guideline.

One taskforce report from Australia recommended, as part of its national action agenda, regular tracking of height and weight status in the community as well as monitoring of knowledge, attitudes, intentions, behaviours and other indicators of healthy eating and active living.[121] The recommendation from this report is not evidence based.

5.3 Review limitations

No review level or controlled trial evidence was found for this review question, resulting in an evidence base of observational longitudinal studies.

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