BMI and WC thresholds

Body mass index and waist circumference thresholds for intervening to prevent ill health among black, Asian and other minority ethnic groups in the UK

External evidence review

Evidence review for Public Health Guidance

Developed by Bazian for NICE

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About Bazian

Bazian specialises at evidence-based analysis and consulting to help NHS organisations and others. Our multidisciplinary team includes information specialists, health research analysts and clinicians with established strengths in applying evidence based methods to quantitative synthesis, health technology assessment, health services research, public health, health economics and modelling. Together we produce tailored outputs to tight timelines and to suit client needs.

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**Acknowledgments**

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# List of Abbreviations

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<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>ACM</td>
<td>All Cause Mortality</td>
</tr>
<tr>
<td>ADA</td>
<td>American Diabetes Association</td>
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<tr>
<td>AUC</td>
<td>Area Under the Curve</td>
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<td>BMI</td>
<td>Body Mass Index</td>
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<tr>
<td>BP</td>
<td>Blood Pressure</td>
</tr>
<tr>
<td>CFBG</td>
<td>Capillary Fasting Blood Glucose</td>
</tr>
<tr>
<td>CI</td>
<td>Confidence Interval</td>
</tr>
<tr>
<td>CRBG</td>
<td>Capillary Random Blood Glucose</td>
</tr>
<tr>
<td>CVD</td>
<td>Cardiovascular Disease</td>
</tr>
<tr>
<td>DH</td>
<td>Department of Health</td>
</tr>
<tr>
<td>FBG</td>
<td>Fasting Blood Glucose</td>
</tr>
<tr>
<td>FBS</td>
<td>Fasting Blood Sugar</td>
</tr>
<tr>
<td>FPG</td>
<td>Fasting Plasma Glucose</td>
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<tr>
<td>HbA1C</td>
<td>Glycated haemoglobin</td>
</tr>
<tr>
<td>HRQ</td>
<td>Health Related Quality of Life</td>
</tr>
<tr>
<td>HSE</td>
<td>Health Survey for England</td>
</tr>
<tr>
<td>IDF</td>
<td>International Diabetes Federation</td>
</tr>
<tr>
<td>NICE</td>
<td>The National Institute for Health and Clinical Excellence</td>
</tr>
<tr>
<td>OECD</td>
<td>Organisation for Economic Co-operation and Development</td>
</tr>
<tr>
<td>OGTT</td>
<td>Oral Glucose Tolerance Test</td>
</tr>
<tr>
<td>r</td>
<td>Correlation coefficient</td>
</tr>
<tr>
<td>ROC</td>
<td>Receiver Operating Characteristics</td>
</tr>
<tr>
<td>SES</td>
<td>SocioEconomic Status</td>
</tr>
<tr>
<td>Sn</td>
<td>Sensitivity</td>
</tr>
<tr>
<td>Sp</td>
<td>Specificity</td>
</tr>
<tr>
<td>UK</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>WC</td>
<td>Waist Circumference</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organization</td>
</tr>
<tr>
<td>WHR</td>
<td>Waist-to-Hip Ratio</td>
</tr>
<tr>
<td>WHtR</td>
<td>Waist-to-Height Ratio (also see WSR)</td>
</tr>
<tr>
<td>WSR</td>
<td>Waist to Stature [height] Ratio</td>
</tr>
</tbody>
</table>
1 Executive Summary

1.1 Background

Two anthropometric indices, body mass index (BMI) and waist circumference (WC) are commonly used to assess overweight and obesity for individuals and populations. Cut-off points are defined from studies of European-derived populations. However, these cut-offs may not be appropriate for other ethnic groups. The National Institute for Health and Clinical Excellence (NICE) has been asked by the Department of Health (DH) to develop public health guidance on assessing body mass index and waist circumference thresholds for intervening to prevent ill health and premature death among adults from black, Asian and other minority ethnic groups in the UK. This guidance will provide recommendations for good practice based on the best available evidence. It is aimed at commissioners, managers and practitioners with public health as part of their remit, working within the NHS, local authorities and the wider public, private, voluntary and community sectors. It may also be of interest to people from black, Asian and minority ethnic groups and other members of the public.

1.1 Aims and Objectives

This review aims to summarise the relevant empirical data that answers four specific questions related to the anthropometric indices in black, Asian and other minority ethnic groups resident in the UK compared with white European groups.

**Question 1:** How accurate are body mass index (BMI) and waist circumference in predicting the future risk of type 2 diabetes, fatal/non-fatal myocardial infarction or stroke and overall mortality among adults from black, Asian and other minority ethnic groups living in the UK compared to the white or general UK population?

**Question 2:** What are the BMI and waist circumference cut-off points indicating a healthy range for these measures among adults from different black, Asian and other minority ethnic groups living in the UK?
**Question 3:** What are the BMI and waist circumference cut-off points that indicate an increased risk of type 2 diabetes, fatal/non-fatal myocardial infarction and stroke and the need for preventative action among adults from different black, Asian and other minority ethnic groups living in the UK?

**Question 4:** What are the cut-off points for BMI and waist circumference among adults from black, Asian and other minority ethnic groups living in the UK that are ‘risk equivalent’ to the current thresholds set for white European populations?

**Expected outcomes:**

Anthropometric measures (that is, BMI or waist circumference) and the associated risk of type 2 diabetes and fatal/non-fatal myocardial infarction or stroke and overall mortality.

The review was conducted in two phases. Phase I resulted in a full report (available in Appendix 1) presented at a PHIAC sub-group meeting in June 2012. **Based on feedback from this meeting, this Phase II report focuses solely on Question 4.** The methods, results and discussion for Questions 1 through 3 are not included in this main report, but can be found in the full Phase I report in Appendix 1.

**1.2 Methods**

This systematic review was undertaken according to the principles recommended in the methods guide for development of NICE public health guidance (2009). Methods followed the development of a review protocol and search protocol. The manual was also used to guide the development of the search methods. Citation searching and an expert call for additional evidence were both used to extend the studies included.

The search strategies were developed and conducted by NICE information specialists. Full text document retrieval was undertaken at NICE. For this review 872 unique studies were identified from database and other sources. Following a first sift at abstract level appraisal, 610 were screened at full text. Of these, 205 were assessed as suitable for inclusion by NICE based on...
expert advice. An adjusted criteria set, developed in negotiation between NICE and Bazian, was used to further sift at full text. This final sifting was based on the following inclusion criteria:

- Population (Black African/Caribbean, South Asian, Middle Eastern, Hong Kong Chinese, mixed race)
- Exposures (BMI and/or WC measured)
- Outcomes (diabetes, stroke, fatal or non-fatal MI, mortality).
- Observational study designs (cohort or cross sectional studies)

Studies were excluded if they were not published in English or if their study design or analysis rendered them unsuitable for data extraction. As Chinese ethnic groups make up a small proportion of the total UK population (see Table 1), priority was given to those Chinese studies conducted in the UK, other Western countries or Hong Kong. As such, 39 studies with Chinese participants conducted in other non-Western countries were excluded. A total of 27 studies were included in Phase I report (see Appendix 1). See Section 3.2 and Appendix 2 for a list of excluded studies and reason(s) for exclusion, and Appendix 3 for a list of excluded Chinese studies.

In June 2012 a PHIAC sub group meeting was held to discuss the initial review and report. Following this meeting, a further sift and review was conducted. Based on feedback from the June 2012 meeting, this Phase II report focuses on absolute risk equivalency between black, Asian and minority ethnic groups and the current overweight and obesity cut-offs in white or European populations. The previously excluded 29 studies in Chinese populations were resifted, as well as an additional 54 papers sent to Bazian by NICE. These papers were included if they met inclusion criteria for Question 4.

Each study was assessed using modified quality checklists described in the methods guide for the development of NICE public health guidance, and scored for validity and applicability (See Appendix 4 for Quality Appraisal Checklists for both review phases).
Applicability of the evidence was assessed according to the methods for the development of NICE public health guidance. Population, setting and outcome characteristics as outlined in the methods manual were considered, and the extent to which these factors aligned with the current review questions was assessed. In addition, the following characteristics were considered to be of particular relevance:

- Population: mean baseline BMI and/or WC
- Setting: UK or Western setting vs. non-Western setting
- Outcomes: diabetes diagnostic methods and criteria

See Section 3.4 for an overview of applicability assessment methods.

Study characteristics and data were extracted from the included studies by a research analyst and checked by a second analyst. The findings were synthesised narratively and used to generate evidence statements. The statements reflect the strength (quality, quantity and consistency) of the evidence and the applicability to black, Asian and minority ethnic groups in the UK.

1.3 Evidence Statements

Question 4

Black populations

Evidence statement Q4.1: BMI cut-points indicating “risk equivalence” for black populations (Type 2 Diabetes)

Strong evidence suggests that black populations have an equivalent risk of diabetes at a BMI of 26 to 29.9 kg/m² as white populations with a BMI of 30 kg/m², and 21 to 23 kg/m² appears to be risk equivalent to 25 kg/m² in a white population.

Q4.1.a: UK or Western Countries

Strong evidence was found from three cohorts in Canada and the US and two cross-sectional studies in the US (Chiu, 2011 [+/+]), Stevens, 2008 [+/+], Stevens, 2002 [++/+]), Stommel, 2010 [+/+], Taylor, 2010 [++/+] and (Pan, 2004 [+/+]), that for
BMI around 30 kg/m² in white populations the equivalent diabetes risk in black populations is at BMI values 0.1 to 4 units lower (26 to 29.9 kg/m²). For a BMI of 25 kg/m² in white populations the equivalent diabetes risk in black populations was found at BMI values 2 to 4 units lower 21 to 23 kg/m².

These studies had moderate applicability to the UK.

**Evidence statement Q4.2: BMI cut-points indicating “risk equivalence” for black populations (myocardial infarction, stroke or mortality)**

Limited evidence was found from one cohort study (Stevens, 2002 [++/+]), that at a BMI of 20 kg/m² black populations have an equivalent mortality risk to that seen in white populations at 30 kg/m². This study has moderate applicability to the UK.

No evidence was found relevant to risk equivalent BMI cut-points for myocardial infarction or stroke in black populations.

**Evidence statement Q4.3: WC cut-points indicating “risk equivalence” for black populations (Type 2 Diabetes)**

No evidence was found relevant to risk equivalent WC cut-points for diabetes in black populations.

**Evidence statement Q4.4: WC cut-points indicating “risk equivalence” for black populations (myocardial infarction, stroke or mortality)**

No evidence was found relevant to risk equivalent WC cut-points for myocardial infarction, stroke or mortality in black populations.

**South Asian populations**

**Evidence statement Q4.5: BMI cut-points indicating “risk equivalence” for South Asian populations (Type 2 Diabetes)**

Q4.5.a: UK or Western Countries

Limited evidence was found from one cohort in Canada (Chiu, 2011 [+/+])² that for BMI 30 kg/m² in white populations the equivalent incident diabetes risk in South Asian
populations was found at BMI values 6 units lower (24 kg/m²). No equivalent value to a BMI of 25 kg/m² was reported.

This study had moderate applicability to the UK.

**Q4.5.b: Other Countries**

Limited graphical evidence was found from one review (Nyamdorj, 2010b [+/-]) related to diabetes risk across BMI values, indicating a risk equivalence at 19 to 20 kg/m² among South Asian men and 30 kg/m² among European men. No risk equivalence points were identified for women at this BMI cut-off, and no values were identified for either men or women equivalent to the risk seen among Europeans at 25 kg/m².

This study had moderate applicability to the UK.

**Evidence statement Q4.6: WC cut-points indicating “risk equivalence” for South Asian populations (Type 2 Diabetes)**

Limited graphical evidence was found from one review (Nyamdorj, 2010b [+/-]) and one cohort study (Cameron, 2010 [+/-]) that at a WC of 62 to 73 cm, South Asian men experience the same diabetes risk as European men exhibit at 102 cm. No risk equivalent values were identified for the European WC cut-off of 94 cm among men, 88 cm among women or 80 cm among women.

These studies had weak to moderate applicability to the UK.

**Evidence statement Q4.7: BMI cut-points indicating “risk equivalence” for South Asian populations (myocardial infarction, stroke or mortality)**

No evidence was found relevant to risk equivalent BMI cut-points for myocardial infarction, stroke or mortality in South Asian populations.

**Evidence statement Q4.8: WC cut-points indicating “risk equivalence” for South Asian populations (myocardial infarction, stroke or mortality)**

No evidence was found relevant to risk equivalent WC cut-points for myocardial infarction, stroke or mortality in South Asian populations.
**Middle Eastern populations**

<table>
<thead>
<tr>
<th>Evidence statement</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q4.9: BMI cut-points indicating “risk equivalence” for Middle Eastern populations (Type 2 Diabetes)</td>
<td>No evidence was found relevant to risk equivalent BMI cut-points for diabetes in Middle Eastern populations.</td>
</tr>
<tr>
<td>Q4.10: BMI cut-points indicating “risk equivalence” for Middle Eastern populations (myocardial infarction, stroke or mortality)</td>
<td>No evidence was found relevant to risk equivalent BMI cut-points for myocardial infarction, stroke or mortality in Middle Eastern populations.</td>
</tr>
<tr>
<td>Q4.11: WC cut-points indicating “risk equivalence” Middle Eastern populations (Type 2 Diabetes)</td>
<td>No evidence was found relevant to risk equivalent WC cut-points for diabetes in Middle Eastern populations.</td>
</tr>
<tr>
<td>Q4.12: WC cut-points indicating “risk equivalence” for Middle Eastern populations (myocardial infarction, stroke or mortality)</td>
<td>No evidence was found relevant to risk equivalent WC cut-points for myocardial infarction, stroke or mortality in Middle Eastern populations.</td>
</tr>
</tbody>
</table>

**Chinese populations**

<table>
<thead>
<tr>
<th>Evidence statement</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q4.13: BMI cut-points indicating “risk equivalence” for Chinese populations (Type 2 Diabetes)</td>
<td>Limited evidence was found from two cohorts (Chiu, 2011 [+/+]), (Stevens, 2008 [+/+]) that for a BMI around 30 kg/m² in white populations the equivalent incident diabetes risk in Chinese populations was found at BMI values 2.5 to 5 units lower. In one (Stevens, 2008 [+/+]) for a BMI around 25 kg/m² in white populations the equivalent incident diabetes risk in Chinese populations was found at BMI values 2 units lower. These studies have moderate applicability to the UK.</td>
</tr>
</tbody>
</table>
Q4.13.b: Other Countries

One review of studies (Nyamdorj, 2010b [+/+]) provides limited evidence that for a BMI around 30 kg/m² in white populations the equivalent incident diabetes risk in Chinese men occurs at BMI values 5 kg/m² lower for Chinese men and 8 kg/m² lower for Chinese women.

This review had moderate applicability to the UK.

Evidence statement Q4.14: WC cut-points indicating “risk equivalence” for Chinese populations (Type 2 Diabetes)

Q4.14.a: UK or Western Countries

No evidence was found relevant to risk equivalent WC cut-points for diabetes in Chinese populations in the UK or other Western populations.

Q4.14.b: Other countries

Limited graphical evidence was found from one review (Nyamdorj, 2010b [+/+]) that a diabetes risk equivalent WC for Chinese men is 82 cm compared to 102 cm in European men, and 67 to 70 cm among Chinese men was found to be risk equivalent to 94 cm among European men. An equivalent diabetes risk is seen among Chinese women at 70 to 73 cm, compared to 88 cm in European women.

This study has moderate applicability to the UK.

Evidence statement Q4.15: BMI cut-points indicating “risk equivalence” for Chinese populations (myocardial infarction, stroke or mortality)

No evidence was found relevant to risk equivalent BMI cut-points for myocardial infarction, stroke or mortality in Chinese populations.

Evidence statement Q4.16: WC cut-points indicating “risk equivalence” for Chinese populations (myocardial infarction, stroke or mortality)

No evidence was found relevant to risk equivalent WC cut-points for myocardial infarction, stroke or mortality in Chinese populations.
Mixed ethnic populations

Evidence statement Q4.17: Optimal BMI cut-points for mixed ethnic populations (Type 2 Diabetes)
No evidence was found relevant to risk equivalent WC cut-points for diabetes in mixed ethnic populations.

Evidence statement Q4.18: Optimal WC cut-points for mixed ethnic populations (Type 2 Diabetes)
No evidence was found relevant to risk equivalent BMI cut-points for myocardial infarction, stroke or mortality in mixed ethnic populations.

Evidence statement Q4.19: BMI cut-points indicating “risk equivalence” for mixed ethnic populations (myocardial infarction, stroke or mortality)
No evidence was found relevant to risk equivalent BMI cut-points for myocardial infarction, stroke or mortality in mixed ethnic populations.

Evidence statement Q4.20: WC cut-points indicating “risk equivalence” for mixed ethnic populations (myocardial infarction, stroke or mortality)
No evidence was found relevant to risk equivalent WC cut-points for myocardial infarction, stroke or mortality in mixed ethnic populations.

1.4 Discussion

This report addresses an on going debate about the interpretation of recommended body-mass index (BMI) or waist circumference cut-off points for determining overweight and obesity in black, Asian and minority ethnic populations in the UK. It reports the evidence that could inform a decision of whether population-specific cut-off points for BMI and or WC are necessary or appropriate.

Key Messages

● The identified research concerning risk-equivalency cut-points has methodological limitations and care is needed in interpreting it.

● The direct applicability to UK populations of some of the identified evidence may be limited.
● Limited evidence was available for the separate minority ethnic groups; several of the evidence statements were based on cut-points derived from a single study.

● Identification of appropriate risk-equivalency cut-points was not possible in several studies, as the risk in black, Asian and minority ethnic groups did not reach levels as low as those seen among white participants at the current overweight and obesity cut-points.

● No evidence was identified relevant to risk-equivalency points in Middle Eastern and mixed ethnic populations. Limited evidence was identified relevant to waist circumference risk-equivalency values, or to BMI values to define overweight among black, Asian and minority groups in the UK.

● No evidence was identified relevant to risk-equivalency points for stroke or myocardial infarction. A single study was identified for mortality risk-equivalency cut-points.

Question 4 - What are the cut-off points for BMI and waist circumference among adults from black, Asian and other minority ethnic groups living in the UK that are ‘risk equivalent’ to the current thresholds set for white European populations?

This question seeks to compare the average risks for individuals and populations from different ethnic groups with those expected for European populations at the existing 25 kg/m² and 30 kg/m² cut-points. The evidence is best inferred from graphs of BMI against incident or prevalent disease by drawing a horizontal line that intersects all plots and is drawn at the level of risk equivalent to a BMI or WC threshold in white populations. Studies are included if they have reported risk in this way and include the relevant ethnic groups compared to white populations.

Incidence and prevalence of diabetes is higher at all BMI and WC cut-points for all minority groups in comparison to white populations. These studies
variably report the additional risk factors that were adjusted for in these analyses. Caution is advised in interpreting the unadjusted incidence and unadjusted prevalence rates which have come from cross-sectional studies. One large US study (Stommel, 2010 [+/+])\(^5\) adjusted for age, sex, education, poverty, marital status, insurance, residency, health behaviours and foreign birth. In these fully adjusted analyses in US populations, similar equivalent BMI or WC equivalents occurred across black, Hispanic, East Asian and white groups (See Figure 8). This could imply that much of the separation of the ethnic specific rates of diabetes, the gap between these curves, is due to confounding by diabetes risk factors other than obesity, and not fully accounted for.

**BMI risk-equivalency**

**Overweight**

The identified research suggest that appropriate risk-equivalent cut-points to define overweight may be 25 kg/m\(^2\) in white populations, 21 to 23 kg/m\(^2\) in black populations and 23 kg/m\(^2\) in Chinese populations.

No risk equivalency cut-points were identified for South Asian, Middle Eastern or mixed ethnic populations.

**Obesity**

The evidence suggests that appropriate risk-equivalent cut-points for defining obesity may be 30 kg/m\(^2\) in white populations, 26 to 29 kg/m\(^2\) in black populations, 19 to 24 kg/m\(^2\) in South Asian populations, and 22 to 25 kg/m\(^2\) in Chinese populations.

No risk equivalency cut-points were identified for Middle Eastern or mixed ethnic populations.

**WC risk-equivalency**

**Overweight**
Limited evidence suggests that appropriate risk equivalency cut-points to define overweight may be 94 cm among white men and 67 to 70 cm among Chinese men.

No evidence was identified relevant to overweight risk-equivalency cut-points for men black, South Asian, Middle Eastern or mixed ethnic populations, or for women in any of the black, Asian and minority ethnic groups.

**Obesity**

Limited evidence suggests that appropriate risk-equivalent obesity cut-points may be 102 cm among white men, 73 cm among black men and 82 cm among Chinese men. Appropriate cut-points to define obesity among women may be 88 cm for white women and 70 to 73 cm for Chinese women.

No evidence was identified relevant to waist circumference thresholds that represent obesity risk-equivalency among men from black, Middle Eastern or mixed ethnic populations. Furthermore, no evidence was identified relevant to WC thresholds for obesity among women in black, South Asian, Middle Eastern or mixed ethnic populations.

1.5 **Summary**

This report addresses an on going debate about the interpretation of recommended body-mass index (BMI) or waist circumference cut-off points for determining overweight and obesity in black, Asian and minority ethnic populations in the UK. It reports the evidence that could inform a decision of whether population-specific cut-off points for BMI and or WC are necessary. The identified evidence suggests that black, Asian and minority ethnic groups are at a higher risk of diabetes than white populations at the same BMI and WC values.

No evidence was identified to support the development of a single cut-point that could be applied to all black, Asian and minority ethnic groups representing a risk of diabetes equivalent to that seen among white populations at the currently recommended cut-off values. However, limited evidence was found relevant to individual sub-populations.
This limited evidence (consistent findings from three studies) suggests that a BMI threshold of 23 kg/m$^2$ in black and Chinese populations is approximately equivalent to an overweight cut-point of 25 kg/m$^2$ in European populations. Similarly limited evidence (consistent findings from four studies) suggests that a BMI of 24 kg/m$^2$ among South Asian and Chinese populations, and 26 kg/m$^2$ for black populations is approximately equivalent to an obesity cut point of 30 kg/m$^2$ in European populations for risk of diabetes.

Significant gaps in the evidence were found. No studies were identified with Middle Eastern populations, and there were few studies that included stroke, myocardial infarction or morality as an outcome, or waist circumference as an independent variable. Finally, no large prospective studies were identified that compared white populations to black, Asian and minority ethnic groups resident in the UK.
2 Introduction

2.1 Background

The National Institute for Health and Clinical Excellence (NICE) has been asked by the Department of Health (DH) to assess the body mass index (BMI) and waist circumference thresholds for intervening to prevent ill health among adults (aged 18 years and over) from black, Asian and other minority ethnic groups in the UK.

Two anthropometric indices, body mass index (BMI) and waist circumference (WC) are the primary measures of body composition currently used to assess overall obesity and abdominal obesity. In developed countries they are used as proxy measures of health risk for individuals and populations, particularly for risk of non-communicable diseases such as heart disease, stroke and cancer. According to the World Health Organisation (WHO), in developing nations they have historically been used to assess undernutrition, though increasingly both undernutrition and non-communicable diseases are being recognised together in populations in these countries.\(^\text{10}\)

Obesity is defined by the WHO (2000) as a condition of abnormal or excessive fat accumulation in adipose tissue to the extent that health is impaired.\(^\text{11}\)

2.2 Population groups

The latest population estimates by ethnic group for England and Wales indicate that the majority White British group has stayed constant in size between 2001 and 2009 while the population belonging to other groups has risen, see Table 1.

According to mid-2009 ONS population estimates, 6.62 million people in England and Wales now identify as belonging to a black, Asian or other minority ethnic group, representing 12.1% of the total population.\(^\text{12}\)

The concept of ‘ethnicity’ or ‘ethnic group’ is difficult to define.\(^\text{13}\) It is a multidimensional concept with dimensions of, colour, national identity,
citizenship, religion, language, country of birth and culture. When a person identifies with a particular ethnic group, it may imply shared origins, social background, culture, or traditions which are distinctive and maintained between generations. However, in a world of migration and mixing, the concept of ethnicity is dynamic. It is virtually impossible to create single, mutually exclusive categories of self identified ethnicity. Amongst the 16 ethnic groups listed in the Census for the UK, it is those who identify as black Asian, Chinese and minority groups listed in Table 1 who are the focus of this review.

Nearly half (48%) of the total black and minority ethnic population live in the London region, where they comprise 29% of all residents.\textsuperscript{14}

<table>
<thead>
<tr>
<th>Ethnic group</th>
<th>Mid-2009 population (thousands)</th>
<th>Average annual percentage growth (%)</th>
<th>Proportion of total population (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All groups</td>
<td>54,809.1</td>
<td>0.6</td>
<td>100%</td>
</tr>
<tr>
<td>White: British</td>
<td>45,682.1</td>
<td>0.0</td>
<td>83.3%</td>
</tr>
<tr>
<td>White: Irish</td>
<td>574.2</td>
<td>-1.5</td>
<td>1.0%</td>
</tr>
<tr>
<td>White: other white</td>
<td>1932.6</td>
<td>4.3</td>
<td>3.5%</td>
</tr>
<tr>
<td>Mixed: White and Black Caribbean</td>
<td>310.6</td>
<td>3.3</td>
<td>0.6%</td>
</tr>
<tr>
<td>Mixed: White and Black African</td>
<td>131.8</td>
<td>6.3</td>
<td>0.2%</td>
</tr>
<tr>
<td>Mixed: White and Asian</td>
<td>301.6</td>
<td>5.8</td>
<td>0.6%</td>
</tr>
<tr>
<td>Mixed: Other Mixed</td>
<td>242.6</td>
<td>5.5</td>
<td>0.4%</td>
</tr>
<tr>
<td>Asian: Indian</td>
<td>1434.2</td>
<td>3.9</td>
<td>2.6%</td>
</tr>
<tr>
<td>Asian: Pakistani</td>
<td>1007.4</td>
<td>4.1</td>
<td>1.8%</td>
</tr>
<tr>
<td>Asian: Bangladeshi</td>
<td>392.2</td>
<td>4.0</td>
<td>0.7%</td>
</tr>
<tr>
<td>Other Asian</td>
<td>385.7</td>
<td>5.7</td>
<td>0.7%</td>
</tr>
<tr>
<td>Black Caribbean</td>
<td>615.2</td>
<td>0.9</td>
<td>1.1%</td>
</tr>
<tr>
<td>Black African</td>
<td>798.8</td>
<td>6.2</td>
<td>1.5%</td>
</tr>
<tr>
<td>Other Black</td>
<td>126.1</td>
<td>3.2</td>
<td>0.2%</td>
</tr>
<tr>
<td>Chinese</td>
<td>451.5</td>
<td>8.6</td>
<td>0.8%</td>
</tr>
<tr>
<td>Other</td>
<td>422.6</td>
<td>8.0</td>
<td>0.8%</td>
</tr>
<tr>
<td>Non-‘White British’</td>
<td>9127.1</td>
<td>4.1</td>
<td>16.7%</td>
</tr>
<tr>
<td>Black, Asian and other minority ethnic group</td>
<td>6620.3</td>
<td></td>
<td>12.1%</td>
</tr>
</tbody>
</table>


2.3 The importance of and prevalence of obesity

2.3.1 Body Mass Index (BMI)

The most common method of measuring obesity is by calculating an individual’s Body Mass Index (BMI). This is calculated by dividing a person’s weight measurement (in kilograms) by the square of their height (in metres).

In adults, a BMI of 25 to 29.9 kg/m² is categorised as overweight and a BMI of 30 kg/m² or above as obese.
BMI is currently the most commonly used method for measuring the prevalence of obesity at the population level. No specialised equipment is needed and therefore it is easy to measure accurately and consistently across large populations. BMI is also widely used around the world, which enables comparisons between countries, regions and population sub-groups.

For most people, BMI correlates well with their level of body fat. However, certain factors such as fitness and ethnic origin are thought to alter the relationship between BMI and body fat. Other measurements of obesity distribution, such as waist circumference are often collected to confirm an individual person's weight status and provide a better measure of abdominal obesity.\(^\text{15}\)

### 2.3.2 Waist circumference (WC)

Waist circumference is also used as a measure of obesity. A ‘raised’ waist circumference is defined as above 102 cm for men and above 88 cm for women. These cut-off points correspond to the risk threshold for a range of chronic diseases and mortality among Europeans.\(^\text{11}\) Several methods for measuring waist circumference have been reported, which may make comparing measures between studies and countries difficult. The most commonly used method identified in the current review assessed waist circumference midway between the costal margin and iliac crest. Alternative measures include at the umbilicus, or midway between the xyphoid process and umbilicus.

### 2.3.3 Obesity worldwide

Obesity is a public health problem that has become epidemic worldwide.\(^\text{16}\) Overweight and obesity are accepted as major risk factors for type 2 diabetes, cardiovascular diseases (coronary heart disease and stroke) and various cancers. These can lead to further morbidity and mortality. A public health approach to developing population-based strategies for the prevention of excess weight gain is of great importance. However, public health intervention programmes have had limited success so far in tackling the rising prevalence of obesity.
According to the WHO, there will be about 2.3 billion overweight people aged 15 years and above, and over 700 million obese people worldwide in 2015. Overweight and obesity are the fifth leading risk factor for global deaths. The WHO reports that at least 2.8 million adults die each year globally as a result of being overweight or obese. In addition, 44% of the diabetes burden, 23% of the ischaemic heart disease burden and between 7% and 41% of certain cancer burdens are attributable to overweight and obesity.

Although a few developed countries have experienced a drop in the prevalence rate of obesity in the past decade, the prevalence of obesity continues to rise in many parts of the world, especially in the Asia Pacific region. For example, the Asia Pacific Cohort Studies Collaboration reports that the combined prevalence of overweight and obesity increased in China from 3.7% in 1982 to 19.0% in 2002.

The prevalence of obesity worldwide is important to this review as many studies included have been conducted in countries other than the UK. The mean BMI reported in the “county of birth” of first generation migrants to the UK can be informative when assessing the applicability of these studies. A WHO report from the Global Health Observatory (2012) estimates the prevalence of overweight and obesity in the WHO Regions. Rates were highest in the Americas (62% for overweight and 26% for obesity for both sexes) and lowest in the WHO Region for South East Asia (14% for overweight and 3% for obesity in both sexes). In the WHO Region for Europe, the Eastern Mediterranean and the Americas over 50% of women were overweight. For all three of these regions, roughly half of overweight women are obese (23% in Europe, 24% in the Eastern Mediterranean, 29% in the Americas). In all WHO regions women were more likely to be obese than men. In the WHO regions for Africa, Eastern Mediterranean and South East Asia, women have roughly double the obesity prevalence of men.

2.3.4 Obesity in the UK

Obesity imposes a significant human burden of morbidity, mortality, social exclusion and discrimination. There is also a significant healthcare cost
associated with treating obesity and its direct consequences. Social care costs are also higher for people who are obese. Higher levels of sickness and absence from work among people who are obese reduce productivity and impose costs on businesses. Premature mortality as a consequence of obesity reduces the national output relative to the level it would be in the absence of obesity.\textsuperscript{21}

The National Obesity Observatory reports that the prevalence of obesity in England has more than doubled in the last 25 years and is amongst the highest amongst the 34 countries who are members of the Organisation for Economic Co-operation and Development (OECD).\textsuperscript{15} The OECD is an international organisation of richer countries dedicated to global development. The latest Health Survey for England (HSE) data shows that in England in 2010:\textsuperscript{22,23}

- 62.8\% of adults (aged 16 or over) were overweight or obese
- 30.3\% of children (aged 2-15) were overweight or obese
- 26.1\% of all adults and 16\% of all children were obese

Foresight’s Tackling Obesities: Future Choices report, published in October 2007, predicted that if no action was taken, 60\% of men, 50\% of women and 25\% of children in Britain would be obese by 2050.\textsuperscript{24}

Obesity negatively impacts on health related quality of life (HRQL) and there is evidence that the negative impact of obesity is greater in people from lower socioeconomic status (SES) groups. Overweight and obese people in lower SES groups have lower HRQL than those of normal weight in the same SES group, and have lower HRQL than those in higher SES groups of the same weight.\textsuperscript{25}

The estimated cost of people being overweight or obese is expected to grow to £49.9 billion by 2050.\textsuperscript{24}
2.3.5 Obesity amongst black, Asian and other ethnic minority groups in the UK

The National Obesity Observatory report that apart from Health Survey for England (HSE) data from 2004, there is little nationally representative data on obesity prevalence in adults from minority ethnic groups in the UK.\textsuperscript{13}

The Health Survey for England (HSE) 2004 contained a sample of individuals from minority ethnic groups and gives the most recent robust data on adult obesity prevalence by ethnic group. Findings suggest that compared to the general population, obesity (BMI more than 30 kg/m\(^2\)) prevalence is lower among men from Black African, Indian, Pakistani, and, most markedly, Bangladeshi and Chinese communities. Among women, obesity prevalence appears to be higher for those from Black African, Black Caribbean and Pakistani groups than for women in the general population and lower for women from the Chinese ethnic group. See Figures 1 and 2.

**Figure 1: Body mass index and waist circumference by ethnic group, 2004, England. (men)**
Figure 2: Body mass index and waist circumference by ethnic group, 2004, England (women)


The Foresight report also modelled the trend in obesity amongst ethnic groups, see Table 2, noting that data sets for some ethnic groups in the 2004 Health Survey for England were relatively small. Black Caribbean and Chinese groups appear to be becoming less obese, with trends suggesting a proportion of just 3% being obese by 2050. Bangladeshi men are also becoming less obese, but this is not the case with Bangladeshi women, although the increase is modest (6% increase). Indian men and women demonstrate smaller increases, while black African women and Pakistani men and women appear to share the trend of the white population.
Table 2: Predicted percentage of population who are obese (i.e. BMI ≥ 30kg/m²) at 2006 and 2050, by ethnic group

<table>
<thead>
<tr>
<th>Ethnic group</th>
<th>Males (%)</th>
<th>Females (%)</th>
<th>Number of Health Survey for England records, 1993-2004 (% of records)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2006</td>
<td>2050</td>
<td>2006</td>
</tr>
<tr>
<td>White</td>
<td>26</td>
<td>63</td>
<td>23</td>
</tr>
<tr>
<td>Black Caribbean</td>
<td>18</td>
<td>3</td>
<td>14</td>
</tr>
<tr>
<td>Black African</td>
<td>17</td>
<td>37</td>
<td>30</td>
</tr>
<tr>
<td>Indian</td>
<td>12</td>
<td>23</td>
<td>16</td>
</tr>
<tr>
<td>Pakistani</td>
<td>16</td>
<td>50</td>
<td>22</td>
</tr>
<tr>
<td>Bangladeshi</td>
<td>26</td>
<td>17</td>
<td>24</td>
</tr>
<tr>
<td>Chinese</td>
<td>3</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>


2.4 Prevalence of type 2 diabetes

In the UK, type 2 diabetes is more prevalent among black Caribbean, Indian, Pakistani and Bangladeshi men aged 35–54 than the general population. With the exception of black African men, it is also more prevalent among those aged 55 and over from these groups. Among women, type 2 diabetes is more common among Indian, Pakistani and Bangladeshi groups (aged 35 years and over) and black Caribbean women (aged 55 years and over).\textsuperscript{26} People from black, Asian and other minority ethnic groups also tend to progress from impaired glucose tolerance (IGT) to diabetes much more quickly than average (more than twice the rate of white populations).\textsuperscript{27}

2.5 Obesity and diabetes

People of South Asian descent living in the UK are up to six times more likely to have type 2 diabetes, and develop the condition 10 years earlier than white populations in the UK. People of African and African-Caribbean descent are three times more likely to have type 2 diabetes than the white population, and the condition is also more common among Chinese and other non-white groups than among white European populations.\textsuperscript{28}
The higher risk for South Asian people living in the UK is at least partly due to the fact that they may accumulate significantly more 'metabolically active' fat in the abdomen and around the waist than white European populations. This is true even for those with a BMI in the 'healthy' range – that is, 18.5 to 24.9 kg/m$^2$. 'Metabolically active' fat is closely associated with insulin resistance, pre-diabetes and type 2 diabetes.\textsuperscript{28}

Minority ethnic groups are less likely to participate in at least moderate-intensity physical activity (for 30 minutes continuously a week) than the general population. For example Bangladeshi men and women have the lowest levels of participation in physical activity when standardised for age.\textsuperscript{29} Black Caribbean men are the only subgroup of an ethnic minority population that are not less physically active than the general population in England.\textsuperscript{29}

\subsection*{2.5.1 What are the ideal measures of obesity?}

The National Obesity Observatory suggests for identifying individuals at increased risk of obesity-related ill health, there is evidence that measures of both general and central adiposity (that is BMI and waist circumference) should be used together.\textsuperscript{30}

In terms of population monitoring, BMI has some advantages over measures of central adiposity. It involves less physical contact, and height and weight can be more reliably measured than waist circumference following basic training; measuring waist circumference reliably requires training in where and how to apply the tape measure. BMI is the most commonly used measure in national and international obesity prevalence statistics and so is most useful for historical trend analyses and international comparisons.\textsuperscript{31}

Guidance from the National Institute for Health and Clinical Excellence (NICE) on obesity published in 2006 currently states that the assessment of the health risks associated with overweight and obesity should be based both on BMI and waist circumference in adults as described in Table 3.\textsuperscript{32}
Table 3: Combining body mass index (BMI) and waist measurement to classify the risks of type 2 diabetes and cardiovascular disease.

<table>
<thead>
<tr>
<th>BMI classification</th>
<th>Waist circumference</th>
</tr>
</thead>
<tbody>
<tr>
<td>*<em>Low</em></td>
<td>*<em>High</em></td>
</tr>
<tr>
<td>Normal weight</td>
<td>No increased risk</td>
</tr>
<tr>
<td>Overweight (25 to less than 30kg/m²)</td>
<td>No increased risk</td>
</tr>
<tr>
<td>Obesity I (30 to less than 35kg/m²)</td>
<td>Increased risk</td>
</tr>
<tr>
<td>Obesity II (35 to less than 40kg/m²)</td>
<td>Very high risk</td>
</tr>
<tr>
<td>Obesity III (40kg/m² or more)</td>
<td>Very high risk</td>
</tr>
</tbody>
</table>

* For men, waist circumference of less than 94 cm is low, 94–102 cm is high and more than 102 cm is very high. For women, waist circumference of less than 80 cm is low, 80–88 cm is high and more than 88 cm is very high.

Source: Obesity: the prevention, identification, assessment and management of overweight and obesity in adults and children, NICE guideline CG43.

The World Health Organization (WHO) also advises that an individual’s relative risk of obesity-related ill health can be more accurately classified using both BMI and waist circumference than by either alone.

2.5.2 Other measures of obesity

A recent report stressed, ‘there is no straightforward relationship between obesity and ethnicity, with a complex interplay of factors affecting health in minority ethnic communities in the UK’. It adds that the validity of using current definitions of obesity for non-white ethnic groups is debatable (National Obesity Observatory 2011).

The waist-height or waist-stature ratio (WHR or WSR) and waist-hip ratio (WHR) have been proposed as good measurements for use across all ethnic groups. It has been suggested that even in populations with low rates of obesity and moderate BMIs such as Japan and China, raised WSR and WHP could be an important early indicator of lifestyle-related disorders and its measurement could be an important part of a public health approach to preventing diabetes and coronary heart disease. Waist-to-height and waist-to-hip ratio were outside the scope of the current review, and are not covered in this report. These measures will be referred back to the Department of Health to be considered for future guidance.
2.6 Context for this review

There is uncertainty regarding which obesity measures are appropriate for use in black, Asian and other minority ethnic groups. A WHO consultation identified several potential public health action points (23.0, 27.5, 32.5, and 37.5 kg/m$^2$) along the continuum of BMI, and proposed methods by which countries could make decisions about the definitions of increased risk for their population. In response to a World Health Organization report, the NHS Health Checks programme uses a BMI of 27.5 kg/m$^2$ as the trigger for preventive action among people of South Asian origin. Neither the World Health Organization paper (2004) or the NICE obesity guidance considered there to be sufficient evidence to set separate cut-off points for the waist circumference of people of South Asian origin. However, lower cut-off points for BMI (23 kg/m$^2$) and waist circumference (90 cm for men and 80 cm for women) have subsequently been proposed in the International Diabetes Federation statement on type 2 diabetes prevention. It is worth noting that and single BMI and waist circumference cut-off point may not be appropriate for all the different black, Asian and other minority ethnic groups.

3 Methods

The “Body mass index and waist circumference thresholds for intervening to prevent ill health among black, Asian and other minority ethnic groups in the UK” review was conducted in two phases, based on feedback from expert panel and PHIAC sub group meeting. The evidence search and sifting strategy for both phases is presented in this section. The results, discussion and summary section of this report are limited to Question 4. The Phase I report, summarising and synthesising the evidence identified for all four questions up to the June 2012 PHIAC sub group meeting can be found in Appendix 1.
3.1 Search and sifting criteria

Identifying the evidence

A group of experts were identified and canvassed to identify/recommend papers that were key to helping answer the referral received from DH. This process identified a set of 46 papers.

The NICE Information Services department undertook a Google Scholar search in February 2012. Each of the 46 references was entered into Google Scholar and then the ‘cited by’ function was used to determine which papers had cited the initial set. The ‘cited by’ function in Google Scholar was selected as it was determined that the papers citing the recommended key papers were also likely to focus on BMI and waist circumference cut-points in black, Asian and other minority ethnic groups. Furthermore, Google Scholar also indexes grey literature (such as theses) and therefore this does not require a separate search. The initial search was not limited by the type of studies being retrieved. Three of the 46 papers resulted in over 9,500 ‘cited by’ hits and a decision was made to take a pragmatic approach to the results that were selected for screening. Google Scholar presents the ‘cited by’ hits in order of relevancy (although the algorithm used is unknown) and in the case of these three papers only the first 100 results were sifted. All of the ‘cited by’ hits were downloaded for the other 43 references. In total Google Scholar ‘cited by’ provided ~ 4,000 references. In addition to the topic expert recommended papers and the Google Scholar ‘cited by’ search, a call for evidence was issued in January, 2012 to include: published, in progress and grey literature. Published papers recommended by stakeholders during the scope consultation process were also included. The call for evidence and stakeholder consultation yielded an additional 99 references.

Selection criteria (Sift 1)

Prior to the expert panel meeting scheduled for March, 2012, an initial sift process of the Google Scholar ‘cited by’ search results was started with broad inclusion terms. This sifting process was carried out by two NICE CPHE analysts with the total number of references split equally between the two.
Studies were retained for further appraisal if the following criteria were met:

- **Population**: any black and minority ethnic population (world literature)
- **Type of study**: any type
- **Type of outcomes**: (BMI OR waist circumference) AND any chronic conditions / mortality.

To determine consistency a 10% check by each analyst of the other’s section was undertaken, using a random number table to identify the references to be checked. This identified some minor incongruence; each sub-section was re-evaluated with a final number of 737 (785 with 48 duplicates removed) ‘cited by’ references included. These were added to the 99 papers from the call for evidence/scope consultation and 46 expert recommended papers (Total: 882 – 10 duplicates = 872).

An expert panel was convened in March 2012 to review progress in identifying the evidence to date, to examine and refine the questions included in the scope/underpinning the evidence review, and to finalise the sifting inclusion criteria for identification of the papers to be passed onto the external review team.

**Table 4: Summary of papers identified for second sift post expert panel meeting.**

<table>
<thead>
<tr>
<th>Sources</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Original papers identified by expert panel</td>
<td>46</td>
</tr>
<tr>
<td>Google Scholar searches</td>
<td>737 (785 - 48 duplicates)</td>
</tr>
<tr>
<td>Call for evidence and stakeholder consultation</td>
<td>99</td>
</tr>
<tr>
<td>Total</td>
<td>882</td>
</tr>
<tr>
<td>Duplicates</td>
<td>10</td>
</tr>
<tr>
<td>Duplicates removed</td>
<td>872</td>
</tr>
</tbody>
</table>

**Selection (Inclusion) criteria (Sift 2 n=872 papers)**

The second sifting process was carried out by one NICE CPHE analyst. It was possible to exclude 262 papers from the information provided in the abstract. The full texts of 610 papers were retrieved before a decision was made. A total of 205 full text papers were passed to Bazian following this second stage screening.
The following criteria were used to identify inclusion papers for the external contractor undertaking the evidence review for this guidance.

**Population:**
- Black African/Caribbean
- South Asian
- Chinese
- Mixed race (*including above ethnic groups*)
- Middle Eastern (*to identify whether comparable risk with for example South Asian*)
  - UK studies most important
  - Worldwide acceptable, must include caveats
    - If possible split (home country, 1st generation, 2nd generation)

**Study type:**
- Large cross-sectional studies
- ROC analysis (*sensitivity analysis of particular interest*)
- Cohort studies (*prospective of particular interest*)
- Review articles (*meeting population/outcome/analysis criteria*)

**Outcomes:**
- Focus: Diabetes
- Plus: Fatal and non-fatal myocardial infarction, fatal and non-fatal stroke and mortality
- Metabolic Syndrome was included if diabetes/glucose related data was reported separately.

**Analysis/Comparison:**
- Focus cross-sectional studies: BAME vs. White population comparisons with a relevant health outcome. However, non-comparator studies also of interest.
• Focus ROC analysis: BAME vs. White population comparisons with a relevant health outcome. However, non-comparator studies also of interest.

• Focus cohort studies (prospective and retrospective): Average BMI and/or waist circumference at development of health outcome. BAME vs. White population comparisons preferred although, non-comparator studies also of interest.

• Percentage body fat studies (i.e. DXA) if BMI was a comparator and a relevant health condition the outcome of interest.

**Exclusion criteria:**

**Population:**
- Aboriginal Japanese
- North American Indian
- Hispanic

**Study type:**
- Consensus statements
- Randomised control trials/intervention studies

**Outcomes:**
- Hypertension only
- Hyperlipidaemia only
- Cardiovascular Disease (*MI and/or Stroke not reported separately*)
- Metabolic Syndrome was excluded if diabetes/glucose related data was NOT reported separately

**Table 5: Summary of evidence provided to contractor for further analysis and data extraction.**

<table>
<thead>
<tr>
<th>Of the 872:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Analysed at full text</td>
<td>610</td>
</tr>
<tr>
<td>Rejected at abstract by CPHE</td>
<td>262</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Of the 610:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Full text analysed by Contractor</td>
<td>205</td>
</tr>
</tbody>
</table>
3.2 **Included studies and criteria for exclusion – Phase I**

After sifting and de-duplication, 205 unique studies were sent to Bazian, and these were further sifted based on the following inclusion criteria:

- Population (Black African/Caribbean, Chinese, South Asian, Middle Eastern, mixed race)
- Exposures (BMI and/or WC measured)
- Outcomes (diabetes, stroke, fatal or non-fatal myocardial infarction [MI], mortality).

Studies were excluded if they were not published in English or if the study design rendered them unsuitable for data extraction, bringing the number of excluded papers to 115. The numbers excluded based on each criterion are listed below (figures sum to greater than 115 due to exclusions based on multiple criteria; see Appendix 2 for a summary of exclusions):

- Population: 19 studies
- Exposure: 16 studies
- Outcome: 67 studies
- Other (language, study design etc.): 28 studies

Following discussions with NICE, the remaining 90 studies were further sifted based on ethnicity. As Chinese ethnic groups make up a small proportion of the total UK population (see Table 1), studies conducted in non-Western setting with Chinese populations were further sifted. Studies conducted in Hong Kong included in the full review, and studies with other ethnic Chinese groups conducted in mainland China, Taiwan and other non-Western settings identified but not included for a full data extraction (See Appendix 3 for a list of these 39 studies). The remaining 51 studies were assessed based on analytical sifting criteria, and a further 24 studies were excluded, resulting in the inclusion of 27 studies in total. This included six studies for Question 1, five studies for Question 2, seventeen studies for Question 3 and five studies for Question 4. Figure 3 summarises the final paper selection process for the initial review.
Figure 3: PRISMA flow chart - Phase I

Records identified through database searching (n = 785) → Additional records identified through other sources (n = 145)

Records after duplicates removed (n = 872) → Records excluded at abstract level (n = 262)

Records screened (Full text) (n = 610) → Records excluded (n = 405)

Full-text articles assessed for eligibility (n = 205) → Full-text articles excluded, with reasons (n = 115)

Studies included in qualitative synthesis (n = 90) → Chinese articles provisionally excluded (n = 39)

Full-text articles assessed for analytic suitability (n = 51) → Records excluded on analytic criteria (n = 24)

Studies included in review (n = 27)

Completed by NICE  Completed by Bazian
3.3 Included studies and reasons for exclusion – Phase II

Based on feedback from the June 2012 PHIAC sub group meeting, amendments to the original report were made. The current review focuses on BMI and WC cut-points that represent an equivalent risk among black, Asian and minority ethnic groups to that seen in white populations at the currently recommended overweight and obesity cut-points (Question 4). The 39 studies previously excluded based on Chinese population were resifted to identify any relevant to this question, and an additional 54 studies were sent to Bazian for further sifting for inclusion in Question 4. None of the provisionally excluded Chinese population studies met the inclusion criteria for Question 4, mainly due to the lack of a white or European comparator group. During the sift of the additional 54 papers, 51 were excluded based on:

- Population: 3 studies
- Exposure: 2 studies
- Outcome: 12 studies
- Other (language, study design etc.): 1 study
- Analysis: 2 studies
- Duplicates: 26 studies
- Question 4 relevance: 44 studies

3 of the additional studies were included in the review, bringing the total number of studies for Question 4 to eight.

See Figure 4 for a summary of the additional sift, and Appendix 2 for a list of Phase II excluded studies and reasons for exclusion.
3.4 Quality Assessment

All included studies were assessed using modified quality assessment checklists based on the tools from Appendices G and J of the ‘Methods for the development of NICE public health guidance’, and Appendices G and J of ‘The guidelines manual 2009’:

- Diagnostic checklist from NICE ‘The guidelines manual 2009’ Appendix G
- Prognostic checklist from NICE ‘The guidelines manual 2009’ Appendix J
- Quantitative correlation and association checklist, from NICE, ‘Methods for the development of NICE public health guidance (second edition)’ Appendix G
- Review checklist from NICE ‘Methods for the development of NICE public health guidance (second edition)’ Appendix J

Modifications for each of the checklists included:
• Diagnostic checklist – addition of an internal validity and UK applicability score
• Prognostic checklist – addition of an internal validity and UK applicability score
• Quantitative correlation and association checklist – addition of a UK applicability score; replacement of ++, +, -, NR and NA scoring options with Yes, No, Unclear and N/A; removal of questions 2.1 to 2.3, 3.3 to 3.4 and 4.1, as they were not considered applicable to the review questions.
• Review checklist – addition of a summary quality score and a UK applicability score; replacement of ++, +, -, NR and NA with Yes, No, Unclear and N/A.

Based on the checklist, each study was given an overall study quality rating, reported using a summary score of [++] strong quality, [+] moderate quality and [-] weak quality.

3.5 Applicability Assessment

Given the nature of the review questions and the various settings of the identified evidence, an additional applicability summary score was given. This rated the study’s generalisability to black, Asian and minority ethnic populations in the UK, and was reported using the same [++] strong, [+] moderate and [-] weak scoring system as the quality summary score.

Applicability of the evidence was assessed according to the methods for the development of NICE public health guidance. Population, setting and outcome characteristics as summarised in Table 6 were considered, and the extent to which these factors aligned with the current review questions was assessed.
Table 6: NICE methods for assessing applicability

<table>
<thead>
<tr>
<th>Area of applicability</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>Age, sex/gender, race/ethnicity, disability, sexual orientation/gender identity, religion/beliefs, socioeconomic status, health status</td>
</tr>
<tr>
<td>Setting</td>
<td>Country, geographical context, healthcare/delivery system, legislative, policy, cultural, socioeconomic and fiscal context</td>
</tr>
<tr>
<td>Outcome</td>
<td>Appropriate/relevant, follow-up periods, important health effects.</td>
</tr>
</tbody>
</table>


In addition, the following characteristics were considered to be of particular relevance to the current review:

- **Population:** mean baseline BMI and/or WC, assessed against data UK data presented in Table 7. Ethnicities for which no UK specific mean BMI or WC figures are available were assessed against the UK general population figures.
- **Setting:** UK or Western setting vs. non-Western setting
- **Outcomes:** diabetes diagnostic methods and criteria, assessed against current criteria outlined in Table 8.
Table 7: Mean body mass index and waist circumference by ethnic group, 2004, England

<table>
<thead>
<tr>
<th>Ethnic Group</th>
<th>Mean BMI (95% CI) Males (kg/m²)</th>
<th>Mean BMI (95% CI) Females (kg/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black Caribbean</td>
<td>27.1 (26.6 to 27.6)</td>
<td>28.0 (26.4 to 27.8)</td>
</tr>
<tr>
<td>Black African</td>
<td>26.4 (25.8 to 27.0)</td>
<td>28.8 (25.5 to 27.3)</td>
</tr>
<tr>
<td>Indian</td>
<td>25.8 (25.3 to 26.3)</td>
<td>26.2 (25.4 to 26.2)</td>
</tr>
<tr>
<td>Pakistani</td>
<td>25.9 (25.4 to 26.4)</td>
<td>27.1 (25.3 to 26.5)</td>
</tr>
<tr>
<td>Bangladeshi</td>
<td>24.7 (24.3 to 25.1)</td>
<td>25.7 (24.1 to 25.3)</td>
</tr>
<tr>
<td>Chinese</td>
<td>24.1 (23.6 to 24.6)</td>
<td>23.2 (23.6 to 24.6)</td>
</tr>
<tr>
<td>General Population</td>
<td>27.1 (26.9 to 27.3)</td>
<td>26.8 (26.6 to 27.0)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Mean WC (95% CI) Males (cm)</th>
<th>Mean WC (95% CI) Females (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black Caribbean</td>
<td>92.5 (90.5 to 94.5)</td>
<td>88.4 (86.2 to 90.6)</td>
</tr>
<tr>
<td>Black African</td>
<td>90.6 (88.3 to 92.9)</td>
<td>90.2 (87.5 to 92.9)</td>
</tr>
<tr>
<td>Indian</td>
<td>93.0 (91.4 to 94.6)</td>
<td>83.9 (82.4 to 85.4)</td>
</tr>
<tr>
<td>Pakistani</td>
<td>95.0 (93.3 to 96.7)</td>
<td>87.7 (85.9 to 89.5)</td>
</tr>
<tr>
<td>Bangladeshi</td>
<td>88.7 (86.7 to 90.7)</td>
<td>85.7 (83.6 to 87.8)</td>
</tr>
<tr>
<td>Chinese</td>
<td>86.8 (84.8 to 88.8)</td>
<td>77.6 (76.1 to 79.1)</td>
</tr>
<tr>
<td>General Population</td>
<td>96.5 (96.1 to 96.9)</td>
<td>86.4 (86.0 to 86.8)</td>
</tr>
</tbody>
</table>


Table 8: Type 2 diabetes diagnostic criteria

<table>
<thead>
<tr>
<th>Measure</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random venous plasma glucose concentration</td>
<td>≥11.1 mmol/L</td>
</tr>
<tr>
<td>Fasting venous plasma glucose concentration (FPG)</td>
<td>≥7.0 mmol/L</td>
</tr>
<tr>
<td>Venous plasma glucose concentration 2 hours after 75g anhydrous glucose challenge in an oral glucose tolerance test (OGTT)</td>
<td>≥11.1 mmol/L</td>
</tr>
<tr>
<td>Glycated haemoglobin (HbA1c )</td>
<td>6.5%</td>
</tr>
</tbody>
</table>


Scores are presented as quality/applicability. For instance, Chiu 2011 was assessed using the modified quantitative correlation and association checklist. This study had moderate quality [+]; it adequately addressed most checklist questions, but as it was unclear whether all likely confounders were controlled for, and whether the outcome measures were complete, it did not receive a strong [++] summary quality rating. This study was rated as having moderate applicability [+] to UK populations; it was carried out in a western country.
(Canada) and mean BMI across ethnicity subgroups was similar to the UK figures, and diabetes cases were identified using a population based registry. However, the methods of identifying diabetes cases were unclear. Overall, Chiu 2011 was rated as having a moderate summary validity score and a moderate summary applicability score [+/+].

The checklists are presented in Appendix 4; the original NICE checklists appear at the beginning of each section, followed by the modified checklist for each appraised study.

### 3.6 Summarising the evidence and evidence statements

Study characteristics and data were extracted from the included studies by a research analyst at Bazian and checked by another. Data extraction tables are provided in Appendix 5, and include descriptions of the studies’ aims, population, methods and results. The review findings were synthesised narratively and used to generate evidence statements. The statements reflect the strength (quality, quantity and consistency) of the evidence, as well as the applicability to black, Asian and minority ethnic groups in the UK.

Evidence statements for Question 4 are based on cohort or cross sectional studies that included a white or European comparator group and either presented graphs with risk curves for incident or prevalent outcomes by BMI or WC (as either a continuous or categorical variables) and ethnicity, provided data on outcome prevalence by BMI or WC (as either continuous or categorical variables) by ethnicity, or reported risk-equivalent BMI or WC values compared to white populations. Appendix 7 provides data extraction tables and quality appraisal checklists for studies included in this Phase II review.

The overall strength of evidence was assessed by considering the quantity, quality and consistency of the evidence.
4 Results

4.1 Question 4:
What are the cut-off points for BMI and waist circumference among adults from black, Asian and other minority ethnic groups living in the UK that are ‘risk equivalent’ to the current thresholds set for white European populations?

Data (or graphs) were extracted for cohort or cross sectional studies which:

- Presented graphs with risk curves for incident or prevalent diabetes by BMI or WC (as either a continuous or categorical variable), with separate curves for each ethnicity, with a white comparator group
- Provided data on diabetes prevalence by BMI or WC (as either a continuous or categorical variable), stratified by ethnicity, with a white comparator group
- Reported absolute risk-equivalent BMI or WC values compared to white populations

4.1.1 People of black descent
Three cohort studies (Chiu, 2011 [+/+])² (Stevens, 2008 [+/+])³ and (Stevens, 2002 [+/-])⁴, three cross sectional studies (Stommel, 2010 [+/-])⁵ (Taylor, 2010 [+/-])⁶ and (Pan, 2004 [+/-])⁷ examined equivalency of the boundary cut-points amongst black populations. The studies were conducted in the UK, Canada, and the USA. All of the studies are relevant to BMI cut-points and none looked at WC equivalency. All have used diabetes as an outcome, and one included all cause mortality as an outcome.

Chiu, 2011.² 747 participants in the black subgroup (mean baseline BMI 26.1 kg/m²) had an increased age-adjusted risk of incident diabetes; HR 2.04 (95% CI 1.50 to 2.68) compared to a white subgroup of 57,210 participants. The risk equivalent BMI values (kg/m²) for European 30 kg/m² was calculated as 26 kg/m². This difference of -4 kg/m² is presented in Figure 5.
This study has moderate applicability to the UK. It was conducted in a Western setting, and mean baseline BMIs were similar to those seen in similar ethnic groups in the UK. However, the diagnostic criteria used to identify diabetes cases were not reported.

Stevens 2008. 3,582 participants in the American black subgroup (mean male baseline BMI 27.8 kg/m², female 30.8 kg/m²; mean follow-up 7.9 to 8.2 years) had an increased risk of incident diabetes in higher BMI categories compared to a reference BMI 18.5 to 23 kg/m² category. In the 25.0 to 27.49 kg/m² category for American whites the risk difference was +4.6% (95% CI -10.1 to 19.3) close to an equivalent risk difference of +5.1% (95% CI -17.3 to +27.6) in the 23.0 to 24.9 kg/m² category among the American black subgroup. This difference of about -2 kg/m² is presented in Figure 6. In the 30.0 to 32.49 kg/m² category for American whites the risk difference was +14.1 (95% CI -27.0 to +55.2), close to an equivalent risk of +15.2 (95% CI -29.9 to +60.2) in the 30.0 to 32.49 kg/m² category for the American black subgroup.

This study has moderate applicability to the UK. The black and white subpopulations were sampled from the USA. Diabetes diagnosis, however, was based on self-report, which may misclassify cases compared to current UK practice.
Figure 5: Association between the incidence rate of diabetes and BMI by ethnic group. Ontario, Canada. 1996–2005

Source: Chiu et al, 2011.² (Fig. 1 in paper)
Figure 6: Adjusted cumulative incidence of diabetes among Chinese Asians, American whites and American blacks across BMI categories

Source: Stevens et al, 2008.\(^3\) (Fig. 2 in paper)

\textit{Stevens 2002.}\(^4\) This study assessed data from two separate cohort studies, one which assessed the association between BMI and incident diabetes, the other between BMI and all cause mortality. 5,715 female black participants (mean baseline BMI 30.8 kg/m\(^2\)) had a diabetes incidence rate at a BMI of 28.0kg/m\(^2\) equivalent to that seen among white females (mean baseline BMI 26.6 kg/m\(^2\)) at 30.0kg/m\(^2\). The association between BMI and all cause mortality was not significant among 3,160 black females (mean baseline BMI
28.0 kg/m$^2$). However, the BMI value among these participants at which the mortality incidence was equivalent to that seen among 193,135 white females (baseline BMI 25.0 kg/m$^2$) was 18 kg/m$^2$. See Figure 7 for graphical representations of this difference of -2 kg/m$^2$ for diabetes and -12 kg/m$^2$ for all cause mortality (ACM).

This study has moderate applicability to the UK. The black and white subpopulations were sampled from the USA. Diabetes diagnostic criteria align with current UK practice, however, some of the mean baseline BMI values did not align with mean levels seen in the UK among similar ethnicities. Additionally, the data was derived from studies conducted 20 to 60 years ago.

**Figure 7:** Diabetes (A) and mortality (B) incidence rate by BMI value in white (solid line) and African American (dashed line) women.

Source: Stevens et al, 2002.$^4$
Stommel, 2010. 47,468 participants in the US black subgroups (mean baseline BMI not reported) self reported their diabetes (9.3% prevalence). The prevalence of diabetes was compared to the prevalence among 219,521 participants in the white subgroup (6.1%). Results are reported by ethnicity or BMI but not both. Visual inspection of the prevalence vs. BMI graph (see Figure 8) suggests that prevalence of diabetes is approximately equivalent at a BMI of 26 kg/m² among black participants and 30 kg/m² among white participants, a difference of -4 kg/m². An equivalent prevalence is seen at approximately 21 to 22 kg/m² among black participants and 25 kg/m² among white participants, a difference of about -3 to -4 kg/m².

This study has moderate applicability to the UK. It was conducted in a Western country, however, BMI and diabetes case status were assessed by self-report, a manner inconsistent with current UK clinical practice.

Figure 8: Prevalence of diabetes by BMI categories in four US populations, adjusted for age, sex, education, poverty, marital status, insurance, residency, foreign birth, health behaviours

Source: Stommel et al, 2010. *(Fig 2 in paper)*

Taylor, 2010. 4,030 participants in the US black subgroup (mean baseline BMI not reported) had consistently higher prevalence of diabetes compared to a US white subgroup (n=5,245) at all BMI categories. Figure 9, generated using the published prevalence data for participants aged 35 to 54 years,
illustrates the increase diabetes risk across the spectrum of BMI categories, and suggests that black Americans may have a diabetes risk equivalent to that seen above 30 kg/m$^2$ in white populations in a BMI range as low as 18.5 to 25 kg/m$^2$. Figure 10, similarly generated from published prevalence data, illustrates a pattern of higher diabetes risk across all BMI categories in black participants aged 55 to 74 years, compared to white participants in the same age cohort. However, as the publication did not provide confidence intervals around the prevalence figures, it is unknown whether the prevalence difference between these two subgroups is significant. Additionally, due to the wide BMI categories used (approximately 5 BMI units per category) it is difficult to interpret these prevalence figures to determine risk equivalency. As such, it has not been included in the results summary tables (Table 9 and 10) for Question 4.

This study has moderate applicability to the UK. It was conducted in a Western country, however, diabetes case status were assessed in part by medication use, which could misclassify cases compared to current UK clinical practice.

**Figure 9: Diabetes prevalence by BMI category among black and white participants aged 35 to 54 years**

Adapted from: Taylor et al, 2010.\(^6\)
Pan, 2004. Graphical evidence suggests that 4,542 participants in the black subgroup (median baseline BMI 25.8 kg/m^2 for males and 27.6 kg/m^2 for females) had a diabetes prevalence of approximately 12% at BMI values between 26.0 and 29.9 kg/m^2. This is similar to that seen among 6,706 white participants (median baseline BMI 26.0 kg/m^2 for males and 24.6 kg/m^2 for females) in the 30.0 to 39.9 kg/m^2 category. This difference of -4 kg/m^2 is presented in Figure 11. A risk equivalent point cannot be calculated for current overweight cut-offs, as the risk curve for the black subgroup does not include prevalence as low as that seen among white participants at 25 kg/m^2.

This study has moderate applicability to the UK. It was conducted in a Western setting, mean BMIs were similar to UK values among males, but lower than UK values among females, and diagnostic criteria used to identify diabetes cases align with current UK practice.
Figure 11: Age- and sex-standardised diabetes prevalence by BMI across Taiwanese, black and white participants

![Figure 11](image)


See Tables 9 through 12 for a summary of results for Question 4.

**Evidence statement Q4.1: BMI cut-points indicating “risk equivalence” for black populations (Type 2 Diabetes)**

Strong evidence suggests that black populations have an equivalent risk of diabetes at a BMI of 26 to 29.9 kg/m² as white populations with a BMI of 30 kg/m², and 21 to 23 kg/m² appears to be risk equivalent to 25 kg/m² in a white population.

**Q4.1.a: UK or Western Countries**

Strong evidence was found from three cohorts in Canada and the US and two cross-sectional studies in the US (Chiu, 2011 [+/+]),² (Stevens, 2008 [+/+]),³ (Stevens, 2002 [++/+]),⁴ (Stommel, 2010 [+/+]),⁵ (Taylor, 2010 [++/+])⁶ and (Pan, 2004 [+/+])⁷ that for BMI around 30 kg/m² in white populations the equivalent diabetes risk in black populations is at BMI values 0.1 to 4 units lower (26 to 29.9 kg/m²). For a BMI of 25 kg/m² in white populations the equivalent diabetes risk in black populations was found at BMI values 2 to 4 units lower 21 to 23 kg/m².

These studies had moderate applicability to the UK.

**Evidence statement Q4.2: BMI cut-points indicating “risk equivalence” for black populations (myocardial infarction, stroke or mortality)**
Limited evidence was found from one cohort study (Stevens, 2002 [++]), that at a BMI of 20 kg/m$^2$ black populations have an equivalent mortality risk to that seen in white populations at 30 kg/m$^2$. This study has moderate applicability to the UK.

No evidence was found relevant to risk equivalent BMI cut-points for myocardial infarction or stroke in black populations.

**Evidence statement Q4.3: WC cut-points indicating “risk equivalence” for black populations (Type 2 Diabetes)**

No evidence was found relevant to risk equivalent WC cut-points for diabetes in black populations.

**Evidence statement Q4.4: WC cut-points indicating “risk equivalence” for black populations (myocardial infarction, stroke or mortality)**

No evidence was found relevant to risk equivalent WC cut-points for myocardial infarction, stroke or mortality in black populations.

4.1.2 People of South Asian descent

One review (Nyamdorj, 2010b [++]$^8$ and two cohort studies (Chiu, 2011 [++]$^2$ and (Cameron, 2010 [+-]$^9$ have examined equivalency of the boundary cut-points amongst South Asian populations. The review included participants from various European and non-Western countries and the cohort studies were based in Canada, Australia and Mauritius. Two studies are relevant to BMI cut-points and two have looked at WC equivalency. All have used diabetes as an outcome.

*Nyamdorj, 2010b.*$^8$ This review and meta-analysis included 30 studies with 54,467 participants from China, India, Mauritius, Cyprus, Finland, Italy, Spain, Sweden, Netherlands, and the UK. Among Indian participants, the ranges of mean baseline BMIs were 22.0 to 23.3 kg/m$^2$ for males and 23.7 to 24.5 kg/m$^2$ for females. Mean baseline BMI ranged from 25.5 to 27.9 kg/m$^2$ among European males and 25.2 to 28.1 kg/m$^2$ among European females. Mean baseline WC ranged from 81.2 to 87.7 cm among Indian males and 75.5 to
84.4 cm among Indian females. European female baseline WC ranged from 77.6 to 86.9 cm.

At the same BMI or WC levels, undiagnosed diabetes was more prevalent in Indians than Europeans (see Figures 12 and 13). Visual inspection of Figure 12 suggests that the pooled risk equivalence for undiagnosed diabetes for Europeans at 30 kg/m\(^2\) was present at a BMI of 19 to 20 kg/m\(^2\) for Indian males, a difference of -10 to -11 kg/m\(^2\) for Indian male compared to European males. A risk equivalent point cannot be calculated for females, as the risk curve for Indian women does not include prevalence as low as that seen among European women at 30 kg/m\(^2\). No risk equivalent points can be identified for a European BMI of 25 kg/m\(^2\), as the risk curves for male and female Indian participants do not include prevalence values as low as that seen at this BMI among Europeans.

Visual inspection of the graphs in Figures 13 suggests that the pooled risk equivalence for undiagnosed diabetes for European men at WC of 102 cm is 73 cm for Indian men, a difference of -29 cm. The risk equivalent for a WC 94 cm cannot be calculated as the risk curve for Indian men does not include prevalence as low as that seen among European men at 94 cm.

The pooled risk equivalent for undiagnosed diabetes for European women at WC of 88 or 80 cm can not be calculated as the risk curve for Indian women does not include prevalence’s as low as those seen among European women at these thresholds.

This study has moderate applicability to the UK. It defines diabetes in a manner consistent with UK clinical practice, and participants from the relevant minority ethnic groups have mean baseline BMI and WC largely align with the mean values seen in the relevant ethnic minority groups in the UK. However, it compares participants drawn from different Western and non-Western populations.
Figure 12: Crude (filled markers) prevalence and estimated (open markers with 95% CIs) probability of undiagnosed diabetes among males according to BMI categories by ethnicity.

Source: Nyamdorj et al, 2010. (fig 1 in paper)
Figure 13: Crude (filled markers) prevalence and estimated (open markers with 95% CIs) probability of undiagnosed diabetes among males and females according to the waist circumference categories by ethnicity.

Source: Nyamdorj et al, 2010. (fig 2 in paper)
1,001 participants in the South Asian subgroup (mean baseline BMI 24.6 kg/m\(^2\); mean follow-up 6 years) had risk equivalent BMI values for a European BMI of 30 kg/m\(^2\) at 24 kg/m\(^2\). A difference of -6 kg/m\(^2\) is presented graphically in Figure 5.

This study has moderate applicability to the UK. It was conducted in a Western setting, and mean baseline BMIs were similar to those seen in South Asian groups in the UK. However the diagnostic criteria used to identify diabetes cases was not reported.

Diabetes incidence was compared between 2,214 South Asian participants in a Mauritius study (mean baseline BMI 23.3 kg/m\(^2\), mean baseline WC 77.2 cm) and 5,515 Europid participants in an Australian study (mean baseline BMI 26.8 kg/m\(^2\), mean baseline WC 90.1 cm). Visual inspection of the graph presented in Cameron et al, 2010\(^9\) suggests a risk equivalency at 102 cm among males of European descent and 62 cm among South Asian males in Mauritius. A risk equivalent point cannot be calculated for current overweight cut-offs, as the risk curve for the black subgroup does not include incidence as low as that seen among white male participants at 94 cm. No risk equivalency points for either 88 cm or 80 cm are presented in the publications figures, as diabetes incidence among South Asian females does not reach levels as low as those seen among Europid participants at these cut-offs.

This study has weak applicability to the UK. It compares populations between Western and non-Western settings, participants from the relevant minority ethnic group (South Asians) have lower baseline and WC values than those seen among South Asian groups in the UK, and the study was conducted 20 to 25 years ago.

See Tables 9 through 12 for a summary of results for Question 4.
**Evidence statement Q4.5: BMI cut-points indicating “risk equivalence” for South Asian populations (Type 2 Diabetes)**

**Q4.5.a: UK or Western Countries**

Limited evidence was found from one cohort in Canada (Chiu, 2011 [+/+])\(^2\) that for BMI 30 kg/m\(^2\) in white populations the equivalent incident diabetes risk in South Asian populations was found at BMI values 6 units lower (24 kg/m\(^2\)). No equivalent value to a BMI of 25 kg/m\(^2\) was reported.

This study had moderate applicability to the UK.

**Q4.5.b: Other Countries**

Limited graphical evidence was found from one review (Nyamdorj, 2010b [+/-])\(^8\) related to diabetes risk across BMI values, indicating a risk equivalence at 19 to 20 kg/m\(^2\) among South Asian men and 30 kg/m\(^2\) among European men. No risk equivalence points were identified for women at this BMI cut-off, and no values were identified for either men or women equivalent to the risk seen among Europeans at 25 kg/m\(^2\).

This study had moderate applicability to the UK.

**Evidence statement Q4.6: WC cut-points indicating “risk equivalence” for South Asian populations (Type 2 Diabetes)**

Limited graphical evidence was found from one review (Nyamdorj, 2010b [+/-])\(^8\) and one cohort study (Cameron, 2010 [+/-])\(^9\) that at a WC of 62 to 73 cm, South Asian men experience the same diabetes risk as European men exhibit at 102 cm. No risk equivalent values were identified for the European WC cut-off of 94 cm among men, 88 cm among women or 80 cm among women.

These studies had weak to moderate applicability to the UK.

**Evidence statement Q4.7: BMI cut-points indicating “risk equivalence” for South Asian populations (myocardial infarction, stroke or mortality)**

No evidence was found relevant to risk equivalent BMI cut-points for myocardial infarction, stroke or mortality in South Asian populations.
Evidence statement Q4.8: WC cut-points indicating “risk equivalence” for South Asian populations (myocardial infarction, stroke or mortality)
No evidence was found relevant to risk equivalent WC cut-points for myocardial infarction, stroke or mortality in South Asian populations.

4.1.3 People of Middle Eastern descent

Evidence statement Q4.9: BMI cut-points indicating “risk equivalence” for Middle Eastern populations (Type 2 Diabetes)
No evidence was found relevant to risk equivalent BMI cut-points for diabetes Middle Eastern populations.

Evidence statement Q4.10: BMI cut-points indicating “risk equivalence” for Middle Eastern populations (myocardial infarction, stroke or mortality)
No evidence was found relevant to risk equivalent BMI cut-points for myocardial infarction, stroke or mortality in Middle Eastern populations.

Evidence statement Q4.11: WC cut-points indicating “risk equivalence” Middle Eastern populations (Type 2 Diabetes)
No evidence was found relevant to risk equivalent WC cut-points for diabetes in Middle Eastern populations.

Evidence statement Q4.12: WC cut-points indicating “risk equivalence” for Middle Eastern populations (myocardial infarction, stroke or mortality)
No evidence was found relevant to risk equivalent WC cut-points for myocardial infarction, stroke or mortality in Middle Eastern populations.

4.1.4 People of Chinese descent

One review (Nyamdorj, 2010b [+/+])⁶ two cohorts (Chiu, 2011 [+/+]),² (Stevens, 2008 [+/+])³ and one cross sectional study (Pan, 2004 [+/+])⁷ have examined equivalency of the boundary cut-points amongst Chinese populations. Studies were conducted in Canada, the US, China, Taiwan and various European and non-Western countries. Three are relevant to BMI cut-
points and one has looked at WC equivalency. All have used diabetes as an outcome.

Nyamdorj, 2010b. In this review and meta-analysis of 30 studies, 54,467 participants from China, India, Mauritius, Cyprus, Finland, Italy, Spain, Sweden, Netherlands, and the UK took part. Mean baseline BMI among Chinese males ranged from 24.3 to 26.6 kg/m², and 24.3 to 26.3 kg/m² in Chinese females. The range in European participants was 25.5 to 27.9 kg/m² among males and 25.2 to 28.1 kg/m² among females. Mean baseline WC ranged from 83.5 to 89.9 cm in Chinese males, 76.6 to 83.4 cm in Chinese females, 91.4 to 98.4 cm in European males and 77.6 to 86.9 cm in European females.

At the same BMI or WC levels, undiagnosed diabetes was more prevalent in Chinese participants than Europeans (see Figures 12 and 13). Visual inspection of Figures 12 suggests that the pooled risk equivalence for undiagnosed diabetes for Europeans at 30 kg/m² was present at a BMI between 24 and 25 kg/m² for Chinese males, a difference of -5 to -6 kg/m² compared to European males. Equivalent prevalence was seen at 22 kg/m² in Chinese females and 30 kg/m² in European females, a difference of -8 kg/m². Risk equivalence for a 25 kg/m² BMI in Europeans could not be estimated as the risk curves for Chinese populations do not include prevalences as low as those seen among Europeans at this threshold.

Visual inspection of the graph in Figure 13 suggests that the pooled risk equivalence for undiagnosed diabetes for European men at WC of 102 cm is 82 cm for Chinese men, a -20 cm difference. The risk equivalent cut-point for a WC 94 cm in European men is between 67 and 70 cm among Chinese men, a difference of -12 to -15 cm.

Visual inspection of Figure 13 suggests that the pooled risk equivalence for undiagnosed diabetes for European women at WC of 88 cm is between 70 and 73 cm among Chinese women, a difference of -15 to 18 cm. An equivalent point for 80 cm cannot be discerned as the risk curve for Chinese
women does not include prevalence as low as those seen among European women at this threshold.

This study has moderate applicability to the UK. It defines diabetes in a manner consistent with UK clinical practice, and participants from the relevant minority ethnic groups have mean baseline BMI and WC largely align with the mean values seen in the relevant ethnic minority groups in the UK. However, it compares participants drawn from different Western and non-Western populations.

Chiu, 2011.² 866 participants in the Chinese subgroup (mean baseline BMI 22.6 kg/m²; follow-up 6 years) had risk equivalent BMI values for a European BMI of 30 kg/m² at 25 kg/m². This difference of -5 kg/m² is presented graphically in Figures 5.

This study has moderate applicability to the UK. It was conducted in a Western setting, and mean baseline BMIs were similar to those seen in similar ethnic groups in the UK. However, the diagnostic criteria used to identify diabetes cases were not reported.

Stevens, 2008.³ 5,980 participants in the Chinese Asian subgroup (mean baseline male BMI 22.0 kg/m², female 22.4 kg/m²; mean follow-up 7.9 to 8.2 years) had an increased risk of incident diabetes in higher BMI categories compared to a reference 18.5 to 23 kg/m² category. In the 25.0 to 27.49 kg/m² category for American whites the risk difference was +4.6% (95% CI -10.1 to 19.3) close to an equivalent +4.9% (95% CI -30.6 to +40.4) risk difference in the 23.0 to 24.9 kg/m² category for the Chinese subgroup. A difference of about -2 kg/m² is presented graphically in Figure 6.

This study has moderate applicability to the UK. Mean baseline BMI among Chinese participants was lower than that seen among Chinese populations in the UK, and diabetes diagnosis was based on self-report.

Pan, 2004.⁷ Diabetes prevalence was compared between 3,047 participants in Taiwan (median male BMI 22.8 kg/m², female 22.4 kg/m²) and 6,706 white participants in the USA (median male BMI 26.0 kg/m², female 24.6 kg/m²).
Visual inspection of the graph presented in Figure 11 identified no risk equivalent points, as the diabetes prevalence values among Taiwanese participants did not reach levels as low as those seen among US white participants at a BMI of 25 or 30 kg/m².

This study has moderate applicability to the UK. It was conducted in a Western setting and non-Western countries, the mean BMIs among Chinese participants were similar to UK values among females, but lower than UK values among males, and diagnostic criteria used to identify diabetes cases align with current UK practice.

**Evidence statement Q4.13: BMI cut-points indicating “risk equivalence” for Chinese populations (Type 2 Diabetes)**

**Q4.13.a: UK or Western Countries**

Limited evidence was found from two cohorts (Chiu, 2011 [+/+]),² (Stevens, 2008 [+/+])³ that for a BMI around 30 kg/m² in white populations the equivalent incident diabetes risk in Chinese populations was found at BMI values 2.5 to 5 units lower. In one (Stevens, 2008 [+/+])³ for a BMI around 25 kg/m² in white populations the equivalent incident diabetes risk in Chinese populations was found at BMI values 2 units lower.

These studies have moderate applicability to the UK.

**Q4.13.b: Other Countries**

One review of studies (Nyamdorj, 2010b [+/+])⁸ provides limited evidence that for a BMI around 30 kg/m² in white populations the equivalent incident diabetes risk in Chinese men occurs at BMI values 5 kg/m² lower for Chinese men and 8 kg/m² lower for Chinese women.

This review had moderate applicability to the UK.

**Evidence statement Q4.14: WC cut-points indicating “risk equivalence” for Chinese populations (Type 2 Diabetes)**

**Q4.14.a: UK or Western Countries**
No evidence was found relevant to risk equivalent WC cut-points for diabetes in Chinese populations in the UK or other Western populations.

**Q4.14.b: Other countries**

Limited graphical evidence was found from one review (Nyamdorj, 2010b [+/+])\(^8\) that a diabetes risk equivalent WC for Chinese men is 82 cm compared to 102 cm in European men, and 67 to 70 cm among Chinese men was found to be risk equivalent to 94 cm among European men. An equivalent diabetes risk is seen among Chinese women at 70 to 73 cm, compared to 88 cm in European women.

This study has moderate applicability to the UK.

**Evidence statement Q4.15: BMI cut-points indicating “risk equivalence” for Chinese populations (myocardial infarction, stroke or mortality)**

No evidence was found relevant to risk equivalent BMI cut-points for myocardial infarction, stroke or mortality in Chinese populations.

**Evidence statement Q4.16: WC cut-points indicating “risk equivalence” for Chinese populations (myocardial infarction, stroke or mortality)**

No evidence was found relevant to risk equivalent WC cut-points for myocardial infarction, stroke or mortality in Chinese populations.

### 4.1.5 Mixed ethnic populations

**Evidence statement Q4.17: Optimal BMI cut-points for mixed ethnic populations (Type 2 Diabetes)**

No evidence was found relevant to risk equivalent WC cut-points for diabetes in mixed ethnic populations.

**Evidence statement Q4.18: Optimal WC cut-points for mixed ethnic populations (Type 2 Diabetes)**

No evidence was found relevant to risk equivalent BMI cut-points for myocardial infarction, stroke or mortality in mixed ethnic populations.

**Evidence statement Q4.19: BMI cut-points indicating “risk equivalence” for mixed ethnic populations (myocardial infarction, stroke or mortality)**
No evidence was found relevant to risk equivalent BMI cut-points for myocardial infarction, stroke or mortality in mixed ethnic populations.

Evidence statement Q4.20: WC cut-points indicating “risk equivalence” for mixed ethnic populations (myocardial infarction, stroke or mortality)
No evidence was found relevant to risk equivalent WC cut-points for myocardial infarction, stroke or mortality in mixed ethnic populations.
Table 9: Risk equivalent BMI values in black, Asian and minority ethnic populations - 25 kg/m²

<table>
<thead>
<tr>
<th>Question 4 BMI 25 kg/m²</th>
<th>BMI values with risk equivalency to 25 kg/m² in European populations</th>
<th>Black</th>
<th>South Asian</th>
<th>Middle Eastern</th>
<th>Chinese</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Male</td>
<td>Female</td>
<td>Male</td>
<td>Female</td>
<td>Male</td>
</tr>
<tr>
<td>Chiu, 2011</td>
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<td>21-22</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Nyamdorj, 2010b</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stevens, 2008</td>
<td>23</td>
<td>23</td>
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</tr>
<tr>
<td>Cameron, 2010</td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Pan, 2004</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Stevens, 2002</td>
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<td></td>
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<td>21-23</td>
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<tr>
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<td>21-23</td>
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</table>

Table 10: Risk equivalent BMI values in black, Asian and minority ethnic populations - 30 kg/m²

<table>
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<th>BMI values with risk equivalency to 30 kg/m² in European populations</th>
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<th>Chinese</th>
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<td>Female</td>
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<td>26</td>
<td></td>
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<tr>
<td>Nyamdorj, 2010b</td>
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<td>19-20</td>
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<td>Stevens, 2008</td>
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<td>19-24</td>
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<td>Applicable Range</td>
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<td>26-29.9</td>
<td>19-24</td>
<td>24</td>
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</tbody>
</table>

*Studies with at least moderate applicability highlighted in light grey.
Table 11: Risk equivalent waist circumference values in black, Asian and minority ethnic male populations

<table>
<thead>
<tr>
<th>Question 4 WC Males</th>
<th>WC values with risk equivalency males</th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Black</td>
<td>South Asian</td>
<td>Middle Eastern</td>
<td>Chinese</td>
<td></td>
</tr>
<tr>
<td>White equivalent</td>
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<td>94 cm</td>
<td>102 cm</td>
<td>94 cm</td>
<td>102 cm</td>
</tr>
<tr>
<td>Chiu, 2011</td>
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<td>94 cm</td>
<td>102 cm</td>
<td>94 cm</td>
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<tr>
<td>Stommel, 2010</td>
<td>73</td>
<td>-</td>
<td>82</td>
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</tr>
<tr>
<td>Nyamdorj, 2010b</td>
<td>62</td>
<td>-</td>
<td>82</td>
<td>67-70</td>
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</tr>
<tr>
<td>Stevens, 2008</td>
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<td>67-70</td>
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<tr>
<td>Cameron, 2010</td>
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<td>67-70</td>
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</tr>
<tr>
<td>Pan, 2004</td>
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<tr>
<td>Stevens, 2002</td>
<td>Total Range</td>
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<td>82</td>
<td>67-70</td>
<td></td>
</tr>
<tr>
<td>Applicable Range</td>
<td>73</td>
<td></td>
<td>82</td>
<td>67-70</td>
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</table>

Table 12: Risk equivalent waist circumference values in black, Asian and minority ethnic female populations

<table>
<thead>
<tr>
<th>Question 4 WC Females</th>
<th>WC values with risk equivalency females</th>
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</thead>
<tbody>
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<td></td>
<td>Black</td>
<td>South Asian</td>
<td>Middle Eastern</td>
<td>Chinese</td>
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</tr>
<tr>
<td>White equivalent</td>
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<td>80 cm</td>
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<td>80 cm</td>
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</tr>
<tr>
<td>Chiu, 2011</td>
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<td>80 cm</td>
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<td>Stommel, 2010</td>
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<tr>
<td>Nyamdorj, 2010b</td>
<td></td>
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<td></td>
<td>70-73</td>
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</tr>
<tr>
<td>Stevens, 2008</td>
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</tr>
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<td>Pan, 2004</td>
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<td></td>
</tr>
</tbody>
</table>

*Studies with at least moderate applicability highlighted in light grey.
5 Discussion

This report addresses an ongoing debate about the interpretation of recommended body-mass index (BMI) or waist circumference cut-off points for determining overweight and obesity in black, Asian and minority ethnic populations in the UK. It reports the evidence that could inform a decision of whether population-specific cut-off points for BMI and or WC are necessary or appropriate.

Key Messages

- The identified research concerning risk-equivalency cut-points has methodological limitations and care is needed in interpreting it.

- The direct applicability to UK populations of some of the identified evidence may be limited.

- Limited evidence was available for the separate minority ethnic groups; several of the evidence statements were based on cut-points derived from a single study.

- Identification of appropriate risk-equivalency cut-points was not possible in several studies, as the risk in black, Asian and minority ethnic groups did not reach levels as low as those seen among white participants at the current overweight and obesity cut-points.

- No evidence was identified relevant to risk-equivalency points in Middle Eastern and mixed ethnic populations. Limited evidence was identified relevant to waist circumference risk-equivalency values, or to BMI values to define overweight among black, Asian and minority groups in the UK.

- No evidence was identified relevant to risk-equivalency points for stroke or myocardial infarction. A single study was identified for mortality risk-equivalency cut-points.
5.1 **Question 4**

This question seeks to compare the average risks for individuals and populations from different ethnic groups with those expected for European populations at the existing 25 kg/m² and 30 kg/m² cut-points. The evidence is best inferred from graphs of BMI against incident or prevalent disease by drawing a horizontal line that intersects all plots and is drawn at the level of risk equivalent to a BMI or WC threshold in white populations. Studies are included if they have reported risk in this way and include the relevant ethnic groups compared to white populations.

Incidence and prevalence of diabetes is higher at all BMI and WC cut-points for all minority groups in comparison to white populations. These studies variably report the additional risk factors that were adjusted for in these analyses. Caution is advised in interpreting the unadjusted incidence and unadjusted prevalence rates which have come from cross-sectional studies. One large US study (Stommel, 2010 [+/+])\(^5\) adjusted for age, sex, education, poverty, marital status, insurance, residency, health behaviours and foreign birth. In these fully adjusted analyses in US populations, similar equivalent BMI or WC equivalents occurred across black, Hispanic, East Asian and white groups (See Figure 8). This could imply that much of the separation of the ethnic specific rates of diabetes, the gap between these curves, is due to confounding by diabetes risk factors other than obesity, and not fully accounted for.

5.1.1 **BMI risk-equivalency**

**Overweight**

The identified research suggest that appropriate risk-equivalent cut-points to define overweight may be 25 kg/m² in white populations, 21 to 23 kg/m² in black populations and 23 kg/m² in Chinese populations.

No risk equivalency cut-points were identified for South Asian, Middle Eastern or mixed ethnic populations.

**Obesity**
The evidence suggests that appropriate risk-equivalent cut-points for defining obesity may be 30 kg/m$^2$ in white populations, 26 to 29 kg/m$^2$ in black populations, 19 to 24 kg/m$^2$ in South Asian populations, and 22 to 25 kg/m$^2$ in Chinese populations.

No risk equivalency cut-points were identified for Middle Eastern or mixed ethnic populations.

5.1.2 WC risk-equivalency

**Overweight**

Limited evidence suggests that appropriate risk equivalency cut-points to define overweight may be 94 cm among white men and 67 to 70 cm among Chinese men.

No evidence was identified relevant to overweight risk-equivalency cut-points for men black, South Asian, Middle Eastern or mixed ethnic populations, or for women in any of the black, Asian and minority ethnic groups.

**Obesity**

Limited evidence suggests that appropriate risk-equivalent obesity cut-points may be 102 cm among white men, 73 cm among black men and 82 cm among Chinese men. Appropriate cut-points to define obesity among women may be 88 cm for white women and 70 to 73 cm for Chinese women.

No evidence was identified relevant to waist circumference thresholds that represent obesity risk-equivalency among men from black, Middle Eastern or mixed ethnic populations. Furthermore, no evidence was identified relevant to WC thresholds for obesity among women in black, South Asian, Middle Eastern or mixed ethnic populations.

6 Summary

This report addresses an on going debate about the interpretation of recommended body-mass index (BMI) or waist circumference cut-off points for determining overweight and obesity in black, Asian and minority ethnic
populations in the UK. It reports the evidence that could inform a decision of whether population-specific cut-off points for BMI and or WC are necessary. The identified evidence suggests that black, Asian and minority ethnic groups are at a higher risk of diabetes than white populations at the same BMI and WC values.

No evidence was identified to support the development of a single cut-point that could be applied to all black, Asian and minority ethnic groups representing a risk of diabetes equivalent to that seen among white populations at the currently recommended cut-off values. However, limited evidence was found relevant to individual sub-populations.

This limited evidence (consistent findings from three studies) suggests that a BMI threshold of 23 kg/m² in black and Chinese populations is approximately equivalent to an overweight cut-point of 25 kg/m² in European populations. Similarly limited evidence (consistent findings from four studies) suggests that a BMI of 24 kg/m² among South Asian and Chinese populations, and 26 kg/m² for black populations is approximately equivalent to an obesity cut point of 30 kg/m² in European populations for risk of diabetes.

Significant gaps in the evidence were found. No studies were identified with Middle Eastern populations, and there were few studies that included stroke, myocardial infarction or morality as an outcome, or waist circumference as an independent variable. Finally, no large prospective studies were identified that compared white populations to black, Asian and minority ethnic groups resident in the UK.
References


