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Enablers and barriers to implementing obesity assessments in clinical practice: a rapid mixed-methods systematic review

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ABSTRACT

Objectives This systematic review aims to improve our knowledge of enablers and barriers to implementing obesity-related anthropometric assessments in clinical practice.

Design A mixed-methods systematic review.

Data sources Medline, Embase and CINAHL to November 2021.

Eligibility criteria Quantitative studies that reported patient factors associated with obesity assessments in clinical practice (general practice or primary care); and qualitative studies that reported views of healthcare professionals about enablers and barriers to their implementation.

Data extraction and synthesis We used random-effects meta-analysis to pool ratios for categorical predictors reported in ≥3 studies expressed as pooled risk ratio (RR) with 95% CI, applied inverse variance weights, and investigated statistical heterogeneity (I^2), publication bias (Egger's test), and sensitivity analyses. We used reflexive thematic analysis for qualitative data and applied a convergent integrated approach to synthesis.

Results We reviewed 22 quantitative (observational) and 3 qualitative studies published between 2004 and 2020. All had ≥50% of the quality items for risk of bias assessments. Obesity assessment in clinical practice was positively associated with patient factors: female sex (RR 1.28, 95% CI 1.10 to 1.50, I^2 99.8%, mostly UK/USA), socioeconomic deprivation (RR 1.21, 95% CI 1.18 to 1.24, I^2 73.9%, UK studies), non-white race/ethnicity (RR 1.27, 95% CI 1.03 to 1.57, I^2 99.6%) and comorbidities (RR 2.11, 95% CI 1.60 to 2.79, I^2 99.6%, consistent across most countries). Obesity assessment was also most common in the heaviest body mass index group (RR 1.55, 95% CI 0.99 to 2.45, I^2 99.6%). Views of healthcare professionals were positive about obesity assessments when linked to patient health (convergent with meta-analysis for comorbidities) and if part of routine practice, but negative about their role, training, time, resources and incentives in the healthcare system.

Conclusions Our evidence synthesis revealed several important enablers and barriers to obesity assessments that should inform healthcare professionals and relevant stakeholders to encourage adherence to clinical practice guideline recommendations.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ Study design that allowed a convergent integrated synthesis of evidence from quantitative and qualitative studies on the enablers and barriers to implementing obesity-related anthropometric assessments in clinical practice.
⇒ Comprehensive search strategy of major electronic databases and rigorous data extraction and risk of bias assessments.
⇒ Conclusive results from several meta-analyses corrected for heterogeneity across studies and convergent with results from rigorous thematic analysis.
⇒ Results from meta-analyses were based on observational studies and slightly weakened or inconclusive for some patient factors. Small number of qualitative studies reviewed also limits the applicability of our findings to encourage better adherence to clinical practice guideline recommendations.
⇒ Findings might have limited applicability in settings not reviewed, especially in low/middle-income countries.

INTRODUCTION

Obesity rates have nearly tripled in most countries since 1975.[1] The rising health problems attributable to obesity are undoubtedly challenging health systems worldwide.[2] As the first point of contact for most people seeking healthcare services, general practice or primary care ('clinical practice') remains at the forefront of efforts to prevent and manage obesity.[2] Although a range of evidence-based guidelines provide recommendations on how to provide effective weight management in clinical practice,[3] obesity and related complications remain under diagnosed and poorly treated.[4 5] Quality improvements in obesity care would result in significant population health and economic benefits.[6–9]

Most international guidelines recommend that body mass index (BMI) should be used as a routine measure for diagnosis.[3 10] They also recommend that waist circumference (WC) should be considered as an additional measure to assess the risk of developing obesity-related complications.[3] There is a growing body of evidence indicating that routine clinical practices for obesity-related anthropometric measures fall short of guideline recommendations and standards.[2] Studies have reported that the rate of weight, BMI or WC measurement in clinical practice could be as low as 20%–30%, even in high-income countries.[11 12] The reasons for such low adherence rates to these guideline recommendations are likely to vary across countries. For instance, patient factors such as female sex was associated with an increased likelihood of weight recording in the UK[11] but not in the Netherlands,[13] and was associated with a decreased likelihood of BMI documentation in Australia.[12] Cardiovascular disease was associated with an increased likelihood of a weight recording in the Netherlands,[13] whereas a reverse association was reported in Australia.[12] Furthermore, qualitative research suggests that healthcare professionals report several barriers to implementing obesity-related anthropometric measure in clinical practice such as lack of knowledge and specific training, negative perceptions about its usefulness, clinical importance and acceptability.[14] Given the existence of relevant quantitative and qualitative studies, as well as several inconsistencies within this evidence base, this mixed-methods systematic review aims to improve our knowledge of the enablers and barriers to implementing obesity assessments in clinical practice.

METHODS

Protocol and registration

We developed the protocol for this systematic review with guidance from previous research,[15–17] the Centre for Review and Dissemination's Guidance for undertaking reviews in healthcare,[18] the JBI methodology for mixed-methods systematic reviews using a convergent integrated approach to synthesis and integration,[19] and the Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols statement.[20]

Patient and public involvement

This rapid systematic review did not involve patients and the public in the protocol development.

Eligibility

Using modified versions of the Population, Interventions, Comparators and Outcomes framework, we developed two research questions and selected study eligibility criteria (table 1).[21]

Quantitative research question

What are the patient factors associated with implementing obesity-related anthropometric assessments in clinical practice?

Qualitative research question

What are the views of healthcare professionals about implementing obesity-related anthropometric assessments in clinical practice?

To answer the quantitative research question, we considered observational studies (eg, cohort, cross-sectional, case–control and case series) that reported associations between patient factors (independent variables) and outcomes (dependent variables) in the clinical practice setting (general practice or primary care). For the qualitative research question, we considered qualitative studies that reported on the views of healthcare professionals about enablers and barriers to implementing obesity-related anthropometric assessments in the clinical practice setting. We considered qualitative studies using designs such as phenomenological, ethnographic, grounded theory, historical, case study and action research.

Table 1 Inclusion criteria for quantitative and qualitative studies

Parameter		Criteria
Quantitative studies		
P	Population and setting	Adult patients in clinical practice (general practice or primary care)
P	Patient factor (independent variable)	Patient factors associated with implementing obesity-related anthropometric assessments such as previous obesity-related anthropometric assessment (eg, weight, waist circumference and BMI); demographic characteristics (eg, age, sex and ethnicity); existing medical conditions (eg, type 2 diabetes, hypertension and hyperlipidaemia) and clinical encounter (eg, reason for appointment)
O	Outcome (dependent variable)	Obesity-related anthropometric assessments (eg, weight, BMI, waist circumference and weight-to-hip ratio)
Qualitative studies		
P	Population and setting	Healthcare professionals in clinical practice (general practice or primary care)
I	Interest	Healthcare professionals' views (perspectives or experiences) about implementing obesity-related anthropometric assessments in clinical practice
Co	Context	Any country worldwide

BMI, body mass index.

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Search strategy, information sources and study selection

The academic liaison librarian (BC) developed our search strategy in consultation with the subject expert (EA). She searched Medline, Embase and CINAHL databases for potentially relevant articles on 25 September 2021. Due to a typographical error for one search term used in Embase, she repeated the search in that database on 25 November 2021. The mixed-methods, quantitative and qualitative search string was adapted from the OVID expert search tool 'Mixed Methods' (online supplemental table S1). All records identified were exported from the databases into EndNote V.20 reference manager and duplicate records were removed where possible. All titles and abstracts were first screened for eligibility against the criteria mentioned above. Second, the available full-length reports retrieved from these records were screened for possible inclusion. We considered studies published in English language without any restrictions on the publication date and geographical location. References from included studies were also searched. Reasons why studies identified in the second screen were excluded are available in online supplemental table S2.

Data extraction and risk of bias assessment

We independently extracted key characteristics and assessed the risk of bias of the quantitative (RC, CNS, DL and EA) and qualitative (KP, GM and EA) studies included for review using the JBI's standardised critical appraisal checklists.[22] We used this information to assist our discussion on the strength of the body of evidence following our synthesis of results. For quantitative studies, we sought information about study details, population and setting, patient factors (independent variables), outcomes (obesity-related anthropometric assessments), statistical methods, results/effect estimates and author's conclusions. For qualitative studies, we sought information about study details, population and setting, study design, aims and methods, main themes and subthemes with explanations, and author's conclusions.

Effect measures

Results for categorical predictor variables, where the effect was expressed as a ratio relative to a reference category accompanied by a 95% CI, were considered for pooling. These results comprised risk ratios (RRs), rate ratios and ORs with no HRs reported. Results which were only reported as frequency counts were converted to RRs and associated 95% CIs using an appropriate online calculator via the VassarStats website.[23]

Synthesis methods

To allow pooling of results, we expressed ratios relative to the same or a similar reference category. Where reference categories were swapped (eg, females defined as the reference category instead of males), we corrected the reference category by inverting the ratio (and associated 95% CI) around the null value of '1'. Where a numeric variable had been categorised into varying categories, the lowest category was taken as the reference category and the highest category compared with it. Where there was a common reference category but varied comparator categories, the comparator categories were combined using the method by Borenstein *et al*.[24] For example, for the variable 'race/ethnicity', as 'white' was the common reference category, the results for the various non-white categories were recombined to produce a single 'non-white' to 'white' ratio. Where a single study presented results separately in independent subgroups (such as separate results for males and females), ratios were first combined using a fixed effects meta-analysis prior to being pooled with results from other studies. Once reference categories, comparator categories and subgroups had been corrected, random-effects meta-analysis was used to pool ratios for predictors reported in three or more studies. To correct for heterogeneity across studies, we applied heterogeneous specific inverse variance weights in these analyses.[25] Meta-analysis was only conducted for the BMI assessment outcome as 'BMI recording' or 'BMI diagnosis recording', which was more commonly reported than alternatives such as WC. Results reported include the pooled ratio with associated 95% CI and p value and the I^2 statistic and the p value from the heterogeneity test. Forest plots are used to present commonly reported predictors, while results for other predictors are tabulated.

We used subgroup analyses to explore possible explanations for heterogeneity. This included assessing candidate grouping variables related to what was measured, how the results were summarised and where the studies were conducted. First, studies were stratified according to whether the outcome was the recording of BMI assessment or the recording of BMI as a health diagnosis. Second, as ORs generally overestimate RRs, studies could be stratified according to whether ORs or RRs were presented. Finally, as we assumed that different countries have different healthcare systems and policies, studies were stratified according to country (UK, USA, Australia or 'other'). Subgroup analyses proceeded when at least two categories of the grouping variable contained at least three studies each. Sensitivity analyses, excluding all studies which failed to achieve 100% 'yes' responses on the quality assessment checklist, were conducted to check whether any of the findings were sensitive to study quality.

Reporting bias assessment

Funnel plots were visually reviewed for indications of reporting bias and Egger's tests were reported for meta-analyses containing 10 or more studies only, as recommended in the Cochrane Handbook for Systematic Reviews of Interventions (section 13.3.5.4 tests for funnel plot asymmetry).[26]

Thematic analysis

We applied the widely used reflexive thematic analysis method by Braun and Clarke to establish findings from the qualitative data.[27] Studies were read several times by two authors (GM and KP). Each author extracted

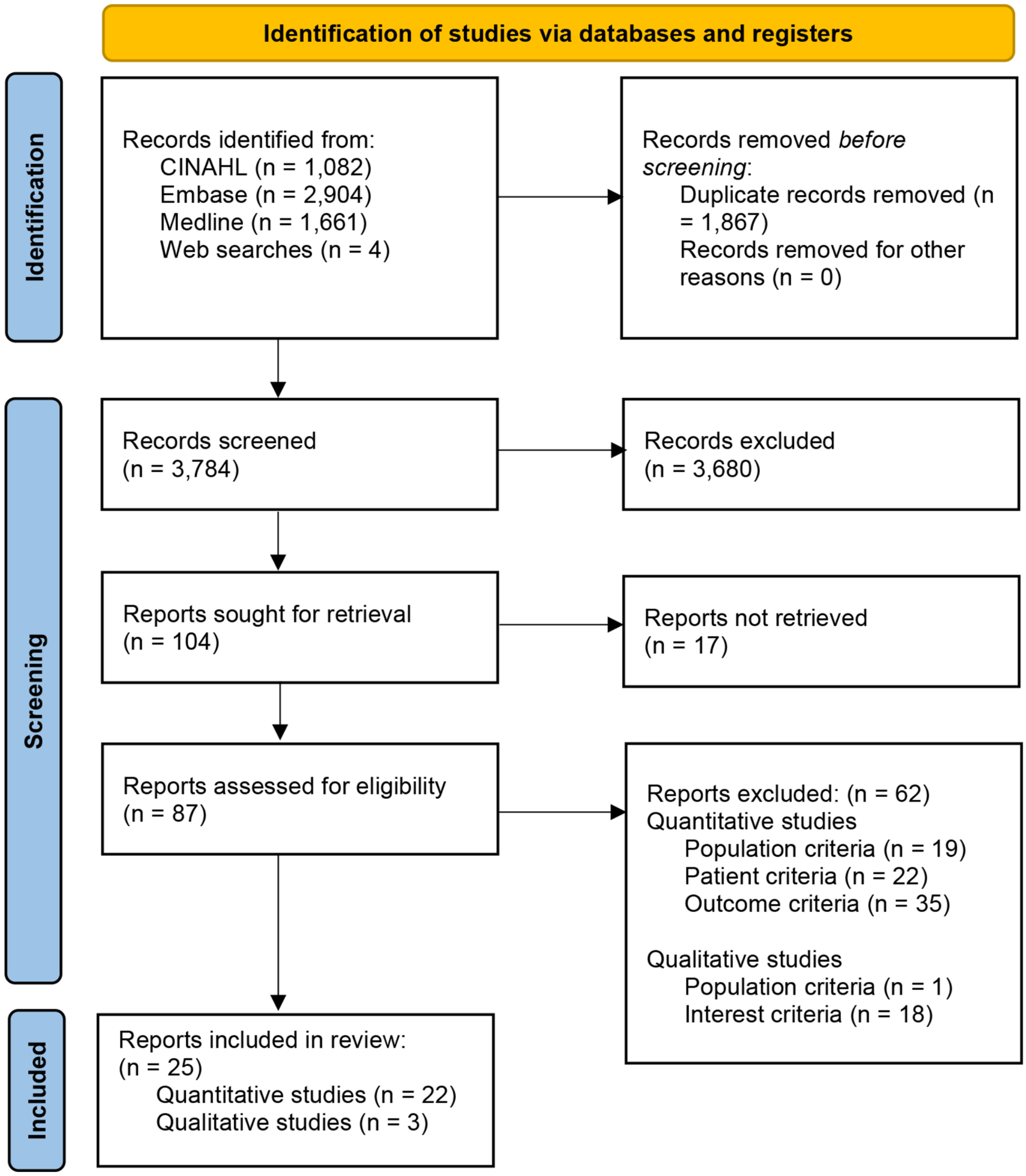

Figure 1 Flow diagram of the study selection process.[59]

the main findings from individual studies. Further, as recommended,[27] we spent time individually coding to construct categories from the data. The categories were reviewed to seek potential commonalities and differences between the papers, from which themes were established. The two authors met regularly to review areas of data extraction, coding allocation and theme creation. Ongoing reflexive discussions created a space for mutual understanding and agreement about the overarching themes.

RESULTS

Study selection

A flow diagram of the study selection process appears below (figure 1). Our search strategy identified 3784 records including four additional studies from other sources after 1867 duplicates were removed. Of these, we excluded 3680 records after the first screening, leaving 104 records for a second screening. After further assessment of 87 reports retrieved, we excluded 62 additional records for reasons summarised below and described in online supplemental table S2.

Study characteristics

We present a detailed summary of the study characteristics in online supplemental tables S3 and S4. In total, there were 22 quantitative studies (observational)[11–13 28–46] and 3 qualitative studies,[14 47 48] published between 2004 and 2020. Eight studies were from the UK,[11 14 37 39 40 43 46 47] nine from the USA,[28 31 32 34 36 41 42 45 48] four from Australia[12 33 35 44] and one each from Germany,[38] Spain,[30] Israel[29] and the Netherlands.[13] All three qualitative studies included interviews with 7–14 primary care practitioners.[14 47 48] All qualitative studies conducted semistructured interviews and thematic analysis to explore healthcare professionals' views towards WC measurement including identification of possible barriers to carrying out the assessment,[14] primary care providers' perception of WC measurement rejection in primary care[48] and primary care providers' perception of recognition of overweight and obesity.[47] Quantitative studies were based on records of patients from primary practices, with sample sizes between 100 and 1000 in 3 studies,[28–30] 1000 and 10 000 in 6 studies,[13 31–35] 10 000 and 100 000 in 6 studies,[36–41] and greater than 100 000 in 7 studies.[11 12 42–46] The patient factors associated with the implementation of obesity-related anthropometric assessment in primary care varied between studies, with sociodemographic factors such as age and sex identified in 16 studies,[11–13 28 31 32 34 35 37–39 41–45] ethnicity and/or race identified in 9 studies,[11 28 31 32 34 39 41 42 45] and socioeconomic status identified in 4 studies.[11 37 39 43] Presence of comorbidities or any specific medical condition was identified to be a patient factor independently associated with the obesity assessment in 20 studies.[11–13 28–35 38–46] Six studies identified insurance type as a factor associated with obesity-related anthropometric assessment.[31 32 34–36 41 42] Outcomes in studies varied, with 11 studies having BMI 'measurements' or 'recording' or 'documentation' or 'screening',[12 29 30 36 37 39–42 44 46] 4 studies having obesity 'diagnosis' or 'recognition' or 'identification',[28 31 38 40] 2 studies having weight 'recording' or 'measurement',[11 13] 2 studies having overweight/obesity 'documentation',[32 34] and 1 study each for null BMI recording,[43] weight and/or WC measurement,[33] ICD-9 (international classification of diseases, ninth revision) codes for overweight/obesity,[45] and non-identification of overweight and obesity[35] as a dependent variable.

Risk of bias within studies

We present the results of our quality assessment of each study in online supplemental table S5. All four cohort studies had at least 70% of the quality items clearly met,[11 37 40 46] with three studies having one to two items unclear.[11 40 46] Of the 18 cross-sectional studies, 12 studies had 100% of the quality items clearly met,[12 13 29 31–34 39 42–45] and 6 studies had at least 50% of the quality items clearly met,[28 30 35 36 38 41] with four studies having one to two items unclear.[28 30 35 38] Of the three qualitative studies, two studies had 70%,[14 47] and one study had 80%[48] of the quality items clearly met.

Findings of meta-analysis

All patient factors potentially associated with obesity assessments as predictors were considered in each quantitative study reviewed (online supplemental table S3). Meta-analyses were conducted on each of the fourteen potential predictors identified, which were reported in at least three studies each (table 2). These were grouped as demographic characteristics (age, sex, race/ethnicity, deprivation index and health insurance status), BMI category, smoking status and comorbidities (number of comorbidities and individual comorbidities such as cardiovascular disease and diabetes). All except one study[40] contributed results to at least one of these predictors. All meta-analyses found very high heterogeneity

Table 2 Summary of meta-analyses which pooled the ratios of BMI assessment by patient groups

Predictor	Comparison	No of studies	Pooled risk ratio	I^2, heterogeneity test, p value
Demographics				
Sex	Female vs male (reference)	15	1.28 (1.10,1.50)	99.8%, p<0.001
Age	Closest to 65 years vs closest to 30 years (reference)	12	0.90 (0.50,1.63)	100%, p<0.001
Race/ethnicity	Non-white vs white (reference)	9	1.27 (1.03,1.57)	99.6%, p<0.001
Deprivation index	Highest deprivation vs least (reference)	4	1.21 (1.18,1.24)	73.9%, p=0.009
BMI category	Highest BMI vs lowest BMI (reference)	8	1.55 (0.99,2.45)	99.6%, p<0.001
Smoking status	Current smoker vs never smoker (reference)	3	1.01 (0.90,1.14)	98.3%, p<0.001
Comorbidities				
No of comorbidities	Most vs fewest (reference)	10	2.11 (1.60,2.79)	99.6%, p<0.001
Cardiovascular disease	Present vs absent (reference)	7	0.94 (0.81,1.10)	98.0%, p<0.001
Diabetes	Present vs absent (reference)	9	1.19 (0.93,1.52)	99.0%, p<0.001
Dyslipidaemia	Present vs absent (reference)	6	1.12 (0.92,1.37)	99.5%, p<0.001
Hypertension	Present vs absent (reference)	10	1.17 (0.98,1.40)	99.5%, p<0.001
Mental illness	Present vs absent (reference)	3	1.16 (0.79,1.70)	99.6%, p<0.001
Depression	Present vs absent (reference)	3	1.22 (0.85,1.74)	98.7%, p<0.001

BMI, body mass index.

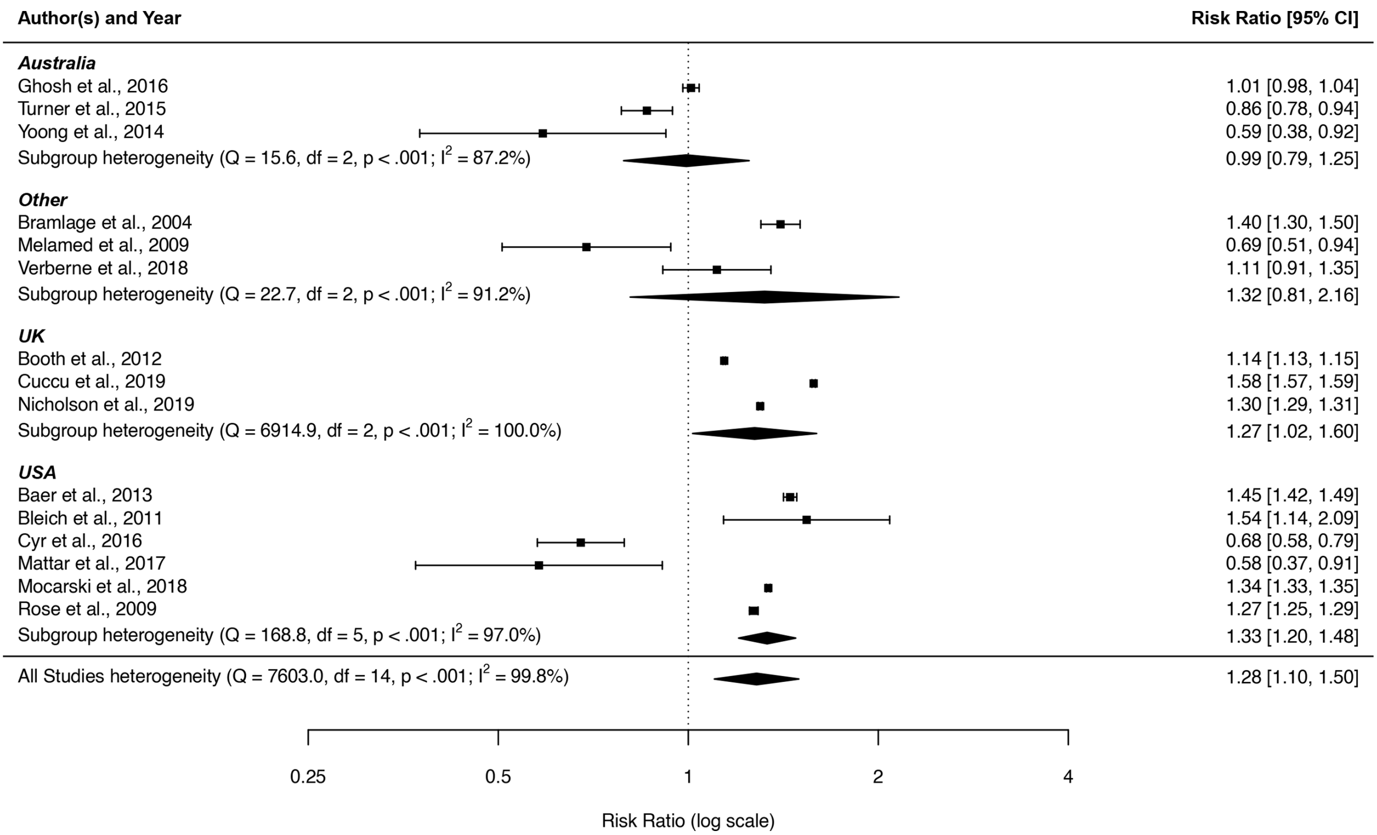

Figure 2 Forest plot of risk ratios for BMI assessment associated with female relative to male sex (reference) by country regions. BMI, body mass index.

between studies. More detailed descriptions appear below, and additional results are presented in online supplemental section S6.

Demographics

Despite the high levels of heterogeneity between studies, the pooled results suggested that female sex, non-white race/ethnicity and socioeconomic deprivation were associated with statistically significant increases in the rate of BMI assessment of 1.2–1.3 fold, and there was no statistically significant evidence of reporting bias (online supplemental sections S6.1–3). There was no evidence of such differences in BMI assessment rates between younger and older age groups.

There was statistically significant evidence of increased assessment of BMI among females among studies from the UK and USA but not Australia (figure 2). As would be expected, the pooled OR (11 studies, OR 1.45, 95% CI 1.21 to 1.74, I^2 99.5%) were higher than pooled other RRs (4 studies, RR 1.18, 95% CI 1.04 to 1.35, I^2 99.7%) (online supplemental section S6 table S6.1). For all other predictors, there were insufficient studies reporting other RRs to allow further investigation of these subgroups. No other statistically significant results arose during the subgroup analysis.

In sensitivity analysis, restricting analysis to studies with the highest quality ratings yielded an increased pooled RR (10 studies, RR 1.45, 95% CI 1.21 to 1.74, I^2 99.6%) for sex, but did not alleviate the heterogeneity between studies. The equivalent sensitivity analysis for age category also increased the size of the effect estimate, although still not statistically significant (nine studies, RR 0.69, 95% CI 0.19 to 2.48, I^2 100%).

BMI and smoking status

All eight studies reporting results for BMI category found statistically significant effects, but the high heterogeneity yielded a wide CI and lack of statistical significance for the pooled RR (figure 3). Sensitivity analysis using only the studies with the highest quality rating produced a larger effect estimate for the difference between BMI assessment in the higher and lower BMI groups, but the high heterogeneity and lack of statistical significance remained (four studies, RR 2.56, 95% CI 0.45 to 14.6, I^2 99.3%) (online supplemental section S6 table S6.6). There was no evidence of difference in BMI assessment between current and never smokers (three studies, RR 1.01, 95% CI 0.90 to 1.14, I^2 98.2%) (online supplemental section S6 table S6.7).

Comorbidities

Despite considerable heterogeneity in measures, methods and outcomes (online supplemental section S6 table S6.8), all 10 studies found that those with the higher comorbidities were more likely to have a BMI assessment recorded, with these results being statistically significant in 9 of the 10 studies (figure 4). Subgroup and sensitivity analyses showed that this association was broadly

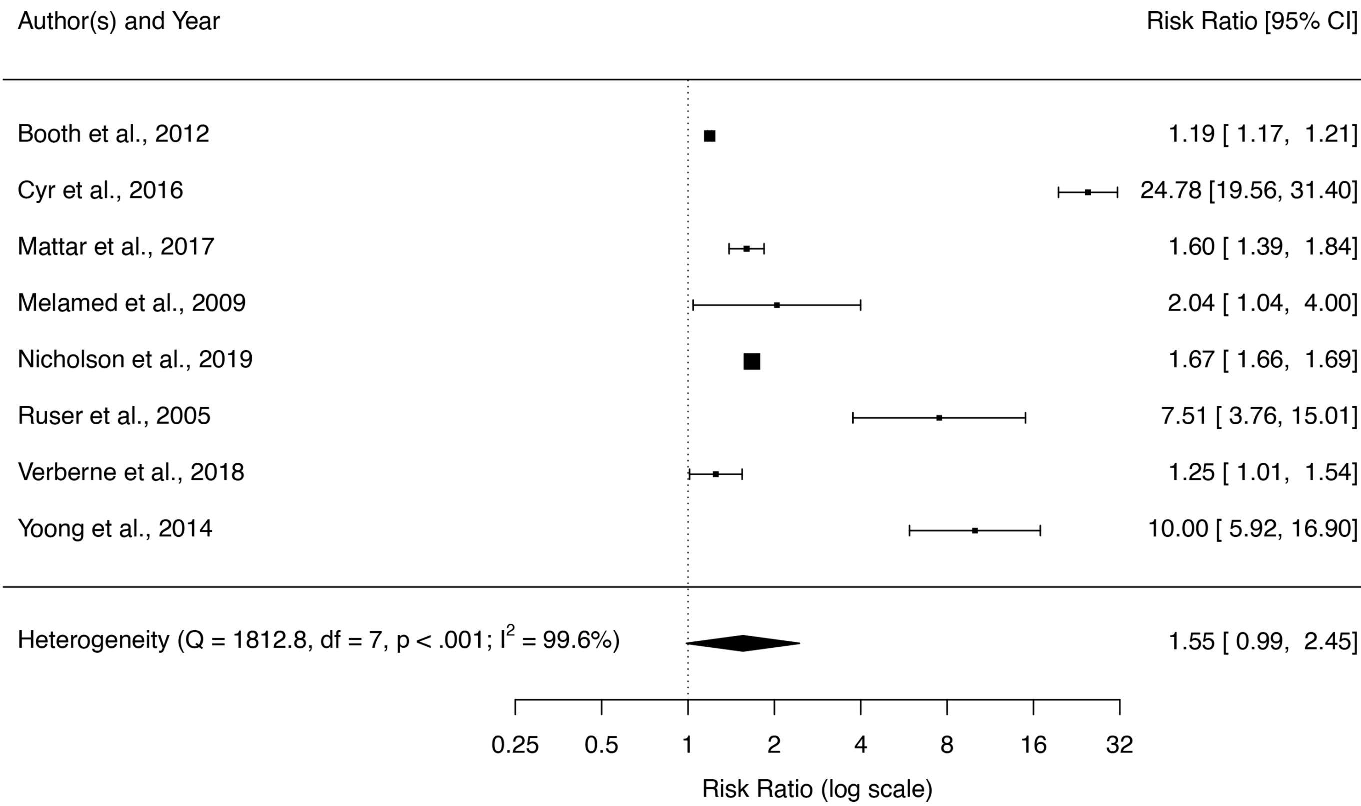

Figure 3 Forest plot of risk ratios for BMI assessment associated with highest relative to lowest (reference) BMI category. BMI, body mass index.

consistent across outcomes, countries and study quality, with no visual or statistical evidence of publication bias (online supplemental section S6 table S6.8).

Pooled ratio of BMI assessment for those with relative to those without each specific comorbidity produced quite uniform results (online supplemental section S6 table S6.8). None of the individual comorbidities had a statistically significant association with BMI assessment and all displayed very high heterogeneity between studies: cardiovascular disease (7 studies, RR 0.94, 95% CI 0.81 to 1.10, I^2 98.0%), diabetes (9 studies, RR 1.19, 95% CI 0.93 to 1.51, I^2 99.0%), dyslipidaemia (6 studies, RR 1.12, 95% CI 0.92 to 1.37, I^2 99.5%), hypertension (10 studies, RR 1.17, 95% CI 0.98 to 1.40, I^2 99.5%), mental illness (3 studies, RR 1.16, 95% CI 0.79 to 1.70, I^2 99.6%) and depression (3 studies, RR 1.22, 95% CI 0.85 to 1.74, I^2 98.7%). However, subgroup analyses found that studies from Australia, unlike those from the UK and USA, had statistically significantly higher BMI assessment for those with comorbidities with lower heterogeneity: diabetes (three studies, RR 1.84, 95% CI 1.75 to 1.93, I^2 0%); dyslipidaemia (three studies, RR 1.21, 95% CI 1.08 to 1.36, I^2 80.6%) and hypertension (three studies, RR 1.15, 95% CI 1.05 to 1.26, I^2 69.4%). Sensitivity analyses, restricting pooling to studies with the higher quality ratings, gave statistically significant evidence of the association between the comorbidity and BMI assessment in dyslipidaemia (four studies, RR 1.21, 95% CI 1.15 to 1.28, I^2 57.3%) and hypertension (eight studies, RR 1.26, 95% CI 1.10 to 1.43, I^2 97.7%).

Findings of thematic analysis

Three themes were established from our thematic analysis of the qualitative studies: personnel, resources and systemic factors.

Personnel

The theme of personnel factors focused on two subthemes: roles and responsibilities and communications and discomfort. While nurse participants believed that weight assessment and management was part of their professional role, there was ambiguity about this among the medical participants. One General Practitioner (GP) noted *"I don't want to be weighing people every week. I don't think that's my role. I think it's also not a good use of our expertise as generalist doctors. I think we've got other things that we could be doing"*,[47] (p. 7). There were variable views among GPs about their role in obesity prevention. The GPs asserted that patients should retain responsibility for their weight unless they have weight-related health issues: *"Patients need to take some responsibility themselves. And if they know that they're carrying a bit of extra weight, they don't need to see a GP necessarily"*,[47] (p. 7): *"I have a responsibility to make them aware that (their weight) is an issue where it's clearly impacting on their (health). Do I have a responsibility to assist them with that? If they are looking for that assistance. I would have a responsibility to assist them or signpost them to what can assist them"*,[47] (p. 7). This finding was aligned with another study which found that weight-related measurements were only undertaken if part of routine practice.[48] Although GPs and nurses

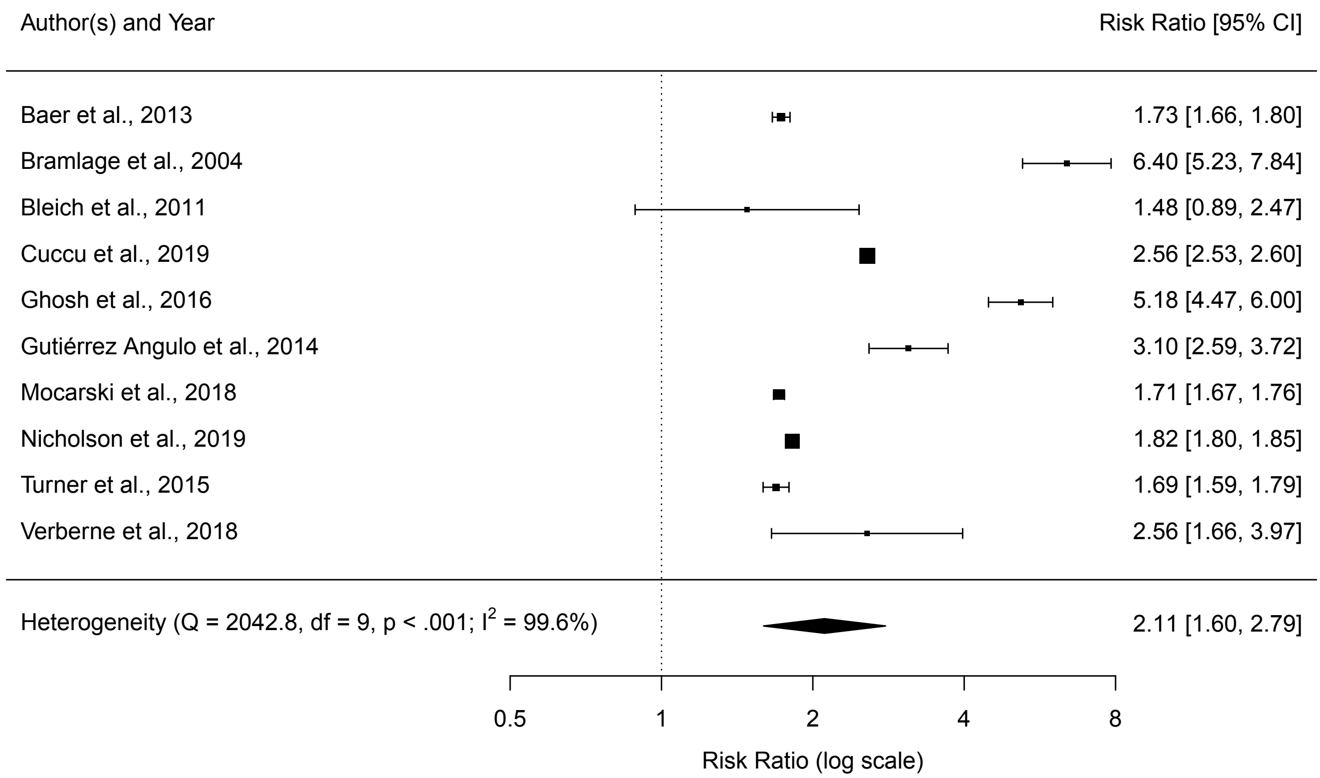

Figure 4 Forest plot of risk ratios for BMI assessment associated with most relative to fewest (reference) number of comorbidities groups. BMI, body mass index.

perceived that patients lacked understanding of the health risks associated with increasing waist size, and that WC measurement could motivate patients to make healthy lifestyle changes, they did not routinely carry out this assessment.[14]

Our thematic analysis highlighted a second subtheme in relation to *personnel factors* namely: communications and discomfort. Primary care practitioners perceived that patients might feel uncomfortable or embarrassed about having their WC measured.[14] Others expressed a preference for discussing weight with the patient within the context of existing, and possibly weight related, health issues[47]: *"So, I have to say that I tend only to (raise weight for discussion) if I see it as relevant to the problem that they've got"*,[47] (p. 7). They also thought that measuring waist might cause patient discomfort, particularly given the intimate nature of WC measurements,[14 48] as a practice nurse highlighted: *"It's personal to go up and start putting your arms around a patient"*,[14] (p. 365). The need to consider cultural sensitivities was also reported: *"Depends on the individual circumstances. Some patients don't care, but if you're a Muslim woman and very strict about it you wouldn't want anybody other than a woman touching you, so it depends on your individual ethnic preferences and your personal preferences as well"*,[14] (p. 368). This was further reinforced when primary care providers reported their own discomfort when measuring a person's WC, more so, a person of a different gender to themselves: *"five providers shared that obtaining a WCM* (abbreviated for WC measurement) *was "uncomfortable," particularly if the patient was "large" and/or the opposite gender of the provider"*,[48] (p. 686).

Resources

The theme of resources included subthemes associated with time, equipment, costs, knowledge and training. All three qualitative studies referred to the challenges of time for appointments and consultations. One healthcare practitioner stated: *"You don't just take the measurement, you have to explain what it means so in itself it doesn't take a moment does it, but then you've got quite a good length of topic of conversation to explain it"*,[14] (p. 368). Limited availability of equipment such as tape measures[48] and lack of specific training on correct measuring technique[14] were other barriers to primary care practitioners for undertaking WC measurements. However, it was noted that *"the degree to which HCPs* (abbreviated for health care professionals) *felt comfortable about WCM appeared to be positively related to the increased experience of measuring waist size and to routine*

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rather than ad hoc use of this measurement and negatively associated with patients being overweight or obese",[14] (p. 369), despite health care professionals noting that they had not received specific training related to implementing WC measurements.[14] An additional barrier to obesity-related anthropometric assessments could be that primary care practitioners question the evidence-base for recommended weight management interventions by clinical guidelines: *"If someone's got obesity, I'm kind of stuck. I can give them advice on what to do but I don't feel in many cases, that's terribly helpful or terribly effective",*[47] (p. 7).

Systemic factors

Two studies found systemic factors as barriers to undertaking WC measurements.[14 47] One study highlighted the limited human and financial resources offered to primary care services.[47] Another referred to the need for greater organisational incentives for undertaking WC measurements.[14] Similarly, one primary care practitioner noted that the National Health Service contracts in the UK did not 'prioritise or incentivise' weight management within primary care settings.[47] However, finance-related issues were not the only systemic factors highlighted. There were concerns about restrictive eligibility criteria for referring to specialised weight management services as summarised: "*There was despondency among PCPs* (abbreviated for primary care practitioners) *that they had nowhere to refer overweight patients when weight was not (yet) impacting on their health, and even when patients had clinical weight issues, they were not eligible for some specialist care",*[47] (p. 6). While findings were mainly related to service level issues, primary care practitioners argued that the inclusion of WC measurement within both quality and outcome frameworks could incentivise clinical practice.[14]

DISCUSSION

We are the first authors to have systematically reviewed, synthesised and integrated the published evidence from quantitative and qualitative studies on the enablers and barriers to implementing obesity-related anthropometric assessments in clinical practice. Our evidence synthesis revealed several important enablers and barriers to obesity assessments that could inform healthcare professionals and relevant stakeholders such as academic institutions, professional bodies and regulatory agencies.

Enablers

We found evidence from our meta-analysis indicating that an obesity assessment is most likely for patients with weight-related complications ('comorbidities'). This finding was broadly consistent across countries and slightly strengthened among high quality studies (including for 'dyslipidaemia' and 'hypertension'). Similarly, the presence of 'obesity-related comorbidities' is reportedly one of the principal reasons cited by healthcare professionals for initiating weight management discussions.[49] Although highly variable, we also found evidence to suggest that BMI assessment ('recording') was most likely among patients with the highest BMI. Overall, the results of our meta-analyses suggest that both excess weight and weight-related complications encourage healthcare professionals to conduct obesity assessments in high-risk patients.

Convergent with this hypothesis, the findings of our thematic analysis revealed positive views among healthcare professionals about obesity assessments if they suspected that their patient's excess weight was negatively impacting on their health.[47] Healthcare professionals also expressed positive views about obesity assessments if part of routine practice,[48] and because they could motivate patients to make healthy lifestyle changes.[14] Indeed, frequent self-weighing is associated with favourable weight loss, particularly among those with excess weight.[50] This is consistent with findings of a recent systematic review of qualitative studies in which healthcare professionals expressed positive views on the usefulness of routine BMI assessment at every consultation alongside a treatment framework for discussing weight management with patients in primary care.[51] Healthcare professionals should consider focusing on the health benefits of obesity assessments for clinical diagnosis and monitoring in all patients with visible signs of obesity, as part of their routine practice.

Findings from our meta-analyses also revealed evidence that obesity assessment was most likely for patients with socioeconomic deprivation in the UK, patients of 'non-white' race/ethnicity in the UK and USA, and for female patients, particularly in the UK and USA. These results are likely partially explained by increasing obesity[52] and higher clinical encounter rates with socioeconomic disadvantage groupings,[53] healthcare professionals being more verbally dominant towards non-White than White patients,[54] and a higher prevalence of severe obesity among women than men,[55] respectively, in high-income countries. Healthcare professionals should be aware of these potential biases to ensure that they conduct routine obesity assessments in all high-risk patients regardless of their socioeconomic status, race/ethnicity and sex.

Barriers

Our thematic analysis revealed negative attitudes among healthcare professionals about patients with obesity and their role in obesity assessment and weight management, generally. They expressed views that patients, rather than healthcare professionals, should retain responsibility for, and lacked motivation to, address their weight issues.[47] Healthcare professionals expressed doubts about their patients' understanding of health risks associated with the results of obesity assessments.[14] Overall, these findings suggest that weight stigma among healthcare professionals is a barrier to obesity assessments.

We found evidence that healthcare professionals expressed negative views about adequate training and equipment for obesity assessments.[14 47 48] They expressed negative views on limited access to specialist weight management services and the evidence base for treatments,[47] as required after an obesity assessment and diagnosis.[3] There were expressions of discomfort about obtaining obesity assessments for patients of the opposite sex,[48] which is consistent with previous research showing that patients often preferred to see a healthcare professional of the same-sex.[56] Convergent with findings from our meta-analyses for patients with weight-related complications, healthcare professionals expressed apprehension to discuss weight in the absence of suspected health issues.[47] A recently validated brief diagnostic screening tool (EOSS-2 Risk Tool) for predicting weight-related complications in patients with excess weight could provide healthcare professionals with a structured framework for further investigations including obesity assessments.[57] Finally, healthcare professionals expressed lack of time,[14 47 48] increased financial cost implications[14] and lack of incentives in the health system[14 47] as additional resource and systematic barriers to obesity assessment. Collectively, these findings strengthen the urgency for implementing recommendations to incorporate 'formal teaching on the causes, mechanisms, and treatments of obesity' into standard curricula for healthcare professionals by academic institutions, professional bodies, and regulatory agencies.[58] It would encourage better adherence to clinical practice guideline recommendations that BMI and WC measurements should be used for routine diagnosis and monitoring.[3 10]

Limitations

The applicability of our findings to encourage better adherence to clinical practice guideline recommendations is limited because results from meta-analyses were based on observational studies and slightly weakened or inconclusive for some patient factors, whereas only a small number of qualitative studies were reviewed. As the studies reviewed were predominately from the UK and USA, our findings might have limited applicability in other settings, especially in low/middle-income countries. Furthermore, we might have missed relevant studies for inclusion by using a streamlined rapid systematic review approach.

CONCLUSION

The key findings of our mixed-methods systematic review indicate that obesity-related anthropometric assessment in clinical practice is positively associated weight-related complications, socioeconomic deprivation, 'non-white' race/ethnicity and female sex among patients. Views of healthcare professionals were positive about obesity assessments when linked to patient health and if part of routine practice, but negative about their role, training, time, resources and incentives in the healthcare system. To encourage better adherence to clinical practice guideline recommendations, high-income countries should consider incorporating formal teaching of obesity medicine into their academic institutions, professional bodies and regulatory agencies. Future research for developing and testing interventions should consider the enablers and barriers to obesity assessments identified in this study.

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Contributors EA and RC were responsible for designing the review protocol, writing the protocol and report, conducting the search, screening potentially eligible studies, extracting data, interpreting results, conducting risk of bias assessments, and updating reference lists. CNS was responsible for conducting the search, screening potentially eligible studies, extracting data, interpreting results, updating reference lists and writing the supplementary. KP and GM were responsible for designing the review thematic analysis protocol, screening potentially eligible studies, extracting qualitative data, interpreting results and updating reference lists. BC was responsible for developing and conducting the search strategy. DL contributed to the design of the review protocol, writing the report, arbitrating potentially eligible studies, conducting risk of bias assessments, and interpreting results. PF was responsible for the meta-analyses including extracting, analysing, writing, and interpreting the results from quantitative data, screening potentially eligible studies and contributed to writing the results and Supplementary. EA is the author responsible for the overall content as the guarantor.

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Competing interests EA was the Founding President, and now serves as the Secretary, of the National Association of Clinical Obesity Services (NACOS). He has received honoraria from Novo Nordisk for speaking and participating at meetings. He has received unrestricted research funding from Novo Nordisk and iNova on behalf of NACOS. RC and CNS have received payments for their contributions through casual employment contracts at Western Sydney University. PF, KP, GM, BC and DL declare no competing financial interests.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

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Supplementary File

Table of contents

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Supplementary Table S1: Search strategy

Ovid MEDLINE(R) ALL <1946 to present>

#	Query	Results from 25th Sept. 2021
1	Primary Health Care/	85,205
2	general practice/ or family practice/	76,814
3	(primary adj2 (care or health*)).tw.	157,253
4	((general or family) adj (practice* or practitioner*)).tw.	93,468
5	((family or community or practice*) adj (medic* or doctor* or physician* or nurs*)).tw.	47,774
6	1 or 2 or 3 or 4 or 5	312,040
7	obesity/ or obesity, abdominal/ or obesity, maternal/ or obesity, metabolically benign/ or obesity, morbid/	221,007
8	Overweight/	28,308
9	Overnutrition/	623
10	overnutrition.tw.	1,652
11	hypernutrition.tw.	44
12	obes*.tw.	330,756
13	overweight.tw.	76,708
14	7 or 8 or 9 or 10 or 11 or 12 or 13	398,378
15	Risk Assessment/	290,450
16	risk analys*.tw.	6,900
17	nutrition assessment/	16,427
18	Nutrition* assessment*.tw.	5,943
19	Anthropometry/	40,283
20	anthropometr*.tw.	59,988
21	"body weights and measures"/ or body fat distribution/ or body mass index/ or body size/ or body height/ or body weight/ or sagittal abdominal diameter/ or waist	365,578

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	circumference/ or waist-height ratio/ or body surface area/ or skinfold thickness/ or waist-hip ratio/	
22	body mass index/	138,215
23	quetelet index.tw.	491
24	Body mass index*.tw.	205,275
25	BMI.tw.	163,110
26	waist hip ratio*.tw.	4,227
27	skinfold thickness.tw.	3,820
28	((waist or abdominal) adj2 (circumference* or diameter* or measur*)).tw.	36,332
29	waist height ratio*.tw.	475
30	(obesity adj2 (manag* or guideline* or measur*)).tw.	6,750
31	(weight adj2 (assess* or Measur* or manag* or record*)).tw.	26,808
32	15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31	897,461
33	6 and 14 and 32	3,947
34	observational study/	112,847
35	exp Cohort Studies/	2,238,711
36	Cross-Sectional Studies/	395,811
37	exp case-control studies/	1,243,913
38	case reports/	2,221,553
39	observational stud*.tw.	129,947
40	cohort stud*.tw.	252,108
41	cross-sectional stud*.tw.	202,987
42	case control stud*.tw.	114,641
43	case series.tw.	87,502
44	case stud*.tw.	108,683

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45	case histor*.tw.	12,948
46	case report*.tw.	407,817
47	case comparison*.tw.	708
48	case base.tw.	122
49	prevalence stud*.tw.	5,709
50	longitudinal stud*.tw.	84,271
51	follow up stud*.tw.	52,359
52	prospective stud*.tw.	188,483
53	retrospective stud*.tw.	183,893
54	Electronic Health Records/	23,614
55	health record*.tw.	24,610
56	medical record*.tw.	122,413
57	patient record*.tw.	13,682
58	qualitative research/	69,103
59	qualitative.tw.	262,287
60	interview/	29,952
61	interview*.tw.	396,852
62	experienc*.tw.	1,239,418
63	34 or 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 or 49 or 50 or 51 or 52 or 53 or 54 or 55 or 56 or 57 or 58 or 59 or 60 or 61 or 62	6,715,787
64	33 and 63	2,347
65	exp child/ or child, preschool/ or exp infant/	2,613,117
66	child*.tw.	1,486,218
67	65 or 66	3,025,083
68	64 not 67	1,769
69	limit 68 to English language	1,661

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Embase via OvidSP (1947 - present)

Search repeated on 25/11/21

#	**Query**	**Results from 25th Nov 2021**
1	primary health care/	71,908
2	general practice/	82,366
3	(primary adj2 (care or health*)).tw.	211,681
4	((general or family) adj (practice* or practitioner*)).tw.	119,145
5	((family or community or practice*) adj (medic* or doctor* or physician* or nurs*)).tw.	61,008
6	1 or 2 or 3 or 4 or 5	402,212
7	obesity/ or overnutrition/ or abdominal obesity/ or diabetic obesity/ or maternal obesity/ or metabolic syndrome x/ or metabolically benign obesity/ or morbid obesity/ or obesity associated inflammation/ or sarcopenic obesity/	564,931
8	overweight.tw.	116,959
9	overnutrition.tw.	2,129
10	hypernutrition.tw.	87
11	obes*.tw.	497,753
12	7 or 8 or 9 or 10 or 11	691,801
13	risk assessment/	642,360
14	risk analys*.tw.	10,891
15	nutritional assessment/	32,946
16	nutrition* assessment*.tw.	9,486
17	anthropometry/	60,255
18	anthropometr*.tw.	88,470
19	body weight/ or body weight change/ or body weight control/	350,919
20	body fat distribution/ or body fat percentage/	8,611
21	body mass/	514,870

22	anthropometric parameters/ or abdominal circumference/ or adipose tissue thickness/ or body adiposity index/ or body fat percentage/ or body height/ or body mass/ or body size/ or body weight/ or sagittal abdominal diameter/ or total body fat/ or total body surface area/ or waist circumference/ or waist hip ratio/ or waist to height ratio/ or weight height ratio/	879,707
23	skinfold thickness/	14,631
24	quetelet index.tw.	568
25	body mass index*.tw.	301,374
26	BMI.tw.	348,314
27	waist hip ratio*.tw.	6,517
28	skinfold thickness*.tw.	5,749
29	((waist or abdominal) adj2 (circumference* or diameter* or measur*)).tw.	58,312
30	waist height ratio*.tw.	750
31	(obesity adj2 (manag* or guideline* or measur*)).tw.	9,735
32	(weight adj2 (assess* or measur* or manag* or record*)).tw.	40,197
33	13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32	1,702,045
34	6 and 12 and 33	7,229
35	observational study/ or observational stud*.tw.	312,495
36	cohort analysis/ or cohort stud*.tw.	855,948
37	cross-sectional study/ or cross-sectional stud*.tw.	493,778
38	case control study/ or population based case control study/ or case control stud*.tw.	238,398
39	case report/ or (case report* or case histor* or case base or case comparison* or case series).tw.	2,909,888
40	longitudinal study/ or longitudinal stud*.tw. or follow up stud*.tw.	267,646
41	prospective study/ or prospective stud*.tw.	824,409

42	retrospective study/ or retrospective stud*.tw.	1,215,975
43	electronic health record/ or (health record* or medical record* or patient* record*).tw.	283,785
44	quantitative.tw	867,485
45	qualitative research/	94,353
46	qualitative.tw.	334,859
47	interview/	227,656
48	interview*.tw.	508,149
49	experienc*.tw.	1,787,221
50	35 or 36 or 37 or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 or 49	8,044,506
51	34 and 50	3,787
52	exp child/	2,994,174
53	child*.tw.	1,998,334
54	52 or 53	3,517,058
55	51 not 54	3,008
56	limit 55 to english language	2,904

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CINAHL via EBSCO

S1	(MH "Primary Health Care")	(68,452)
S2	(MH "Family Practice")	(26,060)
S3	TI (primary N2 (care OR health*)) OR AB (primary N2 (care OR health*))	(98,478)
S4	TI "general practice*" OR AB "general practice*"	(17,218)
S5	TI "family practice*" OR AB "family practice*"	(2,583)
S6	TI "family practitioner*" OR AB "family practitioner*"	(532)
S7	TI "general practitioner*" OR AB "general practitioner*"	(20,299)
S8	TI (((family OR community OR practice*) N2 (Doctor* OR physician* OR NURS*))) OR AB (((family OR community OR practice*) N2 (Doctor* OR physician* OR NURS*)))	(89,399)
S9	S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7 OR S8	(236,098)
S10	(MH "Overnutrition") OR (MM "Obesity, Maternal") OR (MM "Obesity, Morbid") OR (MH "Obesity+")	(107,322)
S11	TI overweight OR obes* OR overnutrition OR hypernutrition	(59,247)
S12	AB overweight OR obes* OR overnutrition OR hypernutrition	(96,744)
S13	S10 OR S11 OR S12	(152,475)
S14	(MH "Risk Assessment")	(121,279)
S15	TI risk analysis OR AB risk analysis	(27,946)
S16	(MH "Nutritional Assessment")	(16,752)
S17	TI nutrition* assessment* OR AB nutrition* assessment*	(5,092)
S18	(MH "Body Mass Index") OR (MH "Body Size") OR (MH "Body Surface Area") OR (MH "Body Weight+") OR (MH "Waist Circumference") OR (MH "Waist-Hip Ratio") OR (MH "Body Weights and Measures+") OR (MH "Anthropometry+")	(254,870)

S19	TI ("body Mass index" OR BMI OR "quetelet index" OR "waist hip ratio*" OR "skinfold thickness" OR "waist height ratio*"") OR AB ("body Mass index" OR BMI OR "quetelet index" OR "waist hip ratio*" OR "skinfold thickness" OR "waist height ratio*")	(99,434)
S20	TI (((waist OR abdominal) N2 (circumference* OR diameter* OR measur*))) OR AB (((waist OR abdominal) N2 (circumference* OR diameter* OR measur*)))	(14,244)
S21	TI (obesity N2 (manag* OR guideline* OR measur*)) OR AB (obesity N2 (manag* OR guideline* OR measur*))	(3,649)
S22	TI (weight N2 (manag* OR assess* OR measur* OR record*)) OR AB (weight N2 (manag* OR assess* OR measur* OR record*))	(14,646)
S23	S14 OR S15 OR S16 OR S17 OR S18 OR S19 OR S20 OR S21 OR S22	(443,890)
S24	S9 AND S13 AND S23	(3,941)
S25	(MH "Prospective Studies+") OR (MH "Cross Sectional Studies") OR (MH "Case Control Studies+")	(742,114)
S26	TI ("cohort stud*" OR "case control stud*" OR "observational stud*" OR "cross sectional stud*") OR AB ("cohort stud*" OR "case control stud*" OR "observational stud*" OR "cross sectional stud*")	(267,124)
S27	(MH "Case Studies")	(25,211)
S28	TI ("case report*" OR "case stud*" OR "case series" OR "case histor*" OR "case base" OR "case comparison*") OR AB ("case report*" OR "case stud*" OR "case series" OR "case histor*" OR "case base" OR "case comparison*")	(173,690)
S29	TI ("prevalence stud*" OR "longitudinal stud*" OR "Follow up stud*" OR "prospective stud*" OR "retrospective stud*") OR AB ("prevalence stud*" OR "longitudinal stud*" OR "Follow up stud*" OR "prospective stud*" OR "retrospective stud*")	(142,287)
S30	(MH "Electronic Health Records+")	(27,388)

S31	TI ("medical record*" OR "patient* record*" OR "health record*") OR AB ("medical record*" OR "patient* record*" OR "health record*")	(64,123)
S32	(MH "Qualitative Studies+")	(161,978)
S33	TI qualitative OR AB qualitative	(143,640)
S34	(MH "Interviews+")	(234,331)
S35	TI interview* OR AB interview*	(237,270)
S36	TI experienc* AND AB experienc*	(54,416)
S37	S25 OR S26 OR S27 OR S28 OR S29 OR S30 OR S31 OR S32 OR S33 OR S34 OR S35 OR S36	(1,477,201)
S38	S24 AND S37	(1,538)
S39	(MH "Child+")	(713,632)
S40	TI child* OR AB child*	(535,788)
S41	S39 OR S40	(901,349)
S42	(S38) NOT (S41)	(1,082)

Web searching

NOTES: Four papers (not retrieved in any of the database searches) were identified by via internet searching.

1. McLaughlin, Hamilton, K., & Kipping, R. (2017). Epidemiology of adult overweight recording and management by UK GPs: a systematic review. *British Journal of General Practice*, *67*(663), e676–e683. https://doi.org/10.3399/bjgp17X692309

   This paper was not retrieved in the searches because it **did not contain any terms from the qual/quant concept group.**

2. Dalton, Bottle, A., Okoro, C., Majeed, A., & Millett, C. (2011). Implementation of the NHS Health Checks programme: baseline assessment of risk factor recording in an urban culturally diverse setting. *Family Practice*, *28*(1), 34–40. https://doi.org/10.1093/fampra/cmq068

   This paper was not retrieved because it **does not contain any terms from the obesity/overweight concept group.**

3. Turner, Harris, M. F., & Mazza, D. (2015). Obesity management in general practice: does current practice match guideline recommendations? *Medical Journal of Australia*, *202*(7), 370–372. https://doi.org/10.5694/mja14.00998

   This paper was not retrieved because it contained the word children in the abstract – **this paper was eliminated by the NOT child* component of the search**

4. Gaynor, Habermann, B., & Wright, R. (2018). Waist Circumference Measurement Diffusion in Primary Care. *Journal for Nurse Practitioners*, *14*(9), 683–688.e1. https://doi.org/10.1016/j.nurpra.2018.06.002

   This paper is indexed in CINAHL, however was not retrieved because it **does not contain any term obesity in the article record in CINAHL.**

Supplementary Table S2: List of excluded studies with reasons

Quantitative studies

- Did not meet eligibility criteria for population and setting[1-19]
- Did not meet eligibility criteria for patient factor[1 2 5-9 11-14 16 18-27]
- Did not meet eligibility criteria for outcome[1 5 6 8 9 11-13 16 18 19 23 28-51]

Qualitative studies

- Did not meet eligibility criteria for population and setting[52]
- Did not meet eligibility criteria for interest[5 6 18 20 28 29 31 52-62]

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Supplementary Table S3: Characteristics and summary of quantitative studies reviewed

Study details	Population and setting	Patient factors (independent variables)	Outcomes (obesity related anthropometric assessments)	Statistical methods, results/effect estimates	Author's conclusions and reviewer's comments
Authors: Aleem et al. [63] **Year published:** 2015 **Study design:** Cross sectional study **Country:** United States	**Sample size:** N=10,931 records **Inclusion criteria:** • Patients aged 18-65 years before or during the study period **Exclusion criteria:** • Visits with missing data **Setting and population:** • Records from Dartmouth-Hitchcock Medical Center data repository system for the year 2012 for the patients coming for preventive care visit in 3 adult primary care center within the system in New Hampshire, US	**1. Factors associated with BMI calculation:** • Insurance type	BMI calculation	**Statistical analysis:** • Descriptive for proportions • Chi-square test or a Fisher's test to find association of the variable with the BMI recording (not relevant to calculated PR below) **Results/effects estimates:** 1. Factors associated with BMI calculation: • Insurance type: (Medicaid Calculated PR*: 1.04, Medicare Calculated PR*: 1.01, others including managed care Calculated PR*: 1.02, Self-pay Calculated PR*: 0.97, Ref Private insurance)	**Author's conclusions:** "Despite high clinician-reported documentation of obesity as an active problem, actual obesity documentation rates remained low in a rural academic medical center." **Reviewer's comments:** This study shows that patients with Medicare and Medicaid insurance were positively associated with BMI calculation and patients on self-pay were negatively associated with BMI calculation. This study has clearly met 5/8 (63%) criteria in the critical appraisal tool.
Authors: Baer et al. [64] **Year published:** 2013 **Study design:** Cross sectional study **Country:** United States	**Sample size:** N=219,356 **Inclusion criteria:** • Patients aged ≥18 years before or during the study period • Patients who had at least 2 visits with the same clinician • Patients who were not pregnant at the time of the visit **Exclusion criteria:** None **Setting and population:**	**1. Factors associated with documentation of BMI:** • Age • Sex • Ethnicity • Primary insurance • Frequency of consultation • Comorbidities	BMI documentation	**Statistical analysis:** • Descriptive for proportions • Logistic regression to estimate OR for documentation of BMI, adjusted for covariates **Results/effects estimates:** Proportion of patients with at least one BMI documentation between 2004 and 2008: • 65.9% had BMI documented 1. Predictors of BMI documentation: • Age (≥70y OR: 0.60, 60-69y OR: 0.94, 30-39y OR: 0.93, Ref 18-29y) • Sex: Female (OR: 1.45, Ref male) • Ethnicity (other or missing OR: 0.84, Ref White)	**Author's conclusions:** "In conclusion, many primary care patients lack documentation of BMI in the EHR, and most overweight and obese patients do not have a diagnosis on the problem list. Further research should focus on interventions to improve documentation of BMI and diagnosis and management of overweight and obesity in the primary care setting." **Reviewer's comments:**

	• Records from 25 primary care practices within a large academic care network in Boston, Massachusetts, US, between 2004 and 2008			• Primary insurance (Medicare OR: 0.94, no insurance or self-pay OR: 0.64, Ref private) • Frequency of consultation (6-9 OR: 1.87, 10-14 OR: 2.78, ≥15 OR: 4.66, Ref 2-5) • Number of obesity-related comorbidities (1 OR: 1.34, 2 OR: 1.48, ≥3 OR: 1.73, Ref 0 comorbidity)	This study shows that female sex, other or missed ethnicity, younger age, having private insurance, increasing number of visits to clinic, and increasing number of chronic medical conditions were positively associated with BMI documentation. This study has clearly met 8/8 (100%) criteria in the critical appraisal tool.
Authors: Bleich, Pickett-Blakely & Cooper [65] **Year published:** 2011 **Study design:** Cross sectional study **Country:** United States	**Sample size:** N=2,458 **Inclusion criteria:** • Patients aged ≥18 years • Patients who had a BMI of ≥30 kg/m^2 **Exclusion criteria:** None **Setting and population:** • Records of patients from participating non-federally employed physicians in 2005 National Ambulatory Medical Care Survey from randomly selected geographic area and speciality in United States	**1. Factors associated with obesity diagnosis:** • Race/ethnicity • Sex • Age • Insurance • Geographic region • Co-morbidity risk status • Obesity category	Obesity diagnosis	**Statistical analysis:** • Descriptive for proportions • Logistic regression to estimate OR for obesity diagnosis, adjusted for covariates **Results/effects estimates:** Proportion of patients with obesity diagnosis at the time of survey: • 28.9% had obesity diagnosis 1. Predictors of BMI documentation: • Sex: Women (OR: 1.54, Ref men) • Age (18-29y OR: 2.61, Ref ≥65y) • Geographic region (Midwest OR: 1.78, Ref South) • Obesity Class (III OR: 4.36, II OR: 2.08, Ref Class I)	**Author's conclusions:** "Most obese patients do not receive an obesity diagnosis or weight-related counseling. Practice implications: Preventive visits may provide a key opportunity for obese patients to receive weight-related counseling from their physician" **Reviewer's comments:** This study shows that female sex, younger age, having severe obesity, and residing in Midwest US were positively associated with obesity diagnosis. This study has clearly met 8/8 (100%) criteria in the critical appraisal tool.
Authors: Booth, Prevost & Gulliford [66]	**Sample size:** N=67,000 **Inclusion criteria:** • Patients who had BMI>30kg/m^2 or a READ	**1. Factors associated with BMI recording:** • Sex • Age • BMI category • Medical code (READ) recorded	BMI records	**Statistical analysis:** • Descriptive for proportions • Poisson regression to estimate Relative Rate Ratio (RRR) for BMI recordings, adjusted for covariates • Person-time was used an offset and the regression model was clustered to allow differences in recording between practices	**Author's conclusions:** "Obese patients do not have BMI values recorded regularly. The mean BMI of obese patients, and the proportion gaining weight

Year published: 2013 **Study design:** Cohort study **Country:** United Kingdom	medical diagnosis code indicating obesity **Exclusion criteria:** • Person-time outside the age range of 18-100 years **Setting and population:** • Records from 127 family practices in UK GPRD which contained EHR from 600 general practices in the United Kingdom, between 1 January 1997 and 31 December 2009	• Socio-economic relative deprivation		**Results/effects estimates:** Proportion of patients with a BMI recording: • 99.2% of all patients at some point between 1 January 1997 and 31 December 2009. 1. Predictors of BMI recording: • Sex: Female (RRR: 1.14, Ref male) • Age (18-24y RRR: 0.85, 25-34y RRR: 0.65, 35-44y RRR: 0.62, 45-54y RRR: 0.75, 55-64y RRR: 0.87, 75-100y RRR: 0.83, Ref 65-74y) • BMI category (obesity class I RRR: 0.78, obesity class III RRR: 1.19, unknown RRR: 0.24, Ref overweight) • Medical code recorded: 'yes' (RRR: 1.46, Ref 'no') • Smoking status (ex-smoker RRR: 1.22, smoker RRR: 0.93, not known RRR: 0.96, Ref non-smoker) • Index of multiple deprivation: IMD Quintile (3 RRR: 1.19, 4 RRR: 1.19, 5 RRR: 1.21, Ref Quintile 1 least deprived)	over time, is increasing. Improved strategies for monitoring and managing obesity are required." **Reviewer's comments:** This study shows that several socio demographics (aged 65-74 years, female sex, increasing socio-economic deprivation), behavioural factors (former smoking), and obesity class II/III and known BMI were positively associated with BMI recordings. This study has clearly met 9/10 (90%) criteria in the critical appraisal tool.
Authors: Bramlage et al. [67] **Year published:** 2004 **Study design:** Cross sectional study **Country:** Germany	**Sample size:** N=45,125 **Inclusion criteria:** • Patients attending the target day assessment (half day, alternatively September 18 or 20, 2001) **Exclusion criteria:** • Patients who had a BMI of <18.5 kg/m^2 **Setting and population:** • Records of patients from participating 1912 primary care practices in HYDRA study performed in September 2001 in Germany	**1. Factors associated with poor recognition of overweight and obesity:** • Age • Sex • Diagnosis with vascular complications • Numbers of comorbidities	Recognition of overweight and obesity	**Statistical analysis:** • Descriptive for proportions • Logistic regression to estimate OR for poor recognition of overweight and obesity, adjusted for covariates **Results/effects estimates:** Proportion of patients with recognition of overweight and obesity by the doctor at the time of survey: • 20-30% of overweight patients had recognition of overweight • 60-70% of patients with grade 3 obesity had recognition of obesity 1. Predictors of poor recognition of obesity: • Sex: female (OR: 1.40, Ref male) • Age (≥60y OR: 1.60, 40-59y OR: 1.50, Ref 30-40y) • Diagnosis with vascular complications: yes (OR: 2.10, Ref no) • Comorbid conditions (3-4 OR: 3.40, ≥5 OR: 6.40, Ref none) 2. Predictors of poor recognition of overweight: • Sex: female (OR: 1.30, Ref male) • Age (≥60y OR: 1.90, 40-59y OR: 1.60, Ref 30-40y) • Diagnosis with vascular complications: yes (OR: 2.20, Ref no) • Comorbid conditions (3-4 OR: 3.30, ≥5 OR: 5.10, Ref none)	**Author's conclusions:** "Primary care management of overweight and obesity is largely deficient, predominantly due to four interrelated factors: doctors' poor recognition of patients' weight status, doctors' inefficient efforts at intervention, patients' poor acceptance of such interventions and dissatisfaction with existing life-style modification strategies." **Reviewer's comments:** This study shows that female sex, older age, having diagnosis with vascular complications and increased number of comorbid conditions were positively associated with poor recognition of obesity by their doctors.

					This study has clearly met 7/8 (88%) criteria in the critical appraisal tool. One of the criteria was unclear.
Authors: Cuccu, Abi-Aad & Duggal [68] **Year published:** 2019 **Study design:** Cross sectional study **Country:** United Kingdom	**Sample size:** N=1,154,652 **Inclusion criteria:** • Patients aged 18-100 years • Patients residing in the Kent County Council, who were alive and registered in Kent general practice as of 6 August 2018 **Exclusion criteria:** • None **Setting and population:** • Records of patients from Kent Integrated Dataset in September 2001 in the Kent, UK, between 2015/2016 and 2017/2018	**1. Factors associated with null BMI recording** • Sex • Age • Socio-economic relative deprivation • Diagnosis of hypertension • Diagnosis of SMI • Presence of multimorbidity	Null BMI recording	**Statistical analysis:** • Descriptive for proportions • Logistic regression to estimate OR for null BMI recording, adjusted for covariates **Results/effects estimates:** Proportion of patients with a missing BMI between 2015/2016 and 2017/2018: • 56.3% had null BMI recorded 1. Predictors of null BMI recording: • Sex: Male (OR: 1.58, Ref female) • Age (≥95y OR: 1.49, 85-94y OR: 0.90, 75-84y OR: 0.62, 65-74y OR: 0.47, 55-64y OR: 0.49, 45-54y OR: 0.53, 35-44y OR: 0.62, 25-34y OR: 0.66, Ref 18-24y) • Socioeconomic deprivation Quintile (3 OR: 0.97, 4: 0.89, Ref Quintile 1 Least deprived) • Diagnosis of hypertension (OR: 0.76, Ref none) • Diagnosis of SMI (OR: 0.62, Ref none) • Presence of multimorbidity (OR: 0.39, Ref 0 or 1 long term conditions)	**Author's conclusions:** "Findings were aligned to previous research using nationally representative samples. Completeness of recording varied by age, sex, deprivation, and comorbidity. Recording within general practice was aligned to chronic disease management. From a prevention perspective, earlier assessment, and intervention for the management of excess weight within primary care may be an opportunity for avoiding increases in BMI trajectory. There may also be merit in recognising that the external disease agents that influence obesity can be controlled or reduced (obesogenic environment) from a national policy perspective. Such a perspective may also help reduce stigmatisation and the pressure around arguments that centre on personal responsibility for obesity." **Reviewer's comments:** This study shows that socio demographics (aged 95y and above and male sex) were positively associated with null BMI recording, while being aged 25 to 94y, increasing socio-economic deprivation,

					diagnosis of hypertension, SMI and presence of multimorbidity were negatively associated with null BMI recording. This study has clearly met 8/8 (100%) criteria in the critical appraisal tool.
Authors: Cyr et al. [69] **Year published:** 2016 **Study design:** Cross sectional study **Country:** United States	**Sample size:** N=6,195 **Inclusion criteria:** • Patients aged ≥18 years • Patients who had a BMI ≥25 kg/m^2 **Exclusion criteria:** • Patients who were pregnant at the time of visit **Setting and population:** • Records of patients from family medicine residency program with two sites (urban and suburban), with 17 faculty and 21 residents in United States between December 2011 and 2013	**1. Factors associated with inclusion of obesity and/or overweight in the problem list:** • Sex • Age • Race • Insurance • BMI • Presence of hypertension • Presence of type 2 diabetes • Presence of hyperlipidemia • Numbers of visit	Overweight/obesity documentation (inclusion of obesity and/or overweight in the problem list)	**Statistical analysis:** • Descriptive for proportions • Multivariate regression to estimate OR for overweight/obesity documentation, adjusted for covariates **Results/effects estimates:** Proportion of patients with overweight/obesity documentation between December 2011 and 2013: • 21.1% had overweight/obesity documentation 1. Predictors of null overweight/obesity documentation: • Sex: Female (OR: 1.48, Ref male) • Insurance (Medicaid OR: 0.72, Ref commercial insurance) • BMI (≥40 kg/m^2 OR: 24.78, 30-<40 kg/m^2 OR: 5.36, Ref 25-<30 kg/m^2) • Presence of hypertension: yes (OR: 1.25, Ref no) • Presence of type 2 diabetes: yes (OR: 1.48, Ref no) • Presence of hyperlipidemia: yes (OR: 1.28, Ref no) • Number of visits (≥6 OR: 1.39, Ref 1-2 visits)	**Author's conclusions:** "Nearly 80% of OW and obese patients were not identified on the problem list. Patient gender, comorbidity, and number of visits were associated with documentation. Future research should examine automatic documentation of OW/obesity on the medical problem list." **Reviewer's comments:** This study shows that female sex, higher BMI, presence of hypertension, type 2 diabetes and dyslipidaemia were positively associated with overweight and obesity documentation. This study has clearly met 8/8 (100%) criteria in the critical appraisal tool.
Authors: Dalton et al. [70] **Year published:** 2011 **Study design:** Cross sectional study	**Sample size:** N=21,510 **Inclusion criteria:** • Patients aged 35-74 years during the study period • Patients who had anthropometric measurement taken in last 5 years **Exclusion criteria:**	**1. Factors associated with BMI recording:** • Sex/Age • Ethnicity • Socio-economic relative deprivation • Hypertension	BMI records	**Statistical analysis:** • Descriptive for proportions • Logistic regression to estimate OR for BMI recordings, adjusted for covariates **Results/effects estimates:** Proportion of patients with a BMI recording between December 2008 and January 2009: • 72.8% of all patients 1. Predictors of BMI recording:	**Author's conclusions:** "The workload implications of the NHS Health Checks programme for general practices in England are substantial. There are considerable variations in risk factor recording between practices and between age, gender and ethnic groups."

Country: United Kingdom	• Patients in CVD or diabetes register **Setting and population:** • Records from 14 general practices participating in the NHS Health Checks programme in Ealing Primary Care Trust (PCT), North West London, between December 2008 and January 2009			• Sex/Age (male/65-74y OR: 0.68, male/55-64y OR: 0.55, male/45-54y OR: 0.47, male/35-44y OR: 0.46, Ref female/35-44y) • Ethnicity (mixed OR:1.77, missing OR:0.31, Ref White) • Socio-economic quintiles: deprivation fifth quintile (2 OR: 1.16, Ref quintile 1) • Presence of hypertension: yes (OR:3.23, Ref no)	**Reviewer's comments:** This study shows that female sex, mixed ethnicity, and having hypertension were positively associated with BMI recording. This study has clearly met 8/8 (100%) criteria in the critical appraisal tool.
Authors: Emanuel et al. [71] **Year published:** 2016 **Study design:** "Matched cohort study" **Country:** United Kingdom	**Sample size:** N=14,586 (RA case: 1121, RA control: 4282, IBD case: 1875, IBD control: 7308) **Inclusion criteria:** • Case: Patients diagnosed with Rheumatoid Arthritis (RA) and Inflammatory Bowel Disease (IBD) (including ulcerative colitis and Crohn's disease) as per READ code on study date • Control: Patients matched on age, gender and general practice with randomly sampled from all patients who were disease free • Patients registered uninterruptedly • with the practice for specified data collection timepoints **Exclusion criteria:** • None **Setting and population:** • Records of patients registered with local general practices on study date of 12 January 2014 from Lambeth DataNet, a	**1. Factors associated with BMI recording and obesity diagnosis:** • Presence of RA • Presence of IBD	BMI recording and obesity diagnosis	**Statistical analysis:** • Descriptive for proportions • Conditional Poisson regression to estimate OR for BMI recording at the prespecified time point (1 year before, 1 year after and 5 years after case index date), adjusted for age, gender, ethnicity and deprivation **Results/effects estimates:** Proportion of patients with BMI recording from study time points (from case index date): • RA case: 13%, 13% and 34% for 1 year before, 1 year after and 5 years after, respectively • RA control: 10%, 8% and 28% for 1 year before, 1 year after and 5 years after, respectively • IBD case: 8%, 12% and 27% for 1 year before, 1 year after and 5 years after, respectively • IBD control: 10%, 8% and 22% for 1 year before, 1 year after and 5 years after, respectively 1. Estimated differences in BMI recoding (Ref control group, time duration from case index date): • Presence of RA: OR: 1.52 and OR: 1.49 for 1 year before and 1 year after, respectively • Presence of IBD: OR: 2.24, OR: 1.61 and OR: 1.31 for 1 year before, 1 year after and 5 years after, respectively 2. Estimated differences in obesity diagnosis (Ref control group, time duration from case index date): • Presence of RA: OR: 1.64 for 1 year after • Presence of IBD: OR: 0.77 for 5 years after	**Author's conclusions:** "The assessment and treatment of vascular risk in patients with RA and IBD in primary care is suboptimal, particularly with reference to CVD risk score calculation." **Reviewer's comments:** This study shows that presence of RA and IBD are positively associated with BMI recording. While the presence of RA is positively associated with obesity diagnosis, the presence of IBD is inversely associated with obesity diagnosis. This study has clearly met 7/8 (88%) criteria in the critical appraisal tool. One of the criteria was unclear.

	patient level database of primary care EHR of over 350, 000 people residing in Lambeth borough, London, United Kingdom				
Authors: Ghosh [72] **Year published:** 2016 **Study design:** Cross sectional study **Country:** Australia	**Sample size:** N=118,709 **Inclusion criteria:** • Patients aged ≥18 years **Exclusion criteria:** • Patients without a recorded age and/or gender **Setting and population:** • Records of patients from 17 general practices in the Sentinel Practices Data Sourcing (SPDS) project in Illawarra Shoalhaven region of New South Wales, Australia between September 2011 and September 2013.	**1. Factors associated with BMI recording:** • Age • Sex • Presence of specific medical conditions: hypertension, hyperlipidaemia, musculoskeletal (osteoarthritis, osteoporosis and inflammatory arthritis), mental (bipolar, anxiety and depression), respiratory (asthma and chronic obstructive pulmonary disease), diabetes (type 1 and type 2 diabetes mellitus), cardiovascular (congestive heart disease, myocardial infarction, heart failure, acute coronary syndrome, peripheral vascular disease, left ventricular hypertrophy, atrial fibrillation and carotid stenosis), renal (renal artery stenosis, acute renal failure, chronic renal failure and renal impairment), stroke and cancer (cancer and multiple myeloma) • Disease count	BMI recording	**Statistical analysis:** • Descriptive for proportions • Multivariate regression to estimate OR for BMI recording, adjusted for SEIFA–IRSD and covariates **Results/effects estimates:** Proportion of patients with an anthropometry measurement between September 2011 and September 2013: • 30.9% had BMI recording • 8.0% had WC recording 1. Predictors of BMI recording: • Age (≥75y OR: 1.17, 45-64y OR: 1.25, Ref 18-44y) • Presence of specific medical conditions: (hypertension OR: 1.11, hyperlipidaemia OR: 1.14, musculoskeletal OR: 1.21, mental OR: 0.80, respiratory OR: 0.91, diabetes OR: 1.83, cardiovascular OR: 1.14, renal OR: 1.52, Ref absence of specific medical condition) • Disease count (≥3 OR: 5.18, 2 OR: 4.12, 1 OR: 2.65, Ref 0)	**Author's conclusions:** "Recording of measures of obesity and overweight in general practices within regional settings is much lower than optimal. More support and advocacy around weighing patients at all interactions is required for regional general practitioners to increase the weight screening in primary care. These findings have policy-relevant implications for weight management in regional Australia." **Reviewer's comments:** This study shows that older age, presence of hypertension, hyperlipidaemia, musculoskeletal conditions, diabetes, cardiovascular conditions, renal conditions were positively associated with BMI recording. Presence of mental health conditions and respiratory conditions were negatively associated with BMI recording. This study has clearly met 8/8 (100%) criteria in the critical appraisal tool.

Authors: Gonzalez-Chica et al. [73] **Year published:** 2019 **Study design:** Cross sectional study **Country:** Australia	**Sample size:** N=2,384 **Inclusion criteria:** • Patients aged ≥35 years **Exclusion criteria:** • Patients with a terminal illness or a mental incapacity • Patients who are unable to speak English **Setting and population:** • Data of Health Omnibus Survey 2017 conducted in South Australia between September 2017 and December 2017	**1. Factors associated with weight and/or waist measurement (self-reported):** • Presence of cardiometabolic risk factor (body mass index ≥30 kg/m^2, hypertension, diabetes and/or dyslipidaemia, but without cardiovascular diseases) • Presence of cardiovascular disease (heart attack, angina, heart failure, and/or stroke, with or without metabolic risk factors)	Weight and/or waist measurement	**Statistical analysis:** • Maximum likelihood estimates (pseudolikelihood log) and Wald tests for heterogeneity and trend were used to estimate predicted prevalence, adjusted for covariates (not relevant to calculated PR below). **Results/effects estimates:** 1. Predicted adjusted prevalence of weight and/or waist measurement by their GP in the last 12 months: • Presence of cardiometabolic risk factor: Yes (Calculated PR*: 1.43, Ref none) • Presence of cardiovascular disease: Yes (Calculated PR*: 1.81, Ref none)	**Author's conclusions:** "More frequent and comprehensive CVD-related assessments by GPs were more important in promoting a healthier lifestyle than the presence of CVD or cardiometabolic risk factors by themselves." **Reviewer's comments:** This study shows higher prevalence of weight and/or waist measurement in patients with self-reported cardiometabolic risk factors and cardiovascular disease. This study has clearly met 8/8 (100%) criteria in the critical appraisal tool.
Authors: Gutiérrez Angulo et al. [74] **Year published:** 2014 **Study design:** Cross sectional study **Country:** Spain	**Sample size:** N=620 **Inclusion criteria:** • Patients aged >14 years# **Exclusion criteria:** • None **Setting and population:** • Records of 620 patients randomly selected from 63,820 patients assigned to 3 participating primary care centres in the province of Gipuzkoa, Spain between January 2012 to January 2013	**1. Factors associated with BMI recording:** • Presence of comorbid conditions (such as diabetes mellitus, hypertension, hyperlipidaemia, coronary ischemia, congestive heart failure, stroke, sleep apnoea syndrome, peripheral venous insufficiency, and hypothyroidism)	BMI recording	**Statistical analysis:** • Descriptive for proportions • Chi-square test or a Fisher's test to find association of the variable with the BMI recording (not relevant to calculated RR below). **Results/effects estimates:** Proportion of patients with an anthropometry measurement between January 2012 to January 2013: • 28% had weight recording • 27% had BMI recording • 0.2% had WC recording • 6% had obesity recording 1. Factors associated with BMI recording: • Presence of comorbidity: Yes (Calculated RR*: 3.10, Ref No)	**Author's conclusions:** "This study confirmed that prevalence of obesity is underestimated, mainly because it is inadequately recorded in clinical histories; that prevalence increases in the presence of other risk factors; and that there is a significant variability in data collection between healthcare professionals." **Reviewer's comments:** This study shows that presence of comorbidity is positively associated with BMI recording. This study has clearly met 4/8 (50%) criteria in the critical

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					appraisal tool. One of the criteria was unclear.
Authors: Mattar et al. [75] **Year published:** 2017 **Study design:** Cross-sectional study **Country:** United states	**Sample size:** N= 3,868 **Inclusion criteria:** • Adults aged 18 years and older with two or more visits during the study window **Exclusion criteria:** • Children and pregnant women **Setting and population:** • Patient EMR gathered through routine care at the Wichita Falls Family Medicine Clinic during June 2012 and June 2015.	**Factors associated with BMI documentation** • Age • Sex • Race • Type of insurance • BMI • Morbid obesity (BMI ≥ 40) • Total number of comorbidities	Obesity documentation	**Statistical analysis:** • Descriptive statistics for proportions • Logistic regression to estimate OR for obesity documentation, adjusted for covariates. **Results/effects estimates:** Proportion of patients had obesity documented during June 2012 and June 2015: • 102 (35.3%) had their BMI calculated and documented 1.Predictors of obesity documentation: • Age (OR: 0.97) (continuous) • Female 0.58 (OR: 0.58, Ref male) • Morbid obesity (BMI ≥ 40) (OR: 1.60, Ref BMI < 40) • Number of Comorbidities (OR: 1.33) (continuous)	**Author's conclusions:** "Based on EHR documentation, obesity is under coded and generally not identified as a significant problem in primary care. Physicians are more likely to document obesity in the patient record for those with higher BMI scores who are morbidly obese. Moreover, physicians more frequently provide exercise than diet counseling for the documented obese." **Reviewer's comments:** This study shows that decreasing age, male sex, morbid obesity BMI ≥ 40, and number of comorbidities were positively associated with obesity documentation. This study has clearly met 8/8 (100%) criteria in the critical appraisal tool.
Authors: Melamed et al. [76] **Year published:** 2009 **Study design:** Cross-sectional study **Country:** Israel	**Sample size:** N= 289 **Inclusion criteria:** • Patients scheduled to see a participating physician (at least 1-year tenure in the family practice and at least a year-long rapport with the patients) • Patients who had medical insurance coverage by CHS **Exclusion criteria:**	**Factors associated with BMI documentation** • Education level • Residence • Sex • Smoking • Physical activity • Comorbidities • Chronic medication use • The number of medical encounters in the past 6 months • BMI	BMI documentation	**Statistical analysis:** • Descriptive statistics for proportions • Logistic regression to estimate OR for BMI documentation, adjusted for covariates. **Results/effects estimates:** Proportion of patients that had their BMI calculated and documented during January 2004 (n=289): • 102 (35.3%) had their BMI calculated and documented 1.Predictors of BMI documentation: • Age (≥ 55y OR: 2.77, Ref < 55y) • Obesity (BMI ≥ 30.0kg/m^2) (OR: 2.04, Ref no)	**Author's conclusions:** "Family physicians failed to identify most obese and overweight patients, as seen by lack of BMI documentation and concordant diagnoses in the medical problem list. Determination of BMI by physicians in family practice is of utmost importance, and its incorporation into medical care should be optimized." **Reviewer's comments:**

	• Patients who were pregnant, younger than 18 years, or not fluent in Hebrew **Setting and population:** • Records from 7 urban family practices of CHS in Israel affiliated with the Department of Family Medicine at Tel Aviv University during January 2004.			• Diabetes mellitus (OR: 4.35, Ref no) • Hypertension (OR: 3.20, Ref no) • Chronic medication use (OR: 3.44, Ref no)	This study shows that older age (≥ 55y), having obesity, diabetes mellitus, hypertension, and chronic medication use were positively associated with BMI documentation. This study has clearly met 8/8 (100%) criteria in the critical appraisal tool.
Authors: Mocarski et al. [77] **Year published:** 2018 **Study design:** Cross-sectional study **Country:** United states	**Sample size:** N=5,512,285 **Inclusion criteria:** • Patients aged ≥20 years on index date and had available BMI measurement in the Quintiles EMR • Patients had at least 3 months of follow-up data after the first recorded BMI • Study group: ICD-9 coded patients with overweight and obesity • Comparison group: non-coded patients **Exclusion criteria:** • Pregnancy or gestational diabetes **Setting and population:** • Records from 1300 sites and 49 states in United States from US primary care EHR database and the Quintile EMR database between 1 January 2014 and 30 June 2014.	**Factors associated with receiving ICD-9 code for overweight or obesity:** • Age • Sex • Race • CCI Category • Comorbidities: • Prader Willi Syndrome • Metabolic Syndrome • Sleep Apnea • Prediabetes • NAFLD • Cushing Syndrome • Vitamin D Deficiency • Type 2 diabetes mellitus • Hypertension • Dyslipidemia • Depression • Gallbladder Disease • Osteoarthritis • Feeding Difficulties • Dyspepsia • Cardiovascular disease • Chronic Kidney Disease • Malignancy • Acute/Chronic Pancreatitis • Inflammatory Bowel Disease • Anorexia	ICD-9 codes for overweight/obesity	**Statistical analysis:** • Descriptive for proportions • Logistic regression to estimate OR for being coded as with obesity and overweight as per ICD-9 code for overweight or obesity, adjusted for covariates **Results/effects estimates:** Proportions of patients who had ICD-9 codes for overweight or obesity between January 2014 and June 2014: • 15.1% of all patients (n = 833,763) 1.Predictors of being coded for obesity in patients with BMI ≥30kg/m^2 (N=2,332,214) • Age (20–44y OR: 1.94, 45–64y OR: 1.46, Ref ≥60y) • Sex: Female (OR: 1.34, Ref male) • Race: (Asian OR: 0.99, Black OR: 1.44, Hispanic OR: 1.69, Native American OR: 2.17, Multi race OR: 1.80, other race OR: 1.05, Ref White) • CCI Category: (1 OR: 1.23, 2 OR: 1.24, 3 OR: 1.42, 4 OR: 1.59, ≥5 OR: 1.71, Ref 0) • Comorbidities (Prader Willi Syndrome OR: 2.25, metabolic syndrome OR: 2.19, sleep apnea OR: 2.16, prediabetes OR: 1.52, NAFLD OR: 1.52, Cushing syndrome OR: 1.37, vitamin D deficiency OR: 1.33, type 2 diabetes mellitus OR: 1.24, hypertension OR: 1.24, dyslipidemia OR: 1.21, depression OR: 1.23, gallbladder disease OR: 1.17, osteoarthritis OR: 1.08, cardiovascular disease OR: 0.93, chronic kidney disease OR: 0.91, malignancy OR: 0.87, acute/chronic pancreatitis OR: 0.81, inflammatory bowel disease OR: 0.74, anorexia OR: 0.74, HIV OR: 0.67, Ref ‘no’ for each comorbidity)	**Author’s conclusions:** “US outpatients with overweight or obesity are not being reliably coded, making ICD-9 codes undependable sources for determining obesity prevalence and outcomes. BMI data available within EHR databases offer a more accurate and objective means of classifying overweight/obese status.” **Reviewer’s comments:** This study shows younger age (20–44y and 45–64y), female sex, increasing CCI category, and a few comorbidities were positively associated while except cardiovascular disease, malignancy, acute/chronic pancreatitis, inflammatory bowel disease, anorexia, and HIV were negatively associated with identification of overweight or obesity using ICD-9 codes.

		• HIV • Cachexia			This study has clearly met 8/8 (100%) criteria in the critical appraisal tool.
Authors: Nicolson et al. [78] **Year published:** 2019 **Study design:** Cohort study **Country:** United Kingdom	**Sample size:** N=4,918,746 **Inclusion criteria:** • Patients aged ≥18 years before or during the study period • ≥1 day of research quality registration (registration at a practice with continuous data reporting deemed fit) • ≥1 face-to-face consultation with an HCP • Eligible for linkage to the NCRAS cancer registry data, practice and patient level IMD data and ONS mortality data **Exclusion criteria:** None **Setting and population:** • Records from Clinical Practice Research Datalink GOLD database between 1 January 2000 and 31 December 2017, an ongoing primary care database of anonymised EHR data covering 6.9% of the UK population	**1. Clinical encounter:** • Clinical event • Staff role **2. Factors associated with (a) any weight measurement and (b) repeat weight measurements:** • Sex • Age • BMI • Socio-economic quintiles • Smoking status • Drinking status • Comorbidities • Ethnicity • Pregnancy, endocrine, digestive, and cardiovascular complaints • Frequency of consultation	Weight records	**Statistical analysis:** • Descriptive for proportions • Mixed effect negative binomial regression to estimate incident rate ratio (IRR) for a weight measurement and Cox models to estimate hazard ratios (HR) for repeat weight measurement, adjusted for covariates (list all in the sup table) **Results/effects estimates:** Proportion of patients with a weight recording between 1 January 2000 and 31 December 2017: • 68.6% had at least one recording • 49.2% had repeat measurement within a year 1. Clinical factors: • Same day as a chronic disease review (16.4%) • Lifestyle advice (10.4%) • Contraception consultation (10.3%) • Health check (6.2%) • Medication review (6.1%) • Practice registration (2.1%) 2 (a). Predictors of any weight measurement: • Sex: Female (IRR: 1.30, Ref male) • Age (80-89y IRR: 0.99, 60-69y IRR: 1.11, 30-39y IRR: 0.91, Ref 18-29y) • BMI (<18.5 kg/m^2 IRR: 1.17, 25-29.99 kg/m^2 IRR: 1.12, 30-34.99 kg/m^2 IRR: 1.38, >35 kg/m^2 IRR: 1.67, Ref 18.5-24.99 kg/m^2) • Socio-economic quintiles: IMD Quintile (II IRR: 1.03, III IRR: 1.08, IV IRR: 1.17, V IRR: 1.22, Ref IMD Quintile I) • Number of comorbidities (1 IRR: 1.13, 2 IRR: 1.35, 3 IRR: 1.52, 4 IRR: 1.67, 5 IRR: 1.82, Ref 0 comorbidity) • Ethnic groups (Indian IRR: 1.25, African IRR: 1.24, Ref White) 2 (b). Predictors of repeat weight measurement: • Sex: Female (HR 1.30, Ref male) • Ex-smoker (HR 1.09, Ref non-smoker) • Age (80-89y HR: 1.21, 60-69y HR: 1.34, 30-39y HR: 0.90, Ref 18-29y)	**Author's conclusions:** "Weight recording is not a routine activity in UK primary care. It is recorded for around a third of patients each year and is repeated on average every 2 years for these patients. It is more common in females with higher BMI and in those with comorbidity. Incentive payments and their removal appear to be associated with increases and decreases in weight recording." **Reviewer's comments:** This study shows that several socio demographics (older age, female sex, ethnic minorities, and increasing socio-economic deprivation), behavioural (former smoking), pregnancy, and increasing number of chronic medical conditions were positively associated with one or more weight recordings. This study has clearly met 7/10 (70%) criteria in the critical appraisal tool. Two of the criteria was unclear.

				• BMI (<18.5 kg/m^2 HR: 1.22, 25-29.99 kg/m^2 HR: 1.11, 30-34.99 kg/m^2 HR: 1.36, >35 kg/m^2 HR: 1.69, Ref 18.5-24.99 kg/m^2) • Socio-economic quintiles: IMD Quintile (II HR: 1.03, III HR: 1.05, IV HR: 1.10, V HR: 1.16, Unknown HR:0.94, Ref IMD Quintile I) • Number of comorbidities (1 HR: 1.27, 2 HR: 1.46, 3 HR: 1.60, 4 HR 1.71, 5 HR: 1.85, Ref 0 comorbidity)	
Authors: Osborn et al. [79] **Year published:** 2011 **Study design:** Cohort study **Country:** United Kingdom	**Sample size:** N=18,696 (with SMI) and 95,512 (without SMI) **Inclusion criteria:** • Patients aged ≥18 years before or during the study period with at least 6 months of follow up data • Study group: patients who had SMI diagnosis based on the READ code list • Comparison group: patients who did not have a SMI diagnosis **Exclusion criteria:** • Patients with pre-existing CVD and patients who registered but had no further record of attendance at the practice **Setting and population:** • Records from practices which had reached pre-defined THIN Quality Standard contributing to the primary care databases THIN in the UK, between January 2000 and December 2007	**1. Factors associated with screening of BMI:** • Presence of SMI • Age	Screened for BMI	**Statistical analysis:** • Descriptive for proportions • Poisson regression to estimate IRR for BMI recording, adjusted for screened for BMI by age 18-59y and ≥60y subgroups **Results/effects estimates:** Proportion of SMI patients who were screened for BMI: • 13.6% in 2000, 14.9% in 2001, 16.1% in 2002, 18.6% in 2003, 24.0% in 2004, 26.1% in 2005, 32.9% in 2006 and 36.9% in 2007 1. Predictors associated with screening of BMI in patients with SMI in comparison to patients without SMI: • People aged 18-59y (IRR: 0.599 in 2000, 0.615 in 2003 and 0.793 in 2005) • People aged 60y and above (IRR: 0.571 in 2000, 0.533 in 2003, 0.657 in 2005 and 0.808 in 2007)	**Author's conclusions:** "In UK primary care, people with SMI over 60 years of age remain less likely than the general population to receive annual CVD screening despite higher risk of developing CVD." **Reviewer's comments:** This study shows having SMI in age group 18-59 years is negatively associated with BMI screening until 2005, however, they were equally likely to be screened in 2007. However, patients with SMI who were aged 60 years and above were less likely to have a BMI screening. This study has clearly met 8/10 (80%) criteria in the critical appraisal tool. One of the criteria was unclear.
Authors: Rose et al. [80]	**Sample size:** N= 79,947 **Inclusion criteria:**	**1. Factors associated with BMI Documentation:** • Sex • Race	BMI Documentation	**Statistical analysis:** • Descriptive for proportions • Chi-square to test association between the variables and the BMI documentation (not relevant to calculated RR below).	**Author's conclusions:** "In a large primary care network BMI documentation has been incomplete and for

Year published: 2009 **Study design:** Cross-sectional study **Country:** United States	• Patients aged ≥18 years before or during the study period • Patient who had at least two clinic visits billed to their PCP during study period **Exclusion criteria:** • Patients with who had a height greater than or equal to 2.13 meters, weight <31.8 or >453.6 kg, systolic BP <50 or >260 mmHg, or diastolic BP<30 or >150 mmHg. **Setting and population:** Records from Massachusetts General Hospital Primary Care Practice Based Research Network in the US, between July 2005 to December 2006	• Commercial Insurance or Medicare • History of CVD • History of diabetes • History of hypertension • History of dyslipidemia		**Results/effects estimates:** Proportion of patients with BMI documentation between July 2005 to December 2006: • 60.5% had weight and height recording 1. Factors associated with BMI documentation: • Female (Calculated RR*: 1.27 Ref male) • Race (Non-White Calculated RR*: 1.05, Ref White) • History of CVD: Yes (Calculated RR*: 0.98 Ref No) • History of diabetes: Yes (Calculated RR*: 1.05, Ref No) • History of hypertension: Yes (Calculated RR*: 0.99 Ref No) • History of dyslipidemia: Yes (Calculated RR*: 0.98, Ref No)	patients with BMI measured, risk factor control has been poorer in obese patients compared with NW, even in those with obesity and CVD or diabetes. Better knowledge of BMI could provide an opportunity for improved quality in obesity care." **Reviewer's comments:** This study shows female sex, Hispanic and black race, having commercial insurance or medicare and history of diabetes is positively associated in BMI documentation.
Authors: Ruser et al. [81] **Year published:** 2005 **Study design:** Cross-sectional study **Country:** United States	**Sample size:** N= 424 **Inclusion criteria:** • Patient who had at least 1 primary care visit during study period • Patients classified with overweight (BMI ≥ 25 kg/m^2) or obesity (BMI ≥ 30 kg/m^2) **Exclusion criteria:** • Patients were excluded if they were born before 1938, • Patients were not classified with overweight nor obesity (BMI <25 kg/m^2), • Patient who had a life expectancy <6 months • Patients with no routine visits with primary clinician during the study period.	**Factors associated with Identification or management of overweight and obesity:** • Age • Race • Sex • Height • Weight • Co-morbidities • Smoking • Alcohol use >2 drinks/day for men or >1 drink/day for women	Identification of overweight and obesity	**Statistical analysis:** • Descriptive statistics for proportions • Logistic regression to estimate OR for identification of overweight and obesity, adjusted for covariates **Results/effects estimates:** Proportions of patients who had ICD-9 codes for overweight or obesity: • 13 of 178 (7.3%) patients classified with overweight in overweight group or 76 of 246 (30.9%) patients classified with obesity in obesity group. 1.Predictors of Identification of overweight and obesity • BMI category (BMI ≥ 30kg/m^2 OR: 7.51, Ref BMI 25–29.9kg/m^2)	**Author's conclusions:** "Our results suggest that Internal Medicine residents markedly underrecognize and undertreat overweight and obesity." **Reviewer's comments:** This study shows having a BMI ≥ 30kg/m^2 is positively associated with identification of overweight and obesity. This study has clearly met 6/8 (75%) criteria in the critical appraisal tool. Two of the criteria was unclear.

	Setting and population: • Records of 2 resident clinics of the Yale Internal Medicine Residency Programs (the Family Health Center, St. Mary's Hospital, Waterbury, Conn and the VA Connecticut Healthcare System Primary Care Clinic, West Haven, Conn) between 1 September 2001 and 31 July 2002.				
Authors: Turner, Harris & Mazza [82] **Year published:** 2015 **Study design:** Cross sectional study **Country:** Australia	**Sample size:** N=270,426 **Inclusion criteria:** • Patients aged ≥18 years before or during the study period • Patients who had visited the same practice more than three times in the previous 2 years **Exclusion criteria:** None **Setting and population:** • Records from Melbourne East Monash General Practice Database (MAGNET), a primary care database of 78 participating general practice clinics in the inner-eastern region of Melbourne between 1 July 2011 and 31 December 2013	**1. Factors associated with BMI documentation:** • Age • Sex • Number of diagnoses recorded • Specific diagnosis recorded: hypertension, hyperlipidaemia, musculoskeletal problems, depression and anxiety, diabetes, cardiovascular disease, stroke, and kidney disease • Prescription of medication related to diabetes, depression and anxiety, blood pressure and cardiovascular disease, lipids, and anticoagulants	BMI documentation	**Statistical analysis:** • Descriptive for proportions • Logistic regression to estimate odd's ratio (OR) for documentation of BMI, adjusted for covariates **Results/effects estimates:** Proportion of patients with an anthropometric measurement recording between 1 July 2011 and 31 December 2013: • 36.9% had height records • 25.8% had weight records • 4.3% had WC records • 22.2% had BMI documented 1. Predictors of BMI documentation: • Age (≥75y OR: 1.60, 65-74y OR: 1.20, 45-64y OR: 1.31, Ref 19-44y) • Sex: Female (OR: 0.86, Ref male) • Number of diagnosis recorded (1 OR: 1.25, 2 OR: 1.45, ≥3 OR: 1.69, Ref 0 comorbidity) • Specific diagnosis recorded (hypertension OR: 1.18, hyperlipidaemia OR: 1.26, musculoskeletal problems OR: 1.07, depression and anxiety OR: 0.94, diabetes OR: 1.85, cardiovascular disease OR: 0.91, stroke OR: 0.87, Ref 'no' for each diagnosis) • Prescription of medication related to specific diagnosis (blood pressure/cardiovascular disease OR: 1.07, depression and anxiety OR: 1.07, diabetes OR: 1.24, Ref 'no' for each diagnosis)	**Author's conclusions:** "Recording of measures of obesity in general practice is currently not consistent with guideline recommendations. Strategies to support general practitioners may improve their documentation of measures of obesity." **Reviewer's comments:** This study shows that socio demographics (older age and male sex), increasing number of chronic medical conditions, diagnosis of chronic medical conditions, and medications for CVD or blood pressure, diabetes, depression/anxiety were positively associated with BMI documentation. This study has clearly met 8/8 (100%) criteria in the critical appraisal tool.
Authors:	**Sample size:** N=3,446	**1. Factors associated with weight measurement:**	Weight records	**Statistical analysis:** • Descriptive for proportions	**Author's conclusions:**

Verberne et al. [83] **Year published:** 2018 **Study design:** Cross sectional study **Country:** Netherlands	**Inclusion criteria:** • Patients born between 1945-1981 and registered in one of the participating general practices in NIVEL Primary Care Database **Exclusion criteria:** • Patients having incomplete registration in general practice • Patients with missing data on height and/or weight in the baseline questionnaire of the AMIGO study • Patients not having consultation with their GP in 2012 • Patients having self-reported BMI<25kg/m^2 • Patients from general practices having poor data quality or unavailability of data **Setting and population:** • Records from NIVEL Primary Care Database combined with records from AMIGO study • Participants for this study were recruited through 99 general practices that participated in the NIVEL-PCD in April 2011 and July 2012	• Sex • Age • Educational level • BMI • Smoking status • Drinking status • Absence or presence of chronic condition • Presence of cardiovascular disorder, osteoarthritis, diabetes mellitus and COPD		• Multiple logistic multilevel regression to estimate OR for weight record, adjusted for covariates (Model 2) **Results/effects estimates:** Proportion of patients with an anthropometric measurement: • 23% had BMI recordings (height and weight) in 2012 • 58% had at least one weight recording from 2012 to 2015 1 Predictors of weight recording: • Age (61-67y OR: 2.53, 51-60y OR: 2.26, 41-50y OR: 1.81, Ref 31-40y) • Educational Level (high OR: 0.70, intermediate OR: 0.83, Ref low) • BMI category: ≥ 30 kg/m^2 (OR: 1.25, Ref ≥ 25 and < 30 kg/m^2) • Chronic condition: 'no' (OR: 0.39, Ref 'yes') • Specific diagnosis recorded (cardiovascular disorder OR: 3.16, diabetes mellitus OR: 10.27, COPD OR: 2.00, Ref 'no' for each diagnosis)	"Weight was frequently recorded for overweight patients with a chronic condition, for whom regular weight measurement is recommended in clinical guidelines, and for which weight recording is a performance indicator as part of the payment system. For younger patients and those without a chronic condition related to being overweight, weight was less frequently recorded. For these patients, routine recording of weight in EHRs deserves more attention, with the aim to support early recognition and treatment of overweight." **Reviewer's comments:** This study shows that socio demographics (older age and low educational level), having BMI ≥ 30 kg/m^2, presence of chronic medical conditions and diagnosis of specific medical conditions (cardiovascular disorder, diabetes mellitus and COPD) were positively associated with weight recordings. This study has clearly met 8/8 (100%) criteria in the critical appraisal tool.
Authors: Yoong et al. [84]	**Sample size:** N=1,111 **Inclusion criteria:**	**1. Factors associated with non-identification of overweight and obesity:** • BMI	Non-identification of overweight and obesity	**Statistical analysis:** • Descriptive for proportions • Multiple logistic regression to estimate OR for non-identification of overweight and obesity for covariates	**Author's conclusions:** "GPs missed identifying a substantial proportion of overweight and obese patients.

Year published: 2014 **Study design:** Cross sectional study **Country:** Australia	• Patients aged ≥18 years proving informed consent • Patients who completed touchscreen computer questionnaire **Exclusion criteria:** • None **Setting and population:** • Records of patients from 12 general practices randomly invited and consented to participate in the study in three urban cities in two Australian states	• Age • Sex • Presence of heart disease • Presence of high blood pressure • Presence of cholesterol • Presence of type 2 diabetes • Ethnicity • Had private health insurance • Frequency of consultation • Education		**Results/effects estimates:** Proportion of patients with an identification of obesity and overweight at study time: • 42% as overweight • 46% as having obesity 1. Predictors of non-identification of overweight and obesity (subsample N=589): • BMI: obesity (OR: 0.1, Ref overweight) • Sex: male (OR: 1.7, Ref female) • Presence of high blood pressure: no (OR: 1.8, Ref yes) • Presence of type 2 diabetes: no (OR: 2.4, Ref yes) • Education: trade qualification/diploma (OR: 0.3, Ref HSC and below)	Strategies to support GPs in identifying their overweight or obese patients need to be implemented." **Reviewer's comments:** This study shows being male, absence of high blood pressure and type 2 diabetes are positively associated with non-identification of overweight and obesity. Whereas, having obesity and higher education are negatively associated with non-identification of overweight and obesity. This study has clearly met 7/8 (88%) criteria in the critical appraisal tool. One of the criteria was unclear.

Notes:
Only significant predictors or those included in meta-analysis were reported in the results section of this table. The statistical significance was confirmed using a significance level of at 5% (p=0.05 or less) or the corresponding confidence level within 95%. * The prevalence ratio was calculated by the authors of this review. # We assumed most of the study sample was aged 18 years and over based on the reported mean (SD) age of 49.4 (18.5)

Abbreviations:
AMIGO: Occupational and Environmental Health Cohort; BP: Blood Pressure; BMI: Body Mass Index; CCI, Charlson Comorbidity Index; CHS, Clalit Health Services; CI: Confidence Interval; COPD: Chronic Obstructive Pulmonary Disease; CVD: Cardio-Vascular Disease; EMR, Electronic Medical Records; EHR: Electronic Health Record; GP: General Practitioner; GPRD: General Practice Research Database; HCP: Health Care Professional/Practitioner; HR: Hazard Ratio; HYDRA: Hypertension and Diabetes Screening and Awareness; IBD: Inflammatory Bowel Disease; ICD: International Classification of Disease; IMD: Index of Multiple Deprivation; IRR: Incident Rate Ratio; IRSD: Index for Relative Socioeconomic Disadvantage; NAFLD: Non-alcoholic Fatty Liver Disease; NCRAS: National Cancer Registration and Analysis Service; NHS: National Health Service; NP: Nurse Practitioner; NIVEL: Netherlands Institute for Health Services Research; NW: Normal Weight; ONS: Office for National Statistics; OR: Odd Ratio; OW: Overweight; PA: Physician Assistant; PCP: Primary Care Physician; PR: Prevalence Ratio; RA: Rheumatoid Arthritis; Ref: Reference category; RRR: Relative Rate Ratio; SEIFA: Socio-Economic Indexes for Areas; SMI: Severe Mental Illness; SPDS: Sentinel Practices Data Sourcing; THIN: The Health Improvement Network; WC: Waist Circumference; y: years;

Definitions:
Biological sex of participants is denoted by the factor "sex", we have assumed "gender" and "sex" as an interchangeable factor while reporting on the studies.
Educational level: low = vocational education/ community college; intermediate = vocational/high school; high = college/university or higher
Index of Multiple Deprivation (IMD) Quintile I = least deprived; IMD Quintile V = most deprived.
READ is the Read Coded Clinical Terms code to identify the primary diagnosis.

Supplementary Table S4: Characteristics and summary of qualitative studies reviewed

Study details	Population and setting	Study design, aims and methods	Main themes and subthemes with explanations	Author's conclusions and reviewer's comments
Authors: Dunkley et al. [85] **Year published:** 2009 **Country:** United Kingdom	**Number of participants:** 10 HCPs (4 PNs, 6 GPs) and 18 patients **Inclusion criteria:** HCPs: • All GPs and PNs in participating practices Patients: • Speak and understand English and/or Gujarati • Aged 25-75 years **Exclusion criteria:** None **Setting and population:** • General practices in Leicestershire, UK • Practices were diverse in size and location, with ethnically diverse patients	Qualitative study conducted using purposive sampling, in-depth, semi-structured interviews and thematic analysis. **Aims:** The study aimed to explore the views of patients and HCPs towards waist size measurement, including identification of possible barriers to carrying out this assessment in a multi-ethnic primary care setting.	**Theme 1:** Understanding of waist size measurement to assess or monitor risk • HCPs demonstrated awareness of large waist size and risk of diabetes • Association of waist circumference with central obesity was less frequently raised • Awareness of ethnic subspecific recommendations was poor • Nearly half of the patients demonstrated no knowledge on the importance of waist circumference measurement and associated risk of high measurements • Some patients demonstrated perception of denial of the association of body size and health **Theme 2:** Attitudes related to perceived barriers and facilitators to waist measurement **Subtheme 1: Standardisation and training needs** • Most HCPs stated no *specific training* was provided related to implementing WCM • Concerns of HCPs were *lack of knowledge* on positioning the tape, lack of repeatability, operator variability and interpretation of results **Subtheme 2: Perceived usefulness** • Most HCPs agreed WCM was more useful than BMI and stated the need of this assessment in addition to BMI • Some HCPs felt patients are *not familiar* with waist size and may not understand how it relates to health risks • Some HCPs stated waist measurement was something that could *motivate* patients to make lifestyle changes • Majority of patients acknowledged the *importance of WCM* in identifying health problems and facilitating healthy lifestyle changes and thought it would be beneficial for their HCP to know their WCM **Subtheme 3: Personal feelings** • For some HCPs, the *perceived intimate nature* of WCM appeared to be a barrier • *HCPs being comfortable* appeared to be positively associated with increased experience of measuring waist size and negatively with patients having overweight or obesity • HCPs felt that *patients might feel uncomfortable* or be embarrassed • Few HCPs demonstrated *preconceived ideas* about cultural groups	**Author's conclusions:** "This study adds to our understanding of views on WCM in a multi-ethnic setting, highlighting factors for consideration if WCM is to be facilitated in routine practice." **Reviewer's comments:** • This study revealed several barriers to implementing WC measurement including lack of knowledge and specific training, negative perceptions about its usefulness, clinical importance, and acceptability (time and cost among HCPs; comfortableness, appearance, and hygiene concerns among their patients) • Perceived enablers of WC measurement include its usefulness to motivate healthy behavioural changes among patients, financial and organisational incentives for HCPs • Findings were consistent across GPs, PNs, and ethnic groups This study has clearly met 7/10 (70%) criteria in the critical appraisal tool.

			• Patients did not think that they would be embarrassed or feel uncomfortable about having their waist measured • Few female patients stated *preference for being measured by a female* HCP, but this was not seen as essential **Subtheme 4: Practical considerations** • Majority of HCPs mentioned *time as a barrier* in relation to appointment length and extra workload associated • Majority of HCPs raised *cost implications* as a barrier in implementation of WCM • HCPs suggested inclusion of WCM in the Quality and Outcomes Framework (QoF) as a *potential incentive* along with *organisational incentives* for implementing WCM • *Patient's concerns* included perceptions about hygiene, the need to wear appropriate clothing, time implications and a perceived need for the opportunity to consider whether it would be appropriate to bring children to the appointment	
Authors: Gaynor et al. [86] **Year published:** 2018 **Country:** United States	**Number of participants:** 7 PC Providers (5 NPs; 1 Doctor of Medicine; 1 Doctor of Osteopathy) attended interviews. 30 PCPs (Doctor of Medicine, Doctor of Osteopathy, NPs and 1 physician assistant) completed the surveys. **Inclusion criteria:** • PC providers **Exclusion criteria:** None **Setting and population:** • 6 PC practices in South-eastern Pennsylvania, New Castle and Kent County, Delaware	Explanatory mixed-methods design. Qualitative component involved purposive sampling, semi-structured interviews and thematic analysis. **Aims:** The study aimed to gain a deeper understanding of waist circumference measurement rejection in primary care.	**Theme 1:** Innovation characteristics • WCM did not offer greater advantage, compatibility, ease of use, or ease of trial over BMI • Disadvantages of WCM included time associated with obtaining and documenting measurement, discomfort with measuring a patient's WCM, lack of knowledge and training re technique, lack of equipment (i.e., tape measures) **Theme 2:** Communication channels and the social system • Peer-to-peer communications had the greatest influence on provider use of measurements, followed by formal education and clinical experiences, experiences with preceptors, webinars, apps and conferences, and professional journals **Theme 3:** Time, comfort and practice norms • Lack of time served as a barrier to adopting WCM • Measurements were taken if part of routine practice • PC providers expressed discomfort in obtaining WCM for members of the opposite sex or people who were overweight/obese	**Author's conclusions:** "Before implementing a new initiative, WCM training modules and time efficient plans for obtaining WCM in PC settings should be piloted." **Reviewer's comments:** • Confusing presentation of qualitative results • Qualitative data collected in 2 group interviews and one individual interview. Unclear whether the group interviews were actually focus groups This study has clearly met 8/10 (80%) criteria in the critical appraisal tool.

Authors: McHale et al. [87] **Year published:** 2020 **Country:** United Kingdom	**Number of participants:** 305 patients completed a questionnaire and 14 PCPs (12 GPs; 2 PNs) completed a questionnaire and participated in interviews **Inclusion criteria:** PCPs: • GPs and PNs in 7 participating practices Patients: • Consulted by one of the participating PCPs **Exclusion criteria:** None **Setting and population:** • 7 Primary Care Practices across 3 NHS Scotland health boards	Convergent mixed methods design using convenience sampling. Qualitative component used semi-structured interviews and thematic analysis. **Aims:** The study aimed to understand the beliefs that PCPs and patients with overweight and obesity have about obesity and primary care weight management in Scotland.	**Theme 1:** PCP role in patient weight management • GPs and PNs had differing views about the role of primary care in patient weight management • Addressing patient weight issues and awareness was GPs' professional responsibility particularly when patients' excessive weight was impacting on their health or when patients requested assistance with their weight • Some GPs did not believe it was their role to engage patients in preventative weight management or monitor their weight and did not perceive prevention and monitoring were an efficient use of their time • GPs perceived that standalone weight issues were the responsibility of the patient, not primary care • PN participants perceived direct weight management was part of their role and regularly engaged in weight management and monitoring with patients **Theme 2:** Discussing weight issues with patients • PCPs preferred to discuss weight issues within the context of patients' existing health issues • PCPs expressed an apprehension to start a discussion about patient weight when they could not establish a clear link between existing health issues and the patient's weight, or when patients did not recognise that their body weight was excessive and potentially problematic • PCPs perceived that weight was a personal issue, and discussing weight without a health-related reason, was inappropriate and may elicit a negative emotional reaction **Theme 3:** Barriers to weight management • The inefficacy of weight management interventions was a barrier • There was a lack of confidence in the evidence base for weight management interventions recommended by clinical guidelines • Systemic barriers to weight management included lack of consultation time, restrictive eligibility criteria for specialised weight management referrals and shortage of financial and human resources in primary care • Lack of referral pathways for overweight patients when weight was not impacting on their health • One PCP highlighted that current NHS working contracts did not prioritise or incentivise weight management • Several PCPs described patients with overweight and obesity as lacking the motivation to address weight issues, and that for many patients their weight was not a priority • PCPs acknowledged that training was always potentially useful; however, most were confident in their ability and were ambivalent about receiving additional weight management	**Author's conclusions:** "Acknowledging a shared responsibility for patient weight could improve outcome for patients with overweight and obesity. There is a pressing need to review, standardise and clarify the primary care weight management process in NHS Scotland." **Reviewer's comments:** • This study revealed that PCPs acknowledged a responsibility for patient weight but they found it challenging to discuss weight related issues with patients • There were multiple barriers to weight management, both systemic and patient related • Some inconsistencies in terminology related to the design, which is a little confusing, i.e., authors refer to cross-sectional mixed methods; convergent mixed methods; concurrent triangulation mixed methods This study has clearly met 7/10 (70%) criteria in the critical appraisal tool.

			training. Lack of weight management effectiveness was due to patient factors, including lack of motivation	

Abbreviations:
BMI: Body Mass Index; GP: General Practitioner; HCP: Health Care Professional/Practitioner; NHS: National Health Service; NP: Nurse Practitioner; PC: Primary Care; PCP: Primary Care Provider; PN: Practice Nurse; UK: United Kingdom; WC: Waist Circumference; WCM: Waist Circumference Measurement.

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Supplementary Table S5: Risk of bias assessment of studies reviewed

Cohort	**1. Were the two groups similar and recruited from the same population?**	**2. Were the exposures measured similarly to assign people to both exposed and unexposed groups?**	**3. Was the exposure measured in a valid and reliable way?**	**4.Were confounding factors identified?**	**5. Were strategies to deal with confounding factors stated?**	**6. Were the groups/participants free of the outcome at the start of the study (or at the moment of exposure)?**	**7. Were the outcomes measured in a valid and reliable way?**	**8. Was the follow up time reported and sufficient to be long enough for outcomes to occur?**	**9. Was follow up complete, and if not, were the reasons to loss to follow up described and explored?**	**10. Were strategies to address incomplete follow up utilized?**	**11. Was appropriate statistical analysis used?**	**Overall Quality**	**Unclear**	**Proportion**
Booth, Prevost & Gulliford (2013)	Yes	Yes	Yes	Yes	Yes	Not applicable	Yes	Yes	Yes	No	Yes	9/10	0	90%
Emanuel et al. (2016)	Yes	Yes	Yes	Yes	Yes	Not applicable	Unclear	Yes	Not applicable	Not applicable	Yes	7/8	1	88%
Nicholson et al . (2019)	Yes	Yes	Unclear	Yes	Yes	Not applicable	Unclear	Yes	Yes	No	Yes	7/10	2	70%
Osborn et al. (2011)	Yes	Yes	Yes	Yes	Yes	Not applicable	Yes	Yes	Unclear	No	Yes	8/10	1	80%
Cross-sectional	**1. Were the criteria for inclusion in the sample clearly defined?**	**2. Were the study subjects and the setting described in detail?**	**3. Was the exposure measured in a valid and reliable way?**	**4. Were objective, standard criteria used for measurement of the condition?**	**5. Were confounding factors identified?**	**6. Were strategies to deal with confounding factors stated?**	**7. Were the outcomes measured in a valid and reliable way?**	**8. Was appropriate statistical analysis used?**				**Overall Quality**	**Unclear**	**Proportion**
Aleem et al. (2015)	Yes	Yes	Yes	Yes	No	No	Yes	No				5/8	0	63%
Baer et al. (2013)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes				8/8	0	100%
Bleich, Pickett-Blakely & Cooper (2011)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes				8/8	0	100%
Bramlage et al. (2014)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Unclear				7/8	1	88%

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Cuccu, Abi-Aad & Duggal (2019)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes				8/8	0	100%
Cyr et al. (2016)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes				8/8	0	100%
Dalton et al. (2011)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes				8/8	0	100%
Ghosh (2016)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes				8/8	0	100%
Gonzalez-Chica et al. (2019)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes				8/8	0	100%
Gutiérrez Angulo et al. (2014)	Yes	Unclear	Yes	Yes	No	No	Yes	No				4/8	1	50%
Mattar et al. (2017)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes				8/8	0	100%
Melamed et al. (2009)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes				8/8	0	100%
Mocarski et al. (2018)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes				8/8	0	100%
Rose et al. (2009)	Yes	Yes	Yes	Yes	No	No	Yes	No				5/8	0	63%
Ruser et al. (2005)	Yes	Yes	Yes	Yes	Unclear	Yes	Yes	Unclear				6/8	2	75%
Turner, Harris & Mazza (2015)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes				8/8	0	100%
Verberne et al. (2018)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes				8/8	0	100%
Yoong et al. (2014)	Yes	Yes	Yes	Yes	Yes	Yes	Unclear	Yes				7/8	1	88%
Qualitative research	**1. Is there congruity between the stated philosophical perspective and the research methodology?**	**2. Is there congruity between the research methodology and the research question or objectives?**	**3. Is there congruity between the research methodology and the methods used to collect data?**	**4. Is there congruity between the research methodology and the representation and analysis of data?**	**5. Is there congruity between the research methodology and the interpretation of results?**	**6. Is there a statement locating the researcher culturally or theoretically?**	**7. Is the influence of the researcher on the research, and vice-versa, addressed?**	**8. Are participants, and their voices, adequately represented?**	**9. Is the research ethical according to current criteria or, for recent studies, and is there evidence of ethical approval by an appropriate body?**	**10. Do the conclusions drawn in the research report flow from the analysis, or interpretation, of the data?**		**Overall Quality**	**Unclear**	**Proportion**
Dunkley et al. (2009)	No	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes		7/10	0	70%
Gaynor et al (2018)	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes		8/10	0	80%

McHale et al (2020)	No	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes		7/10	0	70%

Atlantis E, *et al. BMJ Open* 2022; 12:e063659. doi: 10.1136/bmjopen-2022-063659

Supplementary Section S6: Summary of results from all meta-analyses

S6.1 Sex as a predictor of BMI assessment

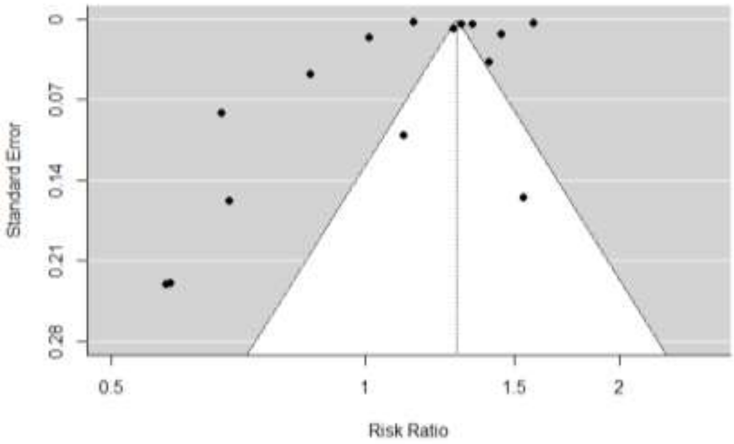
There is statistically significant evidence that BMI assessment is more common in females than in males overall, as well as specific to UK and USA (Table S6.1). As expected, odds ratios are larger than risk ratios. The association is stronger in the higher quality and larger studies. The very high heterogeneity between studies is not relieved by any of the sub-group variable nor by excluding studies with a lower quality rating.

Table S6.1 Summary statistics from the meta-analyses of females relative to males, including sub-group and sensitivity analyses

	Reference category	**No. of studies**	**Pooled risk ratio**	**I^2, heterogeneity test p-value**
Sex	Male	15	1.28 (1.10,1.50)	99.8%, p<0.001
Subgroup by outcome				
- BMI assessment	Male	8	1.27 (1.02,1.58)	99.9%, p<0.001
- BMI diagnosis assessment	Male	6	1.34 (0.87,2.05)	95.0%, p<0.001
Subgroup by ratio measure				
- odds ratio	Male	11	1.45 (1.21,1.74)	99.5%, p<0.001
- risk ratio	Male	4	1.18 (1.04,1.35)	99.7%, p<0.001
Subgroup by country				
- Australia	Male	3	0.99 (0.79,1.25)	87.2%, p<0.001
- UK	Male	3	1.27 (1.02,1.60)	100%, p<0.001
- USA	Male	6	1.33 (1.20,1.48)	97.0%, p<0.001
- Other	Male	3	1.32 (0.81,2.16)	91.2%, p<0.001
Sensitivity by quality				
- High quality	Male	10	1.45 (1.21,1.74)	99.6%, p<0.001

The Funnel plot (Figure S6.1) and Egger's test (p=0.905) reveal no statistically significant evidence of reporting bias.

Figure S6.1 Funnel plot of sex as a predictor of BMI assessment



S6.2 Age as a predictor of BMI assessment

Age categories varied between studies. For meta-analysis the rate of BMI assessment in the age group closest to or including 65 years relative to the age group closest to or including 30 age group are identified and pooled. The actual results pooled were the BMI assessment for 65 or more years relative to 18-29 years,[65 84] 65 or more years relative to 18-39 years,[69] 65-74 years relative to 18-24 years,[66 68] 65-74 years relative to 18-44 years,[72] 60-69 years relative to 18-29 years,[64 78] 61-67 years relative to 31-40 years,[83] 60 or more years relative to 30-44 years,[67] 56-74 years relative to 19-44 years,[82] and 55 or more years relative to less than 55 years.[76]

One study[75] presented results for age as a continuous variable and another[70] presented results for sex by age categories. Neither could not be included in the meta-analysis.

There is no statistically significant evidence that the rate of BMI assessment differs between the older and younger age groups (Table S6.2). The only statistically significant result occurs in the ‘other countries’ category in which a study from Israel[76] is combined with a study from Germany,[67] both of which recorded a statistically significant increased rate of BMI assessment in the older age group. The Funnel plot (Figure S6.2) and Egger’s test (p=0.348) reveal no evidence of reporting bias.

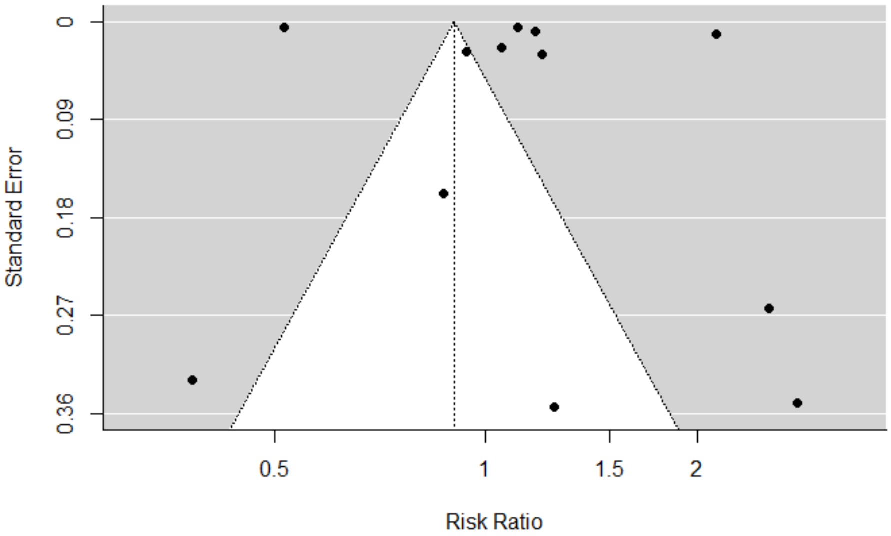
There is very high heterogeneity between studies. This is not alleviated by any of the grouping variables or by the exclusion of studies with a lower quality rating.

Table S6.2 Summary statistics from the meta-analyses of oldest age group relative to youngest, including sub-group and sensitivity analyses

	Reference category	**No. of studies**	**Pooled ratio**	**I^2, heterogeneity test p-value**
Age	Closest to 30 years	12	0.90 (0.50,1.63)	100%, p<0.001
Subgroup by outcome				
- recorded BMI	Closest to 30 years	8	1.21 (0.82,1.78)	99.8%, p<0.001
- recorded BMI diagnosis	Closest to 30 years	4	0.52 (0.25,1.05)	83.3%, p<0.001
Subgroup by country				
- Australia	Closest to 30 years	3	1.11 (0.98,1.26)	83.6%, p=0.002
- UK	Closest to 30 years	3	1.22 (0.78,1.90)	99.9%, p<0.001
- USA	Closest to 30 years	4	0.53 (0.24,1.17)	99.4%, p<0.001
- Other	Closest to 30 years	2	2.61 (1.73,3.95)	0%, p=0.836
Sensitivity by quality				
- High quality	Closest to 30 years	9	0.69 (0.19,2.48)	100%, p<0.001

The funnel plot shown in Figure S6.2 confirms high heterogeneity (many studies outside the central funnel) but provides no evidence of publication bias. Egger's test also returned no statistically significant evidence of small study bias (p=0.348).

Figure S6.2 Funnel plot of age group as a predictor of BMI assessment



S6.3 Race/ethnicity as a predictor of BMI assessment

Results were provided by race/ethnicity group in nine studies, but the classification used varied considerable between studies and countries. For example, one study from the UK classified ethic groups as White, Indian, Bangladeshi, Pakistani, Chinese, Other Asian, Black African, Black Caribbean, Other Black, Other, Mixed Race or Unknown[78] while a US study used a very different classification of White, Asian, Black, Hispanic, Native American, Multi-race, and Other.[77]

In the meta-analysis the race/ethnicity categories 'White' and 'Caucasian' were regarded as equivalent. The reference category was 'White' or 'Caucasian' [84] for eight of the nine studies. Three of these[69 80 84] defined a single comparator group 'Other' or 'non-Caucasian'. Five had multiple comparator race/ethnicity categories which we combined into a single 'Non-White' category using the method in another.[88] One study[75] defined 'Black' as the reference category. We inverted the results for 'White' compared to 'Black' but as the remaining categories 'Hispanic' or 'Other' were only compared to 'Black' we could not include them in the 'White' against 'Non-White' meta-analysis.

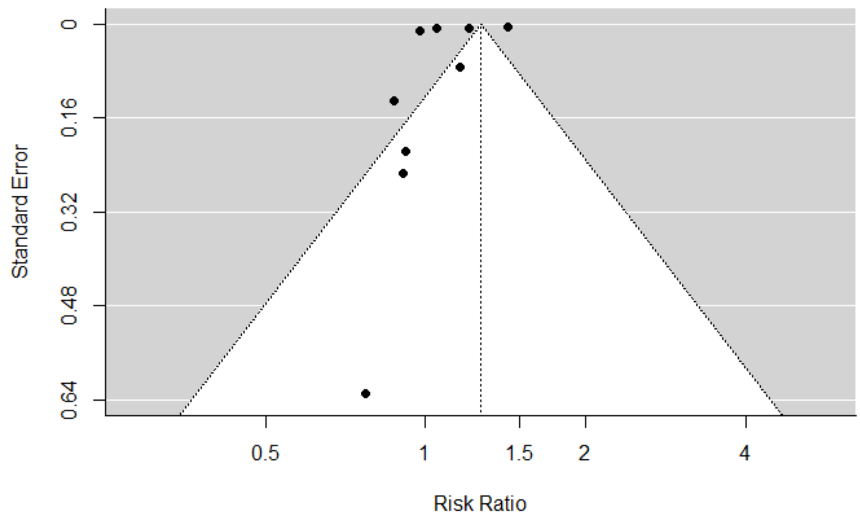
Meta-analyses revealed statistically significant evidence that BMI assessment is more common in people of non-White race/ethnicity than in White race/ethnicity overall, particularly when BMI is recorded as a diagnosis (Table S6.3). The effect size may be marginally stronger in the higher quality studies, though the smaller sample size leads to wider confidence intervals. There are very high levels of heterogeneity between the studies, and this is not alleviated by sub-groups or exclusion of studies with lower quality scores.

Table S6.3 Summary statistics from the meta-analyses of non-White relative to White race/ethnicity, including sub-group and sensitivity analyses

	Reference category	**No. of studies**	**Pooled risk ratio**	**I^2, heterogeneity test p-value**
Race/ethnicity	White	9	1.27 (1.03,1.57)	99.6%, p<0.001
Subgroup by outcome				
- BMI assessment	White	4	1.10 (0.97,1.25)	99.1%, p<0.001
- BMI diagnosis assessment	White	5	1.43 (0.78,2.61)	82.2%, p<0.001
Sensitivity by quality				
- High quality	White	6	1.36 (0.86,2.16)	99.5%, p<0.001

The Funnel plot (Figure S6.3) suggests a tendency for smaller studies to find that non-Whites have lower rates of BMI assessment than Whites. As there are less than 10 studies, Egger's test at p=0.083 may be underpowered.

Figure S6.3 Funnel plot of race/ethnicity as a predictor of BMI assessment


Standard Error
0
0.16
0.32
0.48
0.64
0.5
1
1.5
2
4
Risk Ratio

S6.4 Deprivation as a predictor of BMI assessment

All four studies reporting relative rates of BMI assessment across socio-economic groups were from the UK.[68 70 71] All used postcode-based Indexes of Multiple Deprivation, although version differed.

The pooled results (Table S6.4) provide statistically significant evidence that BMI assessment was more likely among those with most compared with least deprivation, although heterogeneity was high. Given the small number of studies, sub-group and sensitivity analyses are not pursued.

Table S6.4 Summary statistics from the meta-analysis of greatest deprivation relative to least

	Reference category	**No. of studies**	**Pooled risk ratio**	**I^2, heterogeneity test p-value**
Deprivation index	Least	4	1.21 (1.18,1.24)	73.9%, p=0.009

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S6.5 Health insurance status as a predictor of BMI assessment

Five of the 6 studies reporting insurance status as a predictor of BMI assessment used ‘private’ insurance as the reference category. The remaining study[75] could not be include in the meta-analysis as the reference category was unclear, but was not ‘private’. Two studies compared ‘Private’ to ‘Not private’.[65 84] The remaining three studies[63 64 69] had multiple comparator categories (‘Medicare’, ‘Medicaid’, ‘Other’, ‘Self-Pay/None’) which we combined into a single ‘Not private’ category using the method in another study.[88]

The pooled results (Table S6.5) provide no evidence of association between health insurance status and BMI assessment.

Table S6.5 Summary statistics from the meta-analysis of non-private against private health insurance

	Reference category	**No. of studies**	**Pooled risk ratio**	**I^2, heterogeneity test p-value**
Insurance status	Private	5	1.01 (0.83,1.23)	95.3%, p<0.001

S6.6 BMI category as a predictor of BMI assessment

The different studies compared BMI assessment rates across varying BMI-based weight categories. The meta-analysis pools the comparisons of the heaviest available weight group to the lightest available group. These comparison groups were 'BMI 40+' relative to 'BMI 25-29.9',[66 69] 'BMI 40+' relative to 'BMI 30-34.9',[65] 'BMI 40+' relative to 'BMI <40',[75] 'BMI 35+' relative to 'BMI 18.5-24.99',[78] 'BMI 30+' relative to 'BMI <30',[76] and 'BMI 30+' relative to 'BMI 25-29.9'.[81 83]

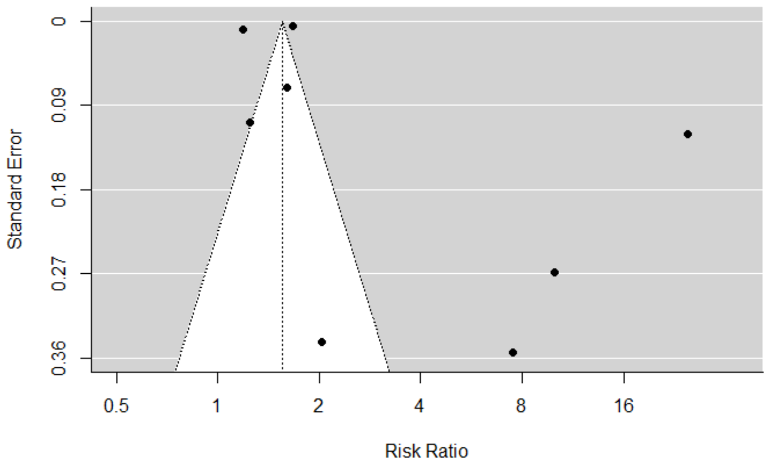
The results of the meta-analyses are presented in Table S6.6. There is very high heterogeneity between the studies. The overall pooled risk ratio is suggestive of an increased rate of BMI assessment among heavier patients, but statistical significance is not reached. The differences between higher and lower weight categories appear to be greater when BMI is being recorded as a diagnosis and when analyses are restricted to studies with the highest quality rating score. However, high heterogeneity and correspondingly wide confidence intervals negate definitive interpretations.

Table S6.6 Summary statistics from the meta-analyses of those in the highest BMI category relative to those in the lowest, including sub-group and sensitivity analyses

	Reference category	**No. of studies**	**Pooled risk ratio**	**I^2, heterogeneity test p-value**
BMI category	Lowest	8	1.55 (0.99,2.45)	99.6%, p<0.001
Subgroup by outcome				
- BMI assessment	Lowest	4	1.55 (1.06,2.26)	99.8%, p<0.001
- BMI diagnosis assessment	Lowest	4	3.53 (0.30,40.9)	99.3%, p<0.001
Sensitivity by quality				
- High quality	Lowest	4	2.56 (0.45,14.6)	99.3%, p<0.001

The funnel plot, Figure S6.6, again shows that some of the smaller studies reported relatively high risk ratios for BMI assessment in the heavier group. However, this pattern is not completely consistent, and the small number of studies precludes formal hypothesis testing for bias.

Figure S6.6 Funnel plot of BMI category as a predictor of BMI assessment



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S6.7 Smoking status as a predictor of BMI assessment

Only three studies reported the relative rate of BMI assessment by smoking status.[66 78 83] The meta-analysis report results of current smokers relative to never smokers. There was high heterogeneity between the three studies and no evidence of association between smoking status and BMI assessment (Table S6.7). Given the small number of studies, sub-group and sensitivity analyses were not pursued.

Table S6.7 Summary statistics from the meta-analysis of greatest deprivation relative to least

	Reference category	**No. of studies**	**Pooled risk ratio**	**I^2, heterogeneity test p-value**
Smoking status	Non smoker	3	1.01 (0.90,1.14)	98.3%, p<0.001

S6.8 The number of comorbidities as a predictor of BMI assessment

In this meta-analysis we have equated the terms 'Obesity-related comorbidities',[64] 'Comorbid conditions',[67] 'Multimorbidity',[68] 'Disease counts',[72] 'Chronic condition',[83] 'Charlson comorbidity index',[77] and 'Number of diagnoses recorded'[82] to 'Comorbidities'. The comparison of the relative frequency of BMI assessment comparing the highest comorbidity class with the lowest are pooled in the meta-analysis. The actual comparisons pooled are 5+ relative to 0,[67 78] 3+ relative to 0,[64 72 82] 2+ relative to 0-1,[68] at least one comorbidity present relative to absent,[74 83] Charlson comorbidity index of 5+ relative to 0,[77] and 'very high' relative to 'lower'[65] based on the presence of absence of specific diagnosis codes.

One study[75] analysed the number of comorbidities as a numeric variable and could not be included in the current meta-analysis.

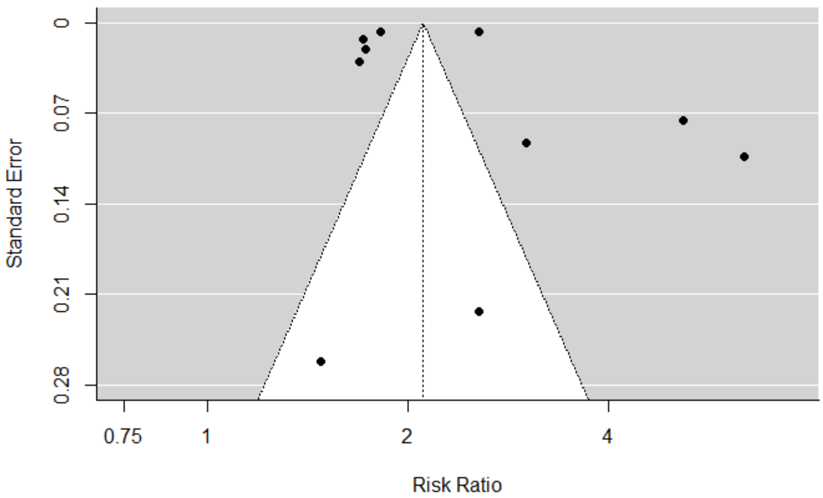
The meta-analysis provides statistically significant evidence that BMI assessment is more common in those in the highest number of comorbidities category, as compared to those in the low comorbidity category (Table S6.8). This effect can be seen in all subgroups and the association is slightly stronger in the higher quality studies (Table S6.8). The clinical magnitude of this association cannot be resolved due to the very high levels of heterogeneity overall and within each sub-group. The Funnel plot (Figure S6.8) and Egger's test (p=0.932) reveal no consistent evidence of reporting bias.

Table S6.8 Summary statistics from the meta-analyses of most comorbidities relative to least, including sub-group and sensitivity analyses

	Reference category	**No. of studies**	**Pooled risk ratio**	**I^2, heterogeneity test p-value**
Number of comorbidities	Fewest	10	2.11 (1.60,2.79)	99.6%, p<0.001
Subgroup by outcome				
- BMI assessment	Fewest	7	2.16 (1.58,2.96)	99.6%, p<0.001
- BMI diagnosis assessment	Fewest	3	1.75 (0.33,9.20)	98.8%, p<0.001
Subgroup by country				
- Australia	Fewest	2	1.98 (0.51,7.63)	99.5%, p<0.001
- UK	Fewest	2	2.19 (1.56,3.07)	99.9%, p<0.001
- USA	Fewest	3	1.72 (1.68,1.75)	0%, p=0.783
- Other	Fewest	3	4.09 (2.18,7.66)	94.1%, p<0.001
Sensitivity by quality				
- High quality	Fewest	7	2.30 (1.53,3.45)	99.5%, p<0.001

Atlantis E, *et al. BMJ Open* 2022; 12:e063659. doi: 10.1136/bmjopen-2022-063659

Figure S6.8 Funnel plot of number of comorbidities as a predictor of BMI assessment



S6.9 Cardiovascular disease as a predictor of BMI assessment

This meta-analysis has combined the terms 'Diagnosis with vascular complications'[67] and 'Presence of heart disease'[84] with 'Cardio-vascular disease'. All studies reported the assessment of BMI in the cardiovascular disease group relative to those without cardiovascular disease.

The pooled risk ratios from the meta-analyses and associated 95% confidence intervals summarised in Table S6.9 do not provide any statistically significant evidence of association between the presence of cardiovascular disease and the assessment of BMI.

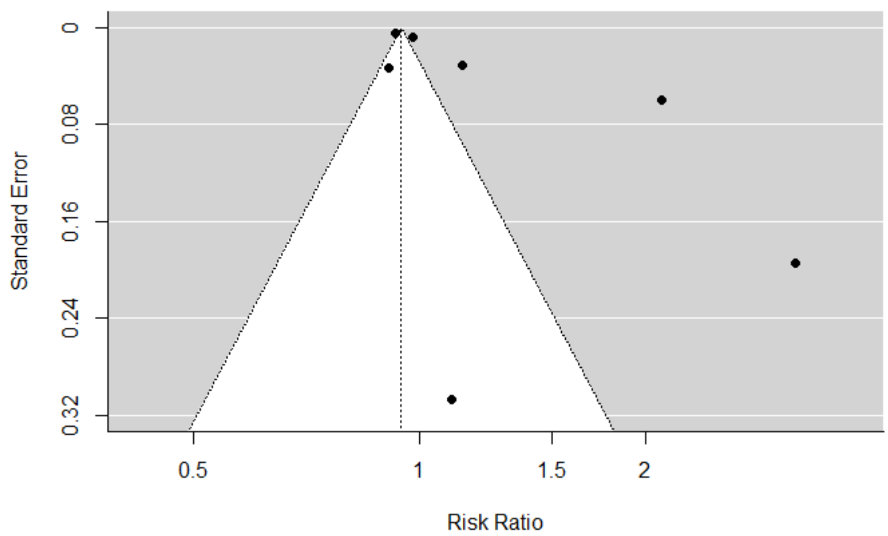
Table S6.9 Summary statistics from the meta-analyses of those with cardio-vascular disease relative to those without, including sub-group and sensitivity analyses

	Reference category	**No. of studies**	**Pooled risk ratio**	**I^2, heterogeneity test p-value**
Cardiovascular disease	No	7	0.94 (0.81,1.10)	98.0%, p<0.001
Subgroup by outcome - BMI assessment - BMI diagnosis assessment	 No No	 4 3	 0.99 (0.78,1.24) 0.93 (0.31,2.80)	 95.3%, p<0.001 98.9%, p<0.001

Sensitivity by quality - High quality	No	4	0.93 (0.71,1.23)	96.4%, p<0.001

The funnel plot presented in Figure S6.9 shows high outliers to the right of most studies but as the number of studies is less than 10, we have not proceeded with testing for publication bias.

Figure S6.9 Funnel plot of cardiovascular disease as a predictor of BMI assessment



Atlantis E, *et al. BMJ Open* 2022; 12:e063659. doi: 10.1136/bmjopen-2022-063659

S6.10 Diabetes as a predictor of BMI assessment

The assessment of BMI among those with a diagnosis of diabetes was compared to the assessment of BMI among those without in 9 studies. The meta-analysis results are summarised in Table S6.10. Overall, there is insufficient evidence to conclude the BMI assessment differs between those with and those without diabetes, with the very high heterogeneity between the studies contributing uncertainty. However, subgroup analyses suggest a statistically significant increase in BMI assessment for Australian patients with diabetes, consistent across all 3 studies (I^2=0%) and statistically significant increase in BMI assessment in the 4 studies where BMI was recorded as a diagnosis, also with low heterogeneity (I^2=30.8%).

Table S6.10 Summary statistics from the meta-analyses of those with diabetes relative to those without, including sub-group and sensitivity analyses

	Reference category	**No. of studies**	**Pooled risk ratio**	**I^2, heterogeneity test p-value**
Diabetes	No	9	1.19 (0.93,1.52)	99.0%, p<0.001
Subgroup by outcome				
- BMI assessment	No	5	1.10 (0.48,2.52)	99.4%, p<0.001
- BMI diagnosis assessment	No	4	1.24 (1.04,1.48)	30.8%, p=0.227
Subgroup by country				
- Australia	No	3	1.84 (1.75,1.93)	0%, p=0.841
- USA	No	4	1.17 (0.99,1.40)	99.2%, p<0.001
- Other	No	2	8.63 (3.42,21.8)	79.4%, p=0.028
Sensitivity by quality				
- High quality	No	7	1.26 (0.66,2.41)	98.4% (p<0.001)

The funnel plot (Figure S6.10) shows most of the smaller studies falling to the right of the expected range. Egger’s test returns a highly statistically significant result (p=0.004) but, given there are less than 10 studies, some care is warranted in the interpretation of this result.

Figure S6.10 Funnel plot of diabetes as a predictor of BMI assessment

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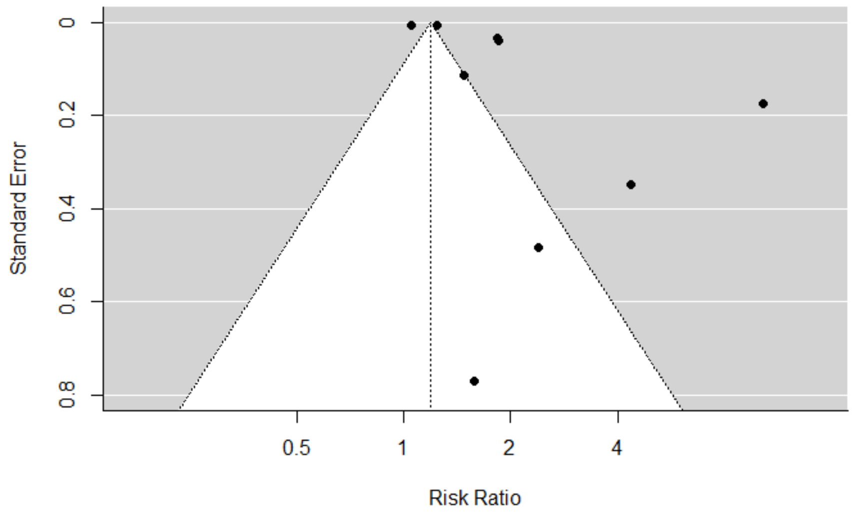


S6.11 Dyslipidaemia disease as a predictor of BMI assessment

For the meta-analysis the presence of 'Hyperlipidaemia'[69 72 82] and 'Presence of cholesterol' [84] were combined with 'Dyslipidaemia'.[77] The overall meta-analysis (Table S6.11) provides insufficient evidence to conclude the BMI assessment differs between those with and those without dyslipidaemia, with the very high heterogeneity between the studies. However, subgroup analyses suggest a statistically significant increase in BMI assessment for Australian patients with dyslipidaemia and where BMI was recorded as a diagnosis. There is still considerable heterogeneity between studies even within these sub-groups (I^2=80.6% and I^2=50.9% respectively) also with low heterogeneity (I^2=30.8%). Restricting analyses to studies with the highest quality ranking produced statistically significant evidence of effect and decreased heterogeneity between the remaining studies (I^2=57.3%).

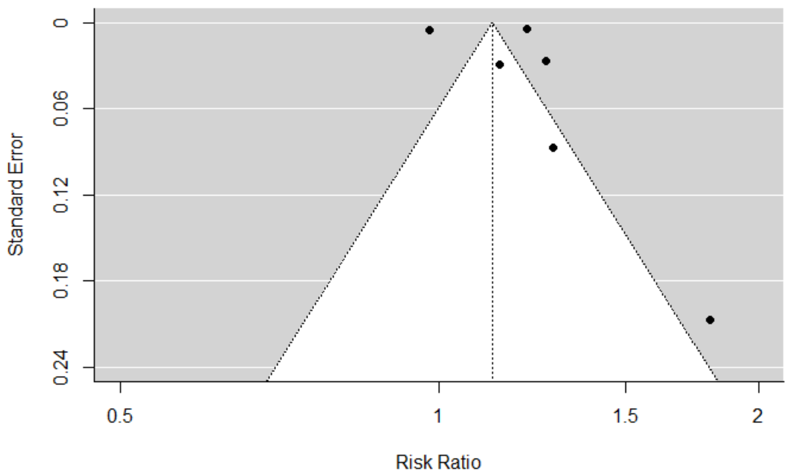
S6.11 Summary statistics from the meta-analyses of those with dyslipidaemia relative to those without, including sub-group and sensitivity analyses

	Reference category	**No. of studies**	**Pooled risk ratio**	**I^2, heterogeneity test p-value**
Dyslipidaemia	No	6	1.12 (0.92,1.37)	99.5%, p<0.001
Subgroup by outcome				
- BMI assessment	No	3	0.99 (0.76,1.30)	98.2%, p<0.001
- BMI diagnosis assessment	No	3	1.21 (1.03,1.42)	50.9%, p=0.131
Subgroup by country				

- Australia - USA	No No	3 3	1.21 (1.08,1.36) 1.12 (0.90,1.39)	80.6% p=0.059 99.8%, p<0.001
Sensitivity by quality - High quality	No	4	1.21 (1.15,1.28)	57.3%, p=0.071

The funnel plot (Figure S6.11) shows most studies are equivalent size with the two smaller studies both reporting an increase in BMI assessment among people with dyslipidaemia. There are insufficient studies to allow statistical testing of this association.

Figure S6.11 Funnel plot of dyslipidaemia as a predictor of BMI assessment



S6.12 Hypertension as a predictor of BMI assessment

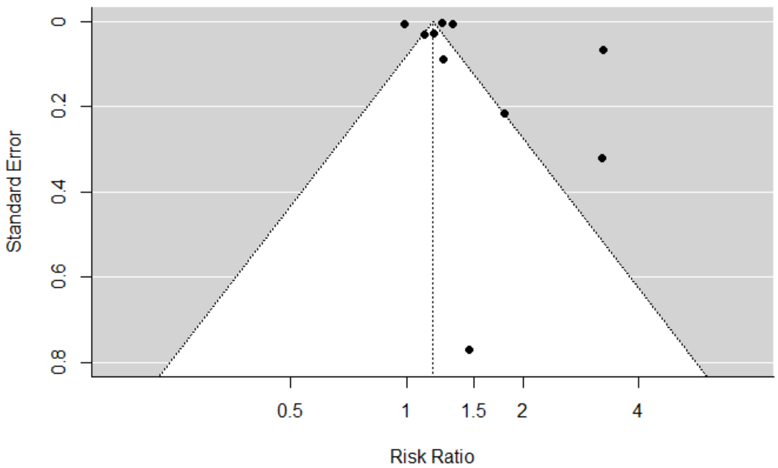
For this meta-analysis 'Presence of high blood pressure'[84] was regarded as equivalent to 'Hypertension' and 'Hypertensive'. The pattern of results is like those from the previous chronic comorbidities meta-analyses. The overall meta-analysis (Table S6.12) suffered very high heterogeneity and fell short of statistical significance. However, subgroup analyses partially alleviated the heterogeneity and suggested a statistically significant increase in BMI assessment both for Australian patients with hypertension and where BMI was recorded as a diagnosis. Restricting analyses to studies with the highest quality rating allowed a statistically significant result but failed to address the heterogeneity between studies.

Figure S6.12 Summary statistics from the meta-analyses of those with hypertension relative to those without, including sub-group and sensitivity analyses

	Reference category	No. of studies	Pooled risk ratio	I^2, heterogeneity test p-value
Hypertension	No	10	1.17 (0.98,1.40)	99.5%, p<0.001
Subgroup by outcome				
- BMI assessment	No	6	1.11 (0.83,1.48)	99.7%, p<0.001
- BMI diagnosis assessment	No	4	1.24 (1.20,1.28)	2.2%, p=0.382
Subgroup by country				
- Australia	No	3	1.15 (1.05,1.26)	69.4%, p=0.038
- UK	No	2	1.33 (0.39,4.54)	99.4%, p<0.001
- USA	No	4	1.14 (0.91,1.43)	99.8%, p<0.001
- Other	No	1	3.20 (1.71,5.99)	n.a.
Sensitivity by quality				
- High quality	No	8	1.26 (1.10,1.43)	97.7%, p<0.001

The funnel plot, Figure S6.12, again shows that some of the smaller studies report relatively high risk ratios for BMI assessment in the hypertensive group. However, there are exceptions and Egger's test returned no statistically significant evidence of bias (p=0.293).

Figure S6.12 Funnel plot of hypertension as a predictor of BMI assessment



S6.13 Mental illness as a predictor of BMI assessment

Three studies compared the rate of BMI reporting for those with 'mental illness',[72] 'serious mental illness',[68] or 'severe mental illness'[79] to those without. These studies returned strongly heterogeneous results (I^2=99.6%) and the pooled risk ratio (Table S6.13) did not provide any statistically significant evidence of association between mental illness and BMI assessment.

Table S6.13 Summary statistics from the meta-analysis of those with mental illness relative to those without

	Reference category	**No. of studies**	**Pooled risk ratio**	**I^2, heterogeneity test p-value**
Mental illness	Not present	3	1.16 (0.79,1.70)	99.6%, p<0.001

S6.14 Depression as a predictor of BMI assessment

Three studies compared the rate of BMI reporting for those with 'depression',[75 77] or 'depression and anxiety'[82] to those without. These studies returned strongly heterogeneous results (I^2=98.7%) and the pooled risk ratio (Table S6.14) did not provide statistically significant evidence of association between mental illness and BMI assessment.

Table S6.14 Summary statistics from the meta-analysis of those with depression relative to those without

	Reference category	**No. of studies**	**Pooled risk ratio**	**I^2, heterogeneity test p-value**
Depression	Not present	3	1.22 (0.85,1.74)	98.7%, p<0.001

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