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REVIEW

Sex Differences in the Assessment of Cardiovascular Risk in Primary Health Care: A Systematic Review

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Objective To determine whether sex differences exist in the assessment of cardiovascular disease (CVD) risk scores/risk factors in primary health care.

Design/Methods PubMed and EMBASE were systematically searched on 31 January 2017. Clinical trials and observational studies were included if they reported on the assessment of CVD risk score, blood pressure (BP), cholesterol or smoking status in primary health care, stratified by sex. Meta-analyses were performed, using random effects models, to determine differences between sexes, separately for adjusted and unadjusted data.

Results Of 14,928 studies found in the search, 22 studies (including 4,754,782 patients) were included in the systematic review with the meta-analysis for quantitative assessment. Overall, the assessment rates of CVD risk score and risk factors were similar in women and men (CVD risk score: 30.7% vs. 35.2% [difference (95% CI): -4.5 (-5.1, -3.9)]; BP: 91.3% vs. 88.5% [2.8 (2.5, 3.0)]; cholesterol: 69.9% vs. 71.0% [-1.1 (-1.5, -0.8)]; and smoking: 85.9% vs. 86.7% [-0.8 (-1.1, -0.5)]). The pooled, adjusted likelihood of having the risk score, BP and cholesterol assessments were comparable between women and men: OR (95% CI): 0.87 (0.70, 1.07); 1.41 (0.89, 2.25); and 1.15 (0.82, 1.60), respectively. However, women were 32% less likely to be assessed for smoking (0.68 [0.47, 1.00]). There was substantial heterogeneity between studies and the risk of publication bias was moderate.

Conclusion Despite the guideline recommendations, assessment of CVD risk score in primary health care was low in both sexes. Further, women were less likely to be assessed for their smoking status than men, whereas no sex discrepancies were found for BP and cholesterol assessments.

Keywords Sex • Cardiovascular factor assessment • Cardiovascular score assessment • Primary health care • Systematic review

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Introduction

Cardiovascular disease (CVD) is the leading cause of death globally for both women and men [1]. In 2015, the World Health Organisation (WHO) estimated that 17.7 million, or 31%, of all deaths were due to CVD, of which 8.8 million were due to coronary heart disease and 6.2 million were due to stroke [1,2]. An estimated 80–90% of premature CVDs are preventable by controlling modifiable risk factors such as high blood pressure (BP), high cholesterol, diabetes, in addition to not smoking, maintaining a healthy diet, and regular physical activity [3,4]. Therapeutic interventions are recommended in those at high risk for CVD [5,6].

To identify high-risk individuals and target therapeutic interventions in individuals without prior CVD, CVD guidelines in primary health care recommend regular assessment of an individual's 10-year risk [5–8]. Guidelines recommend that this risk should be estimated using prediction models, including the Pooled Cohorts Equation in the United States, Systemic Coronary Risk Estimation (SCORE) in Europe, QRISK2 in England and Wales, and absolute CVD risk assessment using the Framingham Risk Equation in Australia, that includes assessment of traditional risk factors including age, sex, smoking, blood pressure, and lipids [5–8]. Cardiovascular risk scores help physicians to make more appropriate clinical decisions and increases patients' awareness of their own risk [9]. Moreover, patients' awareness of their own risk can enhance their medication adherent behaviour, which may help prevent CVD [10]. Current cardiovascular guidelines generally recommend that clinical decisions for preventive care should be based upon an individual's risk of getting a CVD within the next 10 years [6,7].

Traditionally, there has been a misconception that CVD is a male dominated disease, although, ample evidence now shows that CVD affects women as much as, if not more, than men [1,11,12]. However, perhaps due to this misconception, doctors in emergency departments are significantly less likely to identify coronary artery disease as a cause of chest pain and to recommend diagnostic tests to women than men [13,14]. Likewise, in primary health care, physicians are more likely to underestimate the risk in women, compared to men with a similar risk profile [15]. Guidelines, however, recommend the assessment of CVD risk in both women and men.

We conducted a systematic review with meta-analysis to assess whether CVD risk score assessment, or that of individual risk factors, are equally provided to women and men in primary health care service.

Methods

This study was registered in the International prospective register of systematic reviews (PROSPERO) Registry (Registration number: CRD42017068423). The Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines were used [16].

Search Strategy

Medline and EMBASE databases were systematically searched on 31 January 2017 using search terms regarding sex, primary care and assessment of CVD risk scores or individual CVD risk factors (total cholesterol, high-density lipoprotein cholesterol, systolic BP, and smoking status) (Appendix 1). The studies found were imported into a reference management system (Endnote X7) and duplicates were removed.

Study Selection Criteria

Randomised controlled trials and observational studies conducted in a routine primary health care setting including adult women and men were included. As the gender comparison was not the aim of the randomised controlled trials, when the data were reported for both women and men, they were treated as observational data and pooled together with other data from observational studies. Studies needed to report the sex-specific number or rate, or the odds ratio (OR) comparing the sexes, for the assessment of a CVD risk score or individual risk factors. Studies that have not reported the quantitative difference but only described the difference in risk factors in text form were also included for synthesis outside the meta-analysis. While our primary interest was CVD screening among the general population, we also included studies of patients with diabetes or hypertension due to their high CVD risk. Single-sex studies that could not report relative sex difference in the assessment of the risk score/risk factors, studies with less than 1,000 participants, and studies conducted in a population with prior CVD were excluded. There was no restriction on language. Where duplicate reports of the same study were found, the most recent study was included. Reference lists of the included studies were screened to find possibly relevant studies. If only the abstract was available, the data were not included, however, if the full manuscript was published during the screening period, the study data included in the manuscript were used.

The screening of studies was split between two reviewers (KH and EM), each of whom extracted data. To harmonise the methods of screening, both reviewers independently screened the title and abstract of a randomly selected 1,000 studies and their acceptance/rejection decisions were compared. Discrepancies were discussed and solved with other authors.

Data Extraction

Data were independently extracted by KH and EM and entered into a purpose-built database. The extracted data included the study details (authors' names, aim, study design, study population, year of recruitment, and country/region of recruitment), CVD risk factors assessed, and the reported number, rate or the odds ratio (OR) of the assessment of the risk score or the risk factors, by sex.

Assessment of Risk of Bias

A modified Newcastle-Ottawa Quality Assessment Scale for cohort studies was applied to assess bias [17]. According to

that scale, the categories assessed were Selection (three items), Comparability (one item) and Outcome (one item). Studies were awarded one star for each item of assessment within the Selection and Outcome domains, and a maximum of two stars for the one Comparability item. Good quality was defined as having three stars (*) in the Selection domain, one or two stars in the Comparability domain and one star in the Outcome domain. Fair quality was defined as two stars in the Selection domain, one or two stars in the Comparability domain and one star in the Outcome domain. Poor quality was defined as zero or one star in the Selection domain, and zero stars in both the Comparability and the Outcome domains.

Outcomes

The primary outcome was the assessment of a validated CVD risk score or a combination of multiple risk factors. If a study reported on the assessment of more than one risk score, then the more widely used risk score was extracted. For example, Delpech et al. reported the use of SCORE and French scales, and as SCORE is the CVD risk assessment scale recommended by the European guidelines, we extracted SCORE only [6,18]. Secondary outcomes were summary measures of systolic BP, cholesterol (total cholesterol and/or high-density lipoprotein cholesterol) and smoking status, based on the components to calculate the Framingham risk score.

Statistical Analysis

Of the 27 studies, 22 studies reported, for both sexes, either unadjusted results, as the number of people included and the rate of assessment of CVD risk scores/risk factors, and/or adjusted results, as ORs and 95% confidence intervals (CIs). Where only unadjusted results were reported, the women to men prevalence ratio (PR) and the corresponding 95% CI was estimated from the rate and the sample size. For the studies that have reported the adjusted results, the variables that have been adjusted for each outcome in each study were listed in the appendix (Appendix 2). For studies that reported stratified results, e.g. by age group, PRs and the 95% CIs in each stratum were summarised using a fixed effect model to obtain one PR and corresponding 95% CI per study. One study included patients of all ages, with the reported outcomes stratified by age. To limit the results to those for adults, we summarised the information from age groups ≥18 years only [19]. Where more than two studies were pooled together, I^2 was used to quantify heterogeneity, and Cochran's Q test was used to test for heterogeneity ($p < 0.1$ was considered statistically significant for the Q test). In case of heterogeneity, if it cannot be explained, the random effects model can be used with the assumption that the effect of each study was different and to deal with possible heterogeneity [20]. Therefore, random effects meta-analyses with inverse variance weighting were performed separately for the unadjusted results and the adjusted results to obtain the pooled estimates of PR and OR (with 95% CIs), respectively. The five studies that that did not report sufficient data to be pooled with other studies but reported the difference in the assessment of risk score/risk factors, were summarised in text form according to available data. Publication bias was assessed using funnel plots and tested using Egger's test. All analyses were performed using Stata version 13.1 (Stata Corporation, College Station, TX, USA).

Results

Of 14,928 studies identified from the initial search, 494 full-text studies were screened. In total, 27 studies met the eligibility criteria, and 22 reported sufficient data to be included in the meta-analyses for quantitative assessment (Figure 1). Characteristics of the studies are shown in Table 1. Three studies reported data exclusively on diabetic patients [19,21,22] and two studies reported on hypertensive patients [23,24]. All but one were observational studies; the other involved baseline data from a randomised clinical trial [25]. The majority of the studies were from Europe (18 of 27), with nine conducted within the United Kingdom. Overall, data from 4,754,782 (51% women) patients were included in the meta-analyses.

CVD Risk Score

Five studies, including 99,443 patients, reported the sex-specific rate of assessment of a CVD risk score (Appendix 3) [26–30]. Cardiovascular disease risk score was assessed in 30.7% women and 35.2% men (difference (95% CI): -4.5 (-5.1, -3.9)). The pooled unadjusted results suggested that women were 13% less likely to have a CVD risk score recorded than men: PR 0.87 (95% CI: 0.78, 0.96). The pooled adjusted OR was identical to the unadjusted PR but was not statistically significantly different from unity: OR 0.87 (0.70, 1.07) (Figure 2). There was substantial heterogeneity between studies ($I^2_{Unadjusted} = 95.6\%$ [$p < 0.001$] and $I^2_{Adjusted} = 89.2\%$ [$p < 0.001$]).

Blood Pressure Assessment

Twelve (12) studies, with data from 3,996,688 patients, reported on BP assessment (Appendix 3) [19,21,25,26,28,31–37]. Blood pressure was assessed in 91.3% of women and 88.5% of men (difference (95% CI): 2.8 (2.5, 3.0)). The pooled unadjusted PR showed that women were 10% more likely to be screened for BP than men; PR 1.10 (1.07, 1.13). The pooled adjusted OR was directionally similar but found no statistical difference between women and men: OR 1.41 (0.89, 2.25) (Figure 3). There was considerable heterogeneity between studies ($I^2_{Unadjusted} = 99.9\%$ ($p < 0.001$) and $I^2_{Adjusted} = 96.8\%$ ($p < 0.001$)).

Cholesterol Assessment

Fourteen (14) studies, including 4,580,468 patients, reported on the sex-specific assessment of cholesterol (Appendix 3) [19,21–24,26,28,31,33,34,36–39]. Cholesterol levels were assessed in 69.9% of women and 71.0% of men (difference (95% CI): 1.1 (-1.5, -0.8)), with no evidence for sex difference in either the unadjusted or adjusted results: PR 1.01 (0.95, 1.07) and OR 1.15 (0.82, 1.60), respectively (Figure 4). There was

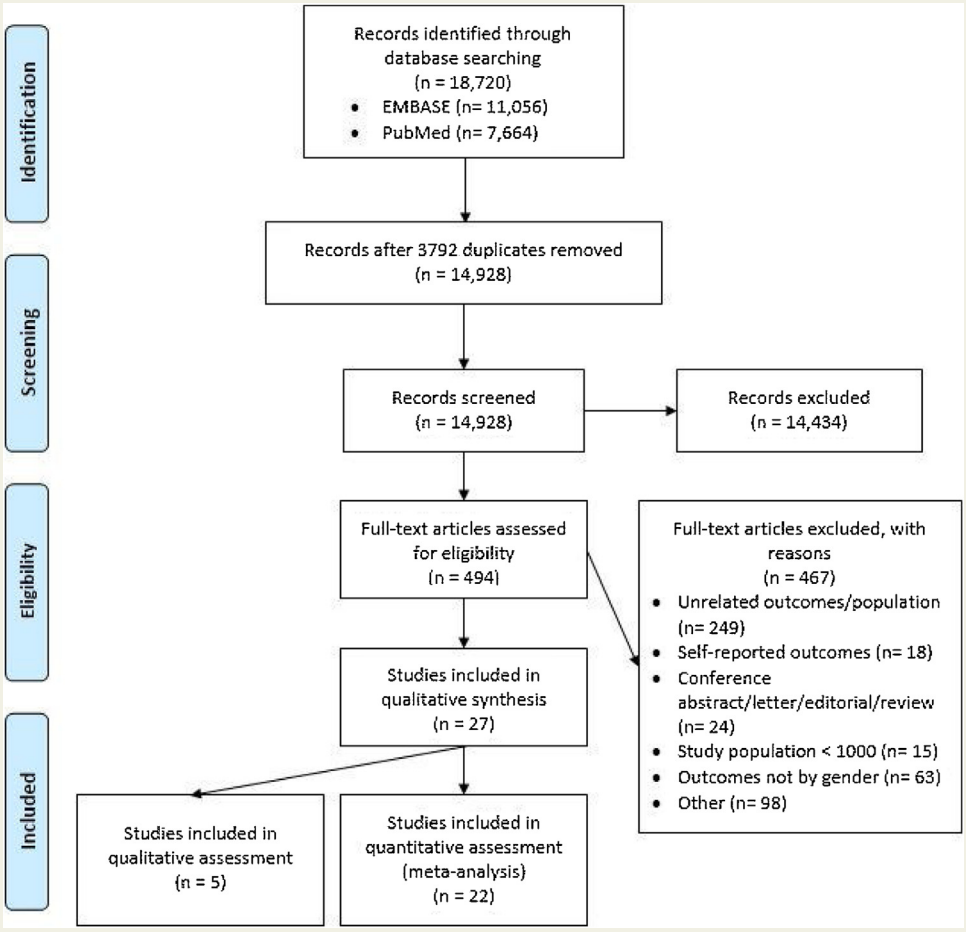

Figure 1 Flowchart of study selection.

significant heterogeneity between the studies ($I^2_{Unadjusted}$ = 99.9% ($p < 0.001$) and $I^2_{Adjusted}$ = 99.4% ($p < 0.001$)).

Smoking Status

The assessment of smoking status, by sex, was reported in 14 studies including 4,007,550 patients (Appendix 3) [19,21,22,24,26,28,31–34,36,37,40,41]; and 85.9% of women and 86.7% of men (difference (95% CI): -0.8 (-1.1, -0.5)) were assessed for smoking status. The pooled unadjusted PR suggested that the assessment of smoking status was comparable between women and men: PR 0.99 (0.97, 1.02). However, the pooled adjusted OR provided evidence of lower assessment rates in women than men by 32%: OR 0.68 (0.47, 1.00); $p = 0.049$) (Figure 5). There was, again, substantial heterogeneity between studies ($I^2_{Unadjusted}$ = 99.9% ($p < 0.001$) and $I^2_{Adjusted}$ = 94.0% ($p < 0.001$)).

Additional Risk Factor Data Unable to Be Included in Meta-Analysis

Of the 27 studies, five did not report sufficient data to be included in the meta-analysis. Blood pressure assessment rate was compared in two of the studies, which showed that women were more likely to receive BP assessment than men [42,43]. Women were more often assessed for cholesterol by about 10% [42–45]. Moreover, Van der Weijden et al. found that cholesterol assessment varied by age and was lower in women than men aged 18–64 years (41 vs. 59%), whereas, the assessment was higher in women than men aged ≥65 years (67 vs. 33%) [46]. Two studies reported that smoking status was less likely to be assessed in women than men, although the differences were small [42,43].

Risk of Bias

The risk of bias was moderate and the information on cohort selection, data collection, comparability of cohort and assessment of outcomes were clearly reported in most studies (Table 2). All studies included a representative sample and ascertained exposures and outcomes from primary health care data extractions. However, as most of these studies did not primarily aim to determine the difference in assessment of CVD risk factors between women and men, only 10 of the 27 studies were adjusted for covariates, two of which adjusted for a single factor. Moreover, there was no indication of publication bias (CVD risk score: $p = 0.625$; BP: $p = 0.824$; cholesterol: $p = 0.892$; and smoking status: $p = 0.192$) (Appendix 4).

Table 1 Description of studies included in the systematic review.

First author, year	Country	Year of data collection	Analysed sample size (% of women)	Age in years	Cohort	Reported assessment of risk factors or risk scores	Type of reported outcome	Adjusted for	Included in meta-analysis
Bartholomeeusen et al. [43], 2008	Belgium	1994-2003	139,148 (NR)	≥25	General patients	Cholesterol	Number and/or %	Unadjusted	No
Broomfield et al. [24], 2008	Canada	2003-04	1,539 (57%)	≥65	General patients	BP	Number and/or % and adjusted OR	Practice clustering	Yes
Brugulat et al. [41], 1998	Spain	1990-95	3,000 (NR)	≥15	General patients	BP, cholesterol and smoking status	Number and/or %	Unadjusted	No
Dalton et al. [30], 2011	United Kingdom	2003-09	21,510 (47%)	35-74	General patients without CVD or diabetes	BP, cholesterol and smoking status	Number and/or % for all three risk factors, and adjusted OR for BP and cholesterol only	*Patient level:* Ethnicity, age, sex and SES quintile *Practice level:* Nno. of FTE GPs, practice register size, practice register per FTE GP and indices of SES quintile of practice population *Interaction term*: Age and sex	Yes
Delpech et al. [25], 2016	France	2005-09	2,124 (59%)	40-74	General patients	BP, cholesterol, smoking status and CVD risk score	Number and/or % and adjusted OR	*Patient variables:* age, no. of consultations annually, duration of physician–patient relationship (years) and educational and SES level *Physician variables:* age, office location, mean duration of consultations (minutes) and mean no. of consultations weekly	Yes
Exeter et al. [37], 2015	New Zealand	2006-11	627,907 (54%)	≥25	General patients without CVD or diabetes.	Cholesterol	Number and/or % and unadjusted and adjusted OR	Sex, age, ethnicity and SES.	Yes

Table 1. (continued).

First author, year	Country	Year of data collection	Analysed sample size (% of women)	Age in years	Cohort	Reported assessment of risk factors or risk scores	Type of reported outcome	Adjusted for	Included in meta-analysis
Gu et al. [26], 2013	New Zealand	2007-12	10,863 (54%)	≥20	General Pacific Islander patients, but not indigenous.	CVD risk score	Number and/or %	Unadjusted	Yes
Hamilton et al. [39], 2016	England	2006-08	41,239 (55%)	≥15	General patients without coronary heart disease, stroke or transient ischaemic attack, hypertension, diabetes, chronic obstructive pulmonary disease, asthma, schizophrenia, bipolar affective disorder or other psychoses.	Smoking status	Number and/or %	Unadjusted	Yes
Hendricks et al. [20], 2015	Netherlands	1997-2013	No overall number but by year*	<75	Diabetic patients	SBP, cholesterol and smoking status	Number and/or %	Unadjusted	Yes
Hetlevik et al. [22], 1997	Norway	1993-94	2,468 (57%)	All ages	Hypertensive patients	Cholesterol	Number and/or %	Unadjusted	Yes
Hippisley-Cox et al. [31], 2004	England	NR (data extracted 1999)	29,492 (52%)	≥35	General patients	SBP and smoking status	Number and/or %	Unadjusted	Yes
Hippisley-Cox et al. [32], 2008a	United Kingdom	1995-2007	1,072,800 (51%)	35-74	General patients without diabetes, CVD or statin prescription	SBP, cholesterol and smoking status	Number and/or %	Unadjusted	Yes
Hippisley-Cox et al. [33], 2008b	England and Wales	1993-2008	2,285,815 (50%)	35-74	General patients without CVD or statin prescription	SBP, cholesterol and smoking status	Number and/or %	Unadjusted	Yes
Hyun et al. [27], 2017	Australia	2009-12	53,085 (58%)	Indigenous: ≥35 Non-	General patients	SBP, cholesterol, smoking status	Number and/or % and unadjusted and adjusted OR	Age, sex, Indigenous status, diabetes, overweight/obese,	Yes

Table 1. (continued).

First author, year	Country	Year of data collection	Analysed sample size (% of women)	Age in years	Cohort	Reported assessment of risk factors or risk scores	Type of reported outcome	Adjusted for	Included in meta-analysis
				Indigenous: ≥45		and CVD risk score		high BP, high total cholesterol, low HDL cholesterol, smoking status and practice clustering	
Journath et al. [23], 2008	Sweden	2002-05	6,537 (52%)	N/R	Treated hypertensive patients	Cholesterol and smoking status	Number and/or %	Unadjusted	Yes
Lang et al. [28], 2016	United Kingdom	2007-09	7,987 (52%)	50-74	General patients without CVD	CVD risk score	Adjusted OR only	Age, SES, practice SES, smoking status and practice clustering	Yes
Laverty et al. [34], 2010	United Kingdom	2006-07	36,407 (47%)	≥40	General patients without CVD	BP	Number and/or %	Age, sex, SES, ethnicity and practice clustering	Yes
Lugomirski et al. [44], 2013	Canada	1999-2005	10,968,715	≥20	General patients	Cholesterol	Number and/or %	Unadjusted	No
Peiris et al. [35], 2009	Australia	2005-08	1,165 (59%)	≥18	General Indigenous patients	BP, cholesterol and smoking status	Number and/or %	Unadjusted	Yes
Petri et al. [19], 2006	England	2002-03	5,980 (44%)	≥35	Diabetic patients	BP, cholesterol and smoking status	Number and/or %	Unadjusted	Yes
Rafi et al. [40], 2015	England	NR	21,403 (52%)	≥18	General patients	Smoking status	Number and/or %	Unadjusted	Yes
Rafter et al. [29], 2005	New Zealand	2000	25,384 (44%)	Men ≥45; women ≥55	General patients	CVD risk score	Number and/or %	Unadjusted	Yes
Rafter et al. [38], 2008	New Zealand	2001-03	1,680 (49%)	Men ≥35; women ≥45	General patients	Cholesterol	Number and/or %	Unadjusted	Yes
Rosell-Murphy et al. [36], 2015	Spain	2006-08	373,203 (NR)	≥16	General patients	BP, cholesterol and smoking status	Adjusted OR	*Patient level:* Age, number of visits, no. of health problems, dyslipidaemia, obesity, tobacco use and at-risk drinker *GP level:* Sex of GP, average no. of patients with health	Yes

Table 1. (continued).

First author, year	Country	Year of data collection	Analysed sample size (% of women)	Age in years	Cohort	Reported assessment of risk factors or risk scores	Type of reported outcome	Adjusted for	Included in meta-analysis
								problems and % of assigned patients visited *Primary healthcare level*: Region, rurality, average coverage and average % of patients aged ≥65	
Seculi et al. [42], 2003	Spain	1995-2000	5,875 (NR)	≥15	General patients	BP, cholesterol and smoking status	Number and/or %	Unadjusted	No
Van der Weijden et al. [45], 1996	Netherlands	1990-92	3,577 (54%)	≥18	General patients	Cholesterol	Number and/or %	Unadjusted	No
Wong et al. [21], 2012	China	2008-09	1,970 (55%)	N/R	Type 2 diabetic patients	Cholesterol and smoking status	Adjusted OR	Duration of diabetes	Yes

Abbreviations: NR, not reported; OR, odds ratio; BP, blood pressure; SBP, systolic blood pressure; CVD, cardiovascular disease; No., number; FTE, full-time equivalent; GP, general practitioner/practice; SES, socioeconomic status; and HDL, high-density lipoprotein.

*See Appendix 2.

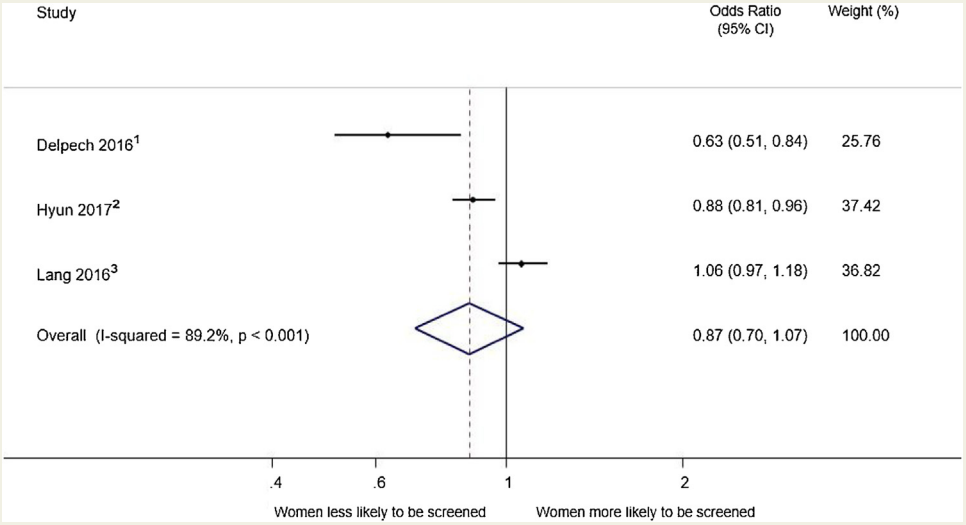

Figure 2 Meta-analysis of the adjusted effect of sex (women vs. men) on cardiovascular risk score assessment.
[1] Patient level: age, no. of consultations annually, duration of physician–patient relationship (years) and educational and SES level. Physician level: age, office location, mean duration of consultations (minutes) and mean no. of consultations weekly.
[2] Age, sex, Indigenous status, diabetes, overweight/obese, high BP, high total cholesterol, low HDL cholesterol, smoking status and practice clustering.
[3] Age, SES, practice SES, smoking status and practice clustering.
Abbreviations: BP, blood pressure; HDL, high density lipoprotein; SES, socioeconomic status.

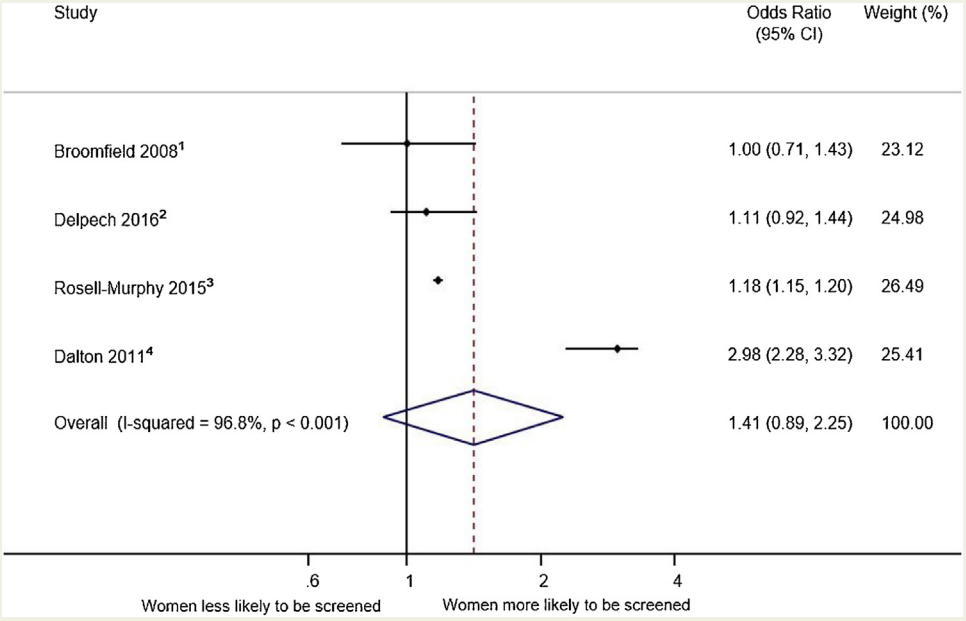

Figure 3 Meta-analysis of the adjusted effect of sex (women vs. men) on blood pressure assessment.
[1] Practice clustering.
[2] Patient level: age, no. of consultations annually, duration of physician–patient relationship (years) and educational and SES level. Physician level: age, office location, mean duration of consultations (minutes) and mean no. of consultations weekly.
[3] Patient level: age, number of visits, no. of health problems, dyslipidaemia, obesity, tobacco use and at-risk drinker. GP level: sex of GP, average no. of patients with health problems and % of assigned patients visited. Primary health care level: region, rurality, average coverage and average % of patients aged ≥65.
[4] Patient level: Ethnicity, age, sex and SES quintile. Practice level: No. of FTE GPs, practice register size, practice register per FTE GP and indices of SES quintile of practice population. Interaction term: Age and sex.
Abbreviations: GP, general practitioner/practice; SES, socioeconomic status; FTE, full-time equivalent.

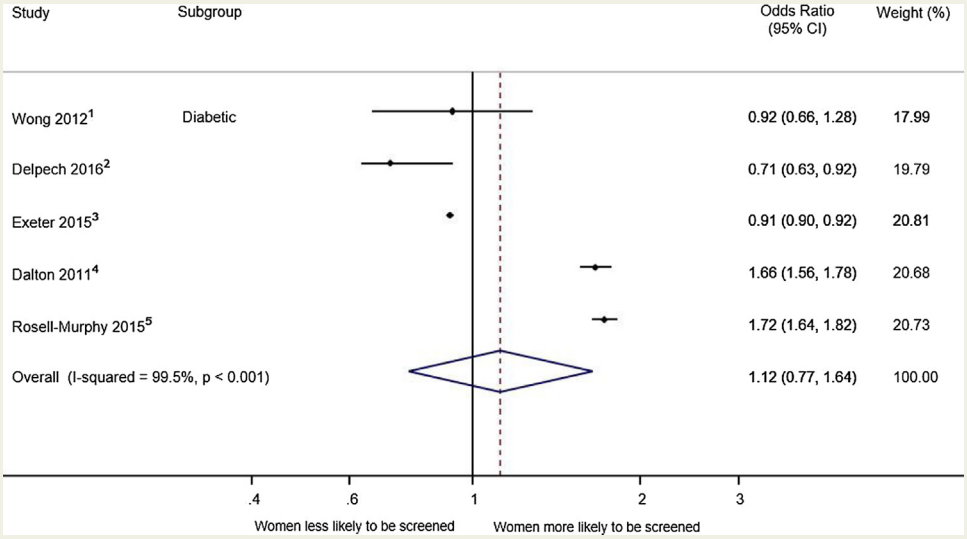

Figure 4 Meta-analysis of the adjusted effect of sex (women vs. men) on cholesterol assessment.
[1] Duration of diabetes.
[2] Patient level: age, no. of consultations annually, duration of physician–patient relationship (years) and educational and SES level. Physician level: age, office location, mean duration of consultations (minutes) and mean no. of consultations weekly.
[3] Age, sex, ethnicity and SES.
[4] Patient level: Ethnicity, age, sex and SES quintile. Practice level: No. of FTE GPs, practice register size, practice register per FTE GP and indices of SES quintile of practice population. Interaction term: Age and sex.
[5] Patient level: age, number of visits, no. of health problems, dyslipidaemia, obesity, tobacco use and at-risk drinker. GP level: sex of GP, average no. of patients with health problems and % of assigned patients visited. Primary health care level: region, rurality, average coverage and average % of patients aged ≥65.
Abbreviations: GP, general practitioner/practice; SES, socioeconomic status; FTE, full-time equalivalent.

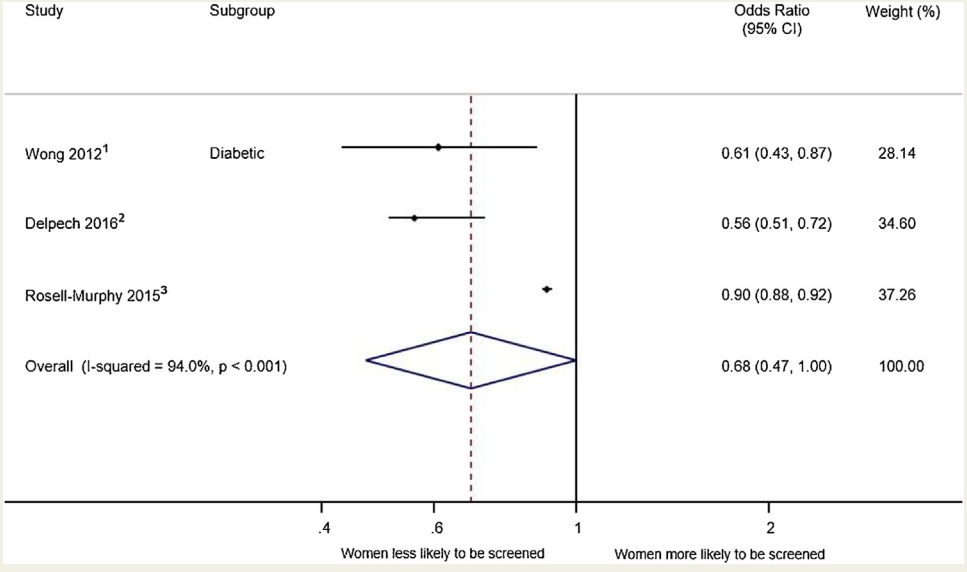

Figure 5 Meta-analysis of the adjusted effect of sex (women vs. men) on smoking status assessment.
[1] Duration of diabetes.
[2] Patient level: age, no. of consultations annually, duration of physician–patient relationship (years) and educational and SES level. Physician level: age, office location, mean duration of consultations (minutes) and mean no. of consultations weekly.
[3] Patient level: age, number of visits, no. of health problems, dyslipidaemia, obesity, tobacco use and at-risk drinker. GP level: sex of GP, average no. of patients with health problems and % of assigned patients visited. Primary health care level: region, rurality, average coverage and average % of patients aged ≥65.
Abbreviations: GP, general practitioner/practice; SES, socioeconomic status.

Table 2 Risk of bias.

First author, year	Selection (out of 3)	Comparability (out of 2)	Outcome (out of 1)	Quality of study
Broomfield et al., 2008	***	*	*	Good
Dalton et al., 2011	***	**	*	Good
Delpech et al., 2016	***	**	*	Good
Exeter et al., 2015	***	**	*	Good
Gu et al., 2013	***		*	Poor
Hamilton et al., 2016	***		*	Poor
Hendricks et al., 2015	***		*	Poor
Hetlevik et al., 1997	***		*	Poor
Hippisley-Cox et al., 2004	***		*	Poor
Hippisley-Cox et al., 2008a	***		*	Poor
Hippisley-Cox et al., 2008b	***		*	Poor
Hyun et al., 2017	***	**	*	Good
Journath et al., 2008	***		*	Poor
Lang et al., 2016	***	**	*	Good
Laverty et al., 2010	***	**	*	Good
Peiris et al., 2009	***		*	Poor
Petri et al., 2006	***		*	Poor
Rafi et al., 2013	***		*	Poor
Rafter et al., 2005	***		*	Poor
Rafter et al., 2008	***		*	Poor
Rosell-Murphy et al., 2015	***	**	*	Good
Wong et al., 2012	***	*	*	Good
Bartholomeeusen et al., 2008	***		*	Poor
Brugulat et al., 1998	***		*	Poor
Lugomirski et al., 2013	***		*	Poor
Seculi et al., 2003	***		*	Poor
van der Weijden et al., 1996	***		*	Poor

Newcastle-Ottawa quality assessment scale. Good quality: 3 stars (*) in selection domain, 1 or 2 stars in comparability domain and 1 star in outcome domain. Fair quality: 2 stars in selection domain, 1 or 2 stars in comparability domain and 1 star in outcome domain. Poor quality: 0 or 1 star in selection domain, 0 stars in comparability and outcome domains.

Discussion

This systematic review with meta-analysis including 27 studies and 4,754,782 patients compared the likelihood of CVD risk score or risk factor assessment among women and men in primary care. The assessments were conducted in only about a third of all patients, without differences between women and men. The assessments for BP and cholesterol were comparable between the sexes, but there was some indication that smoking status was less likely to be assessed in women than men.

Current cardiovascular guidelines widely recommend the use of CVD risk assessment scores to guide clinical decision making in both men and women. While the lifetime risk of CVD is similar in women and men, the risk is generally substantially lower in women than men up until around 85 years of age, which may lead to discrepancies in the utilisation of CVD risk assessment scores [47]. Data from a survey among 500 physicians in the US demonstrated that the likelihood of risk assessment was driven by actual risk level compared to perceived risk [15]. Moreover, sex differences in the prescription of preventive therapy were largely explained by physician's lower perceived risk of CVD in women, despite similar calculated risk for women versus men. In contrast, although we found that women were 13% less likely than men to have their CVD risk score assessed, these results were not statistically significant in the adjusted analyses. Nevertheless, while studies suggest that patients' risk perception through risk assessment increases the medical adherence, assessment of the risk score was low in both men and women, suggesting that improving physician assessment of the risk score may be an important educational target to improve the quality of preventive care and lower morbidity and mortality from CVD for both men and women [10].

Although the risk score assessment is the current paradigm in guiding treatment decisions in the primary prevention of CVD, its effect on clinical outcomes is uncertain. A recent

Cochrane review suggested that the risk scores had limited effects on CVD events, but may slightly reduce CVD risk factor levels and may increase preventive medication prescribing in individuals at high-risk, without evidence of harm [48]. However, multiple limitations and substantial study heterogeneity hampered definitive conclusions and new approaches may be needed to implement and evaluate CVD risk scores in primary CVD prevention. Computerised clinical support tools are a promising strategy to improve health care quality. Several electronic decision support tools have been developed to assist primary health care physicians to deliver equitable and guideline-recommended care [49,50]. A large cluster-randomised trial in Australia demonstrated that a computerised decision support system, combined with audit and feedback strategies, improved the assessment of CVD risk score, but did not increase medication prescription [49]. Digital applications are also increasingly available for patients to monitor their own risk of CVD, which may help to improve lifestyle behaviours and physician-patient communication [51,52]. Further studies are required to evaluate the effects of such digital interventions on the management of CVD risk score in both men and women.

This study provided some evidence for lower rates of smoking assessment in women than men. Globally, smoking is five times more prevalent in men than women, which may explain this discrepancy [53]. However, the prevalence of smoking is largely similar between men and women in high-income countries, where all the studies were based. A meta-analysis found that smoking has 25% greater effect on the risk of coronary heart disease amongst women than men [54]. Therefore, it is important that women receive screening and advice regarding smoking to at least the same extent as men.

Of all the studies included in this review, four reported the assessment of other risk factors, including body mass index, diabetes, fasting blood glucose and family history of CVD, by sex [22,26,31,45]. Dalton et al. found that women were less likely to be assessed for BMI than men (68% vs. 79%), whereas, Wong et al. reported that the BMI assessment rate was not significantly different between women and men [22,31]. Lugomirski et al. found that, along with cholesterol assessment, women were more likely to be assessed for fasting blood glucose (66% vs. 54%, $p < 0.001$), although, Delpech et al. found the opposite, where women were less likely to be assessed than men (45% vs. 49%, $p = 0.020$) [26,45]. Delpech et al. also reported the assessment of family history of CVD but found no significant difference in the rate of the assessment between the sexes [26].

Sex-specific findings should be reported more routinely. In this comprehensive review, only 27 studies reported the sex difference in the assessment of CVD risk, of which only five reported the difference in the assessment of the risk score. Further, 18 of the 27 studies were based in Europe, and of these, nine studies were based in the United Kingdom. Further research is needed to explore the difference between women and men from various parts of the world.

The limitations of this study are inherent to its design and include variation between studies in study design, study duration, and the degree of adjustment for covariables; only nine of the 22 studies were adjusted for one or more factors. Moreover, despite our broad search, only 22 studies met the inclusion criteria and could be included in the meta-analyses. Sex-specific results for CVD risk assessment were generally not reported even when both women and men were included in the study. Further investigation is needed to assess the screening of other risk factors, including diabetes, obesity, depression and a sedentary lifestyle.

Conclusion

Equitable CVD risk score assessment was provided to women and men, however, the assessment rate for both sexes was low. Although marginal evidence of a sex difference was found in the assessment of smoking status, where women were 32% less likely to be assessed, both sexes received a comparable assessment of BP and cholesterol. Further studies and continuous effort are needed to find effective strategies to increase the rate of CVD risk score assessment and continue to provide an equal assessment to both women and men.

Declaration of Interests

The authors declare that there is no conflict of interest.

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Appendix A. Supplementary data

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