

Gender inequalities in cardiovascular risk factor assessment and management in primary healthcare

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1 **ABSTRACT**

2 **Objectives**

3 To quantify contemporary differences in cardiovascular disease (CVD) risk factor assessment and
4 management between women and men in Australian primary healthcare services.

5 **Methods**

6 Records of routinely attending patients were sampled from 60 Australian primary healthcare
7 services in 2012 for the Treatment of Cardiovascular Risk using Electronic Decision Support
8 (TORPEDO) study. Multivariable logistic regression models were used to compare the rate of CVD
9 risk factor assessment and recommended medication prescriptions, by gender.

10 **Results**

11 Of 53085 patients, 58% were female. Adjusting for demographic and clinical characteristics, women
12 were less likely to have sufficient risk factors measured for CVD risk assessment (odds ratio (95%
13 confidence interval): 0.88 (0.81, 0.96)). Amongst 13294 patients (47% women) in the CVD/high CVD
14 risk subgroup, the adjusted odds of prescription of guideline-recommended medications were
15 greater for women than men: 1.12 (1.01, 1.23). However, there was heterogeneity by age ($p < 0.001$),
16 women in the CVD/high CVD risk subgroup aged 35-54 years were less likely to be prescribed the
17 medications (0.63 (0.52, 0.77)), and women in the CVD/high CVD risk subgroup aged ≥ 65 years were
18 more likely to be prescribed the medications (1.34 (1.17, 1.54)) than their male counterparts.

19 **Conclusions**

20 Women attending primary healthcare services in Australia were less likely than men to have risk
21 factors measured and recorded such that absolute CVD risk can be assessed. For those with, or at
22 high risk of, CVD, the prescription of appropriate preventive medications was more frequent in older
23 women, but less frequent in younger women, compared to their male counterparts.

1 **KEY QUESTIONS**

2 **What is already known about this subject?**

3 Risk assessment and medication adherence have a positive impact on preventing and managing
4 cardiovascular disease (CVD), however, differences in CVD assessment and management between
5 women and men have been observed in countries such as the UK.

6 **What does this study add?**

7 In Australian primary healthcare services, women were less likely to be assessed for CVD risk factors
8 at primary healthcare services. Of those at high risk of CVD, younger women (35-54 years) were less
9 likely to be prescribed guideline-recommended medications than younger men (35-54 years),
10 whereas older women (≥ 65 years) were more likely to be prescribed guideline-recommended
11 medications than their counterparts.

12 **How might this impact on clinical practice?**

13 System level strategies are needed to improve the provision of CVD assessment and treatment to
14 minimise the gap between women and men.

1 INTRODUCTION

2 Despite decreasing mortality rates due to cardiovascular disease (CVD) in many countries, it remains
3 the leading cause of death worldwide for both women and men. (1, 2) Previously, CVD was assumed
4 to be more prevalent in men and therefore women tended to be less intensively treated. (3) To close
5 the treatment gap between women and men, the improvement of cardiovascular health in women
6 has been promoted through health initiatives and research. (4, 5) Yet, in Australia, as in the United
7 State and the United Kingdom (UK), (6, 7) women have a higher number of cardiovascular deaths per
8 year than men (23,755 vs. 21,867 deaths in 2012), (1) largely because they live longer. Women with
9 diabetes have over 40% greater excess risk of coronary heart disease (CHD) (8) and nearly 30%
10 higher relative risk for stroke compared to men with diabetes. (9) More research is needed to
11 uncover the reasons for these female disadvantages. One possibility is that women are less often
12 recognised as being prone to CVD than men, and are thus less likely to receive a timely diagnosis and
13 to receive appropriate treatment after a positive diagnosis.

14
15 There is evidence that risk assessments and medication adherence have a positive impact on
16 outcomes. (10, 11) Studies from countries outside Australia have found that women with CHD are
17 less likely than men to undergo risk factor assessments in primary healthcare. (12, 13) Some studies
18 have also shown that women with CHD are less likely to receive recommended medications than
19 men, (13, 14) although other studies have shown no gender differences. (15)

20
21 While differences in CVD assessment and management between women and men have been
22 observed in other countries, the extent to which this may be an issue in Australian primary
23 healthcare is unknown. We aimed to determine whether measurement of CVD risk factors and
24 guidelines recommended medication prescriptions varied between women and men in a large
25 Australian primary healthcare cohort.

METHODS

Study design and data

Baseline data from the Treatment of Cardiovascular Risk using Electronic Decision Support (TORPEDO) study were used for analysis. TORPEDO was a cluster randomised trial to test whether a computer-guided quality improvement intervention improved CVD risk management when compared with usual care. Full details of the study and the primary results of the trial have been published. (16) Although the data was extracted for a cluster randomised trial, only the baseline data were used in this observational study. In brief, Australian general practices (GPs) and Aboriginal Community Controlled Health Services (ACCHSs) were eligible to participate if there was exclusive use of an electronic health record that was compliant with study software to record risk factor information, pathology test results and prescribe medications.

The total TORPEDO cohort included Aboriginal and Torres Strait Islander people aged ≥ 35 years and others aged ≥ 45 years (no upper age limit) from 40 GPs and 20 ACCHSs across New South Wales and Queensland. These age criteria were based on Australian guideline recommendations for conducting a CVD risk assessment. (10) To be eligible for inclusion patients had to be regular attendees of the service. The definition of a regular attendee was based on Australian general practice standards and includes at least 3 attendances in the previous 24 months and at least one attendance in the previous 6 months. The average cluster size was 750 patients and 30% of the patients were at high CVD risk. CVD was defined as a recorded diagnosis of CHD, ischaemic stroke or peripheral vascular disease. High CVD risk was defined in a manner consistent with the definition in Australian guidelines where patients with any of the following are considered high risk of CVD: diabetes mellitus and age >60 years, diabetes mellitus and albuminuria, chronic kidney disease (stage 3B or worse), or extreme individual risk factor elevations: systolic BP ≥ 180 mmHg, diastolic BP ≥ 110 mmHg, total cholesterol >7.5 mmol [290 mg/dL], or a calculated 5-year CVD risk of $>15\%$ (based on the Framingham Risk equation). (10, 17)

Deidentified data were extracted between September 2011 and May 2012 for all patients who met these criteria. Data extraction was performed using a validated extraction tool at randomisation. (18) The study was approved by the University of Sydney Human Research Ethics Committee and the Aboriginal Health and Medical Research Council of New South Wales Human Research Ethics Committee. Individual consent waiver was granted, given that data collection was based on deidentified extracts from the electronic health record system.

Outcomes

Two outcomes were analysed. First, for patients in the total cohort, we analysed the rate of having recorded risk factor information sufficient for guideline-recommended absolute CVD risk assessment. Second, in the CVD/high CVD risk subgroup, we analysed the rate of optimal guideline-recommended preventive medication prescriptions. Based on the components of the Framingham risk score, sufficient assessment of risk factors for CVD risk assessment was defined as having recorded smoking status at least once, systolic blood pressure (BP) in the previous 12 months, total cholesterol and high density lipoprotein (HDL) cholesterol in the previous 24 months. (17) Optimal prescriptions of recommended medication were defined as a current prescription for at least one BP-lowering drug and a statin for people at high risk without established CVD, or at least one BP-lowering drug, a statin and an antiplatelet agent (unless contraindicated by oral anticoagulant use) for people with a recorded diagnosis of CVD. (10)

Statistical analyses

Missing data were not imputed for these analyses. Assessment of individual risk factors or prescription of individual medications were defined as having a record; if the value was missing, this was considered as having had no assessment or prescription. Baseline characteristics and prescription of medications to women and men were compared using chi-squared tests for categorical variables and t-tests for continuous variables. Assessment of individual risk factors were compared between gender and age groups using chi-squared tests. The definition for sufficient assessment of CVD risk factors were: having recorded smoking status at least once, systolic blood

pressure in the previous 12 months, total cholesterol and high density lipoprotein cholesterol in the previous 24 months. (17) Although body mass index and fasting glucose are not included in the Framingham risk score, and therefore not included in the definition for sufficient assessment of CVD risk factors, since they are also important risk factors for CVD we analysed these variables also. Multiple-adjusted generalised estimating equation (to account for the clustering by healthcare provider) logistic regression models with an exchangeable working correlation matrix were used for each of the outcomes to estimate the odds ratios (ORs) and the corresponding 95% confidence intervals (CIs) for women vs. men. For both outcomes, independent predictors included in the models were: gender (women vs. men), age groups (35-54 years, 55-64 years, ≥ 65 years), Aboriginal/Torres Strait Islander status, diabetes status, overweight/obese ($\text{BMI} \geq 25 \text{ kg/m}^2$ vs. not), high BP (systolic BP $\geq 140 \text{ mmHg}$ /diastolic BP $\geq 90 \text{ mmHg}$ vs. not), high total cholesterol (total cholesterol $\geq 5.5 \text{ mmol}$ vs. not), low HDL cholesterol (HDL cholesterol $\leq 1 \text{ mmol}$ vs. not) and smoking status (current smokers vs. ex/never smokers). Moreover, the ORs and the corresponding 95% CIs for women versus men were derived for individual CVD risk factor assessments separately using the same model, but excluding covariates that are related to the outcomes. For example, if the odds of smoking assessment were being analysed, smoking status was excluded from the list of covariates. Similarly, the ORs and the corresponding 95% CIs for women versus men were derived for individual recommended medication prescriptions. The model predicting the measurement and recording of CVD risk factors was performed for the total cohort, while the analysis predicting the receipt of appropriate CVD medications was restricted to those in the CVD/high CVD risk subgroup. For each outcome, pre-defined subgroup analyses were performed by adding an interaction term between gender and the CVD risk factors (age groups, indigenous status, overweight/obese, high BP, high total cholesterol, low HDL cholesterol and current smoker status) to the multiple-adjusted logistic regression model. The covariates and the restrictions for the analyses of each outcome remained the same as above. The subgroup analyses for Aboriginal/Torres Strait Islander status were performed for those who were 45 or older only to keep the age groups consistent. Furthermore, the interaction

between gender and age groups for the two outcomes were also explored by Aboriginal/Torres Strait Islander status, using the same model. To explore the interaction between gender and age groups on prescription of each class of medication (blood pressure medication, statin and antiplatelet), multiple-adjusted generalised estimating equation logistic regression models were used. The covariates for these analyses were as listed above. Interaction was addressed by fitting age group as a continuous variable to produce a test for trend. Data were analysed using SAS 9.4 (SAS Institute Inc. Cary, North Carolina, USA).

RESULTS

Data on 53085 patients were extracted from 60 services at baseline; 30601 (58%) patients were women. Of the total cohort, 13294 (25%) were in the CVD/high CVD risk subgroup (6621 patients with prevalent CVD and 6673 at high CVD risk), 47% (n=6202) of whom were women.

Gender differences in the overall cohort

The mean age was 61 years for women and 60 years for men. Women had lower rates of recorded diabetes and of being a current smoker. Women also had a lower mean systolic BP and a higher mean total cholesterol (Table 1).

Table 1. Baseline comparison by gender

Variable	Total cohort				CVD/high CVD risk subgroup			
	Women 30601 (58%) n (%)	Men 22484 (42%) n (%)	Overall 53085 n (%)	P-value	Women 6202 (47%) n (%)	Men 7092 (53%) n (%)	Overall 13294 n (%)	P-value
Age, mean (SD)	61 (13.3)	60 (12.4)	61 (12.9)	<0.001	70 (13.1)	68 (12.0)	69 (12.6)	<0.001
Aboriginal and/or Torres Strait Islander	5411 (17.7)	4012 (17.8)	9423 (17.8)	0.63	1632 (26.3)	1412 (19.9)	3044 (22.9)	<0.001
Recorded diagnosis of diabetes	4392 (14.4)	4181 (18.6)	8573 (16.1)	<0.001	3264 (52.6)	3240 (45.7)	6504 (48.9)	<0.001
Systolic blood pressure, mean (SD)	128 (17.4)	131 (16.3)	130 (17.0)	<0.001	135 (20.7)	135 (18.6)	135 (19.6)	0.99
Total cholesterol, mean (SD)	5.1 (1.1)	4.8 (1.1)	5.0 (1.1)	<0.001	4.9 (1.5)	4.5 (1.3)	4.6 (1.4)	<0.001
High density lipoprotein cholesterol, mean (SD)	1.5 (0.4)	1.2 (0.3)	1.4 (0.4)	<0.001	1.4 (0.4)	1.2 (0.3)	1.3 (0.4)	<0.001
Current smoker	4817 (19.2)	4252 (22.2)	9069 (20.5)	<0.001	1054 (20.0)	1455 (22.9)	2509 (21.5)	<0.001
Blood pressure lowering prescription	13502 (44.1)	10968 (48.8)	24470 (46.1)	<0.001	4975 (80.2)	5538 (78.1)	10513 (79.1)	<0.001
Statin/other lipid lowering prescription	9575 (31.3)	8755 (38.9)	18330 (34.5)	<0.001	4184 (67.5)	4903 (69.1)	9087 (68.4)	0.04
Oral anticoagulant prescription	889 (2.9)	948 (4.2)	1837 (3.5)	<0.001	469 (7.6)	563 (7.9)	1032 (7.8)	0.42
Antiplatelet prescription	6014 (19.7)	6003 (26.7)	12017 (22.6)	<0.001	3312 (53.4)	4071 (57.4)	7383 (55.5)	<0.001
All essential CVD risk factors measured*	12669 (41.4)	10323 (45.9)	22992 (43.3)	<0.001	-	-	-	-
Recommended medications prescribed**	-	-	-	-	2909 (46.9)	3405 (48.0)	6314 (47.5)	0.20

n (%) if not otherwise stated

SD: standard deviation; CVD: cardiovascular disease

* Defined as having recorded smoking status at least once, systolic blood pressure (BP) in the previous 12 months, total cholesterol and high density lipoprotein cholesterol in the previous 24 months

** Defined as prescription for at least one BP- lowering drugs and a statin for people at high risk without established CVD, or at least one BP-lowering drugs, a statin and an antiplatelet agent (unless contraindicated by oral anticoagulant use) for people with a recorded diagnosis of CVD

1 Overall, only 43.3% of patients had all necessary CVD risk factors recorded for absolute risk
2 assessment. Compared to men, Wwomen were less likely to have ~~recorded all necessary~~the CVD risk
3 factors ~~recorded needed for absolute risk assessment compared to men~~ (41.4% vs. 45.9%, $p < 0.001$).
4 Women were significantly less likely to have smoking status, systolic BP, total cholesterol, HDL
5 cholesterol and BMI recorded compared to men (Table 2). Also, when the rates of risk factor
6 assessment were compared within age groups, where there were significant differences between
7 women and men, women were consistently less likely to have their risk measured than men (Table
8 2).

Table 2. Assessment of individual risk factors by gender and by age groups

Variable	Total cohort			35-54 years			55-64 years			≥65 years		
	Women 30601 (58%) n (%)	Men 22484 (42%) n (%)	P-value	Women 12045 (58%) n (%)	Men 8647 (42%) n (%)	P-value	Women 8168 (56%) n (%)	Men 6414 (44%) n (%)	P-value	Women 10374 (58%) n (%)	Men 7417 (42%) n (%)	P-value
Smoker	25096 (82.0)	19177 (85.3)	<0.001	10222 (84.9)	7568 (87.5)	<0.001	6764 (82.8)	5509 (85.9)	<0.001	8097 (78.1)	6097 (82.2)	<0.001
Systolic blood pressure	27231 (89.0)	20243 (90.0)	<0.001	10740 (89.2)	7750 (89.6)	0.29	7418 (90.8)	5881 (91.7)	0.07	9060 (87.3)	6608 (89.1)	<0.001
Total cholesterol	22966 (75.0)	17154 (76.3)	<0.001	8470 (70.3)	6116 (70.7)	0.52	6409 (78.5)	5088 (79.3)	0.21	8077 (77.9)	5949 (80.2)	<0.001
High density lipoprotein cholesterol	20651 (67.5)	15483 (68.9)	0.001	7262 (60.3)	5331 (61.7)	0.05	5948 (72.8)	4669 (72.8)	0.97	7433 (71.7)	5483 (73.9)	0.001
Body mass index	19501 (63.7)	15143 (67.4)	<0.001	7647 (63.5)	5842 (67.6)	<0.001	5238 (64.1)	4326 (67.4)	<0.001	6603 (63.6)	4972 (67.0)	<0.001
Fasting blood glucose	11735 (38.3)	8591 (38.2)	0.74	3917 (32.5)	2749 (31.8)	0.27	3346 (41.0)	2555 (39.8)	0.17	4471 (43.1)	3286 (44.3)	0.11

After adjustment, the odds of women having all necessary risk factors recorded for an absolute risk assessment was 12% lower compared to men (OR (95% CI): 0.88 (0.81-0.96)) (Figure 1). Taking the individual risk factors separately, the odds of having smoking status recorded was 22% lower (0.78 (0.66-0.91)), SBP recorded was 12% lower (0.88 (0.81-0.96)) and cholesterol (total and/or HDL cholesterol) recorded was 8% lower (0.92 (0.86-0.98)) in women than men. The only significant subgroup heterogeneity observed was in relation to total cholesterol ($p_{\text{interaction}}=0.02$), however, no gender difference was observed among individuals with high total cholesterol (Figure 1). As well as a lack of evidence for heterogeneity in the total cohort, no heterogeneity was found between age groups for both Aboriginal/Torres Strait Islanders and others ($p_{\text{interaction}}=0.49$ and 0.69, respectively). For age groups 35-54, 55-64 and 65 and older, the ORs (95% CIs) for all Aboriginal/Torres Strait Island people were 0.75 (0.63, 0.89), 0.72 (0.51, 1.02) and 1.05 (0.64, 1.72); and the corresponding results for others were 0.92 (0.81, 1.05), 0.87 (0.76, 0.99), and 0.94 (0.83, 1.05).

Gender differences in patients in the CVD/high CVD risk subgroup

Of the 13294 patients found to be in the CVD/high CVD risk subgroup, the mean age of women was 70 years and of men was 68 years (Table 1). The proportion of women and men who were prescribed recommended medications were similar (46.9% vs. 48.0%, $p=0.20$) but low overall, where only 47.5% of the patients in the CVD/high CVD risk subgroup received the prescriptions. When prescription of each class of medication was compared, women were less likely to be prescribed statin and antiplatelet, but slightly more likely to be prescribed BP-lowering medication compared to men (Table 3). Women in the youngest (35-54 years) age group were substantially less likely to be prescribed BP-lowering medication, statin and antiplatelet than men in the same age group (Table 3).

Table 3. Prescription of individual classes of medications to patients in the CVD/high CVD risk subgroup by gender and by age group

Variable	Total CVD/high CVD risk subgroup			35-54 years			55-64 years			≥ 65 years		
	Women 6202 (47%) n (%)	Men 7091 (53%) n (%)	P-value	Women 874 (44%) n (%)	Men 1107 (56%) n (%)	P-value	Women 1417 (43%) n (%)	Men 1887 (57%) n (%)	P-value	Women 3911 (49%) n (%)	Men 4097 (51%) n (%)	P-value
Blood pressure medication	4975 (80.2)	5538 (78.1)	0.003	578 (66.1)	789 (71.3)	0.01	1090 (76.9)	1426 (75.6)	0.37	3307 (84.6)	3323 (81.1)	<0.001
Statin	4088 (65.9)	4820 (68.0)	0.01	505 (57.8)	749 (67.7)	<0.001	986 (69.6)	1293 (68.5)	0.51	2597 (66.4)	2778 (67.8)	0.18
Antiplatelet	3312 (53.4)	4071 (57.4)	<0.001	411 (47.0)	618 (55.8)	<0.001	701 (49.5)	1034 (54.8)	0.002	2200 (56.3)	2419 (59.0)	0.01
Anticoagulant	469 (7.6)	563 (7.9)	0.42	27 (3.1)	30 (2.7)	0.62	49 (3.5)	76 (4.0)	0.40	393 (10.0)	457 (11.2)	0.11

CVD: cardiovascular disease

After adjusting for covariates, the odds of women receiving recommended medication were greater by 12% than for men (OR (95% CI): 1.12 (1.01, 1.23)) (Figure 2). Significant heterogeneity was found between age groups (p for interaction <0.001), where younger women were substantially less likely to be prescribed recommended medications by 37% (0.63 (0.52, 0.77)) and older women were 34% more likely to be prescribed medications (1.34 (1.17, 1.54)) compared to men (Figure 2). Moreover, both Aboriginal/Torres Strait Island people and others showed lower odds of being prescribed recommended medication in younger women than younger men. For age groups 35-54, 55-64 and 65 and older the ORs (95% CIs) for all Aboriginal/Torres Strait Island people were 0.65 (0.53, 0.80), 1.30 (1.00, 1.69) and 1.23 (0.93, 1.62) ($p_{\text{interaction}}=0.01$); and the corresponding results for others were 0.60 (0.37, 0.96), 0.91 (0.76, 1.09), and 1.36 (1.18, 1.57) ($p_{\text{interaction}}=0.004$), respectively.

When examining individual classes of medication, women aged 35-54 years were less likely to be prescribed BP medication, statin and antiplatelet than their male peers (0.69 (0.54, 0.87), 0.65 (0.49, 0.87), and 0.73 (0.56, 0.96) respectively) (Figure 3). Furthermore, a positive trend of the odds of women receiving each medication compared to men by age group was observed for three of the four medication classes. Most especially, women in the youngest age group were less likely to be prescribed BP-lowering medication and statin, whereas women in the oldest age group were more likely to be prescribed BP-lowering medication and statin compared to their male counterparts.

Overall, prescription of recommended medications to overweight/obese women and men were comparable; however, of those who were not overweight/obese, women had 36% higher odds of being prescribed recommended medications than men ($p_{\text{interaction}}=0.02$) (Figure 2).

DISCUSSION

This study provides contemporary gender comparisons of CVD risk assessment and management provided by a sample of primary healthcare services in Australia. Our results show that overall proportion of patients who were assessed and treated were notably low, and women were less likely to have CVD risk factors measured than men. Although there was no evidence of heterogeneity by

age in risk factor measurement between the genders, there was such heterogeneity in treatment for patients in the CVD/high CVD risk subgroup. Our finding suggested that older women in the CVD/high CVD risk subgroup overall had greater odds of being prescribed recommended medications than men, while the converse was true for their younger counterparts.

Despite guidelines, including those of The Royal Australian College of General Practitioners (RACGP) and the National Vascular Disease Prevention Alliance, regarding screening for CVD risk factors, (10, 19, 20) inequality in CVD prevention through assessing risk factors remains between women and men. Our results are similar to those from a study from the UK where the likelihood of assessing smoking status, cholesterol, blood pressure and body mass index was 35% higher in men than in women. (13) Another UK study has found that men tended to have higher rates of comprehensive risk factor assessment than women (22% vs. 20%), although this difference was not statistically significant. (12) This gap may occur due to barriers at individual, social and system levels. (21) At individual and social levels, physicians may not be aware or familiar with the updated guidelines, or physicians and women may have the old misconception of CVD being a man's disease. (22) Further, the misconception of senior physicians may have been passed on to the younger generation of physicians, therefore where there are financial disincentives and time and resource constraints, women have been disadvantaged in receiving appropriate CVD risk factor assessment.

There are a number of study limitations that are noteworthy. First, the services recruited for the TORPEDO study did not represent a random sample of primary healthcare services in Australia. All of the general practices were located in urban areas of New South Wales and Queensland, whereas about 30% of Australian general practices are in rural or remote areas. Further, several services were teaching general practices and this may reflect a stronger commitment to improving health care quality compared to non-teaching practices. It is possible, therefore, that the gaps in care practices encountered in this study may potentially be even larger in the broader primary health care sector.

1 Second, the study population for the TORPEDO study was restricted to regular attendees of the
2 primary healthcare service. Regular attendees are commonly used in the denominator for quality
3 improvement indicators and for the purposes of the randomised trial it was important to define a
4 relatively stable population to test the effect of the intervention. However, this means that we are
5 unable to extrapolate the findings to infrequent attenders who may exhibit different demographic,
6 health and health care seeking characteristics. Third, we were unable to capture contraindications to
7 recommended medications (e.g., pregnancy, high bleeding risk and allergies or medication
8 intolerances). This could explain a small proportion of the treatment gaps encountered.

9
10 To overcome the misconceptions and barriers that may prevent gender equality in assessment and
11 management of CVD, some doctors, researchers and organisations from across the world have made
12 significant efforts to promote women's CVD health. Studies regarding CVD management for women
13 in the past decade have informed educational campaigns for greater attention to women's
14 cardiovascular health. (23) Programs such as Go Red for Women and The Women's Room are
15 examples of these initiatives. (4, 5) Despite such initiatives, our study found that younger women
16 with CVD/high risk of CVD between the ages of 35 and 54 were significantly less often prescribed
17 recommended medications than younger men with CVD/high risk of CVD. This is consistent with
18 previous studies reported from other countries. (13, 24) In contrast, older women with CVD/high risk
19 of CVD were more likely to be prescribed than older men with CVD/high risk of CVD, suggesting
20 possible presence of age stereotypes in medical management of CVD. This indicates that strategies
21 and incentives are needed at the system level, together with education of physicians and public
22 about this inequality at the individual and social level, to minimise the treatment gap between
23 women and men. For example, academic programs such as those of NPS MedicineWise can promote
24 better understanding and improved prescribing of medications; (25) health quality identification
25 system such as gender specific quality indicators may be incorporated into quality improvement
26 programs to support better assessment and treatment of patients; and targeted funding model such

as specific Medicare Benefits Schedule (MBS) re-imbursement for patients with CVD/high risk of CVD can provide financial incentives for physicians.

CONCLUSION

Despite guidelines recommending that risk factors should be assessed and managed in both sexes, inequalities remain. Women are not receiving equitable testing in Australian primary healthcare and, whilst women in general receive appropriate medications more often than do men, younger women with CVD/high risk of CVD are disadvantaged in terms of receipt of essential treatments to prevent CVD events. System-wide solutions to these problems-inequalities as well as the increase of the overall rates of assessment and management of CVD are needed.

STATEMENTS

Contributorship

KH, MW, JR and DP participated in the design of the study. KH performed the statistical analysis. KH, MW, JR, DP and AP participated in the interpretation of the results. KH drafted and all authors reviewed the manuscript. All authors read and approved the final manuscript.

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Competing interests

The author(s) declare(s) that they have no competing interests.

Ethics approval

The study was approved by the University of Sydney Human Research Ethics Committee and the Aboriginal Health and Medical Research Council of New South Wales Human Research Ethics Committee. Individual consent waiver was granted, given that data collection was based on deidentified extracts from the electronic health record system.

LIST OF ABBREVIATIONS

Abbreviations	Definitions
CVD	Cardiovascular disease
UK	United Kingdom
CHD	Coronary heart disease
TORPEDO	Treatment of Cardiovascular Risk using Electronic Decision Support Study
GP	General practice
ACCHS	Aboriginal Community Controlled Health Service
HDL	High density lipoprotein
BP	Blood pressure
OR	Odds ratio
CI	Confidence interval
BMI	Body mass index

REFERENCES

- 1 Nichols M, Peterson K, Alston L, et al. Australian heart disease statistics. Melbourne: National Heart Foundation of Australia, 2014.
- 2 Heron M. Deaths: Leading Causes for 2008. *Natl Vital Stat Rep.* 2012;60(6):1-94.
- 3 Lehto HR, Lehto S, Havulinna AS et al. Gender differences in the prevalence, causes and treatment of high cardiovascular risk: findings from the FINRISK Survey. *Eur J Prev Cardiol.* 2012;19(5):1153-1160.
- 4 National Heart Foundation of Australia. Go Red For Women [Website]. <http://www.goredforwomen.org.au> (accessed 18 Nov 2015).
- 5 British Heart Foundation. Women's Room [Website]. <https://www.bhf.org.uk/heart-health/living-with-a-heart-condition/womens-room> (accessed 11 Nov 2015).
- 6 American Heart Association. Women & Cardiovascular Diseases - Statistical Fact Sheet 2013 American Heart Association, 2013. https://www.heart.org/idc/groups/heart-public/@wcm/@sop/@smd/documents/downloadable/ucm_319576.pdf (accessed 11 Nov 2015).
- 7 Townsend N, Williams J, Bhatnagar P, et al. Cardiovascular disease statistics, 2014. London: British Heart Foundation, 2014.
- 8 Peters SE, Huxley R, Woodward M. Diabetes as risk factor for incident coronary heart disease in women compared with men: a systematic review and meta-analysis of 64 cohorts including 858,507 individuals and 28,203 coronary events. *Diabetologia.* 2014;57(8):1542-1551.
- 9 Peters SA, Huxley RR, Woodward M. Diabetes as a risk factor for stroke in women compared with men: a systematic review and meta-analysis of 64 cohorts, including 775,385 individuals and 12,539 strokes. *Lancet.* 2014;383(9933):1973-1980.
- 10 National Vascular Disease Prevention Alliance. Guidelines for the management of absolute cardiovascular disease risk. National Vascular Disease Prevention Alliance, 2012.
- 11 Wan Q, Harris MF, Zwar N, et al. Sharing risk management: an implementation model for cardiovascular absolute risk assessment and management in Australian general practice. *Int J Clin Pract.* 2008;62(6):905-911.
- 12 Carroll K, Majeed A, Firth C, et al. Prevalence and management of coronary heart disease in primary care: population-based cross-sectional study using a disease register. *Journal of public health medicine.* 2003;25(1):29-35.
- 13 Crilly M, Bundred P, Hu X et al. Gender differences in the clinical management of patients with angina pectoris: a cross-sectional survey in primary care. *BMC Health Serv Res.* 2007;7:142.
- 14 Cruz I, Serna C, Real J et al. Ischemic heart disease and primary care: identifying gender-related differences. An observational study. *BMC Fam Pract.* 2008;9:60.
- 15 Gu Y, Warren J, Walker N, et al. Gender differences in cardiovascular disease risk management for Pacific Islanders in primary care. *Qual Prim Care.* 2013;21(5):275-285.
- 16 Peiris D, Usherwood T, Panaretto K et al. Effect of a computer-guided, quality improvement program for cardiovascular disease risk management in primary health care: the treatment of

1 cardiovascular risk using electronic decision support cluster-randomized trial. *Circ Cardiovasc*
2 *Qual Outcomes*. 2015;8(1):87-95.

3 17 Anderson KM, Wilson PW, Odell PM, et al. An updated coronary risk profile. A statement for
4 health professionals. *Circulation*. 1991;83(1):356-62.

5 18 Peiris D, Agaliotis M, Patel B, et al. Validation of a general practice audit and data extraction tool.
6 *Aust Fam Physician*. 2013;42:816-819.

7 19 The Royal Australian College of General Practitioners. Putting prevention into practice. Guidelines
8 for the implementation of prevention in the general practice setting. Victoria: The Royal Australian
9 College of General Practitioners, 2006.

10 20 The Royal Australian College of General Practitioners. Guidelines for preventive activities in
11 general practice. East Melbourne: The Royal Australian College of General Practitioners, 2012.

12 21 Grol R, Grimshaw J. From best evidence to best practice: effective implementation of change in
13 patients' care. *Lancet*. 2003;362(9391):1225-1230.

14 22 Cabana MD, Kim C. Physician adherence to preventive cardiology guidelines for women. *Womens*
15 *Health Issues*. 2003;13(4):142-149.

16 23 Mosca L, Barrett-Connor E, Wenger NK. Sex/gender differences in cardiovascular disease
17 prevention: what a difference a decade makes. *Circulation*. 2011;124(19):2145-2154.

18 24 George J, Rapsomaniki E, Pujades-Rodriguez M et al. How Does Cardiovascular Disease First
19 Present in Women and Men? Incidence of 12 Cardiovascular Diseases in a Contemporary Cohort of
20 1,937,360 People. *Circulation*. 2015;132(14):1320-1328.

21 25 Gadzhanova SV, Roughead EE, Bartlett MJ. Improving cardiovascular disease management in
22 Australia: NPS MedicineWise. *MJA*. 2013;199(3):192-195.

FIGURES

Figure 1. Multiple-adjusted female to male odds ratios and 95% confidence intervals for the assessment of cardiovascular risk factors

CI: confidence interval; HDL: high density lipoprotein.

Indigenous: Aboriginal and/or Torres Strate Islander; overweight/obese: body mass index ≥ 25 kg/m²; high blood pressure: systolic blood pressure ≥ 140 mmHg and diastolic blood pressure ≥ 90 mmHg; high total cholesterol: total cholesterol ≥ 5.5 mmol; and low HDL cholesterol: HDL cholesterol ≤ 1 mmol.

Each variable in the figure is adjusted for all the others

Figure 2. Multiple-adjusted female to male odds ratios and 95% confidence intervals for guideline-recommended medication prescription amongst the patients in the cardiovascular disease/high cardiovascular risk subgroup

CI: confidence interval; HDL: high density lipoprotein.

Indigenous: Aboriginal and/or Torres Strate Islander; overweight/obese: body mass index ≥ 25 kg/m²; high blood pressure: systolic blood pressure ≥ 140 mmHg and diastolic blood pressure ≥ 90 mmHg; high total cholesterol: total cholesterol ≥ 5.5 mmol; and low HDL cholesterol: HDL cholesterol ≤ 1 mmol.

Each variable in the figure is adjusted for all the others

Figure 3. Multiple-adjusted female to male odds ratios and 95% confidence intervals for the prescription of blood pressure lowering medication, statin, antiplatelet and anticoagulant therapy amongst the patients in the cardiovascular disease/high cardiovascular risk subgroup, by age group

CI: confidence interval

Each variable in the figure is adjusted for age groups, Aboriginal/Torres Strait Islander status, diabetes status, overweight/obese, high blood pressure, high total cholesterol, low high density lipoprotein cholesterol and smoking status