Original research

Gender differences in use of invasive diagnostic and therapeutic procedures for acute ischaemic heart disease in Chinese adults

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ABSTRACT

Objective To investigate gender differences in the use of diagnostic and therapeutic procedures for acute ischaemic heart disease (IHD) in Chinese adults and assess whether socioeconomic or health system factors contribute to such differences.

Methods In 2004–2008, the China Kadoorie Biobank recruited 512 726 adults from 10 diverse areas in China. Data for 38 928 first hospitalisations with IHD (2911 acute myocardial infarction (AMI), 9817 angina and 26 200 other IHD) were obtained by electronic linkage to health insurance records until 31 December 2016. Multivariate Poisson regression models were used to estimate women-to-men rate ratios (RRs) of having cardiac enzyme tests, coronary angiography and coronary revascularisation.

Results Among the 38 928 individuals (61% women) with IHD admissions, women were less likely to have AMI (5% vs 12%), but more likely to have angina (26% vs 24%) or other IHD (69% vs 64%). For admissions with AMI, there were no differences in the use of cardiac enzymes between women and men (RR=1.00; 95% CI, 0.97 to 1.03), but women had lower use of coronary angiography (0.80, 0.68 to 0.93) and coronary revascularisation (0.85, 0.74 to 0.99). For angina, the corresponding RRs were: 0.97 (0.94 to 1.00), 0.66 (0.59 to 0.74) and 0.56 (0.47 to 0.67), respectively; while for other IHD, they were 0.97 (0.94 to 1.00), 0.87 (0.76 to 0.99) and 0.61 (0.51 to 0.73), respectively. Adjusting for socioeconomic and health system factors did not significantly alter the women-to-men RRs.

Conclusions Among Chinese adults hospitalised with acute IHD, women were less likely than men to have coronary angiography and revascularisation, but socioeconomic and health system factors did not contribute to these differences.

INTRODUCTION

Ischaemic heart disease (IHD) is a leading cause of premature death in China, accounting for >1.6 million deaths in 2016.[1] Previous studies have reported a lower incidence of acute coronary syndrome (ACS) in women compared with men, but women have a higher case fatality rate following ACS than men.[2 3] In addition to differences in disease severity, differences in the use of invasive diagnostic and therapeutic procedures for acute IHD could also contribute to differences in the prognosis of acute IHD between men and women.[2] Women experience longer delays in access to hospital care and are less likely than men to have invasive diagnostic procedures,[3 4] but the reasons for such differences in the clinical management of acute IHD remain unexplained.

In recent decades, access to diagnostic and therapeutic procedures for acute IHD have improved substantially in low-income and middle-income countries. In China, the healthcare system has undergone major reforms, with substantial investment in hospitals, improvement in education of health professionals and medical equipment, and better access to hospital care for lower socioeconomic groups.[5 6] Nevertheless, out-of-pocket (OOP) expenses as percentage of total healthcare expenditure have remained high in China,[7] and women remain less likely to use inpatient care and more likely to defer use of healthcare until urgent for economic reasons.[8–10]

Previous studies examined differences in the use of invasive diagnostic tests and procedures for ACS between men and women in China, but were constrained by restriction to tertiary hospitals, lack of longitudinal data, and failure to investigate the effects of socioeconomic or health system factors.[11 12] The aims of the present study were: (1) to examine differences in the use of invasive diagnostic and therapeutic procedures for acute myocardial infarction (AMI), angina and other IHD in Chinese men and women; and (2) to investigate the extent to which socioeconomic or health system factors could explain such differences.

METHODS

Study population

The China Kadoorie Biobank (CKB) is a prospective study of 512 726 adults, aged 30–79 years at entry, who were recruited from five urban and five rural areas in China between 25 June 2004 and 15 July 2008.[13 14] All participants completed an interviewer-administered questionnaire, providing detailed information on demographic and socioeconomic characteristics, medical history, and lifestyle factors. Physical measurements were also recorded.

Socioeconomic and health system factors

Socioeconomic factors, collected at entry into the study (2004–2008), included marital status, household size, highest level of education attained and annual household income. Health insurance (HI) types at admission were categorised into Urban Employee Basic Medical Insurance (UEBMI), Urban Resident Basic Medical Insurance (URBMI) or New Rural Cooperative Medical Scheme (NRCMS), and uninsured or others. Hospitals were classified as tier 3 (≥500 beds), tier 2 (100–500 beds), tier 1 (<100 beds) hospitals, and hospitals with unspecified or missing tier (online supplemental appendix p4–5).

Hospital admissions for IHD

Data on hospital admissions for acute IHD were obtained by linkage via the unique national identification number to electronic hospital records from the nationwide health insurance system and to regional IHD registers. Diagnoses of acute IHD, recorded during hospital admissions, were reviewed, integrated centrally and standardised using the International Classification of Diseases 10th revision (ICD-10) codes. Hospital admissions for AMI, angina pectoris and other IHD were identified using ICD-10 codes I21, I20 and I22–I25, respectively. Admissions for other IHD involved mostly cases with non-specific atherosclerotic heart diseases (I25.1, 92%). The present analyses were restricted to participants' first hospitalisations for acute IHD recorded during the study in any hospital between 25 June 2004 and 31 December 2016.

Outcome measures

Primary outcomes compared use of non-invasive cardiac enzyme tests with invasive diagnostic procedures (coronary angiography during the first acute IHD admission after entry into the study) and invasive therapeutic procedures (coronary revascularisation within 3 months of admission for acute IHD). Cardiac enzyme tests included creatine kinase-MB or troponins, and coronary revascularisation procedures chiefly involved percutaneous coronary intervention (PCI) (few participants had coronary artery bypass graft operations). The secondary outcomes included ECG, echocardiogram, Holter monitor tests and coronary CT angiography (CCTA).

Data on coronary revascularisation procedures were obtained from HI records, supplemented by retrieved medical records. Data on cardiac enzyme tests, coronary angiography and secondary outcomes were obtained from retrieved medical records for 24 408 IHD cases that underwent clinical adjudication by certified cardiologists in China (online supplemental appendix p5).

Patient and public involvement

Prior to recruitment in CKB, local community leaders in China were consulted. The study findings are reported in peer-reviewed publications and any relevant public health messages disseminated using local press, television and internet.

Statistical analysis

All analyses were performed separately for AMI, angina and other IHD. Missing values for length of hospital stay (6% of IHD cases) were imputed using multiple imputation (online supplemental appendix p6). The women-to-men (ie, men as the reference group) rate ratios (RRs) of having a diagnostic test or procedure were estimated using Poisson regression with robust variance estimation to minimise overestimation of variance for binary data.[15] Goodness-of-fit statistics confirmed model adequacy. Age-adjusted and region-adjusted rates of having a diagnostic test or procedure per 100 admissions were estimated in men and women, by age group (<55 years, 55–65 years and ≥65 years old). Models were sequentially adjusted for demographic, lifestyle and morbidity risk factors, followed by HI type, socioeconomic factors and hospital tier. For tests and procedures with statistically significant women-to-men RRs, effect modification by socioeconomic and health system factors was assessed by adding interaction terms to the Poisson regression models. Heterogeneity or trends in women-to-men RRs of having diagnostic tests or procedures were assessed using X^2 tests by categories of selected factors.

Sensitivity analyses included analyses of use of tests and procedures for ST-segment elevation MI (STEMI) and non-STEMI (NSTEMI) in a subsample of AMI admissions with retrieved medical records (60%); first-ever AMI, angina and other IHD (ie, excluding participants with previous cardiovascular disease (CVD)); and stratified by region. Further analyses estimated women-to-men RRs by categories of established IHD risk factors, and 28-day case fatality rates. All analyses were performed using Stata V.15 or R V.3.6.0.

RESULTS

Between 2004 and 2016, 38 928 participants (61% women) were admitted to hospital with a first episode of IHD, including 2911 (8%) with AMI, 9817 with angina (25%) and 26 200 (67%) with other IHD (table 1). Compared with men, women were less likely to be admitted with AMI (5% vs 12% of respective admissions), but more likely to be admitted with angina (26% vs 24%) and other IHD (69% vs 64%). Women admitted with AMI were older than men at baseline (mean age 61.7 vs 58.7 years), and at admission to hospital (67.8 vs 64.7: table 1). Compared with men, women with AMI had a higher prevalence of diabetes, overweight or obesity, self-rated poor health status, mental illness, and higher mean systolic blood pressure and lower physical activity levels at baseline and a lower prevalence of prior stroke or transient ischaemic attack, or being a current smoker or drinker. Women were less likely to be married (77.6% vs 94.5%), have completed high school or above (14.1% vs 30.1%), have an annual household income above ¥20 000 (32.6% vs 47.2%), live in urban areas (60.9% vs 64.4%) and be enrolled in the UEBMI scheme (51.0% vs 62.8%).

Differences in baseline characteristics between men and women admitted with angina or other IHD were similar, although less extreme than those for AMI (table 1). Women with AMI or other IHD were more likely than men to be admitted to smaller (tier 1) rather than larger (tier 3) hospitals (table 1). Duration of hospital stay did not differ by gender for AMI, angina and other IHD (mean: 10–11 days). Overall, the baseline characteristics of individuals with retrieved medical records (n=24 408) were comparable with those of all individuals with AMI, angina and other IHD (online supplemental table 1).

Use of diagnostic tests and procedures

Among AMI admissions, almost 95% had cardiac enzyme tests, with no material differences between men and women (figure 1). In contrast, after adjusting for age and region, among AMI cases, women had lower rates than men of coronary angiography (28% vs 35%) and coronary revascularisation (26% vs 33%). Likewise among cases with angina and other IHD, women had comparable rates with men of use of cardiac enzyme tests (72% vs 76% and 62% vs 65%, respectively), but much lower rates of coronary angiography (12% vs 20% and 8% vs 11%) and coronary revascularisation (6% vs 12% and 2% vs 4%). These differences in the use of invasive coronary investigations attenuated with increasing age (figure 1).

Following adjustment for all relevant factors, the women-to-men RRs of having cardiac enzyme tests, coronary angiography and

Table 1 Selected characteristics of men and women with hospital admission for acute MI, angina and other IHD during 2004–2016

	Acute MI			Angina			Other IHD		
	Men (n=1799)	Women (n=1112)	P value	Men (n=3626)	Women (n=6191)	P value	Men (n=9792)	Women (n=16 408)	P value
(A) Characteristics at baseline									
Age (years), mean (SD)	58.7 (10.1)	61.7 (9.2)	**	58.0 (10.2)	58.0 (9.5)		59.8 (10.1)	58.7 (9.6)	**
Self-reported medical history, %									
Diabetes†	14.8	25.1	**	12.6	13.2		11.6	13.1	**
Hypertension†	55.0	58.4		51.4	44.5	**	53.4	46.8	**
Stroke or TIA	6.7	3.7	**	5.1	3.6	**	6.0	3.8	**
IHD	11.4	13.3		16.4	19.7	**	14.5	14.6	
CKD	1.6	1.9		2.7	3.4		2.3	2.9	*
Poor health status	12.0	17.8	**	12.1	15.3	**	15.0	20.2	**
Mental illness‡	9.6	12.6	**	10.0	13.4	**	10.6	13.5	**
Physical measurements									
Overweight or obese (>25 kg/m²), %	43.5	47.8	*	47.3	49.2		40.2	46.9	**
SBP (mm Hg), mean (SD)	141.8 (22.4)	144.4 (24.6)	**	138.6 (20.9)	134.9 (23.3)	**	139.9 (21.8)	137.1 (23.8)	**
Lifestyle characteristics									
Current smoker, %	61.6	7.3	**	53.9	3.5	**	52.8	5.0	**
Regular alcohol drinker, %	40.2	3.3	**	46.5	5.1	**	42.9	4.8	**
Physical activity (MET—hour/day), mean (SD)	15.5 (13.4)	13.3 (9.0)	**	14.9 (11.8)	13.6 (8.6)	**	15.1 (12.9)	14.7 (9.6)	**
Socioeconomic characteristics									
Currently married, %	94.5	77.6	**	93.6	83.5	**	91.2	82.1	**
Household size, mean (SD)	3.5 (1.6)	3.5 (1.8)		3.4 (1.5)	3.2 (1.5)	**	3.5 (1.6)	3.4 (1.6)	**
High school or above, %	30.1	14.1	**	38.7	30.0	**	30.1	20.3	**
Annual household income ≥ ¥20 000, %	47.2	32.6	**	52.3	46.3	**	43.8	36.3	**
Rural residents, %	35.6	39.1		31.4	23.5	**	48.2	46.4	**
(B) Characteristics at hospital admission									
Age (years), mean (SD)	64.7 (10.0)	67.8 (9.1)	**	64.0 (10.1)	64.1 (9.3)		66.2 (10.2)	65.0 (9.8)	**
Health insurance type§, %			**			*			**
NRCMS or URBMI	36.0	48.1		29.8	28.2		44.7	48.1	
UEBMI	62.8	51.0		69.4	71.4		54.7	51.7	
Other or uninsured	1.2	0.9		0.7	0.5		0.6	0.3	
Hospital tier, %			**						**
Tier 1 or missing/unspecified	9.1	12.1		16.0	14.7		31.3	36.2	
Tier 2	15.3	17.4		18.7	18.8		19.3	18.8	
Tier 3	75.7	70.5		65.3	66.6		49.4	45.1	
Length of stay (days)¶, mean (SD)	10.9 (6.7)	10.8 (6.9)		10.0 (5.9)	10.3 (5.4)		9.9 (11.1)	9.8 (10.2)	

*P value of <0.05, **p value of <0.01.
†Self-reported and screen detected.
‡Mental illness was defined as having at least one symptom of depression or anxiety in the past 12 months.
§Data on health insurance (HI) types for each participant was identified annually in 2012–2016, but was unavailable for the years prior to 2012. Missing data on HI type in 2004–2011 were imputed based on the insurance scheme in which participants were enrolled in 2012.
¶Missing length of stay for 6% of all IHD admissions imputed using multiple imputation.
CKD, chronic kidney disease; IHD, ischaemic heart disease; MET, metabolic equivalents of task; MI, myocardial infarction; NRCMS, New Rural Cooperative Medical Scheme; SBP, systolic blood pressure; TIA, transient ischaemic attack; UEBMI, Urban Employee Basic Medical Insurance; URBMI, Urban Resident Basic Medical Insurance.

coronary revascularisation increased marginally for AMI, angina and other IHD. The attenuation in differences was mainly due to adjustment for age and region. Further adjustment for HI type, socioeconomic factors and hospital tier did not materially alter the women-to-men RRs of having cardiac enzyme tests, coronary angiography and coronary revascularisation. The fully adjusted RRs of having diagnostic tests and procedures for AMI were: 1.00 (95% CI 0.97 to 1.03) for cardiac enzyme tests, 0.80 (0.68 to 0.93) for coronary angiography and 0.85 (0.74 to 0.99) for coronary revascularisation. The corresponding RRs for angina were 0.97 (0.94 to 1.00), 0.66 (0.59 to 0.74) and 0.56 (0.47 to 0.67); and those for other IHD were 0.97 (0.94 to 1.00), 0.87 (0.76 to 0.99) and 0.61 (0.51 to 0.73), respectively (figure 2).

Among cases with AMI, the fully adjusted women-to-men RRs of having coronary procedures did not vary significantly by area of residence, marital status, HI type, education and income (figure 3, online supplemental figure 1), but were higher for individuals admitted to tier 3 hospitals (coronary angiography: heterogeneity

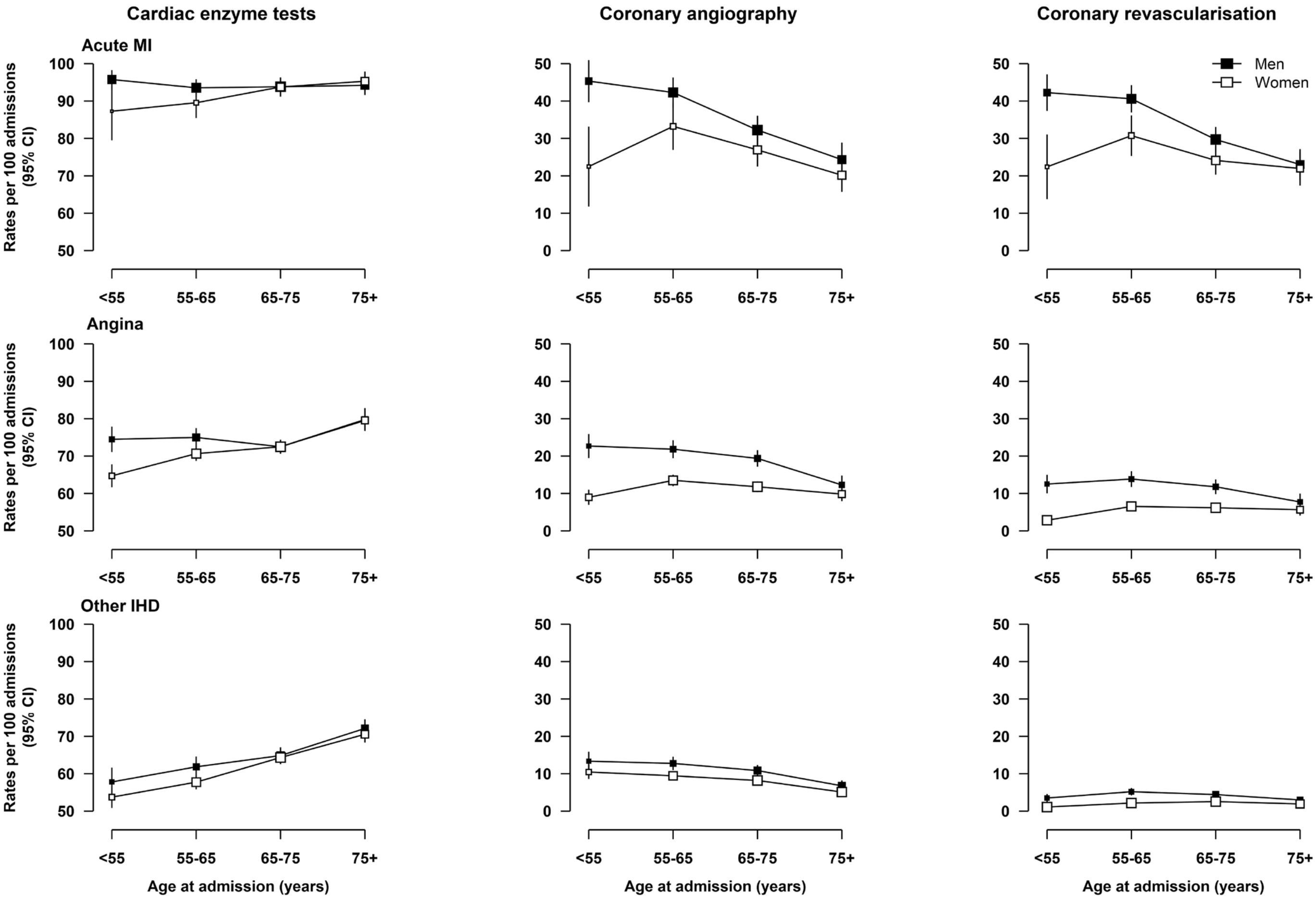

Figure 1 Age-adjusted and region-adjusted rates of having cardiac enzyme tests, coronary angiography and coronary revascularisation per 100 admissions for acute MI, angina and other IHD in men and women, by age group. Poisson models with adjustments for age in years and region were used. Rates were standardised for the overall CKB participant population with acute MI and other IHD, respectively. Coronary revascularisations within 3 months post-admission were included. CKB, China Kadoorie Biobank; IHD, ischaemic heart disease; MI, myocardial infarction.

p=0.03, revascularisation: p=0.04). Among cases with angina and other IHD, there was little evidence of heterogeneity in the adjusted women-to-men RRs of having coronary procedures between different participant categories with the exception of income (both procedures for angina) and marital status (revascularisation for other IHD) (figure 3, online supplemental figure 1). Across categories of IHD admissions, the rates of having cardiac enzyme tests, coronary angiography and revascularisation were higher in urban than in rural areas, and in tier 3 than lower tier hospitals. The rates of having cardiac enzyme tests and coronary angiography were also higher for individuals enrolled in UEBMI than in those enrolled in URBMI or NRCMS (online supplemental tables 2–4). Rates of coronary procedures following AMI increased with levels of education in both men and women (online supplemental table 2).

In sensitivity analyses, using a subsample of AMI admissions with available information on subtypes of AMI, the proportions with STEMI were 52% in women and 68% in men. The women-to-men RRs of having coronary procedures were similar for STEMI and NSTEMI subtypes (online supplemental figure 2). The minimal effect of adjusting for socioeconomic and health system factors on the women-to-men RRs of having cardiac tests and procedures persisted for both STEMI and NSTEMI (online supplemental figure 2), after excluding individuals with prior CVD (online supplemental figure 3) and after stratification by region (online supplemental figure 4).

In further analyses, the adjusted women-to-men RRs of having coronary angiography and revascularisation for AMI did not vary by levels of established risk factors (online supplemental figure 5). In cases with angina, the RRs of having coronary procedures varied by age, hypertension and diabetes, while for participants with other IHD, the RRs of having revascularisation varied by age and prior CVD (online supplemental figures 6 and 7). For all individuals with acute IHD, the rates of having cardiac tests and procedures increased over time (online supplemental tables 2–4). The rates of having ECG, echocardiogram, Holter monitor tests and CCTA were comparable between men and women (online supplemental table 5). Among AMI admissions, the adjusted 28-day case fatality rates did not differ significantly (women-to-men RR: 0.84 (0.63 to 1.11)). A small proportion of admissions for angina and other IHD resulted in death within 28 days, although the case fatality rates for other IHD were higher in men than women (online supplemental table 6).

DISCUSSION

This study of Chinese adults admitted into hospital with acute IHD demonstrated that the use of invasive coronary artery procedures was substantially lower in women compared with

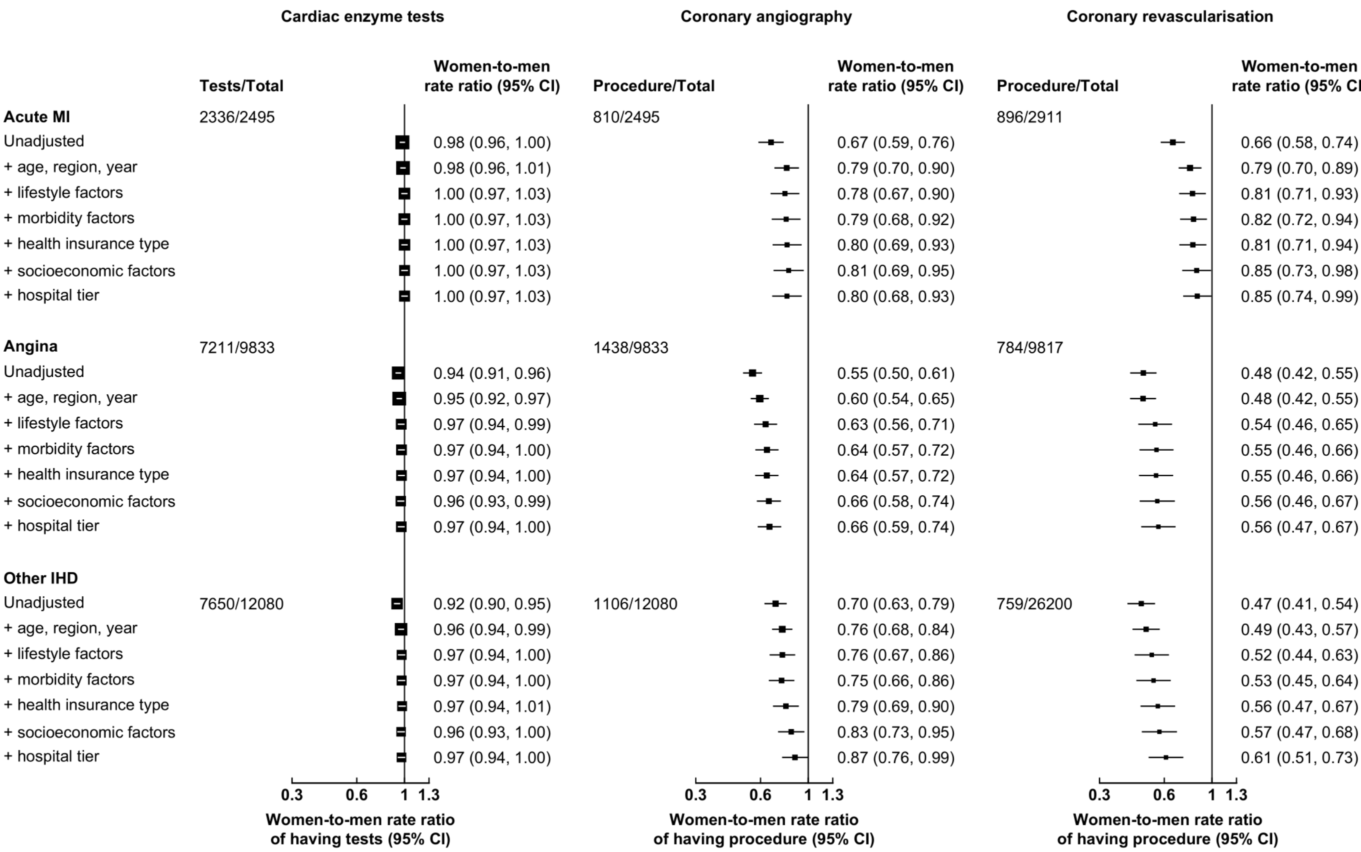

Figure 2 Adjusted women-to-men rate ratios of having cardiac enzyme tests, coronary angiography and coronary revascularisation for acute MI, angina and other IHD, after sequential adjustment for confounding factors. Lifestyle factors included smoking, alcohol consumption, body mass index and physical activity. Morbidity factors included systolic blood pressure, self-rated health status, mental illness, self-reported doctor-diagnosed diseases at entry into CKB, with updated histories of IHD, cerebrovascular disease, malignant neoplasms, respiratory diseases, infectious and parasitic diseases, diabetes mellitus and chronic kidney disease. Socioeconomic factors included marital status, household size, education and income. The total number for analyses of cardiac enzyme tests and coronary angiography included first admissions for participants with retrieved medical records. The total number for analyses of coronary revascularisation included all first IHD admissions for participants with and without retrieved medical records. Coronary revascularisations within 3 months post-admission were included. The area of each square is inversely proportional to the variance. CKB, China Kadoorie Biobank; IHD, ischaemic heart disease; MI, myocardial infarction.

men. Moreover, these differences were greater in younger individuals, but were similar in urban and rural areas. While women had lower socioeconomic status than men and were more likely to be admitted to lower tier hospitals, differences in socioeconomic and health system factors explained only a small fraction of the gender differences in the use of invasive diagnostic or therapeutic procedures.

Contemporary international and Chinese treatment guidelines for ACS have similar recommendations for the use of invasive diagnostic and therapeutic procedures in men and women.[3 16–18] However, previous studies conducted in China also reported lower use of coronary angiography and revascularisation in women compared with men.[11 12] A nationwide registry study of STEMI cases recruited from mostly tertiary hospitals in China in 2014–2018 reported that women had lower rates of primary PCI than men (44% vs 51%).[11] Likewise, the China PEACE-Retrospective Study, involving 162 hospitals in 2001–2011, reported that among patients with STEMI, women had lower rates of coronary angiography (19% vs 29%) and PCI (9% vs 14%).[12] Previous studies had suggested that socioeconomic inequalities might account for some of the differences in access to healthcare services, especially more expensive ones.[19 20] The present study highlighted differences in the management of acute IHD between women and men in China and investigated the contribution of socioeconomic and health system factors.

Consistent with previous findings, women in CKB had lower socioeconomic status compared with men, evidenced by lower educational attainment and household income.[8 9 20] They were more likely to be enrolled in HI types with less generous coverage and seek care in lower rank hospitals with more limited expertise and capacity for performing complex procedures. These gender differences in socioeconomic status are likely to be exacerbated by substantial OOP contributions to hospitalisation costs in China. The OOP payments for individuals with AMI requiring revascularisation procedures have been linked with catastrophic health expenditure, especially for individuals from lower socioeconomic groups.[21] While the magnitude of gender differences in the use of coronary angiography and revascularisation were similar for AMI, they were greater for coronary revascularisation than for coronary angiography among those with angina and other IHD. The differences suggest that financial affordability may influence the use of expensive procedures, particularly in less severe acute IHD cases. Nevertheless, the adjustment for socioeconomic and health system factors accounted for only a small proportion of the gender differences in the use of coronary procedures. It is likely that factors related to disease severity or

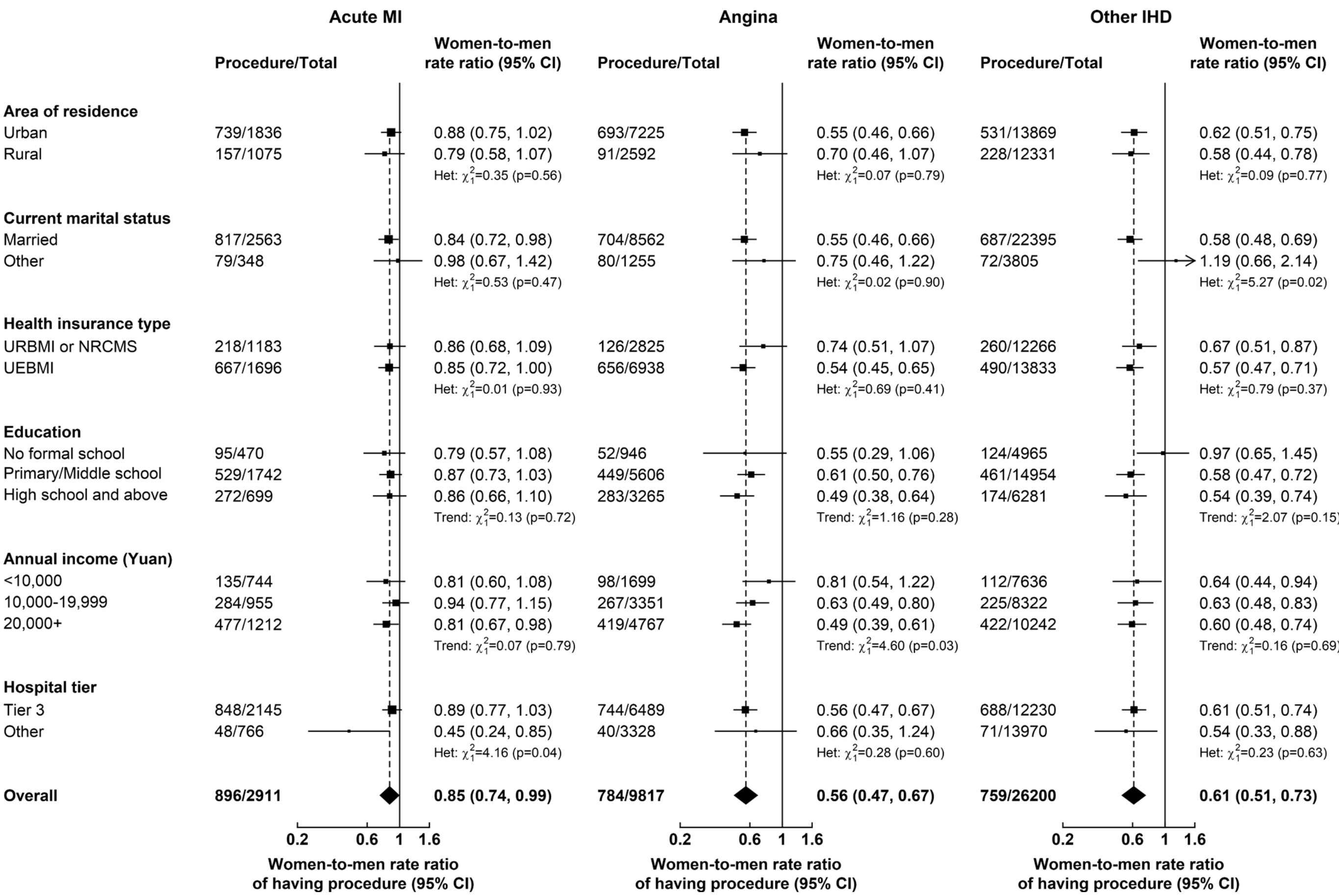

Figure 3 Adjusted women-to-men rate ratios of having coronary revascularisation for acute MI, angina and other IHD, by socioeconomic and health system factors. In analyses by health insurance type, uninsured participants were excluded due to small number of cases. Models included adjustments for demographic factors, lifestyle factors, morbidity factors, health insurance type (except by area of residence), socioeconomic factors and hospital tier, as appropriate. Coronary revascularisations within 3 months post-admission were included. The area of each square is inversely proportional to the variance. IHD, ischaemic heart disease; MI, myocardial infarction; NRCMS, New Rural Cooperative Medical Scheme; UEBMI, Urban Employee Basic Medical Insurance; URBMI, Urban Resident Basic Medical Insurance.

differences in clinical presentation are more likely to explain the observed gender differences in the use of invasive coronary procedures.

Differences in the use of invasive procedures may reflect heterogeneity in the clinical presentation and pathophysiology of IHD between men and women, as suggested by previous studies.[3 22] Women with ACS are more likely to present with atypical symptoms that, particularly at younger ages, are stress related, which makes the diagnostic evaluation and subsequent management more challenging. In addition, women have a higher prevalence of non-occlusive coronary artery disease, microvascular dysfunction and spontaneous coronary artery dissection (SCAD) compared with men. Although the present study assessed gender differences separately in cases with AMI, angina and other IHD, we could only differentiate between STEMI and NSTEMI in a subsample of all AMI admissions. While the benefits of an early invasive strategy for STEMI in both men and women are well established, those for NSTEMI are more uncertain, but recent evidence advocates comparable use of coronary procedures in men and women with elevated biomarkers.[23 24] Previous studies have reported that most AMI cases in both Chinese men and women were STEMI.[25 26] Although there were no differences in the use of cardiac enzyme tests, the lack of sex-specific cardiac biomarker thresholds may have underestimated the severity of ACS in women, resulting in greater risk of diagnosis misclassification.[27]

The differences in the use of coronary artery procedures among women with AMI compared with men may reflect physician bias or concerns about the safety of such procedures in women.[4] Women have higher risks than men of bleeding and other vascular complications following PCI, which may prompt a greater reluctance to use coronary revascularisation.[28 29] Alternatively, unconscious bias or beliefs that AMI or IHD preferentially affect men could lead physicians to underestimate the severity of IHD in women and contribute to a lower use of certain invasive procedures.[2 30] Such biases may be even more extreme in younger patients due to lower incidence of IHD in younger women.[12]

Despite the large population studied, the diversity of regions and hospitals examined, and the extensive data collected, the present study had several limitations. First, the CKB study was not nationally representative, as participants were recruited from 10 diverse areas rather than being representative of the overall Chinese population. Second, the study could not differentiate AMI subtypes in all cases or exclude alternate diagnoses such as Takotsubo cardiomyopathy or SCAD. Third, although medical records were not retrieved for all participants, results were unlikely to be affected by bias, as differences were similar in individuals with and without retrieved medical records. Fourth, the present study lacked information on the clinical indication for revascularisation procedures, such as echocardiographic or angiographic variables or haemodynamic parameters, delay in admission from onset of acute IHD symptoms, timing of procedure following admission or reasons for not having more invasive procedures. Although interhospital transfers could not be reliably identified in the CKB, the probability of 30-day readmission for individuals with acute IHD admitted to tier 1 hospitals (4%) did not vary by gender. Thus, the present study could not fully exclude residual confounding. Given the rapidly evolving field, future research should investigate current use of invasive procedures for acute IHD in men and women.

Overall, this large prospective study demonstrated that Chinese women were less likely than men to have coronary angiography and coronary revascularisation procedures following hospital admission for AMI, angina and other IHD, but socioeconomic and health system factors did not contribute to these differences. Further systematic monitoring of clinical care in men and women is required as the reasons for differences in the use of invasive coronary procedures remain unexplained.

Key messages

What is already known on this subject?

- ⇒ Previous studies have highlighted gender differences in the use of invasive diagnostic and therapeutic procedures for acute ischaemic heart disease (IHD) in high-income countries.
- ⇒ However, the reasons for such gender differences in clinical care of acute IHD remain largely unexplained.

What might this study add?

- ⇒ Among Chinese adults admitted to hospital with acute IHD, the use of coronary angiography and revascularisation was also substantially lower in women than in men.
- ⇒ While Chinese women had lower socioeconomic status than men and were more likely to be admitted to lower tier hospitals, differences in socioeconomic and health system factors did not contribute to the differences in the use of such procedures between men and women.

How might this impact on clinical practice?

- ⇒ The lower use of invasive coronary procedures for acute IHD in women than men may reflect sex differences in the clinical presentation or pathophysiology of IHD, or possibly physician bias or concerns about the safety of such procedures in women.

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Collaborators China Kadoorie Biobank Collaborative Group.

Contributors ML, YC, RC and BM designed and planned the study. ML performed the data analyses and wrote the first draft of the manuscript. YC, RC, ZC and BM provided critical comments on the scientific interpretation of the results and on revised versions of the manuscript. RC, LL and ZC, as members of the CKB Steering Committee, designed and supervised the overall conduct of the study including obtaining funding for the study. YC, YG, JL, CY and ZC coordinated the data acquisition (for baseline and long-term follow-up). All authors provided critical comments on the manuscript.

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Competing interests None declared.

Patient consent for publication Not required.

Ethics approval International, national and local ethical approvals were obtained prior to starting the study and all participants provided written consent.

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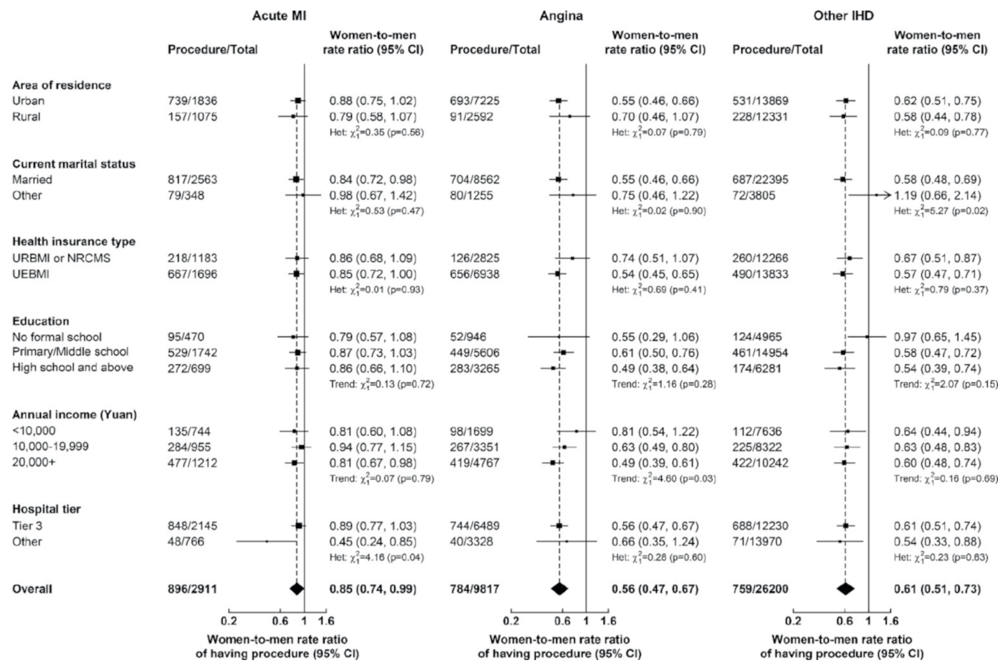
Correction: *Gender differences in use of invasive diagnostic and therapeutic procedures for acute ischaemic heart disease in Chinese adults*

Levy M, Chen Y, Clarke R, *et al*. Gender differences in use of invasive diagnostic and therapeutic procedures for acute ischaemic heart disease in Chinese adults. *Heart* 2022;**108**:292–299.

This article has been corrected since it was first published. In Figure 3, the women-to-men rate ratios by hospital tier for Angina and Other IHD were inverted between 'Tier 3' and 'Other'. This has now been corrected and the new figure is below:



Additionally, the supplementary appendix has been resupplied to make the following corrections to eFigure 1 and eFigure 7:

A: Acute MI: women-to-men rate ratios for other (non-married) should be 1.02 (0.68, 1.53) instead of 0.77 (0.66, 0.91)

C: Other IHD: women-to-men rate ratios for other hospital tiers should be 0.83 (0.55, 1.24) instead of 0.89 (0.73, 1.09).

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Supplementary Appendix

Supplement to: Levy M, Chen Y, Clarke R, et al. Gender differences in use of invasive diagnostic and therapeutic procedures for acute ischaemic heart disease in Chinese adults

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Table of Contents

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Supplementary Methods

Description of different types of health insurance schemes in China

The main health insurance schemes in China differ in their eligible population, administration, source of funding and benefits.

(i) UEBMI (Urban Employee Basic Medical Insurance), launched in 1998, is a compulsory scheme for urban employees. This scheme is funded by both employer (8-10%) and employee (2%) contributions. Retired individuals who were previously employed and covered by UEBMI remain enrolled in UEBMI.

(ii) URBMI (Urban Resident Basic Medical Insurance), launched in 2007, is a voluntary scheme for children, students, urban residents without formal employment and elderly without previous employment. This scheme is mainly funded by government subsidies (~70% of the total funds).

(iii) NRCMS (New Rural Cooperative Medical Scheme), launched in 2003, is a voluntary scheme for rural residents. This scheme is mainly funded by government subsidies (~70% of the total funds).

Imputation methods for health insurance (HI) schemes

Data on HI types by participant were identified annually in 2012-2016. Missing data on HI type for 2004-2011 were imputed based on the insurance scheme in which participants were enrolled in 2012.

Participants were linked to individual HI schemes data annually starting from 2012, using the participants' unique national ID number. Information was also provided on any uninsured participants each year.

Data for participants' HI schemes for the period 2004-2011 were imputed using the participant's earliest available HI scheme information for the period 2012 to 2016, assuming that middle-aged and older individuals in China such as participants in CKB were unlikely to change employment and, hence, their HI scheme. In China, individuals are enrolled in a particular HI scheme depending on their employment status. The proportion of CKB participants insured in each scheme remained stable between 2012 and 2016. Furthermore, at entry into the study (2004-2008), 82% of participants self-reported being insured. This proportion increased to 97% and 98% in the 5% sample of individuals who participated in the 1st resurvey (2008) and the 2nd resurvey (2013-2014), respectively. Thus, it was unlikely for participants to be uninsured.

In the analyses, URBMI and NRCMS were combined, as they provided similar benefits, and in four of the ten CKB regions, the two schemes merged into a single scheme from 2012-2013

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onwards. Uninsured participants were excluded from analyses investigating effect modification by HI type, due to small number of cases.
UEBMI provides the most comprehensive coverage, while the coverage benefits of URBMI and NRCMS are similar. The cost-sharing mechanisms for each scheme vary by area, inpatient or outpatient care and by hospital tier with lower tier hospitals often associated with higher reimbursement rates and lower deductibles by insurer. Patients pay co-payments and deductibles to hospitals at the point of service, there are annual reimbursement ceilings and no ceilings on out-of-pocket spending.

Description of hospital care system in China

The Chinese hospital care system consists mainly of three levels of hospitals:

- Tier 1 or primary hospitals or health institutions: provide preventive, clinical treatment, health care and rehabilitation service in a community. Generally, a tier 1 hospital has 20–99 ward beds/
- Tier 2 or secondary hospitals: provide comprehensive medical and health services to multiple communities and offer medical training and research. Tier 2 hospitals generally have between 100 and 499 beds.
- Tier 3 or tertiary hospitals: provide high-level and specialized medical services and are responsible for higher education and scientific research. Tier 3 hospitals have at least 500 beds.

The number of doctors and nurses per bed and the medical personal's skill levels are higher in higher tier hospitals, and facilities' equipment and physical conditions tends to be of higher quality in higher tier hospitals.

Further information on data sources used

Official local residential records were used to identify about 1.8 million potentially eligible individuals, and 28% of those invited responded and enrolled in the study.

Baseline Questionnaire
Data on demographic, socioeconomic characteristics, and lifestyle and medical history were collected using an interviewer-administered, laptop-based electronic questionnaire (with logic checks to minimise missing values, errors and inconsistencies) administered to study participants. Extensive training was provided for field survey staff, including instruction on data collection using the electronic questionnaire, recording physical measurements using standard protocols and use and maintenance of equipment. Importantly, serial resurveys in 5% of the study population indicated a high level of agreement between corresponding measurements for questionnaire data and clinical measurements.

Data retrieved from medical records
Data on cardiac enzyme test, coronary angiography, electrocardiogram, echocardiogram, coronary computed tomography angiography, and Holter monitor test, were extracted from hospital medical records. Medical records were only retrieved for incident events with a main diagnosis of IHD, which were identified using regional IHD disease registries and health insurance records. Specially trained public health staff sought access to medical records of reported IHD cases in participating hospitals. A Portable Validation Device (PVD) system was

used to photograph the relevant medical records and validate the diagnosis of IHD types during follow-up. Details for each case, including dates of admission and discharge, were checked. Selected clinical data were recorded electronically using standardised, disease-specific protocols. Local regional centres' staff checked the quality and completeness of all records. If data quality was poor in a particular study region, local validation procedures were reviewed, and the retrieved data were checked. A random sample of 5% of all verified events was rechecked each year.
The most common reason for non-retrieval of medical notes was that records could not be found in the hospital. This is likely to be due to the lack of storage for medical records especially in lower tier hospitals and in rural areas.

Data sources used for analyses
When the outcomes of interest were cardiac enzyme test, coronary angiography, ECG, echocardiogram, CCTA, or Holter monitor test, the study population was only participants with retrieved medical records for first IHD admissions. Data on any use of these diagnostic tests and procedures came from the medical records.
When the outcome of interest was coronary revascularisation, the study population included all participants with a first IHD admission, regardless of whether admission's medical records were successfully retrieved. 50% of IHD admissions (AMI: 67%, angina: 82%, other IHD: 34%) had data both in HI and retrieved medical records. 45% of IHD admissions (AMI: 23%, angina: 14%, other IHD: 60%) had data in HI records only. 5% of IHD admissions (AMI: 10%, angina: 4%, other IHD: 5%), had data in retrieved medical records only.

Imputation methods for missing length of stay

For participants with retrieved admission medical records (outcomes of interest: cardiac enzyme test, coronary angiography, ECG, echocardiogram, CCTA, or Holter monitor test), 9% of IHD admissions had missing information on the length of stay (11% of admissions for men and 9% of admissions for women). For AMI, 14% of admissions had missing length of stay and the proportion was slightly lower in men (13%) than women (15%). For angina, 5% of admissions had missing length of stay and the proportion was slightly higher in men (6%) than women (4%). For other IHD, 12% of admissions had missing length of stay and the proportion was slightly higher in men (14%) than women (11%).

For all participants, regardless of whether admission medical records were retrieved (outcome of interest: coronary revascularisation), 6% of IHD admissions had missing information on the length of stay (7% of admissions for men vs 5% of admissions for women). For AMI, 11% of admissions had missing length of stay and the proportion was similar in men and women. For angina, 5% of admissions has missing length of stay and the proportion was slightly higher in men (5%) than women (4%). For other IHD, 5% of admissions had missing length of stay and the proportion was slightly higher in men (6%) than women (5%).

Checking the patterns of missingness, the odds of missing length of stay were related to several of the risk factors included in our main models. Thus, there was evidence that missing length of stay was not missing completely at random (MCAR), and we assumed that it was missing at random (MAR) and included all important covariates in its imputation. We used multiple imputation with Poisson regression and included the same covariates (eg, demographic factors, lifestyle factors, morbidity factors, health insurance type, socioeconomic factors, hospital tier and IHD type) as included in the fully adjusted models for the use of diagnostic tests and procedures. The number of imputations (*m*) was chosen so that m≥100*Fraction of Missing Information (White et al., 2011). Missing values were imputed using chained equations. The mean length of stay was estimated using the 10 separate datasets including imputed data with estimates combined using Rubin's rules (1987). Hence, estimates were adjusted for the variability between imputations.

Day case admissions (ie, participant admitted and discharged on the same day) were counted as having a length of stay of 0.5 days.

Description of established risk factors

Disease risk factors were classified as either demographic, lifestyle or morbidity factors. Demographic factors included annually updated age (ie, age, age-squared, age-cubed), region and calendar year. Lifestyle factors, collected at entry into the study, included smoking, alcohol consumption, body mass index, and physical activity assessed using metabolic equivalents of task (MET). Morbidity factors included systolic blood pressure (SBP), self-rated health status, self-reported mental illness, self-reported doctor-diagnosed diseases at entry into CKB, with history of major diseases updated during follow-up until censored by the onset of IHD in the present analyses.

Description of self-reported mental illness

The self-reported mental illness variable (binary) was used as a broad indicator of participants' mental health. Mental illness was defined as having at least one symptom of depression or anxiety in the past 12 months.
Symptoms of depression included feeling much more sad or depressed than usual, loss of interest in most things like hobbies or activities that usually give pleasure, loss of appetite for favourite food, or feeling worthless or useless for a period of 2 or more weeks.
Symptoms of anxiety included experiencing continuous anxiety for a period lasting one month or longer, feeling, continuous pain in body lasting more than 4 months, panic attacks, or phobias.

Description of other IHD
Admissions for other IHD [I22-I25] included a majority of atherosclerotic heart disease [I25.1].

Statistical analysis

Poisson regression was preferred to logistic regression to estimate relative risks and enable their comparison across different categories of patients, rather than odds ratios which can be misinterpreted. The use of relative risks facilitates comparisons of effect estimates across patient phenotypes with rare (i.e. use of invasive diagnostic procedures for other IHD) and frequent outcomes (i.e. use of invasive diagnostic procedures for AMI) which are required to address the hypothesis in the present study.

Our investigation strategy included all available data in the study on potential confounders or effect modifiers as informed by the literature on determinants of healthcare use. We retained all factors and did not follow data-driven model selection/building. Instead, we sequentially adjusted Poisson regression models for groups of potential confounders/effect modifiers of the association between gender and the use of invasive diagnostic procedures. The order in which groups of factors were included was chosen to reflect likely strength of effect and attempt to tease out the added role of socioeconomic factors. Our objective was to assess the contribution of different groups of factors that might explain the association between gender and use of procedures.

We also evaluated gender differences on an absolute scale as rates per 100 admissions of having a diagnostic test or procedure, standardised for characteristics of CKB participants with AMI, angina or other IHD in 2004-2016. Rates for urban and rural areas were standardised separately for the CKB population characteristics for the relevant urban or rural area.

Additional sensitivity analyses estimated women-to-men RRs by categories of established IHD risk factors except for smoking and alcohol consumption because of their low prevalence in Chinese women.

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eTable 1: Selected characteristics of men and women with retrieved medical records for hospital admissions for acute MI, angina and other IHD, in 2004-2016

	AMI			Angina			Other IHD		
	Men (n=1558)	**Women (n=937)**		**Men (n=3549)**	**Women (n=6284)**		**Men (n=4483)**	**Women (n=7597)**	
(A) Characteristics at baseline									
Age (years), Mean (SD)	58.8 (10.1)	62.4 (8.8)	**	58.3 (10.1)	58.7 (9.2)		60.9 (9.6)	59.2 (9.5)	**
Prior medical history, %									
Diabetes[1]	14.4	26.5	**	14.2	15		10.6	12.5	**
Hypertension[1]	55.7	60.7	*	52.5	44.7	**	55.1	48.9	*
Stroke or TIA	7.8	3.6	**	5.9	4.1	**	5	3.3	**
IHD	11.7	16.1	**	18.7	22	**	14.5	14.7	
CKD	1.7	2.1		3.2	3.9		1.6	2.3	**
Poor health status	11.5	19.1	**	12.7	16.2	**	13.8	18.7	
Mental illness[2]	9.9	11.4		9.7	13.5	**	10.6	12.9	
Physical measurements									
Overweight or obese (>25 kg/m²), %	44.8	48.8		51.6	52.4		38.9	48.2	
SBP (mmHg), Mean (SD)	142.3 (22.1)	145.8 (24.4)	**	138.8 (20.8)	134,8 (23.2)	**	140.5 (21.9)	138.3 (23.9)	**
Lifestyle characteristics									
Current smoker, %	62.6	6.7	**	51.6	3.9	**	53.2	3.9	**
Regular alcohol drinker, %	41.5	3.3	**	47.9	5.3	**	40.2	4	**
Physical activity (MET-h/day), Mean (SD)	15.6 (13.7)	12.7 (8.5)	**	14.2 (11.5)	13.2 (8.3)	**	15.4 (13.3)	14.1 (9.3)	**
Socioeconomic characteristics									
Currently married, %	94	76.6	**	94.3	82.4	**	90.7	82	**
Household size, Mean (SD)	3.5 (1.6)	3.3 (1.6)	**	3.2 (1.4)	3.1 (1.4)	**	3.6 (1.7)	3.5 (1.7)	*
High School or above, %	28.4	13.4	**	43.6	32.2	**	26.3	18.9	**
Annual household income >20,000¥, %	46.6	31.2	**	53.8	46.1	**	43.3	36.4	**
Rural residents, %	34.8	37.7		21	14.2	**	51.2	47.4	**
(B) Characteristics at hospital admission									
Age (years), Mean (SD)	64.9 (9.9)	68.6 (8.8)	**	64.5 (9.9)	64.9 (9.0)	*	67.3 (9.5)	65.8 (9.4)	**
Health insurance type[3], %			**						**
NRCMS or URBMI	36.7	48.6		19.6	19.5		48.8	50.5	
UEBMI	61.9	50.4		79.6	80.1		50.2	49	
Other or uninsured	1.4	1.1		0.7	0.5		1	0.5	
Hospital tier, %			*						
Tier 1 or missing/unspecified	9.2	12.3		10	10.2		29.4	32.7	
Tier 2	14.6	16.8		16.8	17.3		21.5	19.9	*
Tier 3	76.3	71		73.2	72.6		49.1	47.4	
Length of stay (days)[4], Mean (SD)	10.5 (5.9)	10.7 (5.8)		10.4 (5.6)	9.1 (5.2)		10.8 (5.3)	9.4 (5.5)	

MI: myocardial infarction, IHD: ischaemic heart disease, CKD: chronic kidney disease, SD: standard deviation, TIA: transient ischemic attack, MET: metabolic equivalents of task, URBMI: Urban Resident Basic Medical Insurance, NRCMS: New Rural Cooperative Medical Scheme, UEBMI: Urban Employee Basic Medical Insurance. ** p-value <0.01 and * p-value < 0.5. [1]Self-reported and screen-detected. [2]Mental illness was defined as having at least one symptom of depression or anxiety in the past 12 months. [3]Data on health insurance (HI) types for each participant was identified annually in 2012-2016, but was unavailable for the years prior to 2012. Missing data on HI type in 2004-2011 were imputed based on the insurance scheme in which participants were enrolled in 2012. [4]Missing length of stay (14% for AMI and 9% for other IHD) was imputed using multiple imputation.

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eTable 2: Adjusted rates (95% CI) of having cardiac enzyme test, coronary angiography and coronary revascularisation for ACUTE MI per 100 admissions, by gender and socioeconomic and health system factors

	Cardiac enzymes test		Coronary angiography		Coronary revascularisation	
	Men	**Women**	**Men**	**Women**	**Men**	**Women**
Area of residence						
Urban	94.7 (93.1, 96.3)	94.4 (92.4, 96.5)	38.3 (34.8, 41.8)	31.3 (27.5, 35.2)	35.6 (32.6, 38.6)	31.1 (27.5, 34.7)
Rural	84.8 (81.1, 88.5)	85.2 (81.3, 89.1)	13.8 (11.4, 16.1)	9.7 (7.3, 12.1)	8.9 (7.3, 10.6)	7.1 (5.3, 8.9)
Current marital status						
Married	91.7 (89.8, 93.7)	91.6 (89.4, 93.8)	29.9 (27.3, 32.5)	23.1 (20.2, 26.0)	25.4 (23.3, 27.4)	21.3 (18.8, 23.9)
Other	88.0 (82.1, 93.9)	89.4 (85.5, 93.3)	26.6 (17.7, 35.5)	27.3 (21.0, 33.5)	18.9 (13.0, 24.8)	18.5 (14.8, 22.2)
Health insurance type						
URBMI or NRCMS	85.6 (82, 89.1)	86.9 (83.6, 90.3)	15.7 (13.2, 18.3)	12.4 (10.1, 14.7)	26.4 (21.1, 31.7)	22.7 (18.2, 27.2)
UEBMI	94.6 (93, 96.3)	93.8 (91.5, 96.0)	38.2 (34.7, 41.7)	30.5 (26.5, 34.6)	24.1 (22.0, 26.3)	20.5 (17.8, 23.1)
Education						
No formal school	87.4 (82.0, 92.7)	90.1 (87.0, 93.2)	15.9 (10.8, 21.0)	15.7 (12.3, 19.0)	15.4 (11.7, 19.2)	12.1 (9.7, 14.6)
Primary/Middle school	90.8 (88.6, 92.9)	90.3 (87.7, 92.9)	29.7 (26.8, 32.6)	23.0 (19.7, 26.2)	22.7 (20.5, 24.8)	19.7 (17.0, 22.3)
High school and above	93.9 (91.8, 96.0)	93.6 (89.3, 97.8)	37.2 (32.8, 41.7)	29.2 (22.2, 36.2)	34.9 (31.1, 38.7)	29.9 (23.2, 36.5)
Annual household income (Yuan)						
<10,000	92.1 (88.4, 95.7)	93.5 (89.8, 97.2)	29.2 (23.3, 35.1)	21.5 (16.2, 26.8)	24.6 (19.8, 29.4)	19.8 (15.1, 24.5)
10,000-19,999	92.3 (90.1, 94.5)	90.1 (87.0, 93.2)	29.3 (25.8, 32.8)	22.7 (18.6, 26.8)	23.1 (20.4, 25.8)	21.7 (18.3, 25.2)
20,000+	90.0 (87.5, 92.4)	91.3 (88.5, 94.1)	30.5 (27.2, 33.8)	25.6 (21.4, 29.8)	25.7 (23.1, 28.2)	20.8 (17.4, 24.1)
Hospital tier						
Tier 3	95.5 (94.0, 97.1)	95.5 (93.6, 97.3)	44.0 (40.2, 47.8)	36.7 (32.5, 40.8)	36.9 (33.7, 40.2)	32.8 (29.2, 36.4)
Other	86.7 (83.0, 90.4)	86.8 (82.3, 91.3)	11.2 (7.9, 14.6)	4.3 (1.6, 6.9)	10.1 (6.8, 13.3)	4.6 (2.0, 7.1)
Calendar period						
2004-2011	88.3 (85.6, 90.9)	87.8 (84.2, 91.4)	22.8 (19.9, 25.8)	18.4 (14.5, 22.2)	19.6 (17.4, 21.7)	14.9 (12, 17.8)
2012-2014	92.8 (90.5, 95.1)	92.8 (89.9, 95.6)	29.5 (26.1, 32.9)	22.7 (18.7, 26.7)	27.3 (24.3, 30.2)	25.4 (21.4, 29.3)
2015-2016	93.4 (90.5, 96.3)	93.6 (92.3, 94.9)	39.6 (34.8, 44.4)	32.5 (26.8, 38.3)	30.3 (26.6, 34.0)	26.6 (21.9, 31.2)
Overall	**93.6 (92.3, 94.9)**	**93.7 (91.7, 95.6)**	**34.9 (32.5, 37.2)**	**27.8 (24.5, 31.0)**	**32.3 (30.3, 34.3)**	**27.6 (24.5, 30.7)**

UEBMI: Urban Employee Basic Medical Insurance, URBMI: Urban Resident Basic Medical Insurance, NRCMS: New Rural Cooperative Medical Scheme. Models included adjustments for demographic factors, lifestyle factors, morbidity factors, health insurance type (except by area of residence), socioeconomic factors, and hospital tier, as appropriate. In analyses by HI type, uninsured participants were excluded due to small number of cases. For all factors except area of residence, rates were standardised for the overall CKB participant population with AMI or other IHD in 2004-2016. Probabilities by area of residence were standardised separately for the CKB participant population living in urban or rural area, as appropriate. Coronary revascularisations within 3 months post admission were included.

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eTable 3: Adjusted rates (95% CI) of having cardiac enzyme test, coronary angiography and coronary revascularisation for ANGINA per 100 admissions, by gender and socioeconomic and health system factors

	Cardiac enzymes test		Coronary angiography		Coronary revascularisation	
	Men	**Women**	**Men**	**Women**	**Men**	**Women**
Area of residence						
Urban	77.8 (75.9, 79.6)	74.7 (73.3, 76.1)	22.5 (20.6, 24.3)	14.9 (13.6, 16.1)	14.1 (12.4, 15.7)	7.8 (6.8, 8.7)
Rural	57.8 (52.4, 63.2)	57.6 (52.3, 62.8)	8.7 (7.0, 10.3)	6.0 (4.7, 7.3)	3.8 (2.1, 5.5)	2.7 (1.6, 3.8)
Current marital status						
Married	71.1 (68.7, 73.4)	68.8 (66.7, 70.9)	17.9 (16.5, 19.3)	11.8 (10.8, 12.8)	10.1 (8.8, 11.4)	5.6 (4.8, 6.4)
Other	71.4 (65.9, 76.9)	67.8 (64.8, 70.7)	17.2 (12.4, 21.9)	11.1 (9.1, 13.1)	7.4 (4.2, 10.6)	5.5 (4.2, 6.9)
Health insurance type						
URBMI or NRCMS	58.9 (54.3, 63.4)	60 (55.8, 64.2)	10.8 (8.8, 12.9)	7.9 (6.6, 9.3)	8.8 (5.9, 11.8)	6.6 (4.8, 8.3)
UEBMI	77.6 (75.8, 79.3)	74.1 (72.7, 75.5)	21.7 (20, 23.4)	14.1 (13, 15.3)	10.1 (8.6, 11.6)	5.4 (4.6, 6.3)
Education						
No formal school	67.3 (58.6, 76.0)	63.6 (57.3, 70.0)	8.4 (4.0, 12.8)	8.2 (6.5, 9.8)	7.6 (3.0, 12.2)	4.2 (2.7, 5.7)
Primary/Middle school	71.4 (69.2, 73.7)	68.7 (66.8, 70.6)	17.9 (16.2, 19.6)	12.2 (11.0, 13.4)	9.6 (8.2, 11.1)	5.9 (5.0, 6.8)
High school and above	73.0 (70.8, 75.1)	71.1 (69.1, 73.1)	21.1 (19.0, 23.2)	12.8 (11.1, 14.4)	11.8 (10.2, 13.4)	5.8 (4.6, 7.0)
Annual household income (Yuan)						
<10,000	76.8 (72.6, 81.0)	70.2 (67.1, 73.3)	15.4 (12.2, 18.5)	12 (9.9, 14.2)	7.6 (5.2, 10.0)	6.1 (4.5, 7.8)
10,000-19,999	69.9 (67.0, 72.8)	68.4 (66.0, 70.8)	16.9 (14.9, 18.8)	12.3 (10.8, 13.7)	9.4 (7.8, 11.1)	5.9 (4.8, 7.0)
20,000+	69.8 (67.2, 72.4)	67.9 (65.6, 70.2)	19.0 (17.0, 21.0)	11.3 (10.1, 12.5)	10.7 (9.0, 12.3)	5.2 (4.3, 6.1)
Hospital tier						
Tier 3	82.0 (79.6, 84.3)	80.3 (78.3, 82.3)	26.4 (24.2, 28.5)	17.5 (16.1, 18.9)	17.7 (15.1, 20.3)	9.9 (8.4, 11.4)
Other	59.0 (55.5, 62.4)	53.6 (50.7, 56.4)	5.5 (4.1, 6.8)	3.3 (2.4, 4.1)	1.6 (0.9, 2.3)	1.1 (0.6, 1.5)
Calendar period						
2004-2011	61.5 (58.7, 64.4)	55.7 (53.4, 58.1)	15.2 (13.3, 17.0)	10.8 (9.4, 12.1)	8.7 (7.2, 10.3)	5.1 (4.1, 6.1)
2012-2014	73.7 (71.0, 76.5)	73.1 (70.7, 75.5)	18.9 (16.9, 21.0)	12.2 (10.8, 13.5)	11.2 (9.4, 13.1)	6.4 (5.3, 7.6)
2015-2016	78.3 (75.2, 81.3)	79.0 (76.3, 81.6)	19.9 (17.5, 22.3)	12.7 (11.1, 14.4)	10.1 (8.2, 12.0)	5.3 (4.2, 6.5)
Overall	**75.1 (73.4, 76.7)**	**72.5 (71.4, 73.6)**	**18.3 (16.9, 19.7)**	**12.1 (11.2, 13)**	**10.8 (9.6, 12)**	**6.1 (5.4, 6.7)**

UEBMI: Urban Employee Basic Medical Insurance, URBMI: Urban Resident Basic Medical Insurance, NRCMS: New Rural Cooperative Medical Scheme. Models included adjustments for demographic factors, lifestyle factors, morbidity factors, health insurance type (except by area of residence), socioeconomic factors, and hospital tier, as appropriate. In analyses by HI type, uninsured participants were excluded due to small number of cases. For all factors except area of residence, rates were standardised for the overall CKB participant population with AMI or other IHD in 2004-2016. Probabilities by area of residence were standardised separately for the CKB participant population living in urban or rural area, as appropriate. Coronary revascularisations within 3 months post admission were included.

eTable 4: Adjusted rates (95% CI) of having cardiac enzymes test, coronary angiography or coronary revascularisation for OTHER IHD per 100 admissions for men and women, by socioeconomic and health system factors

	Cardiac enzymes test		Coronary angiography		Coronary revascularisation	
	Men	**Women**	**Men**	**Women**	**Men**	**Women**
Area of residence						
Urban	69.2 (67.2, 71.2)	67.5 (66.1, 69)	13.2 (11.9, 14.4)	11.5 (10.5, 12.4)	5.1 (4.5, 5.8)	3.1 (2.7, 3.5)
Rural	59.7 (57.7, 61.7)	56.8 (55.2, 58.4)	4.1 (3.3, 5.0)	3.3 (2.6, 3.9)	2.5 (2.1, 3.0)	1.5 (1.2, 1.8)
Current marital status						
Married	65.7 (64.1, 67.3)	63.8 (62.5, 65.1)	10.2 (9.3, 11.2)	8.8 (8.0, 9.5)	4.3 (3.8, 4.8)	2.5 (2.2, 2.8)
Other	67.7 (63.7, 71.7)	64.4 (62.0, 66.7)	8.0 (5.4, 10.6)	7.6 (6.2, 9.1)	1.8 (0.8, 2.7)	2.1 (1.6, 2.7)
Health insurance type						
URBMI or NRCMS	61.3 (59.2, 63.4)	58.7 (57.1, 60.2)	5.6 (4.7, 6.5)	4.8 (4.1, 5.6)	3.5 (2.8, 4.1)	2.3 (1.8, 2.8)
UEBMI	68.4 (66.5, 70.4)	66.9 (65.4, 68.4)	12.8 (11.5, 14)	10.8 (9.8, 11.7)	4.3 (3.8, 4.9)	2.5 (2.1, 2.9)
Education						
No formal school	69.2 (64.6, 73.9)	64.6 (62.7, 66.6)	5.9 (4.1, 7.8)	5.0 (4.2, 5.9)	2.7 (1.8, 3.7)	2.6 (2.1, 3.1)
Primary/Middle school	65.5 (63.6, 67.3)	64.2 (62.8, 65.7)	10.2 (9.1, 11.3)	9.0 (8.1, 9.9)	4.4 (3.8, 4.9)	2.5 (2.2, 2.9)
High school and above	65.7 (63.1, 68.2)	62.8 (60.4, 65.1)	11.9 (10.3, 13.5)	10.1 (8.8, 11.5)	3.8 (3.1, 4.5)	2.0 (1.5, 2.6)
Annual household income (Yuan)						
<10,000	67.6 (64.4, 70.8)	66.2 (63.6, 68.7)	9.2 (7.1, 11.4)	7.4 (5.8, 8.9)	3.4 (2.4, 4.3)	2.2 (1.6, 2.8)
10,000-19,999	65.7 (63.2, 68.2)	64.2 (62.3, 66.1)	9.7 (8.3, 11.2)	9.1 (7.9, 10.2)	4.1 (3.4, 4.8)	2.6 (2.1, 3.1)
20,000+	65.3 (63.2, 67.4)	62.4 (60.7, 64.1)	10.4 (9.2, 11.5)	8.8 (7.9, 9.7)	4.2 (3.6, 4.8)	2.5 (2.1, 2.9)
Hospital tier						
Tier 3	73.0 (71.1, 75.0)	74.6 (73.0, 76.1)	15.3 (13.9, 16.7)	13.3 (12.2, 14.4)	7.4 (6.4, 8.4)	4.5 (3.9, 5.1)
Other	52.9 (50.9, 54.8)	47.1 (45.6, 48.5)	1.6 (1.1, 2.1)	1.3 (1.0, 1.7)	0.6 (0.4, 0.9)	0.3 (0.2, 0.5)
Calendar period						
2004-2011	53.3 (50.9, 55.8)	50.4 (48.4, 52.5)	6.9 (5.8, 8.0)	5.6 (4.7, 6.5)	2.9 (2.4, 3.4)	1.8 (1.4, 2.1)
2012-2014	70.5 (68.3, 72.8)	69.5 (67.8, 71.2)	9.7 (8.4, 10.9)	9.0 (8.0, 10.1)	4.3 (3.6, 5.1)	2.4 (1.9, 2.9)
2015-2016	73.6 (71.0, 76.1)	72.5 (70.5, 74.4)	14.3 (12.4, 16.1)	12.5 (11.1, 14).0	5.0 (4.2, 5.9)	3.6 (2.9, 4.2)
Overall	**64.6 (63.1, 66.1)**	**62.5 (61.4, 63.7)**	**9.9 (9.1, 10.8)**	**8.6 (7.9, 9.3)**	**3.7 (3.3, 4.1)**	**2.3 (2.0, 2.5)**

UEBMI: Urban Employee Basic Medical Insurance, URBMI: Urban Resident Basic Medical Insurance, NRCMS: New Rural Cooperative Medical Scheme. Models included adjustments for demographic factors, lifestyle factors, morbidity factors, health insurance type (except by area of residence), socioeconomic factors, and hospital tier, as appropriate. In analyses by HI type, uninsured participants were excluded due to small number of cases. For all factors except area of residence, rates were standardised for the overall CKB participant population with AMI or other IHD in 2004-2016. Probabilities by area of residence were standardised separately for the CKB participant population living in urban or rural area, as appropriate. Coronary revascularisations within 3 months post admission were included.

eTable 5: Adjusted rates (95% CI) of having other diagnostic tests per 100 admissions for acute MI, angina and other IHD, by gender

	Acute MI		Angina		Other IHD	
	Men	**Women**	**Men**	**Women**	**Men**	**Women**
ECG	98.5 (97.6, 99.5)	98.4 (97.5, 99.3)	98.1 (97.5, 98.7)	97.9 (97.4, 98.4)	96.1 (95.4, 96.9)	96.5 (96.0, 97.0)
Echocardiogram	63.2 (60.3, 66.1)	60.4 (57.3, 63.6)	67.4 (65.8, 69.0)	65.8 (64.6, 67.1)	63.5 (61.8, 65.2)	63.1 (61.9, 64.3)
Holter monitor test	24.0 (21.2, 26.9)	24.9 (21.7, 28.0)	35.8 (33.1, 38.5)	37.5 (34.9, 40.1)	33.9 (32.1, 35.6)	33.8 (32.6, 35.0)
CCTA	8.2 (6.5, 10.0)	8.5 (6.5, 10.6)	11.0 (9.8, 12.2)	9.9 (9.1, 10.8)	10.8 (9.7, 12.0)	9.8 (9.0, 10.6)

MI: myocardial infarction, IHD: ischaemic heart disease, ECG: electrocardiogram, CCTA: coronary computed tomography angiography. Models included adjustments for demographic factors, lifestyle factors, morbidity factors, health insurance type, socioeconomic factors, and hospital tier, as appropriate. Rates were standardised for the overall CKB participant population with AMI or other IHD in 2004-2016.

eTable 6: Adjusted women-to-men rate ratios and rates of 28-days case fatality for acute MI and other IHD for men and women

	Rates per 100 admissions (95% CI)				Women-to-men rate ratios (95% CI)	
	Acute MI		Other IHD		Acute MI	Other IHD
	Men (n=165)	**Women (n=123)**	**Men (n=166)**	**Women (n=147)**		
Unadjusted	9.2 (7.8, 10.6)	11.1 (9.1, 13.0)	1.7 (1.5, 2)	0.9 (0.7, 1)	1.21 (0.96, 1.52)	0.51 (0.41, 0.64)
+ age, region, year	9.8 (8.3, 11.3)	10.0 (8.2, 11.7)	1.6 (1.4, 1.9)	0.9 (0.8, 1.1)	1.01 (0.80, 1.28)	0.58 (0.46, 0.72)
+ lifestyle and morbidity factors	10.7 (8.9, 10.5)	9.0 (7.2, 10.7)	1.5 (1.3, 1.8)	1.0 (0.8, 1.1)	0.84 (0.63, 1.11)	0.61 (0.46, 0.81)

MI: myocardial infarction, IHD: ischaemic heart disease. Data used was from HI records supplemented by retrieved medical records. Results using data from retrieved medical records only were slightly higher. Case fatality rates for angina were not presented due to small number of 28-day case fatalities (men: 21, women: 19).

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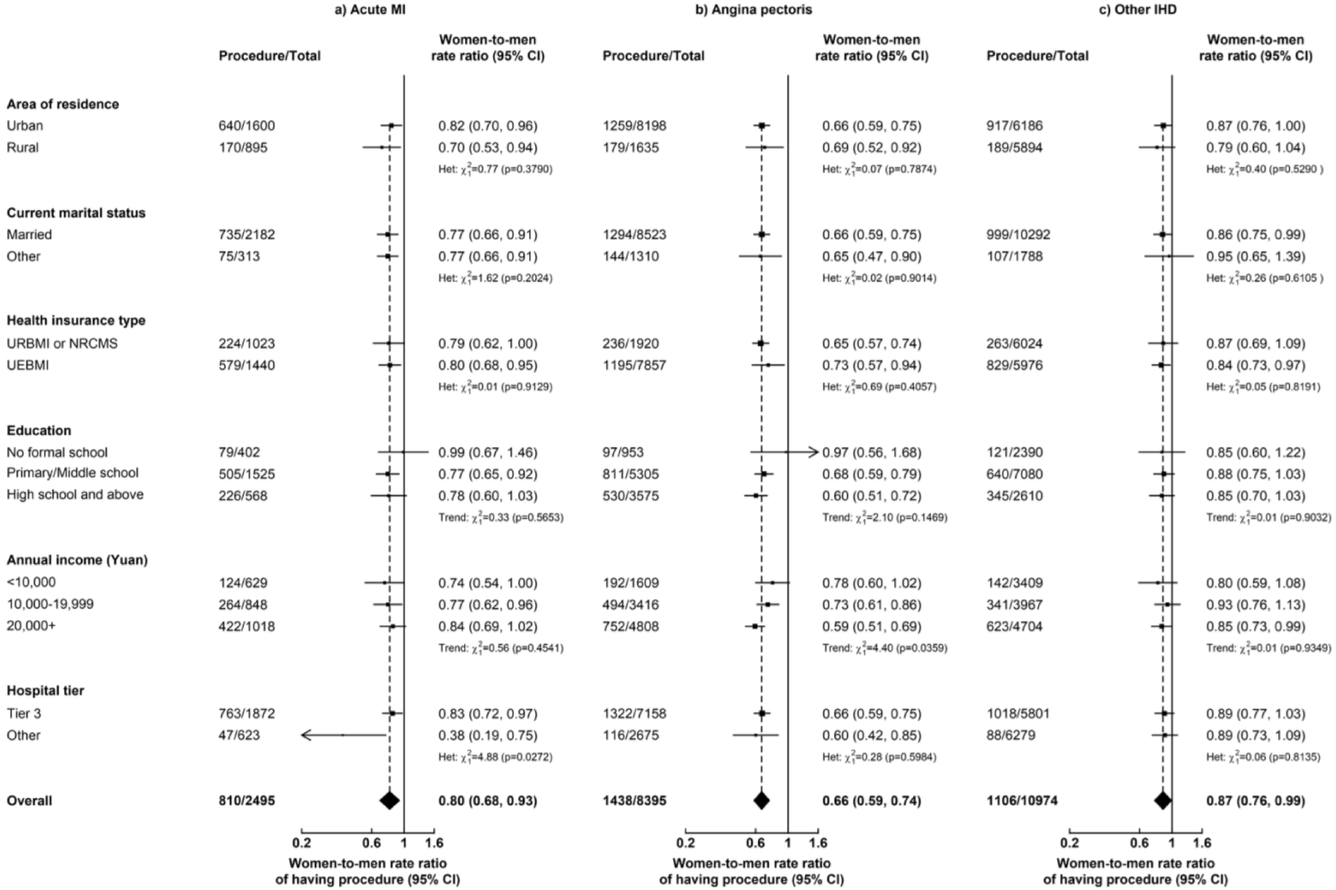
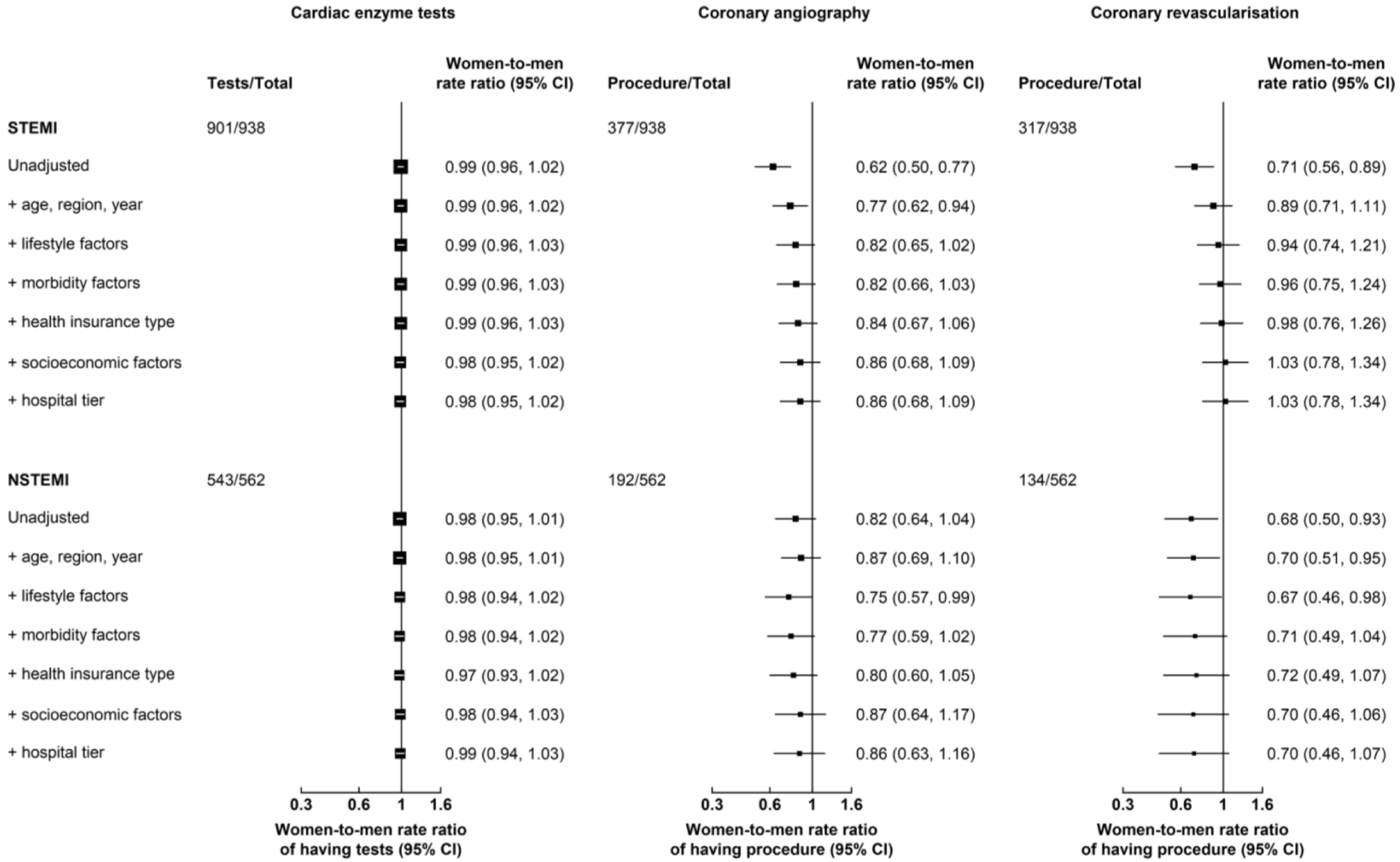
eFigure 1: Adjusted women-to-men rate ratios of having coronary angiography for acute MI, angina and other IHD, by socioeconomic and health system factors



MI: myocardial infarction, IHD: ischaemic heart disease. UEBMI: Urban Employee Basic Medical Insurance, URBMI: Urban Resident Basic Medical Insurance, NRCMS: New Rural Cooperative Medical Scheme. In analyses by health insurance type, uninsured participants were excluded due to small number of cases. Models included adjustments for demographic factors, lifestyle factors, morbidity factors, health insurance type (except by area of residence), socioeconomic factors, and hospital tier, as appropriate. The area of each square is inversely proportional to the variance

eFigure 2: Adjusted women-to-men rate ratios of having cardiac enzyme tests, coronary angiography and coronary revascularisation for STEMI and NSTEMI, after sequential adjustment for confounding factors



STEMI: ST segment elevation myocardial infarction myocardial infarction, NSTEMI: non-ST segment elevation myocardial infarction. Data on AMI subtypes were only available in 1500 AMI admissions with retrieved medical records. The area of each square is inversely proportional to the variance.

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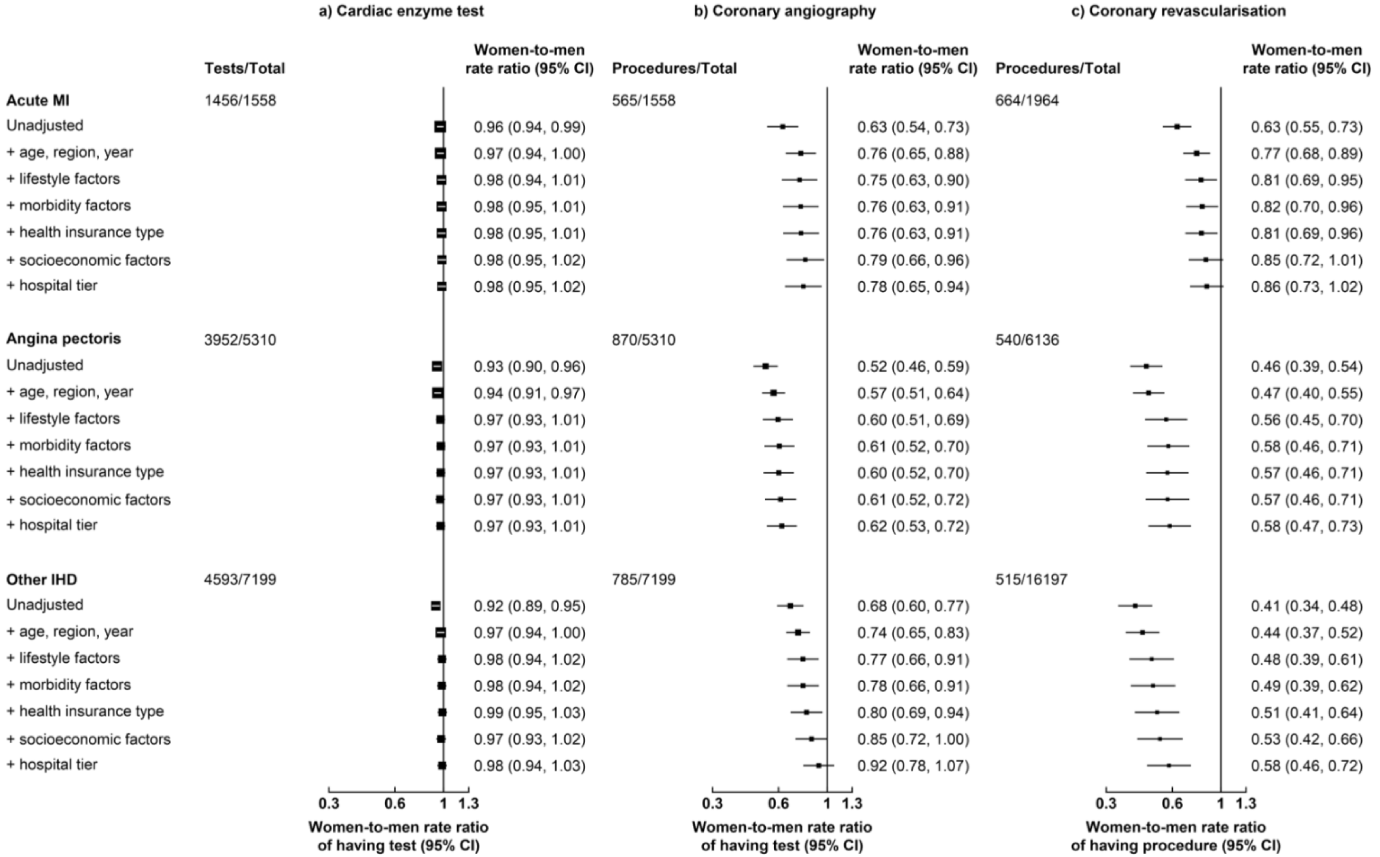
eFigure 3: Adjusted women-to-men rate ratios of having cardiac enzyme test, coronary angiography and coronary revascularisation for FIRST-EVER ACUTE MI, angina and other IHD, by level of adjustment



MI: myocardial infarction, IHD: ischaemic heart disease. Coronary revascularisations within 3 months post admission were included. The total number for analyses of cardiac enzyme test and coronary angiography included first-ever admissions for participants with retrieved medical records. The total number for analyses of coronary revascularisation included all first-ever IHD admissions for participants with and without retrieved medical records. The area of each square is inversely proportional to the variance.

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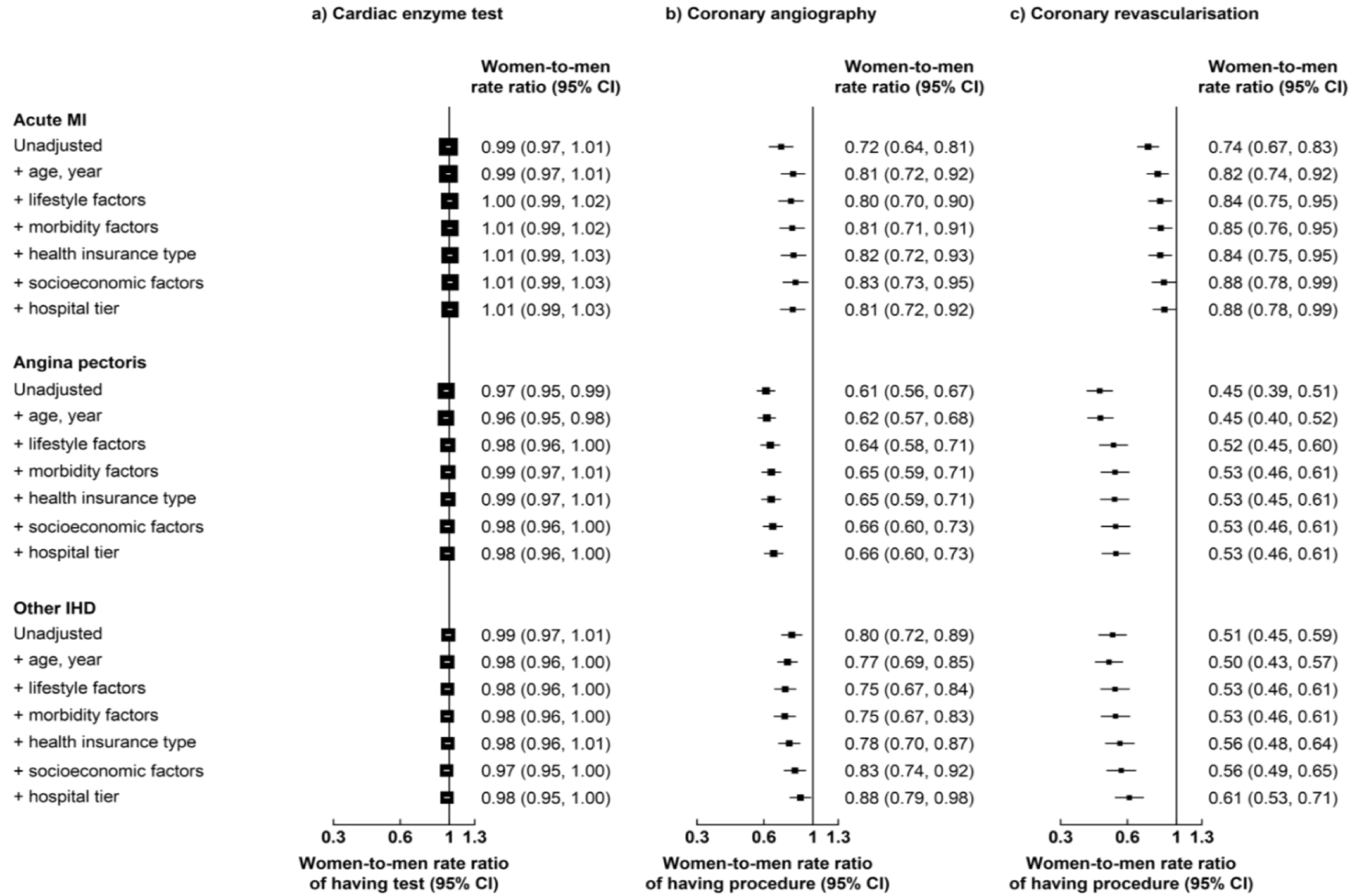
eFigure 4: Adjusted women-to-men rate ratios of having cardiac enzyme test, coronary angiography and coronary revascularisation for acute MI, angina and other IHD by level of adjustment, analyses stratified by region



MI: myocardial infarction, IHD: ischaemic heart disease Coronary revascularisations within 3 months post admission were included. The area of each square is inversely proportional to the variance. Estimates were synthesized using inverse-variance weighting method.

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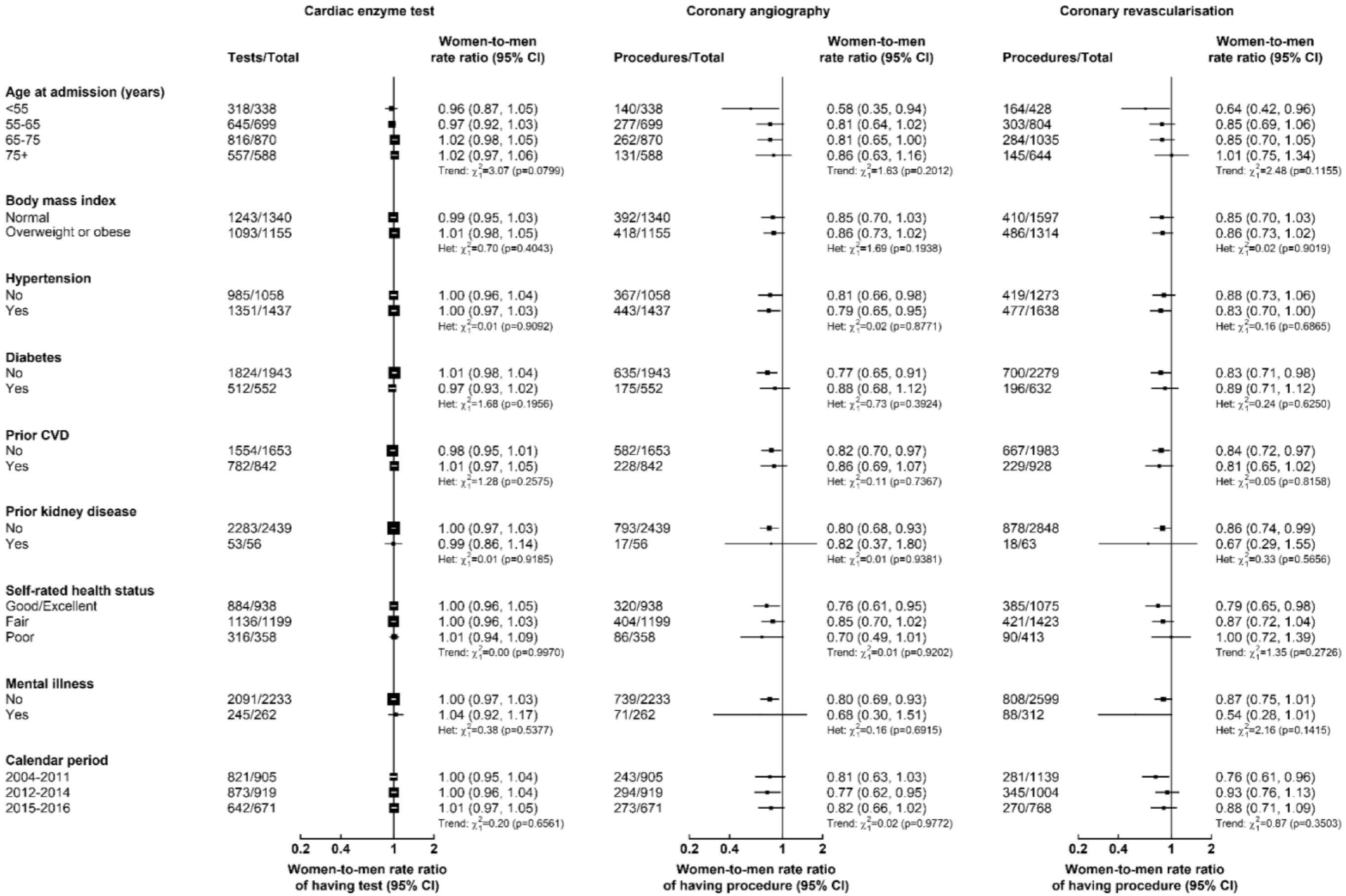
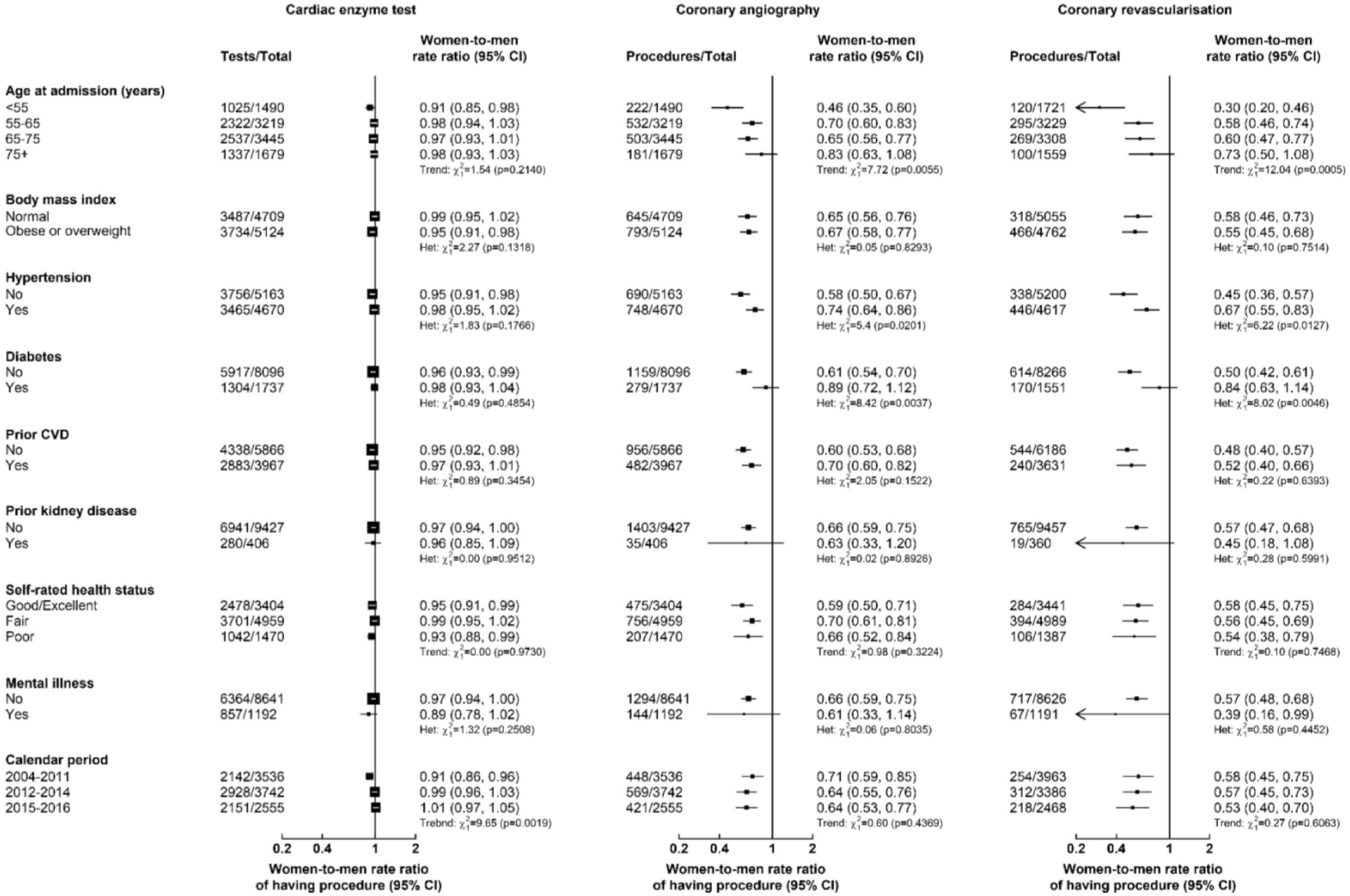
eFigure 5: Adjusted women-to-men rate ratios of having cardiac enzyme test, coronary angiography and coronary revascularisation for ACUTE MI, by selected risk factors



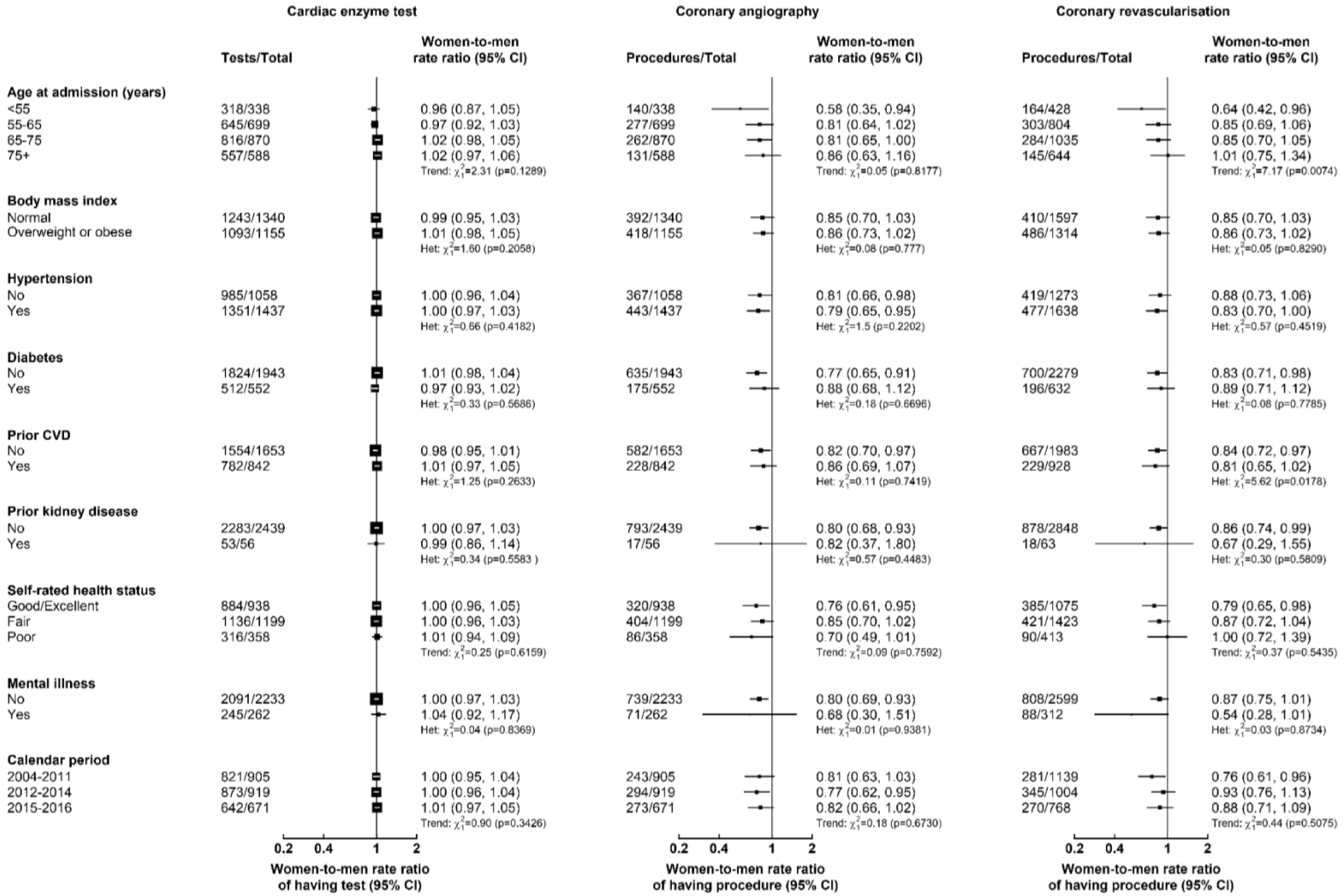
MI: myocardial infarction, CVD: cardiovascular disease. Models included adjustments for demographic factors, lifestyle factors, morbidity factors, health insurance type (except by area of residence), socioeconomic factors, and hospital tier, as appropriate. Coronary revascularisations within 3 months post admission were included. The area of each square is inversely proportional to the variance.

eFigure 6: Adjusted women-to-men rate ratios of having cardiac enzyme test, coronary angiography and coronary revascularisation for ANGINA, by selected risk factors



CVD: cardiovascular disease. Models included adjustments for demographic factors, lifestyle factors, morbidity factors, health insurance type (except by area of residence), socioeconomic factors, and hospital tier, as appropriate. Coronary revascularisations within 3 months post admission were included. The area of each square is inversely proportional to the variance.

eFigure 7: Adjusted women-to-men rate ratios of having cardiac enzyme test, coronary angiography and coronary revascularisation for OTHER IHD, by selected risk factors



IHD: ischaemic heart disease. CVD: cardiovascular disease. Models included adjustments for demographic factors, lifestyle factors, morbidity factors, health insurance type (except by area of residence), socioeconomic factors, and hospital tier, as appropriate. Coronary revascularisations within 3 months post admission were included. The area of each square is inversely proportional to the variance.

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