

# Gender difference in clinical outcomes of the patients with coronary artery disease after percutaneous coronary intervention

A systematic review and meta-analysis

Yaya Guo, MD<sup>a</sup>, Fahui Yin, MD<sup>a</sup>, Chunlei Fan, MD<sup>a</sup>, Zhilu Wang, MD<sup>b,\*</sup>

#### Abstract

**Background and objectives:** Previous researches have reported the controversial results regarding the gender difference in clinical outcomes of patients with coronary artery disease after percutaneous coronary intervention. Hence, this systematic review and meta-analysis was designed to investigate whether gender difference existed in patients with coronary artery disease after percutaneous coronary intervention.

**Methods:** PubMed, Embase, and the Cochrane Library database were searched up to February 10, 2018. Studies comparing the gender-specific effect on clinical outcomes of patients with coronary artery disease after percutaneous coronary intervention were identified, to analyze mortality, major adverse cardiovascular events (MACE) and revascularization. Statistical software RevMan was utilized in this meta-analysis.

**Results:** A total of 49 studies, involving 1,032,828 patients (774,115 males and 258,713 females) reporting gender-specific outcomes, were included in this study. The in-hospital mortality, 30-day mortality, 1-year mortality, and at least 2-years mortality in male patients with coronary artery disease after percutaneous coronary intervention were significantly lower than those of females (odds ratio [OR] 0.58 95% confidence interval [CI] 0.52–0.63, P < .001; OR 0.64, 95% CI 0.61–0.66, P = .04; OR 0.67, 95% CI 0.60–0.75, P < .001 and OR 0.71, 95% CI 0.63–0.79, P = .005, respectively). The MACE was significantly decreased in male subjects after initial percutaneous coronary intervention compared with females in <1-year or at least 1-year (OR 0.67, 95% CI 0.56–0.80, P < .001 and OR 0.84, 95% CI 0.76–0.93, P < .001). The male patients after percutaneous coronary intervention harbored higher rate of revascularization compared with females for at least 1-year (OR 1.17, 95% CI 1.00–1.36, P < .001), while the rate of revascularization in male patients for < 1-year was lower than that of females (OR 0.93, 95% CI 0.69–1.26, P < .001).

**Conclusions:** The systematic review and meta-analysis suggests that the prognosis of male patients with coronary artery disease after percutaneous coronary intervention is better than that of females, except for long-term revascularization.

**Abbreviations:** CI = confidence interval, MACE = major adverse cardiovascular events, OR = odds ratio, PCI = percutaneous coronary intervention.

Keywords: coronary artery disease, gender, percutaneous coronary intervention

# 1. Introduction

Coronary artery disease is the most common cardiovascular disease caused by coronary stenosis, spasm or occlusion. It is estimated that

#### Editor: Salvatore Patanè.

Funding and conflict of interest: All authors have declared that no support, financial, or otherwise, has been received from any organization that may have an interest in the submitted work and there are no other relationships or activities that could appear to have influenced the submitted work.

YG, FY, and CF contributed equally to this work.

Supplemental Digital Content is available for this article.

<sup>a</sup> The First Medical Clinical College of Lanzhou University, <sup>b</sup>Department of Cardiology, The First Hospital of Lanzhou University, Lanzhou, Gansu, China.

\* Correspondence: Zhilu Wang, Department of Cardiology, The First Hospital of Lanzhou University, Lanzhou, Gansu, China, 730000 (e-mail: wangzhl@lzu.edu.cn).

Copyright © 2018 the Author(s). Published by Wolters Kluwer Health, Inc. This is an open access article distributed under the terms of the Creative Commons Attribution-Non Commercial License 4.0 (CCBY-NC), where it is permissible to download, share, remix, transform, and buildup the work provided it is properly cited. The work cannot be used commercially without permission from the journal.

Medicine (2018) 97:30(e11644)

Received: 25 February 2018 / Accepted: 28 June 2018 http://dx.doi.org/10.1097/MD.000000000011644 up to 23.3 million people will die of cardiovascular disease by 2030.<sup>[1]</sup> To improve patient's viability, percutaneous coronary intervention (PCI) is the most commonly applied approach of reperfusion in many countries. However, multiple researches have pointed out that there were some prognostic differences between different genders.<sup>[2–44]</sup> Some studies have showed persistent gender difference in outcomes after adjusting multivariate factors,<sup>[2,5,7,9,10,13,15,18,20–2,5,28,30–33,35–39,41–43]</sup> while other studies also demonstrated that gender was not an independent factor for patient's outcome.<sup>[3,4,11,12,14,17,19,26,27,29,34,40,44]</sup> Although previous meta-analysis has demonstrated the effect of gender on response to PCI, which not involved major adverse cardiovascular events (MACE) and revascularization, and the follow-up period was also comparatively short.<sup>[45–48]</sup> Therefore, this meta-analysis was designed to determine the gender difference in patients with coronary artery disease after PCI, and provide evidence for the development of the guideline.

# 2. Materials and methods

# 2.1. Date source and search strategy

PubMed, Embase, and the Cochrane Library database were searched up to February 10, 2018. The following keywords and

medical subject headings were utilized according to the "PICO" strategy: "coronary artery disease", "percutaneous coronary intervention" or "PCI", "gender", or "sex". Meanwhile, to prevent missing the related articles, the bibliography of the articles included in this study was retrieved manually. All analyses were based on previous published some studies, thus no ethical approval and patient consent are required.

### 2.2. Study selection and quality assessment

Three reviewers (YYG, FHY, and CLF) preliminarily and independently screened the articles that were eligible for study based on the title and summary. In the case of disagreements, the issues were solved through tripartite negotiation when checking the selected articles. The filtered article satisfied the following criteria: Coronary artery disease, including acute coronary syndrome, acute myocardial infarction, ST-segment elevation myocardial infarction, non-ST-segment elevation myocardial infraction, non-ST segment elevation acute coronary syndrome, unstable angina, and stable coronary artery disease; patients undergoing PCI; gender, sex, female, and male; gender-related different outcomes, including short and long-term mortality, MACE, revascularization. In this meta-analysis, all original articles were endeavored to collect, without considering case reports, summaries of the meeting or relevant comments of the original study. The Cochrane collaboration's tool<sup>[49]</sup> and Newcastle-Ottawa scale<sup>[50]</sup> were utilized to assess the quality of randomized controlled trials and observational studies.

#### 2.3. Outcome definition

The outcomes of this pooled analysis included 3 primary endpoints, that was, mortality, MACE, and revascularization. The mortality was assessed mainly from in-hospital mortality, 30-day mortality, 1-year mortality, and at least 2-years mortality. The MACE and revascularization were divided by the cutoff of 1 year, including <1-year and at least 1-year MACE, revascularization for <1 year and at least 1 year.

#### 2.4. Statistical analysis

Statistical software RevMan (version 5.3, Cochrane Collaboration Network) was utilized for data analysis in this meta-analysis. For all the outcomes, dichotomous data were pooled as Mantel– Haenszel odds ratio (OR) with the corresponding 95% confidence interval (CI). Statistical heterogeneity was evaluated by Chi-square test, which was showed by  $I^2$  statistic. Fixed effects models were employed in the case of no evidence of heterogeneity ( $I^2 \ge 50\%$ ), otherwise random effects model was used. Subgroup analysis was performed to figure out sources of heterogeneity in the case of large heterogeneity. Sensitivity analysis was performed to determine whether any single study was primarily responsible for the final results. All statistical tests were two-tailed, and a *P* value < 0.05 was considered as statistical significance.

### 3. Results

# 3.1. Search results

A total of 6636 articles were retrieved, of which 157 related articles were identified after screening the title and abstract. Studies with subjects <100, non-English literature and those failed to meet the inclusion criteria of the study were excluded by reading the full text. Final only 49 nonrandomized control studies

are included, which 13 studies were from Asian countries, 25 studies from European countries, 11 studies from North American, and 2 studies from Australia. The duration of follow-up varied from hospital stay to 30-day, and lasting to 7 years. The NOS was utilized to evaluate all the enrolled studies in this pooled analysis. Of them the quality score was 7 and 8 in 16 and the remaining 33 studies on the 0 to 10 scoring system, respectively (see Table, Supplemental Content, http://links.lww. com/MD/C358, which illustrates the specific scores for each study).

#### 3.2. Baseline data characteristics

Age, a history of hypertension, hyperlipidemia or dyslipidemia, diabetes mellitus, and smoking are reviewed by carefully reading the full text and summarizing the baseline data of each study (Table 1). Meanwhile, the male patients with coronary artery disease after PCI were found to harbor lower incidence of hypertension (OR 0.58, 95% CI 0.47-0.71, P < .001), diabetes (OR 0.72, 95% CI 0.68-0.77, P<.001), hyperlipidemia or dyslipidemia (OR 0.98, 95% CI 0.94-1.02, P<.001), and cardiogenic shock (OR 0.78, 95% CI 0.65-0.92, P<.001) compared with females. Although the smoking rate of male subjects (OR 2.65, 95% CI 2.16–3.24, P < .001) was higher than that of females, but the symptom onset time, door-to-balloon time and reperfusion time for female patients with coronary artery disease after PCI were longer than those of males (Table 2). In addition, the age of male patients is younger compared with females (Table 1).

#### 3.3. The mortality

The 24 studies  $(n=430,914)^{[5,10,12,14,18,19,21,22,24-$ reported on PCI postoperative inhospital mortality, which show that the in-hospital mortality of male patients was significantly lower than that of females (OR 0.58, 95% CI 0.52–0.63, P < .001,  $I^2 = 66\%$ ) (Fig. 1). This gender differences also reflect in 30-day mortality [OR 0.64, 95% CI 0.61–0.66, P=.04,  $I^2=40\%$ ; 19 studies (n=523,304)],<sup>[2-4,7,8,13–17,23,25,26,33–36,42,53]</sup> 1-year mortality [OR 0.67, 95% CI 0.60– 0.75, P < .001,  $I^2 = 73\%$ ; 20 studies  $(n = 590, 590)]^{[8,10,13,15-17,20,25,26,28,30,333,35,36,38,43,44,53-55]}$  and >2-years mortality [OR 0.71, 95% CI 0.63–0.79, P=.005,  $I^2=57\%$ ; 14 studies (n= 43,096)]<sup>[4–6,18,19,23,29,31,34,36,40,43,52,56]</sup> (Figs. 2–4). Due to the low heterogeneity ( $I^2 < 50\%$ ) of the 30-day follow-up, the fixed effects models were used, without subgroup analysis. Other follow-up results showed that the  $I^2$  value was >50%. Subgroup analysis was carried out according to different prognostic factors. However, the source of heterogeneity could not be accurately identified, thus the random effects model was used. Sensitivity analysis indicated that the results of each group were relatively stable and reliable.

# 3.4. MACE

Pooled analysis of 15 studies (n=230,477) shows that the incidence of MACE was lower in male patients with coronary artery disease after PCI compared with females in follow-up period of < 1-year (OR 0.67, 95% CI 0.56–0.80, P<.001,  $I^2$  = 88%)<sup>[3,7,11,13,14,17,18,25,26,30,36,37,38,53,56]</sup> (Fig. 5). The male patients also experienced lower rate of MACE than females when the follow-up period was extended to at least 1-year [OR 0.84, 95% CI 0.76–0.93, P<.001,  $I^2$ =74%; 17 studies

# Table 1 Characteristics of included studies.

		Total						Cardiogenic
Study	Gender	patients	Age, years	Hypertension	Diabetes	Dyslipidemia	Smoking	shock
Cheng et al, 2004	M/W	874/158	61±12/67±11	393/106	199/61	370/65	570/8	102/27
Zimmermann et al, 2009	M/W	405/161	$61 \pm 13/69 \pm 13$	254/127	116/60	271/108	267/55	32/14
Bufe et al, 2010	M/W	376/124	$58 \pm 11/65 \pm 12$	248/68	42/30	178/62	253/50	38/14
Ferrante et al, 2011	M/W	343/138	53.6~70.8/63.2~80.1	187/94	65/38	166/67	163/42	NS
Ferrante et al. 2012	M/W	565/179	53~72/62~78	308/118	80/28	213/73	226/51	NS
Pu et al. 2011	M/W	446/148	$61.3 \pm 11.3/70.4 \pm 9.3$	222/96	80/47	90/22	337/23	NS
Dziewierz et al. 2013	M/W	814/272	51~71/60~79	NS	115/53	NS	319/71	NS
Wiinbergen et al. 2013	M/W	668/202	$59.0 \pm 10.7/64.7 \pm 11.7$	167/87	58/30	194/49	439/109	NS
Birkemever et al. 2014	M/W	823/281	61 + 12/69 + 11	478/191	165/79	379/116	379/65	82/28
Motovska et al. 2008	M/W	371/159	61 7/66 7	127/81	58/40	NS	107/59	NS
Zanchi et al. 2009	M/W	364/124	60.3/67.3	203/93	125/45	173/60	187/34	NS
Otten et al. 2013	M/W	4991/1755	48~77/48~80	1489/740	486/284	1073/341	2331/704	NS
Zhang et al 2010	MAW	1574/468	$639 \pm 113/717 \pm 88$	803/322	348/171	624/210	1033/46	NS
Jakobsen et al. 2012	MAN	5405/1980	NS	NS	NS	NS	NS	NS
Meller et al 2013	MAN	935/366	49~66/57~75	406/219	139/93	341/166	341/132	NS
Mrdovic et al 2013	MAN	1533/563	NS	NS	NS	NS	NS	NS
Toyota et al. 2013	MAN	3182/1197	$645 \pm 117/741 \pm 109$	2442/966	1046/380	NS	1652/175	270/128
Pain et al 2013	MAN	5429/1875	$61.1 \pm 12.2/67.9 \pm 11.9$	2350/1012	1096/444	2177/804	1529/370	NS
Velders et al 2013	MAN	2615/868	61.8 + 11.9/67.6 + 13.1	841/394	264/122	608/187	1222/344	NS
Gevent et al 2017	MAN	6153/1020	60 7/68 2	2/55/1056	868/355	NS	NS	NS
lackson at al 2011	MAN	6220/25/2	58 3/65 1	/012/1801	1280/680	NS	2021/1037	NS
do Roor at al 2014	MAN	9599/22/2	61.2 + 11.5/66.2 + 12.1	2726/1951	1264/600	6690/2522	2/06/791	152/62
Benamer et al 2014	N// N/	13 006/366/	50 3/60 7	NS	2016/687	NS	2430/701 NS	522/2/6
Al-Fieldh et al. 2011	MAN	2151/802	62 17 ± 12 3/60 6 ± 11 6	1156/56/	/22/217	NS	1513/388	71/35
Elkoustaf at al. 2006	MAN	2151/002	62.6 ± 12.9/69.0 ± 12.2	528/220	951/110	624/204	102/96	NC
Ordoubadi et al. 2000	NAAA/	1069/270	$62.0 \pm 12.0/00.0 \pm 12.3$	782/265	220/122	702/225	133/00 900/107	NG
Clasor at al. 2006	NAAA/	2020/1565	03.1 ± 11.0/07.0 ± 10.3	102/203	1610/65/	2170/1200	2295/0/2	NG
Hiraka wa at al. 2006	NAAA/	1022/202	61 + 19/60 + 22	2/5/1/2	220/01	122/25	696/66	NG
Kumphani at al. 2010		1177/607	64 6 · 11 7/69 0 · 12 60	040/140 NC	230/91	102/00 NC	000/00	NO
Liu at al 2014		202/162	70 4 . 2 0/70 7 . 2 0	000/100	100/67	160/70	200/114	INO NC
Liu el al, 2014 Takagi at al. 2016		011/010	10.4±3.2/10.1±3.2	220/130	205/102	100/70 544/144	02/40 NC	INO NC
Takagi et al. 2010		014/212	$07.0 \pm 9.9/09.9 \pm 10.3$	010/170	290/102	2042/2101	0670/1100	6/I
		4400/24/4	$03 \pm 12/07 \pm 13$	3049/2107	1307/1023	3042/2101	20/3/1100	221/139
Yang et al, 2017	IVI/ VV	3305/1355	$61.6 \pm 10.9/66.5 \pm 9.3$	1986/997	679/399	888/381	NS	INS NG
Wada et al. 2017		1019/390	$04.0 \pm 14.0/09.7 \pm 0.0$	1140/301	10.050/4500	10 CEZ/2020	1207/110	110
NulliaSawa, et al. 2010		31,910/11,320	$100.7 \pm 11.4/75 \pm 10.3$	23,312/0747	12,932/4333	19,007/7030	12,042/11/1	020/303 FF70/0007
		33,8402/119,799	03.76/08.49	100,210/97,200	005/101	102,330/00,030	1/0310/00,407	33/3/230/
Kanic et al, 2017	IVI/ VV	2514/1110	62.7/69.3	999/4/1	295/161	839/332	INS	104/60
Jarran et al, 2017	IVI/ VV	1926/500	57.2±4.9/62.9±5.5	1104/407	840/328	893/291	992/63	INS ZO (OO
Idris et al. 2017	IVI/ VV	2200/747	43~75/41~80	11/3/485	529/231	1547/515	/2//148	73/29
Heer et al, 2017	IVI/ VV	125,918/48,717	53~75/61~81	NS	28,782/13,880	INS	INS NO	INS
Farmer et al, 2017	M/W	63,717/1040	60.1~70.6/54.7~65.8	57,807/913	31,246/495	57,575/898	NS	NS
Chandrasekha r, et al, 2016	M/W	3689/1162	$48.6 \pm 5.6/48.1 \pm 6.0$	2580/859	1029/476	2802/898	16/4/5/1	NS
Ng et al, 2015	IVI/VV	11,004/3780	$61.1 \pm 11.0/65.6 \pm 11.5$	6624/2721	2520/1134	NS	3752/1077	NS
Lempereur et al, 2014	M/W	95,030/35,955	$64.8 \pm 11.6/70.3 \pm 11.3$	50,270/22,759	19,291/9635	55,498/21,177	64,240/12,656	1806/755
Kanic et al, 2016	M/W	1472/597	$61.8 \pm 12.0/68.3 \pm 12.6$	547/234	146/82	472/179	NS	92/50
Numasawa et al, 2015	M/W	8114/2106	$66.6 \pm 10.8/72.7 \pm 9.7$	5924/1629	3421/865	5309/1435	3257/300	NS
Perl et al, 2015	M/W	1075/271	$60 \pm 13/69 \pm 13$	415/171	215/73	490/151	580/92	NS
Imami et al, 2015	M/W	611/221	$61.8 \pm 12.3/71.2 \pm 12.1$	223/111	128/46	126/54	259/71	NS
Barthélémy et al, 2015	M/W	593/182	$69 \pm 15/70 \pm 15$	251/102	108/33	233/63	NS	NS

 $M\!/\!W\!=\!Man/Woman,\ NS\!=\!Not$  Statement.

7-1-1-0										
The ischemia-reperfusion time between different genders were mentioned in this study.										
Study	Gender	Symptom onset time, minutes	Door-to-balloon time, minutes	Reperfusion time, minutes						
Cheng et al, 2004	M/W	$186 \pm 155/205 \pm 148$	NS	284±172/317±175						
Zimmermann et al, 2009	M/W	$236 \pm 263/262 \pm 235$	$63 \pm 58/57 \pm 45$	NS						
Bufe et al, 2010	M/W	NS	NS	$230 \pm 157/254 \pm 168$						
Ferrante et al, 2011	M/W	140-395/165-485	52-117/57-148	NS						
Ferrante et al, 2012	M/W	145-315/150-320	70-138/74-164	NS						
Pu et al, 2011	M/W	NS	NS	$246 \pm 174/294 \pm 174$						
Dziewierz et al, 2013	M/W	NS	NS	140-340/145-359						
Wijnbergen et al, 2013	M/W	$176 \pm 119/204 \pm 135$	$16 \pm 7/16 \pm 6$	$193 \pm 119/220 \pm 135$						
Otten et al, 2013	M/W	NS	70-73/30-73	NS						
Zhang et al, 2010	M/W	NS	NS	$351 \pm 176/362 \pm 168$						
Meller et al, 2013	M/W	NS	NS	229.8/295.8						
Velders et al, 2013	M/W	128-279/141-286	33-67/33-68	NS						
Perl et al, 2015	M/W	$596 \pm 367/815 \pm 460$	$44 \pm 40/45 \pm 17$	NS						

M/W = man/woman, NS = not statement.

	Ma	le	Fem	nale		Odds Ratio	Odds Ratio
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Random, 95% Cl	M-H, Random, 95% CI
Al-Fiadh 2011	44	2151	31	802	3.1%	0.52 [0.33, 0.83]	
Barthelemy 2015	67	593	36	182	3.3%	0.52 [0.33, 0.81]	
Benamer 2011	564	13096	359	3664	8.6%	0.41 [0.36, 0.48]	-
Birkemeyer 2014	37	823	28	281	2.7%	0.43 [0.26, 0.71]	
Elkoustaf 2006	9	816	1	381	0.2%	4.24 [0.53, 33.57]	
Ferrante 2011	14	343	8	138	1.1%	0.69 [0.28, 1.69]	
Gevaert 2014	302	6153	194	1920	7.5%	0.46 [0.38, 0.55]	+
Heer 2017	2501	125918	1461	48717	9.9%	0.66 [0.61, 0.70]	•
Hirakawa 2006	54	1033	31	303	3.1%	0.48 [0.31, 0.77]	
mami 2015	11	611	7	221	0.9%	0.56 [0.21, 1.46]	
Jackson 2011	215	6229	153	2542	7.0%	0.56 [0.45, 0.69]	-
Jarrah 2017	12	1926	7	500	1.0%	0.44 [0.17, 1.13]	
Kanic 2016	115	1427	85	597	5.3%	0.53 [0.39, 0.71]	
<umbhani 2012<="" td=""><td>17</td><td>1177</td><td>11</td><td>697</td><td>1.4%</td><td>0.91 [0.43, 1.96]</td><td></td></umbhani>	17	1177	11	697	1.4%	0.91 [0.43, 1.96]	
empereur 2014	1520	95030	899	35955	9.7%	0.63 [0.58, 0.69]	•
Liu 2014	4	303	5	162	0.5%	0.42 [0.11, 1.59]	
Numasawa 2015	772	8114	312	2106	8.5%	0.60 [0.52, 0.70]	-
Numasawa 2016	219	31913	98	11326	6.4%	0.79 [0.62, 1.01]	
Ordoubadi 2012	1	1268	1	372	0.1%	0.29 [0.02, 4.69]	
Pain 2013	55	5429	30	1857	3.3%	0.62 [0.40, 0.98]	
Pendyala 2013	155	4455	112	2474	6.2%	0.76 [0.59, 0.97]	-
Foyota 2013	155	3182	104	1197	6.0%	0.54 [0.42, 0.70]	-
Zanchi 2009	14	364	14	124	1.4%	0.31 [0.15, 0.68]	
Zhang 2010	60	1574	21	468	2.7%	0.84 [0.51, 1.40]	
fotal (95% CI)		313928		116986	100.0%	0.58 [0.52, 0.63]	•
Fotal events	6917		4008				
leterogeneity: Tau <sup>2</sup> = est for overall effect	= 0.02; Ch Z = 11.09	i <sup>2</sup> = 68.17 ) (P < 0.00	, df = 23 ( )001)	(P < 0.000	01); I² = 6	6%	0.01 0.1 1 10 100

Figure 1. Forest plot of in-hospital mortality in male vs female patients with coronary artery disease after PCI. PCI = percutaneous coronary intervention.

(n = 111,903)]<sup>[4-6,13,17,18,25,26,29,30,31,36,38,52,54-56]</sup> (Fig. 6). The results of both groups displayed that the  $I^2$  value was >50%, but the appropriate factors for the high heterogeneity after adopted the subgroup analysis cannot be identified. Therefore, the meta-

analysis of MACE was performed by random effects model. Sensitivity analysis showed that no single study was responsible for the overall effect size, and the results were stable and credible.

	Ma	le	Fem	ale		Odds Ratio	Odds Ratio
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Fixed, 95% Cl	M-H, Fixed, 95% Cl
Al-Fiadh 2011	51	2151	38	802	1.0%	0.49 [0.32, 0.75]	
Bufe 2010	21	347	12	143	0.3%	0.70 [0.34, 1.47]	
Cheng 2004	65	874	23	158	0.7%	0.47 [0.28, 0.78]	
de Boer 2014	316	8588	158	3343	4.2%	0.77 [0.63, 0.94]	-
Dziewierz 2013	35	814	21	272	0.6%	0.54 [0.31, 0.94]	A CONTRACT OF A
Idris 2017	44	2265	27	747	0.8%	0.53 [0.32, 0.86]	
Jakobsen 2012	295	5405	168	1980	4.4%	0.62 [0.51, 0.76]	+
Jarrah 2017	20	1926	9	500	0.3%	0.57 [0.26, 1.27]	
Kanic 2017	148	2514	110	1110	2.7%	0.57 [0.44, 0.74]	-
Kunadian 2017	5137	338462	2800	119799	77.2%	0.64 [0.61, 0.67]	
Meller 2013	10	935	20	366	0.5%	0.19 [0.09, 0.40]	
Mrdovic 2013	69	1533	32	563	0.8%	0.78 [0.51, 1.20]	
Ng 2015	110	11004	49	3780	1.4%	0.77 [0.55, 1.08]	
Ordoubadi 2012	7	1268	3	372	0.1%	0.68 [0.18, 2.65]	
Otten 2013	178	4991	126	1775	3.4%	0.48 [0.38, 0.61]	-
Perl 2015	21	1075	13	271	0.4%	0.40 [0.20, 0.80]	
Pu 2011	14	464	7	148	0.2%	0.63 [0.25, 1.58]	
Zhang 2010	89	1574	29	468	0.8%	0.91 [0.59, 1.40]	
Zimmermann 2009	21	374	12	143	0.3%	0.65 [0.31, 1.36]	2
Total (95% CI)		386564		136740	100.0%	0.64 [0.61, 0.66]	
Total events	6651		3657				
Heterogeneity: Chi <sup>2</sup> =	29.92, df	= 18 (P =	0.04); I <sup>2</sup> =	40%			
Test for overall effect:	Z=21.49	(P < 0.00	001)				

Figure 2. Forest plot of 30-day mortality in male vs female patients with coronary artery disease after PCI. PCI = percutaneous coronary intervention.

	Ma	le	Fem	ale		Odds Ratio	Odds Ratio
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Random, 95% CI	M-H, Random, 95% Cl
Al-Fiadh 2011	103	2151	51	802	4.8%	0.74 [0.52, 1.05]	
Barthelemy 2015	91	593	41	182	4.0%	0.62 [0.41, 0.94]	
Birkemeyer 2014	57	823	42	281	3.9%	0.42 [0.28, 0.65]	
Chandrasekhar 2016	71	3689	25	1162	3.5%	0.89 [0.56, 1.41]	
Dziewierz 2013	50	814	29	272	3.3%	0.55 [0.34, 0.89]	
Farmer 2017	3122	63717	37	1040	5.1%	1.40 [1.00, 1.94]	-
Glaser 2006	149	3030	71	1565	5.7%	1.09 [0.81, 1.45]	+
Idris 2017	91	2265	50	747	4.7%	0.58 [0.41, 0.83]	
Imami 2015	17	611	21	221	2.1%	0.27 [0.14, 0.53]	
Jakobsen 2012	444	5405	256	1980	7.8%	0.60 [0.51, 0.71]	-
Jarrah 2017	32	1926	15	200	2.3%	0.21 [0.11, 0.39]	
Kumbhani 2012	173	1177	110	697	6.2%	0.92 [0.71, 1.19]	-
Kunadian 2017	11946	338462	6272	119799	9.4%	0.66 [0.64, 0.68]	
Meller 2013	34	935	28	366	3.0%	0.46 [0.27, 0.76]	
Mrdovic 2013	99	1533	47	563	4.6%	0.76 [0.53, 1.09]	
Ng 2015	297	11004	140	3780	7.1%	0.72 [0.59, 0.88]	+
Ordoubadi 2012	17	1268	10	372	1.6%	0.49 [0.22, 1.08]	
Otten 2013	316	4991	171	1755	7.3%	0.63 [0.52, 0.76]	+
Pendyala 2013	329	4455	263	2474	7.7%	0.67 [0.57, 0.79]	+
Velders 2013	173	2615	86	868	6.0%	0.64 [0.49, 0.84]	
Total (95% CI)		451464		139126	100.0%	0.67 [0.60, 0.75]	•
Total events	17611		7765				10
Heterogeneity: Tau <sup>2</sup> = 0 Test for overall effect: Z	.03; Chi <sup>2</sup> : = 7.27 (P	= 69.71, d < 0.00001	f=19 (P 1)	< 0.00001	); I² = 739	Хо	0.01 0.1 1 10 100 Favour males Favour females

Figure 3. Forest plot of 1-year mortality in male vs female patients with coronary artery disease after PCI. PCI = percutaneous coronary intervention.

#### 3.5. The revascularization

The pooled data show that the revascularization rate in male patients with coronary artery disease after PCI was lower than that of females during a follow-up period of <1-year [OR 0.93, 95% CI 0.69–1.26, P <.001,  $I^2$ =64%; 9 studies (n= 39,375)]<sup>[2,13,14,25,26,35,36,53,56]</sup> (Fig. 7), which was on opposite to the outcomes between male and female patients for at least 1-year [OR 1.17, 95% CI 1.00–1.36, P <.001,  $I^2$ =71%; 16 studies (n=37,770)<sup>[4–6,9,10,13,18,25,26,29,30,35,36,44,52,56]</sup> (Fig. 8). The result showed that the  $I^2$  values of both groups were >50%. Random effects model was utilized, because the heterogeneity cannot be explained according to subgroup analysis. Sensitivity analysis indicated that the result was stable and relatively robust.

# 4. Discussion

The main results of this meta-analysis are as follows: the mortality in male patients with coronary artery disease after PCI was lower than that of females; the male patients with coronary artery disease after PCI harbored a lower incidence of MACE, no matter whether the follow-up period was <1 year or at least 1 year; the male patients with coronary artery disease after PCI overwhelmed females in long-term revascularization.

The mortality in male patients with coronary artery disease after PCI was lower than that of females in this study both in short-term and long-term follow-up, which was consistent with previous systematic reviews.<sup>[45–48]</sup> Because female subjects had much more hypertension, diabetes, dyslipidemia this meta-

	Ma	е	Fema	ale		Odds Ratio	Odds Ratio
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Random, 95% Cl	M-H, Random, 95% Cl
Bufe 2010	36	376	15	124	2.7%	0.77 [0.41, 1.46]	
de Boer 2014	1134	8588	512	3343	13.7%	0.84 [0.75, 0.94]	-
Ferrante 2011	39	343	23	138	3.3%	0.64 [0.37, 1.12]	
Ferrante 2012	37	565	17	179	3.0%	0.67 [0.37, 1.22]	
Idris 2017	167	2265	81	747	8.1%	0.65 [0.49, 0.87]	-
Imami 2015	44	611	29	221	4.0%	0.51 [0.31, 0.84]	
Kanic 2016	222	1472	141	597	9.4%	0.57 [0.45, 0.73]	+
Kanic 2017	338	2514	211	1110	11.1%	0.66 [0.55, 0.80]	+
Liu 2014	35	303	12	162	2.4%	1.63 [0.82, 3.24]	
Pain 2013	592	5429	278	1875	12.3%	0.70 [0.60, 0.82]	*
Takagi 2016	126	814	39	212	5.5%	0.81 [0.55, 1.21]	
Toyota 2013	313	3182	192	1197	10.9%	0.57 [0.47, 0.69]	+
Wada 2017	154	1619	52	390	6.7%	0.68 [0.49, 0.96]	
Yang 2017	134	3365	53	1355	7.0%	1.02 [0.74, 1.41]	+
Total (95% CI)		31446		11650	100.0%	0.71 [0.63, 0.79]	•
Total events	3371		1655				
Heterogeneity: Tau <sup>2</sup> =	= 0.02; Chi	<sup>2</sup> = 29.97	7, df = 13	(P = 0.0)	05); I <sup>2</sup> = 5	7%	
Test for overall effect	Z= 5.90 (	P < 0.00	001)				0.01 0.1 1 10 100

Figure 4. Forest plot of at least 2-years mortality in male vs female patients with coronary artery disease after PCI. PCI = percutaneous coronary intervention.

	Ma	le	Fem	ale		Odds Ratio	Odds Ratio
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Random, 95% Cl	M-H, Random, 95% Cl
Al-Fiadh 2011	138	2151	81	802	7.1%	0.61 [0.46, 0.81]	
Chandrasekhar 2016	249	3689	104	1162	7.6%	0.74 [0.58, 0.94]	-
Heer 2017	2750	125918	1607	48717	8.7%	0.65 [0.61, 0.70]	
Idris 2017	93	2265	39	747	6.2%	0.78 [0.53, 1.14]	
Motovska 2008	31	371	16	159	4.1%	0.81 [0.43, 1.54]	
Mrdovic 2013	121	1533	52	563	6.6%	0.84 [0.60, 1.18]	
Ng 2015	846	11004	305	3780	8.4%	0.95 [0.83, 1.09]	+
Ordoubadi 2012	48	1268	20	372	4.8%	0.69 [0.41, 1.18]	
Otten 2013	284	4991	296	1755	8.1%	0.30 [0.25, 0.35]	+
Pendyala 2013	221	4455	162	2474	7.8%	0.74 [0.60, 0.92]	-
Pu 2011	82	446	39	148	5.7%	0.63 [0.41, 0.97]	
Toyota 2013	220	3182	135	1197	7.7%	0.58 [0.47, 0.73]	-
Yang 2017	55	3365	32	1355	5.7%	0.69 [0.44, 1.07]	
Zhang 2010	155	1574	50	468	6.6%	0.91 [0.65, 1.28]	-
Zimmermann 2009	37	405	26	161	4.8%	0.52 [0.30, 0.89]	
Total (95% CI)		166617		63860	100.0%	0.67 [0.56, 0.80]	•
Total events	5330		2964				
Heterogeneity: Tau <sup>2</sup> = 0	.09; Chi <sup>2</sup> =	= 119.79.	df = 14 (F	< 0.000	01); I <sup>2</sup> = 8	38%	
Test for overall effect: Z	= 4.49 (P	< 0.0000	1)				U.U1 U.1 1 10 100 Favour males Favour females

	Ma	е	Fema	ale		Odds Ratio	Odds Ratio
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Random, 95% Cl	M-H, Random, 95% Cl
Al-Fiadh 2011	302	2151	131	802	6.6%	0.84 [0.67, 1.05]	+
Bufe 2010	217	376	68	124	3.9%	1.12 [0.75, 1.69]	-
Chandrasekhar 2016	514	3689	217	1162	7.4%	0.71 [0.59, 0.84]	-
Farmer 2017	4397	63717	56	1040	5.8%	1.30 [0.99, 1.71]	-
Ferrante 2011	106	343	36	138	3.5%	1.27 [0.81, 1.97]	+
Ferrante 2012	106	565	58	179	4.2%	0.48 [0.33, 0.70]	
Glaser 2006	883	3030	551	1565	8.2%	0.76 [0.66, 0.86]	-
Idris 2017	441	2265	165	747	6.9%	0.85 [0.70, 1.04]	-
Liu 2014	63	303	31	162	3.2%	1.11 [0.69, 1.79]	
Mrdovic 2013	167	1533	70	563	5.4%	0.86 [0.64, 1.16]	-
Ordoubadi 2012	95	1268	33	372	3.8%	0.83 [0.55, 1.26]	
Otten 2013	1444	4991	515	1755	8.3%	0.98 [0.87, 1.10]	+
Pendyala 2013	1267	4455	886	2474	8.5%	0.71 [0.64, 0.79]	-
Takagi 2016	250	814	76	212	5.0%	0.79 [0.58, 1.09]	
Toyota 2013	414	3182	233	1197	7.4%	0.62 [0.52, 0.74]	-
Wada 2017	259	1619	77	390	5.6%	0.77 [0.58, 1.03]	-
Yang 2017	255	3365	97	1355	6.2%	1.06 [0.83, 1.36]	Ť
Total (95% CI)		97666		14237	100.0%	0.84 [0.76, 0.93]	•
Total events	11180		3300				
Heterogeneity: Tau <sup>2</sup> = 0	0.03; Chi <sup>2</sup> :	= 60.56,	df = 16 (F	< 0.000	001); I <sup>2</sup> = 1	74%	
Test for overall effect: Z	= 3.24 (P	= 0.001)	1				0.01 0.1 1 10 1

Figure 6. Forest plot of the least 1-year MACE in male vs female patients with coronary artery disease after PCI. PCI = percutaneous coronary intervention.

	Ma	e	fema	le		Odds Ratio		Odds Ratio
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Random, 95% Cl		M-H, Random, 95% Cl
Al-Fiadh 2011	54	2151	32	802	14.4%	0.62 [0.40, 0.97]		
Cheng 2004	12	874	2	158	3.3%	1.09 [0.24, 4.90]		
Idris 2017	34	2265	9	747	9.2%	1.25 [0.60, 2.62]		
Jarrah 2017	23	1926	7	500	7.7%	0.85 [0.36, 2.00]		
Ng 2015	187	11004	49	3780	17.1%	1.32 [0.96, 1.81]		+
Ordoubadi 2012	29	1268	14	372	10.5%	0.60 [0.31, 1.14]		
Otten 2013	513	4991	130	1775	19.3%	1.45 [1.19, 1.77]		-
Yang 2017	27	3365	17	1355	11.2%	0.64 [0.35, 1.17]		
Zhang 2010	17	1574	7	468	7.3%	0.72 [0.30, 1.74]		
Total (95% CI)		29418		9957	100.0%	0.93 [0.69, 1.26]		•
Total events	896		267					
Heterogeneity: Tau <sup>2</sup> :	= 0.11; Ch	i <sup>2</sup> = 22.4	3, df = 8 (	P = 0.0	$(04);  ^2 = 6$	4%	-	
Test for overall effect	Z= 0.45	(P = 0.65	5)				0.01	0.1 1 10 100 Favour males Favour females

Figure 7. Forest plot of <1-year revascularization rate in male vs female patients with coronary artery disease after PCI. PCI = percutaneous coronary intervention.

	Mal	е	Fema	ale		Odds Ratio	Odds Ratio
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Random, 95% Cl	M-H, Random, 95% Cl
Al-Fiadh 2011	150	2151	63	802	7.7%	0.88 [0.65, 1.19]	
Barthelemy 2015	59	593	15	182	4.2%	1.23 [0.68, 2.23]	10 Barrier
Birkemeyer 2014	116	823	27	281	5.8%	1.54 [0.99, 2.40]	
Bufe 2010	154	376	46	124	6.1%	1.18 [0.77, 1.79]	
Ferrante 2011	43	343	13	138	3.7%	1.38 [0.72, 2.65]	
Ferrante 2012	60	565	14	179	4.1%	1.40 [0.76, 2.57]	
Idris 2017	203	2265	52	747	7.5%	1.32 [0.96, 1.81]	
Jarrah 2017	63	926	10	500	3.5%	3.58 [1.82, 7.03]	
Liu 2014	17	303	7	162	2.3%	1.32 [0.53, 3.24]	
Ordoubadi 2012	66	1268	22	372	5.1%	0.87 [0.53, 1.44]	
Otten 2013	838	4991	253	1755	10.0%	1.20 [1.03, 1.40]	-
Pendyala 2013	626	4455	382	2474	10.2%	0.90 [0.78, 1.03]	*
Takagi 2016	146	814	51	212	6.9%	0.69 [0.48, 0.99]	
Toyota 2013	1039	3182	294	1197	10.0%	1.49 [1.28, 1.73]	+
Wijnbergen 2013	66	668	24	202	5.1%	0.81 [0.50, 1.34]	
Yang 2017	197	3365	62	1355	7.9%	1.30 [0.97, 1.74]	
Total (95% CI)		27088		10682	100.0%	1.17 [1.00, 1.36]	•
Total events	3843		1335				
Heterogeneity: Tau <sup>2</sup> = Test for overall effect	= 0.06; Chi : Z = 1.98 (	<sup>2</sup> = 52.60 P = 0.05	D, df= 15 )	(P < 0.0	0001); P:	= 71%	0.01 0.1 1 10 100 Favour males Favour females

Figure 8. Forest plot of the least 1-year revascularization rate in male vs female patients with coronary artery disease after PCI. PCI = percutaneous coronary intervention.

analysis, especially longer times of reperfusion ischemia,<sup>[1-8,12,13,15,19,41]</sup> the latter may be caused by chest pain symptoms, which had not been fully explained in female patients with coronary artery disease, leading to delay prehospital visits. Therefore, the high mortality in female patients with coronary artery disease after PCI had been largely attributed to more adverse cardiovascular risk profiles compared with males. This meta-analysis has confirmed that the female patients with coronary artery disease were older than males, which may also attribute to the high mortality of female patients, and consistent with National Cardiovascular Data Registry ACTION Registry of America.<sup>[57]</sup> Meanwhile, in this study, it had also been verified that the female subjects were more prone to suffer from cardiogenic shock, which was considered as another important indicator for higher mortality in female patients with coronary artery disease after PCI. The same consequences were obtained by meta-analysis by Kano et al.<sup>[47]</sup> In short, it is an indisputable fact that the mortality in female patients with coronary artery disease after PCI was high.

Similar to the above results, the male patients with coronary artery disease after PCI also had a lower incidence of MACE for <1 year or at least 1-year in this meta-analysis, which is a supplement and summary to previous systematic reviews and observational studies.<sup>[7,25,29,38,54,56]</sup> The reasons for the above differences should first be attributed to the fact that the mortality in female patients with coronary artery disease after PCI is higher than that of males. Moreover, possessing more adverse cardiovascular risk profile was also an important factor for high incidence of MACE in female patients with coronary artery disease, the baseline data of this study had witnessed this proposition. The study of Jakobsen et al<sup>[15]</sup> also showed female patients with coronary artery disease were burdened with more complications and worse hemodynamic status compared with males. The gender difference of MACE was still largely attributed to the higher incidence of heart failure in female patients with STEMI in some cohort.<sup>[3,6,13,20]</sup> In summary, the above pathological factors had led to the high incidence of MACE in female patients with coronary artery disease after PCI. It is noteworthy that females had a worse clinical outcome, which reminds physicians should pay more attention to female patients in clinical practice.

This systematic review and meta-analysis also showed that male patients with coronary artery disease after PCI had the advantages of revascularization compared with females in the long-term follow-up, which was consistent with the parts of previous observational studies,<sup>[4–6,10,13,18,35,36,44,52,56]</sup> and supplied the main outcome of previous systematic reviews.<sup>[45-48]</sup> This may be associated with more smoking in males from the baseline data of this study. On the contrary, the low incidence of revascularization in female subjects also included lower followup rates, atypical symptoms, difficult identification of myocardial ischemia, unwillingness of receiving invasive examinations, as well as the prejudices of doctor that female subjects might harbor lower rate of coronary arteriography during follow-up.<sup>[17]</sup> In addition, female subjects with coronary artery disease after PCI had higher mortality during short and long-term follow-up, which might reduce the chance of next revascularization. Moreover, a research had indicated that the application of drug-eluting stents could decrease probability of coronary artery revascularization in female patients with PCI.<sup>[58]</sup> Furthermore, the coronary artery of male patient with coronary artery disease is prone to harbor complicated lesions, including left main disease, chronic total occlusion and diffuse lesion.<sup>[56]</sup> Meanwhile, male subjects suffering from more platelet-rich thrombus, atherosclerotic plaque rupture as well as micro-embolization were also demonstrated in some studies.<sup>[59]</sup> The above-described pathophysiological difference would result in elevated risks of revascularization in male subjects. However, the female had a high incidence of <1-year revascularization, which was an integral part to <1-year MACE. Overall, the incidence of revascularization in female patients with coronary artery disease after PCI was higher than that of males in short-term follow-up, which was opposite in long-term follow-up showed the opposite result.

#### 4.1. Limitations

Firstly, the main limitations of this study were that all articles included in this study were nonrandomized control studies. Therefore, many subjective factors were inevitable during the follow-up. Secondly, of the 1,032,828 patients included in the meta-analysis, the female patients accounted for only 1/4 of the total sample size. Thus, unequal distribution of gender may lead to a bias. Thirdly, there are large discrepancy in sample size and follow-up spans among different studies, which may lead to heterogeneity. Because most studies had larger heterogeneity, the random effects model was adopted; the results may weaken the large sample information with better quality. Fourthly, due to the lack of patient-level data, subgroup analysis was not conducted according to the type of subjects, and the specific prognosis of patients with different types of coronary artery disease undergoing PCI could not be assessed. Final, the language included in the study was limited to English, and there was a lack of researches in South America and Africa countries. Therefore, language and regional bias may be unavoidable.

# 5. Conclusions

In conclusion, the prognosis of male patients with coronary artery disease after PCI is better than that of females, except for long-term revascularization.

### **Acknowledgments**

We would like to thank Professor Jinhui Tian of Evidence Based Medicine Center of Lanzhou University for guidance in the systematic search and statistical support.

## **Author contributions**

Conceptualization: Yaya Guo, Zhilu Wang. Data curation: Yaya Guo. Formal analysis: Yaya Guo, Fahui Yin, Chunlei Fan. Investigation: Yaya Guo, Fahui Yin, Chunlei Fan. Methodology: Yaya Guo, Fahui Yin, Chunlei Fan. Project administration: Zhilu Wang. Resources: Yaya Guo. Software: Yaya Guo. Software: Yaya Guo. Supervision: Zhilu Wang. Validation: Zhilu Wang. Writing – original draft: Yaya Guo. Writing – review & editing: Fahui Yin, Chunlei Fan.

#### References

- World Health Organization. The top 10 causes of death, Fact Sheet No.310. Updated January 2017. Accessed date: Jan 16 2018. Available at: www.who.int/mediacentre/factsheets/fs310/en/.
- [2] Cheng CI, Yeh KH, Chang HW, et al. Comparison of baseline characteristics, clinical features, angiographic results, and early outcomes in male vs female with acute myocardial infarction undergoing primary coronary intervention. Chest 2004;126:47–53.
- [3] Zimmermann S, Ruthrof S, Nowak K, et al. Short-term prognosis of contemporary interventional therapy of ST-elevation myocardial infarction: does gender matter? Clin Res Cardiol 2009;98:709–15.
- [4] Bufe A, Wolfertz J, Dinh W, et al. Gender-based differences in long-term outcome after ST-elevation myocardial infarction in patients treated with percutaneous coronary intervention. J Females Health 2010;19:471–5.
- [5] Ferrante G, Corrada E, Belli G, et al. Impact of female sex on long-term outcomes in patients with ST-elevation myocardial infarction treated by primary percutaneous coronary intervention. Can J Cardiol 2011;27:749–55.

- [6] Ferrante G, Presbitero P, Corrada E, et al. Sex-specific benefits of sirolimus-eluting stent on long-term outcomes in patients with STelevation myocardial infarction undergoing primary percutaneous coronary intervention: insights from the Multicenter Evaluation of Single High-Dose Bolus Tirofiban versus abciximab with sirolimuseluting stent or bare-metal stent in acute myocardial infarction study trial. Am Heart J 2012;163:104–11.
- [7] Pu J, Shan P, Ding S, et al. Gender differences in epicardial and tissuelevel reperfusion in patients undergoing primary angioplasty for acute myocardial infarction. Atherosclerosis 2011;215:203–8.
- [8] Dziewierz A, Siudak Z, Rakowski T, et al. Early administration of abciximab reduces mortality in female patients with ST-elevation myocardial infarction undergoing primary percutaneous coronary intervention (from the EUROTRANSFER Registry). J Thromb Thrombolysis 2013;36:240–6.
- [9] Wijnbergen I, Tijssen J, van't Veer M, et al. Gender differences in longterm outcome after primary percutaneous intervention for ST-segment elevation myocardial infarction. Catheter Cardiovasc Interv 2013;82:379–84.
- [10] Birkemeyer R, Schneider H, Rillig A, et al. Do gender differences in primary PCI mortality represent a different adherence to guideline recommended therapy? a multicenter observation. BMC Cardiovasc Disord 2014;14:71.
- [11] Motovska Z, Widimsky P, Aschermann M. The impact of gender on outcomes of patients with ST elevation myocardial infarction transported for percutaneous coronary intervention: analysis of the PRAGUE-1 and 2 studies. Heart 2008;94:e5.
- [12] Zanchi J, Miric D, Giunio L, et al. Gender differences in in-hospital mortality and angiographic findings of patients with acute ST-segment elevation myocardial infarction (STEMI) undergoing percutaneous coronary intervention (PCI). Coll Antropol 2009;33:1359–62.
- [13] Otten AM, Maas AH, Ottervanger JP, et al. Is the difference in outcome between male and female treated by primary percutaneous coronary intervention age dependent? Gender difference in STEMI stratified on age. Eur Heart J Acute Cardiovasc Care 2013;2:334–41.
- [14] Zhang Q, Qiu JP, Zhang RY, et al. Absence of gender disparity in shortterm clinical outcomes in patients with acute ST-segment elevation myocardial infarction undergoing irolimus-eluting stent based primary coronary intervention: a report from Shanghai Acute Coronary Event (SACE) Registry. Chin Med J 2010;123:782–8.
- [15] Jakobsen L, Niemann T, Thorsgaard N, et al. Sex- and age-related differences in clinical outcome after primary percutaneous coronary intervention. Eurointervention 2012;8:904–11.
- [16] Meller SM, Lansky AJ, Costa RA, et al. Implications of myocardial reperfusion on survival in female versus male with acute myocardial infarction undergoing primary coronary intervention. Am J Cardiol 2013;112:1087–92.
- [17] Mrdovic I, Savic L, Asanin M, et al. Sex-related analysis of short- and long-term clinical outcomes and bleeding among patients treated with primary percutaneous coronary intervention: an evaluation of the RISK-PCI data. Can J Cardiol 2013;29:1097–103.
- [18] Toyota T, Furukawa Y, Ehara N, et al. Sex-based differences in clinical practice and outcomes for Japanese patients with acute myocardial infarction undergoing primary percutaneous coronary intervention. Circ J 2013;77:1508–17.
- [19] Pain TE, Jones DA, Rathod KS, et al. Influence of female sex on long-term mortality after acute coronary syndromes treated by percutaneous coronary intervention: a cohort study of 7304 patients. Coron Artery Dis 2013;24:183–90.
- [20] Velders MA, Boden H, van Boven AJ, et al. Influence of gender on ischemic times and outcomes after ST-elevation myocardial infarction. Am J Cardiol 2013;111:312–8.
- [21] Gevaert SA, De BD, Evrard P, et al. Gender, TIMI risk score and inhospital mortality in STEMI patients undergoing primary PCI: results from the Belgian STEMI registry. Eurointervention 2014;9:1095–101.
- [22] Jackson EA, Moscucci M, Smith DE, et al. The association of sex with outcomes among patients undergoing primary percutaneous coronary intervention for ST elevation myocardial infarction in the contemporary era: Insights from the Blue Cross Blue Shield of Michigan Cardiovascular Consortium (BMC2). Am Heart J 2011;161:106–12.
- [23] de Boer SP, Roos-Hesselink JW, van Leeuwen MA, et al. Excess mortality in female compared to male after PCI in STEMI: an analysis of 11, 931 patients during 2000-2009. Int J Cardiol 2014;176:456–63.
- [24] Benamer H, Tafflet M, Bataille S, et al. Female gender is an independent predictor of in-hospital mortality after STEMI in the era of primary PCI: insights from the greater Paris area PCI Registry. Eurointervention 2011;6:1073–9.

- [25] Al-Fiadh AH, Andrianopoulos N, Farouque O, et al. Contemporary outcomes in female undergoing percutaneous coronary intervention for acute coronary syndromes. Int J Cardiol 2011;151:195–9.
- [26] Fath-Ordoubadi F, Barac Y, Abergel E, et al. Gender impact on prognosis of acute coronary syndrome patients treated with drug-eluting stents. Am J Cardiol 2012;110:636–42.
- [27] Hirakawa Y, Masuda Y, Uemura K, et al. Differences in in-hospital mortality between male and female with acute myocardial infarction undergoing percutaneous coronary intervention in Japan: Tokai Acute Myocardial Infarction Study (TAMIS). Am Heart J 2006;151:1271–5.
- [28] Kumbhani DJ, Shishehbor MH, Karim S, et al. Influence of gender on long-term mortality in patients presenting with non-ST-elevation acute coronary syndromes undergoing percutaneous coronary intervention. Am J Cardiol 2012;109:1087–91.
- [29] Takagi K, Chieffo A, Shannon J, et al. Impact of gender on long-term mortality in patients with unprotected left main disease: The Milan and New-Tokyo (MITO) Registry. Int J Cardiol 2014;177:1131–3.
- [30] Pendyala LK, Torguson R, Loh JP, et al. Comparison of adverse outcomes after contemporary percutaneous coronary intervention in female versus male with acute coronary syndrome. Am J Cardiol 2013;111:1092–8.
- [31] Wada H, Ogita M, Miyauchi K, et al. Impact of gender difference on long-term outcomes of percutaneous coronary intervention for coronary artery disease in patients under statin treatment. Heart Vessels 2017;32:16–21.
- [32] Numasawa Y, Inohara T, Ishii H, et al. Comparison of outcomes of female versus male with non-ST-elevation acute coronary syndromes undergoing percutaneous coronary intervention (from the Japanese Nationwide Registry). Am J Cardiol 2017;119:826–31.
- [33] Kunadian V, Qiu W, Lagerqvist B, et al. Gender differences in outcomes and predictors of all-cause mortality after percutaneous coronary intervention (data from United Kingdom and Sweden). Am J Cardiol 2017;119:210–6.
- [34] Kanic V, Vollrath M, Tapajner A, et al. Sex-Related 30-Day and longterm mortality in acute myocardial infarction patients treated with percutaneous coronary intervention. J Females Health 2017;26:374–9.
- [35] Jarrah MI, Hammoudeh AJ, Alnatour DB, et al. Gender differences in risk profile and outcome of Middle Eastern patients undergoing percutaneous coronary intervention. Saudi Med J 2017;38:149–55.
- [36] Idris H, French JK, Shugman IM, et al. Influence of age and gender on clinical outcomes following percutaneous coronary intervention for acute coronary syndromes. Heart Lung Circ 2017;26:554–65.
- [37] Heer T, Hochadel M, Schmidt K, et al. Sex differences in percutaneous coronary intervention—insights from the coronary angiography and PCI registry of the German society of cardiology. J Am Heart Assoc 2017;6: e004972.
- [38] Chandrasekhar J, Usman Baber MD, Sartori S, et al. Sex-related differences in outcomes among male and female under 55 years of age with acute coronary syndrome undergoing percutaneous coronary intervention: Results from the PROMETHEUS Study. Catheter Cardiovasc Interv 2016;89:629–37.
- [39] Lempereur M, Magne J, Cornelis K, et al. Impact of gender difference in hospital outcomes following percutaneous coronary intervention. Results of the Belgian Working Group on Interventional Cardiology (BWGIC) registry. Eurointervention 2014;12:e216–223.
- [40] Kanic V, Vollrath M, Naji FH, et al. Gender related survival differences in ST-elevation myocardial infarction patients treated with primary PCI. Int J Med Sci 2016;13:440–4.
- [41] Numasawa Y, Kohsaka S, Miyata H, et al. Gender differences in in-hospital clinical outcomes after percutaneous coronary interventions: an insight from a Japanese multicenter registry. PLoS One 2015;10:e0116496.
- [42] Michal Laufer-Perl MD, Yacov Shacham MD, Sivan Letourneau-Shesaf MD, et al. Gender-related mortality and in-hospital complications following ST-segment elevation myocardial infarction: data from a

www.md-journal.com

primary percutaneous coronary intervention cohort. Clin Cardiol 2015;38:145-9.

- [43] Ghauharali-Imami S, Bax M, Haasdijk A, et al. The impact of gender on long-term mortality in patients with multivessel disease after primary percutaneous coronary intervention. Netherlands Heart J 2015;23: 592–9.
- [44] Barthélémy O, Degrell P, Berman E, et al. Sex-related differences after contemporary primary percutaneous coronary intervention for STsegment elevation myocardial infarction. Arch Cardiovasc Dis 2015;108:428–36.
- [45] Bavishi C, Bangalore S, Patel D, et al. Short and long-term mortality in female and male undergoing primary angioplasty: a comprehensive meta-analysis. Int J Cardiol 2015;198:123–30.
- [46] Mg VDM, Nathoe HM, Van d GY, et al. Worse outcome in female with STEMI: a systematic review of prognostic studies. Eur J Clin Invest 2015;45:226–35.
- [47] Conrotto F, D'Ascenzo F, Humphries KH, et al. A meta-analysis of sexrelated differences in outcomes after primary percutaneous intervention for ST-segment elevation myocardial infarction. J Interv Cardiol 2015;28:132–40.
- [48] Jang JS, Park YA, Jin HY, et al. P4661Sex difference in mortality among patients with acute myocardial infarction treated by primary percutaneous coronary intervention: a meta-analysis. Eur Heart J 2017; 38(suppl 1):
- [49] Higgins JPT, Altman DG, Gøtzsche PC, et al. The Cochrane Collaboration's tool for assessing risk of bias in randomized trials. Brit Med J 2011;343:d5928.
- [50] Stang A. Critical evaluation of the Newcastle–Ottawa scale for the assessment of the quality of non-randomized studies in meta-analyses. Eur J Epidemiol 2010;25:603–5.
- [51] Elkoustaf RA, Mamkin I, Mather JF, et al. Comparison of results of percutaneous coronary intervention for non-ST-elevation acute myocardial infarction or unstable angina pectoris in male versus female. Am J Cardiol 2006;98:182–6.
- [52] Liu Y, Hu X, Xue Q, et al. Influence of sex on outcomes after percutaneous coronary intervention in patients over 75 years of age with coronary heart disease. Clin Interv Aging 2014;9:1831–7.
- [53] Ng VG, Baumbach A, Grinfeld L, et al. Impact of bleeding and bivalirudin therapy on mortality risk in female undergoing percutaneous coronary intervention (from the REPLACE-2, ACUITY, and HORI-ZONS-AMI Trials). Am J Cardiol 2015;117:186–91.
- [54] Farmer MM, Stanislawski MA, Plomondon ME, et al. Sex differences in 1-year outcomes after percutaneous coronary intervention in the Veterans Health Administration. J Females Health 2017;26:1062–8.
- [55] Glaser R, Selzer F, Jacobs AK, et al. Effect of gender on prognosis following percutaneous coronary intervention for stable angina pectoris and acute coronary syndromes. Am J Cardiol 2006;98:1446–50.
- [56] Yang J, Zhang F, Qian J, et al. Sex-based influence on clinical outcomes after drug-eluting stent implantation in real-world patients: insight from the FOCUS registry. Ann Med 2017;49:185–95.
- [57] Smilowitz NR, Mahajan AM, Roe MT, et al. Mortality of myocardial infarction by sex, age, and obstructive coronary artery disease status in the ACTION Registry-GWTG (Acute Coronary Treatment and Intervention Outcomes Network Registry-Get With the Guidelines). Circ Cardiovasc Qual Outcomes 2017;10:e003443.
- [58] Iyanoye A, Moreyra AE, Swerdel JN, et al. Gender disparity in the use of drug -eluting stents during percutaneous coronary intervention for acute myocardial infarction. Catheter Cardiovasc Interv 2015;86:221–8.
- [59] Wiviott SD, Cannon CP, Morrow DA, et al. Differential expression of cardiac biomarkers by gender in patients with unstable angina/non-STelevation myocardial infarction: a TACTICS-TIMI 18 (Treat Angina with Aggrastat and determine Cost of Therapy with an Invasive or Conservative Strategy-Thrombolysis In Myocardial Infarction 18) substudy. Circulation 2004;109:580–6.