Review Article

Prevalence and associated factors of mortality after percutaneous coronary intervention for adult patients with ST-elevation myocardial infarction: A systematic review and meta-analysis

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Background: There is a paucity of systematic reviews on the associated factors of mortality among ST-elevation myocardial infarction (STEMI) patients after percutaneous coronary intervention (PCI). This meta-analysis was designed to synthesize available evidence on the prevalence and associated factors of mortality after PCI for adult patients with STEMI. **Materials and Methods:** Databases including the Cochrane Library, PubMed, Web of Science, Embase, Ovid, Scopus, ProQuest, MEDLINE, and CINAHL Complete were searched systematically to identify relevant articles published from January 2008 to March 2020 on factors affecting mortality after PCI in STEMI patients. Meta-analysis was conducted using Stata 12.0 software package. **Results:** Our search yielded 91 cohort studies involving a total of 199, 339 participants. The pooled mortality rate for STEMI patients after PCI was 10%. After controlling for grouping criteria or follow-up time, the following 17 risk factors were significantly associated with mortality for STEMI patients after PCI: advanced age (odds ratio [OR] = 3.89), female (OR = 2.01), out-of-hospital cardiac arrest (OR = 5.55), cardiogenic shock (OR = 4.83), renal dysfunction (OR = 3.50), admission anemia (OR = 3.28), hyperuricemia (OR = 2.71), elevated blood glucose level (OR = 2.00), diabetes mellitus (OR = 1.8), chronic total occlusion (OR = 2.56), Q wave (OR = 2.18), without prodromal angina (OR = 2.12), delay in door-to-balloon time (OR = 1.72), delay in symptom onset-to-balloon time (OR = 1.43), anterior infarction (OR = 1.66), ST-segment resolution (OR = 1.40), and delay in symptom onset-to-door time (OR = 1.29). **Conclusion:** The pooled prevalence of mortality after PCI for STEMI patients was 10%, and 17 risk factors were significantly associated with mortality for STEMI patients after PCI.

Key words: Meta-analysis, mortality, percutaneous coronary intervention, ST-elevation myocardial infarction

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INTRODUCTION

ST-elevation myocardial infarction (STEMI) is the most common type of myocardial infarction, accounting for 74.15% of all myocardial infarcts,[1] and it is the leading cause of death in cardiovascular patients.[2] Percutaneous coronary intervention (PCI) is recommended as the preferred treatment for patients with STEMI due to reduce reinfarction, mortality compared with fibrinolysis.[3] However, STEMI patients still have to face a series of physiological and psychological problems after PCI, especially all-cause death events. Moreover, it is not clear whether this development will improve

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survival in patients with STEMI. Most national studies reported a consequent reduction in mortality in unselected STEMI patients compared with thrombolysis, which was insufficient to assess the extent of the improvement.[4-6] There was a considerable difference in mortality (1.5% to 48.1%) in studies with 1-year follow-up after PCI.[7,8] Therefore, it is necessary to systematically synthesize the mortality rate for patients with STEMI following PCI.

Furthermore, the occurrence and development of mortality were the results of the additive effect of multiple factors. Studies have shown that there were many risk factors for mortality, including age,[9] gender,[10] blood glucose levels,[11] and door-to-balloon time (DTB)[12]. However, no systematic review has synthesized the evidence of screening-associated factors. Therefore, this study will systematically evaluate the mortality and risk factors of STEMI patients after PCI, to provide a theoretical basis for designing a cost-effective prevention program to control factors, and further improve the prognosis and reduce the mortality of adult STEMI patients after PCI.[13,14]

METHODS

The manuscript has been prepared according to the meta-analysis of observational studies in epidemiology guidelines.[15] Ethical approval was unnecessary in this study, because it was a meta-analysis of existing articles, and no individual patient data were handled. This review has been registered on PROSPERO (CRD 42017070969) and the protocol[16] has been published, the authors declare that all method details are available within the article, and any additional information is available from the corresponding author on reasonable request.

In this study, we stratified participants based on factors that reported an association with mortality for STEMI patients after PCI, and then assessed mortality prevalence. Studies associated with a specific factor for which there are ≤2 studies will be excluded. Due to the inconsistency between the retrieved factors and the categories defined in the protocol,[16] we did not categorize the included factors for presentation. Some risk factors, grouping criteria, and follow-up periods varied by study and were not standardized. Therefore, subgroup analyses were performed according to factors' grouping criteria and follow-up period when significant and practicable. If a study held two or more grouping criteria and follow-up period, which were included in each subgroup analysis. Moreover, due to the small weight in the pooled effect of Chinese literature, we did not retrieve the Chinese database according to the content in the protocol.

RESULTS

According to the search strategy, the initial search retrieved 28,015 articles, of which 9554 were duplicates. After screening titles and abstracts, 333 articles were selected on the basis of inclusion criteria. The full-text of the remaining 333 studies were further evaluated in detail, of which 91 were considered eligible for this review, and more details are in Figure 1.

Ninety-one studies examined 23 risk factors for mortality after PCI for adult STEMI patients. Of them, 65 articles were prospective cohort studies, while 26 articles were retrospective cohort studies. The number of patients in the included studies ranged from 131[17] to 17,021,[18] other characteristics of included studies are summarized in Table 1. Quality assessment results are listed in Table 2, of which 42 studies were evaluated to be at low risk of bias.

Prevalence of mortality

The prevalence of mortality ranged from 2% to 59% among 91 studies available for this analysis. The pooled mortality rate for STEMI patients after PCI was 10% (95% confidence

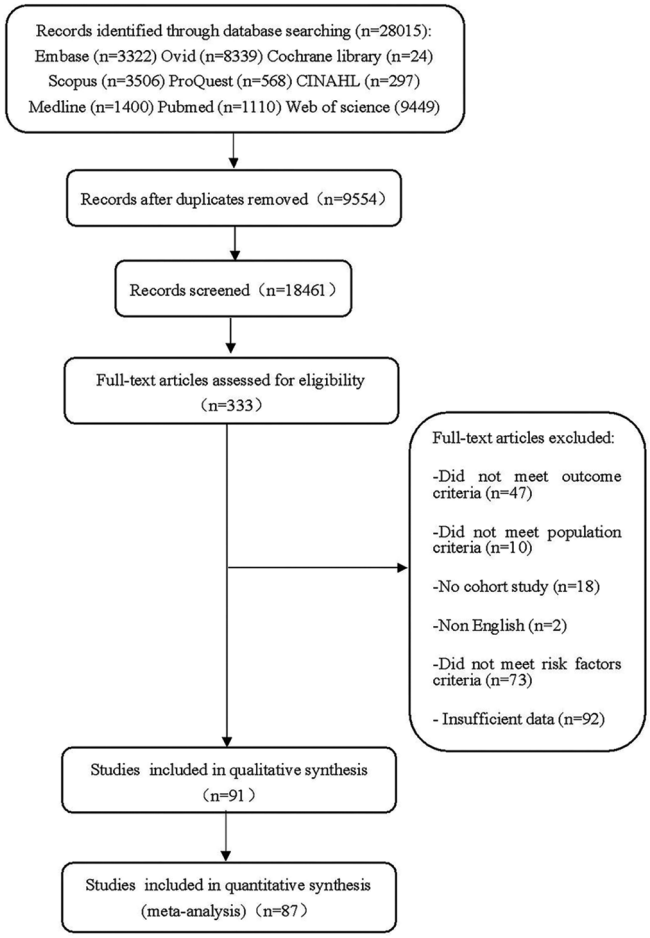

Figure 1: Flowchart of study selection

Table 1: Characteristics of included studies

First author (year)	Region	Study type (cohort study)	Study period	Sample size	Age (years)	Male/female	STEMI definition	Definition of mortality
Marije M. Vis (2007)[61]	Netherlands	Prospective	1997.01-2005.03	208	None	142/66	A1+B1	Death
Zhang, Qi (2008)[62]	China	Prospective	2004.01-2008.03	619	63.5	458/161	C1+(B2+A2)+(B3+A1)+G4	Death
Kumar, Saurabh (2009)[51]	Australia	Prospective	2004.04-2008.04	669	59	525/144	None	Death
Mark B. Nienhuis (2009)[63]	Netherlands	Prospective	1991.01-2004.12	4990	61.3	3802/1188	(A2+B1+C2) or (A1+B1+C2)	Death
Stefan Zimmermann (2009)[64]	Germany	Retrospective	1999.06-2006.06	566	63±13	405/161	(A1+B1) or (A2+B1) or E or G4	Death
Stefan Zimmermann (2009)[65]	Germany	Prospective	1999-2005	504	63	360/144	(A1+B1) or (A2+B1) or (E+G2) or (E+G4)	Death
Alexander Bufe (2010)[66]	Germany	Prospective	1999.11-2001.09	500	59.7	376/124	None	Death
Andrzej Lekston (2010)[67]	Poland	Prospective	1999.01-2001.12	1237	57.5	927/310	(A2+B1+C2) or (A1+B1+C2) or E	Death
Bimmer E P M Claessen (2010)[68]	Netherlands	Prospective	1997-2007	4506	None	3221/1285	A1+B1	Death
Damian Pres (2010)[69]	Poland	Prospective	1998-2006	258	62.4	169/89	(A1+B1+C2) or (A2+B1) or E	Death
Edward L. Hannan (2010)[70]	New York	Retrospective	2004.01-2006.12	5092	None	3661/1431	None	Death
Guido Parodi (2010)[71]	Italy	Prospective	1997.01-2007.03	2379	65	1805/574	None	Death
H.B. van der Zwaan (2010)[72]	Netherlands	Prospective	None	223	63.4	154/69	(A1+B1) or (A2+B1)	Death
Loes P. Hoebers (2010)[73]	Netherlands	Prospective	2005.03-2007.12	1646	61.8	1170/476	A1+B1	Death
Tzu-Hsien Tsai (2010)[32]	Taiwan	Prospective	2002.01-2009.09	212	63.9	164/48	(A1+B1+C2) or (C2+E)	Death
Won Yu Kang (2010)[74]	Korean	Prospective	2005.11-2007.11	3824	61.1	2896/928	None	Death
Zheng Xin (2010)[75]	China	Prospective	2004.04-2008.11	522	60.2	413/109	A1+B1+C2	Death
Marc C. Newell (2011)[76]	Minneapolis	Retrospective	2003.03-2008.12	2262	None	1621/641	None	Death
Michael P. Hudson (2011)[77]	None	Prospective	2004.07-2006.05	5745	≥18	4523/1222	(B1+A2) or (B1+A5)	Death
Ralf Birkemeyer (2011)[78]	Germany	Prospective	2005.01-2007.10	400	63	309/91	(A3+B2+C1) or (B3+A1+C1) or E	Death
S.Michael Gharacholou (2011)[79]	Canada	Retrospective	2004.07-2006.05	5745	61	4420/1325	None	Death
Sofifia Sederholm Lawesson (2011)[80]	Sweden	Retrospective	2005.01-2005.12	274	66.2	176/98	None	Death
Zbigniew Siudak (2011)[81]	Poland	Prospective	2005.11-2007.01	1650	62.9	143/1507	None	Death
Anna Tomaszuk-Kazberuk (2012)[17]	Poland	Prospective	2000.01-2001.12	131	58.3±10.8	90/41	None	Death
David Planer (2012)[82]	New York	Prospective	None	3405	60.1	2613/792	None	Death
Gjin Ndrepepa (2012)[50]	Germany	Prospective	2002.01-2007.12	900	61.2	692/208	(A1+B1+C3) or (A2+B1) or E	Death
Mateusz Tajstra (2012)[44]	Poland	Prospective	1999.01-2004.12	666	61	479/187	C2+(B1+A1)/(B1+A2)/E	Death
Padma Kaul (2012)[83]	Canada	Prospective	None	4530	≥18	3468/1062	(A2+B1) or (B1+A5) or E	Death
Siudak, Zbigniew (2012)[84]	Seven countries in Europe	Prospective	2005.11-2007.01	1650	64.0	1189/461	None	Death
Ahmet Ekmekci (2013)[11]	Turkey	Retrospective	2003.10-2008.03	601	72.2±5.4	454/147	(A2+B1+C2) or (A2+B1+E)	Death
Awsan Noman (2013)[19]	United Kingdom	Retrospective	2008.03-2011.06	2310	62.5	1633/677	A4 or C2 or E	Death

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Table 1: Cond...

First author (year)	Region	Study type (cohort study)	Study period	Sample size	Age (years)	Male/female	STEMI definition	Definition of mortality
C. Lazzeri (2013)[85]	Italy	Prospective	2004.01-2010.12	1268	66.7	928/340	None	Death
Ellen C. Christiansen (2013)[86]	Minnesota	Prospective	2003.03-2006.11	1323	None	946/377	None	Death
Han, Yang-Chun (2013)[87]	Korean	Prospective	2005.01-2009.12	326	61.85	247/79	(A1+B1) or (A6+B1+C2+G2) or (A6+B1+C2+G4) or E	Death
Inge Wijnbergen (2013)[88]	Netherlands	Retrospective	2006.01-2008.05	870	60.3	668/202	None	Death
Kaya, Mehmet G (2013)[89]	None	Prospective	None	682	60.9	535/147	(A1+B1+C2) or E	Death
Ki-Woon Kang (2013)[90]	Korean	Prospective	2008.01-2011.08	541	40	520/21	A1+B1+C1+D1	Death
Lisbeth Antonsen (2013)[91]	Denmark	Retrospective	2002.01-2009.12	1326	84.2	1326/0	(A1+B1) or (A2+B1) or E	Death
Michael E. Farkouh (2013)[92]	New York	Prospective	None	2484	60	1916/568	(A1+B1) or E or (A5+B1)	Death
Roberto J. Cubeddu (2013)[93]	Boston	Prospective	2005.03-2007.05	2440	59.7	1870/570	(A1+B1) or (A5+B1) or E	Death
Trzeciak, Przemyslaw (2013)[59]	Poland	Prospective	2003.10-2009.11	2090	65.7	1335/785	(A1+B1) or (A1+B2) or E or G1	Death
Tzu-Hsien Tsai (2013)[94]	Taiwan	Prospective	2002.01-2009.11	1432	61.5	1176/256	(A1+B1+C2) or (C2+E)	Death
Usaid K. Allahwala (2013)[95]	Australia	Retrospective	2004.05-2010.12	382	≥18	285/97	None	Death
Zimmermann, Stefan (2013)[96]	Germany	Prospective	2001.01-2008.12	767	62.8	545/222	(A1+B1) or (A2+B1) or E or G4	Death
Anna Tomaszuk-Kazberuk (2014)[97]	Poland	Retrospective	2005	551	63±12	386/165	(A2+B1) or (A1+B3) or G4	Death
Hamdi Pusuroglu (2014)[98]	Turkey	Prospective	2010.09-2012.07	443	18-80	362/81	(B1+A2) or C2	Death
Jian-wei Zhang (2014)[99]	China	Prospective	2012.01-2013.11	237	54±16	165/72	(A2+B1+C1) or (A1+B1+C1)	Death
Krishnaraj S. Rathod (2014)[100]	United Kingdom	Prospective	2004.01-2010.08	2178	63.8	525/1653	None	Death
Renato Budzyn David (2014)[101]	Brazil	Prospective	2010.12-2012.05	740	60.5	513/227	C2+B1+A1+E	Death
Tomohiko Taniguchi (2014)[102]	Japan	Prospective	2005.01-2007.12	3476	67.2	2528/948	None	Death
Yuan-Chih Ho (2014)[103]	Taiwan	Retrospective	2008.01-2011.12	559	60.8	468/91	None	Death
Bimmer E.P.M.Claessen (2015)[104]	Netherlands	Retrospective	2003.01-2008.07	2002	None	None	(A1+B1+C1) or E	Death
Chong-hui Wang (2015)[105]	China	Retrospective	2005.01-2007.12	312	51.1	195/117	(A1+B1+C2) or (A1+B1+E)	Death
Kiril Karamfiloff (2015)[10]	Bulgaria	Prospective	2008.06-2011.06	527	>18	362/165	None	Death
Laufer-Perl, Michal (2015)[106]	Israel	Retrospective	2008.01-2013.12	1346	61.8	1075/271	C1+G1	Death
M. Bilal Iqbal (2015)[107]	London	Retrospective	2005-2011	5934	62	4593/1341	None	Death
Olivier Barthélémy (2015)[108]	France	Prospective	2007.08-2011.01	364	69.5	182/182	(A2+B2+G4) or (A1+B3+G4) or E	Death from any cause
Pan, Wei (2015)[109]	China	Prospective	2008.01-2011.09	636	59.3	495/141	(A1+B1+C2) or E	Death
Cheng-Wei Liu (2016)[110]	Taiwan	Retrospective	2006.02-2012.09	951	57	841/110	(A2+B1) or (A3+B4) or (A1+B3) or E	Death
Gokhan Cicek (2016)[111]	Turkey	Prospective	2013.12-2015.06	796	56.6	670/126	(B1+A2) or C2 or E	Death
Jaya Chandrasekhar (2016)[56]	Australia	Retrospective	2008.01-2014.12	893	62.2	695/198	(B1+A1) or (B4+A2) or (B1+A5) or E	Death
Jin Geng (2016)[112]	China	Retrospective	2012.01-2015.12	1594	64.4	1266/328	None	Death

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Table 1: Cond...

First author (year)	Region	Study type (cohort study)	Study period	Sample size	Age (years)	Male/female	STEMI definition	Definition of mortality
Krishnaraj S Rathod (2016)[113]	United Kingdom	Retrospective	2004.01-2012.09	3618	63	2682/936	None	Death
Ma, Wen-fang (2016)[114]	China	Prospective	2001.01-2004.07	7033	62.4	5031/2002	None	Death
Veemal V. Hemradj (2016)[115]	Netherlands	Prospective	2000.01-2011.12	7149	62.9	5223/1926	(A2+B1+C2) or (A1+B1+C2)	Death
Fu-Cheng Chen (2017)[12]	Taiwan	Retrospective	2011.01-2014.12	345	≥18	303/42	(B1+A1) or (B1+A2) or E	Death
Guy Topaz (2017)[116]	New York	Prospective	2008.01-2014.12	1657	61.5	1331/326	None	Death
Jie Den (2017)[45]	China	Retrospective	2006.01-2014.12	377	66.6	298/79	G1	Death
Kanic, Vojko (2017)[117]	Germany	Prospective	2007.01-2015.12	2572	62.8	1813/759	None	Death
Konstanze Ertelt (2017)[118]	New York	Prospective	None	3599	59.9	2758/841	None	Death
Kosmidou, I. (2017)[119]	America	Prospective cohort study	None	2723	59.6	2070/653	None	Death
Liu, C. W (2017)[39]	Taiwan	Prospective	2006.02-2012.09	944	56.6	834/110	(A3+B4) or (A1+B1) or E	Death
Matias B. Yudi (2017)[120]	Australia	Prospective	2005-2014	2972	63.7	2285/687	(A1+B3) or (A3+B4) or E	Death
Po-Jui Wu (2017)[121]	Taiwan	Retrospective	2009.10-2014.12	975	57.8	767/208	(B1+A1+C2) or (C2+E)	Death
Zuin, M. (2017)[122]	Italy	Prospective	2010.01-2016.01	2401	64.3	1724/677	None	Death
Eva Rumiz (2018)[123]	Spain	Prospective	2009.01-2015.06	381	66.1	307/74	(A1+B1) or C2	Death
Fu, W. X. (2018)[124]	China	Prospective	2006.01-2012.12	1920	52.53	1693/227	None	Death
Gabriele Ghetti (2018)[125]	Italy	Prospective	2003.01-2015.12	3015	68±14	2178/837	(A1+B5) or (A2+B2) or E	Death
Giosafat Spitaleri (2018)[126]	Spain	Retrospective	None	1351	61	1126/225	None	Death
Her, Ae-Young (2018)[18]	Korean	Prospective	2005.11-2011.07	17,021	None	12,562/4459	(A1+B1+C2) or (A2+B1+C2) or E or G4	Death
Kanic, Vojko (2018)[127]	Slovenia	Prospective	2009.01-2014.12	804	50.8	641/163	F	Death
Mandurino-Mirizzi, A. (2018)[40]	None	Prospective	None	101	57.8	93/8	None	Death
Ming Gao (2018)[9]	China	Prospective	2013.01-2015.01	530	51	498/32	F	Death
Cenko, Edina (2019)[128]	Italy	Prospective	2010.01-2016.01	2596	60.4	1923/673	None	Death
David Zahle (2019)[54]	Tel Aviv	Retrospective	2013.01-2017.08	889	61.3	738/151	C1 or G1	Death
Jonghanne Park (2019)[129]	Korean	Prospective	2011.11-2015.12	5243	62	4162/1081	(B2+A2) or (B3+A1) or (E+G2+G3)	Death
Krishnamurthy, Arvindra (2019)[130]	United Kingdom	Prospective	2009.01-2011.12	3049	62.4	2223/826	(A1+B1) or (A2+B1) or E	Death
Lloyd Steele (2019)[131]	United Kingdom	Retrospective	2009.01-2014.01	3133	≥45	2296/837	None	Death
Murphy, A. C. (2019)[132]	Australia	Prospective	2005.01-2017.06	6179	63.1	4921/1258	A4 or E	Death
Stehli, Julia (2019)[133]	Australia	Prospective	2013-2016	6431	62.0	5114/1317	A4 or G1	Death
Luke P. Dawson a, Diem (2020)[134]	Australia	Prospective	2005.01-2018.12	12,637	63.4	9884/2753	None	Death

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Table 1: Contd...

First author (year)	Length of follow-up	Factors	Definition of factors	Measurement method of factors
Marije M. Vis (2008)[61]	1-year	Elevated glucose levels	Admission glucose concentration	None
Zhang, Qi (2008)[62]	30-day	RD	A serum creatinine level ≥115 μmol/L (1.3 mg/dL)	Serum creatinine level on admission
Kumar, Saurabh (2009)[51]	1-year	Q-wave	Any new Q waves (2 contiguous leads) in leads V1-V3 Q-waves 30 ms in width and 1 mm in depth in leads I, II, aVL, aVF, V4, V5, or V6	ECG
Mark B. Nienhuis (2009)[63]	1-year	Anterior infarction	None	ECG
Stefan Zimmermann (2009)[64]	30-day	Female	None	None
Stefan Zimmermann (2009)[65]	1-year	Advanced age	None	None
Alexander Bufe (2010)[66]	7-year	Female	None	None
Andrzej Lekston (2010)[67]	5-year	CS	Clinical symptoms of shock, peripheral hypoperfusion, systemic systolic pressure lower than 90 mmHg	None
Bimmer E *P* M Claessen (2010)[68]	1-year	Advanced age	None	None
Damian Pres (2010)[69]	5-year	Elevated glucose levels	Plasma glucose levels	Measured in emergency room
Edward L. Hannan (2010)[70]	3-year	STD DTB	None	None
Guido Parodi (2010)[71]	6-month	Elevated HR		Presentation by a caliper
H.B. van der Zwaan (2010)[72]	1-year	STR	None	ECG
Loes P. Hoebers (2010)[73]	3-year	Elevated glucose levels	Plasma glucose levels	None
Tzu-Hsien Tsai (2010)[32]	30-day	Anterior infarction	None	None
Won Yu Kang (2010)[74]	12-month	Obesity	Recommendation by WHO for the Asian population	BMI
Zheng Xin (2010)[75]	6-month	Advanced age	None	None
Marc C. Newell (2011)[76]	1-year	Advanced age	None	None
Michael P. Hudson (2011)[77]	90-day	STB DTB	S: Presented to the initial care facility D: At the initial hospital arrival, including transfer duration between facilities	Determined by ambulance emergency and ECG
Ralf Birkemeyer (2011)[78]	30-day	Advanced age	None	None
S.Michael Gharacholou (2011)[79]	90-day	Advanced age	None	None
Sofifia Sederholm Lawesson (2011)[80]	1-year	Female	None	None
Zbigniew Siudak (2011)[81]	1-year	Off-hour operation	Between Friday 5 pm and Monday 7.59 am and during the night on Monday-Friday	None
Anna Tomaszuk-Kazberuk (2012)[17]	5-year	Obesity	BMI ≥25 kg/m^2	BMI
David Planer (2012)[82]	3-year	Elevated glucose levels	Plasma glucose levels	Drawn on admission
Gjin Ndrepepa (2012)[50]	5-year	STR	None	None
Mateusz Tajstra (2012)[44]	5-year	CTO	A noninfarction related artery with 100% luminal narrowing before PCI without anterograde	None
Padma Kaul (2012)[83]	90-day	Female Q wave STB	Female: None Q wave: Selvester QRS screening criteria STB: None	None
Siudak, Zbigniew (2012)[84]	1-year	OHCA	None	None
Ahmet Ekmekci (2013)[11]	>1-year	Elevated glucose levels	Admission blood glucose levels	Determined at hospital admission and during patient stay in hospital
Awsan Noman (2013)[19]	559-day	Elevated HR	Admission HR	None

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Table 1: Contd...

First author (year)	Length of follow-up	Factors	Definition of factors	Measurement method of factors
C. Lazzeri (2013)[85]	1-year	Obesity Advanced age	BMI≥25 kg/m2	BMI and age recorded at treating
Ellen C. Christiansen (2013)[86]	1-year	Advanced age	None	None
Han, Yang-Chun (2013)[87]	1-year	Elevated NLR	None	Automated blood cell counter
Inge Wijnbergen (2013)[88]	2-year	Female	None	None
Kaya, Mehmet G (2013)[89]	43.3-month	Elevated NLR	None	Automated blood cell counter
Ki-Woon Kang (2013)[90]	1-year	Obesity	Recommendation by WHO for the Asian population	None
Lisbeth Antonsen (2013)[91]	5-year	Advanced age	None	None
Michael E. Farkouh (2013)[92]	3-year	STR	None	ECG
Roberto J. Cubeddu (2013)[93]	3-year	Off-hour operation	Off-hours: Weekdays from 5:00 pm to 8:00 am and all weekends and holidays	The day and time
Trzeciak, Przemyslaw (2013)[59]	1-year	Anterior infarction	None	None
Tzu-Hsien Tsai (2013)[94]	1-year	RD	Estimated glomerular filtration rate	None
Usaid K. Allahwala (2013)[95]	30-day	Smoking	Regularly smoked within the last 12 months	Self reported history
Zimmermann, Stefan (2013)[96]	1-year	OHCA	None	None
Anna Tomaszuk-Kazberuk (2014)[97]	6-year	Admission anemia	Male: Value of haemoglobin level ≤13 g/dL Female: ≤12 g/dL	None
Hamdi Pusuroglu (2014)[98]	1-year	Eleveated HbA1c	None	Blood samples
Jian-wei Zhang (2014)[99]	30-day	DM	None	Self reported
Krishnaraj S. Rathod (2014)[100]	3-year	Admission anemia	Male: Value of haemoglobin level ≤13 g/dL Female: ≤12 g/dL	None
Renato Budzyn David (2014)[101]	30-day	DM	None	None
Tomohiko Taniguchi (2014)[102]	5-year	Without PA	Chest discomfort or radiating pain	Persisting <30 min within 48 h at admission for STEMI
Yuan-Chih Ho (2014)[103]	30-day	STB DTB	None	None
Bimmer E.P.M.Claessen (2015)[104]	3-year	Advanced age	None	None
Chong-hui Wang (2015)[105]	48.3-month	RD	Estimated glomerular filtration rate using the Modifi-cation of Diet in renal	Serum creatinine analysis at admission, within 60-90 min before PCI
Kiril Karamfiloff (2015)[10]	1-year	Female	None	None
Laufer-Perl, Michal (2015)[106]	30-day	Female	None	None
M. Bilal Iqbal (2015)[107]	3-year	Off-hour operation	All other times except 9 am-5 pm (Monday-Friday)	None
Olivier Barthélémy (2015)[108]	1-year	Female	None	None
Pan, Wei (2015)[109]	1-year	Elevated NLR	None	Automatic blood cell analyzer
Cheng-Wei Liu (2016)[110]	1-year	Admission anemia	Male: Value of haemoglobin level ≤13 g/dL; female: ≤12 g/dL	None
Gokhan Cicek (2016)[111]	2-year	Elevated HbA1c	None	Blood samples
Jaya Chandrasekhar (2016)[56]	1-year	STB	From self-reported onset of symptoms to time of first device delivery in the culprit artery	Recorded at the time of presentation by catheter laboratory staff
Jin Geng (2016)[112]	4-year	Off-hour operation	Off-hours: Weekdays from 18:00 to 08:00, weekends and holidays	None
Krishnaraj S Rathod (2016)[113]	30-day	Advanced age	None	None

Contd...

Table 1: Contd...

First author (year)	Length of follow-up	Factors	Definition of factors	Measurement method of factors
Ma, Wen-fang (2016)[114]	30-day	Female	None	None
Veemal V. Hemradj (2016)[115]	1-year	CS	None	None
Fu-Cheng Chen (2017)[12]	30-day	DTB	None	None
Guy Topaz (2017)[116]	30-day	Advanced age	None	None
Jie Den (2017)[45]	1-year	CTO	A flow vessel of TIMI grade 0 and a complete obstruction of a native coronary artery over 3 months	None
Kanic, Vojko (2017)[117]	30-day	RD	A rise in the serum creatinine level of ≥1 μmol/L and <26.5 μmol/L	Serum creatinine level after PCI compared with baseline during hospital
Konstanze Ertelt (2017)[118]	3-year	DM	A history of hyperglycemia managed by insulin, oral hypoglycemic agents or diet	None
Kosmidou, I. (2017)[119]	3-year	Q-wave	≥30 ms in lead aVF; ≥40 ms in leads I and aVL ≥40 ms in ≥2 of leads V4, V5, V6; any Q wave ≥20 ms	ECG
Liu, C. W (2017)[39]	1-year	RD	Serum uric acid	Blood samples
Matias B. Yudi (2017)[120]	1-year	Advanced age	None	None
Po-Jui Wu (2017)[121]	30-day	Obesity	Recommendation by WHO	None
Zuin, M. (2017)[122]	1-year	Elevated NLR	None	Automatic blood cell analyzer
Eva Rumiz (2018)[23]	22-month	Advanced age	None	None
Fu, W. X. (2018)[124]	3-year	Female	None	None
Gabriele Ghetti (2018)[125]	2-year	Without PA	None	None
Giosafat Spitaleri (2018)[126]	5-year	STR	None	Post-PCI ECG
Her, Ae-Young (2018)[18]	1-year	Female	None	None
Kanic, Vojko (2018)[127]	2-year	Female	None	None
Mandurino-Mirizzi, A. (2018)[40]	7.3-year	RD	Serum uric acid	Blood samples
Ming Gao (2018)[9]	2-year	Advanced age	None	None
Cenko, Edina (2019)[128]	30-day	Female	None	None
David Zahle (2019)[54]	1-year	DTB	Between a patient's arrival at the hospital and the first balloon inflation or device deployment in the culprit artery	Documented in the patient's medical record
Jonghanne Park (2019)[129]	1-year	STD DTB	S: The symptom onset on the basis of patient interview D: Patients presenting to the PCI-capable center B: First balloon inflation during PCI	Calculated from the corresponding time entries
Krishnamurthy, Arvindra (2019)[130]	1-year	Female	None	None
Lloyd Steele (2019)[131]	3-year	Smoking	1 month of smoking cessation or documentation of ex-smoker in case notes	None
Murphy, A. C. (2019)[132]	30-day	Female	None	None
Stehli, Julia (2019)[133]	30-day	Female	None	None
Luke P. Dawson a, Diem (2020)[134]	30-day	OHCA	Patients who received attempts at either external defibrillation or chest compressions Patients who were pulseless as prior to admission to the emergency department	Determined by emergency medical services

A1=The presence of≥0.1 mV ST-segment elevation; A2=2-mm ST-segment elevation; A3=0.2 mV in men or 0.15 in women; A4=New ST-segment elevation; A5=ST depression; A6=New Q wave; B1=Two contiguous ECG; B2=Leads V1-3; B3=Leads I-III, aVF, aVL, V1, V4-V6; B4=Leads V2-3; B5=Leads I-III, aVF, aVL, V4-V6; C1=Ongoing chest pain; C2=Typical chest pain lasting for more than 30 min; C3=Chest pain lasting≥20 min; D1=With or without an elevation of cardiac enzyme levels above the reference range; E=A new-onset complete left bundle branch block; F=The guidelines of the European Society of Cardiology/American College of Cardiology; G1=Serial elevation of cardiac biomarkers; G2=Increase in troponin-I; G3=Troponin-T; G4=CK elevation >170 U/L. RD=Renal dysfunction; PA=Prodromal angina; BMI=Body mass index; CS=Cardiogenic shock; CTO=Chronic total occlusion; DM=Diabetes mellitus; DTB=Door-to-balloon; ECG=Electrocardiogram; HbA1c=Hemoglobin A1c level; HR=Heart rate; NLR=Ratio of neutrophils to lymphocytes; OHCA=Out-of-hospital cardiac arrest; PA=Prodromal angina; STB=Symptom onset-to-balloon; STD=Symptom onset-to-door time; STR=ST-segment resolution; WHO=World Health Organization; PCI=Percutaneous coronary intervention; TIMI=Thrombolysis in myocardial infarction; STEMI=ST-elevation myocardial infarction; CK=Creatine kinase

Table 2: The quality of included studies

First author (year)	Selection				Comparability	Outcome			Total stars
	Representativeness of the exposed cohort[†]	Selection of the nonexposed cohort[‡]	Ascertainment of exposure[§]	Demonstration that outcome of interest was not present at start of study[‖]	Comparability of cohorts on the basis of the design or analysis[¶]	Assessment of outcome[#]	Was follow-up long enough for outcomes to occur[@]	Adequacy of follow-up of cohorts[$]	
Marije M. Vis (2007)[61]	a	a	a	a	ab	d	b	a	7
Zhang, Qi (2008)[62]	a	a	a	a	No	a	b	a	5
Kumar, Saurabh (2009)[51]	a	a	a	a	ab	d	b	a	7
Mark B. Nienhuis (2009)[63]	b	a	a	a	ab	d	b	a	7
Stefan Zimmermann (2009)[64]	b	a	a	a	ab	d	b	b	7
Stefan Zimmermann (2009)[65]	a	a	d	b	ab	d	b	a	5
Alexander Bufe (2010)[66]	a	a	d	a	ab	d	a	a	7
Andrzej Lekston (2010)[67]	a	a	a	a	No	d	a	a	6
Bimmer E P M Claessen (2010)[68]	a	a	a	a	a	d	a	a	7
Damian Pres (2010)[69]	a	a	a	a	ab	d	a	a	8
Edward L. Hannan (2010)[70]	b	a	a	b	No	b	b	a	5
Guido Parodi (2010)[71]	a	a	a	a	No	d	b	a	5
H.B. van der Zwaan (2010)[72]	a	a	a	a	No	d	b	a	5
Loes P. Hoebers (2010)[73]	a	a	a	a	No	d	b	a	5
Tzu-Hsien Tsai (2010)[32]	a	a	a	a	ab	d	b	a	7
Won Yu Kang (2010)[74]	c	a	d	a	No	b	b	a	4
Zheng Xin (2010)[75]	d	c	a	a	ab	d	b	a	5
Marc C. Newell (2011)[76]	a	a	a	b	ab	d	a	d	6
Michael P. Hudson (2011)[77]	c	a	a	a	No	d	b	b	4
Ralf Birkemeyer (2011))[78]	a	a	a	b	ab	b	b	a	7
S.Michael Gharacholou (2011)[79]	c	a	a	a	ab	d	b	a	6
Sofifia Sederholm Lawesson (2011)[80]	c	a	a	b	ab	d	b	a	5
Zbigniew Siudak (2011)[81]	d	a	a	a	ab	d	b	a	6
Anna Tomaszuk–Kazberuk (2012)[17]	a	a	d	a	No	b	a	a	6
David Planer (2012)[82]	c	a	a	a	No	d	b	a	4
Gjin Ndrepepa (2012)[50]	a	a	a	a	No	a	a	a	7
Mateusz Tajstra (2012)[44]	a	a	a	a	No	d	a	a	6
Padma Kaul (201283	c	a	a	a	No	d	b	a	4

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Table 2: Contd...

First author (year)	Selection				Comparability	Outcome			Total stars
	Representativeness of the exposed cohort[†]	Selection of the nonexposed cohort[‡]	Ascertainment of exposure[§]	Demonstration that outcome of interest was not present at start of study[‖]	Comparability of cohorts on the basis of the design or analysis[¶]	Assessment of outcome[#]	Was follow-up long enough for outcomes to occur[@]	Adequacy of follow-up of cohorts[$]	
Siudak, Zbigniew (2012)[84]	c	c	d	a	ab	d	b	a	4
Ahmet Ekmekci (2013)[11]	a	a	a	b	ab	d	b	a	6
Awsan Noman (2013)[19]	a	a	a	b	ab	b	b	a	7
C. Lazzeri (2013)[85]	a	a	a	a	ab	d	b	a	7
Ellen C. Christiansen (2013)[86]	c	a	a	a	a	d	b	a	5
Han, Yang-Chun (2013)[87]	a	a	a	a	No	d	b	a	5
Inge Wijnbergen (2013)[88]	a	a	a	b	ab	b	b	a	7
Kaya, Mehmet G (2013)[89]	d	c	a	a	ab	d	b	a	5
Ki-Woon Kang (2013)[90]	c	a	a	a	ab	d	b	a	6
Lisbeth Antonsen (2013)[91]	c	a	a	b	ab	d	a	a	6
Michael E. Farkouh (2013)[92]	d	c	a	a	No	a	b	a	4
Roberto J. Cubeddu (2013)[93]	c	a	a	a	ab	a	b	a	7
Trzeciak, Przemyslaw (2013)[59]	c	c	a	a	No	b	b	a	4
Tzu-Hsien Tsai (2013)[94]	c	a	a	a	ab	d	b	a	6
Usaid K. Allahwala (2013)[95]	a	a	c	b	No	b	b	a	4
Zimmermann, Stefan (2013)[96]	a	a	d	a	No	d	b	a	4
Anna Tomaszuk-Kazberuk (2014)[97]	b	a	a	b	No	d	a	a	5
Hamdi Pusuroglu (2014)[98]	a	a	a	a	No	d	b	a	5
Jian-wei Zhang (2014)[99]	c	a	a	a	ab	d	b	a	6
Krishnaraj S. Rathod (2014)[100]	a	a	d	b	ab	b	b	a	6
Renato Budzyn David (2014)[101]	a	a	a	a	No	d	b	a	5
Tomohiko Taniguchi (2014)[102]	a	a	a	a	ab	d	b	a	7
Yuan-Chih Ho (2014)[103]	c	a	a	a	ab	d	a	a	7
Bimmer E.P.M.Claessen (2015)[104]	a	a	a	b	No	b	b	c	4
Chong-hui Wang (2015)[105]	b	a	a	b	ab	d	b	a	6
Kiril Karamfiloff (2015)[10]	b	a	a	a	No	d	b	d	4
Laufer-Perl, Michal (2015)[106]	a	a	d	b	a	d	b	a	4
M. Bilal Iqbal (2015)[107]	c	a	a	b	No	a	b	a	4
Olivier Barthélémy (2015)[108]	a	c	a	a	ab	d	b	a	6

Contd...

Table 2: Contd...

First author (year)	Selection				Comparability	Outcome			Total stars
	Representativeness of the exposed cohort[†]	Selection of the nonexposed cohort[‡]	Ascertainment of exposure[§]	Demonstration that outcome of interest was not present at start of study[‖]	Comparability of cohorts on the basis of the design or analysis[¶]	Assessment of outcome[#]	Was follow-up long enough for outcomes to occur[@]	Adequacy of follow-up of cohorts[$]	
Pan, Wei (2015)[109]	a	a	a	a	ab	d	b	a	7
Cheng-Wei Liu (2016)[110]	a	a	a	b	ab	d	b	a	6
Gokhan Cicek (2016)[111]	c	a	d	a	ab	d	b	b	5
Jaya Chandrasekhar (2016)[56]	a	a	a	b	No	d	b	b	4
Jin Geng (2016)[112]	c	a	a	b	No	b	b	a	4
Krishnaraj S Rathod (2016)[113]	a	a	a	a	No	d	b	a	5
Ma, Wen-fang (2016)[114]	a	a	a	b	ab	b	a	a	8
Veemal V. Hemradj (2016)[115]	a	a	a	a	ab	d	b	b	7
Fu-Cheng Chen (2017)[12]	b	a	d	b	No	a	b	a	4
Guy Topaz (2017)[116]	a	a	a	a	No	d	b	a	5
Jie Deng (2017)[45]	a	a	a	b	No	d	b	a	4
Kanic, Vojko (2017)[117]	a	a	a	a	No	d	b	a	5
Konstanze Ertelt (2017)[118]	c	a	a	a	No	a	b	b	5
Kosmidou, I. (2017)[119]	c	a	a	a	No	d	b	a	5
Liu, C. W (2017)[39]	a	a	a	a	ab	d	b	a	7
Matias B. Yudi (2017)[120]	c	a	a	a	ab	d	b	b	6
Po-Jui Wu (2017)[121]	a	a	a	b	No	d	b	a	4
Zuin, M. (2017)[122]	c	a	a	a	ab	d	b	c	5
Eva Rumiz (2018)[123]	a	a	a	a	ab	d	b	a	7
Fu, W. X. (2018)[124]	d	a	d	a	ab	d	b	a	5
Gabriele Ghetti (2018)[125]	a	a	a	a	ab	d	b	b	7
Giosafat Spitaleri (2018)[126]	a	a	d	a	ab	d	b	a	6
Her, Ae-Young (2018)[18]	c	a	a	b	No	b	a	a	5
Kanic, Vojko (2018)[127]	c	a	d	a	ab	d	b	a	5
Mandurino-Mirizzi, A. (2018)[40]	d	c	a	a	ab	d	a	b	6
Ming Gao (2018)[9]	a	a	d	a	ab	d	b	a	6
Cenko, Edina (2019)[128]	c	a	d	a	ab	d	b	a	5
David Zahler (2019)[54]	a	a	a	b	No	b	b	a	5
Jonghanne Park (2019)[129]	a	a	a	a	ab	d	b	a	7
Krishnamurthy, Arvindra (2019)[130]	c	a	b	a	No	A	b	a	5

Contd...

Table 2: Contd...

First author (year)	Selection				Comparability	Outcome			Total stars
	Representativeness of the exposed cohort[†]	Selection of the nonexposed cohort[‡]	Ascertainment of exposure[§]	Demonstration that outcome of interest was not present at start of study[‖]	Comparability of cohorts on the basis of the design or analysis[¶]	Assessment of outcome[#]	Was follow-up long enough for outcomes to occur[@]	Adequacy of follow-up of cohorts[$]	
Lloyd Steele (2019)[131]	a	a	a	b	No	D	b	a	4
Murphy, A. C. (2019)[132]	c	a	d	a	ab	D	b	a	5
Stehli, Julia (2019)[133]	c	b	d	a	ab	D	b	a	4
Luke P. Dawson a, Diem (2020)[134]	c	b	a	a	No	B	b	a	4

[†]a. Truly representative of the average ___ (describe) in the community*[135], b. Somewhat representative of the average _____ in the community*, c. Selected group of users, e.g., nurses, volunteers, d. No description of the derivation of the cohort; [‡]a. Drawn from the same community as the exposed cohort*, b. Drawn from a different source, c. No description of the derivation of the nonexposed cohort; [§]a. Secure record (e.g., surgical records), * b. Structured interview*, c. Written self report, d. No description; [‖]a. Yes*, b. No; [¶]a. Study controls for _____ (select the most important factor)*, b. Study controls for any additional factor* (This criteria could be modified to indicate specific control for a second important factor); [#]a. Independent blind assessment*, b. Record linkage*, c. Self report, d. No description; [@]a. Yes (select an adequate follow up period for outcome of interest)*, b. No; [$]a. Complete follow up-all subjects accounted for*, b. Subjects lost to follow up unlikely to introduce bias-small number lost - > ____ % (select an adequate %) follow up or description provided of those lost*, c. Follow up rate < ____ % (select an adequate %) and no description of those lost, d. No statement

interval [CI]: 9%–11%) with high heterogeneity (I^2 = 98.8%, P < 0.001) [Figure 2]. Funnel plot indicated no publication bias, and more details are in Figure 3.

Mortality prevalence based on associated factors

Advanced age

Advanced age was a risk factor (odds ratio [OR] = 3.89, 95% CI: 3.47–4.37, I^2 = 78.60%, P < 0.001, Population Attributable Fraction (PAF) = 32.9%) we retrieved from 15 articles (N = 28, 360) in this study [Table 3]. The pooled mortality rate for STEMI patients after PCI at an advanced age was 17% (95% CI: 14%–21%) with high heterogeneity (I^2 = 97.50%, P < 0.001). In a subgroup of two studies (N = 4, 148) with advanced age definition at or above 45 and 30-day follow-up (OR = 2.42, 95% CI: 1.28–4.59, I^2 = 0.00%, P = 0.007, PAF = 6.6%), the pooled mortality rate was 5% (95%CI: 4%-5%) with low heterogeneity (I^2 = 11.80%, P = 0.287). For the subgroup of nine studies (N = 15, 339) with advanced age definition at or above 75 (OR = 4.90, 95% CI: 3.95–6.09, I^2 = 50.40%, P < 0.001, PAF = 41.2%), the pooled mortality rate was 18% (95% CI: 14%–22%) with high heterogeneity (I^2 = 89.70%, P < 0.001). The high heterogeneity could be explained by the variation of the follow-up period, the pooled mortality rate for six studies (N = 13, 168) with 30-day follow-up was 11% (95% CI: 9%–12%) with low heterogeneity (I^2 = 0.00%, P = 0.49), while the pooled mortality rate for four studies (N = 7, 006) with 1-year follow-up was 17% (95% CI: 15%–20%) with low heterogeneity (I^2 = 55.70%, P = 0.079). For the remaining three studies (N = 7, 831) with advanced age definition at or above 80 (OR = 4.36, 95%CI: 3.66–5.19, I^2 = 32.90%, P < 0.001, PAF = 51.8%), the pooled mortality rate was 32% (95% CI: 23%–40%) with high heterogeneity (I^2 = 84.50%, P = 0.002). The significant heterogeneity could also be explained by the variation of the follow-up period, the pooled mortality rate for two studies (N = 5, 829) with 30-day follow-up was 18% (95% CI, 12%–25%) with medium heterogeneity (I^2 = 72.60%, P = 0.056), while the pooled mortality rate for two studies (N = 5, 829) with 1-year follow-up was 27% (95% CI, 24%–31%) with low heterogeneity (I^2 = 0.00%, P = 0.5).

Female

Across 15 studies (N = 47, 782) in Table 3 reported female was a risk factor (OR = 2.01, 95% CI: 1.87–2.16, I^2 = 46.30%, P < 0.001, PAF = 10.0%) of mortality for STEMI patients after PCI. The pooled mortality rate for female patients was 11% (95% CI: 8%–13%) with high heterogeneity (I^2 = 91.30%, P < 0.001). In a subgroup of 11 studies (N = 43, 236) with 30-day follow-up, the pooled mortality rate was 8% (95% CI: 6%–10%) with significant heterogeneity (I^2 = 92.90%, P < 0.001). For the subgroup of six studies (N = 23, 155) with 1-year follow-up, the

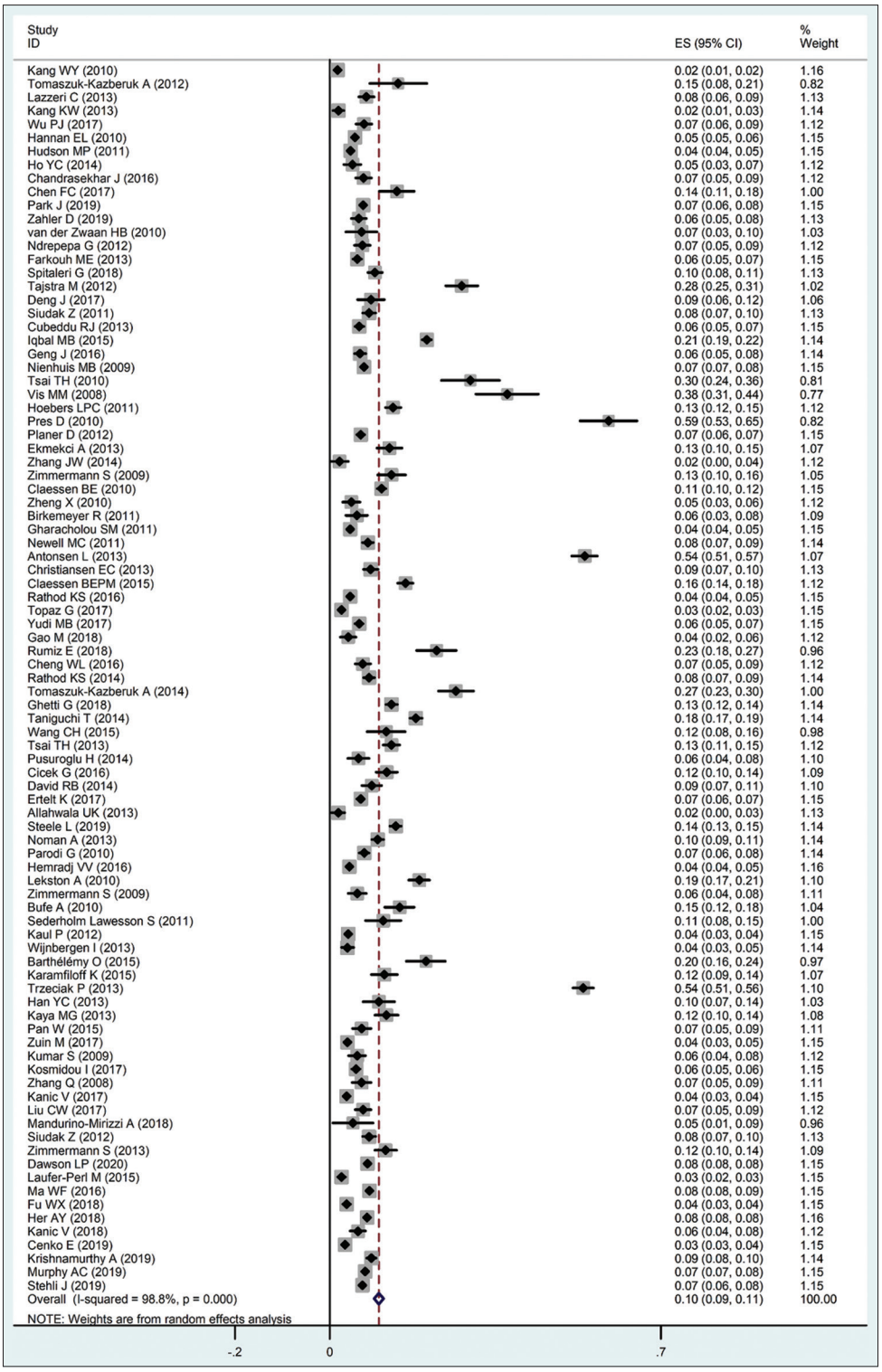

Figure 2: The pooled mortality rate for STEMI patients after PCI. STEMI = ST-elevation myocardial infarction; PCI = Percutaneous coronary intervention

pooled mortality rate was 13% (95% CI: 9%–17%) with high heterogeneity (I^2 = 91.60%, P < 0.001). This may be due to differences in the age range of the included study subjects or large differences in the sample size. For two studies (N = 1, 674) with 2-year follow-up, the pooled mortality rate was 9% (95% CI: 6%–12%) with low heterogeneity (I^2 = 0.00%, P = 0.529).

Obesity

The pooled analysis result from five studies (N = 6, 739) in Table 3 showed that obesity (OR = 0.41, 95% CI: 0.16–1.04, I^2 = 82.80%, P = 0.061, PAF = 2.9%) did not reach statistical significance. The pooled mortality rate for obesity STEMI patients after PCI was 5% (95% CI: 3%–8%) with high heterogeneity (I^2 = 92.80%, P < 0.001).

Table 3: Meta-analysis of the correlation between risk factors and mortality

Risk factors	Grouping (exposure group/unexposure group)	Follow-up time	Number of studies	Sample size	Exposure group			Unexposure group			OR				PAF (%)
					Heterogeneity test		P_{pooled} (95% CI)	Heterogeneity test		P_{pooled} (95% CI)	Heterogeneity test		OR_{pooled} (95% CI)	*P*	
					I^2 (%)	*P*		I^2 (%)	*P*		I^2 (%)	*P*			
Advanced age	Advanced age/control	-	15	28,360	97.50	<0.001	0.17 (0.14-0.21)	99.00	<0.001	0.07 (0.05-0.10)	78.60	<0.001	3.89 (3.47-4.37)	<0.001	32.9
	≥45/<45	30-day	2	4148	11.80	0.287	0.05 (0.04-0.05)	0.00	0.813	0.02 (0.01-0.03)	0.00	0.327	2.42 (1.28-4.59)	0.007	6.6
	≥75/<75	-	9	15,339	89.70	<0.001	0.18 (0.14-0.22)	92.10	<0.001	0.04 (0.03-0.05)	50.40	0.041	4.90 (3.95-6.09)	<0.001	41.2
		30-day	6	13,168	0.00	0.49	0.11 (0.09-0.12)	83.50	<0.001	0.03 (0.02-0.04)	31.80	0.197	4.29 (3.60-5.10)	<0.001	26.6
		1-year	4	7006	55.70	0.079	0.17 (0.15-0.20)	83.70	<0.001	0.05 (0.04-0.07)	5.40	0.366	4.36 (3.62-5.25)	<0.001	36.4
	≥80/<80	-	3	7831	84.50	0.002	0.32 (0.23-0.40)	96.20	<0.001	0.09 (0.06-0.13)	32.90	0.226	4.36 (3.66-5.19)	<0.001	51.8
		30-day	2	5829	72.60	0.056	0.18 (0.12-0.25)	96.60	<0.001	0.05 (0.02-0.08)	24.40	0.250	3.82 (3.01-4.85)	<0.001	33.7
		1-year	2	5829	0.00	0.5	0.27 (0.24-0.31)	95.00	<0.001	0.08 (0.04-0.11)	64.40	0.094	4.51 (3.04-6.67)	<0.001	48.7
Female	Female/male	-	15	47,782	91.30	<0.001	0.11 (0.08-0.13)	95.60	<0.001	0.06 (0.05-0.07)	46.30	0.025	2.01 (1.87-2.16)	<0.001	10.0
		30-day	11	43,236	92.90	<0.001	0.08 (0.06-0.1)	97.50	<0.001	0.04 (0.03-0.05)	38.00	0.096	2.13 (1.96-2.31)	<0.001	8.3
		1-year	6	23,155	91.60	<0.001	0.13 (0.09-0.17)	96.70	<0.001	0.08 (0.05-0.10)	57.10	0.040	1.87 (1.47-2.38)	<0.001	10.2
		2-year	2	1674	0.00	0.529	0.09 (0.06-0.12)	81.40	0.02	0.04 (0.01-0.06)	0.00	0.334	2.54 (1.60-4.04)	<0.001	12.2
Obesity	Obesity/control	-	5	6739	92.80	<0.001	0.05 (0.03-0.08)	77.50	<0.001	0.10 (0.05-0.16)	82.80	<0.001	0.41 (0.16-1.04)	0.061	2.9
	BMI≥25/<25	-	3	2374	0.00	0.71	0.08 (0.06-0.09)	72.80	0.025	0.09 (0.04-0.13)	71.0	0.032	0.78 (0.40-1.50)	0.453	1.7
		30-day	2	1106	88.40	0.003	0.05 (−0.01-0.1)	15.10	0.278	0.07 (0.04-0.09)	0.00	0.663	1.01 (0.62-1.65)	0.96	0.05
		1-year	2	1399	85.00	0.01	0.06 (0.01-0.11)	0.00	0.895	0.07 (0.05-0.10)	0.00	0.808	1.06 (0.67-1.67)	0.808	0.4
	BMI≥27.5/<27.5	1-year	2	4365	0.00	0.555	0.01 (0.01-0.02)	0.00	0.753	0.03 (0.03-0.04)	0.00	0.544	0.39 (0.16-1.00)	0.050	0.6
Smoking	Smoking/no smoking	30-day	2	3515	93.90	<0.001	0.03 (−0.00-0.07)	82.40	0.017	0.04 (0.01-0.07)	0.00	0.619	0.90 (0.64-1.28)	0.563	0.3
OHCA	OHCA/no OHCA	-	3	15,054	74.90	0.019	0.31 (0.21-0.41)	92.20	<0.001	0.08 (0.05-0.10)	87.10	<0.001	5.55 (2.58-11.94)	<0.001	58.5
		30-day	2	14,287	95.60	<0.001	0.25 (0.01-0.49)	0.00	0.748	0.05 (0.05-0.06)	87.80	0.004	5.40 (1.36-21.43)	0.016	52.4
		1-year	2	2417	72.20	0.058	0.27 (0.12-0.42)	14.80	0.279	0.09 (0.07-0.10)	41.10	0.193	4.12 (2.64-6.41)	<0.001	45.7
Elevated HbA1c level	≥6.5/<6.5 mmol/L	-	2	1239	97.90	<0.001	0.22 (−0.06-0.50)	0.00	0.405	0.05 (0.03-0.06)	95.20	<0.001	4.53 (0.52-39.46)	0.171	43.7
CS	CS/no CS	-	2	8386	99.00	<0.001	0.34 (−0.13-0.81)	99.00	<0.001	0.09 (−0.01-0.20)	92.50	<0.001	4.83 (3.71-6.29)	<0.001	56.6
RD	RD/no RD	-	4	4935	97.70	<0.001	0.19 (0.05-0.33)	79.10	0.002	0.05 (0.03-0.07)	89.90	<0.001	3.50 (1.56-7.84)	0.002	32.2
	eGFR (<60/≥60 mL/min/1.73 m^2)	-	2	1744	33.00	0.222	0.26 (0.22-0.30)	0.00	0.706	0.06 (0.05-0.08)	21.80	0.258	5.32 (3.91-7.23)	<0.001	52.9
	Serum creatinine level (≥115/<115 μmol/L)	30-day	2	3191	87.10	0.005	0.09 (−0.02-0.20)	76.20	0.040	0.04 (0.02-0.06)	76.60	0.039	1.93 (0.84-4.44)	0.124	7.7
Admission anemia	With admission anemia/without	-	3	3680	90.50	<0.001	0.25 (0.13-0.38)	97.75	<0.001	0.12 (0.05-0.18)	0.00	0.852	3.28 (2.57-4.18)	<0.001	36.3
Hyperuricemia	With hyperuricemia/without	-	2	1045	0.00	0.473	0.12 (0.08-0.15)	50.10	0.157	0.04 (0.02-0.07)	44.90	0.178	2.71 (1.67-4.39)	<0.001	17.0
Elevated blood glucose level	≥7.8/<7.8 mmol/L	-	3	2112	98.80	<0.001	0.42 (0.11-0.74)	94.90	<0.001	0.23 (0.03-0.43)	0.00	0.741	2.56 (1.98-3.04)	<0.001	39.6
		30-day	2	1854	98.20	<0.001	0.26 (−0.04-0.56)	88.80	0.003	0.09 (−0.06-0.24)	0.00	0.405	4.44 (2.91-6.77)	<0.001	47.2
		1-year	2	466	38.70	0.202	0.48 (0.43-0.54)	75.60	0.043	0.27 (0.12-0.42)	17.60	0.271	2.44 (1.57-3.78)	<0.001	40.9

Contd...

Table 3: Contd...

Risk factors	Grouping (exposure group/unexposure group)	Follow-up time	Number of studies	Sample size	Exposure group			Unexposure group			OR				PAF (%)
					Heterogeneity test		P_{pooled} (95% CI)	Heterogeneity test		P_{pooled} (95% CI)	Heterogeneity test		OR_{pooled} (95% CI)	*P*	
					I^2 (%)	*P*		I^2 (%)	*P*		I^2 (%)	*P*			
DM	DM/no DM	-	4	6222	89.80	<0.001	0.12 (0.06-0.18)	96.10	<0.001	0.07 (0.03-0.11)	0.00	0.472	2.00 (1.62-2.46)	<0.001	10.7
		30-day	4	6222	88.40	<0.001	0.09 (0.03-0.14)	94.40	<0.001	0.04 (0.02-0.07)	0.00	0.943	2.24 (1.71-2.94)	<0.001	10.0
		3-year	2	5245	85.10	0.010	0.15 (0.07-0.22)	98.20	<0.001	0.09 (0.02-0.16)	41.20	0.192	1.93 (1.54-2.42)	<0.001	12.2
CTO	CTO/no CTO	1-year	2	1043	81.00	0.022	0.20 (0.11-0.30)	92.00	<0.001	0.08 (0.007-0.14)	2.80	0.311	3.03 (2.08-4.41)	<0.001	28.9
Q wave	Q wave/no Q wave	-	3	7922	73.90	0.022	0.07 (0.05-0.09)	85.90	0.001	0.03 (0.02-0.05)	17.30	0.299	2.18 (1.74-2.73)	<0.001	7.6
		30-day	2	7253	83.30	0.014	0.04 (0.02-0.05)	0.00	0.562	0.02 (0.01-0.02)	71.40	0.062	2.11 (1.17-3.83)	0.014	4.3
		1-year	2	3392	74.50	0.048	0.06 (0.03-0.09)	0.00	0.453	0.03 (0.02-0.04)	0.00	0.504	1.96 (1.38-2.78)	<0.001	5.4
Without PA	Without PA/with PA	-	2	6491	95.10	<0.001	0.17 (0.13-0.22)	90.80	0.001	0.09 (0.04-0.14)	51.90	0.149	2.12 (1.58-2.85)	<0.001	16.0
Delay in DTB time	Delay in DTB time/control	-	6	17,501	91.70	<0.001	0.07 (0.05-0.09)	64.6	0.015	0.04 (0.03-0.05)	5.30	0.383	1.72 (1.47-2.01)	<0.001	4.8
	≥45 min/<45 min	-	2	5802	89.40	0.002	0.06 (0.03-0.10)	0.00	0.624	0.05 (0.03-0.06)	58.40	0.121	1.42 (0.66-3.02)	0.367	2.5
	≥60 min/<60 min	-	5	12,781	94.00	<0.001	0.08 (0.05-0.12)	79.80	0.001	0.05 (0.04-0.07)	17.70	0.302	1.72 (1.45-2.03)	<0.001	5.4
		30-day	4	7538	87.20	<0.001	0.07 (0.04-0.10)	82.40	0.001	0.04 (0.02-0.07)	22.40	0.276	1.77 (1.32-2.37)	<0.001	5.1
		1-year	2	6132	0.00	0.786	0.09 (0.08-0.10)	0.00	0.36	0.05 (0.05-0.06)	0.00	0.421	1.78 (1.46-2.17)	<0.001	6.6
	≥90 min/<90 min	-	3	16,080	95.40	<0.001	0.09 (0.05-0.12)	93.40	<0.001	0.05 (0.03-0.06)	89.40	0.000	1.92 (1.20-3.09)	0.007	7.6
Delay in STB time	Delay in STB time/control	-	4	11,353	63.20	0.043	0.05 (0.04-0.06)	64.10	0.039	0.04 (0.03-0.05)	0.00	0.942	1.43 (1.18-1.72)	<0.001	2.1
	>3 h/≤3 h	-	3	10,834	0.00	0.531	0.05 (0.04-0.05)	0.00	0.457	0.03 (0.03-0.04)	0.00	0.586	1.43 (1.17-1.76)	0.001	2.1
		30-day	3	10,834	29.70	0.241	0.04 (0.03-0.05)	0.00	0.473	0.03 (0.02-0.03)	0.00	0.502	1.38 (1.11-1.72)	0.004	1.5
		90-day	2	10,275	0.00	0.485	0.05 (0.04-0.05)	12.80	0.284	0.03 (0.03-0.04)	0.00	0.634	1.40 (1.14-1.73)	0.002	2.0
	>4 h/≤4 h	-	2	1452	61.40	0.108	0.07 (0.04-0.11)	56.00	0.132	0.05 (0.03-0.07)	0.00	0.991	1.55 (1.00-2.39)	0.048	3.7
Anterior infarction	Anterior/nonanterior	-	3	7292	99.80	<0.001	0.34 (0.00-0.74)	99.70	<0.001	0.27 (0.00-0.58)	0.00	0.554	1.66 (1.46-1.90)	<0.001	18.3
		30-day	3	7292	99.70	<0.001	0.30 (0.00-0.65)	99.70	<0.001	0.23 (0.00-0.50)	0.00	0.715	1.67 (1.45-1.92)	<0.001	16.7
		1-year	2	7080	99.90	<0.001	0.35 (0.00-0.86)	99.90	<0.001	0.26 (0.00-0.67)	0.00	0.433	1.68 (1.47-1.93)	<0.001	19.2
STR	≤70%/>70	-	4	4958	80.80	0.001	0.09 (0.06-0.12)	62.90	0.044	0.06 (0.04-0.08)	43.10	0.153	1.40 (1.12-1.75)	0.003	3.5
		3-year	2	3835	46.10	0.173	0.07 (0.06-0.08)	0.00	0.391	0.05 (0.04-0.06)	61.00	0.109	1.44 (0.92-2.25)	0.112	3.0
		5-year	2	2251	85.70	0.008	0.10 (0.05-0.14)	52.20	0.148	0.07 (0.05-0.09)	0.00	0.631	1.50 (1.10-2.04)	0.011	4.8
Delay in STD time	≥2 h/<2 h	-	2	10,335	88.90	0.003	0.07 (0.05-0.09)	71.70	0.06	0.06 (0.04-0.07)	0.00	0.553	1.29 (1.10-1.51)	0.002	2.0
Off-hour operation	Off-hour/on-hour	-	4	11,618	98.80	<0.001	0.11 (0.04-0.18)	98.80	<0.001	0.10 (0.02-0.17)	0.00	0.405	1.11 (1.00-1.24)	0.053	1.2
		1-year	2	4090	93.80	<0.001	0.07 (0.02-0.11)	91.50	0.001	0.06 (0.02-0.09)	0.00	0.766	1.23 (0.94-1.61)	0.141	1.6
		3-year	2	8374	99.50	<0.001	0.14 (−0.01-0.29)	99.40	<0.001	0.13 (−0.00-0.26)	0.00	0.624	1.10 (0.98-1.23)	0.125	1.4

OR=Odds ratio; OR_{pooled}=Pooled OR; P_{pooled}=Pooled proportion; CI=Confidence interval; BMI=Body mass index; CS=Cardiogenic shock; CTO=Chronic total occlusion; DM=Diabetes mellitus; DTB=Door-to-balloon time; eGFR=Estimated glomerular filtration rate; HbA1c=Hemoglobin A1c levels; OHCA=Out-of-hospital cardiac arrest; PA=Prodromal angina; RD=Renal dysfunction; STB=Symptom onset-to-balloon time; STR=ST-segment resolution; STD=Symptom onset-to-door time; -: Not considering follow-up times; PAF=Population Attributable Fraction

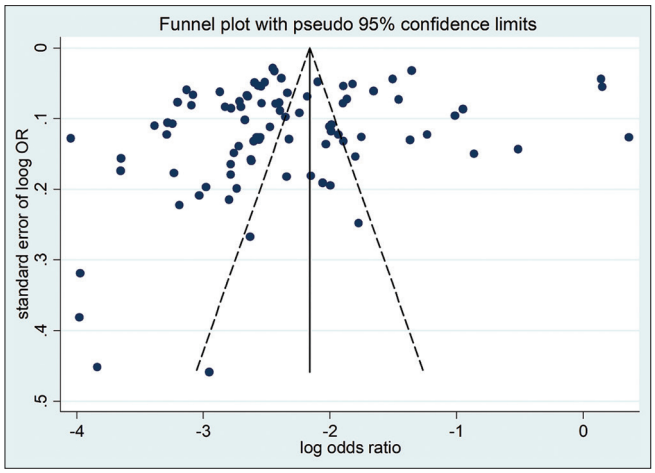

Figure 3: Funnel plot for assessing publication biases

Smoking

The pooled analysis result from two articles (N = 3, 515) in Table 3 showed that smoking (OR = 0.90, 95% CI: 0.64–1.28, I^2 = 0.00%, P = 0.563, PAF = 0.3%) did not reach statistical significance. The pooled 30-day mortality rate for smoking STEMI patients after PCI was 3% (95% CI: 0%–7%) with high heterogeneity (I^2 = 93.90%, P < 0.001).

Out-of-hospital cardiac arrest

Across three studies (N = 15, 054) in Table 3 reported out-of-hospital cardiac arrest (OHCA) was a risk factor (OR = 5.55, 95% CI: 2.58–11.94, I^2 = 87.10%, P < 0.001, PAF = 58.5%) of mortality for STEMI patients after PCI. The pooled mortality rate after PCI for STEMI patients with OHCA was 31% (95% CI: 21%–41%) with medium heterogeneity (I^2 = 74.90%, P = 0.019). In a subgroup of two studies (N = 14, 287) with 30-day follow-up, the pooled mortality rate was 25% (95% CI: 1%–49%) with significant heterogeneity (I^2 = 95.60%, P < 0.001). For the subgroup of two studies (N = 2, 417) with 1-year follow-up, the pooled mortality rate was 27% (95% CI: 12%–42%) with insignificant heterogeneity (I^2 = 72.20%, P = 0.058).

Elevated hemoglobin A1c level

Across two studies (N = 1, 239) in Table 3 reported elevated hemoglobin A1c (Hb1Ac) level (≥6.5 mmol/L) was a risk factor (OR = 4.53, 95% CI: 0.52–39.46, I^2 = 95.20%, P = 0.171, PAF = 43.7%) of mortality for STEMI patients after PCI. The pooled mortality rate after PCI for STEMI patients with elevated Hb1Ac levels was 22% (95% CI: 6%–50%) with high heterogeneity (I^2 = 97.90%, P < 0.001).

Cardiogenic shock

Across two studies (N = 8, 386) in Table 3 reported cardiogenic shock (CS) was a risk factor (OR = 4.83, 95% CI: 3.71–6.29, I^2 = 92.5%, P < 0.001, PAF = 56.6%) of mortality for STEMI patients after PCI. The pooled mortality rate after PCI for STEMI patients with CS was 34% (95% CI: 13%–81%) with high heterogeneity (I^2 = 99.00%, P < 0.001).

Renal dysfunction

Across four studies (N = 4, 935) in Table 3 reported renal dysfunction (RD) was a risk factor (OR = 3.50, 95% CI: 1.56–7.84, I^2 = 89.90%, P = 0.002, PAF = 32.2%) of mortality for STEMI patients after PCI. The pooled mortality rate after PCI for STEMI patients with RD was 19% (95% CI: 5%–33%) with high heterogeneity (I^2 = 97.70%, P < 0.001). In a subgroup of two studies (N = 1, 744) with estimated glomerular filtration rate (eGFR) <60 mL/min/1.73 m^2, the pooled mortality rate was 26% (95% CI: 22%–30%) with low heterogeneity (I^2 = 33.00%, P = 0.222). For the subgroup of two studies (N = 3, 191) with RD definition of serum creatinine level ≥ 115 μmol/L, the pooled mortality rate was 9% (95% CI: 2%–20%) with high heterogeneity (I^2 = 87.10%, P = 0.005).

Admission anemia

Across three studies (N = 3, 680) in Table 3 reported admission anemia was a risk factor (OR = 3.28, 95% CI: 2.57–4.18, I^2 = 0.00%, P < 0.001, PAF = 36.3%) of mortality for STEMI patients after PCI. The pooled mortality rate after PCI for STEMI patients with admission anemia was 25% (95% CI: 13%–28%) with high heterogeneity (I^2 = 90.50%, P < 0.001).

Hyperuricemia

Across two studies (N = 1, 045) in Table 3 reported hyperuricemia was a risk factor (OR = 2.71, 95% CI: 1.67–4.39, I^2 = 44.90%, P < 0.001, PAF = 17.0%) of mortality for STEMI patients after PCI. The pooled mortality rate for hyperuricemia STEMI patients after PCI was 12% (95% CI: 8%–15%) with high heterogeneity (I^2 = 0.00%, P = 0.473).

Elevated blood glucose level

Across three studies (N = 2, 112) in Table 3 reported elevated blood glucose level (≥7.8 mmol/L) was a risk factor (OR = 2.56, 95% CI: 1.98–3.04, I^2 = 0.00%, P < 0.001, PAF = 39.6%) of mortality for STEMI patients after PCI. The pooled mortality rate for exposure group patients was 42% (95% CI 11%–74%) with high heterogeneity (I^2 = 98.80%, P < 0.001). In a subgroup of two studies (N = 1, 854) with 30-day follow-up, the pooled mortality rate was 26% (95% CI: 4%–56%) with significant heterogeneity (I^2 = 98.20%, P < 0.001). For the subgroup of two studies (N = 466) with 1-year follow-up, the pooled mortality rate was 48% (95% CI: 43%–54%) with insignificant heterogeneity (I^2 = 38.70%, P = 0.202).

Diabetes mellitus

Across four studies (N = 6, 222) in Table 3 reported diabetes mellitus (DM) was a risk factor (OR = 2.00, 95% CI: 1.62–2.46,

I^2 = 0.00%, P < 0.001, PAF = 10.7%) of mortality for STEMI patients after PCI. The pooled mortality rate after PCI for STEMI patients with DM was 12% (95% CI: 6%–18%) with high heterogeneity (I^2 = 89.80%, P < 0.001). In a subgroup of four studies (N = 6, 222) with 30-day follow-up, the pooled mortality rate was 9% (95% CI: 3%–14%) with significant heterogeneity (I^2 = 88.40%, P < 0.001). For the subgroup of two studies (N = 5, 245) with 3-year follow-up, the pooled mortality rate was 15% (95% CI: 7%–22%) with significant heterogeneity (I^2 = 85.10%, P = 0.01).

Elevated heart rate

Across two studies (N = 4, 689) in Table 3 reported elevated heart rate was a risk factor of mortality for STEMI patients after PCI. However, a meta-analysis could not be conducted due to differences in grouping criteria. One study was based on previous studies in populations with various cardiovascular diseases including postprimary PCI,[19] while the other did not mention the basis for the classification.

Elevated ratio of neutrophils to lymphocytes

Across four studies (N = 4, 045) in Table 3 reported elevated neutrophils to lymphocytes (NLR) was a risk factor of mortality for STEMI patients after PCI. NLR was calculated as the ratio of NLR. However, the grouping criteria of the four studies were different, and the basis of grouping was not clearly mentioned. Therefore, we compare with grouping criteria of NLR according to mortality for STEMI patients after PCI [Figure 4].

Chronic total occlusion

Across two studies (N = 1, 043) in Table 3 reported chronic total occlusion (CTO) was a risk factor (OR = 3.03, 95% CI: 2.08–4.41, I^2 = 2.80%, P < 0.001, PAF = 28.9%) of mortality for STEMI patients after PCI. The pooled mortality rate after PCI for STEMI patients with CTO was 20% (95% CI: 11%–30%) with high heterogeneity (I^2 = 81.00%, P = 0.022).

Q wave on presentation

Across three studies (N = 7, 922) in Table 3 reported Q wave on presentation was a risk factor (OR = 2.18, 95% CI: 1.74–2.73, I^2 = 17.30%, P < 0.001, PAF = 7.6%) of mortality for STEMI patients after PCI. The pooled mortality rate after PCI for STEMI patients with Q wave on presentation was 7% (95% CI: 5%–9%) with medium heterogeneity (I^2 = 73.90%, P = 0.022). In a subgroup of two studies (N = 7, 253) with 30-day follow-up, the pooled mortality rate was 4% (95% CI: 2%–5%) with significant heterogeneity (I^2 = 83.30%, P = 0.014). For the subgroup of two studies (N = 3, 392) with 1-year follow-up, the pooled mortality rate was 6% (95% CI: 3%–9%) with medium heterogeneity (I^2 = 74.50%, P = 0.048). This may be the reason for the large heterogeneity caused by the large difference in sample size.

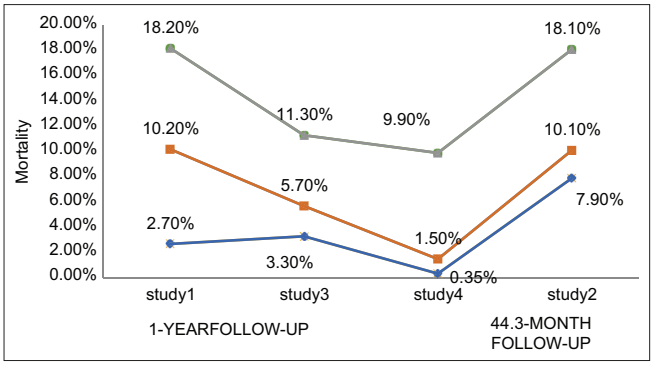

Figure 4: Comparison of grouping criteria of NLR according to mortality. NLR = neutrophils to lymphocytes

Without prodromal angina

Across two studies (N = 6, 491) in Table 3 reported without prodromal angina (PA) was a risk factor (OR = 2.12, 95% CI: 1.58–2.85, I^2 = 51.90%, P < 0.001, PAF = 16.0%) of mortality for STEMI patients after PCI. The pooled mortality rate after PCI for STEMI patients without PA was 17% (95% CI: 13%–22%) with high heterogeneity (I^2 = 95.10%, P < 0.001).

Delay in door-to-balloon time

Delay in DTB time was a risk factor (OR = 1.72, 95% CI: 1.47–2.01, I^2 = 5.30%, P < 0.001, PAF = 4.8%) we retrieved from six articles (N = 17, 501) in this study [Table 3]. The pooled mortality rate for STEMI patients after PCI at the delay in DTB time was 7% (95% CI: 5%–9%) with high heterogeneity (I^2 = 91.70%, P < 0.001). In a subgroup of two studies (N = 5, 802) with a delay in DTB time definition at or above 45 min (OR = 1.42, 95% CI: 0.66–3.02, I^2 = 58.40%, P = 0.367, PAF = 2.5%), the pooled mortality rate was 6% (95% CI: 3%–10%) with high heterogeneity (I^2 = 89.40%, P = 0.002). For the subgroup of five studies (N = 12, 781) with delay in DTB time definition at or above 60 min (OR = 1.72, 95% CI: 1.45–2.03, I^2 = 17.70%, P < 0.001, PAF = 5.4%), the pooled mortality rate was 8% (95% CI: 5%–12%) with high heterogeneity (I^2 = 94.00%, P < 0.001). The high heterogeneity could be explained by the variation of follow-up period, the pooled mortality rate for four studies (N = 7, 538) with 30-day follow-up was 7% (95% CI: 4%–10%) with significant heterogeneity (I^2 = 87.20%, P < 0.001), while the pooled mortality rate for two studies (N = 6, 132) with 1-year follow-up was 9% (95% CI: 8%–10%) with low heterogeneity (I^2 = 0.00%, P = 0.786). For the remaining three studies (N = 16, 080) with delay in DTB time definition at or above 90 min (OR = 1.92, 95% CI: 1.20–3.09, I^2 = 89.40%, P = 0.007, PAF = 7.6%), the pooled mortality rate was 9% (95% CI: 5%–12%) with high heterogeneity (I^2 = 95.40%, P < 0.001).

Delay in symptom onset-to-balloon time

Across four studies (N = 11, 353) in Table 3 reported delay in symptom onset-to-balloon time (STB) time was a risk

factor (OR = 1.43, 95% CI: 1.18–1.72, I^2 = 0.00%, P < 0.001, PAF = 2.1%) of mortality for STEMI patients after PCI. The pooled mortality rate for STEMI patients after PCI at the delay in STB time was 5% (95% CI: 4%–6%) with low heterogeneity (I^2 = 63.20%, P = 0.043). In a subgroup of three studies (N = 10, 834) with delay in STB time definition at or above 3 h (OR = 1.43, 95% CI: 1.17–1.76, I^2 = 0.00%, P = 0.001, PAF = 2.1%), the pooled mortality rate was 5% (95% CI, 4%–5%) with low heterogeneity (I^2 = 0.00%, P = 0.531). Different studies involved the variation of the follow-up period, the pooled mortality rate for three studies (N = 10, 834) with 30-day follow-up was 4% (95% CI, 3%–5%) with low heterogeneity (I^2 = 29.70%, P = 0.241), while the pooled mortality rate for two studies (N = 10, 275) with 90-day follow-up was 5% (95% CI, 4%–5%) with low heterogeneity (I^2 = 0.00%, P = 0.485). For the subgroup of two studies (N = 1, 452) with delay in STB time definition at or above 4 h (OR = 1.55, 95% CI: 1.00–2.39, I^2 = 0.00%, P = 0.048, PAF = 3.7%), the pooled mortality rate was 7% (95% CI, 4%–11%) with low heterogeneity (I^2 = 61.40%, P = 0.108).

Anterior infarction

Across three studies (N = 7, 292) in Table 3 reported anterior infarction was a risk factor (OR = 1.66, 95% CI: 1.46–1.90, I^2 = 0.00%, P < 0.001, PAF = 18.3%) of mortality for STEMI patients after PCI. The pooled mortality rate for anterior infarction STEMI patients after PCI was 34% (95% CI: 0%–74%) with high heterogeneity (I^2 = 99.80%, P < 0.001). In the group of three studies (N = 7, 292) with 30-day follow-up, the pooled mortality rate was 30% (95% CI: 0%–65%) with significant heterogeneity (I^2 = 99.70%, P < 0.001). For the subgroup of two studies (N = 7, 080) with 1-year follow-up, the pooled mortality rate was 35% (95% CI: 0%–86%) with significant heterogeneity (I^2 = 99.90%, P < 0.001). This may be the reason for the large heterogeneity caused by the large difference in sample size.

ST-segment resolution

Across four studies (N = 4, 958) in Table 3 reported ST-segment resolution (STR) (≤70%) was a risk factor (OR = 1.40, 95% CI: 1.12–1.75, I^2 = 43.10%, P = 0.003, PAF = 3.5%) of mortality for STEMI patients after PCI. The pooled mortality rate for exposure group patients was 9% (95% CI: 6%–12%) with high heterogeneity (I^2 = 80.80%, P = 0.001). In a subgroup of two studies (N = 3, 835) with 3-year follow-up, the pooled mortality rate was 7% (95% CI, 6%–8%) with low heterogeneity (I^2 = 46.10%, P = 0.173). For the subgroup of two studies (N = 2, 251) with 5-year follow-up, the pooled mortality rate was 10% (95% CI, 5%–14%) with high heterogeneity (I^2 = 85.70%, P = 0.008). Other confounding factors may affect heterogeneity due to the long follow-up time.

Delay in symptom onset-to-door time

Across two studies (N = 10, 335) in Table 3 reported delay in symptom onset-to-door time (STD) time longer than 2 h was a risk factor (OR = 1.29, 95% CI: 1.10–1.51, I^2 = 0.00%, P = 0.002, PAF = 2.0%) of mortality for STEMI patients after PCI. The pooled mortality rate for exposure group patients was 7% (95% CI: 5%–9%) with high heterogeneity (I^2 = 88.90%, P = 0.003).

Off-hour operation

Across four studies (N = 11, 618) in Table 3 reported off-hour operation was a risk factor (OR = 1.11, 95% CI: 1.00–1.24, I^2 = 0.00%, P = 0.053, PAF = 1.2%) of mortality for STEMI patients after PCI. The pooled mortality rate for exposure group patients was 11% (95%CI: 4%–18%) with high heterogeneity (I^2 = 98.80%, P < 0.001). In a subgroup of two studies (N = 4, 090) with 1-year follow-up, the pooled mortality rate was 7% (95% CI: 2%–11%) with high heterogeneity (I^2 = 93.80%, P < 0.001). For the subgroup of two studies (N = 8, 374) with 3-year follow-up, the pooled mortality rate was 14% (95% CI: 1%–29%) with high heterogeneity (I^2 = 99.50%, P < 0.001).

DISCUSSION

Being 45 or older and female increased the risk of mortality after percutaneous coronary intervention for ST-elevation myocardial infarction patients

Our study reported that mortality prevalence increased with age criteria and follow-up criteria for grouping. STEMI patients at or above 80 years old after PCI held the highest mortality rate at 32%. This may have something to do with the elderly, who have multiple chronic comorbidities, and their basic cardiac functions were worse.[20] Moreover, when the follow-up period was taken into account, the 1-year mortality rate was higher than the 30-day mortality rate, and the 1-year mortality rate for STEMI patients after PCI at or above 80 was the highest at 27%, similar to previous findings.[21,22] However, it was slightly lower than Christiansen's study result,[23] which showed that the 1-year mortality rate for American STEMI patients after PCI at or above 80 was 25.6%. This may be related to the deterioration of body functions with complications, leading to slow postoperative recovery and the increased risk of noncardiac death in elderly STEMI patients after PCI with the extension of follow-up time. Therefore, it is indicated that patients aged at or over 45 years are already at risk, and risk assessment before PCI treatment, targeted preoperative preparation, and regular follow-up for at least 1 year after surgery should be carried out actively to prevent adverse events, especially for STEMI patients at or over 80 years old.

The results of the meta-analysis showed that female was a risk factor for STEMI patients after PCI, and the mortality

in female patients within 1 year after PCI was higher than that in more than 1 year, which was consistent with Stone's study results.[24] The symptoms of female STEMI patients are often atypical, it is likely to miss the best time for treatment due to ignorance, which leads to the relatively severe condition compared with men patients and prolonged recover time after PCI.[25-27] Therefore, it is suggested that health education and transitional care for female patients after PCI should be strengthen, especially how to identify dangerous signs timely and carry forward follow-up examinations regularly.

Complicated with out-of-hospital cardiac arrest, cardiogenic shock, renal dysfunction, admission anemia, hyperuricemia, blood glucose level ≥7.8 mmol/L, and diabetes mellitus increased the risk of mortality after percutaneous coronary intervention for ST-elevation myocardial infarction patients

This study evidenced the greatest risk of mortality after PCI for STEMI patients complicated with OHCA (OR = 5.55). As one of the most dangerous complications, OHCA can seriously affect the prognosis of patients significantly.[28,29] Previous studies have reported that poor nervous system recovery associated with the prolonged recovery time of spontaneous circulation and myocardial dysfunction associated with ischemic load influenced the short-term prognosis of patients,[30,31] which may also explain why the association between OHCA and mortality is higher at 30 days than at 1 year. Therefore, it is suggested that patients can achieve more significant benefits from effective medical treatment aimed to shorten the aid and transport time and restore spontaneous circulation as soon as possible.

The results of the meta-analysis showed that CS was significantly associated with mortality after PCI in this study, but pooled mortality in the CS group was much higher (25%) than unexposure group. The fundamental reason may be the difference in clinical manifestation between the two groups. Compared with patients without CS, the angiographic performance of CS patients is more serious, for example, they are often diagnosed with multivessel coronary disease, and the percentage of left anterior descending artery disease is much higher (50%–79%).[32,33] In addition, baseline TIMI 0-1 blood flow is more likely to occur (62%) in infarct-related arteries.[33] Patients with CS are prone to no reflow, and their infarct-related arteries are more likely to be completely blocked for a longer time, resulting in microvascular dysfunction very quickly.[34,35] This finding indicates that early rescue and effective treatment regimens are crucial for STEMI patients complicated with CS to improve the survival rate.

As an important factor reflecting vascular physiological abnormalities, renal function affect the occurrence of cardiovascular adverse events significantly.[28,29] In the sense that it is important to establish criteria for RD. This study evidenced the significant risk of mortality after PCI for STEMI patients complicated with renal dysfunction (OR = 5.32) when eGFR was used as the indicator and calculated with the modification of diet in the renal disease equation. More specially, angiography is required during PCI, and the contrast agent itself may cause damage to renal function.[36] Therefore, this finding evidenced the risk of RD and emphasizes the preventative role that continuous monitoring of renal function, prudent use of nephrotoxic drugs, and practical guidance on the excretion of contrast agents may have in terms of mortality after PCI.

Admission anemia was significantly associated with mortality after PCI for STEMI patients in this study. The chronic state of admission anemia may cause hemodynamic adaptation, which has a significant impact on microvascular remodeling and atherosclerosis. Previous studies[37,38] have showed that anemia of chronic disease can lead to decreased blood viscosity accompanied by decreased afterload, and eventually result in failure and death. Although the significant heterogeneity may have been due to differences in follow-up time, which varied from 1 year to 6 years across included three studies, mortality increased along with prolonged follow-up time in three included studies. This finding has established that the active prevention and correction of anemia in STEMI patients before PCI can reduce the risk of death and improve long-term outcomes.

Hyperuricemia was significantly associated with mortality after PCI for STEMI patients in this study. However, included studies in this meta-analysis indicated that mortality decreased with prolonged follow-up time from 11.7% at 1 year to 7% at 7.3 years.[39,40] Such findings suggest that patients with hyperuricemia should strongly be considering for active control of uric acid levels before PCI and regular detection of uric acid levels after PCI. Meanwhile, dietary guidance is necessary for patients and their co-residents, so as to effectively control purine intake.

DM and blood glucose levels ≥7.8 mmol/L (hyperglycemia) were significantly associated with mortality after PCI for STEMI patients in this study, and blood glucose level ≥7.8 mmol/L (OR = 2.56) demonstrated a greater risk than DM (OR = 2.00). More specially, DM and blood glucose levels are highly correlated. DM patients are in a state of hyperglycemia for a long time, previous studies[41,42] have shown that hyperglycemia can increase the tendency for blood clots to form and cytokines to release, thus lead to endothelial dysfunction and oxidative stress, and eventually aggravate myocardial injury. Moreover, results showed that 1-year mortality in STEMI patients after PCI with

hyperglycemia was highest (48%), mortality increased along with prolonged follow-up time in both the exposure group and unexposure group for patients with DM or hyperglycemia, while OR decreased along with prolonged follow-up time. There are two aspects of this finding that need to deserve some explanation. On the one hand, this finding indicated the actual effect that would be expected to be prevented following the elimination of exposure to DM or hyperglycemia, which was consistent with trends in PAF. On the other hand, studies[43] have shown that a large proportion of STEMI patients experience glucose intolerance during acute events, but over time, the symptoms of glucose intolerance in some patients will be alleviated, which may be the reason why the association became progressively weaker with prolonged follow-up time. Therefore, it is important to keep the preoperative blood glucose under control to improve the prognosis of patients, regardless of whether or not they have diabetes.

The manifestation and feature of chronic total occlusion, Q wave on presentation, without prodromal angina, delay in door-to-balloon time, delay in symptom onset-to-balloon time, anterior infarction, ST-segment resolution ≤70%, and delay in symptom onset-to-door time increased the risk of mortality after percutaneous coronary intervention for ST-elevation myocardial infarction patients

CTO, as the most challenging form of PCI, has received more and more clinical attention. Previous reports[44,45] of non-IRA CTO, in particular, have been demonstrated higher short-term and long-term mortality, which was consistent with this study. This relationship is known to be robust[46] and constitutes the basis for guideline recommendations promoting CTO-PCI with aggressive attempts involving dissection techniques and retrograde collateral channel crossing.[47] In this study, only two studies with 1-year follow-up were synthesized, and the pooled risk was lower compared with a previous meta-analysis,[48] which reported a pooled OR of 3.76 at 30 days and 2.9 at a median follow-up of 25.2 months. The inconsistency regarding the trends of the relationship between the occurrence of non-IRA CTO and mortality after PCI for STEMI patients, at least in part, from the exclusion of patients with prior PCI and prior MI in this study.

In this study, STR and Q wave on presentation were significant electrocardiography manifestations associated with mortality after PCI for STEMI patients. Prior studies[46,49] have shown that ST-segment monitoring after PCI is a widely available, well-validated, noninvasive tool to reflect effective perfusion of myocardial tissue and microvascular integrity. However, research on the relationship between the extent of STR and clinical outcomes, particularly long-term outcomes, have been inconsistent.[46,49,50] The uncertainty stems at least in part from the different methods they used for quantifying and categorizing STR. Included studies with the same grouping criteria for STR extent, this study evidenced the robust relationship between STR and long-term mortality for STEMI patients. In addition, subgroup meta-analysis results showed a stronger association between STR and 5-year mortality than 3-year mortality. However, moderate heterogeneity, possible concurrency problems from the differences in the measured time of STR in the original literature, indicates the results may not reliable and future research may benefit from expanding the samples' quantity and defining the measured time of STR so as to more robustly test the association. Q wave on presentation, as a physiological indicator of the development stage of infarction, indicates a broader myocardial invasion. Studies[51] have demonstrated that patients with Q wave on presentation were much less likely to reach the appropriate STR immediately after PCI when compared with patients without Q wave, resulting in higher mortality. Moreover, the subgroup meta-analysis results showed that the correlation between Q wave on presentation and mortality was higher at 30 days than 1 year, suggesting that Q wave may have a significant influence on the short-term prognosis. At last, based on the points discussed above, the combined application of Q wave to predict short-term mortality and STR to predict long-term mortality can be strongly practical with the evidence of definite measure time and method.

The symptom of PA was significantly associated with mortality after PCI for STEMI patients in this study. The analyzed data indicated that the prevalence of mortality was lower among patients with symptoms of PA (9%) than among those without (17%). The difference may result from enhanced myocardial endurance by ischemic preconditioning, the establishment of collateral circulation, and accelerated coagulation lysis by thrombolytic substances accompanying angina before infarction.[52] Murry[53] reported that the transient, nonfatal myocardial ischemic attack made the heart preconditioned and greatly reduced the infarction area, and proposed the concept of "preconditioned effect." Therefore, PA does not only mean the occurrence of the disease but may have a positive effect on the prognosis. It is a well-worth effort to introduce the warning role of PA as the end result will be much more timely and effective treatment.

The current analysis documented several interval metrics, delay in the STD, DTB, and STB time, constituted risk factors for mortality after PCI for STEMI patients. Previous studies[54-56] have demonstrated that delay in the STD time, DTB time, and STB time was significantly associated with mortality, and the correlates constitute the basis for guideline recommendations shortening of DTB time to within 90 min.[57] The subgroup analysis of DTB time also indicated the strongest protective

effect of mortality when STEMI patients were treated with PCI within 90 min upon arrival at the hospital. However, it is estimated that nearly 90% of patients have a DTB duration of 90 min[58] currently. The delay may result from the deficiency of associated knowledge, inconvenience of hospital visits, and inadequate emergency system. Studies have shown that the time of STD has remained relatively stable in recent years. In this study, the protective effect of STD time with grouping criteria of 2 h was the lowest, compared with DTB time or STB time with any grouping criteria. STB time, the sum of STD time and DTB time, was a valid measure of the efficiency of a health-care system, and the protective effect of STB time with grouping criteria of 3 h was lower than that with grouping criteria of 4 h.

The meta-analysis results showed that the prevalence of mortality was higher among patients with anterior infarction (34%) than among those with nonanterior infarction (27%). It was demonstrated that the anterior wall was the place where the heart contracts most powerfully, and patients with anterior infarction were at greater risk of infarction area dilatation, and the more vessels involved, the more likely it was to cause CS, leading to poor prognosis.[32,59] Consistent with these results, this study has well established that anterior infarction was significantly associated with mortality after PCI for STEMI patients (OR = 1.66). Moreover, the subgroup meta-analysis results showed that the correlation between anterior infarction and mortality was higher at 30 days than at 1 year, suggesting that anterior infarction may have a significant influence on the short-term prognosis. Studies[60] have proved that an electrocardiogram was of great value in the diagnosis of acute myocardial infarction, and clinicians need to carefully analyze the characteristics of electrocardiogram, so as to predict the infarct-related arteries of acute myocardial infarction well. In addition, the combination of coronary angiography results can better select vessels requiring emergency intervention, provide more accurate information for early treatment and prognosis assessment, and strengthen specialized medical care to improve the long-term prognosis of patients.

Strengths and limitations

A fundamental strength of the current analysis is the adoption of robust methodology. Nine electronic databases were searched systematically to identify relevant articles. This extensive effort, undertaken by two reviewers, enhanced the ability to accurately catalog the entire information on associated factors of mortality among STEMI patients after PCI and allowed stratifying the studies based on the degree of controlling for grouping criteria or follow-up time. However, the potential limitations of this study should be noted. First, the differences in the measurement of exposure factors and the definition of outcome indicators among different studies may become one of the sources of heterogeneity. Second, the review gathered 91 cohorts, but each analysis was based on 2 to 15 studies. Although a small number of studies were included in each index, the sample size was large and did not affect the outcome of the research results. Third, further analysis of some risk factors as described in the protocol, such as sensitive analysis and meta-regression, was not conducted to explore sources of heterogeneity due to the small number of studies on individual risk factors. Fourth, some eligible studies published in other languages were excluded due to the language filter, which limited the comprehensiveness of this study. In view of the limitations of this study, more high-quality studies are needed to verify the above conclusions.

CONCLUSIONS

To sum up, this systematic review found that the pooled mortality rate after PCI for STEMI patients was 10%. Such a high prevalence indicates the urgent need for controlling associated factors: Advanced age, female, OHCA, CS, RD, admission anemia, hyperuricemia, blood glucose level ≥7.8 mmol/L and DM, CTO, Q wave on presentation, without PA, delay in DTB time, delay in STB time, anterior infarction, STR ≤70%, and delay in STD time.

Among the factors above, modifiable factors include blood glucose level, RD, hyperuricemia, DM, STD time, DTB time, and STB time, which lead to the interventions for reasonable lifestyle, good medication compliance, and correct first aid knowledge to improve the outcome for STEMI patients after PCI. This research can provide a theoretical basis for the prevention of mortality after PCI for STEMI patients.

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Conflicts of interest

There are no conflicts of interest.

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