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Retraction

Retracted: A Systematic Review and Meta-Analysis of Influences of Chronic Kidney Disease on Patients after Percutaneous Coronary Intervention for Chronic Total Occlusions

Computational and Mathematical Methods in Medicine

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This article has been retracted by Hindawi, as publisher, following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of systematic manipulation of the publication and peer-review process. We cannot, therefore, vouch for the reliability or integrity of this article.

Please note that this notice is intended solely to alert readers that the peer-review process of this article has been compromised.

Wiley and Hindawi regret that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] W. Wu, M. Gao, and X. Wu, "A Systematic Review and Meta-Analysis of Influences of Chronic Kidney Disease on Patients after Percutaneous Coronary Intervention for Chronic Total Occlusions," *Computational and Mathematical Methods in Medicine*, vol. 2023, Article ID 9450752, 10 pages, 2023.

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Review Article

A Systematic Review and Meta-Analysis of Influences of Chronic Kidney Disease on Patients after Percutaneous Coronary Intervention for Chronic Total Occlusions

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Objective. Chronic kidney disease (CKD) is a clinical collective term for kidney disease with glomerular filtration rate (GFR) < 60 mL/min for more than three months due to various factors and is usually associated with coronary heart disease and is also an independent risk factor for coronary heart disease. This study is aimed at systematically reviewing the influence of CKD on the outcomes of patients after percutaneous coronary intervention (PCI) for chronic total occlusions (CTOs). *Methods.* The Cochrane Library, PubMed, Embase, China biomedical literature database (SinoMed), China National Knowledge Infrastructure, and Wanfang database were searched for case-control studies on the influence of CKD on outcomes after PCI for CTOs. After screening the literature, extracting data, and evaluating the quality of literature, RevMan 5.3 software was used for meta-analysis. *Results.* There were 11 articles with a total of 558,440 patients included. Meta-analysis results indicated that left ventricular ejection fraction (LVEF) level, diabetes, smoking, hypertension, coronary artery bypass grafting, angiotensin converting enzyme inhibitor (ACEI)/angiotensin receptor blocker (ARB), β-blockers, age, and renal insufficiency were the factors affecting outcomes after PCI for CTOs [risk ratio and 95% confidence interval were: 0.88 (0.86, 0.90), 0.96 (0.95, 0.96), 0.76 (0.59, 0.98), 1.39 (0.89, 2.16), 0.73 (0.38, 1.40), 0.24 (0.02, 3.9), 0.78 (0.77, 0.79), 0.81 (0.80, 0.82), and 1.50 (0.47, 4.79)]. *Conclusion.* LVEF level, diabetes, smoking, hypertension, coronary artery bypass grafting, ACEI/ARB, β-blockers, age, renal insufficiency, etc. are important risk factors for outcomes after PCI for CTOs. Controlling these risk factors is of great significance for the prevention, treatment, and prognosis of CKD.

1. Introduction

Chronic kidney disease (CKD), a clinical collective term for kidney disease with glomerular filtration rate (GFR) < 60 mL/min for more than three months due to various factors, is usually associated with coronary heart disease and is also an independent risk factor for coronary heart disease [1]. Chronic kidney disease (CKD) is recognized as an irreversible reduction of functional nephrons and leads to an increased risk of various pathological conditions; additionally, CKD patients have impaired immunity against bacteria and viruses [2]. It has been revealed that GFR decline is an independent predictive factor for coronary artery lesions and adverse cardiovascular events [3]. CKD has become a chronic disease that seriously threatens human health, bringing a huge economic burden to the country, society, and family.

Percutaneous coronary intervention (PCI) has been recognized by the medical community at home and abroad as an effective method for the treatment of coronary heart diseases [4]. PCI relieves symptoms of chronic ischemic heart disease patients resistant to optimal medical therapy and alters natural history of acute coronary syndromes [5]. According to the data reported by the National Health and Family Planning Commission online, an average of 426.82 patients per million population in China underwent PCI treatment, and the average number of implanted stents remained at about 1.5 [6]. In an existing system, a virtual

reality- (VR-) based surgery simulation system is presented for personalized PCI; in addition, the simulation system can directly take patient-specific clinical data as input and generate virtual 3D intervention scenarios [7]. However, PCI angina also negatively impacts 20-40% of patients and imposes a high burden on the healthcare system [8].

Chronic total occlusion (CTO) refers to lesions in which the coronary arteries are completely occluded, and the occlusion time exceeds 3 months. It is a common type of coronary heart disease, accounting for approximately half of the total number of coronary heart diseases. With the rapid development of PCI, more and more CTO patients have received PCI and achieved perfect recanalization. However, a study has revealed that CTO patients are usually older and are often complicated with diabetes mellitus, multivessel disease, lower left ventricular ejection fraction, and poor basal renal function [9]. At present, the meta-analysis of the influence of CKD on outcomes after PCI for CTOs is still rare in China, and the research cases are relatively scattered and lack quantitative statistics. To the best of our knowledge, seldom systematic review has attempted to analyze evidence on the subject in question, and no meta-analysis has been conducted in the literature to present pooled evidence on the outcomes after PCI for CTOs in the elderly [10]. Therefore, this study systematically evaluated the influencing factors affecting outcomes after PCI for CTOs, in order to provide an evidence-based insight for clinical early nursing intervention.

2. Materials and Methods

2.1. Literature Inclusion Criteria. Literatures involving patients diagnosed with coronary heart disease and accompanied by CKD were included. The influence of CKD risk factors on outcomes after PCI for CTOs served as exposure factors. Case-control studies in Chinese and English from 2010 to 2020 were included for meta-analysis. Exclusion criteria were listed as follows: (1) duplicates, (2) reviews, (3) full text is unavailable, and (4) inconsistency with the theme. Literatures adjudged to be eligible were identified using the preferred reporting items for systematic reviews and meta-analysis algorithm.

2.2. Literature Retrieval Strategy. The Cochrane Library, PubMed, Embase, China biomedical literature database (SinoMed), China National Knowledge Infrastructure (CNKI), and Wanfang database were searched online. The English search terms were "chronic kidney disease", "percutaneous coronary intervention", "chronic total occlusion", "CKD", "PCI", and "CTO". The related original documents were retrieved in each database by connecting the search terms with Boolean logic operators, and the related documents needed for this study were determined by analyzing the titles, abstracts, keywords, subject headings, and references of the documents.

2.3. Literature Screening and Data Extraction. According to the inclusion and exclusion criteria established by the meta-analysis, two researchers read through the abstracts of the selected literature to exclude literatures that did not meet the research conditions, and then the two researchers jointly extracted the research data and other relevant information, which were checked by another three independent researchers. If there was a disagreement, it would be resolved through a three-party consultation, and the opinions of the tutor and the tutor group would be listened.

2.4. Evaluation of Literature Quality. The Newcastle-Ottawa scale [11] was used to assess the quality of literatures, including comparability and outcomes. The full score of the scale was 9 points, of which comparability was counted as 2 points, and the remaining items were 1 point. Evaluation results >6 points were regarded as high-quality studies.

2.5. Statistical Analysis. Meta-analysis of the collected data was performed using RevMan 5.3 software. The final-effects indicators were measured by mean ± standard deviation (mean ± SD). The heterogeneity of the included papers was identified using both the statistical method and the forest plots, with P value of the Chi-squared and I^2 as heterogeneity measures. I^2 ranged from 0 to 100%. $I^2 = 0$ indicated that there was no heterogeneity, while higher I^2 indicated greater heterogeneity. The threshold of P values was 0.1, and I^2 was distinguished by 50%. If $P \geq 0.1$ and $I^2 \leq 50\%$, it indicated no statistical heterogeneity or small heterogeneity among the study results, and a fixed-effects model could be used for meta-analysis; if $P < 0.1$ and $I^2 > 50\%$, it indicated statistical heterogeneity among the study results, and a random-effects model could be used for meta-analysis. All count data were pooled as risk ratio (RR), and 95% confidence intervals (CI) were reported. $P < 0.05$ was considered statistically significant.

By making a funnel plot to evaluate whether the included studies had publication bias, simple scatter plot was made with the effect measure (RR) as the abscissa, and the standard error of the effect measure [SE (logRR)] as the ordinate. If the funnel graph in the funnel plot was symmetrical on both sides, it meant that there was no publication bias, otherwise, there was publication bias.

3. Results

3.1. Literature Retrieval Results. A total of 2610 related literatures were obtained through preliminary database search, including 387 in Cochrane Library, 588 in PubMed, 689 in Embase, 358 in SinoMed, 387 in CNKI, and 201 in Wanfang. There were 1864 remaining articles after using NoteExpress software to remove the duplicates. After reading the titles and abstracts, 654 reviews, 39 unavailable literatures, and 689 literatures inconsistent with the theme were excluded. After searching and reading the full text, 471 articles were further excluded, and 11 articles were finally included, involving 558,440 patients.

3.2. Basic Characteristics and Methodological Quality Evaluation of Included Studies. The basic characteristics and methodological quality evaluation of the included studies are shown in Table 1 and Table 2.

Table 1: Basic information of included studies.

Author	Year of publication	Number of cases/*N*		LVEF <40%/*N*		Type 2 diabetes/*N*		Smoking/*N*		Hypertension/*N*		Hyperlipidemia/*N*		Coronary artery bypass grafting/*N*		ACEI/ARB/*N*		*β*-blockers/*N*		Death/*N*		eGFR/mL·min^{-1}		Age >75 years/*N*		Renal insufficiency/*N*	
		S	C	S	C	S	C	S	C	S	C	S	C	S	C	S	C	S	C	S	C	S	C	S	C	S	C
Jiang et al. [12]	2010	35	393			12	77			20	193									12	1							
Bufe et al. [13]	2010	250	250																							67	21
Pu et al. [14]	2011	289	305																							25	18
Laufer-Perl et al. [15]	2014	878	471																								
Yang et al. [16]	2015	35	265	7	60	22	194	24	175	16	98	31	228	1	7	32	241	26	225	3	0	83.39 ± 44.00	76.33 ± 22.41	7	54		
Zheng and Cai [17]	2018	78	429																			88.9 ± 27.9	117.1 ± 45.7				
Azzalini et al. [18]	2018	214	878	115	278	100	301	38	288	179	628	157	657	41	115					2	1	43.0 ± 14.6	91.8 ± 20.8				
Naganuma et al. [19]	2018	555	908			268	412	81	153	491	734	363	693									31 ± 20	81 ± 17				
Faridi et al. [20]	2019	456402	94340	44423	10479	181793	39416	86778	18869	392034	82896			84803	21529			280131	63277	1826	377			189313	43937	34	13
Malik et al. [21]	2020	225	732			120	268	21	104											0	0	44.2 ± 14.5	87.3 ± 19.1				
Charalambous et al. [22]	2020	254	254			127	103	47	57	235	231	221	231	57	51	118	237			9	3						

Note: S indicates the study group while C indicates the control group.

Table 2: Evaluation of literature quality.

Authors	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	Total scores
Jiang et al. [12]	1	1	1	1	1	0	1	0	6
Bufe et al. [13]	1	1	1	1	1	1	1	1	8
Pu et al. [14]	1	1	1	1	1	1	1	1	8
Laufer-Perl et al. [15]	1	1	1	1	1	1	0	1	7
Yang et al. [16]	1	1	1	1	1	1	1	0	7
Zheng and Cai [17]	1	1	0	1	1	0	1	1	6
Azzalini et al. [18]	1	1	1	1	1	1	1	1	8
Naganuma et al. [19]	1	1	1	1	1	0	1	1	7
Faridi et al. [20]	1	1	1	1	1	1	1	1	8
Malik et al. [21]	1	1	1	1	1	1	1	1	8
Charalambous et al. [22]	1	1	1	1	1	1	1	1	8

3.3. Meta-Analysis Results

3.3.1. LVEF <40%. Three studies demonstrated the influence of LVEF <40% on outcomes after PCI for CTOs, with data heterogeneity ($I^2 = 97\%$), using a random-effects model. The number of cases with LVEF <40% included in the three studies was 44,545 (CKD group) and 10,817 (non-CKD group), respectively. The analysis results showed that the CKD group was higher than the non-CKD group [RR = 0.88, 95% CI (0.86, 0.90), $P < 0.00001$], and the difference was statistically significant (Figure 1).

3.3.2. Type 2 Diabetes. Seven studies demonstrated the influence of type 2 diabetes on outcomes after PCI for CTOs, with data heterogeneity ($I^2 = 90\%$), using a random-effects model. The number of cases with type 2 diabetes included in the seven studies was 182,442 (CKD group) and 40,771 (non-CKD group), respectively. The analysis results showed that the CKD group was higher than the non-CKD group [RR = 0.96, 95% CI (0.95, 0.96), $P < 0.00001$], and the difference was statistically significant (Figure 2).

3.3.3. Smoking. Six studies demonstrated the influence of smoking on outcomes after PCI for CTOs, with data heterogeneity ($I^2 = 74\%$), using a random-effects model. The number of cases with smoking included in the six studies was 86,989 (CKD group) and 19,646 (non-CKD group), respectively. The analysis results showed that the CKD group was higher than the non-CKD group [RR = 0.76, 95% CI (0.59, 0.98), $P = 0.03$], and the difference was statistically significant (Figure 3).

3.3.4. Hypertension. Six studies demonstrated the influence of hypertension on outcomes after PCI for CTOs, with data heterogeneity ($I^2 = 90\%$), using a random-effects model. The number of cases with hypertension included in the six studies was 392,975 (CKD group) and 84,780 (non-CKD group), respectively. The analysis results showed that the CKD group was higher than the non-CKD group [RR = 1.39, 95% CI (0.89, 2.16), $P = 0.14$], and the difference was not statistically significant (Figure 4).

3.3.5. Hyperlipidemia. Four studies demonstrated the influence of hyperlipidemia on outcomes after PCI for CTOs, with data heterogeneity ($I^2 = 66\%$), using a random-effects model. The number of cases with hyperlipidemia included in the four studies was 772 (CKD group) and 1809 (non-CKD group), respectively. The analysis results showed that the CKD group was lower than the non-CKD group [RR = −0.07, 95% CI (-0.10, -0.03), $P < 0.00001$], and the difference was statistically significant (Figure 5).

3.3.6. Coronary Artery Bypass Grafting. Four studies demonstrated the influence of coronary artery bypass grafting on outcomes after PCI for CTOs, with data heterogeneity ($I^2 = 92\%$), using a random-effects model. The number of cases with coronary artery bypass grafting included in the four studies was 84,896 (CKD group) and 21,769 (non-CKD group), respectively. The analysis results showed that the CKD group was higher than the non-CKD group [$RR = 0.73$, 95% CI (0.38, 1.40), $P = 0.35$], and the difference was not statistically significant (Figure 6).

3.3.7. ACEI/ARB. Two studies demonstrated the influence of ACEI/ARB on outcomes after PCI for CTOs, with data heterogeneity ($I^2 = 94\%$), using a random-effects model. The number of cases with ACEI/ARB included in the two studies was 150 (CKD group) and 478 (non-CKD group), respectively. The analysis results showed that the CKD group was higher than the non-CKD group [$RR = 0.24$, 95% CI (0.02, 3.9), $P = 0.32$], and the difference was not statistically significant (Figure 7).

3.3.8. β-Blockers. Two studies demonstrated the influence of β-blockers on outcomes after PCI for CTOs, without data heterogeneity ($I^2 = 0\%$), using a fixed-effects model. The number of cases with β-blockers in the two studies was 280,157 (CKD group) and 63,502 (non-CKD group), respectively. The analysis results showed that the CKD group was higher than the non-CKD group [RR = 0.78, 95% CI (0.77, 0.79), $P < 0.00001$], and the difference was statistically significant (Figure 8).

3.3.9. Death. Five studies demonstrated the mortality after PCI for CTOs, with data heterogeneity ($I^2 = 89\%$), using a random-effects model. The number of deaths included in

Study or subgroup	Experimental Events	Experimental Total	Control Events	Control Total	Weight	Risk ratio M-H, fixed, 95% CI	Year
Yang 2015	7	35	60	265	0.1%	0.88 [0.44, 1.78]	2015
Azzalini 2018	115	214	278	878	0.6%	1.70 [1.45, 1.99]	2018
Faridi 2019	44423	456403	10479	94340	99.3%	0.88 [0.86, 0.89]	2019
Total (95% CI)		**456651**		**95483**	**100.0%**	**0.88 [0.86, 0.90]**	
Total events	44545		10817				

Heterogeneity: chi² = 66.57, df = 2 ($P < 0.00001$); $I^2 = 97\%$
Test for overall effect: Z = 12.40 ($P < 0.00001$)

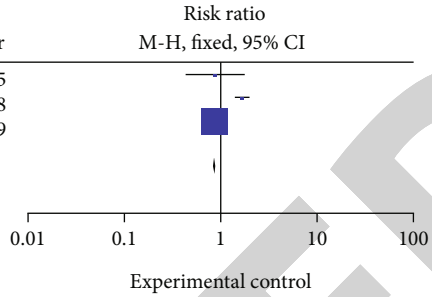

Figure 1: Forest plot of meta-analysis of LVEF on outcomes after PCI for CTOs.

Study or subgroup	Experimental Events	Experimental Total	Control Events	Control Total	Weight	Risk ratio M-H, fixed, 95% CI	Year
Jiang 2010	12	35	77	393	0.0%	1.75 [1.06, 2.89]	2010
Yang 2015	22	35	194	265	0.1%	0.86 [0.66, 1.12]	2015
Azzalini 2018	110	214	301	878	0.2%	1.36 [1.15, 1.62]	2018
Naganuma 2018	268	555	412	908	0.5%	1.06 [0.95, 1.19]	2018
Faridi 2019	181793	456402	39416	94340	98.9%	0.95 [0.95, 0.96]	2019
Charalambous 2020	127	254	103	254	0.2%	1.23 [1.02, 1.50]	2020
Malik 2020	120	225	268	732	0.2%	1.46 [1.25, 1.70]	2020
Total (95% CI)		**457720**		**97770**	**100.0%**	**0.96 [0.95, 0.96]**	
Total events	182442		40771				

Heterogeneity: chi² = 61.98, df = 6 ($P < 0.00001$); $I^2 = 90\%$
Test for overall effect: Z = 10.63 ($P < 0.00001$)

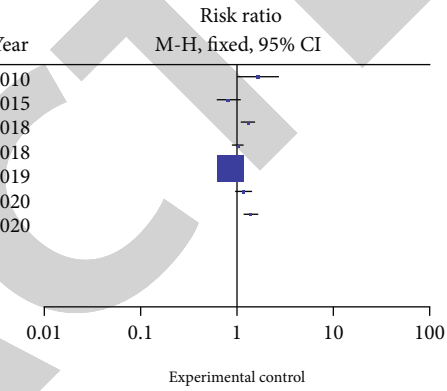

Figure 2: Forest plot of meta-analysis of type 2 diabetes on outcomes after PCI for CTOs.

Study or subgroup	Experimental Events	Experimental Total	Control Events	Control Total	Weight	Odds ratio M-H, random, 95% CI	Year
Yang 2015	24	35	175	265	7.9%	1.12 [0.53, 2.39]	2015
Azzalini 2018	38	214	288	878	16.9%	0.44 [0.30, 0.65]	2018
Naganuma 2018	81	555	153	908	19.8%	0.84 [0.63, 1.13]	2018
Faridi 2019	86778	456402	18869	94340	26.9%	0.94 [0.92, 0.96]	2019
Malik 2020	21	225	104	732	13.3%	0.62 [0.38, 1.02]	2020
Charalambous 2020	47	254	57	254	15.1%	0.78 [0.51, 1.21]	2020
Total (95% CI)		**457685**		**97377**	**100.0%**	**0.76 [0.59, 0.98]**	
Total events	86989		19646				

Heterogeneity: tau² = 0.06; chi² = 19.22 df = 5 ($P = 0.002$); $I^2 = 74\%$
Test for overall effect: Z = 2.15 ($P = 0.03$)

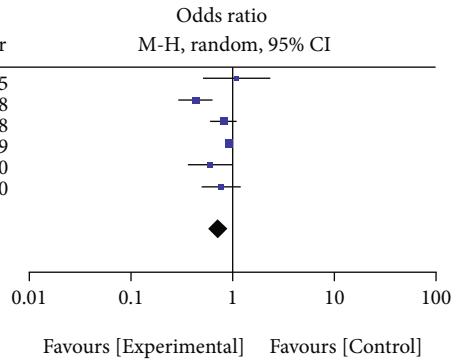

Figure 3: Forest plot of meta-analysis of smoking on outcomes after PCI for CTOs.

Study or subgroup	Experimental Events	Experimental Total	Control Events	Control Total	Weight	Odds ratio M-H, random, 95% CI	Year
Jiang 2010	20	35	193	393	13.8%	1.38 [0.69, 2.78]	2010
Yang 2015	16	35	98	265	13.6%	1.44 [0.71, 2.92]	2015
Azzalini 2018	491	555	734	908	19.0%	0.82 [1.34, 2.48]	2018
Naganuma 2018	179	214	628	878	18.0%	2.04 [1.38, 3.01]	2018
Faridi 2019	392034	456402	82896	94340	20.9%	0.84 [0.82, 0.86]	2019
Charalambous 2020	235	254	231	254	14.6%	1.23 [0.65, 2.32]	2020
Total (95% CI)		**457495**		**97038**	**100.0%**	**1.39 [0.89, 2.16]**	
Total events	392975		84780				

Heterogeneity: tau² = 0.24; chi² = 48.72, df = 5 ($P < 0.00001$); $I^2 = 90\%$
Test for overall effect: Z = 1.46 ($P = 0.14$)

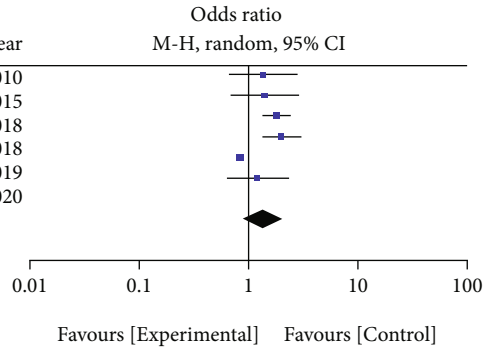

Figure 4: Forest plot of meta-analysis of hypertension on outcomes after PCI for CTOs.

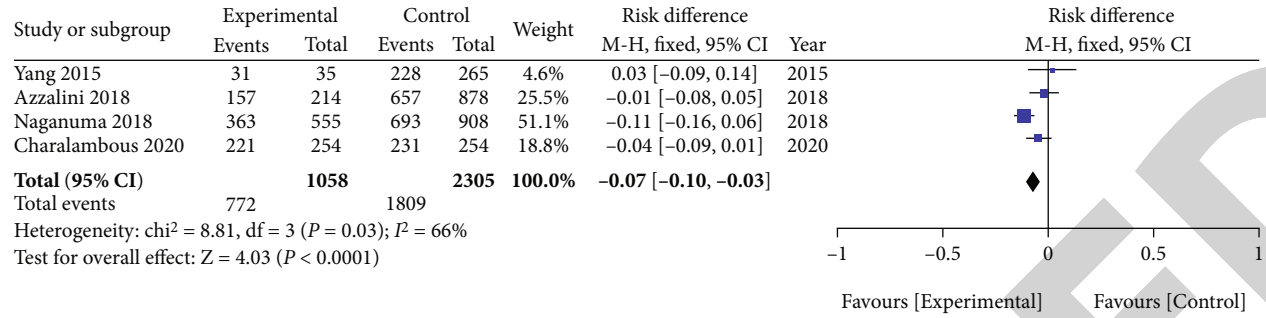

Figure 5: Forest plot of meta-analysis of hyperlipidemia on outcomes after PCI for CTOs.

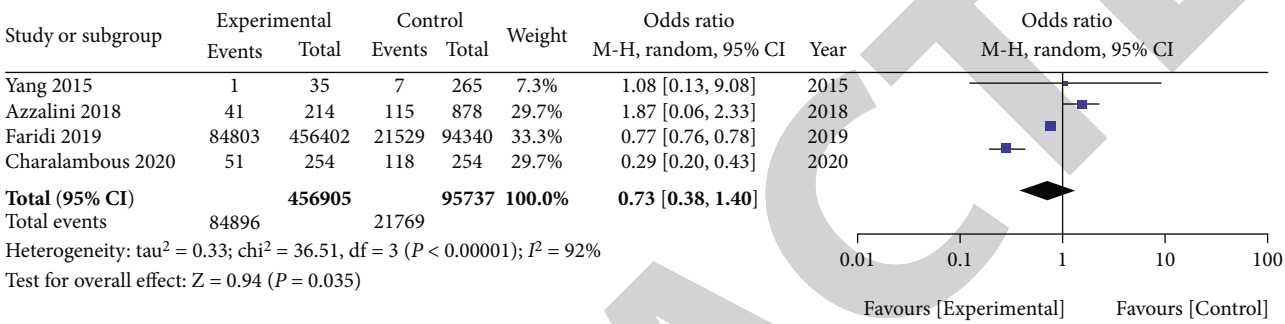

Figure 6: Forest plot of meta-analysis of coronary artery bypass grafting on outcomes after PCI for CTOs.

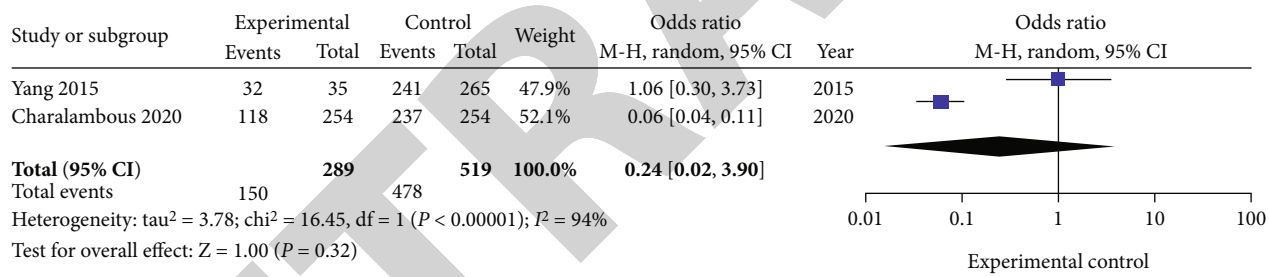

Figure 7: Forest plot of meta-analysis of ACEI/ARB on outcomes after PCI for CTOs.

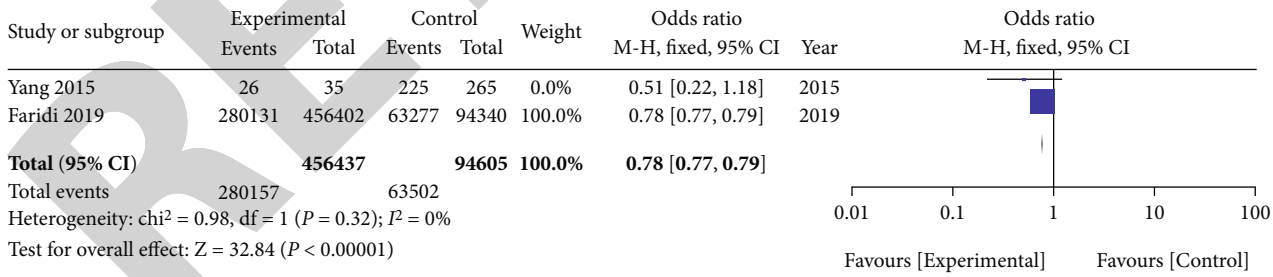

Figure 8: Forest plot of meta-analysis of β-blockers on outcomes after PCI for CTOs.

the five studies was 1852 (CKD group) and 382 (non-CKD group). The analysis results showed that the CKD group was higher than the non-CKD group [RR = 9.93, 95% CI (1.39, 70.67), $P = 0.02$], and the difference was statistically significant (Figure 9).

3.3.10. eGFR. Five studies demonstrated the influence of eGFR on outcomes after PCI for CTOs, with data heterogeneity ($I^2 = 96\%$), using a random-effects model. The analysis results showed that the CKD group was lower than the non-CKD group [RR = −37.25, 95% CI (-44.43, -30.08), $P < 0.00001$], and the difference was statistically significant (Figure 10).

3.3.11. Age >75 Years. Two studies demonstrated the influence of age on outcomes after PCI for CTOs, without data heterogeneity ($I^2 = 0\%$), using a fixed-effects model. The number of cases with age >75 years included in the two

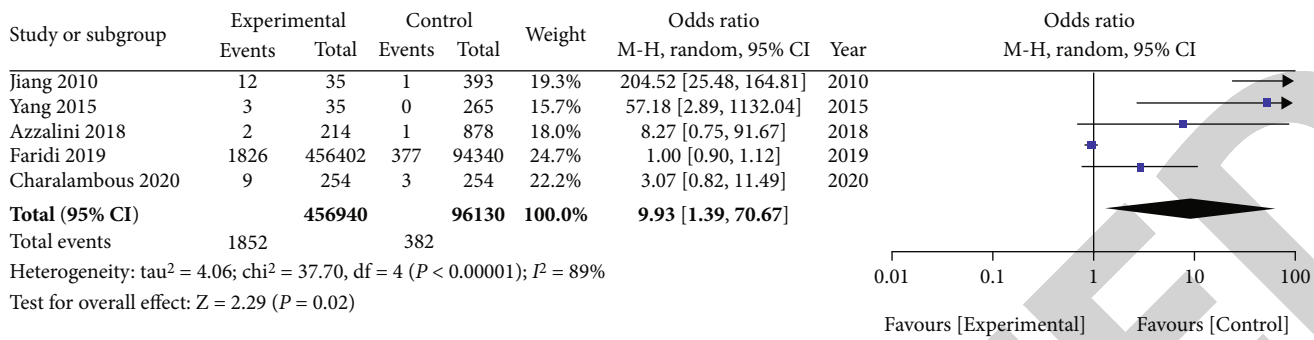

Figure 9: Forest plot of meta-analysis of death on outcomes after PCI for CTOs.

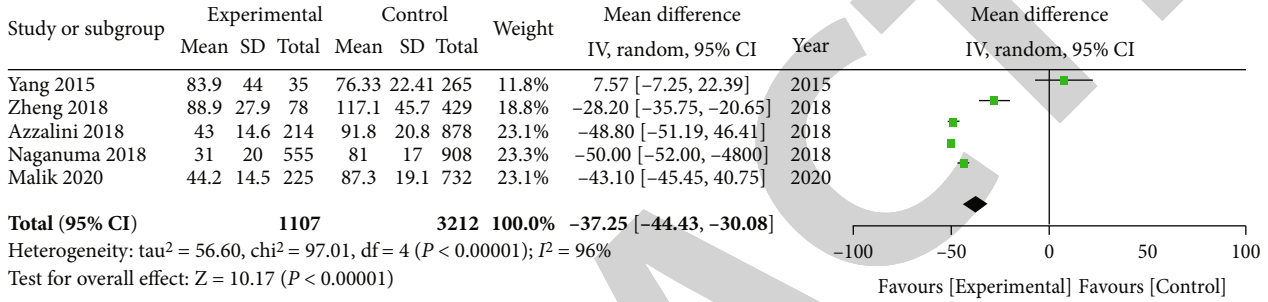

Figure 10: Forest plot of meta-analysis of eGFR on outcomes after PCI for CTOs.

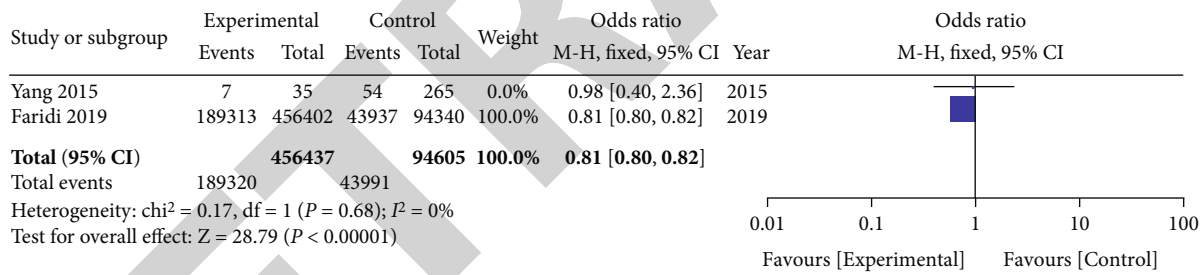

Figure 11: Forest plot of meta-analysis of age on outcomes after PCI for CTOs.

studies was 189,320 (CKD group) and 43,991 (non-CKD group), respectively. The analysis results showed that the CKD group was higher than the non-CKD group [RR = 0.81, 95% CI (0.80, 0.82), $P < 0.00001$], and the difference was statistically significant (Figure 11).

3.3.12. Renal Insufficiency. Three studies demonstrated the influence of renal insufficiency on outcomes after PCI for CTOs, with data heterogeneity ($I^2 = 91\%$), using a random-effects model. The number of cases with renal insufficiency included in the three studies was 126 (CKD group) and 52 (non-CKD group), respectively. The analysis results showed that the CKD group was higher than the non-CKD group [RR = 1.50, 95% CI (0.47, 4.79), $P = 0.5$], and the difference was not statistically significant (Figure 12).

3.4. Publication Bias Analysis. Publication bias analysis was performed on the included studies. The results showed that the funnel plot presented an inverted triangle pattern, and the results were less biased, and the results were credible (Figure 13).

4. Discussion

A total of 11 literatures were included in this study, of which 9 articles with a NOS scale score of ≥7 were of high quality, including 8 articles in English and 10 articles in Chinese. All literatures demonstrated that a controlled study was conducted, the experimental group was a CKD group, and the control group was a non-CKD group. The indicators included in the studies were concentrated, and the influence of various risk factors of CKD on outcomes after PCI for

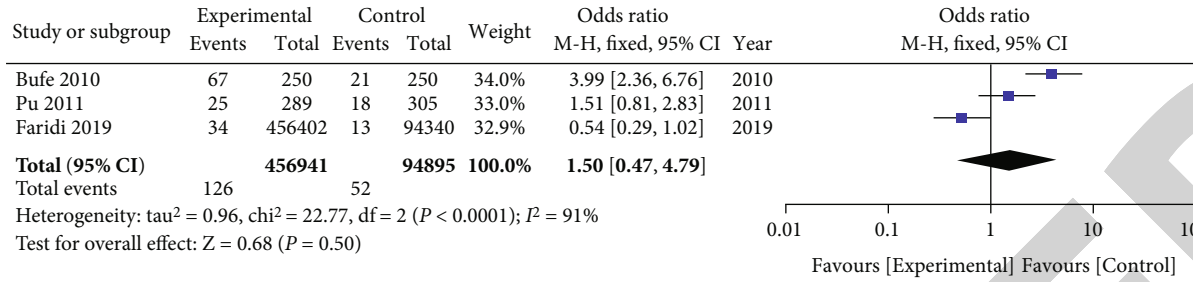

Figure 12: Forest plot of meta-analysis of renal insufficiency on outcomes after PCI for CTOs.

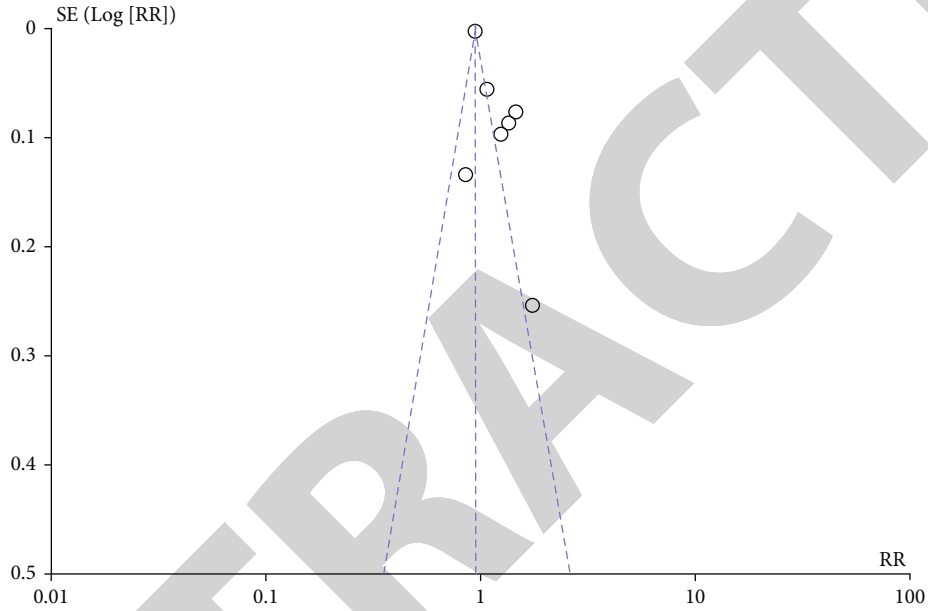

Figure 13: Funnel plot.

CTOs was analyzed to different degrees. The bias of the results was small, and the results of the studies were credible, which can be used for clinical reference.

CKD is one of the important causes of iatrogenic kidney damage [23]. Once it occurs, it will seriously affect the prognosis of patients. In 2004, Mehran et al. made a systematic scoring for chronic risk factors, and the final model for scoring included multiple factors of age >75 years, diabetes mellitus, chronic congestive heart failure, perioperative hypotension, anemia and chronic renal insufficiency, and elective use of intra-aortic balloon pump (IABP) implantation [24]. However, with the development of interventional techniques, more and more CTO patients can achieve ideal revascularization through interventions [25]. The pathophysiological mechanism of chronic disease is not yet fully understood, and the possible mechanisms include renal vasoconstriction and direct nephrotoxicity of oxidative stress [26]. Previously, the incidence of CKD in general population was about 1%-11% [27], and the incidence of CKD in different populations may vary considerably. In high-risk patients complicated with renal insufficiency, the incidence of CKD significantly increased [28]. CTO patients undergoing PCI may be a high-risk population of CKD, and the proportion of patients complicated with renal insufficiency is high. The meta-analysis results of this study demonstrated that renal insufficiency is one of the most important factors for outcomes after PCI for CTOs, with positive correlations. There have been previous studies on the incidence of CKD after PCI in CTO patients [29]. The results of literature studies have demonstrated that smoking after PCI can significantly reduce the long-term efficacy of antithrombotic therapy and increase the incidence of cardiovascular and cerebrovascular events, which may be related to the reduction of platelet activation of antithrombotic drugs by smoking [30]. The meta-analysis results of this study demonstrated that smoking is one of the most important factors for outcomes after PCI for CTOs, with positive correlations. A study has revealed that renal insufficiency is related to left ventricular remodeling, and there is a synergistic effect between the two, which will greatly increase the morbidity and mortality of coronary heart disease patients [31]. The meta-analysis results of this study also demonstrated that LVEF level, diabetes, hypertension, coronary artery bypass grafting, ACEI/ARB, β-blockers, and age were the most important factors for outcomes after PCI for CTOs, with positive correlations. Therefore, for CKD patients,

attention should be paid to the monitoring and control of blood pressure, LVEF level, age, and renal function testing, so that blood pressure can be controlled at the corresponding level, in order to improve the in-hospital prognosis of patients after PCI. At the same time, attention should be paid to whether the patients have diabetes, whether the patients smoke, and whether the patients take β-blockers, so as to effectively improve the prognosis of patients after PCI.

Our systemic review may provide theoretical reference for clinical treatments and research. Limitations of this meta-analysis need to be stated. At present, there are few studies on CKD in CTO-PCI. The sample size was small, the included trials had certain geographical limitations, and there was the possibility of publication bias; the studies evaluated the results using trial data, so baseline characteristics of different trials cannot be assessed. Thus, more randomized controlled trials with high quality, multifocus and large sample remained to be performed to further prove the conclusions.

5. Conclusion

With the acceleration of population aging and urbanization in China, people's living standards and lifestyles have undergone great changes, resulting in more and more factors affecting the cure of coronary heart disease. CKD also has a greater impact on the prognosis of coronary heart disease patients. At present, PCI has become an important treatment method for coronary heart disease. There are many influencing factors of coronary heart disease, and the prognosis of coronary heart disease patients complicated with CKD is also affected by the interaction of multiple factors. LVEF level, diabetes, smoking, hypertension, coronary artery bypass grafting, ACEI/ARB, β-blockers, age, and renal insufficiency are important risk factors for outcomes after PCI for CTOs. Controlling these risk factors is of great significance for the prevention, treatment, and prognosis of coronary heart disease.

Data Availability

All data generated or used during the study appear in the submitted article.

Conflicts of Interest

The authors declared that no conflicts of interest exist in this study.

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