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American Journal of Emergency Medicine

journal homepage: www.elsevier.com/locate/ajem

# Significant association between ischemic heart disease and elevated risk for COVID-19 mortality: A meta-analysis



Ruiying Zhang <sup>a</sup>, Yuqing Hao <sup>b</sup>, Yadong Wang <sup>c</sup>, Haiyan Yang <sup>a,\*</sup>

<sup>a</sup> Department of Epidemiology, School of Public Health, Zhengzhou University, Zhengzhou 450001, China

<sup>b</sup> International College of Zhengzhou University, Zhengzhou 450052, China

<sup>c</sup> Department of Toxicology, Henan Center for Disease Control and Prevention, Zhengzhou 450016, China

A number of previous papers have examined the association between ischemic heart disease (IHD) and the risk for mortality among patients with coronavirus disease 2019 (COVID-19), but there have been inconsistent findings across studies. For example, a few studies have found that there was a significant association between IHD and an elevated risk for COVID-19 mortality [1,2], but some other studies have concluded that IHD was not significantly associated with the risk for COVID-19 mortality [3,4]. Therefore, we performed this quantitative meta-analysis to determine whether there was a significant association between IHD and COVID-19 mortality or not. Gender, age and several comorbidities have been documented to affect the clinical outcomes of COVID-19 patients [5-8], indicating that those variables might affect the relationship between IHD and the risk for COVID-19 mortality. Taken together, the pooled effect on the relationship between IHD and COVID-19 mortality was estimated on the basis of adjusted effects in this meta-analysis.

We searched PubMed, Web of Science and EMBASE up to February 20, 2022 by using the following keywords: ("SARS-CoV-2" or "COVID-19" or "2019-nCoV") and ("ischemic heart disease") and ("death" or "mortality" or "fatality" or "deceased" or "non-survivor"). Studies were considered eligible if they evaluated the association between IHD and COVID-19 mortality based on adjusted effects. Case reports, review papers, errata, duplications, comments and studies reporting un-adjusted effects were excluded. The additional eligible articles were identified through reading the references of the included studies or related reviews.

We applied R software for this meta-analysis. Heterogeneity was measured using  $I^2$  statistic. The pooled effect size was calculated by appropriate analysis model. If significant heterogeneity was observed ( $I^2 > 50\%$ , P < 0.1), the random effects model was used; otherwise, the fixed effects model was used. Sensitivity analysis was used to assess the stability of our results. Publication bias was evaluated by Begg's test and Egger's test. P < 0.05 was considered statistically significant.

A total of 36 studies (335, 720 cases) were included in this metaanalysis (Supplementary Table 1). Our meta-analysis demonstrated that there was a significant association between IHD and an elevated risk of COVID-19 mortality (pooled effect size = 1.27, 95% confidence interval (CI) [1.17–1.38]; Fig. 1A). The significant association was also

E-mail address: yhy@zzu.edu.cn (H. Yang).

observed in the subgroup analyses by cases (pooled effect size = 1.22, 95% CI [1.11–1.33] for ≥ 1000 and pooled effect size = 1.62, 95% CI [1.29-2.05] for < 1000), region (pooled effect size = 1.77, 95% CI [1.33–2.36] for Asia; pooled effect size = 1.15, 95% CI [1.07–1.23] for North America and pooled effect size = 1.22, 95% CI [1.10-1.36] for Europe), study design (pooled effect size = 1.37, 95% CI [1.21–1.56] for retrospective studies and pooled effect size = 1.15, 95% CI [1.10-1.20] for prospective studies), setting (pooled effect size = 1.16, 95% CI [1.06–1.27] for all patients and pooled effect size = 1.33, 95% CI [1.20-1.48] for hospitalized patients), age (pooled effect size = 1.27, 95% CI [1.13–1.43] for age  $\geq$  60 and pooled effect size = 1.39, 95% CI [1.17-1.64] for age < 60) and proportion of males (pooled effect size = 1.31,95% CI [1.19-1.45] for  $\ge 50\%$  and pooled effect size = 1.20, 95% CI [1.08–1.33] for < 50%). Sensitivity analysis showed that our results were stable (Fig. 1B). Publication bias was found in Begg's test (P = 0.027) and Egger's test (P = 0.002).

In summary, our meta-analysis showed that IHD was significantly associated with an increased risk for death among COVID-19 patients. Further well-designed studies with large sample sizes are required to verify the findings of our present study.

Supplementary data to this article can be found online at https://doi. org/10.1016/j.ajem.2022.03.010.

#### Statements and declarations

All authors report that they have no potential conflicts of interest.

#### Author contributions

Haiyan Yang and Yadong Wang conceptualized the study. Ruiying Zhang and Yuqing Hao performed literature search and data extraction. Ruiying Zhang, Yuqing Hao and Yadong Wang analyzed the data. Ruiying Zhang wrote the manuscript. All the authors approved the final manuscript.

# Funding

This study was supported by grants from the National Natural Science Foundation of China (grant number 81973105) and Henan Young and Middle-aged Health Science and Technology Innovation

<sup>\*</sup> Corresponding author at: Department of Epidemiology, College of Public Health, Zhengzhou University, No. 100 of Science Avenue, Zhengzhou 450001, China.

(A)		(	<b>B</b> )	
Study	Effect Size	Adjusted ES 95%-Cl Weight	Study Eff	ectSize Adjusted ES95%-CI
Ahlstrom B		0.88 [0.56; 1.39] 2.4%	Omitting Ablstrom B	
Al Mutair A	1	1.72 [1.10; 2.69] 2.4%	Omitting Al Mutair A	
Ayaz A		> 26.50 [4.73; 148.60] 0.2%	Omitting Avaz A	
Azarkar Z	÷	3.45 [1.54; 7.72] 0.9%	Omitting Azarkar 7	
Badr Ol		0.88 [0.20; 3.87] 0.3%	Omitting Badr Ol	
Bae HJ		* 1.93 [0.37; 10.05] 0.2%	Omitting Bae HJ	
Basu A		1.07 [0.74; 1.54] 3.2%	Omitting Basu A	
Calderón-Parra J		0.98 [0.84; 1.14] 6.5%	Omitting Calderón–Parra J	
Carbonell R		1.65 [1.14; 2.38] 3.2%	Omitting Carbonell R	
Chauhan NK	1:	→ 4.32 [1.02; 18.34] 0.3%	Omitting Chauhan NK	
Dolci G		3.01 [1.04; 8.70] 0.6%	Omitting Dolci G	
Efros O		1 42 [0.65; 3.10] 1.0%	Omitting Efros O	
Fakih MG		1 13 [1 04; 1 22] 7 7%	Omitting Eakih MG	
Galloway JB	- <u>1</u>	1.26 [0.93; 1.71] 3.9%	Omitting Galloway JB	
Genovesi S	- 12	1.12 [0.83; 1.52] 3.9%	Omitting Genovesi S	
Gonzalez-Fajardo JA <		> 0.98 [0.08; 12.28] 0.1%	Omitting Gonzalez-Faiardo JA	
Graziani D		1.05 [0.81; 1.36] 4.6%	Omitting Graziani D	
Gude-Sampedro F	12	1.61 [1.16; 2.24] 3.6%	Omitting Gude-Sampedro F	
Kim HS		0.93 [0.57; 1.52] 2.1%	Omitting Kim HS	
Ling SF		1.76 [0.71; 4.35] 0.8%	Omitting Ling SF	
Mahendra M	- 12	1.23 [0.86; 1.77] 3.2%	Omitting Mahendra M	
Mateo Gomez C 🛛 🗧		0.49 [0.05; 4.81] 0.1%	Omitting Mateo Gomez C	
Meisel E		1.47 [0.80; 2.70] 1.5%	Omitting Meisel F	
Moreno G	10 +	1.57 [1.14; 2.17] 3.7%	Omitting Moreno G	
Najafi N		2.31 [1.19; 4.46] 1.3%	Omitting Najafi N	
Nassar Y		→ 13.04 [3.66; 46.44] 0.4%	Omitting Nassar Y	
Orlando V		1.24 [0.88; 1.75] 3.4%	Omitting Orlando V	
Oto OA		→ 4 13 [1 10; 15.44] 0.4%	Omitting Oto OA	
Pishgahi M	+	1.14 [1.09; 1.20] 8.1%	Omitting Pishgahi M	<u> </u>
Raparelli V		1.76 [1.39; 2.23] 5.0%	Omitting Raparelli V	1.24 [1.14: 1.34]
Reilev M	- 4	1.10 [0.88; 1.37] 5.2%	Omitting Reiley M	
Rubio-Rivas M	<u><u><u></u></u></u>	1.19 [1.06; 1.34] 7.1%	Omitting Rubio-Rivas M	1.28 [1.17; 1.40]
Topless RK		0.92 [0.68; 1.24] 4.0%	Omitting Topless RK	
Vafadar Moradi E	+ 1 <u>2</u> 1 <u>2</u>	1.98 [0.94; 4.17] 1.1%	Omitting Vafadar Moradi E	1.26 [1.16; 1.37]
Vasheghan M		0.68 [0.28; 1.64] 0.8%	Omitting Vasheghan M	
Zerbo O		1.20 [1.05; 1.37] 6.9%	Omitting Zerbo O	1.28 [1.17; 1.40]
Random effects model 1.27 [1.17: 1.38] 100.0% Random effects model				1.27 [1.17; 1.38]
Heterogeneity:/~= 62%, 7 =	= 0.0214,p < 0.01	1	0.8	1 1.25
0.	1 0.2 0.5 1 2 5	10		

Fig. 1. Forest plot demonstrated the significant association between ischemic heart disease (IHD) and the elevated risk for mortality among coronavirus disease 2019 (COVID-19) patients (A) and leave-one-out sensitivity analysis exhibited the stability of our results (B).

Talent Project (grant number YXKC2021005). The funders have no role in the data collection, data analysis, preparation of manuscript and decision to submission.

## Data availability statement

The data that support the findings of this study are included in this article and available from the corresponding author upon reasonable request.

#### **Ethics approval**

Not applicable.

# **Declaration of Competing Interest**

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

#### Acknowledgements

We would like to thank Xueya Han, Jiahao Ren, Shuwen Li, Mengke Hu, Ying Wang, Li Shi, Xuan Liang, Jie Xu, Wenwei Xiao, Hongjie Hou, Jian Wu, Peihua Zhang and Yang Li (All are from Department of Epidemiology, School of Public Health, Zhengzhou University) for their kind help in searching articles and collecting data, and valuable suggestions for data analysis.

## References

- [1] Raparelli V, Palmieri L, Canevelli M, Pricci F, Unim B, Lo Noce C, et al. Sex differences in clinical phenotype and transitions of care among individuals dying of COVID-19 in Italy. Biol Sex Differ. 2020;11(1):57. https://doi.org/10.1186/ s13293-020-00334-3.
- [2] Rubio-Rivas M, Corbella X, Mora-Lujan JM, Loureiro-Amigo J, Lopez Sampalo A, Yera Bergua C, et al. Predicting clinical outcome with phenotypic clusters in COVID-19 pneumonia: an analysis of 12,066 hospitalized patients from the Spanish registry SEMI-COVID-19. J Clin Med. 2020;9(11). https://doi.org/10.3390/ jcm9113488.
- [3] Galloway JB, Norton S, Barker RD, Brookes A, Carey I, Clarke BD, et al. A clinical risk score to identify patients with COVID-19 at high risk of critical care admission or death: an observational cohort study. J Infect. 2020;81(2):282–8. https://doi.org/10. 1016/j.jinf.2020.05.064.
- [4] Reilev M, Kristensen KB, Pottegard A, Lund LC, Hallas J, Ernst MT, et al. Characteristics and predictors of hospitalization and death in the first 11 122 cases with a positive RT-PCR test for SARS-CoV-2 in Denmark: a nationwide cohort. Int J Epidemiol. 2020;49(5):1468–81. https://doi.org/10.1093/ije/dyaa140.
- [5] Liang X, Shi L, Wang Y, Xiao W, Duan G, Yang H, et al. The association of hypertension with the severity and mortality of COVID-19 patients: evidence based on adjusted effect estimates. J Infect. 2020;81(3). https://doi.org/10.1016/j. jinf.2020.06.060. e44-e7.

- [6] Liang X, Xu J, Xiao W, Shi L, Yang H. The association of diabetes with COVID-19 disease severity: evidence from adjusted effect estimates. Hormones (Athens). 2021;20(2): 409–14. https://doi.org/10.1007/s42000-020-00259-x.
  [7] Mesas AE, Cavero-Redondo I, Alvarez-Bueno C, Sarria Cabrera MA, Maffei de Andrade S, Sequi-Dominguez I, et al. Predictors of in-hospital COVID-19 mortality: a comprehensive systematic review and meta-analysis exploring differences by age, sex and

health conditions. PLoS One. 2020;15(11):e0241742. https://doi.org/10.1371/journal.pone.0241742.

[8] Yang H, Xu J, Liang X, Shi L, Wang Y. Autoimmune diseases are independently associ-ated with COVID-19 severity: evidence based on adjusted effect estimates. J Infect. 2021;82(4). https://doi.org/10.1016/j.jinf.2020.12.025. e23-e6.