SYSTEMATIC REVIEW

Comparison of STEMI Management and Outcomes in Asia and Europe Before and During the Covid-19 Pandemic: A Meta-analysis

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ABSTRACT

Introduction: The Covid-19 pandemic created global issue especially in the scope of cardiovascular disease, chiefly in ST-elevation myocardial infarction of acute coronary syndrome. The aim of this research is to compare the results of STEMI management before and during the Covid-19 pandemic in Asia and Europe. **Materials and Methods:** The study design of this study is meta - analysis, and based on PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) 2020 guidelines. This study search for PubMed, Scopus, Web of Science, Proquest, and EBSCO (until October 11, 2022). Inverse variance random effects model were used in this research. **Results**: With a total of 38 cohort studies were included in this meta analysis, Asia group's managements and main outcomes were: Symptom to first medical contact (MD 18.66 min [95% CI 5.16-32.17], I2= 70%, p<0.007), door-to-balloon time (MD 22.76 min (95% CI 13.34-32.18) I2= 97%, p<0.00001), and mortality (OR = 1.09 [95% CI 1.03–1.15], I2 = 48%, p = 0.002). Meanwhile, the Europe group's were: Symptom to first medical contact (MD 25.93 min [95% CI 13.93-37.92], I2= 61%, p<0.0001), door-to-balloon time (MD 6.00 min [95% CI 1.26-10.74,], I2= 89%, p=0.01), and mortality (OR = 1.21 [95% CI 1.08–1.37], I2 = 22%, p = 0.001). **Conclusion:** Europe group has a lower door to balloon time compared to Asia group, Asia and Europe group experienced a longer time of symptom onset to FMC time, DtB time, and higher mortality rate.
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Keywords: Cardiovascular risk, Covid-19, STEMI, Patient delay, System delay

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INTRODUCTION

The Covid-19 pandemic first appeared in Wuhan, Hubei, China, at the end of 2019. Was first reported on December 8, 2019, and the virus made a fast spread to the other provinces of China. At the February 1, 2020 there are 7.153 confirmed cases in Hubei province only, afterwards 66.337 cumulative cases confirmed there in China at February 29, 2020. After almost 1 month, the parameter increased in number being in the total of 67.801 cases. (1)

STEMI (ST – Elevation Myocardial Infarction) is a type of acute coronary syndrome beside Non STEMI and unstable angina do to stenosis of artery coronary. Covid – 19 affect outcome of management STEMI like door-to-balloon (DtB) time, cardiogenic shock, cardiac arrest, and mortality. The main problem in the era pandemic is patient delay to hospital and then delay to first medical contact (FMC), and affect outcome.

PCI or Percutaneous Coronary Intervention on the heart blood vessels. This procedure is also called coronary angioplasty. Study of STEMI patients demonstrates that patients' ability to receive timely primary PCI during a pandemic is constrained. (2) The number of PPCI procedures decreased for a variety of reasons in Asia and Europe.

Several studies in several countries have conducted research on the impact of Covid-19 on STEMI management, especially when primary PCI is carried out. Like research in Europe conducted by Aldujeli et al. (3), Kwok et al. (4), Gramegna et al. (5) and in Asia by Chew et al. (6), Ginanjar et al. (7) ,and different outcome.

The fatal cases also increased from no cases at the February 1 up to 3.163 cases at March 25 2020. (1) As in Europe, at the end of March 2020, there are 105.792 cases reported with 12.428 fatal events in Italy.(8) Italy had their first confirmed cases on January 31, 2020, with a total of new per day cases of 3009. In line with Italy as one of the most infected country in Europe, France reported their first confirmed cases at January 24, 2020. By April 15, 2020, the mortality rate of these countries are 11% in Spain, 13% in Italy, and 15% in France. (9) However, there has been no meta-analysis that looks at or evaluates whether there are differences between Asia and Europe regarding the outcomes of this STEMI. The aim of this research is to compare the results of STEMI management before and during the Covid-19 pandemic in Asia and Europe.

MATERIALS AND METHODS

Study Design

The study design of this study is meta analysis, and based on PRISMA 2020 guidelines on selecting the study available. Meta – analysis is a statistical technique intended to combine two or more original studies that can be combined. Meta – analysis can be viewed as part of a systematic review of articles (called a systematic review) that uses formal statistical analysis.

Literature Search and Eligibility Criteria

This meta – analysis conducted a literature search of articles using the MeSH (Medical Subject Headings) terminology (Supplementary Table), and has been registered at PROSPERO database (CRD42022353252). PROSPERO is the most widely known and used registration platform, and is specifically designed for systematic observations and meta-analyses relevant to human health. We searched PubMed, Scopus, Web of Science, Proquest, and EBSCO (until October 11, 2022) to identify all publications comparing Before and During Pandemic. The following terms were used by combining with appropriate logical connectors: “STEMI”, “Covid-19”, “PCI”, and “STEMI Management”. We seek for cohort studies in English that report the the time from symptom to FMC, DtB time, as well as cardiogenic shock, cardiac arrest, stroke and mortality data. Each study specified the duration of the research. This study excluded systematic reviews, meta-analysis, data from conference abstracts, case reports, review articles, posters, and conference reports conducted prior to and during pandemics. Supplementary Figure 1 depicts the conceptual framework of a literature search strategy.

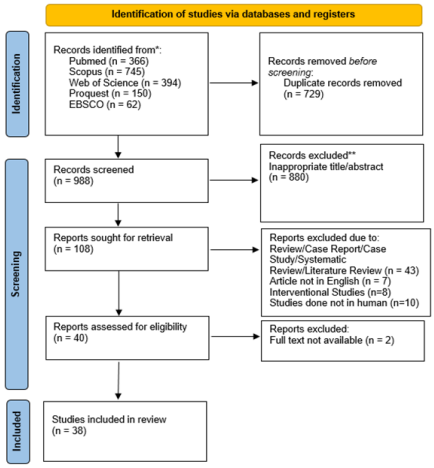

Figure 1: Preferred Reporting Items for Systematic Review and Meta Analyses (PRISMA) Flow Diagram of Study Selection.

Data Extraction

The following data: age, sex, patient’s status of hypertension, diabetes, smoking, and dyslipidemia, and the paramount data of time from symptom to onset FMC time, DtB time, cardiogenic shock, cardiac arrest, stroke, mortality, and were extracted from the included studies, each representing Asia and Europe before and during the pandemic. Patients treated prior to and during the start of the pandemic year (2020) were classified to the before pandemic and during pandemic groups. In this section, the content is related to extraction data, what data was extracted in this research, and is available in the table. It is in accordance with meta-analysis standards.

Study Quality

Two independent reviewers did the bias quality assessment (PS and and PBTS). Our senior reviewer (MYA) (this is an abbreviation for the person doing the meta – analysis and is usually not mentioned) will made final decision, if there was differences in the results of the assessment. We used the Newcastle-Ottawa Scale instrument to evaluate the risk of bias for each study independently, with each bias assessment consisting of the selection of the study groups; the comparability of the groups; and the ascertainment of either the exposure or outcome of interest, with the assessment of good, fair, and low quality of a study.

Statistical and Sensitivity Analysis

This systematic review and meta-analysis utilized secondary data from databases to summarize several journals in response to the research queries. The software Review Manager 5.4 was used to conduct statistical analyses, dichotomous data (risk ratio and

odds ratio) used Mantel-Haenszel statistical method for cardiogenic shock, cardiac arrest, and mortality outcome, and continuous data (mean difference) used inverse variance statistical method for DtB and onset to FMC time outcome.

Heterogeneity were analysed using the DerSimonian and Laird random-effect model. This study summed up numerical data with mean and standard deviation, and categorical data with proportion. Using an estimated formula, median and interquartile range data were converted to mean and standard deviation.(10,11)

Sensitivity analysis also be done, by using leave-one-out approach to detect study outliers and changes in heterogeneity (I^2), with I^2 values of 0-50% representing low heterogeneity, 50-75% representing moderate heterogeneity, and 76-100% representing substantial heterogeneity. The data analysis employed either the fixed or random effect model. A p-value below 0.05 is considered significant.

RESULTS

Study Results

Baseline Characteristics

With 38 cohort studies being analyzed, the total of 151.892 STEMI patients were included. (3-40) Patients in the studies before the pandemic had a mean age of 62.3 years, 93.4% were male, 86.43% had hypertension, 50.17% had diabetes, 36.22% were active smokers or had a smoking history, and 75.19% had dyslipidaemia. In the pandemic group, the mean age was 62,7 years old, and 8.64% of patients were male, 7.69% of patients had hypertension, 4.52% had diabetes, 3.77% were active or former smokers, and 6.43% have dyslipidaemia. Supplementary Table I and Supplementary Table II contains detail information on fundamental population characteristic.

Table I: Baseline Characteristics of Before and During Pandemic Included Studies

Studies	Country	Monocentric/ multicentric	Mean Age (years)	Sex (Male)	HTN (%)	D (%)	SM (%)	DL (%)
Before Pandemic Included Studies								
Oriol *et al*	Spain	Multicentric	63.7	1023	647	324	581	592
Callum *et al*	London	Multicentric	63	343	217	106	245	154
Chun Shing *et al*	England	Multicentric	63	24.829	13.826	6.006	7.869	11.186
Aldujeli *et al*	Lituania	Monocentric	68.5	39	54	11	15	**NR**
Mario *et al*	Italy	Monocentric	68	**NR**	11	4	4	8
Hesham K *et al*	England	Monocentric	66.6	53	16	16	21	9
Andre *et al*	Portugal	Monocentric	61.9	46	35	16	24	29
Enrico *et al*	Italy	Monocentric	62	31	26	7	21	21
Guillaume *et al*	France	Multicentric	64.0	2.505	1476	626	1270	1108
Chenxi Song *et al*	Beijing	Monocentric	60.6	**NR**	56	22	55	51
Nicholas *et al*	Singapore	Monocentric	57	134	114	76	122	145
Doni Firman *et al*	Indonesia	Multicentric	55.31	294	196	131	193	**NR**
Amin Daoulah *et al*	Saudi Arabia	Multicentric	56.5	454	296	312	248	216
Korhan Soylu *et al*	Turkey	Multicentric	60.7	61	55	27	37	**NR**
Wen-Xiu Leng *et al*	China	Monocentric	62.21	178	**NR**	**NR**	**NR**	**NR**
Kyohei Yamaji *et al*	Japan	Multicentric	71.0	192.866	189.538	112.240	75.744	166.699
Mingliang Zuo *et al*	China	Monocentric	64.4	42	26	12	34	**NR**
Seok Oh *et al*	South Korea	Monocentric	67.64	224	154	93	**NR**	38
Eka Ginanjar *et al*	Indonesia	Monocentric	55	224	162	113	**NR**	101
Xuhe Gong *et al*	Beijing	Monocentric	61	105	78	29	87	43
Valeria Cammalleri *et al*	Italy	Monocentric	62±10	31	66	23	54	31
Marc J. Claeys *et al*	Belgian	Multicentric	63 ± 15	74	47	15	**NR**	**NR**
Giuseppe De Luca *et al*	Italy	Multicentric	64	73.7	54.7	18.1	41.3	41.5
Batric Popovic *et al*	France	Monocentric	62.5 ± 12.6	73.6	43.1	19.4	55.6	38.9
Göksel Çinier *et al*	Turkey	Monocentric	63.7 ± 13.3	85.6	50.6	34.5	67.2	14.9
Mustafa Kemal Erol *et al*	Turkey	Multicentric	51 – 70	**NR**	38.4	28.3	56.4	9.4
Ofer Kobo *et al*	Israel	Monocentric	51.68	**NR**	47.8	29.4	61	53.7
Jing Nan *et al*	Beijing							

CONTINUE

Table I: Baseline Characteristics of Before and During Pandemic Included Studies. (CONT.)

Studies	Country	Monocentric/ multicentric	Mean Age (years)	Sex (Male)	HTN (%)	D (%)	SM (%)	DL (%)
During Pandemic Included Studies								
Oriol *et al*	Spain	Multicentric	63.1	786	520	226	442	466
Callum *et al*	London	Multicentric	63	278	178	86	145	124
Chun Shing *et al*	England	Multicentric	64	498	234	107	148	195
Aldujeli *et al*	Lituania	Monocentric	67	34	40	11	10	**NR**
Mario *et al*	Italy	Monocentric	66	**NR**	14	7	8	15
Hesham K *et al.*	England	Monocentric	63.2	32	14	9	15	9
Andre *et al.*	Portugal	Monocentric	64.5	38	38	11	18	32
Enrico *et al.*	Italy	Monocentric	66	21	14	6	12	13
Guillaume *et al.*	France	Multicentric	64.4	2270	1372	591	1180	1034
Chenxi Song *et al.*	Beijing	Monocentric	61.6	**NR**	43	16	36	39
Nicholas *et al.*	Singapore	Monocentric	59	54	51	34	53	56
Doni Firman *et al.*	Indonesia	Multicentric	55.17	167	103	79	85	**NR**
Amin Daoulah *et al.*	Saudi Arabia	Multicentric	65.4	454	229	257	213	190
Korhan Soylu *et al.*	Turkey	Multicentric	61.2	61	58	28	31	**NR**
Wen-Xiu Leng *et al.*	China	Monocentric	63.13	131	**NR**	**NR**	**NR**	**NR**
Kyohei Yamaji *et al.*	Japan	Multicentric	71.0	15.092	14.802	8.972	6.188	13.079
Mingliang Zuo *et al.*	China	Monocentric	64.0	142	87	36	110	**NR**
Seok Oh *et al.*	South Korea	Monocentric	67.01	228	159	101	**NR**	55
Eka Ginanjar *et al.*	Indonesia	Monocentric	58	104	93	60	**NR**	46
Xuhe Gong *et al.*	Beijing	Monocentric	58	79	67	39	71	44
Valeria Cammalleri *et al*	Italy	Multicentric	65±12	11	54	23	77	61.5
Marc J. Claeys *et al*	Belgian	Multicentric	63 ± 12	80	48	27	**NR**	**NR**
Giuseppe De Luca *et al*	Italy	Multicentric	64	74.5	53.4	18.4	41.1	42.5
Batric Popovic *et al*	France	Monocentric	63.6 ± 17.4	63.9	45.5	19.4	18.2	27.3
Guksel 3inier *et al*	Turkey	Monocentric	59.3 ± 13.4	81.1	45.6	26.7	47.8	14.4
Mustafa Kemal Erol *et al*	Turkey	Multicentric	49 - 66	**NR**	45.6	31.1	51.1	22.3
Ofer Kobo *et al*	Israel	Monocentric	52.70	**NR**	52.3	34.6	63.6	58.9
Jing Nan *et al*	Beijing							

HTN, hypertension; D, diabetes; SM, smoker; DL, dyslipidaemia
Source: Author's Own

Symptom Onset to FMC Time

The Asia group displayed a mean difference of MD 18.66 min [95% CI 5.16-32.17], with the MD results being significant (p<0.007) while having high heterogeneity (I^2 = 70%). The mean difference for the Europe group was MD 25.93 min [95% CI 13.93-37.92], with high significance (p<0.0001) and heterogeneity of I^2 = 61. After doing the leave-one-out sensitivity analysis of the Asia group found that the heterogeneity changed from I^2=70% to I^2=36%, ruling out study by Erol (2020) (22), meanwhile in the Europe group excluding study by Aldujeli (2021) (17), changed the heterogeneity from I^2=61% down to I^2=48% (Figure 2).

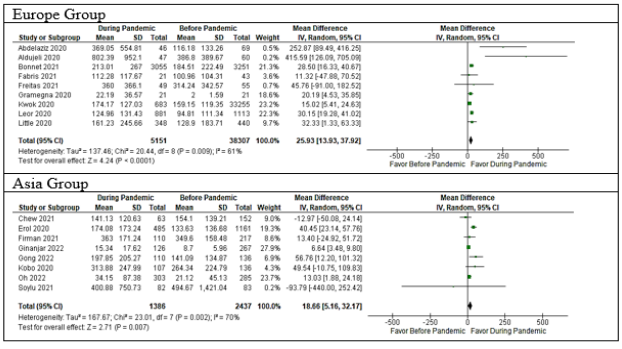

Figure 2: Symptom Onset to FMC Time of the Europe and Asia Group

Door to Balloon Time

The mean difference of the Europe group was 6.00 minutes (95% CI 1.26-10.74), while the Asia group had a mean difference of 22.76 minutes (95% CI 13.34-32.16). More than the Europe group (p = 0.01), the Asia group's mean difference was statistically significant (p<0.00001). Both group have a high level of heterogeneity (I^2 = 97% for Asia and I^2 = 89% for Europe) (Figure 3).

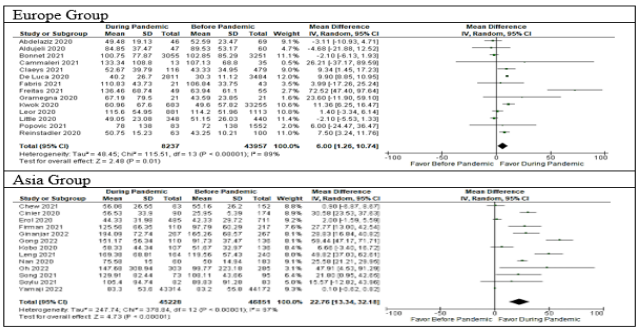

Figure 3: Door to Balloon time of the Europe and Asia Group

Mortality

In the Asia group (I^2 = 48%), the result exhibited no mortality difference between before and during the pandemic (OR = 1.09, 95% CI 1.03–1.15), p = 0.002). In the Europe group (I^2 = 22%), there was significant difference between mortality before and during the pandemic (OR = 1.21, 95% CI 1.08–1.37, p = 0.001) (Figure 4).

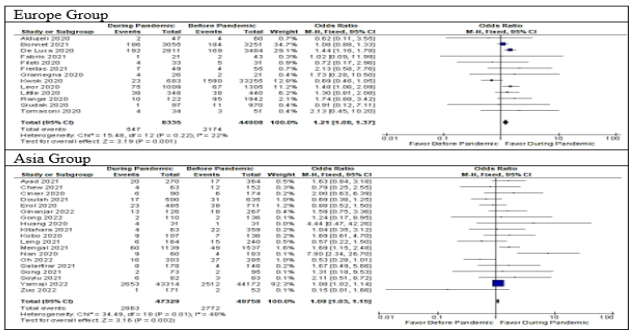

Figure 4: Mortality of the Europe and Asia Group

Cardiogenic Shock

Of the 10 studies were included to seek for the cardiogenic shock incidence in Asia and Europe combined, showing no difference statistically before and during the pandemic (OR=1.55 95% CI 0.38-6.29, I^2=99%) and p=0.54. Asia group analysis showing odds ratio of 2.21 (95%CI [0.35-14.07]) and p=0.40 and Europe group of 0.95 (95%CI [0.83-1.10]) and p=0.49. Asia group had substantial heterogeneity (I^2=98%) and Europe group showing low heterogeneity (I^2=0%).The leave-one-out sensitivity analysis in this study, excluding study in Asia group by Yamaji (2022)(14), reduced the heterogeneity from I^2=99%, down to I^2=0%.

Cardiac Arrest

Five studies were included to evaluate the number of cardiac arrest occurred. By both continent being combined, with a heterogeneity of I^2=0%, studies showing no difference in the incidence before and during pandemic (OR=1.03 95%CI 0.98-1.08) with p=0.24. In Asia and Europe independently showing results of no difference in cardiac arrest incidence ([OR=1.03 95%CI 0.98-1.09] and [OR=1.01 95%CI 0.83-1.22] respectively) with p=0.24 and p=0.92 sequentially, but Asia and Europe group each had low heterogeneity (I^2=0%).

Stroke

No significant difference was seen in strokes that occurred during pandemic in both Asia and Europe (OR = 1.18, 95% CI 0.93 – 1.48, I^2 = 0%, p = 0.17). In Asia and Europe group, stroke did not differ significantly between before and during pandemic. The odds ratio of stroke in Asia was 1.76 (95% CI 0.73 – 4.25, p = 0.21), while the odds ratio of stroke in Europe was 1.14 (95% CI 0.90 – 1.45, p = 0.28). Both continent groups also had a low heterogeneity in this study (I^2 = 0%).

DISCUSSION

To the best of our knowledge, this is the first study that comparing STEMI management and outcomes of Asia and Europe, during the Covid-19 pandemic, and dig deep into the factors of changes. Asia and Europe had an escalation in this aspect. One factor that contributed to this, was patient's fear of in-hospital infection. The fear resulted in delay to go the hospital as a result, higher onset of symptoms to FMC time. (47) While the patient's fear influenced strongly on the patient's delay, other factor like the mode of transportation influenced this parameter. When transported by ambulance, the time and distance traveled reduced, which led to a lower value for this parameter. Patients were discovered to be more inclined towards using self-transport than an ambulance.(53)

This research states that for the onset of first medical contact (FMC) there is a significant relationship between before and during the pandemic. These results are in line with research conducted by Range et al.(32) stated that the "symptom onset-FMC" delay in patients who presented directly to the ED was significantly longer in the lockdown group. Analysis of data regarding door to balloon time showed that there was a significant relationship between before and during the pandemic. The results of this study are in line with De Luca et al.(50) which states that door to balloon time has a significant relationship between before and during the pandemic. Most patients arrived at the most efficient time, but patients admitted in 2020 had significantly longer discharge times. The results of the analysis regarding deaths show that there is a significant relationship before and during the pandemic. In this study, many deaths occurred during the pandemic, this is in line with research conducted by Popovic et al.(26) stated

that there was a significant association with mortality and the hospital mortality rate was much higher in the Covid-19 group.

There were several factors considering the delayed in the door to balloon time during the pandemic. The hospital protocol were said to be the first culprit of the increased door-to-balloon time. Most hospital had a Covid-19 protocol for an incoming patients, regardless of the patient's illness. Inadequate trained staff and system of the hospital to aid transfer to the laboratory (in this case catheterization laboratory) lead to delay in door to balloon time. Some healthcare also found it hard to diagnosed STEMI in patients with Covid-19, hence the patient's transfer will be longer in time. The deficiency of catheterization laboratory number available itself also had the potential to increase the door to balloon time. In this research, we were not asked to check first, because it was not primary research but only researched literature from existing journals.

The highest risk of stroke associated with PCI, occurs in patients with STEMI. Post-PCI stroke likely happened more in patients with STEMI than patients with Non-ST-segment Elevation Myocardial Infarction (NSTEMI) or stable angina.(51) A blocked blood vessel in stroke comes from a thrombi made from emboli causing ischemic stroke. The emboli occurred due to dyskinesia prior to blood stasis, hypercoagulability, and inflammatory changes during the event of myocard infarction.(52)

The level of mortality during the pandemic is different compared to level of mortality prior to it. In the Covid-19 period, the suggested main culprit of the mortality is the delay in ischemic time. Longer ischemic time is associated with larger infarct size and chance of subsequent left ventricle dysfunction.(53)

The lack of knowledge combined with the thoughts of fear, making a higher symptom onset to FMC time. Increased in door to balloon time with the mentioned reason, increase total ischemic time. Decreased population willingness to go to the healthcare, tighter community management and control, healthcare facilities with large numbers of patients, complex referral systems, play a role on both patient's delay and system delay. Increased number of STEMI patients that do not pursue timely treatment, leads to higher chance of having mortality.(54) As a result of its direct and indirect impact on the incidence and treatment of STEMI acute coronary syndrome, the Covid-19 virus alone may increase cardiovascular mortality, if the patient is co-infected with the virus.(25)

This study has several limitations. One included study compared data of before pandemic using broader time frame than other studies, while only using 4 months of time frame during pandemic (Time frame before pandemic of the study was 2017-2019, and during pandemic was January to April 2020). Data on parameter such as cardiogenic shock, cardiac arrest, and stroke of complication are not as much as other parameter. However, the 38 articles examined above therefore met the requirements of the research protocol.

CONCLUSION

This meta-analysis examines the management of STEMI before and after Covid-19 in Asia and Europe. For onset to FMC time, DtB time, and mortality were more significant during the pandemic in both the Asia and Europe groups. This meta analysis showed that during the Covid-19 pandemic, Europe group has a lower door to balloon time compared to Asia group, Asia and Europe group experienced a longer time of symptom onset to FMC time, DtB time, and higher mortality rate.

REFERENCES

1. Baloch S, Baloch MA, Zheng T, Pei X. The Coronavirus Disease 2019 (COVID-19) Pandemic. Tohoku J Exp Med. 2020;250(4):271–8. Available from: https://doi.org/10.1620/tjem.250.271
2. Pereira H, Naber C, Wallace S, Gabor T, Abdi S, Alekyan B, et al. Stent-Save a Life International Survey On The Practice Of Primary Percutaneous Coronary Intervention During The Covid-19 Pandemic. Rev Port Cardiol [Internet]. 2022;41(3):221–7. Available from: https://doi.org/10.1016%2Fj.repc.2021.04.006
3. Aldujeli A, Hamadeh A, Briedis K, Tecson KM, Rutland J, Krivickasa Z, et al. Delays in Presentation in Patients With Acute Myocardial Infarction During The COVID-19 Pandemic. Cardiol Res [Internet]. 2020;11(6):386–91. Available from: https://doi.org/10.14740/cr1175
4. Kwok CS, Gale CP, Kinnaird T, Curzen N, Ludman P, Kontopantelis E, et al. Impact Of COVID-19 On Percutaneous Coronary Intervention For ST-Elevation Myocardial Infarction. Coron Artery Dis. 2020;106(23):1805–11. Available from : https://doi.org/10.1136/heartjnl-2020-317650
5. Gramegna M, Baldetti L, Beneduce A, Pannone L, Falasconi G, Calvo F, et al. ST-Segment–Elevation Myocardial Infarction During COVID-19 Pandemic. Circ Cardiovasc Interv. 2020;13(8):E009413. Available from : https://doi.org/10.1161/circinterventions.120.009413
6. Chew NWS, Sia CH, Wee HL, Benedict LJ Da, Rastogi S, Kojodjojo P, et al. Impact of the COVID-19 pandemic on door-to-balloon time for primary percutaneous coronary intervention — Results from the Singapore Western STEMI Network —. Circ J. 2021;85(2):139–49. Available from : https://doi.org/10.1253/circj.cj-20-0800
7. Ginanjar E, Mansjoer A, Rusdi L, Ramadantie R, Habib H, Liastuti LD, et al. Effects Of The COVID-19 Pandemic On The Management Of

St- Segment Elevation Myocardial Infarction In Indonesia : A Cohort Study. F1000Research [Internet]. 2022;1–13. Available from: https://doi.org/10.12688/f1000research.121526.1
8. La Maestra S, Abbondandolo A, De Flora S. Epidemiological trends of COVID-19 epidemic in Italy over March 2020: From 1000 to 100 000 cases. J Med Virol. 2020 Oct;92(10):1956–61. Available from: https://doi.org/10.1002%2Fjmv.25908
9. Ceylan Z. Estimation of COVID-19 prevalence in Italy, Spain, and France. Sci Total Environ. 2020 Aug;729:138817. Available from : https://doi.org/10.1016/j.scitotenv.2020.138817
10. Luo D, Wan X, Liu J, Tong T. Optimally estimating the sample mean from the sample size, median, mid-range, and/or mid-quartile range. Stat Methods Med Res. 2018 Jun;27(6):1785–805. Available from : https://doi.org/10.1177/0962280216669183
11. Wan X, Wang W, Liu J, Tong T. Estimating the sample mean and standard deviation from the sample size, median, range and/or interquartile range. BMC Med Res Methodol. 2014 Dec;14(1):135. Available from : https://doi.org/10.1186/1471-2288-14-135
12. Ginanjar E, Mansjoer A, Rusdi L, Ramadantie R, Habib H, Liastuti LD, et al. Effects of the COVID-19 pandemic on the management of ST-Segment elevation myocardial infarction in Indonesia: a cohort study. F1000Research. 2022 Jun;11:629. Available from : https://doi.org/10.12688/f1000research.121526.1
13. Firman D, Mangkuanom AS, Iryuza N, Fahri I, Artha IMJR, Mulia E, et al. Decrease in the Number of Patients Presenting With ST-Segment Elevation Myocardial Infarction Across Catheterization Centers in Indonesia During the Coronavirus Disease 2019 Pandemic. Front Cardiovasc Med. 2021 Aug;8. Available from : https://doi.org/10.3389/fcvm.2021.676592
14. Yamaji K, Kohsaka S, Inohara T, Numasawa Y, Ando H, Wada H, et al. Percutaneous coronary intervention during the COVID-19 pandemic in Japan: Insights from the nationwide registration data. Lancet Reg Heal - West Pacific. 2022;22:100434. Available from : https://doi.org/10.1016/j.lanwpc.2022.100434
15. Zuo M, Xiang S, Bhattacharyya S, Chen Q, Zeng J, Li C, et al. Management strategies and outcomes of acute coronary syndrome (ACS) during Covid-19 pandemic. BMC Cardiovasc Disord. 2022 Dec;22(1):242. Available from : https://doi.org/10.1186/s12872-022-02680-z
16. Abdelaziz HK, Abdelrahman A, Nabi A, Debski M, Mentias A, Choudhury T, et al. Impact of COVID-19 pandemic on patients with ST-segment elevation myocardial infarction: Insights from a British cardiac center. Am Heart J. 2020 Aug;226:45–8. Available from : https://doi.org/10.1016%2Fj.ahj.2020.04.022
17. Aldujeli A, Hamadeh A, Briedis K, Tecson KM, Rutland J, Krivickas Z, et al. Delays in Presentation in Patients With Acute Myocardial Infarction During the COVID-19 Pandemic. Cardiol Res. 2020;11(6):386–91. Available from : https://doi.org/10.14740/cr1175
18. Bonnet G, Panagides V, Becker M, Riviиre N, Yvorel C, Deney A, et al. ST-segment elevation myocardial infarction: Management and association with prognosis during the COVID-19 pandemic in France. Arch Cardiovasc Dis. 2021 May;114(5):340–51. Available from : https://doi.org/10.1016/j.acvd.2021.01.005
19. Chew NW, Sia CH, Wee HL, Benedict LJD, Rastogi S, Kojodjojo P, et al. Impact of the COVID-19 Pandemic on Door-to-Balloon Time for Primary Percutaneous Coronary Intervention- Results From the Singapore Western STEMI Network —. Circ J. 2021 Jan;85(2):139–49. Available from : https://doi.org/10.1253/circj.cj-20-0800
20. Daoulah A, Hersi AS, Al-Faifi SM, Alasmari A, Aljohar A, Balghith M, et al. STEMI and COVID-19 Pandemic in Saudi Arabia. Curr Probi Cardiol [Internet]. 2021;46(3):1–20. Available from: https://doi.org/10.1016/j.cpcardiol.2020.100656.
21. Fabris E, Bessi R, Bellis A De, Gregorio C, Peratoner A, Lardieri G, et al. COVID-19 Impact On St-Elevation Myocardial Infarction Incidence Rate In A Italian STEMI Network: A U-Shaped Curve Phenomenon. Ital Fed Cardiol [Internet]. 2021;22(5):344–9. Available from: https://doi.org/10.2459/JCM.0000000000001153
22. Gong X, Zhou L, Dong T, Ding X, Zhao H, Chen H, et al. Impact of COVID-19 Pandemic on STEMI undergoing Primary PCI Treatment in Beijing, China. Am J Emerg Med [Internet]. 2022;53(3):68–72. Available from: https://doi.org/10.1016/j.ajem.2021.11.034
23. Cammalleri V, Muscoli S, Benedetto D, Stifano G, Macrini M, Di Landro A, et al. Who Has Seen Patients With ST-Segment–Elevation Myocardial Infarction? First Results From Italian Real-World Coronavirus Disease 2019. J Am Heart Assoc. 2020 Oct;9(19). Available from : https://doi.org/10.1161/jaha.120.017126
24. Claeys MJ, Argacha JF, Collart P, Carlier M, Van Caenegem O, Sinnaeve PR, et al. Impact of COVID-19-related public containment measures on the ST elevation myocardial infarction epidemic in Belgium: a nationwide, serial, cross-sectional study. Acta Cardiol. 2021 Nov;76(8):863–9. Available from : https://doi.org/10.1080/00015385.2020.1796035
25. De Luca G, Verdoia M, Cercek M, Jensen LO, Vavlukis M, Calmac L, et al. Impact of COVID-19 Pandemic on Mechanical Reperfusion for Patients With STEMI. J Am Coll Cardiol. 2020;76(20):2321–30. Available from : https://doi.org/10.1016/j.jacc.2020.09.546
26. Popovic B, Varlot J, Metzdorf PA, Jeulin H,

Goehringer F, Camenzind E. Changes in characteristics and management among patients with <scp>ST</scp> -elevation myocardial infarction due to <scp>COVID</scp> -19 infection. Catheter Cardiovasc Interv. 2021 Feb;97(3). Available from : https://doi.org/10.1002/ccd.29114

27. ÇİNİER G. The Effect of Covid-19 Pandemic on Access to the Primary Percutaneous Coronary Intervention for ST-Segment Elevation Myocardial Infarction. Turk Kardiyol Dern Arsivi-Archives Turkish Soc Cardiol. 2020; Available from : https://doi.org/10.5543/tkda.2020.95845
28. Erol MK. Treatment Delays and In-Hospital Outcomes In Acute Myocardial Infarction During The Covid-19 Pandemic: A Nationwide Study. Anatol J Cardiol. 2020; Available from : https://doi.org/10.14744/anatoljcardiol.2020.98607
29. Kobo O, Efraim R, Saada M, Kofman N, Abu Dogosh A, Abramowitz Y, et al. The impact of lockdown enforcement during the SARSCoV-2 pandemic on the timing of presentation and early outcomes of patients with ST-elevation myocardial infarction. PLoS One. 2020 Oct;15(10):e0241149. Available from : https://doi.org/10.1371/journal.pone.0241149
30. Nan J, Meng S, Hu H, Jia R, Chen W, Li Q, et al. Comparison of Clinical Outcomes in Patients with ST Elevation Myocardial Infarction with Percutaneous Coronary Intervention and the Use of a Telemedicine App Before and After the COVID-19 Pandemic at a Center in Beijing, China, from August 2019 to March 2. Med Sci Monit. 2020 Sep;26. Available from : https://doi.org/10.12659/msm.927061
31. Fileti L, Vecchio S, Moretti C, Reggi A, Aquilina M, Balducelli M, et al. Impact of the COVID-19 pandemic on coronary invasive procedures at two Italian high-volume referral centers. J Cardiovasc Med. 2020 Nov;21(11):869–73. Available from : https://doi.org/10.2459/jcm.0000000000001101
32. Rangé G, Hakim R, Beygui F, Angoulvant D, Marcollet P, Godin M, et al. Incidence, Delays, and Outcomes Of Stemi During Covid-19 Outbreak: Analysis From The France PCI Registry. J Am Coll Emerg Physicians Open [Internet]. 2020;1(6):1168–76. Available from: https://doi.org/10.1002%2Femp2.12325
33. Siudak Z, Grygier M, Wojakowski W, Malinowski KP, Witkowski A, Gąsior M, et al. Clinical and procedural characteristics of <scp>COVID</scp> -19 patients treated with percutaneous coronary interventions. Catheter Cardiovasc Interv. 2020 Nov;96(6). Available from : https://doi.org/10.1002%2Fccd.29134
34. Kwok CS, Gale CP, Kinnaird T, Curzen N, Ludman P, Kontopantelis E, et al. Impact of COVID-19 on percutaneous coronary intervention for ST-elevation myocardial infarction. Heart. 2020 Dec;106(23):1805–11. Available from : https://doi.org/10.1136/heartjnl-2020-317650
35. Tomasoni D, Adamo M, Italia L, Branca L, Chizzola G, Fiorina C, et al. Impact of COVID-2019 outbreak on prevalence, clinical presentation and outcomes of ST-elevation myocardial infarction. J Cardiovasc Med. 2020 Nov;21(11):874–81. Available from : https://doi.org/10.2459/jcm.0000000000001098
36. Ayad S, Shenouda R, Henein M. The Impact of COVID-19 on In-Hospital Outcomes of ST-Segment Elevation Myocardial Infarction Patients. J Clin Med. 2021 Jan;10(2):278. Available from : https://doi.org/10.3390%2Fjcm10020278
37. Mengal N, Saghir T, Hassan Rizvi SN, Khan N, Qamar N, Masood S, et al. Acute ST-Elevation Myocardial Infarction Before and During the COVID-19 Pandemic: What is the Clinically Significant Difference? Cureus. 2020 Sep; Available from : https://doi.org/10.7759/cureus.10523
38. Salarifar M, Ghavami M, Poorhosseini H, Masoudkabir F, Jenab Y, Amirzadegan A, et al. The impact of a dedicated coronavirus disease 2019 primary angioplasty protocol on time components related to ST-segment elevation myocardial infarction management in a 24/7 primary percutaneous coronary intervention–capable hospital. Kardiol Pol. 2020 Dec;78(12):1227–34. Available from : https://doi.org/10.33963/kp.15607
39. Huang B, Xu C, Liu H, Deng W, Yang Z, Wan J, et al. In-Hospital Management and Outcomes of Acute Myocardial Infarction Before and During the Coronavirus Disease 2019 Pandemic. J Cardiovasc Pharmacol. 2020 Nov;76(5):540–8. Available from : https://doi.org/10.1097/fjc.0000000000000909
40. Kitahara S, Fujino M, Honda S, Asaumi Y, Kataoka Y, Otsuka F, et al. COVID-19 pandemic is associated with mechanical complications in patients with ST-elevation myocardial infarction. Open Hear. 2021 Feb;8(1):e001497. Available from : https://doi.org/10.1136/openhrt-2020-001497
41. Leng W xiu, Yang J gang, Li X dong, Jiang W yang, Gao L jian, Wu Y, et al. Impact Of The Shift To A Fibrinolysis-First Strategy On Care And Outcomes Of Patients With St-Segment–Elevation Myocardial Infarction During The COVID-19 Pandemic—The Experience From The Largest Cardiovascular-Specific Centre In China. Int J Cardiol [Internet]. 2021;329:260–5. Available from: https://doi.org/10.1016/j.ijcard.2020.11.074
42. Rodríguez-Leor O, Cid-Álvarez B, Pérez de Prado A, Rossello X, Ojeda S, Serrador A, et al. Impact of COVID-19 on ST-segment elevation myocardial infarction care. The Spanish experience. Rev Espacola Cardiol (English Ed. 2020 Dec;73(12):994–1002. Available from : https://doi.org/10.1016/j.rec.2020.08.002
43. Little CD, Kotecha T, Candilio L, Jabbour RJ, Collins GB, Ahmed A, et al. COVID-19 Pandemic and STEMI : Pathway Activation and Outcomes

From The pan-London Heart Attack Group. Br Med J [Internet]. 2020;7(2):1–8. Available from: https://doi.org/10.1136/openhrt-2020-001432
44. Oh S, Jeong MH, Cho KH, Kim MC, Sim DS, Hong YJ, et al. Treatment Delay And Outcomes Of St-Segment Elevation Myocardial Infarction Treated By Primary Percutaneous Coronary Intervention During The Covid-19 Era In South Korea. Korean J Intern Med [Internet]. 2022;37(4):786–99. Available from: https://doi.org/10.3904/kjim.2022.077
45. Song C, Liu S, Yin D, Wang Y, Zhao Y, Yang W, et al. Impact of Public Health Emergency Response to COVID-19 on Management and Outcome for STEMI Patients in Beijing—A Single-Center Historic Control Study. Curr Probl Cardiol. 2021 Mar;46(3):100693. Available from : https://doi.org/10.1016%2Fj.cpcardiol.2020.100693
46. Soylu K, Coksevim M, Yanık A, Bugra Cerik I, Aksan G. Effect of Covid-19 pandemic process on STEMI patients timeline. Int J Clin Pract. 2021 May;75(5). Available from : https://doi.org/10.1111%2Fijcp.14005
47. Marotta M, Gorini F, Parlanti A, Chatzianagnostou K, Mazzone A, Berti S, et al. Fear of COVID-19 in Patients with Acute Myocardial Infarction. Int J Environ Res Public Health. 2021 Sep;18(18):9847. Available from : https://doi.org/10.3390%2Fijerph18189847
48. Basar C. Evaluation of transfer parameters in patients admitted to our hospital with ST-elevation myocardial infarction. Turk Kardiyol Dern Arsivi-Archives Turkish Soc Cardiol. 2015; Available from : https://doi.org/10.5543/tkda.2015.04680
49. Demirkan B, Refiker Ege M, Dogan P, Gucuk Ipek E, Guray U, Guray Y. Factors influencing the use of ambulance among patients with acute coronary syndrome: results of two centers in Turkey. Anadolu Kardiyol Dergisi/The Anatol J Cardiol. 2013 Jul; Available from : https://doi.org/10.5152/akd.2013.171
50. Megaly M, Yildiz M, Tannenbaum E, Okeson B, Dworak MW, Garberich R, et al. Incidence and Long-Term Outcomes of Stroke in Patients Presenting With ST-Segment Elevation–Myocardial Infarction: Insights From the Midwest STEMI Consortium. J Am Heart Assoc. 2021 Dec;10(23). Available from : https://doi.org/10.1161/jaha.121.022489
51. Putaala J, Nieminen T. Stroke Risk Period After Acute Myocardial Infarction Revised. J Am Heart Assoc. 2018 Nov;7(22). Available from : https://doi.org/10.1161/jaha.118.011200
52. Scholz KH, Lengenfelder B, Thilo C, Jeron A, Stefanow S, Janssens U, et al. Impact of COVID-19 outbreak on regional STEMI care in Germany. Clin Res Cardiol. 2020;109(12):1511–21. Available from : https://doi.org/10.1007/s00392-020-01703-z
53. Ma J, Zhou S, Li N, Dong X, Maimaitiming M, Yue D, et al. Quality of healthcare and admission rates for acute cardiac events during COVID-19 pandemic: a retrospective cohort study on ST-segment-elevation myocardial infarction in China. BMJ Open. 2022 Nov;12(11):e059720. Available from : https://doi.org/10.1136%2Fbmjopen-2021-059720