

Factors Associated with Cardiopulmonary Resuscitation Success Among Patients with Cardiac Arrest in Hospital

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ABSTRACT

Background: Cardiac arrest requires timely resuscitation, but associations between event characteristics and immediate resuscitation outcomes require careful interpretation, particularly in small hospital samples.

Purpose: To examine the associations of initial heart rhythm, cardiopulmonary resuscitation duration, and arrest-to-resuscitation interval with recorded resuscitation success at Elizabeth Hospital Situbondo, Indonesia.

Methods: This observational cross-sectional study included 38 patients selected through convenience sampling during February–March 2025. Data were extracted from patient records and resuscitation documentation using an observation sheet. Aggregate contingency-table counts were reanalyzed using Pearson chi-square or two-sided Fisher exact tests, as appropriate. Crude odds ratios and 95% confidence intervals were calculated where estimable.

Results: Resuscitation was recorded as successful in 24 patients (63.2%). Success occurred in 15/18 patients with shockable rhythms versus 9/20 with nonshockable rhythms (odds ratio, 6.11; 95% confidence interval, 1.34–27.96; $p = 0.014$), and in 17/21 receiving resuscitation for <10 minutes versus 7/17 for ≥ 10 minutes (6.07; 1.42–26.03; $p = 0.011$). Success occurred in 24/32 patients with an arrest-to-resuscitation interval <2 minutes and 0/6 with an interval ≥ 2 minutes (Fisher $p = 0.001$).

Conclusion: All three variables were associated with recorded immediate resuscitation success. These findings support attention to timely response and rhythm assessment but do not establish causality, independent predictors, or a duration threshold for stopping resuscitation.

Keywords : Arrest-To-Resuscitation Interval; Cardiopulmonary Resuscitation; Initial Heart Rhythm; Resuscitation Duration; Resuscitation Success.



BACKGROUND

Cardiac arrest is an emergency condition that frequently occurs in patients with cardiovascular disorders. It is characterized by the sudden cessation of cardiac circulation, resulting in loss of consciousness, respiratory arrest, and the absence of a palpable pulse in major arteries (Cristy et al., 2022; Tsuruda et al., 2022). Sudden cardiac arrest may occur in individuals with or without a previous history of heart disease (Brown, 2023; Zhou et al., 2021). The condition can be reversed if cardiopulmonary resuscitation (CPR) and defibrillation are performed immediately to restore cardiac function.

Globally, the incidence of cardiac arrest ranges from 50 to 60 cases per 100,000 population each year. In the United States, approximately 1.2% of hospitalized adults experience cardiac arrest, with 25.8% surviving to hospital discharge and 82% demonstrating good functional status at discharge (American Heart Association (AHA), 2020). In Indonesia, the incidence of cardiac arrest is estimated at 10 cases per 100,000 population aged under 35 years, with approximately 300,000–350,000 cases occurring annually. More than 350,000 cases occur outside hospitals, with only 12% survival, while approximately 209,000 in-hospital cardiac arrest cases have a survival rate of 24.8%. East Java reported the highest number of coronary heart disease cases in 2019, reaching 144,279 cases (0.5%) (Ditjen Kesehatan Masyarakat, 2020).

The urgency of improving cardiac arrest management extends beyond achieving an immediate resuscitation response. In a Thai hospital cohort, sustained ROSC occurred in 67.3% of patients, whereas only 18.0% survived to discharge and 9.6% achieved favorable neurological outcomes, illustrating the substantial difference between initial recovery and subsequent survival (Rattananon et al., 2024). These differences emphasize the importance of examining the processes surrounding the arrest event rather than relying solely on an overall success percentage. From a nursing perspective, early recognition, prompt initiation of CPR, and accurate rhythm assessment are closely connected to bedside response and team coordination. Guetterman et al. (2019) identified nursing competence, organizational support, and empowerment as important features of hospitals with better resuscitation performance. Examining event characteristics can therefore help identify priorities for reviewing local response processes, documentation, and resuscitation training (Guetterman et al., 2019).

Initial heart rhythm, the interval before resuscitation, and cardiopulmonary resuscitation (CPR) duration represent different aspects of a cardiac arrest event. Shockable rhythms may respond to defibrillation, whereas delayed initiation of chest compressions prolongs the period without effective circulation. CPR duration reflects both the course of treatment and the time required to achieve return of spontaneous circulation (ROSC) or terminate an unsuccessful attempt. Previous study reported an association between initial shockable rhythm and survival to hospital discharge after adjustment for measured covariates, also found that delays in initiating CPR and subsequent resuscitation treatments were associated with lower survival (Merchant et al., 2026; Tsuruda et al., 2022).

The relationship between CPR duration and successful resuscitation requires particular caution. Previous studies evaluated time-dependent outcome probabilities among patients who had not yet achieved ROSC and examined associations between resuscitation duration and

short- and long-term outcomes. Although shorter attempts were associated with better outcomes, duration is partly determined by the outcome itself: patients who achieve ROSC early generally receive shorter resuscitation attempts. Consequently, these associations should not be interpreted as evidence that deliberately shortening CPR improves survival (Brooks et al., 2022; Eberhard et al., 2021; Randjelovic et al., 2024).

Resuscitation outcomes must also be clearly distinguished. Park et al. (2021) and Sandroni et al. (2021) separately evaluated sustained ROSC, survival to discharge, and favorable neurological outcomes. These endpoints describe different stages of recovery and should not be used interchangeably. In a small hospital sample, examining event characteristics alongside a clearly defined immediate outcome may support local evaluation of resuscitation processes, but it cannot establish independent predictors without adequate adjustment for patient and treatment characteristics. (Park et al., 2022; Sandroni et al., 2021)

Despite the reported associations, differences in timing definitions, outcome measures, and patient characteristics limit the direct application of previous findings to local resuscitation evaluation. The interval before CPR begins and the duration of CPR itself represent different processes, yet both may be interpreted broadly as measures of treatment speed. This distinction is important because the former reflects delay before intervention, whereas the latter is partly determined by treatment response and the timing of ROSC. Furthermore, evidence concerning survival to discharge cannot automatically explain a recorded immediate resuscitation outcome. Standardized reporting and time-dependent analyses highlight these interpretive challenges (Okubo et al., 2024; Yonis et al., 2022). The research gap addressed here is therefore the need to distinguish these event characteristics and examine their associations with the specific outcome recorded in the local patient sample.

The specific contribution of this study is the parallel examination of initial rhythm, arrest-to-resuscitation interval, and CPR duration within the same patient sample and against the same recorded outcome. This approach distinguishes the presenting rhythm, the delay before intervention, and the subsequent treatment course, allowing their clinical meanings to be considered separately. Its contribution lies in providing a focused assessment of local resuscitation patterns while avoiding the assumption that shorter treatment duration necessarily causes success or that the smallest p-value identifies the strongest independent predictor. The findings may inform priorities for documentation and response-process evaluation and provide a basis for subsequent prospective studies using standardized timing and outcome definitions.

This study aimed to examine the associations of initial heart rhythm, cardiopulmonary resuscitation duration, and arrest-to-resuscitation interval with recorded resuscitation success at Elizabeth Hospital Situbondo, Indonesia.

METHODS

Design and Setting

This analytical observational study used a cross-sectional approach at Elizabeth Hospital Situbondo, Indonesia, from February to March 2025. The study examined associations between cardiac arrest event characteristics and recorded immediate resuscitation outcomes. The observational design permits assessment of associations but does not establish causal effects.

Participants and Sampling

The sample comprised 38 patients who experienced cardiac arrest and underwent CPR at the study hospital. Convenience sampling, described as accidental sampling, was used. The numbers screened and excluded were not specified in the available study documentation. Hospital incidence was not calculated because a hospital-wide case count and admission denominator were unavailable.

Instruments and Data Collection

An observation sheet was used to extract information from patient records and resuscitation documentation. The variables available for analysis were age group, sex, disease history, initial heart rhythm, CPR duration category, arrest-to-resuscitation interval category, and recorded CPR success. The instrument's development, validation, and extraction-quality procedures were not documented in sufficient detail to establish measurement reliability.

Initial heart rhythm was defined as the first cardiac rhythm detected during cardiac arrest before resuscitation began. It was classified as shockable, comprising ventricular fibrillation and pulseless ventricular tachycardia, or nonshockable, comprising asystole and pulseless electrical activity.

The arrest-to-resuscitation interval was defined as the time from cardiac arrest onset to initiation of CPR by medical personnel. CPR duration referred to the recorded length of time spent performing chest compressions and ventilation; the precise stopping point used for timing was not specified.

CPR duration was grouped as <10 and >10 minutes, while the arrest-to-resuscitation interval was grouped as <2 and >2 minutes, following the labels in the Indonesian study report. Handling of observations exactly at 10 or 2 minutes was not specified. These categories are study groupings rather than validated clinical thresholds or stopping rules. Time measured in minutes is conceptually ratio-scale; the analyzed duration groups were ordered categorical variables. Initial rhythm and recorded resuscitation success were binary nominal variables.

The outcome was the recorded binary classification of CPR as successful or unsuccessful. A standardized operational definition, including any required duration of sustained ROSC, was not documented. Therefore, findings are reported as recorded immediate resuscitation success and are not equated with sustained ROSC, survival to discharge, or neurological recovery. The Utstein framework distinguishes event timings and immediate and later outcomes and provides a reference for complete reporting.

Data Analysis

Aggregate contingency-table counts were reanalyzed to check statistical consistency. Frequencies and percentages were calculated using the relevant denominators. Pearson chi-square tests without continuity correction were used for initial rhythm and CPR duration because all expected cell counts exceeded five. A two-sided Fisher exact test was used for the arrest-to-resuscitation interval because two expected counts were below five and one observed cell contained zero patients.

Crude odds ratios and 95% log-Wald confidence intervals were calculated when all cells were nonzero. No finite uncorrected odds ratio or Wald confidence interval was estimable for the arrest-to-resuscitation interval. Tests were exploratory, with statistical significance defined as $p < 0.05$. Statistical rechecking used SciPy.

The reported associations were unadjusted. Age, sex, and disease history were described but were not controlled through a verified multivariable analysis. Complete patient-level data and regression output were unavailable for the reanalysis; therefore, adjusted odds ratios and independent predictors were not reported. Potential confounding by illness severity, arrest etiology, monitoring, and treatment characteristics was considered when interpreting the findings.

Ethical Considerations

Ethical approval was obtained from the relevant institutional ethics committee before data collection. The confidentiality and anonymity of participants were maintained throughout the study, and no personally identifiable information was included in the presentation of the findings.

RESULT

The analysis included 38 patients. Most were in the younger age category (23/38; 60.5%) and were male (26/38; 68.4%). Other diseases constituted the largest disease-history category (16/38; 42.1%; Table 1). Percentages were recalculated from the reported counts to one decimal place.

Table 1. Characteristics of Respondents

Variables	Category	n	%
Age	< 60 years	23	60.5
	≥ 60 years	15	39.5
Sex	Male	26	68.0
	Female	12	32.0
History of Disease	Heart disease	8	21.0
	Hypertension	6	16.0
	Hypercholesterolemia	4	10.5
	Diabetes mellitus	4	10.5
	Other diseases	16	42.0

Nonshockable rhythms occurred in 20 patients (52.6%). The shorter CPR-duration category contained 21 patients (55.3%), and the shorter arrest-to-resuscitation interval category contained 32 patients (84.2%). Resuscitation was recorded as successful in 24 patients (63.2%; Table 2). These outcomes do not establish survival to discharge or neurological recovery.

Table 2. Distribution of Study Variables

Variables	Category	n	%
Initial heart rhythm	Shockable (VF/PVT)	18	47.0
	Unshockable (Asystole/PEA)	20	53.0
CPR duration	< 10 minutes	21	55.0
	≥ 10 minutes	17	45.0
Arrest duration	< 2 minutes	32	84.0
	≥ 2 minutes	6	16.0
CPR success	Successful	24	63.0
	Unsuccessful	14	37.0

Table 3 presents the unadjusted associations. Shockable rhythm was associated with greater odds of recorded success than nonshockable rhythm (odds ratio, 6.11; 95% confidence

interval, 1.34–27.96; $p = 0.014$). The shorter CPR-duration category was also associated with greater odds of recorded success (6.07; 1.42–26.03; $p = 0.011$). Both estimates had wide confidence intervals. No successful outcomes were recorded among the six patients in the longer arrest-to-resuscitation interval category, compared with 24 of 32 patients in the shorter category (two-sided Fisher exact $p = 0.001$).

Table 3. Relationship Between Study Variables and CPR Success

Variable and category	Successful, n (%)	Unsuccessful, n (%)	Crude OR (95% CI)	<i>p</i>
Initial rhythm				
Shockable	15 (83.3)	3 (16.7)	6.11 (1.34–27.96)	0.014
Nonshockable	9 (45.0)	11 (55.0)	Reference	
CPR duration				
<10 minutes	17 (81.0)	4 (19.0)	6.07 (1.42–26.03)	0.011
>10 minutes	7 (41.2)	10 (58.8)	Reference	
Arrest-to-resuscitation interval				
<2 minutes	24 (75.0)	8 (25.0)	Not estimable	0.001*
>2 minutes	0 (0.0)	6 (100.0)	Reference	

Note. Percentages were calculated within each category. CPR = cardiopulmonary resuscitation; OR = odds ratio; CI = confidence interval. Initial rhythm and CPR duration were analyzed using Pearson chi-square tests without continuity correction. *The arrest-to-resuscitation interval was analyzed using a two-sided Fisher exact test. No finite uncorrected OR or Wald CI was reported for this comparison because one cell contained zero patients. Timing labels reproduce the study report; handling of observations exactly at 10 or 2 minutes was not specified. All estimates were unadjusted.

DISCUSSION

Relationship Between CPR Duration and Cardiopulmonary Resuscitation Success

The findings of this study demonstrated a significant relationship between CPR duration and successful cardiopulmonary resuscitation among patients with cardiac arrest ($p = 0.011$). Patients who received CPR for less than 10 minutes had a greater proportion of successful resuscitation than those who underwent CPR for more than 10 minutes.

Recorded success was more frequent in the shorter CPR-duration category. However, this association should be interpreted as a feature of the resuscitation course rather than evidence that shortening treatment improves outcomes. Where CPR ends upon ROSC, early responders necessarily have shorter durations, whereas persistent arrest generally leads to longer treatment. The exact timing endpoint in the present study was insufficiently documented (Eberhard et al., 2021; Randjelovic et al., 2024).

Previous studies addressed outcome-dependent duration by evaluating time-dependent probabilities among patients who had not yet achieved ROSC. Park et al. (2022) also found better survival with shorter attempts while documenting meaningful longer-term outcomes among survivors of prolonged resuscitation. The present findings are directionally consistent

with the association between prolonged CPR and lower sustained-ROSC probability reported by Brooks et al. (2022), although differences in outcome definitions limit direct comparison (Brooks et al., 2022; Park et al., 2022).

The 10-minute category boundary used in this study must not be interpreted as a threshold for terminating resuscitation. Duration should be considered alongside treatment response, rhythm, reversible causes, and the clinical context.

An important implication is that CPR duration should not be used as a stand-alone indicator of resuscitation quality. A shorter attempt may reflect an early favorable response, whereas a longer attempt may reflect persistent arrest despite appropriate treatment. Okubo et al. (2024) evaluated outcomes among patients who had not yet achieved ROSC at successive time points, demonstrating why the clinical meaning of duration changes throughout an attempt. Yonis et al. (2022) also documented meaningful longer-term outcomes among survivors of prolonged resuscitation. These findings suggest that evaluating the treatment course requires consideration of the patient's response rather than assuming that longer treatment itself causes an unsuccessful outcome (Yonis et al., 2022).

For nursing practice, the present association identifies a need for more informative event documentation. Recording when CPR begins, when spontaneous circulation returns or resuscitation ends, and whether key interventions are delayed would provide a clearer account of the treatment course. Such documentation could help distinguish persistent clinical difficulty from potentially correctable process delays. It could also support structured debriefing by directing attention toward actions performed during resuscitation rather than the final duration alone. These are priorities for subsequent evaluation; the present data do not establish whether differences in treatment quality explain the observed association.

Relationship Between Initial Heart Rhythm and Cardiopulmonary Resuscitation Success

Initial heart rhythm was significantly associated with CPR success ($p = 0.014$). Patients presenting with shockable rhythms showed a substantially higher success rate compared with patients with unshockable rhythms.

Initial heart rhythm is considered one of the strongest predictors of cardiac arrest outcomes. Shockable rhythms, including ventricular fibrillation and pulseless ventricular tachycardia, remain electrically active and can respond to early defibrillation. Conversely, asystole and pulseless electrical activity often indicate severe myocardial dysfunction and prolonged circulatory failure.

The findings are consistent with Hidayat et al. (2022), who reported a significant relationship between initial heart rhythm and CPR outcomes. Similar findings indicating that shockable rhythms were associated with increased survival (Mandigers et al., 2022; Park et al., 2022). Aschieri et al. (2021) also demonstrated that ventricular fibrillation carries a better prognosis because early defibrillation can restore organized electrical activity (Aschieri et al., 2021).

The higher success proportion with shockable rhythm is biologically plausible because defibrillation can terminate ventricular fibrillation or pulseless ventricular tachycardia. Han et al. (2024) reported an association between initial shockable rhythm and survival to hospital discharge across several adjusted analyses. However, the present crude estimate had a wide confidence interval and did not account for monitoring, witnessed status, arrest etiology, or

treatment timing. Initial rhythm should therefore be interpreted as a clinically relevant event characteristic rather than a confirmed independent predictor in this sample.

The relationship between rhythm and outcome may also depend on how promptly rhythm recognition is translated into appropriate treatment. Evans et al. (2021) reported that administration of epinephrine before defibrillation in patients with shockable in-hospital arrest was associated with delayed defibrillation and poorer survival. This finding indicates that the presence of a shockable rhythm alone does not guarantee a favorable outcome; the sequence and timing of subsequent actions remain relevant. Because the present analysis did not include time to first shock, medication timing, or changes in rhythm, it cannot determine whether these treatment processes contributed to the difference between rhythm groups (Evans et al., 2021).

Nonshockable rhythms should likewise be interpreted within their clinical context rather than as evidence of inevitable failure. Asystole and pulseless electrical activity represent different patterns, and potentially reversible causes may be present in either group. Current guidance emphasizes rhythm-appropriate management and assessment of reversible causes (Wigginton et al., 2025). For local nursing evaluation, this supports attention to accurate rhythm identification, communication of findings, and readiness for the next intervention. Documentation should also distinguish the first detected rhythm from rhythms developing later during treatment. These considerations provide practical directions for improving the interpretability of future data without assuming that staff competence or treatment adherence was measured in this study.

Relationship Between Arrest Duration and Cardiopulmonary Resuscitation Success

The arrest-to-resuscitation interval was significantly associated with recorded CPR success (two-sided Fisher exact $p = 0.001$). Patients in the shorter-interval category had a higher proportion of successful outcomes than those in the longer-interval category. However, this unadjusted comparison does not establish the interval as an independently dominant predictor. Patients who received resuscitation within two minutes experienced a substantially higher success rate than patients with delayed intervention.

All six patients in the longer arrest-to-resuscitation interval category had unsuccessful outcomes, whereas 24 of 32 patients in the shorter category had recorded success. Delayed chest compressions plausibly prolong the period without effective organ perfusion. Previous study linked delays in CPR, defibrillation, and epinephrine with lower hospital survival (Matsuyama et al., 2022).

Nevertheless, the small delayed-response subgroup is insufficient to define a universally prognostic threshold or establish that delay alone caused the outcomes. The study defined the interval from cardiac arrest onset to CPR initiation but did not explain how onset was determined in unwitnessed events. Consistent timestamps and explicit event definitions are necessary for valid comparisons (Yan et al., 2020). The observed association supports a local review of recognition and response processes rather than identification of an independently strongest predictor.

A further consideration is that the interval before CPR represents only one component of the response timeline. Previous study distinguished delays in initiating CPR from delays between CPR initiation and subsequent defibrillation or epinephrine treatment, with each interval showing an association with survival. Consequently, a short arrest-to-resuscitation

interval should not automatically be interpreted as evidence that the entire resuscitation process was timely. Conversely, a longer recorded interval may arise from difficulties in recognizing or establishing the onset of arrest, rather than solely from delayed action after recognition. Separating these stages would help identify which part of the response process requires attention (Kim et al., 2018) .

Future documentation could therefore record the estimated onset of arrest, the time it was recognized, team activation, and the initiation of chest compressions as separate events. Where the onset is uncertain, particularly in unwitnessed cases, that uncertainty should be explicitly recorded rather than represented as an exact interval. The Utstein framework provides a basis for consistent event definitions and comparable reporting. Applying these distinctions would make subsequent evaluation more informative and reduce the risk of attributing delays to individual responders when system processes or uncertainty in the records may also contribute (Khaled et al., 2022) .

Factors Associated with Successful CPR

The observed associations indicate that recorded resuscitation success differed according to initial rhythm and the two timing categories. However, the relative size of separate p-values does not establish which variable has the greatest independent influence. Such a conclusion would require a verified multivariable analysis with adequate patient-level information.

Resuscitation outcomes may also depend on compression quality, airway management, arrest etiology, underlying illness, treatment timing, equipment readiness, and team coordination. These factors were not evaluated in the available analysis and may contribute to confounding. Guetterman et al. (2019) highlighted the importance of supporting nurses as first responders and resuscitation team members through appropriate training and organizational support.

The recorded success proportion of 63.2% describes the immediate outcome available in this study. It should not be interpreted as survival to discharge or favorable neurological recovery. Future evaluations should report these outcomes separately. The importance of separating outcomes is illustrated by Rattananon et al. (2024), who reported sustained ROSC in 67.3% of patients, survival to discharge in 18.0%, and favorable neurological outcomes in 9.6%. Evans et al. (2021) similarly demonstrated that acute resuscitation survival and postresuscitation survival represent distinct dimensions of hospital performance. Therefore, numerical similarity between the present success proportion and another study's ROSC proportion does not establish equivalent performance. Differences in operational definitions, illness severity, arrest characteristics, and subsequent care must be considered before drawing comparisons. The present findings should consequently remain focused on the recorded immediate outcome rather than being extended to longer-term recovery (Evans et al., 2021; Rattananon et al., 2024) .

At the organizational level, the findings support evaluating event characteristics alongside team readiness and coordination. Evans et al. (2021) identified clear responsibilities, communication, leadership, and training as distinguishing features of higher-performing resuscitation teams. Together with the nursing roles described by Guetterman et al. (2019), this evidence suggests relevant domains for local review, including role allocation, equipment

readiness, and structured debriefing. These practices should be evaluated rather than assumed to explain the present results. The contribution of this study is to identify patterns that warrant closer investigation; establishing which patient characteristics or care processes independently influence outcomes will require larger prospective studies with standardized documentation and appropriate adjustment (Evans et al., 2021; Guetterman et al., 2019) .

Limitations

This single-center convenience sample comprised only 38 patients, limiting precision and generalizability. The cross-sectional, unadjusted analysis cannot establish causal effects or control confounding. CPR duration is partly determined by whether and when ROSC occurs, complicating its interpretation as an independent exposure.

Operational definitions and measurement procedures were incompletely reported. Exact timing endpoints, handling of boundary values, sustained-ROSC criteria, instrument reliability, and missing-data procedures could not be established. The small delayed-response subgroup and zero cell limited effect estimation. Patient-level joint data were unavailable for adjusted analysis, and survival to discharge and neurological outcomes were not reported. Consequently, independent predictors and an optimal stopping duration cannot be identified.

Implications for Nursing Practice

The findings support reviewing bedside recognition of cardiac arrest, immediate initiation of CPR, accurate rhythm assessment, and timely access to defibrillation. Hospital quality-improvement activities should also assess compression quality, equipment readiness, team communication, and resuscitation documentation.

Regular simulation and structured debriefing may help identify response delays and clarify team responsibilities. Future multicenter prospective studies should collect patient-level event timings, clinical severity, arrest etiology, treatment details, and outcomes extending beyond immediate resuscitation. These data would support more reliable adjustment for confounding and evaluation of longer-term recovery.

CONCLUSION

Initial heart rhythm, CPR duration category, and arrest-to-resuscitation interval category were associated with recorded immediate resuscitation success in this sample of 38 patients. Shockable rhythms and the shorter timing categories had higher success proportions. The findings support attention to timely response and rhythm assessment but do not establish causality, independent dominance, long-term survival, or a threshold for stopping CPR.

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AUTHOR CONTRIBUTIONS

Joaquim Pinto: Conceptualization, Methodology, Writing – original draft, Supervision, Writing – review and editing. **Novita Ana Anggraini:** Conceptualization, Methodology, Investigation, Writing – original draft. **Jayasree S Kanathasan:** Supervision,

Writing – review and editing. **Imelda Dwi Agustin:** Investigation. **Rahmania Ambarika:** Formal analysis. **Nurma Afiani:** Formal analysis.

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CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

DECLARATION OF AI USE

During manuscript revision, the authors used ChatGPT (OpenAI) to assist with English language editing and identification of potentially relevant literature. The authors reviewed and edited the AI-assisted content, verified the cited references and reported calculations, and take full responsibility for the accuracy, originality, and integrity of the article.

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