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Cardiorespiratory fitness for emergency nursing performance: Association with initial response time and clinical decision-making performance

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Abstract

Background: Emergency department (ED) nurses must respond quickly and make accurate clinical decisions in life-threatening situations. Although technical skills and experience are known to influence emergency performance, the role of cardiorespiratory fitness has received limited attention, especially among Indonesian emergency nurses.

Purpose: To determine the relationship between cardiorespiratory fitness, response time, and clinical decision-making performance among ED nurses.

Method: This cross-sectional correlational study included all 28 ED nurses at Jember Klinik Hospital using total sampling. Cardiorespiratory fitness was measured with the Harvard Step Test and estimated VO_2 max. Response time was assessed during a standardized in-hospital cardiac arrest simulation as the interval from scenario completion to the first chest compression. Clinical decision-making performance was evaluated using a standardized vignette based on the American Heart Association 2020 cardiac arrest algorithm. Spearman rank correlation was used, with $p < 0.05$ considered significant.

Results: Most nurses had good cardiorespiratory fitness (42.9%), optimal response time (53.6%), and good clinical decision-making performance (50.0%). Cardiorespiratory fitness was significantly associated with faster response time ($r = -0.612$; $p = 0.001$), indicating that fitter nurses initiated emergency actions more rapidly. A significant positive association was also found between cardiorespiratory fitness and clinical decision-making performance ($r = 0.584$; $p = 0.001$), suggesting that higher fitness levels were linked to better performance during the cardiac arrest simulation.

Conclusion: Cardiorespiratory fitness was significantly associated with faster emergency response and better clinical decision-making performance among ED nurses. These findings suggest that fitness assessment and structured physical conditioning programs should be considered in occupational health and professional development strategies to strengthen emergency care quality and patient safety.

Keywords: Cardiorespiratory Fitness; Clinical Decision-Making Performance; Emergency Department Nurse; Harvard Step Test; In-Hospital Cardiac Arrest; Response Time.

INTRODUCTION

The Emergency Department (ED) is a hospital service unit responsible for providing initial management for patients with life-threatening conditions or conditions that may result in permanent disability (Ministry of Health of the Republic Indonesia, 2019). The nature of emergency care requires health professionals, particularly nurses, to deliver responses that are both rapid and accurate within a very limited time frame (World Health Organization, 2018). In daily practice, ED nurses are responsible for triage, initial assessment, identification of priority problems, and the implementation of immediate interventions that directly affect patient outcomes. Therefore, two important indicators reflecting the performance of emergency nurses are response time and the accuracy of clinical decision-making. Delayed responses and errors in clinical decision-making may increase the risk of morbidity and mortality and reduce patient safety (Gates et al., 2018; Ministry of Health of the Republic Indonesia, 2019).

Various studies have shown that the clinical performance of health workers is influenced not only by knowledge, experience, and technical competence, but also by individual physiological conditions (Almarwani & Alzahrani, 2023; Kim, 2022). One physiological component that may affect work performance is cardiorespiratory fitness, defined as the ability of the heart, lungs, and blood vessels to efficiently supply oxygen during physical activity (American College of Sports Medicine, 2021; Mohamed & Ghalab, 2022). Good cardiorespiratory fitness is known to be associated with improved cerebral blood flow, enhanced brain metabolic efficiency, and the ability to maintain cognitive function under high work demands (Heuel et al., 2024). Studies in sports science and behavioral science have shown that individuals with higher fitness levels tend to demonstrate better reaction speed, attention, concentration, and information processing ability compared with those with lower fitness levels (Mohebb et al., 2019; Niu et al., 2021). Conversely, physical fatigue is associated with decreased alertness, slower responses, and an increased risk of errors in task performance (Sagherian et al., 2018; Subih et al., 2024; Jacob et al., 2025).

Although the relationship between physical fitness and cognitive function has been widely reported, evidence regarding the influence of cardiorespiratory fitness on the clinical performance of health workers, particularly ED nurses, remains limited. Direct evidence on the association between fitness status and nurses' clinical performance is still scarce. Most studies have examined health status, work ability, or physical activity behavior rather than the quality of clinical decision-making itself (Sagherian et al., 2018; Jacob et al., 2025). In fact, the ED work environment has unique characteristics, including high work pressure, the need for rapid decision-making, and sustained physical readiness throughout working hours (Matsugaki et al., 2017). The accuracy of clinical decision-making is an important outcome to investigate because decisions made by nurses at the initial stage of emergency care determine intervention priorities, the speed of treatment, and patient safety (Prakash et al., 2026; Tan et al., 2021). Errors in clinical decision-making during the early phase of care may lead to delayed treatment, triage errors, or failure to recognize life-threatening conditions (Prakash et al., 2026).

Based on the above description, there is a knowledge gap regarding the relationship between cardiorespiratory fitness and the clinical performance of emergency nurses, particularly in terms of response time and the accuracy of clinical decision-making. This study was conducted to analyze the relationship between cardiorespiratory fitness, response time, and the performance of clinical decision-making among ED nurses at Perkebunan Jember Klinik Hospital. The findings are expected to provide a scientific basis for the development of fitness promotion programs for nursing staff as part of a strategy to improve the quality of emergency care and patient safety.

RESEARCH METHOD

This study employed a correlational analytic design with a cross-sectional approach. The study was conducted in the ED of Perkebunan Jember Klinik Hospital, Jalan Bedadung, Jemberlor, Jember Regency, in June 2026. The population in this study

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consisted of all active nurses working in the ED of Perkebunan Jember Klinik Hospital using total sampling technique. This technique was chosen because the number of ED nurses was fewer than 50 ($n = 28$). Therefore, the entire population was included in the study to obtain a more representative picture.

The inclusion criteria were as follows: (1) active nurses assigned to the ED, (2) aged 21–50 years, (3) having at least 1 year of work experience in the ED, (4) willing to participate by signing informed consent, and (5) having no history of chronic cardiorespiratory disease. Participants who experienced musculoskeletal injury, acute illness, or did not complete the entire measurement procedure were excluded from the study.

Cardiorespiratory fitness was measured using the Harvard Step Test (HST) as a method for estimating aerobic capacity (VO_{2max}). The Harvard Step Test was performed using a bench with a height of 50.8 cm (20 inches) for men and 40.6 cm (16 inches) for women, a metronome set at 120 beats per minute (30 steps per minute), and a stopwatch. The test was conducted using an up-up-down-down stepping pattern in time with the metronome for a maximum of 5 minutes (300 seconds) or was terminated if the participant was unable to maintain the rhythm for 15 seconds. Immediately after the test was terminated, pulse rate was recorded for 30 seconds at minute 1 (F1), minute 2 (F2), and minute 3 (F3). Based on these pulse measurements, the Fitness Index was calculated using the following formula:

$$\text{Fitness Index} = \text{test duration (seconds)} \times 100 / [2 \times (F1 + F2 + F3)]$$

The obtained Fitness Index was then converted into an estimated VO_{2max} value ($ml/kg/min$), which reflects the participant's cardiorespiratory fitness level, using the following formula:

$$\text{Estimated } VO_{2max} = (\text{Fitness Index} \times 0.396) + 18.36$$

The results were then categorized according to sex and age using the Estimated VO_{2max} reference table from the American College of Sports Medicine (ACSM) (American College of Sports Medicine, 2018).

Response time was measured using a standardized in-hospital cardiac arrest (IHCA) simulation scenario. Response time was operationally defined as the time interval between the completion of scenario presentation and the initiation of the first chest compression. This operational definition was adapted from the American Heart Association (AHA) Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care (Panchal et al., 2020), which emphasize rapid recognition of cardiac arrest, simultaneous assessment of breathing and pulse (within 10 seconds), prompt activation of the emergency response system, and immediate initiation of high-quality chest compressions. Based on this sequence of actions, response time was operationally classified into three categories: optimal (<20 seconds), acceptable (20–30 seconds), and delayed (>30 seconds). Shorter response times indicated better emergency response performance.

Clinical decision-making performance was measured using a scenario-based clinical decision-making instrument (clinical vignette) developed according to the cardiac arrest management algorithm based on AHA Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care (Panchal et al., 2020). The clinical vignette consisted of a single standardized IHCA scenario involving a 45-year-old male patient who was being observed in the ED for chest pain. During observation, the cardiac monitor suddenly displayed asystole and the patient became unresponsive. At this point, participants were instructed to initiate emergency management, and the scenario commenced ("Start now!"). The scenario included several predefined clinical decision-making points reflecting the initial management of IHCA. Participants were instructed to manage the patient according to their usual clinical practice without receiving additional prompts or feedback during the simulation. Clinical performance was assessed using a structured scoring rubric with a total score ranging from 0 to 100 by an emergency nursing lecturer trained in the use of the assessment instrument. Higher scores indicated better clinical decision-making ability. Prior to data collection, the clinical vignette and scoring rubric were reviewed by two emergency nursing experts to establish content validity. All participants were

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assessed by the same observer using standardized assessment procedures to minimize inter-rater variability.

Data analysis was conducted using univariate and bivariate analyses. Univariate analysis was used to describe participants characteristics and the distribution of each study variable in terms of mean, standard deviation, frequency, and percentage. Bivariate analysis was performed using the Spearman rank test to determine the relationship between cardiorespiratory fitness and response time as well as clinical decision-making accuracy. The relationship

between variables was considered statistically significant at $p < 0.05$, with the strength of the correlation interpreted based on the correlation coefficient (r). The correlation coefficient was interpreted as very weak, weak, moderate, strong, or very strong.

This study was approved by the Health Research Ethics Committee of Perkebunan Jember Klinik Hospital (No.698/KEPK/UDS/VI/2026). Participants were provided with complete information before taking part in the study and had the right to withdraw without any consequences.

RESEARCH RESULTS

Table 1. Characteristics of the Participants (N=28)

Variable	Result	Mean $\pm$ SD
Age (Year) (n/%)		
<25	6 / 21.4	30.0 $\pm$ 4.0
25-35	16 / 57.1	
>35	6 / 21.4	
Gender (n/%)		
Male	8 / 28.6	20 / 71.4
Female	20 / 71.4	
Work Experience (Year)(n/%)		
< 1	8 / 28.6	18 / 64.3
1-5	18 / 64.3	
>5	2 / 7.1	
Education (n/%)		
S1/Ners	6 / 21.4	22 / 78.6
Diploma	22 / 78.6	
Estimated VO2max (ml/kg/min)(n/%)		
Good (≥ 30)	12 (42.9)	28.4 $\pm$ 5.2
Moderate (25-29,9)	10 (35.7)	
Poor (<25)	6 (21.4)	
Response Time (sec)(n/%)		
Optimal (<20)	15 (53.6)	28.3 $\pm$ 2.1
Acceptable (20-30)	8 (28.6)	
Delayed (>30)	5 (17.9)	
Clinical Decision-Making Performance (n/%)		
Good (≥ 75)	14 (50.0)	72.8 $\pm$ 12.4
Adequate (60-74,9)	9 (32.1)	
Poor (<60)	5 (17.9)	

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A total of 28 ED nurses from Jember Klinik Hospital participated in this study. As presented in Table 1, most participants were female (71.4%), aged 25–35 years (57.1%), had 1–5 years of ED work experience (64.3%), and held a diploma degree (78.6%).

Regarding the study variables, 42.9% of participants demonstrated good cardiorespiratory fitness, with a mean estimated VO_2max of 28.4 ± 5.2 mL/kg/min. More than half of the participants (53.6%) exhibited an optimal response time, with a mean response time of 28.3 ± 2.1 seconds. In addition, 50.0% of participants achieved good clinical decision-making performance, with a mean performance score of 72.8 ± 12.4 .

Table 2. Data analysis

Independent Variable	Dependent variable	r	p-value	Interpretation
Cardiorespiratory Fitness	Response Time	-0.612	0.001*	Moderate negative correlation
Cardiorespiratory Fitness	Clinical Decision-Making Performance	0.584	0.001*	Moderate positive correlation

The results of the Spearman rank correlation analysis are presented in Table 2. Cardiorespiratory fitness was significantly associated with response time ($r = -0.612$; $p = 0.001$), indicating a moderate negative correlation, where higher levels of cardiorespiratory fitness were associated with shorter response times. Cardiorespiratory fitness was also significantly associated with clinical decision-making performance ($r = 0.584$; $p = 0.001$), demonstrating a moderate positive correlation, indicating that participants with better cardiorespiratory fitness tended to achieve higher clinical decision-making performance scores.

DISCUSSION

This study demonstrated that cardiorespiratory fitness was significantly associated with both initial response time and clinical decision-making performance among emergency department nurses. Nurses with higher estimated cardiorespiratory fitness initiated chest compressions more rapidly and achieved better clinical decision-making performance during a standardized in-hospital cardiac arrest (IHCA) simulation. To our knowledge, evidence examining the relationship between cardiorespiratory fitness and emergency nursing performance remains limited, particularly among emergency nurses. Most previous studies have focused on healthy adults,

older individuals, athletes, military personnel, or law enforcement officers rather than healthcare professionals. Therefore, the present findings contribute new evidence suggesting that cardiorespiratory fitness may represent an important component of emergency nursing readiness (Gates et al., 2018; Heuel et al., 2024; Mohamed & Ghalab, 2022; Mohebb et al., 2019).

The observed associations are biologically plausible. Cardiorespiratory fitness reflects the capacity of the cardiovascular and respiratory systems to deliver oxygen efficiently to working muscles and the brain during physical activity. Adequate oxygen availability supports executive brain functions that are essential for emergency nursing practice, including attention, working memory, cognitive flexibility, processing speed, and psychomotor coordination (Cantelon & Giles, 2021; Alibazi et al., 2020; Potter et al., 2022). In addition, individuals with higher cardiorespiratory fitness generally demonstrate greater resistance to physical and mental fatigue, enabling them to maintain alertness and stable cognitive performance during prolonged or stressful tasks (Chu et al., 2024; Luque-Casado et al., 2016; Wu et al., 2022).

Although professional competence remains the primary determinant of emergency nursing performance, these physiological advantages may

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enable nurses to recognize clinical deterioration more rapidly, prioritize interventions more effectively, and execute emergency procedures with greater consistency under pressure. Consequently, cardiorespiratory fitness should not be viewed merely as an indicator of physical health but as a supporting component of professional readiness in emergency nursing.

The present study demonstrated that nurses with better cardiorespiratory fitness initiated chest compressions more rapidly during the IHCA simulation. Unlike previous studies that evaluated the total duration required to complete an emergency scenario, the present study operationally defined initial response time as the interval between completion of scenario presentation and initiation of the first chest compression. This definition was intentionally selected because early recognition of cardiac arrest and prompt initiation of chest compressions constitute the first critical links in the chain of survival and are strongly emphasized in current resuscitation guidelines (Panchal et al., 2020).

From a clinical perspective, a shorter initial response time reflects not only faster physical movement but also the ability to recognize an emergency, activate an appropriate response, and immediately translate clinical assessment into life-saving action. Emergency nurses routinely work under conditions characterized by unpredictable patient acuity, heavy workload, frequent interruptions, and considerable psychological stress. Such environments may impair reaction speed and psychomotor performance through fatigue and cognitive overload (Kao et al., 2022). The present findings suggest that nurses with better cardiorespiratory fitness may be better prepared to maintain alertness and execute these critical initial actions efficiently, thereby supporting timely emergency care (Bauermeister & Bunce, 2016; Ludyga et al., 2016).

This study also demonstrated that higher cardiorespiratory fitness was associated with better clinical decision-making performance during the standardized IHCA simulation. Clinical decision-making in emergency settings requires rapid integration of patient assessment, interpretation of

clinical findings, prioritization of interventions, and immediate implementation of evidence-based management. These processes place substantial demands on executive cognitive functions, particularly under conditions of uncertainty and time pressure.

Previous studies have consistently shown that higher cardiorespiratory fitness is associated with superior cognitive performance, including better working memory accuracy, sustained attention, inhibitory control, and faster information processing, particularly during tasks with high cognitive demands (Di Muccio et al., 2022; Looser et al., 2023; Wu et al., 2022). Furthermore, individuals with higher cardiorespiratory fitness appear to demonstrate better physiological regulation and recovery under stressful conditions, which may help preserve judgment quality and decision-making performance when workload is high (Gerber et al., 2026; Oggionni et al., 2025; Schilling et al., 2020).

Nevertheless, clinical decision-making performance should be interpreted as a multidimensional construct. Knowledge, clinical experience, emergency training, teamwork, communication, and situational awareness remain essential determinants of effective emergency care. Therefore, the findings of this study should not be interpreted as indicating that cardiorespiratory fitness alone determines clinical performance. Rather, cardiorespiratory fitness appears to function as an important supporting factor that enables nurses to apply their clinical competence more effectively during high-pressure emergency situations.

The present findings have important implications for emergency nursing practice and hospital management. Professional development programs for emergency nurses traditionally emphasize technical competencies such as Basic Life Support (BLS), Advanced Cardiac Life Support (ACLS), trauma management, and triage (World Health Organization, 2018). However, considerably less attention has been directed toward maintaining the physical fitness required to perform emergency procedures efficiently. The findings of this study suggest that cardiorespiratory fitness may represent an overlooked component of emergency nursing competence.

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From an occupational health perspective, maintaining adequate cardiorespiratory fitness may improve not only individual health but also professional readiness during emergency response (Cantelon & Giles, 2021; Chu et al., 2024; Wu et al., 2022). Hospitals may therefore consider integrating periodic cardiorespiratory fitness assessments, structured exercise programs, and workplace wellness initiatives alongside mandatory emergency skills training (Alibazi et al., 2020; Luque-Casado et al., 2016). Although this study did not directly evaluate patient outcomes, both initial response time and clinical decision-making performance represent essential components of safe emergency care. Consequently, promoting cardiorespiratory fitness among emergency nurses may contribute to improving workforce resilience, emergency care quality, and ultimately patient safety.

This study has several strengths. Cardiorespiratory fitness was assessed using the standardized Harvard Step Test, while emergency nursing performance was evaluated using a structured IHCA simulation based on current resuscitation guidelines. All participants were assessed using standardized procedures by the same trained observer, thereby minimizing inter-observer variability. Several limitations should also be acknowledged. First, the cross-sectional design precludes causal inference. Second, the relatively small sample drawn from a single hospital may limit the generalizability of the findings. Third, cardiorespiratory fitness was estimated using the Harvard Step Test rather than direct cardiopulmonary exercise testing, which may introduce measurement limitations. Finally, only one standardized IHCA scenario was used to assess clinical decision-making performance, which may not fully represent the diversity of emergency situations encountered in routine clinical practice. Future multicenter studies involving larger samples, multiple emergency scenarios, and multivariable analyses are warranted to further clarify the contribution of cardiorespiratory fitness to emergency nursing performance and to evaluate the effectiveness of fitness promotion interventions in improving clinical outcomes.

CONCLUSION

This study demonstrated that cardiorespiratory fitness was significantly associated with both response time and clinical decision-making performance among ED nurses. Nurses with better cardiorespiratory fitness tended to initiate emergency interventions more rapidly and achieved higher clinical decision-making performance during a standardized IHCA simulation. These findings suggest that cardiorespiratory fitness should be recognized not only as an indicator of individual physical health but also as an important component of professional readiness in emergency nursing practice. Therefore, healthcare institutions should consider integrating periodic cardiorespiratory fitness assessments and structured fitness promotion programs into occupational health and continuing professional development strategies to support optimal emergency care performance and enhance patient safety. Future studies involving larger multicenter samples, diverse emergency scenarios, and multivariable analyses are recommended to further clarify the contribution of cardiorespiratory fitness to emergency nursing performance and to evaluate the effectiveness of fitness interventions in improving clinical outcomes.

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