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The Effect of Footrest Use on the Quality of Chest Compression during Cardiopulmonary Resuscitation (CPR) Simulation

Setiyawan[1], Desak Made Yuni Antari[1], Happy Indri Hapsari[1]
[1]Faculty of Health Sciences, Universitas Kusuma Husada Surakarta

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ABSTRACT

Cardiopulmonary Resuscitation (CPR) is a critical life-saving procedure in the management of cardiac arrest. High-quality chest compressions significantly determine the effectiveness of CPR, including adequate depth, rate, and consistency. Rescuer stability plays a crucial role in maintaining compression quality, and the use of a footrest may help maintain ergonomic posture, reduce fatigue, and enhance the effectiveness of chest compressions. This study aims to analyse the effect of footrest use on the quality of chest compressions during CPR simulation among professional nursing students at Kusuma Husada University Surakarta. This research employed a quasi- experimental design with a post-test only control group approach. A total of 44 participants were selected using purposive sampling, with inclusion criteria of having received CPR training and possessing a normal body mass index (BMI). Observational instruments were used based on the five indicators of CPR quality according to the 2020 AHA guidelines: depth, rate, hand placement, interruptions, and chest recoil. The sample was divided into experimental and control groups. The results showed that CPR quality with the use of a footrest was predominantly in the high category (90%) compared to those without a footrest (81.8%). The Mann- Whitney test (p= .000) indicated a significant effect of footrest use on the quality of chest compressions. Further research is recommended under actual clinical conditions.

Corresponding Authors:
Setiyawan
Nursing Study Programme, Faculty of Health Sciences, Universitas Kusuma Husada Surakarta
Jl. Jaya Wijaya No. 11 Banjarsari, Kota Surakarta, Jawa Tengah, Indonesia
Email: etya1025@gmail.com

1. INTRODUCTION

Cardiopulmonary Resuscitation (CPR) is an emergency procedure that aims to maintain blood circulation and oxygen to the brain and other vital organs in patients who experience cardiac arrest (American Heart Association, 2015). One important indicator of successful CPR is the quality of chest compressions, which includes depth, speed, rhythm, and consistency during execution (Irmawati, 2019). Poor compression quality, such as insufficient depth or inappropriate speed, can significantly decrease the effectiveness of CPR and reduce the chances of successful resuscitation (Irmawati, 2018).

According to the American Heart Association (2020), optimal chest compression quality is characterised by a minimum depth of 5 cm and a maximum of 6 cm, a rate of 100-120 compressions per minute, proper hand placement, perfect chest recoil, and minimal interruptions during the action. However, global studies show that the success rate of out-of-hospital CPR is still low, at only around 10%, signalling the need to improve the quality of its implementation (Meaney et al., 2019).

Various factors have been identified as influencing the quality of chest compressions, one of which is the position and posture of the helper. A study by Nicolau et al. (2024) showed that optimal helper position and arm angle of around 90° can increase compression depth and effectiveness. A helper position that is higher than the patient's surface has also been shown to improve compression quality. In contrast, kneeling on a medical bed is considered less effective as it destabilises the upper body and limits the ability to generate sufficient force (Hasegawa et al., 2020). This is reinforced by the findings of Lee et al. (2018), who mentioned that a fixed bed height makes ergonomic adjustments between the helper and patient difficult, especially in emergency situations.

Physical fatigue is also a challenge in maintaining CPR quality. Research (Ock et al., 2021) on simulation using mannequins found that about 37% of CPR actions decreased in quality after 5-7 minutes due to fatigue, mainly characterised by reduced compression depth and speed. In addition, anthropometric factors such as height also affect the effectiveness of the action. Helpers with lower height tend to have difficulty achieving the appropriate compression depth, especially when working in less than ideal positions (Cheng et al., 2017). In the context of ergonomics, the use of footrests has been shown to be beneficial in improving working posture and reducing pressure on the lower back and lower extremities. Montano (2023) noted that the use of footrest can increase body stability, improve working position, and reduce the risk of fatigue and musculoskeletal injuries. The instability of the helper's position, especially when performing CPR on a bed, often compromises the quality of chest compressions. This study aims to analyze the effect of using a footrest on the quality of chest compressions during CPR simulation.

2. RESEARCH METHOD

This research is a quantitative study that focuses on numerical data analysed statistically. The research design used is quasi-experimental with a post-test only control group design approach, which is a design that compares two groups (intervention and control) after treatment is given, without providing initial measurements. The population in this study were 44 students of Ners Profession at Kusuma Husada University Surakarta.

The sampling technique used purposive sampling with normoweight criteria based on body mass index (BMI), to ensure homogeneity of physical characteristics of respondents that could affect the quality of CPR implementation. Body Mass Index (BMI) was calculated using the following formula (WHO, 2020) :

$$\text{BMI} = \frac{Body\ weight\ (kg)}{(Height\ (m))2}$$

According to WHO (2020), standards, the normal weight category is defined as having a Body Mass Index (BMI) between 18.5 and 24.9. The sample size in this study was determined using Slovin's formula as follows Sugiyono (2014) :

$$n = \frac{N}{1+N\ (e)^2}$$

where:
n = sample size
N = population size
e = margin of error (standard error), set at 10% (0.10)

Data collection was conducted using a cheklist sheet for hand-only CPR implementation. Data were analysed using the Mann-Whitney U statistical test at a 95% confidence interval and a significance threshold of (0.05).

3. RESULT AND DISCUSSION

Based on the results of the study, the following results were obtained:

Table 1. Frequency distribution of respondents' age (n=44)

No	Age	(f)	(%)
1	<25	41	93.2
2	≥25	3	6.8
	Total	44	100%

Based on Table 1, the majority of respondents were <25 years old (93.2%), while the rest were ≥25 years old (6.8%). All respondents belonged to the early adulthood group (18-44 years) according to WHO and the Indonesian Ministry of Health (2018), a phase characterised by the peak of physical and physiological maturity. Younger age is associated with more optimal physical performance in CPR, including depth, pressure, and frequency of chest compressions, as well as more effective ventilation volume (Fikriana et al., 2016; Nurkholis et al., 2023). Conversely, older age may limit the effectiveness of CPR implementation (Ardiansyah et al., 2019). The age division of <25 and ≥25 years was used to illustrate variations in physical capacity within the young adult group, particularly among university students.

Table 2. Frequency distribution of respondents' gender (n=44)

No	Gender	(f)	(%)
1	Male	0	0
2	Female	44	100
	Total	44	100%

Based on Table 2, it is known that the majority of the number of respondents who are female are 44 people (100%). In the context of CPR, several studies have shown that men have an advantage in terms of muscle strength, particularly the arms and shoulders, which impacts the depth and quality of chest compressions. However, with proper technique and stable body positioning, women can still achieve effective compression quality (Irmawati, 2019). Apart from gender, body mass index (BMI) also plays an important role in the quality of CPR. Research by Fikriana et al. (2016) and Al Afik et al. (2015) showed that individuals with normal BMI tend to have more optimal compressive power and depth of compression compared to those who are overweight or obese. An ideal BMI supports better cardiovascular and respiratory function, and reduces fatigue when performing CPR. Conversely, obesity can reduce compression effectiveness due to impaired recoil and low cardiorespiratory capacity (Chalkias et al., 2015; Santosa & Gayatri, 2019).

The majority of female respondents had a normal BMI, reflecting balanced body proportions to support effective compression. Proper technique, stable positioning and physical endurance enabled them to meet the standards for compression depth and speed. This shows that CPR effectiveness is influenced not only by biological factors, but also technical and postural skills.

Table 3. Frequency distribution of CPR quality without footrest (n=44)

No	CPR quality	(f)	(%)
1	High	18	81.8
2	Low	4	18.2
	Total	22	100%

Based on table 3, the majority of CPR without footrest is high as many as 18 respondents (81.8%). Helper fatigue is an important factor affecting the quality of chest compressions. Without the support of assistive devices, the helper experiences fatigue more quickly because they have to stabilise their own body while performing chest compressions. This is due to the increased physical load borne by the helper's muscles, especially those of the back arms and shoulders. The combination of holding the balance, maintaining a stable posture, and providing consistent compression pressure causes the helper's energy to be depleted more quickly, which risks reducing the quality of cardiopulmonary resuscitation (CPR). According to a study published in the Proceedings of the Hi-Tech Seminar, to prevent a decrease in the quality of chest compressions due to fatigue, the helper should be replaced every 5 CPR cycles. This shows that fatigue can affect the effectiveness of chest compressions, and the absence of adequate assistive devices can accelerate the onset of fatigue due to unstable positioning. In addition, a helper who fatigue can interfere with the frequency and depth of chest compressions, resulting in decreased effectiveness of CPR. Fatigue usually sets in after 1 minute of CPR without adequate support, especially if the helper must maintain compressions with optimal force and consistency. Research conducted by Alomedika et al. (2024) confirms that the stability of the helper during CPR is very important in ensuring optimal chest compression quality. The ideal helper's body position is higher than the patient's position, with straight arms and the use of body weight to provide compression pressure. Wik et al., (2015) also stated that improper body position when

performing chest compressions can cause back pain and reduce the quality of action. In addition, according to Fikriana et al. (2016), hand placement that is too low and compression depth exceeding 6 cm can pose a risk of injury to surrounding organs. The recommended compression depth is in the range of 5-6 cm, but in practice it is often too shallow. In line with this, Wahadi et al. (2022) emphasised that the depth and speed of compression are two important components in determining the quality of CPR. Effective compressions should have a minimum depth of 5-6 cm and a speed of 100-120 times per minute. Discrepancies in these two indicators can reduce the effectiveness of CPR and minimise the chance of spontaneous circulation resumption. CPR without a footrest showed good quality, but there was a decrease in five key indicators, presumably due to a lack of stability in the helper's posture, which affected the effectiveness of the compressive force, resulting in too shallow a compressive force. These findings suggest that postural alignment and the use of a footrest can support improved chest compression quality during CPR.

Table 4. Frequency distribution of CPR quality with footrest (n=44)

No	CPR quality	(f)	(%)
1	High	20	91
2	Low	2	9.0
	Total	22	100%

Based on table 4, the majority of CPR with footrest is high as many as 20 respondents (91%). According to the American Heart Association guidelines (AHA, 2020) stable posture plays an important role in maintaining compression quality during CPR. A higher and more stable position allows for more efficient pressure distribution and reduces premature fatigue in the helper. Research by Imardiani et al., (2021) found that the use of certain aids can improve the quality of cardiopulmonary resuscitation (CPR) compressions. Research by Darmawan et al. (2018) found that compression speed is influenced by the posture and stability of the helper during CPR. Research by Hwang et al. (2021) in the Resuscitation Journal also shows that the use of positioning aids can increase compression depth because it reduces the use of arm muscles that tire quickly, so that energy is more focused on the pressure generated by body weight. This study is in line with research by Smith et al. (2021) who found that the use of a step stool improved the quality of chest compressions by maintaining a more optimal compression depth.

In this study, CPR with the use of footrest, low CPR quality was still found due to inconsistency in compressions and speed when performing chest compressions. Based on the researcher's observation during the study, the quality of chest compression is influenced by the posture and stability of the helper. The use of a footrest in CPR has the potential to provide significant benefits in maintaining the quality of chest compressions by improving body position stability, reducing fatigue, and increasing the effectiveness of chest compressions. With a footrest, the helper can maintain better body balance, and reduce excessive stress on the back muscles and lower limbs. This contributes to more optimal postural stability, allowing the helper to maintain the quality of chest compressions for a longer period of time.

Table 5. Effect of Footrest Use on the Quality of Chest Compression during CPR Simulation in Ners Professional Students at Kusuma Husada University Surakarta (n=44)

	Class	Category	N	p-Value	
Post test	Control group	High : 18 Low : 4	22	Asymp. Sig. (2-tailed)	0.000
	Experiment group	High : 20 Low : 2	22		

Based on the Mann Whitney test results, the Sig-(2-tailed) value is 0.000 because the Sig value. (2-tailed) <0.05, it can be concluded that Ho is rejected and Ha is accepted. These results indicate that the use of footrest has a significant influence on the quality of chest compression during CPR simulation. According to the American Heart Association guidelines (AHA, 2020), optimal chest compression quality is achieved with a depth of 5-6 cm and a rate of 100-120 times per minute. The use of stability aids such as footrests provides better ergonomic support compared to no aids, as it helps maintain body balance, reduces fatigue, and increases the effectiveness of compression pressure. Studies by Hightower et al. (2019) and Jones (2020) showed that ergonomic interventions significantly improved compression depth and consistency. Research by Jo et al. (2020), Hong et al. (2014), and Lee et al. (2018) confirmed that the use of a step stool can maintain standardised depth,

speed, and hand placement. Nicolau et al,. (2024) also found that a higher helper position with a 90° arm angle contributes to CPR effectiveness, especially for helpers of short stature. Based on the researcher's observation, the use of footrest in this study helped respondents achieve a more stable posture, resulting in improved chest compression quality in five key indicators. This finding strengthens the evidence that footrest is an effective tool in improving the performance and quality of CPR execution.

4. CONCLUSION

The results of the study showed that during CPR without the use of a footrest, the majority of respondents demonstrated high-quality chest compressions, with 18 respondents (81.8%) in the high category and 4 respondents (18.2%) in the low category. In contrast, the use of a footrest was associated with improved chest compression quality, with 20 respondents (90%) in the high category and only 2 respondents (9.0%) in the low category. Statistical analysis revealed a significant effect of footrest use on chest compression quality, with a p-value of 0.000. Therefore, it can be concluded that the use of a footrest significantly enhances the quality of chest compressions during CPR simulations and may be considered an important factor in CPR training and implementation to improve the effectiveness of resuscitation efforts.

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