

Original Research

Correlation of Body Mass Index and The Ability to Perform High Quality Cardiopulmonary Resuscitation: Manikin Study



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Article Info	Abstract
Article history: Received: 16 February 2023 Accepted: 28 April 2023	<i>Introduction:</i> When assisting unconscious victims, the ability to perform High-Quality Cardiopulmonary Resuscitation (HQ-CPR) is critical for optimizing patient outcomes. However, many factors could contribute to achieving HQ-CPR, primarily the rescuer's BMI (body mass index). Hence, this study aimed to investigate the correlation between BMI and the ability to perform HQ-CPR.
Keywords: body mass index, cardiac arrest, cardiac resuscitation, high quality CPR	<i>Methods:</i> This study used a correlational and was conducted at the Institute of Technology, Science and Health Sciences (ITSK) of Dr. Soepraoen Malang Hospital from 25th to 26th September 2021. A total of 101 nursing students who participated in Basic Trauma Cardiac Life Support (BTCLS) training in the institute in 2021 were assigned as population. Finally, 91 eligible participants were recruited using a purposive sampling technique. Their BMI and the ability to perform HQ-CPR was studied as the independent and dependent variable, respectively. <i>Results:</i> The Kolmogorov-Smirnov correlation test analysis yielded a p-value of 0.000, indicating a correlation between BMI and the ability to perform HQ-CPR. <i>Conclusion:</i> These findings supported the notion of the effect of BMI on the ability to execute HQ-CPR procedures. Mildly obese, severely obese, and severely underweight individuals were less likely to perform HQ-CPR compared to healthy or mildly obese individuals. HQ-CPR is highly required to be maintained in the first two minutes by rescuers with normal BMI. BMI posed a crucial role in fitness level and was associated with the weariness level of an individual.

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INTRODUCTION

Out-of-hospital cardiac arrest (OHCA), one of the top causes of death in developed nations each year, has claimed about one life per 1000 individuals [1]-[4]. Enhancing the standard of cardiopulmonary resuscitation (CPR) is the most crucial strategy for lowering this fatality rate [5]-[9]. It is well established that making small adjustments to CPR techniques, such as using an adequate compression rate, performing adequate compression depth, allowing the chest to recoil, limiting compression interruptions, and avoiding excessive breathing, will improve survival rates [5]-[9].

The outcomes of CPR are majorly depended on its quality. It was broadly documented that High-quality CPR (HQ-CPR) was the cornerstone to achieving Return of Spontaneous Circulation (ROSC) in the resuscitation procedure [5], [6], [8]. In many cases, rescuers (compressors) can deliver HQ-CPR only in the initial cycles. As the cycles continue, the quality of CPR commonly declined [10], [11]. Whereas HQ-CPR is the basis of the cardiac arrest treatment algorithm, the provision of HQ-CPR will increase the survival rate of patients twice or even three times [5], [12]. A survey conducted in 2009 demonstrated that the majority of health professionals (75%) perceived themselves owned adequate HQ-CPR skills, but in reality, only 26% were able to maintain HQ-CPR. Even worse, 55% of them did not fully aware of their perfunctory CPR [8].

It has been emphasized elsewhere that anthropometric variables impacted the quality of CPR [13]-[16]. Several studies

discussed the effect of anthropometric parameters on CPR quality, including weight, height, physical fitness, and muscle strength [17][18]. Anthropometric variables may affect the depth of chest compressions [14][17][19]. In particular, underweight rescuers were less likely able to perform compressions with adequate depth. Consequently, they may require special attention during CPR training due to their weight [15]-[19]. On the other hand, there were no data on how anthropometry variables influence chest recoil [13]. Thus, we aimed to compare data that may impact CPR quality based on Body Mass Index (BMI) parameters by using manikins.

METHODS

This study enrolled a correlation design involving all sixth-semester nursing students in the Institute of Technology, Science and Health Sciences (ITSK) of Dr. Soepraoen Malang Hospital who participated in Basic Trauma Cardiac Life Support (BTCLS) training in 2021 as study population, with a total of 101 students. Ninety-one eligible participants who met the inclusion and exclusion criteria were recruited in this study using the purposive sampling method [20]. The inclusion criteria were participating in BTCLS training at ITSK Dr. Soepraoen Hospital in 2021, partaking in CPR training, and voluntarily willing to be documented. All students with improper CPR documentation were excluded from the study. The independent and dependent variable was the body mass index (BMI) and the ability to perform HQ-CPR, respectively. This study was

conducted at the Nursing Study Program of the Institute of Technology, Science and Health Sciences (ITSK) of Dr. Soepraoen Malang Hospital from September 25th-26th, 2021. Univariate and bivariate statistical analysis was employed to analyze the data [20]. Univariate tests were applied to describe the BMI and HQ-CPR performance data. The bivariate test was subsequently conducted using the Kolmogorov-Smirnov correlation test with $\alpha = 0.05$ [20][21]. The study ethical approval has been granted by a letter Number 041/KEPK-POLKESMA/ 2021.

RESULTS

Table 1 reveals that the median age of the participants was 21 years, with an average of 21.71 years (20-33 years). In the height and weight category, the median value was 159 cm with an average of 158.42 cm (140 -179 cm) and 57 kg with a mean of 60.76 kg (37-131 kg), respectively. Further, according to Table 1, the median BMI was 23, with a mean of 24.01 (15-44). Most participants were female (71 or 78%) and had a normal BMI of

40 or 44%.

Furthermore, result shows that 75 participants (82.4%) performed chest compressions at a 100-120x/minute rate. Most participants also had adequate skills in executing chest recoil (59;64.8%). Sixty participants (65.9%) performed adequate depth of compression (2 inches). In the category of minimal interruption, nearly all respondents were performing minimal interruption properly (74;81.3%). Most participants also achieved a compression ratio of 30:2 (78; 85.7%). From the overall assessment, most participants had performed high quality-CPR procedures (49; 53.8%).

The crosstabulation analysis in Table 2 signified that an individual with a normal or slightly thin BMI category managed to perform HQ-CPR better compared to an individual with a mildly obese, severely obese, and severely thin BMI category. Table 3 revealed findings from the Kolmogorov-Smoirnov test that found a p-value of 0.000. This finding signified a correlation between BMI and ability to perform HQ-CPR.

Table 1

Participant's Demography Characteristics Based on Age, Gender, Height, Weight, and BMI

Variable	Mean	Median	Min	Max	n	%
Age	21.71	21	20	33		
Height ± Body Weight	158.42±60.76	159±57	140±37	179±131		
Gender						
Male ± Female					20±71	22±78
BMI Category						
Severely Thin					5	5.5
Slightly Thin					14	15.4
Normal					40	44
Mildly Obese					8	8.8
Severely Obese					24	26.4
Total					91	100

Table 2

Crosstabulation Analysis of BMI Category and Ability to Perform HQ-CPR

		Criteria of HQ-CPR Performance		Total
		Yes	No	
BMI Category	Severely Thin	1	4	5
	Slightly Thin	8	6	14
	Normal	35	5	40
	Mildly Obese	4	4	8
	Severely Obese	1	23	24
Chest Compression (100-120 x/min)				
BMI Category	Severely Thin	5	0	5
	Slightly Thin	14	0	14
	Normal	40	0	40
	Mildly Obese	7	1	8
	Severely Obese	9	15	24
Chest Recoil				
BMI Category	Severely Thin	1	4	5
	Slightly Thin	9	5	14
	Normal	35	5	40
	Mildly Obese	6	2	8
	Severely Obese	8	16	24
Depth of Compression (2 inches)				
BMI Category	Severely Thin	1	4	5
	Slightly Thin	8	6	14
	Normal	36	4	40
	Mildly Obese	6	2	8
	Severely Obese	9	15	24
Minimum Interruption				
BMI Category	Severely Thin	4	1	5
	Slightly Thin	12	2	14
	Normal	40	0	40
	Mildly Obese	6	2	8
	Severely Obese	12	12	24
Compression and Respiration Ratio (30:2)				
BMI Category	Severely Thin	4	1	5
	Slightly Thin	14	0	14
	Normal	40	0	40
	Mildly Obese	7	1	8
	Severely Obese	13	11	24

Table 3

Kolmogorov Smirnov Non-Parametric Test Results

		HQ-CPR Performance		Total	P value
		Yes	No		
BMI	Severely Thin	1	4	5	0.000
	Slightly Thin	8	6	14	
	Normal	35	5	40	
	Mildly Obese	4	4	8	
	Severely Obese	1	23	24	
Total		49	42	91	

DISCUSSION

Findings signified that the ability to perform HQ-CPR was associated with Body Mass Index (BMI) classifications. An individual with a normal weight and mild obesity was more likely to perform HQ-CPR than an individual with mild and severe obesity or a severely underweight individual. CPR rescuers with normal BMI were more likely to maintain HQ-CPR in the first two minutes during the resuscitation procedure.

HQ-CPR refers to a proper resuscitation technique characterized by adequate compression depth and speed, full chest recoil, minimal interruption, and good ventilation control. The desired outcome of this procedure is ROSC [5]. AHA recommends compressing the chest at least two inches (five centimeters) [2][3], and the compression procedure have changed to the priority of bypassing the airway. The compression depth must be appropriately adjusted to assure the proper oxygen circulation in the blood vessels through the compression pressure on the heart between the sternum and spinal bone, delivering an effective resuscitation and generating optimal cardiac output [6]. Further, AHA suggested that the recommended rate of CPR is at least 100 times/minutes. This recommendation originally derives from the average pulse of healthy adults of 80x/minutes. Cardiac perfusion in cardiac arrest patients is inadequate, thus a higher rate is required to achieve a decent perfusion rate and maintain minimal circulation until the heart can return to function [2]. Minimal interruptions are also suggested in HQ-CPR to maintain blood

circulation to the heart and brain. Frequent and long interruptions will reduce this blood flow. In line with this recommendation, a study conducted by Edelson (2006) also mentioned that more than ten seconds of interruption during CPR will increase the risk of shock [6][14]. Complete recoil is also crucial to give a relaxation period after the contraction. The recoil process is beneficial to increase venous return to the heart. Poor recoil would result in ineffective compression because of the inadequate blood pumped [2].

These four components (depth, speed, recoil, and interruption) may sound and look superficial, but they are not. A survey conducted in 2009 showed that most healthcare workers (75%) perceived that they had decent HQ-CPR skills, but in reality, only 26% performed HQ-CPR. Even worse, 55% of them did not fully aware of their perfunctory CPR [15]. There were common disadvantages in manual compression (by humans), such as inconsistent speed and depth. These drawbacks may occur due to physical fatigue factors considering that HQ-CPR requires much energy [5].

This finding was parallel to previous studies [15]-[19] that demonstrated a significant correlation between BMI and the attainment of recommended compression depth in CPR procedures [17]. Compression depth during CPR could be influenced by the strength generated from both arms and the rescuers' fitness factor [11]. The healthy BMI is ranged within the normal limits. Rescuers with a normal or ideal BMI are more likely to deliver adequate compression power and depth in line with the predetermined standard of > 5 cm [18]. In addition, the

healthy physiological status would also influence fitness and fatigue levels [10]. A person with an ideal BMI tends to be able to show better physical endurance due to healthier organ functions, especially the heart and lungs [19]. Thus, the healthier an individual generally is, the higher chance they get to achieve proper compression depth [17].

In addition, CPR procedures that are performed in two minutes or five cycles demand a lot of energy, signifying the role of fitness factors in HQ-CPR [10][11]. A higher BMI or obesity will affect the physical endurance in performing adequate chest compressions [19]. Obese individuals have a lower cardiorespiratory function that eventually reduces their fitness and triggers exhaustion [17]. This finding was also parallel with previous studies that mentioned compression power from an individual with a higher BMI was more likely to achieve poor outcomes. This situation may attribute to their poor cardiorespiratory function compared to those individuals with ideal body mass index [16].

AHA 2020 Guidelines also mentioned the team approach as a recommendation to improve HQ-CPR delivery during resuscitation [6]. There were several backgrounds to employ this approach. Practically, HQ-CPR requires a lot of energy, requires consistent stamina, and burns 322 kcal per hour, which may lead to extreme physical exhaustion among the rescuers. The factor of fatigue has been stated broadly as an aspect that influences poor HQ-CPR performance. They may deliver the first and second cycles adequately, however as the cycles continue, the quality of CPR provided

may decrease [8]. With a team approach, the compressors can be alternated, as the Resuscitation Academy Guidelines suggested that compressors should be alternated every two minutes [9].

CONCLUSION AND RECOMMENDATION

The Kolmogorov-Smoirnov statistical analysis obtained a p-value of 0.000 that indicated an association between BMI and the ability to perform HQ-CPR. Thus, an emergency situation demanded HQ-CPR procedure ideally involves rescuers with normal BMI. Additionally, a sufficient team approach and synergy are highly required to improve or maintain HQ-CPR during cardiac resuscitation procedures.

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CONFLICT OF INTEREST

The authors have no conflict of interest to declare.

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