

Correlation between physical features of elementary school children and chest compression depth

小學兒童身體特徵與壓胸深度間的關係

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Introduction: The height and body weight of 6th grade elementary school children may have influence on chest compression. **Materials & methods:** In accordance with the 2005 American Heart Association guidelines and 2006 Korean Association of CardioPulmonary Resuscitation (CPR) guidelines, a 25-minute audiovisual presentation and practical demonstration of CPR were presented by the researchers and assistants. The assistants supervised and corrected the practical performance of the students who performed 5 cycles of CPR (2 minutes each) with the aid of the Laerdal Resusci® Anne SkillReporter™. The students then carried out another 5 cycles of CPR (2 minutes each) using the skill reporter; and a short report was printed. **Results:** The correlation coefficient between body weight and chest compression was 0.467 ($p=0.000$), and the correlation coefficient between height and chest compression was 0.309 ($p=0.009$). The intercept between body weight and chest compression was 21.763 ($p=0.000$), and the slope was 0.324 ($p=0.000$). Student height showed no linear correlation with chest compression depth. **Conclusions:** The body weight of 6th grade elementary school children showed moderate correlation with chest compression depth. A minimal body weight of 50 kg is required to attain a standard chest compression depth of 38 mm. With improved training, some students with body weight less than 50 kg may also achieve satisfactory performance of CPR. (*Hong Kong j.emerg.med.* 2010;17:218-223)

引言：小學6年級兒童的高度及體重可能會影響壓胸。**材料及方法：**根據2005年美國心臟協會指引及2006年韓國心肺復甦協會指引，研究員及助手進行25分鐘的視聽描述及實際示範心肺復甦法。學生進行5個循環的心肺復甦法（每個兩分鐘），而助手以挪度的「復甦安妮技巧記錄器」幫助，指導及糾正學生的實習表現。學生其後使用技巧記錄器進行另5個循環的心肺復甦法（每個兩分鐘），及打印簡短報告。**結果：**體重及壓胸的相關系數為0.467（ $p=0.000$ ），而高度及壓胸的相關系數為0.309（ $p=0.009$ ）。體重及壓胸間的截距為21.763（ $p=0.000$ ），而斜度為0.324（ $p=0.000$ ）。學生的高度與胸壓深度沒有直線的關係。**結論：**六年級小學兒童的體重與壓胸深度顯示有中度的關係。最少需要體重50公斤以達成標準的38毫米壓胸深度。如增加訓練，一些體重少於50公斤的學生亦可達到心肺復甦法滿意的表現。

Keywords: Body height, body weight, cardiopulmonary resuscitation

關鍵詞：體高、體重、心肺復甦法

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Introduction

Cardiopulmonary resuscitation (CPR) supplies oxygen to the vital organs of the body through the maintenance of respiration and blood circulation. Vascular circulation in a cardiac arrest victim may be recommenced by direct external compression of the chest with the patient in the supine position. CPR is an emergency care measure that delays brain and cardiac death through reperfusion and resumption of oxygen supply after cardiac arrest. Because advanced cardiopulmonary life support can improve the rate of survival for victims of cardiac arrest, CPR education for the general public is important. In Korea, the average ambulance arrival time after an emergency call is 7.7 minutes, and the average time to reach the hospital is 24.6 minutes.¹

In Korea, the law on emergency medicine was established in 1995. The law designates ambulance drivers, bus drivers, public health teachers and policemen as CPR practitioners.² Approximately 26,900 of these have passed the basic life support (BLS) provider course.^{3,4} Due to a shortage of qualified lecturers and equipment, no BLS provider courses have been given in elementary schools, middle schools, or high schools in Korea. Van Kerschaver et al⁵ stated that CPR courses for students were very effective, and that BLS courses should be taught as a basic skill for children over the age of 11 years. Lester et al⁶ showed that there was no correlation between knowledge of CPR and practical CPR skills; however, they stated that middle school students were of an appropriate age to attend BLS courses. Uray et al⁷ stated that attendance in a BLS course should be a prerequisite for children 6-7 years old. Lubrano et al⁸ described a BLS course program for 8-11 year-old students. Data from a comparison of CPR skills between 5th and 6th grade elementary school children and adults suggested that understanding of CPR theory was better in elementary school children. However, because their body size was smaller than that of adults, practical CPR competency was insufficient in these students. Therefore, the outcome of the practical test is dependent on the body build of the students.⁹ Body build is dependent on sex, height, and body weight.

Height and body weight may affect the depth of chest compression during CPR.

We hypothesized that height and body weight of 6th grade elementary school children were correlated with chest compression depth, and, therefore, CPR performance.

Materials and methods

Subjects

The duration of this study was from 1st April to 27th May 2008. Eulji University Emergency Medical Safety Education Institute provided 19 Seongnam City Children Safety Education courses to 1,778 6th grade elementary school students. The course consisted of safety education and emergency care education; and its duration was 120 minutes. Of the 1,778 students, 586 (6 courses) received instruction from the researchers. Among the 586 students, 71 were selected at random by their teachers for this study.

Methods

The researchers explained the aim of the study to the teachers prior to each CPR course. For each course, the teachers selected approximately 12 students who were willing to perform CPR on mannequins. The researchers obtained informed consent from each student and teacher (for minor consent). Student names and the names of the schools were deleted when the data were analysed. Data on chest compression, ventilation rate, CPR cycle, speed, and accuracy were used in the analysis. The students were free to stop attending the CPR course or to withdraw from participation. The attendees were provided with writing tool sets as a reward for participation in the course. In accordance with the 2005 American Heart Association (AHA) guidelines¹⁰ and 2006 Korean Association of CardioPulmonary Resuscitation guidelines,¹¹ a 25-minute audiovisual presentation and a practical CPR demonstration were presented by the researchers and assistants. The assistants supervised and corrected the practical performance of the students, who performed 5 cycles of CPR (2 minutes each) with the aid of the Laerdal Resusci® Anne SkillReporter™

(Figure 1). After a specified period of time, the students carried out another 5 cycles of CPR (2 minutes each) using the skill reporter; and a short report was then printed. A total of 44 students performed chest compression only without artificial ventilation, and 27 students performed chest compression with artificial ventilation through disposable face-shields.

Research tools

Park et al⁹ reported that sufficient chest compression was achieved by 9% of 5th to 6th grade elementary school children and 61% of the adults. It has been suggested that height and body weight might affect chest compression depth. Height (cm), body weight (kg), sex, and birth date of the participants were recorded before CPR was performed. The Laerdal Resusci® Anne SkillReporter™ was used for assessment of CPR performance. In accordance with the American and Korean guidelines, chest compression depth and artificial ventilation were set to 38-50 mm and 500-600 ml. The limit of inflation volume was between 700-1,000 ml (Cat. No. 152250).

Statistics

Body weight, height, chest compression depth, and artificial ventilation were reported as mean, median, and standard deviation. The depth of chest compression was compared (1) between the two groups with chest compression only and chest compression



Figure 1. Data collected by using Laerdal Resusci® Anne SkillReporter™.

plus ventilation, (2) between genders using t test, and (3) among the different genders with chest compression only and chest compression plus ventilation using ANOVA. Regression techniques were used for analysis of the relationship between depth of chest compression and body weight and height. A p value <0.05 was regarded as a statistically significant difference. SPSS for Windows 11.0 was used for data analysis.

Results

The researchers demonstrated CPR to 71 children (45 boys and 26 girls, 11 students in 1 course and 12 students in each of the other 5 courses) in this study. The mean age was 11.6 years, mean height was 151.6 cm, and mean body weight was 44.5 kg. The mean chest compression depth was 36.2 mm, the mean artificial ventilation volume was 511.1 ml, and 36 children (50.7%) achieved the standard chest compression depth of 38 mm as recommended by the AHA guidelines (Table 1) (Figure 2).

The compression depth was greater in the "compression only" group (36.5 mm) when compared with the "compression with ventilation" group (35.7 mm). The difference was not statistically significant ($p=0.61$). Boys (37.0 mm) achieved deeper chest compression than girls (34.7 mm), however, the difference was not statistically significant ($p=0.133$) (Table 2). Among the four groups between genders with chest compression only and with chest compression plus ventilation, boys who performed compression only had the deepest compression depth (38.2 mm). However, the difference among the four groups was not statistically significant ($p=0.241$) (Table 3).

The correlation coefficient between body weight and chest compression was 0.467 ($p=0.000$) and the correlation coefficient between height and chest compression was 0.309 ($p=0.009$). Body weight and height showed moderate correlation with compression depth, and the shared variance between body weight and chest compression was 0.218 (equals R squared) (Table 4) (Figure 3).

Table 1. Physical characteristics of participants and their compression depths and ventilation volumes

	Mean	Standard deviation	Median	Minimum	Maximum
Age	11.6	0.59	11.7	10.3	12.3
Height (cm)	151.6	6.50	152.2	131.3	170.1
Weight (kg)	44.5	9.28	42.7	27.1	69.9
Average depth (mm)	36.2	6.44	38.0	14.0	44.0
Average ventilation volume (ml)	511.1	100.24	490.0	390.0	730.0

Table 2. Comparison of compression depth between different CPR modes and different genders

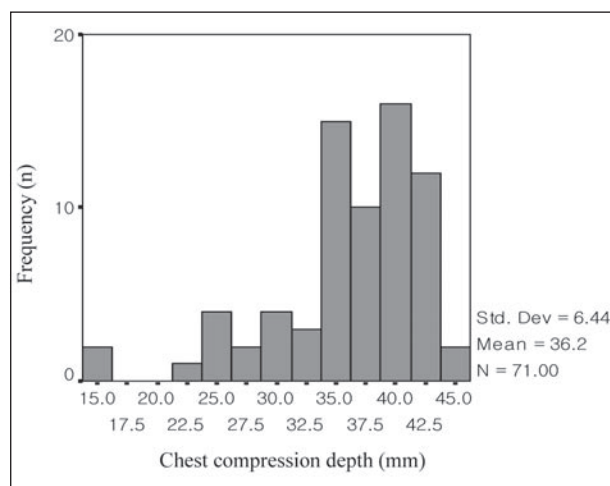
	n	Mean depth (mm)	Standard deviation	Difference	t	p value (two-tailed)
Compression + ventilation	27	35.7	6.65	-	-0.512	0.610
Compression only	44	36.5	6.37	+0.8		
Boys	45	37.0	5.60	+2.3	1.521	0.133
Girls	26	34.7	7.55	-		

Table 3. ANOVA of compression depth according to different CPR techniques and genders

		n	Mean depth (mm)	Standard deviation	F	p value
Compression + ventilation	Boys	20	35.7	6.93	1.433	0.241
	Girls	7	35.7	6.26		
Compression only	Boys	25	38.2	4.08		
	Girls	19	34.3	8.10		

Table 4. Correlations between compression depth and participants' physical characteristics

	R	R ₂	Adjusted R ₂	Standard error	p value (two-tailed)
Weight	0.467	0.218	0.206	5.736	0.000
Height	0.309	0.096	0.082	6.168	0.009

**Figure 2.** Histogram of compression depth.

Linear regression analysis showed that the intercept between body weight and chest compression was 21.763 ($p=0.000$) and the slope was 0.324 ($p=0.000$). The rescuer is summarised according to the following equation: compression depth (mm) = 21.763 + 0.324 x weight (kg) (Table 5 and Figure 3). On the other hand, no linear relationship was observed between body height and chest compression depth (Table 6) (Figure 4).

Discussion

Lester et al emphasized the importance of CPR education for the public and elementary school

students.¹² However, there has been no consensus on the age at which CPR education should begin. Van Kerschaver et al⁵ suggested the age of 11 years as the best age for training people between the ages of 11 and 23 years. Uray et al⁷ proposed an optimal age of 11 years on the basis of motivation to develop an understanding of CPR. Lester et al⁶ also suggested an optimal age of 11 years. Lester distinguished between CPR theory and practice but did not observe a correlation between physical features and performance of chest compression.

Park et al⁹ showed that physical features might affect performance of CPR and chest compression in 5th to 6th grade elementary school children.

In these studies, physical features of the students were important for effective chest compression and artificial ventilation. This study examined the correlation between physical features and chest compression in 11-year-old elementary school children using the Laerdal Resusci® Anne SkillReporter™.

Table 5. Linear regression analysis between compression depth and weight of students

Weight	Un-standardised coefficients		Standardised coefficients	t	p value (two-tailed)
	B	Standard error	Beta		
	21.763	3.358	–	6.482	0.000
	0.324	0.074	0.467	4.382	0.000

Table 6. Linear regression analysis between compression depth and height of students

Height	Un-standardised coefficients		Standardised coefficients	t	p value (two-tailed)
	B	Standard error	Beta		
	-10.209	17.196	–	-0.594	0.555
	0.306	0.113	0.309	2.699	0.009

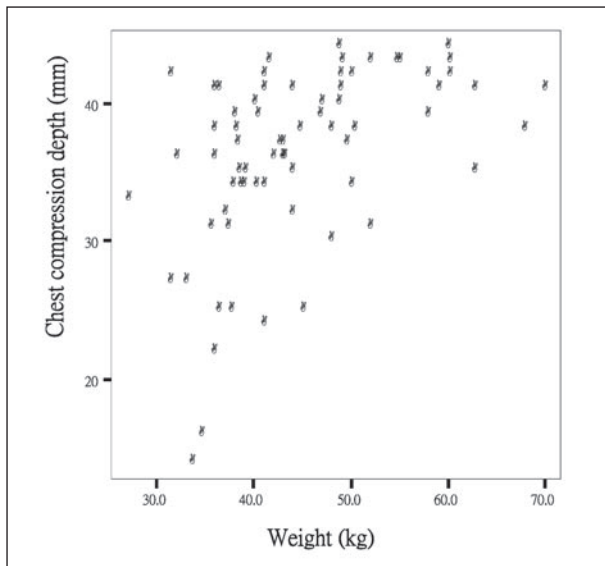


Figure 3. Scatterplot between body weight and chest compression depth.

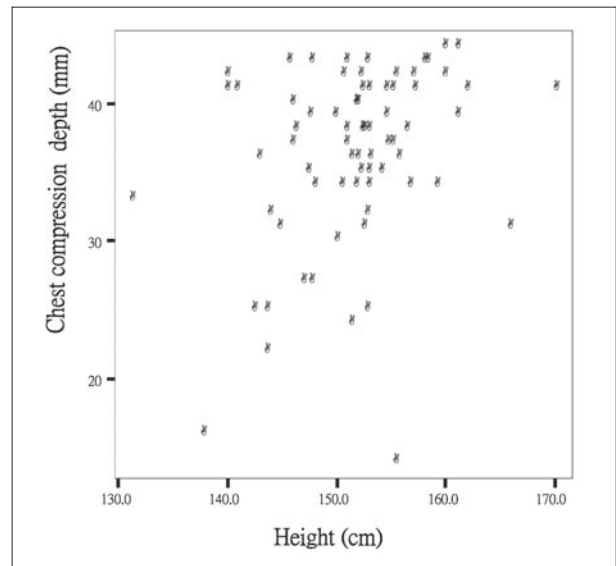


Figure 4. Scatterplot between height and chest compression depth.

The mean chest compression depth was 36.2 ± 6.44 mm, which is close to the chest compression depth recommended by the 2005 American Heart Association Guidelines for cardiopulmonary resuscitation and emergency cardiovascular care (38 mm).¹⁰ The mean artificial ventilation volume was 511.1 ml, which is within the range of the recommended ventilation volume (500-600 ml). These findings supported the suggestions of Van Kerschaver et al⁵ and Lester et al⁶ on the optimal starting age for CPR education.

No statistically significant difference was observed between the group performing compression only and the group performing compression with ventilation, even when gender was taken into consideration. No linear relationship was noted between chest compression depth and body height.

Linear regression analysis showed that a minimal body weight of 50 kg was required to achieve a standard chest compression depth of 38 mm. It may be possible for some children weighing less than 50 kg to perform effective chest compression. As a matter of fact, rescuers of lower body weight can perform CPR for infants and children.

One limitation of the study is that the duration of effective chest compression was not evaluated. Determination of any correlation between chest compression depth and duration of chest compression or duration of chest compression plus artificial ventilation in elementary school children will be informative. Furthermore, ventilation and chest compression might be affected by CPR proficiency and familiarity with the mannequin; however, this was not investigated in this study.

Conclusions

A 25-minute audiovisual presentation and CPR demonstration using the Laerdal Resusci[®] Anne SkillReporter[™] was presented to 71 boys and girls at six elementary schools in Seongnam City. Both the body weight and height showed moderate correlation

with chest compression depth, and body weight for effective chest compression is at least 50 kg. However, with better training and improved knowledge of CPR, children with a body weight below 50 kg may be able to perform effective CPR, in particular if the cardiac arrest victim happens to be an infant or a small child.

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