Defining the Optimal Age for Basic Life Support and Cardiac Compression Training in Thai Adolescents

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Objective: *To determine the optimal age ranges for implementing basic life support and chest compression course in Thai adolescents.*

Material and Method: *This was a cross sectional study in a secondary school in Khon Kaen, Thailand. Participants were divided into three age groups (13 to 14, 15 to 16, and 17 to 18-year-old groups). Every age group attended basic life support lecture and chest compression practice. Performance of each student was evaluated by practical examinations with the manikins and multiple-choice questions. Data were analyzed in descriptive and multiple logistic regression models by STATA program version 10.*

Results: *Two hundred seventy five students were enrolled. There were 118 males (43%). There were 99, 96, and 80 participants in age group 13 to 14, 15 to 16, and 17 to 18-year-old, respectively. Mean score differences between pre- and post-test significantly increased in all age groups. More than 50% of trainees achieved quality chest compression after training by experienced healthcare providers in all age groups (52.2% in 13 to 14 years, 52.5% in 15 to 16 years, and 65.0% in 17 to 18 years). Men had significant higher rates of quality chest compression compared to women after adjusted for age and body mass index.*

Conclusion: *Thai adolescents in age groups of 13 to 14, 15 to 16, and 17 to 18-year-old can perform quality chest compression in similar success rates after theory lecture and hand-on training. Basic life support and chest compression course can be initiated at the age of thirteen.*

Keywords: *Cardiac life support, Cardiopulmonary resuscitation, High school students, Curriculum*

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Out of hospital cardiac arrest (OHCA) is a crucial emergency condition. It is a leading cause of death in many countries[1]. In United States of America, there are 300,000 OHCA patients per year[2]. However, only small number of patients survived (7.6 to 7.9%) [3,4]. Fifty to 75% of OHCA happened at home. The first bystanders were their own relatives[4,5]. Unfortunately, less than 1% of population can do basic life support (BLS) properly[6].

American Heart Association (AHA) proposed that, if 20% of world population can do BLS, survival rate would significantly increase[7]. Many countries embedded BLS as a part of national school curriculum[8,9]. A study in England found that 13- to 14-year-old children could do chest compression in the same quality as adults[10]. Sex, age, and body mass index (BMI) were associated factors[10-13]. BLS courses have been implemented in Thai-adult healthcare providers or village heath volunteers but have not been officially established for adolescents. Furthermore, there was no study that identifies optimal age for teaching BLS and cardiac compression in Thai adolescents. To extrapolate results of Caucasian with Asian adolescents may not be appropriate since body built of Asian or Thai adolescents are generally smaller and BMI were lesser than Westerners.

The aim of the present study was to determine the optimal age ranges for implementing BLS and chest compression course in Thai adolescents.

Objective

To determine the optimal age ranges for implementing BLS and chest compression course in Thai adolescent.

Material and Method

This was a cross sectional study. The setting was at the Demonstration School of Khon Kaen University, Khon Kaen, Thailand between September 4, 2014 and January 23, 2015.

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The study was approved by the Ethical Committee of Khon Kaen University in April 2014. All participants and advisory teachers signed inform consents before enrolled to the study.

The participants were secondary school students. Cluster random sampling was used to choose classrooms. From the sample classrooms, students were divided into three age groups, 13 to 14, 15 to 16, and 17 to 18-year-old.

The inclusion criteria was students aged between 13 and 18-year-old. We excluded students who had underlying diseases that could affect in learning chest compression, students who were not willing to participate, and students who withdrawn from study prematurely.

Sample size calculation for multiple logistic regression analysis was done. For a type-I error of 0.05 and 80% power, we required 273 subjects based on method proposed by Hsieh[15] to be able to detect a 50% increase in effective BLS learning in every increasing year of age.

Material used for BLS and chest compression course were 1) standard BLS slide set, knowledge according to 2010 AHA Cardiopulmonary Resuscitation guidelines, 2) BLS Manikins (Resusci® Anne Modular System Torso SkillReporter™), and 3) multiple-choice questions (pre- and post-study examination).

Operating definitions

Factors that determined quality chest compression consisted of right position (at sternal area, half way between nipple line), depth (2 inches depth, there was a sensor built in each manikin that detected the depth of each compression and printed the results), and optimum rate (more than 100 times per minute, there was a sensor built in each manikin which detected each compression and printed the results).

Quality chest compressions in the present study meant all of three factors above were achieved at least 80% of total chest compressions.

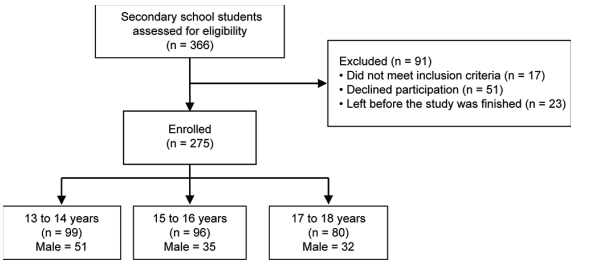

Fig. 1 Study populations.

Results

Three hundred sixty six students enrolled in the study. Fifty-one students did not give inform consents, 17 students did not meet inclusion criteria and 23 students withdrew themselves from the trial prematurely. Therefore, 275 participants enrolled for statistical analysis. Forty-nine percent were male. There were 99, 96, and 80 participants in 13 to 14, 15 to 16, and 17 to 18-year-old groups consecutively (Fig. 1). Mean weight was 58.0±13.6 kg, mean height was 1.63±0.08 m, mean BMI was 21.6±4.2 kg/m^2. Minimal number of students had taken prior BLS courses (6%). Some of students had experienced family member died of cardiac diseases (11%).

Pre-test scores of students in 13 to 14, 15 to 16, and 17 to 18-year-old groups were less than half of total score (14 points); 6.1±1.9, 6.8±1.8, and 7.1±2.5 points, respectively. The post-test scores were improved in all age groups (11.0±2.0, 12.5±1.3, and 12.5±1.3 points, consecutively). Mean differences of pre-test and post-test scores (post-test minus pre-test scores) were also significantly increased in all age groups (Table 1). The ability of theory learning was significantly better according to the mean difference of all participants, which was 5.1 points (95% CI 4.78, 5.34; p<0.001) (Table 1). Participants were asked about their confidence in doing chest compression, 47% felt confident before learning and 63% felt confident after learning. After practicing, 236 students

Table 1. Pre-test and post-test scores according to age groups

Age groups (years)	Pre-test score (mean ± SD)	Post-test score (mean ± SD)	Mean difference	95% CI
13 to 14 (n = 99)	6.1±1.9	11.0±2.0	4.89	4.38 to 5.40*
15 to 16 (n = 96)	6.8±1.8	11.8±1.6	4.99	4.52 to 5.46*
17 to 18 (n = 80)	7.1±2.5	12.1±1.3	5.38	4.90 to 5.85*
All groups (n = 275)	6.7±1.9	11.7±1.8	5.06	4.79 to 5.35*

CI = confidence interval
Total scores were 14, * p-value <0.001

(85.8%) did chest compression at the proper body site, 172 students (62.5%) did chest compression at the right depth (2 inches) and 255 students (92.7%) did chest compression at the correct rate (greater than 100 beats per minute). More than half of students accomplished quality chest compression after practicing (57.1%). Divided by age groups, there were 52.5%, 55.2%, and 65% of students accomplished quality chest compressions in 13 to 14, 15 to 16, and 17 to 18-year-old groups, respectively (Table 2). Fifty-five percent of male students and 44% of female students performed quality chest compression.

Male students performed 3.49 times higher of quality chest compression than female (95% CI 2.08, 5.85; $p<0.001$). Every 1 kg/m^2 increasing of BMI was associated with quality chest compression (OR 1.07; 95% CI 1.01, 1.13; $p = 0.023$). However, GPA and prior chest compression learning were not associated with quality chest compression (OR 1.09; 95% CI 0.79, 1.51; $p = 0.573$ and OR 2.57; 95% CI 0.81, 8.10; $p = 0.106$, respectively).

From multivariable analysis of sex, age, BMI, and post-test scores, male sex was the only factor that significantly associated with quality chest compression performance, adjusted OR by age, scores, and BMI (OR 3.80; 95% CI 2.21, 6.54; $p<0.001$). However, age was not the factors that influenced quality chest compression after adjusted by sex, scores, and BMI (Table 3).

Discussion

The AHA proposed that the higher number of world population who can do BLS, the higher survival rate would significantly increase[7]. This is one of the reasons that BLS and chest compression courses have been embedded to school curriculum in many countries[8,9,14]. A study in England found that 10 to 12-year-old students have ability to learn theory of BLS by lecturing, determined by increasing of post-test scores after teaching[6]. The results were consistent with the present study, mean difference of scores (post-test minus pre-test scores) significantly increased in all age groups. This showed that theory about BLS and chest compression can be understood by students as young as seventh grade (13 years old).

In the practical part of the BLS and chest compression course, we found that the majority of students in every age group had ability to perform quality chest compression, determined by accomplishment of three factors according to the AHA criteria including right position, 2-inch depth, and rate greater than 100 time/minute more than 80% of entire compressions. Over 50% of members of each groups can perform quality chest compression. The rate was higher than the study of Meany et al, which showed that 65% of adult trainees still required additional skills remediation to pass the course using AHA criteria after practice[16]. According to prior studies involved chest compression training in adults, we determined succeed of BLS and chest compression training by using criteria of more than half of subjects passed chest compression test after learning. We concluded that Thai children from age of 13-year-old could do chest compression after practice under supervision of experienced healthcare workers. Similarly, the study of Jones et al[10], which BLS was taught in students aged 9 to 10, 11 to 12, and

Table 2. Quality chest compression rate according to age groups

	Age groups (years)			
	13 to 14 (n = 99)	15 to 16 (n = 96)	17 to 18 (n = 80)	All groups (n = 275)
Male sex, n	51	35	32	118
Correct hand placement, n (%)	82 (82.8)	82 (85.4)	72 (90.0)	236 (85.8)
Correct compression depth, n (%)	59 (59.6)	57 (59.4)	56 (70.0)	172 (62.6)
Correct compression rate, n (%)	96 (97.0)	83 (86.5)	76 (95.0)	255 (92.7)
Correct compression rate , n (%)	52 (52.5)	53 (55.2)	52 (65.0)	157 (57.1)

Table 3. Factors associated with quality chest compression by multivariable analysis

Factors	n	Quality chest compression, n (%)	Unadjusted OR	95% CI	*p*-value	Adjusted OR	95% CI	*p*-value
Female	157	70 (44.59)	1	-	-	1	-	-
Male	118	87 (55.41)	3.48	2.08, 5.85	<0.01	3.80*	2.21, 6.54	<0.001
BMI (every +1 kg/m^2)	N/A	N/A	1.07	1.01, 1.13	0.023	1.06	0.99, 1.13	0.066

CI = confidence interval; OR = odds ratio; BMI = body mass index; N/A = not applicable

13 to 14-year-old, they found that students younger than 13-year-old could not perform chest compression at the same quality as adults. Only 13 to 14-year-old groups could perform quality chest compression[10]. This may due to limitation of physical strength in children. However, to conclude that thirteen is the optimal age to teach BLS and chest compression would require more specific research.

A few trials showed that sex, age, and BMI were important factors that affect quality of chest compression[10-13]. However, in the present study we found that only male sex had significant higher rate of quality chest compression after adjusting for other factors. Fleischhackl et al[13] also found that male students at age of 9 to 18-year-old could perform chest compression at the proper depth (2 inches) and significantly better than female students at the same age. This could be explained by higher muscle mass in male sex. In the present study, we did not measure muscle mass. Further study should explore this factor.

BLS training was not prominent in Thai school curriculum. From our interview, only 6.1% of students had learned BLS prior to participate in the present study. BLS course, including theory lectures and practical part, for students as young as 13-year-old was proved possible. Early BLS and chest compression teaching could improve survival rate of cardiac arrest patients.

Conclusion

Students aged 13- to 18-years-old have similar ability to learn and perform quality chest compression. More than 50% of students understood theory of BLS and accomplished quality chest compression.

BLS and chest compression teaching can begin at age of thirteen to increase the number of people who can provide chest compression to improve survival rate of out-of-hospital cardiac arrest patients.

What is already known in this topic?

BLS and quality chest compression by bystanders had been proved to improve survival rate in OHCA patients. Establishing the course in the school curriculum will lead to increasing number of effective chest compressors.

What this study adds?

Trials in western countries found that 13- to 14-year-old groups could perform quality chest compression. However, bodies built of Caucasian and Asian are different.

This study proved that Thai adolescents at the age of 13 to 14 years not only perform quality chest compression as effectively as older age but also understand the theory of BLS after the lectures. BLS and chest compression course should be implemented in secondary school curriculum as early as possible, to improve survival rate of OHCA. The results may be used for other Asian adolescents since the bodies built of Thai children are similar to other Asian citizens.

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Potential conflicts of interest

None.

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อายุที่เหมาะสมในการสอนกู้ชีพขั้นพื้นฐานและสอนกดหน้าอกในเยาวชนไทย

ณญาวดี กวีณัฐญานนท์, ปริวัฒน์ ภู่เงิน, แพรว โคตรุฉิน, กมลวรรณ เอี้ยงฮง, สิวิชญ์ ฉันทวัฒนรักษ์, ฉัตรเลิศ พงษ์ไชยกุล

วัตถุประสงค์: *เพื่อประเมินช่วงอายุที่เหมาะสมในการสอนกู้ชีพขั้นพื้นฐานและสอนกดหน้าอกในเยาวชนไทย*

วัสดุและวิธีการ: *การศึกษานี้เป็นการศึกษาเชิงพรรณนา ณ จุดหนึ่งของเวลา โดยทำการศึกษาที่โรงเรียนมัธยมแห่งหนึ่งในจังหวัดขอนแก่น ประเทศไทย ผู้เข้าร่วมการศึกษาถูกแบ่งเป็น 3 กลุ่ม ได้แก่ กลุ่มอายุ 13-14 ปี 15-16 ปี และ 17-18 ปี ซึ่งทั้ง 3 กลุ่มได้รับการสอนทฤษฎีในการกู้ชีพขั้นพื้นฐานและได้ฝึกปฏิบัติกดหน้าอกโดยบุคลากรทางการแพทย์ที่มีประสบการณ์ หลังจากนั้นผู้เข้าร่วมการศึกษาจะถูกประเมินโดยการสอบปฏิบัติกับหุ่นที่ใช้เพื่อสอนกดหน้าอกโดยเฉพาะ และสอบข้อเขียนด้วยข้อสอบแบบหลายตัวเลือก ข้อมูลที่ได้ถูกวิเคราะห์ด้วยสถิติเชิงพรรณนาและการวิเคราะห์การถดถอยพหุโลจิสติกด้วยโปรแกรม STATA เวอร์ชั่น 10*

ผลการศึกษา: *ผู้เข้าร่วมการศึกษาทั้งหมด 275 ราย เป็นเพศชาย 118 ราย (ร้อยละ 43) และหญิง 157 ราย (ร้อยละ 57) กลุ่มตัวอย่างอายุ 13-14, 15-16 และ 17-18 ปี มีจำนวน 99, 96 และ 80 ราย ตามลำดับ คะแนนสอบข้อเขียนหลังสอนสูงกว่าคะแนนสอบก่อนสอนอย่างมีนัยสำคัญทางสถิติในทุกกลุ่มอายุ และในภาคปฏิบัติพบว่ามากกว่าร้อยละ 50 ของผู้เข้าร่วมการศึกษาในทุกกลุ่มสามารถกดหน้าอกอย่างมีประสิทธิภาพ (ร้อยละ 52.2, 52.5 และ 65 ในกลุ่มอายุ 13-14, 15-16 และ 17-18 ปี ตามลำดับ) เพศชายมีอัตราการกดหน้าอกอย่างมีประสิทธิภาพสูงกว่าเพศหญิงอย่างมีนัยสำคัญทางสถิติโดยไม่ขึ้นกับอายุ หรือ ดัชนีมวลกาย*

สรุป: *เยาวชนไทยในกลุ่มอายุ 13-14, 15-16 และ 17-18 ปี สามารถกดหน้าอกอย่างมีประสิทธิภาพหลังจากได้เรียนภาคทฤษฎีและได้ฝึกปฏิบัติ การศึกษานี้บ่งชี้ว่าการสอนกู้ชีพขั้นพื้นฐานและสอนกดหน้าอกในเยาวชนไทยสามารถเริ่มสอนได้ตั้งแต่อายุ 13 ปีขึ้นไป*