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Kids Save Lives Malaysia Handbook for Primary School Children: Development and Usability Study

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Out-of-hospital cardiac arrest (OHCA) is an important global public health issue that leads to death if not recognised and managed early. Integrating Cardiopulmonary Resuscitation (CPR) as part of the educational school programs will increase trained resuscitators within the community. Unfortunately, CPR courses are only available voluntarily, and not part of the Malaysian national curriculum. We report the development of the KIDS SAVE LIVES MALAYSIA (KSLM) handbook for primary school students in Malaysia. An in-depth review of the latest literature, adapting and adopting relevant guidelines for the handbook was conducted. Next, experts ranging from certified American Heart Association (AHA) instructors, language, and primary school teachers were appointed for content validity. Lastly, the drafted handbook was further tested to determine the usability of selected year 4 - 6 students. All items had an I-CVI and S-CVI of 1.00. Four students passed the knowledge test whilst 18 of the students passed the technical skills test. On average, year four (age 10) students' knowledge and technical skills scores were the highest. As for attitude, year five (age 11) exhibit the highest score. A MANOVA analysis yielded significant effect of the students' age on the technical skills, $F(2,35) = 10.29$, $p < .001$, partial $\eta^2 = .370$ and attitude, $F(2,35) = 13.87$, $p < .001$, partial $\eta^2 = .442$. The outcomes of this preliminary study make the KSLM handbook worthy of future application towards primary school students across Malaysia.

Keywords: Basic life support; Cardiopulmonary resuscitation; Handbook; Kids save lives; Primary Schoolchildren

I. INTRODUCTION

Out of hospital cardiac arrest (OHCA) is the third common cause of death worldwide after cancer and cardiovascular disease (Taniguchi, Baerstein & Nichol, 2012). OHCA is a significant global public health issue, with global incidences and results varying by ten (Berdowski, Berg & Tijssen, 2010). After cardiac arrest outside the hospital, the survival rate is normally 2-10%, although the survival rate may be improved (Bottiger *et al.,* 1999). Awareness raising and educating the public about this subject is critical. Unfortunately, studies revealed that public awareness of CPR differs by region, with over half of adults knowing little about CPR performance (Chair *et al.,* 2014). The World Health Organisation accepted the declaration 'Children Save Lives' created in 2015 by the ERC, the European Safety Foundation, the International Liaison Committee on Resuscitation, and the World Federation of Anesthesiologist Societies. (Bottiger & Van Aken, 2015a; 2015b; Stiell *et al.,* 2003). This declaration recommends that CPR instruction be given annually to students in schools worldwide (Bohn *et al.,* 2015). In addition, the American Heart Association (AHA) released a 2011 advisory statement suggesting

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compulsory CPR instruction for schoolchildren (Cave *et al.,* 2011).

The school-based CPR training aims to improve bystander CPR and OHCA survival rates (Cave *et al.,* 2011). Over time, school-based CPR intervention will dramatically increase the number of community adults trained in Basic Life Support (BLS) (Cave *et. al.,* 2011; Wilks & Pendergast, 2017). Over the past two decades, many programs were created to teach CPR in classrooms. In addition, in 2011, the (AHA) proposed mandatory CPR training with high-quality chest compressions and limited interruptions (Cave *et al.,* 2011). Since then, there has been debate about school age, physical factors, training factors, retention methods, styles of trainers, and AED training as predictors of effective high-quality CPR training (Nina & Katherine, 2013). The ERC and AHA guidelines suggested a chest compression rate of 100-120 per minute with a depth of 50-60 mm (Spooner *et. al.,* 2007; Noordergraaf *et. al.,* 2006; Perkins *et al.,* 2005).

Several studies have shown that children as young as nine years old can understand the value of on-going CPR, learn how to help basic life, maintain their airways, and are fully capable of achieving adequate chest compression, but fail to achieve the AHA and ERC recommended compression depth (Isbye *et. al.,* 2007; Hill *et. al.,* 2009; Jones *et al.,* 2007). Good compression depth depends on age, height, and weight, so children's physical characteristics affect chest compression quality (Abelairas *et. al.,* 2014; Berthelot *et. al.,* 2013; Beard *et. al.,* 2015; Contri *et al.,* 2017). Effective chest compression requires physical strength and stamina above the average schoolchild. Although some studies have discussed the cut-off age of appropriate quality chest compression (Fleischhacki *et. al.,* 2009; Jones *et. al.,* 2007; Berthelot *et al.,* 2013), it is worth investigating especially in different counterparts across the world. Studies predicted that at least 15 % of the population is expected to have undergone training in yielding public resuscitators which cannot be done by voluntary courses. Integrating CPR training into the school's training activities would potentially increase the number of trained resuscitators among the population (Bottiger & Van Aken, 2015b). In 2020, the British curriculum effectively incorporated CPR training into the national curriculum. ("School CPR," 2021). In 35 states, the United States successfully incorporated CPR training into secondary and high school curricula (Watanabe *et al.,* 2017).

Malaysia has over 10,000 schools, an estimated 5 million students, and 420,000 teachers from pre-school to high school (Ministry of Education, n.d.). Over the years, CPR training has been offered in Malaysian schools as part of co-curricular activities by professionals including doctors, firefighters, medical students, and paramedics (Tanaka *et al.,* 2011). To date, the Malaysian national school curriculum currently lacks certain subjects and tools to enforce them (Free Malaysia Today, 2019). Students were able to learn CPR in the Physical Education period through the limited content within the secondary Physical Education textbook. In addition, the exposure to these topics varies according to the level of education together with the gaps in techniques and procedures. This does not fulfil the requirement of WHO policy which enforces at least two hours of annual training which includes theory and practical training. Since the enforcement of CPR and AED training towards primary school children remain sparse in the literature, especially in the context of Malaysian primary school children, we created a handbook for CPR and AED teaching for primary school students. This study aims to describe the development, content validity and usability of the KIDS SAVE LIVES MALAYSIA (KSLM) handbook for teaching CPR and AED to primary school children in Malaysia.

II. MATERIALS AND METHOD

A. Overview

We intend to create an easy-to-use handbook to teach CPR and use AED for school students. We aimed to ensure that this handbook can be used for all school students around Malaysia to assist with compression-only CPR training with the successful use of AED. This handbook was created in several phases, starting with an in-depth analysis through the literature search process, including adopting and implementing relevant documents to create the appropriate curriculum for the handbook. Secondly, a panel of experts ranging from accredited AHA instructors, language experts, and several school teachers was selected to be part of the evaluation process in refining the established content, and finally, the draught handbook was subjected to further

testing to determine the usability of this handbook on a selected primary school in Malaysia. Consent was obtained from all experts and participants. This study was conducted following the Declaration of Helsinki with ethics number REC/11/2021 (MR/886).

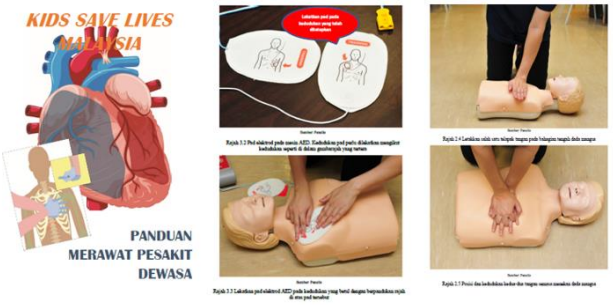
B. Needs Assessment

For handbook content creation, we conducted a need evaluation via a comprehensive literature search. We checked index papers with keywords on "CPR teaching" AND "school children" to obtain effective CPR teaching in school settings worldwide. We have interviewed three selected experts in gathering perspectives on existing evidence in teaching layman CPR. This evaluation's findings highlighted several points, (1) the teaching of CPR and AED should focus on a layperson, (2) the syllabus and the latest teaching guidelines can be obtained from the AHA website (http://www.cpr.heart.org), and the Malaysian Ministry of Health (http://www.moh.gov.my), (3) evidence of effective teaching and learning of CPR for school children such as age, physical factors, duration of the training, types of trainers, method of assessment. In response to these assessments, we developed the KSLM handbook to teach CPR and AED to primary school children.

C. Handbook Design & Content

The standard recommendations and associated training instructions contained in this handbook were adopted and adapted from HEARTSAVER First Aid CPR AED, international guidelines. As for the design, this handbook was designed using the Train-the-Trainer (TTT) model, also known as Pyramidal Training, Triadic Training, and Helper Model Training, consisting of four different phases (Goal, Growth, Activity, & Practice), focusing on initially training a school child who, in turn, teaches other people at home including their relatives, friends, and family members. This handbook consists of three chapters, starting with emergency assessment, followed by effective compression-only CPR, and lastly the use of an Automated External Defibrillator (AED) with the inclusion of pre-designed scenarios in school settings (Figure 1). Each chapter was accompanied by diagrams and flowcharts to aid with the understanding. The content was written in Bahasa Melayu (national language) and once it's published, selected experts from different fields were required to review the content and provide the relevant rate and comments based on Likert scale questionnaires.

Figure 1. The KSLM Handbook content



D. Survey Design

Six experts from three different fields (Content, Language, and Application) related to medical science, linguistics, and school education with years of experience in the related discipline evaluated the content validity of the KSLM handbook. Each selected expert was asked to rate the validity of the KSLM handbook independently from different perspectives. (1) KSLM handbook material – 10 items, (2) language – 5 items, and (3) overall application – 18 items on a four-point scale (1 = not important, 2 = somewhat relevant, 3 = very relevant, 4 = quite relevant). For each item, the content validity index (CVI) and the cumulative rating for all items based on the percentage of experts were used to assess expert agreement. With two experts per viewpoint, a value of 0.78 for the item validity index (I-CVI) is considered a fair presentation of the potential universe score, and a value of 0.80 or higher for the overall scale content (S-CVI) is appropriate (Polit & Beck, 2006). Additional expert comments were also considered especially on the appearance of the handbook, if necessary.

E. Outcome Measures

The final stage of handbook development was the edited and improvised KSLM handbook. This handbook was tested for usability in a selected international private primary school in Malaysia. Three teachers were selected to conduct the CPR

and AED teaching using the KSLM handbook. These three teachers attended BLS training independently as part of their teacher training and were deemed to be sufficient to conduct the KSLM handbook teaching as per guidelines. A 90-minute session was held with 38 students (Malaysian, age 10-12, fluency in Bahasa Melayu with no physical disabilities) from each class with a combination of CPR and AED teaching. Before the event, the school headmaster approved it and the teaching slot allocated was on the physical education time slot. The first session (45 minutes) included CPR teaching, including theory and practical steps focusing primarily on effective adult chest compression and multiple video presentations to help deliver content, followed by AED teaching with a similar concept. In the following sessions (45-minutes), the teacher demonstrated for about 15 minutes each practical task using the Quality-CPR (QCPR) mannequin (Laerdal Little Family Pack). Lastly, all students were divided into smaller groups, with five participants per manikin allowing individual exposure to the practical task of each mannequin while anonymously evaluating the schoolchildren for the practical skills assessment using the 10-point skills assessment rubric questions (Fariduddin & Mohd Johar, 2021; Fariduddin & Siau, 2021). The session ended with an evaluation of CPR knowledge through 10-item multiple-choice questions (Fariduddin & Mohd Johar, 2021; Fariduddin & Siau, 2021) and attitude in performing CPR through 10 statements using 5-point Likert scale responses ranging from 1 (strongly disagree) to 5 (strongly agree) with higher scores representing a more positive attitude towards performing CPR (Lieven *et al.*, 2018).

F. Data Analysis

Data were analysed using IBM SPSS version 27. Content validity was determined by calculating the validity index. CPR and AED knowledge, practical skills assessment and attitude were tabulated, calculated, and presented as mean and standard deviation. A One-Way Multiple Analysis of Variance (MANOVA) test was calculated to determine the differences in the level of knowledge, skills, and attitude towards performing CPR among students at different age groups.

III. RESULTS

Based on Table 1-3, all items had a CVI of 1.00 (greater than 0.78), with a total item content of 1.00 (greater than 0.80). A subsequent adjustment was required based on experts' additional comments, especially on the terminology and grammatical errors.

Table 1. Validity Index for KSLM Handbook Content

Item	Expert 1	Expert 2	No of agreement	I-CVI
Content-1	√	√	2	1.00
Content-2	√	√	2	1.00
Content-3	√	√	2	1.00
Content-4	√	√	2	1.00
Content-5	√	√	2	1.00
Content-6	√	√	2	1.00
Content-7	√	√	2	1.00
Content-8	√	√	2	1.00
Content-9	√	√	2	1.00
Content-10	√	√	2	1.00

Table 2. Validity Index for KSLM Language

Item	Expert 1	Expert 2	No of agreement	I-CVI
Language-1	√	√	2	1.00
Language-2	√	√	2	1.00
Language-3	√	√	2	1.00
Language-4	√	√	2	1.00
Language-5	√	√	2	1.00

Table 3. Validity Index for KSLM Overall Application

Item	Expert 1	Expert 2	No of agreement	I-CVI
OA-1	√	√	2	1.00
OA-2	√	√	2	1.00
OA-3	√	√	2	1.00
OA-4	√	√	2	1.00
OA-5	√	√	2	1.00
OA-6	√	√	2	1.00
OA-7	√	√	2	1.00
OA-8	√	√	2	1.00
OA-9	√	√	2	1.00
OA-10	√	√	2	1.00
OA-11	√	√	2	1.00
OA-12	√	√	2	1.00
OA-13	√	√	2	1.00
OA-14	√	√	2	1.00
OA-15	√	√	2	1.00

Table 4 describes the 38 respondents' demographic profiles as summarised. Based on table 5, a passing mark of 84% (8 out of 10) for the MCQ and a full mark of 100% (10 out of 10) for the practical skills was adopted in this study, consistent with the official AHA guidelines. One mark was awarded for each correct answer, while no penalty was given for incorrect answers. The responses to the 10 attitude statements were summated to give an overall attitude score, ranging from 10 (lowest) to 50 (highest). Overall, four students passed the knowledge test whilst 18 of the students passed the technical skills test. On average, year four students' knowledge and technical skills scores were the highest. As for attitude, year five exhibit the highest scores.

Table 4. Respondents' demographics

Demographic	Participants, n (%)
Gender	
Male	22 (57.9)
Female	16 (42.1)
Age Group (years)	
10	14 (36.8)
11	19 (50)
12	5 (13.2)
Ethnicity	
Malay	36 (94.7)
Chinese	1 (2.6)
Others	1 (2.6)

Table 5. Knowledge, practical skills scores, and attitude among respondents

Variables	Frequency (%)	
	Pass	Fail
Knowledge	4 (10.5)	34 (89.5)
Technical Skills	18 (21.1)	30 (78.9)
	Score (Mean)	
Knowledge		
Age 10 (Year 4)	6.64	
Age 11 (Year 5)	6.37	
Age 12 (Year 6)	6.00	
Technical Skills		
Age 10 (Year 4)	8.93	
Age 11 (Year 5)	6.74	
Age 12 (Year 6)	8.40	
Attitude		
Age 10 (Year 4)	38.07	
Age 11 (Year 5)	39.43	
Age 12 (Year 6)	29.72	

A multivariate analysis of variance (MANOVA) was used to compare students' knowledge, technical skills, and attitude to perform CPR based on their age. Univariate normality was assumed via Shapiro-Wilk tests and boxplots. No multivariate outliers were discovered in the data, confirming multivariate normalcy. No excessive correlations between the dependent variables indicated that multicollinearity was not an issue. Also, the dependent variables' relationship was linear. Finally, at a = 0.001, Box's M was not significant, showing that variance-covariance matrices were homogeneous. The students' age had a significant effect on the combined dependent variables, F (3,34) = 10.59, p < 0.001, partial η^2 = 0.483. Individual dependent factors demonstrated an effect on the students' age groupings. The technical skills, F (2,35) = 10.29, p < .001, partial η^2 = .370 and attitude, F (2,35) = 13.87, p < .001, partial η^2 = .442 were all statistically significant at a Bonferroni corrected alpha level of .017 except for the knowledge (Table 6).

Table 6. Multivariate test of knowledge, technical skills, and attitude towards CPR among students

Source	Value	F	Hypothesis df	Error df	Sig	Partial Eta Squared
Pillai's Trace	0.135	10.59	3	34	<0.001	0.483

Source	Dependent Variable	df	Mean Square	F	Sig	Partial Eta Squared
Students' Age	Technical Skills Score	2	11.83	10.29	<0.001	0.370
	Attitude Score	2	16.79	13.87	<0.001	0.442

IV. DISCUSSIONS

With the rise of OHCA worldwide, it is far essential to emphasise CPR and AED training towards school children as part of the global initiative to create a ripple effect, increasing the bystander's CPR. It is vital to have the training or manual handbook for initiating CPR and AED training among school children. Despite the availability of different guides endorsed by various resuscitation councils, selecting the most suitable teaching and learning resources is crucial in ensuring the suitability to be implemented as part of the school curriculum, especially in the country with the introductory phases. We introduced a novel handbook to improve the learning of CPR and AED for our Malaysian primary school children. With extensive development ranging from the literature search, experts input and suggestion, comments, and ratings from various fields of expertise, this handbook appeared to play a key role in providing a whole new experience. In addition, this handbook was the first handbook ever written in Bahasa Melayu (national language), and we believe this will improve the overall learning in the school setting.

The value of (I-CVI) and (S-CVI) for all validity testing of this handbook was 1.00, indicating an excellent content validity index (Polit & Beck, 2006). The original content in this handbook was adopted and adapted with several resuscitation modules; thus, we tend to adhere strictly to the standard international guidelines that have been applied worldwide to date. In the context of usability, we have taken the literature consideration in designing the method of executing the training using this handbook. CPR trainers were usually healthcare practitioners rather than teachers. However, physical and health educators could provide a longer-term investment as the cost of CPR training in a school is largely attributable to the need for qualified

instructors (Watanabe *et al.,* 2017). The benefits of using schoolteacher trainers include reducing healthcare workers' needs and using trained educators to provide instruction, in addition, students taught by highly rated teachers exceed those trained by low-rated or uncertified instructors/trainers (McCluskey, 2010).

In cardiac arrest events, compression-only training achieved comparable results to standard basic life support involving chest compression and artificial ventilation (Olasveengen, Wik, & Steen, 2008). Thus, offering continuous chest compression-only as taught by this handbook is an alternative solution that may increase the ability to initiate bystander CPR. This ensures our students' teaching and learning experience did not deviate while achieving the national standard of effective and high-quality CPR and AED training (Drajer, 2011; Piscopo *et al.,* 2018). Traditionally, CPR teaching included video and instructor presentations, together with hands-on manikin-based guidance and practice with a handbook. Next, a written test and practical assessment were conducted to measure the effectiveness of the training. Practical training is important in resuscitation training. Research showed that children who received theoretical knowledge alone perform poorly on practical assessment (Bahar & Sule, 2018; Nina & Katherine, 2013) whilst children receiving immersive training including theory, practical, knowledge, and practical testing resulted in better functional CPR skills (Yildiran *et al.,* 2016). A similar concept has been applied in our study; firstly, the selection of teachers is based on the inclusion criteria such as having pre-existing knowledge on CPR, attending BLS courses from accredited institutions, and passing the knowledge and practical test. Secondly, we try to conduct the teaching within the stipulated time given as per the school standard timetable slot. This gives the impression of the feasibility of this teaching to be implemented as part of the school curriculum. We also hybrid the teaching process by combining theoretical and practical aspects side to side, accompanied by virtual teaching aids in delivering the content.

This can be seen in our studies in which as early as 10 years old, these students have successfully acquired the knowledge and subsequently translating the knowledge into practices whereby students at this age are able to perform effectively based on the scores recorded as compared to the other groups. In addition, a short program lasting 40 minutes to an hour, deemed to be adequate to improve and acquire overall CPR skills in up to 89% of school students (Kim *et. Al.,* 2011; Nakagawa *et al.,* 2020). Despite the low level of passing rate recorded for both knowledge and technical skills, these students scored up to 20% despite the first exposure to a complete CPR training. Moreover, the mean scores were reported to be beyond average with a moderate attitude score in performing CPR. We believe, with recurrent on-going training and exposure at early age, this will subsequently improve the overall CPR skills.

As for the practical sessions, we break the session into smaller groups to allow the students to translate the acquired knowledge into practice. Lastly, the assessment was conducted towards the end to measure the overall effectiveness of the teaching experience. Results showed that only 10% of the students from all years passed the knowledge test based on the tabulated scores. Nevertheless, these percentages doubled up among the student's practical assessments. Some instructors revealed several possibilities which include variables of concerns such as body proportions, physical characteristics, and body stamina among the students. Some students also experience difficulties in interpreting and seeking constant translation on certain terminology in Bahasa Melayu whilst the session is being conducted despite being a Malaysian enrolling in the Malaysian National Curriculum syllabus. These variables couples with the limitations deemed to be an area of concern in this study that requires immediate attention in future research.

Overall, we believe that using this handbook as introductory teaching of CPR and AED towards Malaysian primary school children will likely be helpful and the main reference in executing the teaching across Malaysia. The process of developing and validating this handbook, like any other researcher, is not without any limitations. Based on the validity index output above, we would consider the content, language, and general application of this handbook to be feasible, especially in the school setting, but with some concerns over the issue, such as the expertise of the selected areas. Since this handbook was developed for teaching school children, it is unclear whether raters from different

professions, teaching experience, and clinical aspects provide a reliable rating. Although crucial identification was made in selecting the targeted experts for a specific expert rating, it is unlikely that the experience, level of knowledge, and understanding may impede ratings.

Secondly, because this is not a pilot feasibility study, the sample size was relatively small in-group. Also, the outcome of the practical assessment related to the effectiveness of the training utilising the handbook was questionable due to the limitations and areas of concern. The level of understanding in Bahasa Melayu among the students was low despite being Malaysian enrolling in a Malaysian National Curriculum. We believe future implementation in National schools in Malaysia would yield a better outcome as compared to this study. Therefore, the effectiveness of this handbook is yet to be determined in the next phase of this research.

V. FUTURE RESEARCH DESIGN

Future research will study larger populations, including several schools across Malaysia. A face validity will also be conducted among the school students for further improvement. The next phase of this research will also include a comparison between students' age groups and retention rate. Variables such as physical factors, gender, age, height, and weight will be determined to infer the predictors towards successful teaching of CPR and AED on knowledge, skills, and changes in the attitude. At the same time, we also plan to review the handbook's content annually and use the feedback from the respective school teachers and students for further improvement.

VI. CONCLUSION

The KSLM handbook is in the early stages of application, but it has enormous potential. In this study, the handbook has gone through several stages of development including an in-depth review, input from experts, and content validity in obtaining the latest guideline and evidence for effective teaching and learning of CPR and AED for primary school students and has shown usability by the school teacher in teaching their students. The positive outcomes of this preliminary study make the KIDS SAVE LIVES MALAYSIA handbook worthy of future application in the CPR and AED training towards primary school students across Malaysia.

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