EFFECT OF CERTIFIED ADULT CARDIOPULMONARY RESUSCITATION TRAINING ON KNOWLEDGE AND SKILLS AMONG NURSING STUDENTS IN SELECTED KENYA MEDICAL TRAINING COLLEGES

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Effect of Certified Adult Cardiopulmonary Resuscitation Training on Knowledge and Skills among Nursing Students in Selected Kenya Medical Training Colleges

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DECLARATION

This thesis is my own original work and has not been presented for a degree in any other University

Signature……..Date……..

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This thesis has been submitted for examination with our approval as the University Supervisors

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DEDICATION

I dedicate this work to the entire Wambugu, Ndung'u and Muthami families for the great support they accorded me through the PhD study journey. In a special way I dedicate this work to my late mum Lucy Wangeci who used to encourage me to excel in this PhD journey.

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ABBREVIATIONS/ ACRONYMS

ACLS	Advanced Cardiac Life Support
AED	Automated External Defibrillator
ALS	Advanced Life Support
BLS	Basic Life Support
BSN	Bachelor of Science in Nursing
CPR	Cardio-Pulmonary Resuscitation
EN	Enrolled Nursing
KECHN	Kenya Enrolled Community Health Nursing
KMTC	Kenya Medical Training College
KRCHN	Kenya Registered Community Health Nursing
KRN	Kenya Registered Nursing
NACOSTI	National Commission for Science, Technology Innovation
OSCE	Objective Structured Clinical Examination
RN	Registered Nursing
SPSS	Statistical Package for Social Sciences

OPERATIONAL DEFINITION OF TERMS

Basic life support It is care provided to victims following cardiac arrest awaiting specialized care.

Basic life support certification A credential earned by health care providers on life saving skills

Cardiac arrest A sudden impairment in the blood flow to body systems following a failure of the heart pumping action

Cardiopulmonary resuscitation A lifesaving medical procedure that involves repeated chest compressions and artificial respiration aimed at maintaining circulation and oxygenation to the vital organs

Defibrillation The use of electric current to revert an arrhythmia to normal heart rhythm

Senior nursing student A third year student undertaking a diploma in Kenya Registered Community Health Nursing.

ABSTRACT

Cardio-pulmonary resuscitation is a lifesaving skill that nurses and other health workers should be proficient in. Prompt initiation of the procedure ultimately saves lives following cardiac arrest. It has been scientifically proved that survival rate following cardiac arrest deteriorates at 7%-10% every minute if cardiopulmonary resuscitation procedure is not initiated. Medical and nursing students are potential rescuers for inpatient cardiac arrest. However, they have been reported to have low knowledge and skill levels for effective and efficient resuscitation. The study aimed at assessing effect of certified cardio-pulmonary resuscitation training on knowledge and skills among senior nursing students in selected campuses of Kenya Medical Training College. A nonequivalent control group quasi experimental design was applied in the study with four campuses being sampled conveniently. A lottery simple random method was used to assign two campuses into experimental group and two into control group. Ethical approval was granted by Kenyatta University Ethics Review Committee (PKU/2166/E1310) and National Commission for Science, technology & Innovation (Ref No. 430422). All ethical principles were upheld throughout the study. The study was conducted in three phases. Pretest phase where baseline data was collected in the beginning of the semester in both groups. A theoretical and practical examination was administered. The second phase was the execution of certified cardio-pulmonary resuscitation training for a period of two months involving theory and practical sessions. In this phase the students in the experimental group who achieved the desired score of 84% were awarded with an American Heart Association certificate for Basic Life Support providers. The third phase was the posttest evaluation after six months where both groups were subjected to a theoretical and practical examination. Data was analyzed using SPSS version 26. Measures of frequency, central tendency, and dispersion were used for descriptive statistics. T-test, Mann Whitney and Wilcoxon rank test were used for inferential statistics based on data distribution. On baseline cardio-pulmonary resuscitation knowledge, the intervention group had a mean score of 41.80 ±8.7 and the control group had a mean score of 41.86±7.9. On baseline cardio-pulmonary resuscitation skills, the intervention group had a mean score of 29.2% ±14.8 while the control group had a mean of 24.65±12.7. Perception that cardio-pulmonary resuscitation knowledge and skill were complex, minimal skills laboratory guidance, and lack of confidence in performing cardio-pulmonary resuscitation was found to have an influence the cardio-pulmonary resuscitation knowledge and skills. There was a significant statistical difference in cardio-pulmonary resuscitation knowledge of large effect size ($Z = -10.9$, $p<0.0001$, $d= 0.85$) between the performance of the intervention and the control groups at posttest. The intervention group also had significant statistical difference in cardio-pulmonary resuscitation skills of large effect size ($Z=-7.826$, $p=<0.0001$, $d=0.8$. The training intervention was effective in enhancing the learner's knowledge and skills on cardiopulmonary resuscitation. There is need for certified refresher cardio-pulmonary resuscitation trainings for nursing students to facilitate acquisition and retention of cardio-pulmonary resuscitation knowledge and skills.

CHAPTER ONE:

INTRODUCTION

1.1 Background to the Study

Cardio Pulmonary Resuscitation (CPR) is a life saving procedure that aims at reversing the effects of sudden cardiac arrest (Harris & Kudenchuk, 2018). Sudden cardiac arrest is a disorder in which there is an abrupt cessation of cardiac rhythm characterized by unresponsiveness, abnormal or no breathing and no pulse (Carrick et al., 2020). Sudden cardiac arrest is the leading cause of mortality worldwide. More than 500000 cases of sudden cardiac arrest occur annually in the United States. Specifically 360000 cases account for out of hospital cardiac arrest while 210000 account for in-hospital cardiac arrest cases (Carrick et al., 2020). In Africa there are limited epidemiological studies on sudden cardiac arrest. According to cardiovascular diseases management guidelines in Kenya, 25% of all hospital admissions in Kenya are as result of cardiovascular disorders. In the same guidelines a quoted study show that 13.2% of autopsies conducted revealed that the cause of the deaths was as a result of cardiovascular complications (MOH Kenya, 2018).

Cardiopulmonary resuscitation is usually a basic course taught to first years undertaking various health related courses in Kenya Medical Training College. In the nursing group, basic life support is taught as a topic rather that a unit or a course. The students are taught in their first semester of first year. The training entails theory and also some practical sessions using the manikins. Cardiopulmonary resuscitation trainings are based on American Heart Association (AHA) guidelines. The AHA guidelines for basic life support providers 2020 gives a stepwise approach for offering cardiopulmonary resuscitation based on whether the incident happens in hospital or community setting. This forms adult out of hospital chain of survival and in hospital chain of survival (AHA, 2020)

Despite the procedure having been operational for over 60 years, the success rates keep on varying. The American Heart Association (AHA) and European Resuscitation Council lay a lot of emphasis on high quality chest compressions as the foundation basis of successful cardiopulmonary resuscitation (Harris & Kudenchuk, 2018). The burden of sudden cardiac arrest thus necessitates all health workers to be competent in performing this life saving procedure.

Prompt initiation of the procedure ultimately saves lives. It has been scientifically proven that survival rate following sudden cardiac arrest deteriorates at 7%-10% every minute if cardiopulmonary resuscitation procedure is not initiated. The survival rate if CPR is initiated promptly is 29.7% (Yan et al., 2020). Nursing students are potential rescuers for inpatient cardiac arrest. Nevertheless they have been reported to have low knowledge and skills levels for effective and efficient resuscitation (Roel & Bjørk, 2020). Competency in performing CPR is evaluated on the acquired and retained knowledge and psychomotor skills (Baldi et al., 2020). The success of CPR procedure is based on the knowledge base and proficiency on the hands on skills. Thus it is required that these professionals must have updated technical knowledge and skills for efficient and effective CPR to take place (Sabir, 2017). Nursing students should be competent to perform CPR. However, despite this life saving skill being a core competency, globally various studies have deduced that student nurses are deficient in cardiopulmonary resuscitation knowledge and skills (Vandali et al., 2018). In a study done at Arab America University Jenin in Palestine comparing qualified nurses and student nurses, the average score of the student nurses was 48.6% as compared to the qualified at 56.7%. This study revealed that both groups were deficient in CPR knowledge as compared to the recommended score (Salameh et al., 2018). Similarly, according to Mendhe et al., (2018) study on CPR knowledge, practice and attitude among nursing and medical students, the findings revealed that the two groups had insufficient knowledge and skills. In a skill practical exam of 10 points, the nursing students had a median score of 4 and the medical students a score of 6. On the knowledge score, 46%

of the nursing students had poor knowledge while 36% of the medical students had poor knowledge.

According to a quasi experimental study done in Lahore University in Pakistan where a group of 62 post- registered degree nurses were enrolled in the study to assess on their knowledge on CPR, the study revealed that only 3.2% of the participants achieved a high score in the pretest. This created a great concern to the researchers basing that the participants had already learnt CPR in their Registered Nurse (RN) program. They recommended that there is need for frequent refresher trainings to improve on the deterioration knowledge (Sabir, 2017). As revealed by a similar study by Vural (2017) on the assessment of student nurses knowledge on CPR in a Turkey University, the student lacked basic knowledge on key resuscitation aspects. It was only 11% who were aware of the recommended compression ventilation ratio, 16.2 % were conversant with the recommended compression depth, while only 22 % were aware of the updated order of CPR.

In another research in India assessing the CPR knowledge among diploma nursing students, it was only 38% who had adequate knowledge for the core skill. These findings indicated a big gap in CPR knowledge and skills not only among students but also among the qualified staff. These findings thus created a recommendation for continuous CPR trainings to sustain the CPR competence (Salameh et al., 2018).

It is expected that fresh graduates will have gathered enough confidence to handle CPR from the trainings they have had. Contrary to this expectation, studies have shown that the students' level of confidence is very low. A study by Guner et al. (2017) indicated that 20% of senior medical students rated to have some confidence in handling a resuscitation case while 62.7% of the participants indicated that they were not confident at all to carry out the procedure. They recommended that there should be regular compulsory trainings to boost on their confidence.

In the developed countries many schools of nursing require that nursing students must be certified in CPR before enrolling for the course or before starting clinical placements. According to Claire and Hall (2018), the university of Pennsylvania requires that a student must be certified in CPR before starting clinical rotations. Globally all medical training institutions recognize the importance of cardiopulmonary resuscitation and thus they incorporate CPR training in their curricula. Some utilize the traditional instructor led training, high fidelity mannequins, multimedia computer CPR training and others virtual reality. Most institutions offer these courses during the first years of training; however many studies have identified that there is rampant knowledge and skills deterioration over time. Many studies have reported very low competency levels among medical and nursing students in performing CPR (Ruangrit & Keawpimon 2021). Nursing students should receive their initial CPR training while in the training colleges. This will enhance knowledge and skills acquisition and help them gain confidence in performing the procedure. It also primes them in emergency care skills (Sabir, 2017).

There is scanty data on CPR practice in Africa. A study in South Africa showed that critical care nurses lacked required knowledge on how to perform effective CPR. Their mean score was 46% way below the competency score of 84%. This was attributed to lack of ongoing training programs and affected their competence levels (Botes & Moepeng, 2020).

In a related study in Kenya conducted in one of the county referral hospitals it was found out that nurses, clinical officers and doctors were deficient on CPR competencies. This was attributed to low training support by the hospital administration (Wambugu et al., 2018). Though CPR is taught in the various school of nursing in Kenya, Kipsang and Bruce (2011) points out that CPR training lacks standardization. Each training institution implements the training differently.

Various factors influence the acquisition of CPR knowledge and skills. In some developed countries, basic life support is trained in primary and secondary schools, this makes it easy for health care workers to practice with confidence based on the

knowledge and skills base (Salameh et al., 2018). In other countries, CPR certification is a requirement for admission into a nursing training college. In addition, while in training the students are expected to maintain the CPR licensure. This makes the students to have adequate knowledge and skills on resuscitation (Tirado, 2016). Various countries make it a requirement that nurses must have valid CPR license before renewing the practicing license. This makes them to have updated knowledge and skills always (Munezero et al., 2018). A study done at Kenyatta National Hospital showed that health practitioners working in the emergency department had some deficiencies in cardiopulmonary resuscitation knowledge and adherence to the guidelines. The author recommended that there is need for recertification of the practitioners and availing of the guidelines for better outcomes (Omolo, 2020). In a related study among health care workers in Nakuru county referral hospital, 54.3% had low knowledge on CPR while 61.1% had low CPR skills (Manono et al., 2021).

1.2 Statement of the Problem

Cardiopulmonary resuscitation procedure is a core skill that health workers should have proficiency as early as from their basic training at the colleges/universities. Nursing students should be in a position to initiate and perform high standard CPR when they start their career in nursing. The unique role of nurses makes them the first to initiate CPR in case of cardiac arrest in an inpatient setup. Globally, studies have shown that nursing students are deficient in CPR competence at senior level of training and thus there is need for a better training during nursing education (Siv &Torunn, 2020).

Studies done in North Cyprus and Norway University have found out that senior nursing students have low levels of CPR knowledge and skills despite them having learnt the concepts in their first year of training (Dal & Sarpkaya, 2013; Sun & Young 2016).
Few studies have been done on Cardiopulmonary resuscitation in Kenya and none has been done to assess senior nursing students at Kenya Medical Training Colleges. A research study done at Kenyatta National Hospital training college among in-service nurses, showed that only 5 out of 71 students achieved the desired 90% marks (Kipsang

& Bruce, 2011). In another study done at Coast General Hospital Kenya, it was established that only 68.8 % of the participants who got cardiopulmonary resuscitation training at their respective medical and nursing schools but with no certification (Ndung'u et al., 2019).

A study done at Coast General Hospital in 2015 on CPR practices among doctors, nurses and clinical officers reflected that nurses' knowledge on CPR was below average. The study further highlighted statistical significance (p=0.014) on how level of education affected CPR practice. Health workers with diploma training scored lowest (Wambugu et al., 2018). Cardio-Pulmonary Resuscitation training is universal irrespective of the different cadres of health profession.

Anecdotal evidence shows that newly qualified nurses are deficient in the cardiopulmonary resuscitation procedure. Retraining senior nursing students in a certified program before they join the work force may enhance their resuscitation knowledge and skills.

Kenya Medical Training College releases approximately 2500 nurses annually into the Kenyan and global labor market. This translates to new 2500 new life savers.
Out of the observations made by the researcher and research findings, the researcher was prompted to carry out a quasi experimental study to assess effect of certified CPR training on knowledge and skills among nursing students in selected campuses of Kenya Medical Training College.

1.3 Justification of the study

The study aimed at assessing the effect of adult cardiopulmonary resuscitation training on knowledge and skills among the KRCHN students. Sudden cardiac arrest cases are on the rise making it a global health concern. Early identification of cardiac arrest and initiation of high standard CPR improves the chances of survival. Student nurses are also potential bystanders who can perform out of hospital resuscitation (Shuk et al., 2017).

The nursing students should have competency in performing CPR in cases of in hospital cardiac arrest (Garc et al., 2019). Nursing students training at KMTC forms the majority of the country health work force upon completion of their study. With high competency levels, this group may save many lives and as well offer knowledge and skills transfer to other health care workers and to a greater extent to the community.

1.4 Significance of the study

The study aimed at assessing the effect of certified CPR training among senior nursing students. Statistically significant findings will help trainers replicate the prototype training and adopt universally accepted CPR guidelines. The study will expand the body of knowledge on resuscitation more so in Africa since limited research have been conducted on the topic. The findings will inform the policy makers on need to certify nurses on CPR before licensure. The findings will provide beneficial information that can also be utilized in development of national guidelines. The trainings in CPR will help reduce cardiac mortality rates by approximately 7.5%. Ultimately the findings will help achieve Sustainable Development Goal (SDG) number 3 which seeks to ensure health and well being of all ages. The methods applied in this study also helped evaluate the preparedness of the senior nursing students in offering CPR upon qualifying for employment.

1.5 Research questions

1. What is the level of Cardio-Pulmonary Resuscitation knowledge among senior nursing students at selected KMTC campuses?
2. What is the level of CPR skill among senior nursing students at selected KMTC campuses?
3. What factors influence CPR knowledge and skills among senior nursing students at selected KMTC?
4. What is the effect of a certified CPR training on knowledge among senior nursing students at selected KMTC?

5. What is the effect of a certified CPR training on skills among senior nursing students at selected KMTC?

1.6 Broad objective

To assess the effect of certified cardiopulmonary resuscitation training on knowledge and skills among nursing students in selected Kenya Medical Training College.

1.6.1 Specific Objectives

1. To assess the level of CPR knowledge of senior nursing students at selected KMTC campuses.
2. To assess the level CPR skills of senior nursing students at selected KMTC campuses
3. To assess factors influencing CPR knowledge and skills among senior nursing students at selected KMTC campuses.
4. To assess effect of certified training on CPR knowledge among senior nursing students at selected KMTC campuses.
5. To assess effect of certified training on CPR skills among senior nursing students at selected KMTC campuses

1.7 Hypothesis

H_0: CPR training and certification has no significant effect on CPR knowledge among senior nursing students

H_1: CPR training and certification among senior nursing students has a significant effect on CPR knowledge

H_0: CPR training and certification has no significant effect on CPR skill among senior nursing students

H_1: CPR refresher training and certification among nursing students has significant effect on CPR skill

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Sudden cardiac arrest is the cessation of effective circulation, manifested by the patient not being responsive and having no/abnormal breathing, which may be accompanied by impalpable central pulses (Parish et al., 2018). Sudden cardiac death is a major presentation of a heart disease. Swift commencement of Cardio-pulmonary resuscitation saves lives while done with quality. Nurses usually become the first responders to a victim who suffers in hospital cardiac arrest making this skill a core competency for the profession (Rajeswaran et al., 2018).

Cardio-pulmonary resuscitation is a life saving procedure that aims at reversing the effects of sudden cardiac arrest (Harris & Kudenchuk, 2018). Sudden cardiac arrest is the leading cause of mortality worldwide. More than 500,000 cases of sudden cardiac arrest occur annually in the united state. Specifically 360000 cases are out of hospital cardiac arrest while 210000 account for in-hospital cardiac arrest cases (Carrick et al., 2020). In Africa there are limited epidemiological studies on sudden cardiac arrest. However, a study has indicated that 25% of all hospital admissions in Kenya are as result of cardiovascular disorders. In the same study 13.2% of autopsy reviews indicated that the cause of the deaths were as a result of cardiovascular complications (MOH Kenya, 2018).

Despite the procedure having been in existence for over 60 years, the success rates keep on varying. The American heart Association (AHA) and European resuscitation council lay a lot of emphasis on high quality chest compressions as the foundation basis of successful cardiopulmonary resuscitation (Harris & Kudenchuk, 2018). The burden of sudden cardiac arrest thus necessitates all health workers to be competent in performing this life saving procedure.

Cardio-pulmonary resuscitation is a vital life saving procedure which all health workers should be proficient in. Prompt initiation of the procedure ultimately saves lives. It has been scientifically proved that survival rate following sudden cardiac death deteriorates at 7%-10% every minute if cardiopulmonary resuscitation procedure is not initiated. Medical and nursing students are potential rescuers for inpatient cardiac arrest. Nevertheless medical and nursing students have been reported to have low knowledge and skills levels for effective and efficient resuscitation (Oktay, 2019)

2.1.1 Cardiopulmonary resuscitation guidelines

Cardiopulmonary resuscitation at basic life support level comprises of high quality chest compressions, ventilations and defibrillation. For successful implementation of these components, the American Heart Association formulates algorithms to guide the rescuers during the process. The algorithm makes it easier for the rescuers to learn, remember and perform high quality cardiopulmonary resuscitation (Panchal et al., 2020). The adult cardiopulmonary resuscitation algorithm entails the following steps based on American Heart Association guidelines 2020 for basic life support.

2.1.1.1 Verify scene safety

Upon identification of a patient who is suspected to have had a cardiac arrest, the rescuer should ascertain that the area of intended rescue is safe for the provider. A quick scan of the patient's environment is done to ensure that there are no physical threats like electric hazards. The responder/ rescuers safety comes first. They should never become victims themselves (Panchal et al., 2020).

2.1.1.2 Check for response

This is done by trying to arouse the patient by touching or shouting asking them whether they are okay. By doing this, the rescuer applies the AVPU (alert, voice, pain, unresponsive) assessment in less than 10 seconds (Panchal et al., 2020).

2.1.1.3 Shout for nearby help

If the patient is not responsive in the step above, seek help from the coworkers or activate the resuscitation team. It has been found out that a team approach yields better results as compared to one or two rescuers. A rescuer may use a mobile phone to activate the resuscitation team or he/she may send someone else. At this step it is required that the rescuer gets an AED (automated external defibrillator) or sends someone if it is available (Panchal et al., 2020).

2.1,1,4 Assess for breathing and pulse

The rescuer should simultaneously assess for the breathing pattern and pulse rate. In the scenario that the patient has normal breathing and pulse, the rescuer should continue observing the patient until the emergency/ resuscitation team arrives. In the instance that the patient has no normal breathing but has a pulse, the rescuer should provide rescue breaths in the following sequence; one breath every 5-6 seconds or approximately 12 breaths per minute via a bag valve mask.

The rescuer should continue providing rescue breaths and monitoring for pulse at two minute intervals. In a situation whereby the pulse will be absent, the rescuer and the emergence team should start with cardiopulmonary resuscitation. In the scenario that the patient has abnormal or no breathing and no pulse, the rescuers should start cardiopulmonary resuscitation immediately (Panchal et al., 2020).

2.1.1.5 Initiate Cardiopulmonary resuscitation

The rescuer should start cardiopulmonary resuscitation at 30 compressions to 2 breaths (30:2). For the CPR to be effective, the chest compressions have to be done with the desired quality and quantity. Quality of CPR is measured based on the rate, depth, degree of chest recoil, minimized interruptions and avoidance of over ventilation. The hand position is paramount while performing the procedure. The hands should be interlocked and placed over the lower third of the sternum. The compressions at this

anatomical position aids at manually helping the pumping mechanism of the heart (Panchal et al., 2020).

To achieve return of spontaneous circulation (ROSC) the rescuer must have a chest compression of between 100 – 120 compressions per minute. This has scientifically been proven to improve on the cardiac output, blood pressure and also end tidal carbon dioxide levels. As the rescuer maintains the desired uninterrupted compressions, the depth of chest compressions should also be done at an approximately 5cm (2 inches). This desired depth has been scientifically proven to increase on the intra- thoracic pressures. Consequently the increased intrathoracic pressure forces forward blood flow out of the heart directing it to the major vessels. This improves on the cardiac output hence improving on the systemic blood circulation. Chest compressions of lower than the desired 5 cm have been shown to have delayed return of spontaneous circulation resulting to poor outcomes. Chest compressions of over 5 cm in depth have also been proven to cause chest injuries (Panchal et al., 2020).

As the rescuers perform CPR at the right rate and depth, they should also ensure that there is full chest recoil. Full recoil is determined by the sternum resuming its position before the chest compressions. Complete chest recoil creates a negative intrathoracic pressure that facilitates forward blood blow and also promote the venous return of blood. The rescuer should not lean on the patient chest during the procedure since it increases in the intrathoracic pressure and impede on the venous return, reduce coronary blood flow and reduce myocardial perfusion. Complete chest recoil has been shown to improve on return of spontaneous blood circulation and hence improve on the cardiac arrest outcomes (Panchal et al., 2020).

During the CPR procedure the rescuers should have minimal chest interruptions pre shock and also post shock. During ventilation phase the rescuers should not take more than 10 seconds to deliver the two breaths. Observational studies have demonstrated an association of minimal chest interruptions and successful return of spontaneous circulation thus improving on patient’s outcomes (Panchal et al., 2020)

2.2.1.6 Use of Automated External Defibrillator

Once the automated external defibrillator is provided, the rescuer is expected to analyze the cardiac rhythm and detect whether the patient has shockable rhythms. There are two shockable rhythms which the Automated External Defibrillator (AED) is able to detect i.e. pulseless ventricular tachycardia and ventricular fibrillations. If a patient has a shockable rhythm, the rescuer is expected to give one shock and continue with cardiopulmonary resuscitation for about two minutes until prompted by the AED to recheck for the rhythm. The rescuer should continue until advanced life support provider takes over or when the patient starts moving (Panchal et al., 2020).

In the scenario that the patient does not have a shockable rhythm, the health provider is expected to continue with cardiopulmonary resuscitation for approximately two minutes awaiting a prompt by the AED to recheck the rhythm. CPR should continue until advanced life support provider arrives or the patient starts moving. Defibrillation has improved outcomes of cardiac arrest since it restores the heart to a normal sinus rhythm (Panchal et al., 2020).

2.2 CPR knowledge and skills among student nurses

2.2.1 General CPR knowledge and skills among student nurses

Despite Cardiopulmonary resuscitation knowledge and skills being life saving, global and local research findings indicate that medical and nursing students are deficient in this live saving procedure. According to American Heart Association, a person who scores at 84% on the basic life support exams is deemed to have attained a proficient level of practice (Zideman et al., 2015). Sankar et al. (2013) conducted a study at a teaching hospital in New Delhi India to assess cardiopulmonary resuscitation competence between pre-service and in-service nurses. The study revealed that the pre-service nurses who were senior undergraduate nursing students had significant ($p=0.001$) low knowledge on CPR as compared to the already practicing nurses. However the study

further revealed that the two groups had no significant difference (p=0.08) in knowledge at baseline evaluation. In another study done at Istanbul Turkey teaching hospital assessing nursing students on CPR knowledge, it was found out that their knowledge score was deficient at 64.62%. Despite the score being above average, the score was below the recommended standards of competency (Vural, 2017) .

According to Mendhe et al., (2017) medical and nursing interns do not have sufficient knowledge and skills to practice on cardiopulmonary resuscitation despite them having the right attitudes. In their cross section study done at a health institute in India, they found out that 36% of the medical officer interns had low CPR knowledge while 46 % of the nursing interns scored below average on various CPR knowledge aspects. Mendhe et al., (2017) recommends that CPR should be included in medical and nursing training curricula to foster knowledge, attitude and skills acquisition.

According to Salameh et al. (2018), CPR mastery is insufficient among practicing nursing and nursing students. In their study involving 150 qualified nurses working in government facilities and 150 nursing students in a Palestine University, the two groups had a statistical difference (p=0.001) on CPR competence. Despite the evaluated difference being statistically significant, the two groups had low scores as compared to the recommended American Heart Association score of above 84%. The qualified nurses scored 56.7 % while the student nurses scored 48.6%. In a study assessing diploma nursing students' knowledge on cardiopulmonary resuscitation, the findings indicated that no single student had poor knowledge. Above half (62%) of the students had good knowledge while 38% had adequate knowledge. The researchers noted that despite the students having good knowledge, the students required regular refresher training and practice to reach competency levels of practice (Vandali et al., 2018). According to Sabir (2017) quantitative experimental study at Lahore University in Pakistan, it was found out that post Registered Nurses (RN) Bachelor of Science in Nursing (BSN) student lacked basic knowledge on CPR practices. In the pretest assessment only 2 students (3.2%) attained a desired competence score. The rest 96.8% of the students were scored to lack the basic resuscitation knowledge and skills.

Globally studies have indicated that retention of CPR knowledge and skills is a big challenge. Cardiopulmonary resuscitation cognitive knowledge and hands on skills deteriorate rapidly 6-12 months after training with skills being the most affected (Saramma et al., 2016). Cardiopulmonary resuscitation knowledge and skills deteriorate rapidly if refresher training is not done regularly. In a study done at King Saud University among dental students, it was revealed that senior students' knowledge on CPR is inadequate as compared to junior students. In this study fifth year student scored lowest with a mean of 4.74, fourth year had a mean of 5.59 while third year students had a mean of 7.2 out of 10 (Alotaibi et al., 2016).

In a quasi experimental study done at a teaching hospital in New Delhi, pre-service and in-service nursing students were evaluated post training and after six weeks. The nursing students having had significant improvement theoretically and practically at post test, the study reveals that both groups had some reduction in knowledge and also skills when retested at six weeks post training (Sankar et al., 2013).

Locally few studies have evaluated nursing student's knowledge on cardiopulmonary resuscitation. A study done at Kenyatta National Hospital nursing training school compared cardiopulmonary resuscitation competence among the post basic nursing students. It involved a sample of 71 post basic nursing students who were grouped into two groups; those who had basic life support training and those who had advanced life support training. Upon being evaluated on the knowledge and skills on BLS, the students with advanced life support training performed better as compared to the ones with BLS training. However only 7.04% of the student attained a competency score of 84 % (Kipsang & Bruce, 2011). In a related study done in Nakuru County Referral Hospital among health care providers, 54.3% were shown to have low knowledge on CPR (Manono et al., 2021).

2.2.2 Specific CPR knowledge and skills gaps on cardiopulmonary resuscitation

Generally various studies have revealed that nursing students are deficient in their CPR knowledge and skills. Further studies have been done to evaluate specific knowledge on CPR which has identified various gaps to include understanding of common concepts. Basic life support is a common abbreviation that is even known to the lay people and is expected to be known by all health providers including students undertaking health sciences. In a study done in Nigeria among senior medical and nursing students, 12 % of them did not expand the BLS abbreviations correctly. This was identified as a major gap for senior health sciences students (Okonta & Okoh, 2015). Another study done in India assessing medical and nursing students on CPR knowledge, 17% of the nursing students could not expand the BLS abbreviations (Vausedvan et al., 2016).

In another study done in India among college of health sciences students, 96 % of the students were able to expand the BLS abbreviations (Sangamesh et al., 2017a). Another notable knowledge gap was in the recommended sequence of circulation , airway and breathing (CA) of BLS activities as recommended in the AHA guidelines 2020 (AHA, 2020). In the study by Sangamesh et al. (2017), 28% of the students did not know the recommended sequence of adult CPR. In the study by Amberkar et al., (2014), it was only 20 % of the medical students who were aware of the recommended sequence. In the study done in South India assessing nursing, dental and medical students on CPR, it was only 10.8% of the students who were aware of the update (Aroor et al., 2014). According to Vausedvan (2016) study in India, 40.7% of the nursing students did not know on the updated sequence of circulation, airway and breathing. According to a study done in a Saudi Arabian University, 59% of the nursing students were not aware of the updated BLS sequence (Alsharari et al., 2018).

In a case of cardiac arrest, before assessing a patient, the rescuer is supposed to scan the environment for his/her safety (Kleinman et al., 2015). In a pretest of a quasi experimental study done in a Turkey University, 84.6% of the nursing students did not scan the environment for their safety (Kose et al., 2019). In pulse assessment, it is

recommended that a rescuer should assess for carotid pulse in an adult within ten minutes (Kleinman et al., 2015). According to Sangamesh et al. (2017) study assessing nursing student's knowledge on CPR, 26% were not aware of the recommended point of pulse check. In a related study in Turkey among nursing students revealed that only 37.3% of the student nurses were aware of the pulse to be checked in an adult during CPR (Oktay, 2019). In another study at a tertiary institute in India, assessing nursing students knowledge on CPR,72.9% of the students were not aware of the adult carotid pulse assessment in CPR (Vausedvan et al., 2016). In a practical study in Egypt by Mohamed (2017), 81.8% of the students could not effectively assess for the carotid pulse in the case of cardiac arrest. According to Kose et al. (2019) study on nursing students' CPR skills, 76% of the students could not sufficiently assess the carotid pulse.

The correct hand position at the lower sternum during CPR is critical to ensure effective chest compressions (Kleinman et al., 2015). Okonta and Okoh (2015) in their study on theoretical knowledge of CPR found that 22% of the nursing students were not aware on the recommended position for placing hands during CPR. In a similar study by Sangamesh et al. (2017), 23% of the students were not aware of the recommended hand position during CPR. In a pretest post test study in Spain, 71.8% of the nursing students were aware of the correct hand placement during chest compressions at pretest (Alarc & Garc, 2021). According to Vausedvan et al. (2016), in their study assessing nursing student's knowledge on CPR, 39% were not aware of the correct lower half of the sternum position. In Egypt, a practical study by Mohamed (2017), 81.8% of the students did not have the correct hand placement during CPR.

The recommended chest compression of 100-120 per minute is vital for effective circulation to achieve and maintain the desired cardiac output (Kleinman et al., 2015). Sangamesh et al. (2017) in their study among students in the college of health sciences on knowledge of CPR aspects found that, 25 % of the students were not aware of the recommended number of chest compressions in a minute. In a study done at a nursing, dental and medical school assessing awareness of emergency medical services and basic life support, it was only 34 % of the students who were aware of the effective

compressions per minute (Aroor et al., 2014). In a related study done in a tertiary institute in India, 50.7% of the nursing students did not know on the recommended compression rate (Vausedvan et al., 2016). In a similar study done in Egypt by Mohamed (2017), 75% of the students did not perform the recommended chest compression. In a related study done in Turkey, at pretest 81.5% of the students did not perform effective chest compressions at the recommended rate and depth (Kose et al., 2019).

The current resuscitation guidelines recommend opening the airway via head tilt chin lift or jaw thrust maneuvers (Kleinman et al., 2015). The study findings further indicated that 48% of the students did not know how to assess for respirations in a cardiac arrest victim. In a practical exam done at a tertiary nursing institute in Egypt, a majority (61.4%) of the nursing students could not perform the maneuvers to open the airway. The study further indicated that 79.5% of the students could not effectively assess breathing within the recommended ten seconds (Mohamed, 2017). In the pretest stage of a quasi experimental study done in a Turkey University, 87.8% of the nursing students could not effectively perform the maneuvers of opening the airway. The study further revealed that 76.9% of the students did not sufficiently assess the respiration (Kose et al., 2019).

The recommended adult compression to ventilation ratio is thirty compressions to two breaths. This should be basic knowledge to students undertaking health related courses at the university level. In the study by Sangamesh et al. (2017), 23 % of the students were not aware of the recommended ratio. In a related study that was evaluating medical students on CPR knowledge, its only 1.2% of the students who were aware of the recommended chest compression to ventilation ratio (Kumari et al., 2014). In the study by Aroor et al. (2014), it was only 40% of the medical students who were aware of the recommended compression to ventilation ratio. According to a study done in Spain among nursing students, 71% were conversant with the desired compression to ventilation ratio (Alarc & Garc, 2021). As indicated in a similar study by Vausedvan et

al., (2016), 40.3% of the nursing students were not conversant with the effective chest compression to ventilation ratio.

A chest compression depth of 2-2.4 inches is recommended for effective cardiac massage. According to Sangamesh et al. (2017), 29% of the students were not aware of the recommended depth. In another study evaluating student nurses on CPR psychomotor knowledge and psychomotor skills, it was found out that many students could not perform chest compressions at the recommended depth (Roel & Bjørk, 2020). Another study done in the United states among nursing states showed that only 43.5 % of the nursing students knew the recommended cardiac compaction depth (Oermann et al., 2020). In a practical exam study by Mohamed (2017) in Egypt 70.5% of the nursing students did not carry out chest compressions at the recommended depth. The use of Automated External Defibrillation has been incorporated in basic life support (Zideman et al., 2015). In the study in India by Sangamesh et al. (2017), 45% of the students were not aware of what the AED abbreviations meant.

2.3 Factors influencing CPR knowledge and skills among nursing students

There are many factors that may foster or hinder the cardiopulmonary resuscitation knowledge and skills acquisition and retention.

2.3.1 Factors influencing CPR knowledge and skills

2.3.1.1 CPR training at primary schools, secondary schools, community training

Developed countries commence CPR trainings from primary schools and secondary schools. Basic life support is as well taught in the community to the lay people as majority of out of hospital cardiac arrests occur in homes. This implies that upon admission to a medical or a nursing school, the students already have prior knowledge and skills on basic life support. This prior exposure enhances that the learners gain mastery of the concepts once repeated at a tertiary level of training. The Prior knowledge

also fosters better resuscitation outcomes since the learners have adequate knowledge, skills and confidence (Napp et al., 2020; Saramma et al., 2016).

2.3.1.2 Requirement for admission to nursing training

Cardiopulmonary resuscitation training and certification is a requisite for admission to a nursing training program. In a systematic review study done at university of Central Florida, various studies indicate that it is a requirement to have a BLS certificate for one to be admissible to a school of nursing. Other institutions require that a nursing student should have basic life certification before starting clinical rotations and that the certification must be maintained throughout the training (Tirado, 2016)

2.3.1.3 Requirement for nursing employment

Globally most countries will require a qualified nurse to have a valid basic life support certificate to be among the requirements for employment. In some developed countries, basic life support and advanced cardiac life support certification is a requirement for nursing licensure acquisition and retention. This requirement ensures that student nurses are well prepared in their nursing training schools before qualification. In a systematic review study done at university of Central Florida, various studies cite that a valid basic life support certificate is provided upon employment. This provides a prove that a nurse is able to handle cases of sudden cardiac arrest (Tirado, 2016)

Research evidence has shown that cardiopulmonary resuscitation knowledge and skills deteriorate rapidly. To ensure that the health practitioners retain the knowledge and skills, the health regulatory bodies in developed countries require practitioners to have refresher trainings of basic life support every two years (Munezero et al., 2018)

2.3.1.4 Requirement for renewing practicing licenses

Nurses and other health care providers should always be updated in their CPR knowledge and skills. Most health professional bodies will require their members to

have valid basic life support and advanced cardiac life support certificates to ensure that their skills do not deteriorate. This requirement prompts the health workers to have BLS/ACLS refresher trainings every two years as per the American Heart Association training to remain practitioners (Pettersen et al., 2018).

2.3.2 Barriers to effective CPR practices among nursing students

2.3.2.1 Lack of certified BLS trainers

BLS and ACLS trainers' preparation is vital on the delivery of the content to the students. In a study done in Korea assessing CPR training for institution instructors, the study found out that of all the 62 instructors who participated in the study, its only 54.8% who were certified to provide basic life support training. This was a big instruction gap that could have affected the students' performance on CPR. The American Heart Association reviews the training guidelines every five years. Inadequate preparation of instructors leads to delivery of outdated information and practice (Sun & Young, 2016).

2.3.2.2 Lack of obligatory BLS certificate before clinical placement

Many counties require that the nursing and other health sciences students undergo a certified BLS training course to be able to manage cardiac arrest cases since nurses are the first to respond. A study done in Korea found out that it was only 21% of the nursing training institutions that had enacted the policy of BLS training before nursing students could start on their clinical placement. This implied that many students were not able to handle cardiopulmonary resuscitation procedure in the event of a cardiac arrest (Sun & Young, 2016).

2.3.2.3 Lack of refresher training

Evidence from studies indicates that cardiopulmonary resuscitation competence deteriorates rapidly from 3-6 months after training. Some schools of nursing offer

refresher training on BLS after training the students in the first years of training. Others require that the students maintain their BLS certificates on their own (Florida, 2018). According to Kim et al. (2016) in their assessment on Korean school of nursing, they found out that only 9.7% of the institutions offered BLS refresher training for their students. This was seen as a major barrier to effective CPR practices by the students (Sun & Young, 2016). Another research shows that having frequent short CPR trainings can enhance knowledge and skills retention. Practicing CPR for only 6 minutes a month for 12 continuous months can help nursing students to maintain their CPR competence (Sook et al., 2016). In a related study in a Nakuru county Referral Hospital, is was found out that refresher trainings had a significant effect p=0.000 on the CPR competence among the health care workers (Manono et al., 2022).

2.3.2.4 Negative attitudes towards CPR

Positive attitude toward clinical practice yields god outcomes. Negative attitude toward cardiopulmonary resuscitation has been shown to affect the nursing student's performance on the procedure. A study done at a college of Health Sciences in Ethiopia evaluating health sciences graduates on attitude and skills on CPR revealed that nursing students had poor attitude towards the practice which affected their CPR skills (Gebremedhn et al., 2017). According to Abolfotouh et al. (2017), negative attitudes affects chain of survival. Health care providers must be willing to attempt CPR when cases of arrest arise. In their study on evaluating impact of BLS training on health care workers attitudes toward CPR and defibrillation, the pretest score on attitude was 53.4% and 64.8% at post test. Although the rating was above average, the score was insufficient for effective resuscitation (Abolfotouh et al., 2017).

2.3.2.5 Lack of effective knowledge and skills transfer from qualified health personnel

Nursing and medical students are expected to enhance their learnt knowledge and skills at the clinical settings during clinical rotations. However, evidence from studies

indicates that practicing doctors and nurses are deficient on CPR competence and thus the mentorship is inadequate for effective knowledge and skills transfer. In a study done in Botswana, the following challenges were pointed out as affecting CPR practices; shortages of nurses and doctors, low staff patient ratios, inadequate and incomplete resuscitation equipment, no CPR guidelines, no resuscitation teams, and low CPR incompetence on the health providers (Rajeswaran & Ehlers, 2013).

In a local study done at Coast General Hospital Kenya, assessing CPR knowledge among 142 doctors, nurses and clinical officers, the study established that 75.9% had below average knowledge, 18.2% were average while only 5.8% had above average knowledge. When the knowledge was cross tabulated against their self rating on CPR practice, the knowledge had a statistical significant (P=<0 .001) effect on practice. These findings may impact negatively on the learning of the nursing students at the clinical settings (Ndung'u et al., 2019). A study done in Kashan University hospital Iran to evaluate effect of CPR practice revealed that all the clinical units lacked content on CPR theory and psychomotor skills. 82 % of the units had low knowledge and 71 % had low rating on skills (Shahrakivahed et al., 2015a)

2.3.2.6 Fear and lack of confidence

Despite the nursing students having learned CPR in class and skills laboratory settings, studies have demonstrated that students are fearful to do the procedure and also lack confidence. In a study in Wuhan China, it was found that students lack the confidence to do CPR thus its required that they have more practice to boost on their confidence and eliminate fear (Huang et al., 2016). According to a study done in Taiwan assessing final year medical students on readiness to perform CPR upon a cardiac arrest case, the study reveals that only 20.4% of the 255 students demonstrated confidence to undertake the live saving procedure. It was recommended that students should have simulated trainings to build up on the confidence levels (Guner et al., 2017).

2.3.2.7 Inadequate CPR training resources

To have effective CPR training, the institutions must have adequate training resources in terms of books, manuals, manikins, simulators among others. A study done in Nakuru County referral hospital showed that lack of adequate resuscitation materials had a significant effect p=0.000 on the CPR among the health care workers (Manono et al., 2022).

2.4 Cardiopulmonary resuscitation training and evaluation

Globally all medical and nursing schools appreciate the importance of cardiopulmonary resuscitation. They schedule CPR courses in the preclinical stages of training. A few schools retrain the students at their senior levels in preparedness for clinical practice upon qualification (Alkhalaileh et al., 2017). Gary et al. (2015) emphasize that certifying graduating nursing students on BLS and ACLS improves on clinical competence of handling cardiac arrest cases. They further note that certification bolsters on clinical decision making, clinical assessment, competence and prioritization of patient care.

Various methods are applied in teaching this procedure. Some technologically advanced schools use simulated mannequins and multimedia based visual aids. Many of the developing countries use the instructor led method with theory and some lab sessions. All students undertaking medical courses usually undertake the CPR training during the basic first aid course and are retrained at advanced critical care courses at their final year of training. The difference in training methods may yield different competence levels as simulated mannequins give prompt feedbacks (Demirtas et al., 2020).

2.5 Effect of certified CPR training on knowledge

Cardiopulmonary resuscitation training promotes theoretical information mastery and psychomotor skills acquisition and also facilitates retention of the acquired competencies (Shahrakivahed et al., 2015b). Various studies have shown that formal certified CPR training and retraining improve on nurses' CPR knowledge and skills. A

study done in Iran at a university hospital through lecture, manikins demonstrations and practice improved the nurses knowledge and skills significantly ($p < 0.05$) (Shahrakivahed et al., 2015a).

In a prospective research study done in India to assess the impact of formal certified CPR training, the findings were as follows; 82% indicated that the formal training improved on the knowledge (Saramma et al., 2016). In a pretest post test study done at a hospital in Uganda, a training done among nurses using AHA guidelines 2015 indicated that the training improved on the nurse's knowledge from a mean of 53.8% at pretest to 82.5% at post-test. This was a significant change with a p values of <0.001 (Munezero et al., 2018).

Nurses who are formally trained and certified perform cardiopulmonary resuscitation better than others. In a study done at Botswana to assess CPR knowledge among nurses at three district hospitals, the study indicates that the nurses who had a certified CPR training had better knowledge as compared to others who had informal training (Rajeswaran et al., 2018). According to a quantitative experimental study in a teaching hospital at Lahore Pakistan, sixty student nurses were taken through a formal workshop on cardiopulmonary resuscitation. A pretest post test design was applied. Upon subjecting the pretest and post test results on paired t-test, there results yielded strong significance ($p<0.001$) that indicated that the training impacted positively on the students knowledge (Sabir, 2017). Another study done in Taiwan through a quasi experimental design, revealed that after randomization of 169 nursing students into experimental and control groups, the experimental group later had better ($p=0.01$) knowledge as compared to the control group. The author from the study recommends that CPR training programs can improve on the nursing students knowledge, attitude and skills towards CPR (Lin, 2017).

In a hospital based quasi experimental study aimed at evaluating effectiveness of basic life support training education program for nurses in a Turkey hospital, it was found out that certification of nurses on CPR improves on their knowledge. A sample of 404

nurses was enrolled in the study where a pretest post test evaluation was done. Upon analysis using a paired t –test on their pretest posttest knowledge, the results yielded some significance ($p < 0.05$) indicating that the certification program was effective. From the study the recommendations are that hospitals should have regular effective BLS education programs for nursing students and staffs based on their unique role of responding to sudden cardiac arrest cases as compared to other health care workers (Terzi et al., 2017).

In a related study done in India among bachelors of Science in nursing students, the structured education program increased the mean knowledge score from 39.6% to 55.08 % with t value of 5.7 and $P<0.05$ (Gurung et al., 2020). The findings also mirror a study done in Spain among nursing students where a similar intervention changed the mean knowledge from 12.61 at pretest to 15.60, $p<0.001$(Alarc & Garc, 2021). In a related one group pretest posttest study at Kolkata India among third year nursing students, a structured education plan was deduced to be effective as it changed the mean CPR knowledge scores from 15.83 to 24.75. This yielded a statistical significance of < 0.05 (Syeda, 2020).

In another one group pretest post test study among diploma nursing students in India, the education program intervention was considered effective as it changed the level of CPR knowledge of the nurses. At pretest 64% had poor level, 16% average and to 20% good. This changed to 68% with good levels of CPR knowledge and 32% with average knowledge (Abdul-wahhab & Ahmed, 2020). Similarly, a study done in Brazil among undergraduate nursing students evaluating the effectiveness on an online training program showed significant improvement in the CPR knowledge and efficacy. The mean scores changed from 6.4 ± 1.61 out of 10 at pretest to 9.3 ± 0.82 at posttest (Tobase et al., 2017)

In another related study in Tanta University in Egypt, a similar intervention was effective in changing the levels of knowledge of the nursing students. At pretest stage, 89.3% had poor level, 8.7% average level and 2.0% good. Following the education

program, 0.7% had poor level, 12.7% were average and 86.7 had good levels of CPR knowledge (Ahmed & Farag, 2018). The findings also get along with a study done in Baghdad among nursing students where the mean knowledge changed from 23.18% to 52.58% following a structured education program (Abdulwahhab, 2017).

The effectiveness of the intervention is also mirrored in a study done in India among first year nursing students. At the pretest stage, 96.3% had poor level, 3.7% average and no student had good level of CPR knowledge. At posttest, the performance increased to 7.4% had poor levels, 30.9% had average level and 61.8% had good levels of CPR knowledge (Sharma & Sharma, 2017).

2.6 Effect of certified CPR training on skills

Cardiopulmonary resuscitation training promotes theoretical information mastery and psychomotor skills acquisition and also facilitates retention of the acquired competencies (Shahrakivahed et al., 2015b). Various studies have shown that formal certified CPR training and retraining improve on nurses' CPR knowledge and skills. A study done in Iran at a university hospital through lecture, manikins demonstrations and practice improved the nurses knowledge and skills significantly ($p < 0.05$) (Shahrakivahed et al., 2015a).

In a prospective research study done in India to assess the impact of formal certified CPR training improved on their skills by 56% (Saramma et al., 2016). In a pretest post test study done at a hospital in Uganda, a training done among nurses using AHA guidelines 2015 showed that the training improved on the nurse's skills from a mean of 46 % at pretest to 81.5% at post-test. This was a significant change with a p values of 0.02 (Munezero et al., 2018).

Nurses who are formally trained and certified perform cardiopulmonary resuscitation better than others. In a study done at Botswana to assess CPR knowledge and skills among nurses at three district hospitals, the study indicates that the nurses who had a

certified CPR training had better skills as compared to others who had informal training (Rajeswaran et al., 2018). According to a quantitative experimental study in a teaching hospital at Lahore Pakistan, sixty student nurses were taken through a formal workshop on cardiopulmonary resuscitation. A pretest post test design was applied. Upon subjecting the pretest and post test results on paired t-test, there results yielded strong significance (p=0.00) that indicated that the training impacted positively on the students skills (Sabir, 2017). In a hospital based quasi experimental study aimed at evaluating effectiveness of basic life support training education program for nurses in a Turkey hospital, it was found out that certification of nurses on CPR improves on their CPR skills. A sample of 404 nurses was enrolled in the study where a pretest post test evaluation was done. Upon analysis using a paired t –test, the results yielded some significance ($p < 0.001$) indicating that the certification program was effective (Terzi et al., 2017).

In a related one group pretest posttest study at Kolkata India among third year nursing students, a structured education plan was deduced to be effective as it changed the mean CPR knowledge scores from 15.58 to 25.41. This yielded a statistical significance of < 0.05 (Syeda, 2020).

In a related study in Kolkata India, the CPR education intervention among nursing students increased their infant CPR skills from 15.58 at pretest to 25.41 at post test with a t value of 19.89. The author of this study recommended that such trainings should be replicated to enhance the learners CPR skills (Syeda, 2020). The improved skills performance at posttest are comparable to a study done in brazil among nursing students where 90% assessed responsiveness, 98% exposed the chest, 97% assessed breathing, 76% shouted for help, 92% requested for a defibrillator, 77% checked for pulse, 87% had the correct hand placement, 95% made the right compression to ventilation ratio, 89% compressed at the recommended depth, and 97% operated the AED effectively (Tobase et al., 2017).

Another similar study done in Uganda among qualified nurses increased the skills performance from 46% at pretest to 81.5% at posttest following a CPR training (Munezero et al., 2018). In a similar fashion, a study done in Ethiopia in Tanta University deduced that a similar education program as being effective in improving the CPR skills among the nursing students. In the study at pretest, 88.7% had unsatisfactory scores, 10% had satisfactory scores and only 1.3% had good scores. After the education program, only 3.3% had unsatisfactory scores, 16.7 had satisfactory scores and 80% had good scores at posttest (Ahmed & Farag, 2018).

Similar study at Harvard showed similar outcome results after a programmed intervention. The overall compression scores were 42.76 at pretest and significantly $p<0.0001$ improved to 77.87. The compression depth increased significantly $p<0.0001$ from 58.98% to 88.69%. The compression rate increased significantly $p<0.0001$ from 42.03 to 54.74. Concerning the ventilations, the overall score increased from 19.06 to 70.61. The ventilation volume increased from 52.46% to 67.52% (Oermann, et al., 2020).

2.7 Research gaps

Evidence from the literature search indicates that, nursing students are deficient in their resuscitation knowledge and skills. The students have gaps on all the components of cardiopulmonary resuscitation that entail patient assessment, circulation, opening the airway and ventilations. To a larger extent, the student nurses have a big challenge in chest compressions that this research study should address to improve on the knowledge and skills gap.

Further researches indicate that the methods of cardiopulmonary resuscitation training and evaluation are also deficient. Cardiopulmonary resuscitation training should be done at regular intervals to ensure that the students remain updated. Many nursing training institutions only use the traditional methods of training. Simulated manikins have shown

to produce better outcomes for students. Many nursing training institutions do not offer certified trainings as recommended by the American Heart Association.

2.8 Theoretical framework

" A theoretical framework is a logically developed and connected set of concepts and premises developed from one or more theories that a researcher creates to scaffold a study" (Varpio& Elise, 2020). This study was guided by Patricia Benner's theory of nursing from novice to expert. The theory was developed in 1982 having been adapted from Dreyfus Model of Skill acquisition. Every year new graduates qualify from nursing schools and transit to be registered nurses. This transition to have nurses who offer quality and safe nursing care has been a challenge. To bridge this transition gap a mentorship program is required to facilitate the new nurses deliver optimal care. Patricia Benner's theory has been applied before to enhance competence among nurses. The theorist described five steps of nursing experience. These are novice, advanced beginner, competent, proficient and expert (Murray et al., 2019).

The novices have no experience and thus they are taught skills at the school. They rely on instructions from the trainer. They are taught on simple, objective and easy to follow tasks. They are taught on general rules to help the m perform tasks. The rules are independent of specific cases, context free and applied universally. The novice lack discretional judgment. They struggle to make decisions on the priority tasks since there is no concrete rule to regulate the performance. They lack self drive and have to be guided to perform tasks (Murray et al., 2019).

The advanced beginners are able to have some acceptable level of performance. They have gained some experience through practice or through mentorship. They are task oriented and aim at implementing the rules. Their scope is narrow rather than having a holistic patient approach. The nurses at this stage require a mentor to plan for patient care. Patricia Benner classified new graduates as new beginners (Brown, 2017).

The third level of nursing experience is the competent nurses. A competent nurse is one who has been on work for two to three years. They have gained experience over time and are self driven. They are more plan and goal oriented. They are conscious of their interventions and how they affect the patient care. They have deliberate interventions and have gained mastery of nursing practice. They are organized and effective in delivering nursing care (Murray et al., 2019).

The fourth stage is the proficient nurse. At this stage the nurse understands the situations as a whole not in parts. They have a more holistic understanding that improves on decision making. From experience they have learnt what to expect from different situations and the plans needed for each situation. They don't rely on the preset goals and as a result they have confidence in their knowledge and skills (Brown, 2017).

The fifth stage is the expert nurse. The nurse does not require following rules to understand the situation. They have an intuitive understanding of the clinical situation. They make prompt diagnosis without wasting time of going through alternative diagnosis. The nurses have a grasp of the situation and they foresee the unexpected. They have patient's priorities at heart (Brown, 2017).

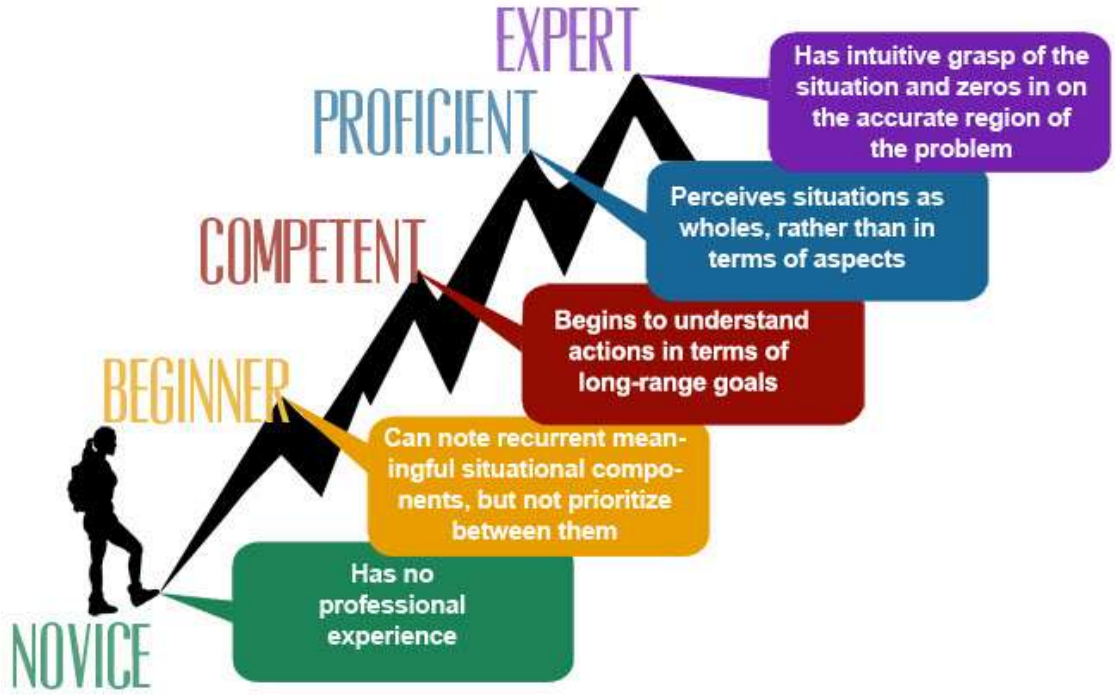

Figure 2.1: Patricia Banners theory from Novice to Experts

(Available online: http://xbrl.squarespace.com/journal/2019/8/6/from-novice-to-expert.html)

In the context of this study, the nursing students at third year are still novices. They still rely on directions to perform CPR. They may not initiate the procedure on themselves but with instruction or guidelines from a mentor they are able to perform the task. Upon qualification the new employees are still novices and take more time to be advanced beginners.

The intervention applied in this study was meant to offer a mentorship program to the senior nursing students who were almost joining the work force. The certified training helped the nursing students to achieve acceptable level of performance in offering adult cardiopulmonary resuscitation. The students were able to conceptualize the principles of cardiopulmonary resuscitation from the theoretical and practical training done through the research study. The students may not have become experts in performing

cardiopulmonary resuscitation. However from the training and practice done, the students could be termed to have attained the advanced beginner stage. They will be ushered into the employment as advanced beginners who will take less time to be competent, proficient and expert rescuers.

2.9 Epistemological perspective for the study

Research paradigms aid scientific discoveries through principles and assumptions (Park et al., 2020). The research methodology of this study adopted the positivist paradigm. The positivist philosophy asserts that you require an overt approach to understand the social world and that the researcher has to be an overt analyst (Zukauskas et al., 2018). In this view, the study objectively aimed at identifying the cardiopulmonary resuscitation knowledge of the students at selected KMTCs. The researcher objectively analyzed the pretest and post test scores of CPR to analyze the effectiveness of certified CPR training on the theoretical knowledge and skills.

According to Park et al. (2020) positivist approach can derive a cause – effect relationship through quantitative analysis of independent and dependent variables. With regard to the assertion, the researcher aimed at evaluating the effects of a moderating variable which was a prototype CPR training and certification on improving the learner's knowledge and skills. In a related study, the author indicated that positivist approach uses quantitative data and the data collection methods include tests, scales, half experiments and experiments. In line with this the researcher developed a multiple choice test to evaluate knowledge and an observation checklist which collected quantitative data for analysis. According to Zukauskas et al. (2018) positivist paradigms employs quasi experimental design, survey and experiments. The researcher adopted a quasi experimental design for the study. The study comprised of a control sample and a treatment sample in form of a certified cardiopulmonary resuscitation training that helped the novice transit to advanced beginners.

Positivist researchers uses existing theories to derive hypotheses that are empirically tested to generate knowledge (Saunders, 2016). The researcher utilized an existing theory by Patricia Benner from novice to experts. The null hypothesis generated was aimed at accepting or rejecting the effectiveness of the theory application in enhancing cardiopulmonary resuscitation knowledge and practices among KRCHN students at KMTCs. Positivist researches are aimed at eliminating confounders so that there is an actual causal effect relationship (Park et al., 2020). In this study the researcher used third year nursing students and a census method was applied to avoid selection bias which would affect the predictor effect. Students who would have done a certified BLS course could have been excluded during analysis stage since they would have been outliers.

The positivist paradigm is very practical in this study in that it guided on objective and hypothesis development. It also guided in research methods of the study to include, research design, data collection methods and analysis to aid in hypothesis testing.

2.10 conceptual framework

The conceptual framework of the study was informed by Patricia Benner theory. The conceptual framework directed that the intervention of a certified BLS training was meant to usher the novice third year students who had low levels of cardiopulmonary resuscitation knowledge and skills to advanced beginners who had a better capacity to handle cardiac arrest cases on their own. This meant that upon graduation, the fresh graduates were to join the work force as new beginners but not as novices.

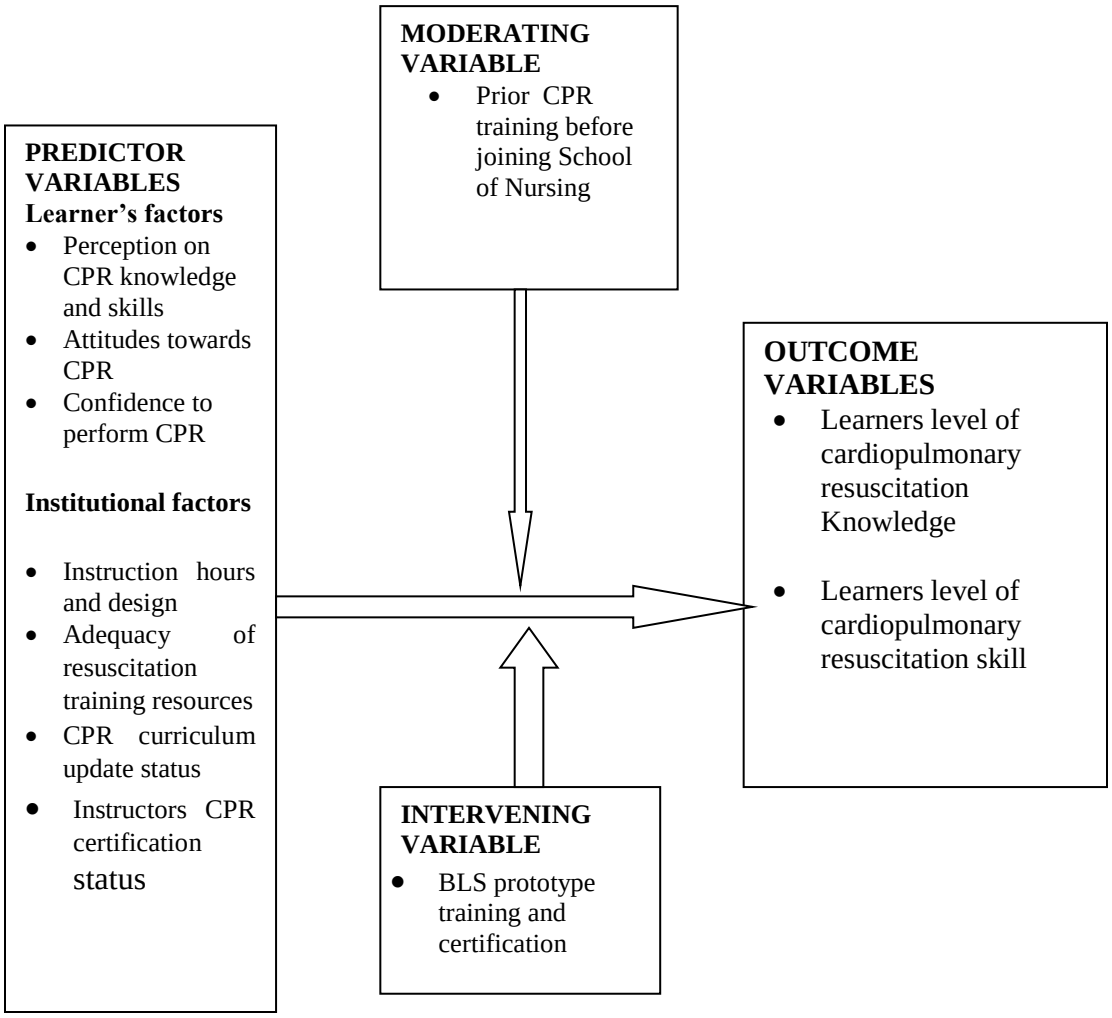

Figure 2.2: Conceptual Framework

Author: Wambugu (2020)

CHAPTER THREE

MATERIALS AND METHODS

3.1 Introduction

This chapter presents the research methods that were applied in this study. This includes the research design, research area, population of interest, sample, sample size calculation, data collection methods, data entry, cleaning, analysis and interpretations. It also entails the ethical considerations adhered to in the study.

3.2 Research design

A pre-test post-test nonequivalent quasi experimental design was applied in the study (Figure 3.1). The design shares similarities with a pretest posttest control group of true experimental design except that it lacks random assignment of subjects. Quasi experimental design involves manipulation of predictor variables without randomization of subjects. Existing or intact groups are used for the study groups. Quasi experimental designs are advantageous in that using naturally existing groups, the real world is easier approximated than in randomly assigned groups (Nieswiadomy, 2018). The design also provides a good cause effect relationship with a high degree of external validity (Bärnighausen et al., 2017).

The design was chosen because there was no random assignment of the groups to fit into a true experimental design. However naturally existing groups were used and assigned into experimental and control groups. The experimental group had prototype CPR training and certification was done to participants who achieved the desired competence. This study involved a pretest post test design with three stages in the implementation. The main limitation of the main limitation of pre-test post-test design is the element of recall bias. To navigate this, questions were shuffled and the post-test evaluation was done six months later.

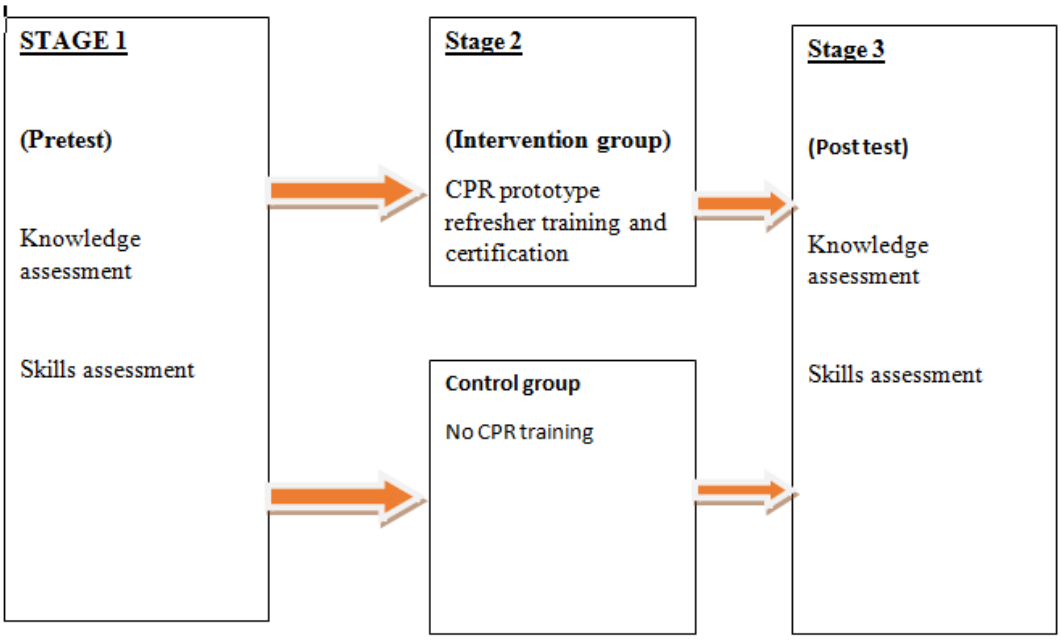

Figure 3.1: Research design

3.2 Study Area

The study was carried out in selected campuses of Kenya Medical Training College. KMTC was founded in 1927. KMTC has 71 campuses nationally offering 17 diploma and certificate programs and other short courses. KMTC is the lead trainer in the health sciences in Kenya as compared to other health training institutions. It produces approximately 85% of the health work force in Kenya making it a good study site for this study. During the 87th graduation held on 5th December 2019, a total of 12621 students graduated from various departments. Out of the total number of graduates, over 2000 were nurses. The institution is run on semester basis. Semester one runs from September to late January. The second semester starts from early February to late July. The number of campuses was determined based on the sample size calculated. Four KMTC institutions were conveniently selected that had the capacity for the sample size calculated since the study findings were aimed at replicability. The institutions were Nyeri KMTC, Thika KMTC, Murang'a KMTC and Embu KMTC. The four institutions had fully established skills laboratories and the students practice in level five hospitals

where they have had real life experiences on resuscitation situations. All the institutions utilize different clinical training sites and thus there was no foreseen contamination.

Nyeri KMTC was started in 1947 as part of the Nyeri Provincial General Hospital which is currently Nyeri County Referral Hospital with Enrolled Nursing program (EN). In 1975 the institution started the Enrolled Community Health Nursing (ECHN) program and later in 1995 they started the diploma in Kenya Registered Community Health Nursing (KRCHN). Other programs offered are diplomas in clinical medicine, medical laboratory technology, pharmacy, medical imaging and environmental health sciences.

Thika KMTC was started in 1969 with ECHN training with the support of Norwegian government. Later in 1995 they started KRCHN upgrading program. The institution also offers diploma courses in clinical medicine, nutrition and dietetics, orthopedics and higher diplomas in critical care nursing and anesthesia. They also offer certificate course in nutrition and dietetics and orthopedic plaster technology. In addition they also offer short courses in infection prevention and control, HIV training and counseling services and nutrition in critical care.

Murang'a KMTC was started in 1950's with a training of Enrolled Midwifery (EM) program. Later in 1960's the institution started training Enrolled Nursing program which were later replaced by ECHN program in 1977. In 2005, they started KRCHN program and later in 2013 they enhanced the program to Kenya Registered Nursing/ Mental Health and Psychiatry. The institution also offers diploma in health information records and clinical medicine and surgery.

Embu KMTC was started in 1975 by missionaries as a health training college and later in 1987 the KMTC management took over. The institution currently offers diplomas in Community Health Nursing, Clinical Medicine and Surgery, Medical Laboratory Sciences and Environmental Health Sciences. They also offer a higher diploma in clinical medicine and surgery.

3.3 Study Population

The population of interest in the study was third year nursing students in their first semester of study. At this stage the students had been taught on first aid and basic life support in first year of training and had clinical experience on resuscitation. Thika KMTC had a class capacity of 55 students while Nyeri, Embu and Murang'a KMTCs had a capacity of 50 students respectively. This created a population of 205 students. However during recruitment stage, the available students in Embu were 34 while in Murang'a was 36. This created an actual population of 175 students. A simple random method was applied and assigned Thika and Embu KMTC campuses into experimental groups while Murang'a and Nyeri into control group. The choice of this population was based on the fact the students were completing their diploma in nursing study and thus their preparedness to offer cardiopulmonary resuscitation in practice was vital. The population of study had no previous certified cardiopulmonary resuscitation training and thus minimized confounders. There was no student who had done the training privately and thus there were no outliers. This population was fit for the study to evaluate on the effectiveness of the intervention administered.

3.4 Sample Size determination

The calculation of the Sample size was guided by the main statistical test that evaluated the difference between post test and pretest. In this study a student t-test was used to evaluate significance between the pretest and posttest. The following steps were used when calculating sample size while using t –test (Hulley & Cummings, 2013)

Sample size calculation

Sample size was calculated based on beta, power, and alpha, standardized effect size and then use statistical table to identify sample size.

Steps in calculating sample size for t-test

1. Develop the null hypothesis and indicate the direction whether it is one- or two sided.
2. Estimation of the effect size (E) which is the difference in the mean value of the outcome variable between the treatment and control groups.
3. Estimation of the study variability of the study outcome variable. Standard deviation (S) is approximated from previous studies.
4. Calculation of the standardized effect size (E/S). This is calculated by the effect size divided by the standard deviation of the outcome variable.
5. Set α and β.

Calculation

1. H_0: CPR training and certification does not enhance knowledge and skill acquisition
2. H1: one sided
3. A previous study had mean difference of 8.07, sd 2.26 (Kim &Ahn,2019). The researcher wanted a 10% or more difference in the outcomes.
4. Effect size =10/100 * 8.07 = 0.807
5. Standard deviation = 2.26
6. Standardized effect size = effect size/standard deviation = 0.807/2.26 = 0.4
7. α – set at 0.05, power 0.80. power = 1-β thus 0.80 = 1- β so β = 0.20
8. From the table (annexed) for a one tailed test, the sample size was 78 for each group. This means that each group must had a minimum of 78 students for the desired effect to be achieved.
9. The calculations informed the use of four KMTC campuses since they had approximately 200 students

3.5 Sampling Procedure

3.5.1 Sampling of the study institutions

Convenient sampling was applied based on anecdotal evidence that the practice of CPR was low. Also the sampled study sites had high capacity of students and the students practiced at level 5 hospitals. Embu, Nyeri, Murang'a and Thika KMTCs were sampled for the study. A lottery technique of simple random sampling was used to allocate two institutions in experimental group and the other two into control group. Four papers were written indicating the institutions and they were randomly picked to assign the institutions into the two groups. This simple random exercise assigned Thika and Embu KMTC campuses as intervention sites while Nyeri and Murang'a campuses were assigned to be control sites. Simple random sample ensures that all subjects have equal chances of being allocated in each group.

3.5.2 Sampling the students

Since the research activity was undertaken within the clinical teaching semester, a census method was used whereby all available students undertaking the clinical rotation were involved in the study. Out of the expected 205 students, only 175 availed themselves for recruitment to participate in the study. Students were engaged while off duty or over the weekends (Table 3.1).

Table 3.1: Participant's distribution

	Participants distribution		
Group	**Campus**	**Frequency**	**Percent**
Intervention	Thika KMTC	55	31.4
	Embu KMTC	34	19.4
Control	Nyeri KMTC	50	28.6
	Murang'a KMTC	36	20.6
	Total	175	100.0

3.6 Inclusion and Exclusion Criteria

Inclusion criteria

i. Nursing student undertaking third year of study
ii. Students registered for the semester for easier follow up
iii. Students who consent to participate in the study

Exclusion criteria

i. Students who would have had prior BLS certification would have been excluded to avoid skewing the results

3.7 Data collection tools

A 40 multiple choice questions exam and a 20 points observational checklist were the main data collection tools. Both tools were based on the 2020 American Heart Association guidelines on cardiopulmonary resuscitation. The multiple choice questions were used to evaluate the learner's knowledge on cardiopulmonary resuscitation. Multiple choice questions were chosen since they were able to evaluate knowledge widely in limited time and they are also inexpensive to administer (Klufa, 2015).

A customized structured observation checklist to evaluate on the cardiopulmonary resuscitation skills was also used. The checklist was based on the 2020 American Heart Association algorithm that illustrates on the steps of performing cardiopulmonary resuscitation. Practical evaluations are highly objective in assessing hands on skills. They also measure the students ability to integrate between knowledge and skills (Klufa, 2015).

3.8 Validity and reliability of data collection tools

To ensure that the research tools were valid and reliable, a pretest was conducted at Mathari KMTC. Mathari KMTC was conveniently chosen since it was similar to the

study sites in that the students shared admission criteria and was at the same level of nursing training. Twenty three students were recruited during pretesting the tool. A study done to calculate the sample size for pretesting questionnaires showed that the normally used sample of 5-15 fail to achieve a power of 60% in detecting a problem. The study further revealed that a sample size of 20-30 yields to a power of 80% in detecting a problem (Perneger et al., 2015).

The reliability of a research instrument has to be checked to ensure that the instrument is of quality and adequate in evaluating a situation of interest (Polit, 2013). To ensure reliability of the instruments, a test retest evaluation was done. The questionnaires were serialized and assigned to specific students. The students filled in the questionnaires and were marked. After three weeks the same questionnaires were administered again and marked. Test retest reliability coefficient was calculated that yielded a Cronbach's Alpha of 0.995 which indicated that the tool was reliable as shown in the table 3.2 below. The observation tool is globally utilized and its validity and reliability has been tested (AHA, 2020)

Table 3.2: Test re-test reliability

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.995	.996	2

The instrument validity is the second most important criterion of evaluating a quantitative instrument. An expert review by two nurses with Masters of Science in nursing in critical care was done and the tools were evaluated to have face, content and concurrent validity. These experts had vast knowledge and experience in emergency and critical care for a couple of years.

3.9 Data collection Procedure

The data collection was done in three phases. The research instruments were serialized and the codes allocated to the students for consistency in data collection phases.

3.9.1 Selection and training of research assistants

The data collection procedure commenced with recruitment of research assistants. Four research assistants were recruited to aid in the data collection process. They were Bachelors of Science nurses with valid BLS certificates. Each assistant assisted in collecting data in one study site. They were trained on the study purpose and the methodology that was utilized in the study.

3.9.2.1 Phase 1 (Baseline assessment)

This phase entailed collection of baseline data. A multiple choice question examination with 40 points was administered at the beginning of the semester to the students. The tool evaluated on cardiopulmonary resuscitation knowledge of the senior nursing students. A structured observation check list was also used to assess the student's psychomotor skills on carrying out cardiopulmonary resuscitation skill. The tool was based on the 2020 American Heart Association algorithm. The participants were given a case scenario and they demonstrated the resuscitation procedure on the Little Ann manikins at the skills laboratory. The observation tool had 20 steps of evaluation. Participants were also given a likert scale questionnaire where they scored on various factors that influence cardiopulmonary resuscitation knowledge and skills. This phase was conducted in two weeks.

3.9.2.2 Test of baseline CPR knowledge data distribution

The pretest scores for both groups were subjected to a normality test to determine the distribution of data. Kolmogorov –Smirnov test was used to test the distribution. The distribution for the intervention group was normal ($p>0.05$) while the distribution for the

control was not normally distributed (p<0.05) as indicated in table 3.3. The distribution of the data between the groups being mixed, non parametric test was used to compare the means between the intervention and the control groups.

Table 3.3: CPR knowledge pretest data normality test

Tests of Normality For Pretest CPR Scores Group		Kolmogorov-Smirnov[a]		
		Statistic	**df**	**Sig.**
Intervention	Pretest CPR knowledge	.092	89	.058
Control	Pretest CPR knowledge	.104	86	.021

a. Lilliefors Significance Correction

3.9.2.3 Comparison of group's CPR knowledge at pretest

The data of the intervention group having been normally distributed and for the control group skewed, the pretest CPR knowledge scores were subjected to a Mann Whitney test to compare whether the intervention and the control groups were homogenous at the beginning of the study. The significance level was p=0.87 indicating that the intervention and the control groups had no significant CPR knowledge difference at the beginning of the study (Table 3.4).

Table 3.4: Comparison of group's pretest CPR knowledge

Test Statistics[a]	
	Total CPR knowledge percentage
Mann-Whitney U	3774.000
Wilcoxon W	7779.000
Z	-.159
Asymp. Sig. (2-tailed)	.874

a. Grouping Variable: Group

3.9.2.4 Baseline CPR skill scores normality test

The skills performance scores were tested for distribution using Kolmogorov-Smirnov test. The distribution of the intervention group was normally distributed (p>0.05) while the distribution for the control group was skewed (p<0.05) as indicated in table 3.5. The

distribution in the groups having been mixed, a non parametric test was used to compare the means of the pretest skills performance to determine whether the two groups were homogenous at the beginning of the study.

Table 3.5: Pretest CPR Skill scores normality test

Tests of Normality				
Group		Kolmogorov-Smirnov[a]		
		Statistic	df	Sig.
intervention	Total CPR pretest skills percentage	.090	89	.072
control	Total CPR pretest skills percentage	.128	86	.001

a. Lilliefors Significance Correction

3.9.2.5 Comparison of CPR skills between the groups at baseline

The pretest skills performance data having not been normally and skewed distributed, Mann Whitney U test was used to compare whether the two groups had significant CPR skills difference at the beginning of the study. The findings from the test indicated that the two groups had significant skills difference ($p < 0.05$) at the beginning of the study. However, the difference between the two groups was very small as indicated by an effect size of 0.15 measured using Cohen d (Table 3.6).

Table 3.6: Independent samples Mann Whitney U Test

Hypothesis Test Summary				
Null Hypothesis	Test	Sig.	Decision	Effect size
The distribution of total skills percentage is the same across categories of Group.	Independent-Samples Mann-Whitney U Test	.041	Reject the null hypothesis.	Cohen d= 0.15

Asymptotic significances are displayed. The significance level is .050.

3.9.3 Phase 2 (Intervention)

The intervention phase was conducted to the experimental group only. This phase took two months. Students were given BLS manuals for health providers to read on their own to revise on the concepts for a period of two weeks. During off times tutorials were organized and also the students were taken through practical sessions. Trainings were done by the researcher who was a proficient basic life support provider. The students were taken through five tutorials sessions. There was collaboration with Avenue Rescue Services an accredited AHA training agency for evaluation (Appendix VII). This was conducted a day (8 hours) each for the two intervention sites. The competency score was 84% as recommended by AHA. A total of 69(79.3%) of the students in the experimental group achieved a score of 84% and above and were awarded with AHA BLS certificate for health providers viable for two years as indicated in the table 3.7 below.

Table 3.7: BLS certification

BLS certification		
Performance	Frequency	Percent
Fail	18	20.7
Pass	69	79.3
Total	87	100.0

3.9.4 Phase 3 (Post -test)

Data collection at this phase was carried out six months after the intervention. The six months gave the students ample time to practice the skills in the skills lab and also practically in the clinical setting. The data collection in this phase took a month. Same instruments used in pretest were utilized to collect data though the questions in the questionnaire were shuffled. The post test was also administered to the control group at the same time as the experimental group.

3.9.4.1 Test of normality for post test CPR knowledge scores

The CPR knowledge posttest data was also tested for normality using the Kolmogorov-Smirnov test. The intervention group data was not normally distributed ($p<0.05$) while the control group data was normally distributed ($p >0.05$) as indicated in table 3.8. The mixed distribution informed the use of non parametric test while comparing the effects of the intervention on the CPR knowledge of the senior nursing students.

Table 3.8: Posttest CPR knowledge scores normality test

Tests of Normality				
Group		Kolmogorov-Smirnov[a]		
		Statistic	df	Sig.
Intervention	Posttest CPR knowledge	.114	81	.011
Control	Posttest CPR knowledge	.084	83	.200*

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

3.9.4.2 Test of normality for posttest CPR skill scores

The posttest CPR skills scores were tested for normality using the Kolmogorov-Smirnov test. Both the intervention and the control group data were not normally distributed since the significance levels were <0.05 rejecting the null hypothesis (Table 3.9). The skewed distribution informed the use of non-parametric test while comparing the effects of the intervention.

Table 3.9: Posttest CPR skill scores normality test

Tests of Normality				
Group		**Kolmogorov-Smirnov[a]**		
		Statistic	**Df**	**Sig.**
Intervention	CPR skills percent	.155	170	.000
Control	CPR skills percent	.119	169	.000

a. Lilliefors Significance Correction

3.10 Data management

Data management involved data sorting, data entry, data cleaning, analysis, presentation and interpretation.

3.10.1 Data sorting

The questionnaires and the observation check lists were first sorted according to the issued serial numbers to facilitate systematic data entry. This enhanced easier data cleaning as well.

3.10.2 Data entry and cleaning

The data gathered from the tools was entered in epi data software version 3.1. The software utilizes checks thus it helped to clean and correct erroneous data.

3.10.3 Data analysis

The data in epi data software was exported to Statistical Package for Social Sciences (SPSS) version 26. Descriptive statistics such as mean, percentages, mode and standard deviation were used to analyze knowledge and skills scores on various aspects of cardiopulmonary resuscitation among the students.

Various inferential statistics were applied to test associations and relationships within the study. Mann U Whitney test was done after pretest to compare knowledge and skills level between the experimental and control groups. Spearman Rho correlation and logistic regression were used to analyze factors influencing CPR knowledge and skills acquisition such as BLS lecture time, skills lab demonstration time, clinical practice, BLS resources etc. influence CPR knowledge and skills acquisition among the students. Paired t-test and Wilcoxon rank test were used to analyze CPR learning independently for experimental and control groups. For the purpose of testing hypothesis whether CPR training and certification enhanced knowledge and skills, unpaired t-test and Mann U

Whitney test were used. In the case where the data was not normally distributed, Mann Whitney U test was used to test the hypothesis. Statistical significance was set at $p<0.05$ so that the results have universally acceptable levels of accuracy. The summary of data analysis is shown in table 3.10.

Table 3.10: Data analysis summary

	Objectives and other parameters of analysis	**Study variables**	**Section in the questionnaire / observation check list**	**Statistical test**
1	Demographic characteristics	Age, gender, previous CPR exposure	Questionnaire section A	Count and percentage
2	To assess CPR baseline knowledge and skills of senior Kenya Registered Community Health Nursing students at Kenya Medical Training College	Pretest CPR knowledge	Questionnaire section B Observation check list part 1-4	Mean, standard deviation, mode, two sample t-test
3	To assess factors influencing CPR knowledge and skills acquisition among senior KRCHN students	CPR challenges vs. post test analysis	Questionnaire section A and D	Logistic regression, Spearman Rho'
4	To evaluate outcomes of CPR training and certification on knowledge acquisition	Pretest knowledge tabulated with post test knowledge	Questionnaire part B	Mean, paired t –test/ Mann Whitney U test
5	To evaluate outcomes of CPR training and certification on skills acquisition	Pretest skills Vs post test skills score	Observation check list part 1-4	Paired t –test/ Mann Whitney U test
5	To test the hypothesis	Post test scores on knowledge and skills	Analysis of post test multiple choice exam and practical exam	Unpaired t-test
6	To assess the relationship between posttest knowledge and skills	Knowledge vs. skills	Analysis of posttest	Pearson correlation

3.10.4. Data Presentation

The analyzed data was presented in tables, figures and narrative.

3.11 Ethical Considerations

Various issues were addressed to ensure that the study observed all the ethical principles. Having worked with the supervisors, the proposal was subjected to Kenyatta University Ethics and Research committee and approval granted Ref No: PKU/2166/E1310. Having passed the ethical review stage, approval was sought and granted from National Commission for Science and Technology Innovation (Nacosti) Ref No: 430422. To have access to the training sites, approval was granted by Kenya Medical Training College head quarters to be allowed to carry out the study in their institutions. The study subjects were enlightened on the study and they signed consent in agreement to participate in the study. All the ethical principles were adhered to.

Autonomy

The respondents made an informed choice and consented to participate in the study having been given all the information concerning the study.

Justice

All respondents were treated fairly. The respondents who withdrew from the study were not victimized.

Beneficence

The study aimed at improving the senior nursing skills on CPR which will eventually save lives of patients who suffer sudden cardiac arrest. The study participants benefited with a BLS certificate for health care providers.

Non-maleficence

The study posed absolutely no risk to the study participants.

Privacy and confidentiality

Privacy and confidentiality was maintained all through the study and data collection tools remain anonymous with serial numbers.

Covid-19 considerations

To ensure safety of the participants, the training was done in subgroups to ensure safe distancing was maintained. The participants were provided with surgical masks and sanitizers. Hand washing and sanitization was adhered to before and after the procedures. Disinfection of the study manikins was also done before and after every procedure.

3.12 Study Assumptions

The researcher assumed that the selected training institutions were a true representation of other Kenya Medical Training Colleges in Kenya and that the study findings will be replicated based on the outcomes.

3.13 Dissemination of research findings

The research findings were disseminated to Kenya Medical Training College headquarters, KMTC study sites administration and Jomo Kenyatta University of Agriculture and Technology School of Nursing Sciences. The findings have also been disseminated in East African Medical Journal and African Journal of Health Sciences.

3.14 Limitations of the study

The main limitation of the study was that only four campuses of Kenya Medical Training College were involved in this study. Thus, the findings of the study may not be a true reflection of cardiopulmonary resuscitation preparedness for all the graduating diploma nursing students in Kenya. The sampling method used was also a limitation since it may have selection bias.

The findings thus lack generalizability though the study methodology and recommendations can be replicated by other training institutions.

Another limitation of the study was the research design. The control group also had some increases in knowledge and skills at post-test indicating a weakness of the design.

CHAPTER FOUR

RESULTS

4.1 Introduction

This chapter presents findings of the quasi experimental study conducted in the four campuses of Kenya Medical Training College. The results comprise of 89(50.9%) participants in the intervention group and 86(49.1%) in the control group.

4.2 Demographic characteristics

4.2.1 Participants' age and gender distribution

The modal class for participant's age in both groups was 21-25 years with 59(66.3%) participants in the intervention group and 73(84.9%) in the control group as indicated in table 4.1 below. Majority of the participants in both groups were females with 55(61.8%) in the intervention group and 53(61.6%) in the control group (Table 4.1).

Table 4.1: Age and gender distribution

Demographics	Response	Intervention group	Control group
Respondents age	15-20	4(4.5%)	2(2.3%)
	21-25	59(66.3%)	73(84.9%)
	26-30	24(27.0%)	10(11.6%)
	31-35	2(2.2%)	1(1.2%)
	Total	89(100%)	86(100%)
Respondents gender	Male	34(38.2%)	33(38.4%)
	Female	55(61.8%)	53(61.6%)
	Total	89(100%)	86(100%)

4.2.2 Basic life support (BLS) training

Nearly all the participants in both groups; intervention 85(95.5%) and control 82(95.3%) indicated that they had previous BLS training. On where they had learnt the BLS skills, more than three quarters of the participants in both groups; intervention 66(77.6%) and

control 76(92.7%) indicated that they learnt in their colleges while the rest had learnt in the clinical settings. In addition, all the participants in both groups did not have basic life support certification as shown in table 4.2.

Table 4.2: Basic Life Support Training and Certification

BLS training aspects	Response	Intervention group	Control group
Previous BLS training	Yes	85(95.5%)	82(95.3%)
	No	4(4.5%)	4(4.7%)
	Total	89(100%)	86(100%)
Place of training	KMTC	66(77.6%)	76(92.7%)
	Clinical settings	19(22.4%)	7(7.3%)
	Total	85(100%)	82(100%)
BLS certification	Certified	0(0%)	0(0%)
	Not certified	85(100%)	82(100%)
	Total	85(100%)	82(100%)

4.3 Baseline knowledge on cardiopulmonary resuscitation

The participants were administered with a 40 item questionnaire comprising of multiple choice and true/false questions. The questions assessed general principles of basic life support, circulation, airway, breathing and the use of an automated external defibrillator.

4.3.1 Baseline knowledge on general cardiopulmonary resuscitation principles

Table 4.3 gives findings on general cardiopulmonary resuscitation knowledge at pretest.

The participants were expected to choose the correct expansion of BLS initials. Majority of the respondents in both groups; intervention 85(96%) and control 74(86%) were able to expand the abbreviations. In addition majority; intervention 87(98%) and control 84(98%) were not updated on the recommended BLS sequence which is circulation, airway and breathing (CAB).

The adult compression to ventilation ratio is 30:2 irrespective of the number of rescuers. Majority of the participants in both groups; intervention 64(72%) and control 55(64%) were not aware of the ratio for a single rescuer. A similar question on adult compression to ventilation ratio of 30:2 for two rescuers was also tested. Majority of the participants in both groups; intervention 53(60%) and control 48(56%) were aware of the recommended ratio

Rescuers should alternate roles after every 5 cycles of CPR. Majority of the participants in both groups; intervention 77(87%) and control 60(70%) were not aware of this recommendation. There are two chains of survival; In-hospital and out of hospital chains. Majority 50 (56%) of participants in the intervention group were aware of the steps of in hospital chain of survival while a majority 54(63%) in the control group were not aware.

Most out of hospital cases of cardiac arrest occur at homes. Majority 50(56%) of the participants in the intervention group were aware of this happening while majority 54 (63%) in the control group were not aware. The foundation of basic life support is high quality chest compressions. Majority of the participants in both groups; intervention 65(73%) and control 67(78%) were not aware of this foundation of CPR.

A single rescuer should be positioned at the victim's side while performing CPR. Majority of the respondents in both groups; intervention 62(70%) and control 63(73%) were aware of this recommended position. The first step in a case of a sudden cardiac arrest is checking for scene safety. Majority of the participants in both groups; intervention 61(69%) and control 53(62%) were not aware of this initial step.

A rescuer should check for responsiveness before assessing for pulse and breathing. Majority of the respondents in both groups; intervention 75(84%) and control 73(85%) were not aware of this step. The duration between compressions and ventilation should be limited to less than 10 seconds to maintain perfusion to vital organs. Majority of the participants in both groups; intervention 59(66%) and control 70(81%) were not aware

of this recommendation. Most inexperienced rescuers fear performing CPR to avoid hurting the victims. Majority of the respondents in both groups; intervention 54(61%) and control 65(76%) were aware of this fear.

Table 4.3: Pretest knowledge on general BLS principles

Questions	Responses	Intervention		Control	
		Count	Column N %	Count	Column N %
1. Expanding BLS initials	Wrong	4	4%	12	14%
	Correct	85	96%	74	86%
2. BLS sequence	Wrong	87	98%	84	98%
	Correct	2	2%	2	2%
3. One rescuer adult compression ventilation ratio	Wrong	64	72%	55	64%
	Correct	25	28%	31	36%
4. Two rescuer adult compression ventilation ratio	Wrong	36	40%	38	44%
	Correct	53	60%	48	56%
5. Cycles to alternate CPR roles	Wrong	77	87%	60	70%
	Correct	12	13%	26	30%
6. In hospital adult chain of survival	Wrong	39	44%	54	63%
	Correct	50	56%	32	37%
7. Where out of hospital cardiac arrest mostly occur	Wrong	50	56%	46	53%
	Correct	39	44%	40	47%
8. Foundation of CPR	Wrong	65	73%	67	78%
	Correct	24	27%	19	22%
9. Position for a lone rescuer	Wrong	27	30%	23	27%
	Correct	62	70%	63	73%
10. First step in a case of cardiac arrest	Wrong	61	69%	53	62%
	Correct	28	31%	33	38%
11. Checking for responsiveness before doing CPR	Wrong	14	16%	13	15%
	Correct	75	84%	73	85%
12. Limit interruptions to less than 10 seconds	Wrong	59	66%	70	81%
	Correct	30	34%	16	19%
13. Fear holding people from doing CPR	Wrong	35	39%	21	24%
	Correct	54	61%	65	76%

4.3.2 Baseline Knowledge on circulation

Table 4.4 presents findings on circulation knowledge at pretest.
Adult chest compressions should have a depth of 2-2.4 inches or 5 cm to facilitate optimal manual heart pumping. Majority of the respondents in both groups; experimental 63(71%) and controls 64(74%) were not aware of this recommendation. The pulse and breathing check should be done simultaneously for a period of between 5-10 seconds. Majority of the participants in both groups; experimental 64 (72%) and control 73 (63%) were not aware of this timing recommendation.

Pulse check in an adult should be assessed on the carotid artery. Majority of the participants in both groups; experimental 71(80%) and control 50 (58%) were not aware on the recommended artery to check the adult pulse. To ensure optimal perfusion, it is recommended that the chest compressions should be within a rate of 100-120 per minute. Majority of the participants in both groups; experimental 73 (82%) and controls 65 (76%) were not aware of this recommendation. While assessing the pulse, if a rescuer misses the pulse the next step is to continue with CPR. In the intervention group, 51(57%) were aware of this resuscitation step while 46 (53%) of the control group were not aware.

Chest compressions should be done on a firm surface to optimize compression depth and facilitate blood circulation. A majority of the participants in both groups; experimental 47(53%) and controls 54(63%) were not aware of this recommendation. To ensure the compressions achieve optimal cardiac output, the hands should be placed on the lower half of the sternum. Most of the participants in both groups; experimental 72(81%) and controls 66(77%) were aware of this positioning. After chest compressions the rescuer should allow for chest recoil to facilitate blood circulation in the heart. Most of the participants in both groups; experimental 65(73%) and controls 48(56%) were aware of this principle.

Table 4.4: Pretest knowledge on circulation

Questions		Group			
		Intervention		Control	
		Count	Column N %	Count	Column N %
1. Depth of adult chest compression	wrong	63	71%	64	74%
	correct	26	29%	22	26%
2. Duration of pulse check	wrong	64	72%	63	73%
	correct	25	28%	23	27%
3. Adult pulse check	wrong	71	80%	50	58%
	correct	18	20%	36	42%
4. Compression rate/min	wrong	73	82%	65	76%
	correct	16	18%	21	24%
5. Continue with CPR if you miss pulse in 10 seconds	wrong	38	43%	46	53%
	correct	51	57%	40	47%
6. Resume CPR after 10 sec if patient is pulseless	wrong	48	54%	44	51%
	correct	41	46%	42	49%
7. CPR should be done on a firm surface	wrong	42	47%	32	37%
	correct	47	53%	54	63%
8. Position of hands during chest compression	wrong	17	19%	20	23%
	correct	72	81%	66	77%
9. Chest recoil facilitates blood circulation	wrong	24	27%	38	44%
	correct	65	73%	48	56%

4.3.3 Baseline Knowledge on airway management

Table 4.5 presents findings on knowledge of airway management at pretest.
In a victim with suspected neck/spinal cord injury, the rescuer should open the airway using jaw thrust maneuver. A majority of the respondents in both groups; experimental 60 (67%) and controls 59 (69%) were not aware of this recommended technique. The recommended management for adult chocking in a person not obese or pregnant is use of abdominal thrust maneuver. A majority of participants in both groups; experimental 58(65%) and control 57(66%) were not aware of this technique.

If the rescuer is not able to deliver air by mask, they should reposition the airway. A majority of the participants in both groups; experimental 67(75%) and control 65(76%) were not aware of this corrective measure. When the chest is not inflating the rescuer should evaluate the airway. A majority of the respondents in both groups; experimental 49(55%) and control 57(66%) were aware of this measure.

There are several signs of airway obstruction like wheezing, high pitched noise on inhalation, forceful cough among others. Most of the participants in both groups; experimental 51(57%) and control 48(56%) were aware of these manifestations. The bag valve mask is best controlled by two rescuers so that one opens the airway and holds the mask as the second one delivers the ventilations. Most participants in both groups; experimental 57(64%) and control 49(57%) were aware of this recommendation.

Table 4.5: Pretest knowledge on airway management

Questions		Group			
		Intervention		Control	
		Count	Column N %	Count	Column N %
1. Maneuver of opening airway in a neck injury patient	wrong	60	67%	59	69%
	correct	29	33%	27	31%
2. Adult chocking management	wrong	58	65%	57	66%
	correct	31	35%	29	34%
3. Action to take when delivering oxygen by a mask fails	wrong	67	75%	65	76%
	correct	22	25%	21	24%
4. Action to take if chest is not inflating	wrong	40	45%	29	34%
	correct	49	55%	57	66%
5. Signs of severe airway obstruction	wrong	38	43%	38	44%
	correct	51	57%	48	56%
6. Number of rescuers best to control bag valve mask	wrong	32	36%	37	43%
	correct	57	64%	49	57%

4.3.4 Baseline knowledge on breathing

Table 4.6 presents findings on participant's knowledge on breathing at pretest. Agonal breaths are a sign of cardiac arrest. Upon identifying them the first responder should activate the emergence response team. A majority of the participants in both groups; experimental 70(79%) and control 60(70%) were not aware of this action step. When delivering a breath using a pocket mask or a bag valve device, each breath should be delivered within 1 second. Most of the respondents in both groups; experimental 78(88%) and control 75(87%) were now aware of this recommendation.

The effective indicator of successful ventilation is a chest rise. A majority; 58(65%) of experimental group were not aware of this indicator while a majority; 44(51%) of the control group were aware. When having two rescuers, the one delivering compressions should be at the side of the victim while the second one delivering breaths should be at the victims head. Most of the participants in the intervention group; 57(64%) knew about this positioning while 53(62%) of the control group did not know. Chest compressions do not promote breathing rather they promote blood circulation. A majority of participants in both groups; experimental 85(96%) and 80(93%) were not aware of this principle.

Table 4.6: Pretest knowledge on breathing

Questions		**Group**			
		Intervention		**Control**	
		Count	**Column N %**	**Count**	**Column N %**
1. Action to take on identifying agonal breaths	wrong	70	79%	60	70%
	correct	19	21%	26	30%
2. Duration of delivering a breath	wrong	78	88%	75	87%
	correct	11	12%	11	13%
3. indicator of effective breathing	wrong	58	65%	42	49%
	correct	31	35%	44	51%
4. Position of a second rescuer delivering breaths	wrong	32	36%	53	62%
	correct	57	64%	33	38%
5. Compressions do not promote breathing	wrong	85	96%	80	93%
	correct	4	4%	6	7%

4.3.5 Baseline knowledge on the use of automated external defibrillator (AED)

Table 4.7 presents findings on participant's knowledge on automated external defibrillation at pretest.

The universal steps of operating an automated external defibrillator are; power on AED, attach the electrode pads, analyze rhythm and shock the victim. Most of the participants in both groups; intervention 61(69%) and control 59(69%) were not aware of the universal steps. After delivering a shock the rescuer should continue with CPR. A majority of the participants in both groups; intervention 67(75%) and control 65(76%) were not aware of this action step. Adult defibrillator pads should be used to victims above 8 years. More than half of the participants in both groups; intervention 82(92%) and control 79(92%) were not aware of this recommendation.

The two shockable rhythms are ventricular fibrillation and pulseless ventricular tachycardia. A majority of the participants in both groups; experimental 62(70%) and control 71(83%) were not aware of the rhythms. In cases of patients with implantable devices like pacemaker or medication patches, the rescuer delivering shocks should not place the defibrillator pads on top of these devices or patches. A majority of the respondents in experimental group 52(58%) were not aware of this principle while 45(52%) of the control group were aware. The period between collapse of a victim and defibrillation determines the outcomes. A majority of participants in both groups; experimental 75(84%) and control 75(87%) were aware of this principle.

Table 4.7: Baseline knowledge on AED use

Questions and responses		Group			
		Intervention		Control	
		Count	Column N %	Count	Column N %
1. Universal steps in operating an AED	wrong	61	69%	59	69%
	correct	28	31%	27	31%
2. Action after delivering shock	wrong	67	75%	65	76%
	correct	22	25%	21	24%
3. Action if no rhythm is advised by AED	wrong	58	65%	61	71%
	correct	31	35%	25	29%
4. Age of using adult defibrillator pads	wrong	82	92%	79	92%
	correct	7	8%	7	8%
5. shockable rhythms	wrong	62	70%	71	83%
	correct	27	30%	15	17%
6. avoid placing defibrillator pads on top of a pacemaker	wrong	52	58%	41	48%
	correct	37	42%	45	52%
7. Duration between collapse and defibrillation determines survival	wrong	14	16%	11	13%
	correct	75	84%	75	87%

4.3.6 Overall baseline CPR knowledge score between the groups at pretest

The forty items in the questionnaire were marked and converted into percentage. The total knowledge score for both groups was below 50%. The intervention group had a mean knowledge score of 41.80 $\pm$ 8.709 and the control group a mean of 41.86 $\pm$ 7.889 (Table 4.8).

Table 4.8: Overall CPR knowledge at baseline

CPR knowledge descriptive statistics		
	Intervention	**Control**
Mean	41.80	41.86
Median	42.50	42.50
Mode	40[a]	40
Std. Deviation	8.709	7.889
Variance	75.851	62.233
Range	40	43
Minimum	25	23
Maximum	65	65

4.3.7 Baseline CPR knowledge levels of participants

The performance scores were graded according to KMTC examination policy. A score of 0-39 was graded as poor, 40-49 fair, 50-64 average, 65-74 good and 75-100 excellent. About a quarter of participants in both groups; intervention 42(24%) and control 45(25.71%) had fair level of CPR knowledge. Nearly a fifth in both groups; intervention 29(16.57%) and control 26(14.86%) had poor level of knowledge. Nearly a tenth in both groups; intervention 17(9.71%) and control 14(8.0%) had average level of knowledge. Less than 1% 1(0.57%) in both groups had good level of knowledge with no student having excellent level (Figure 4.1).

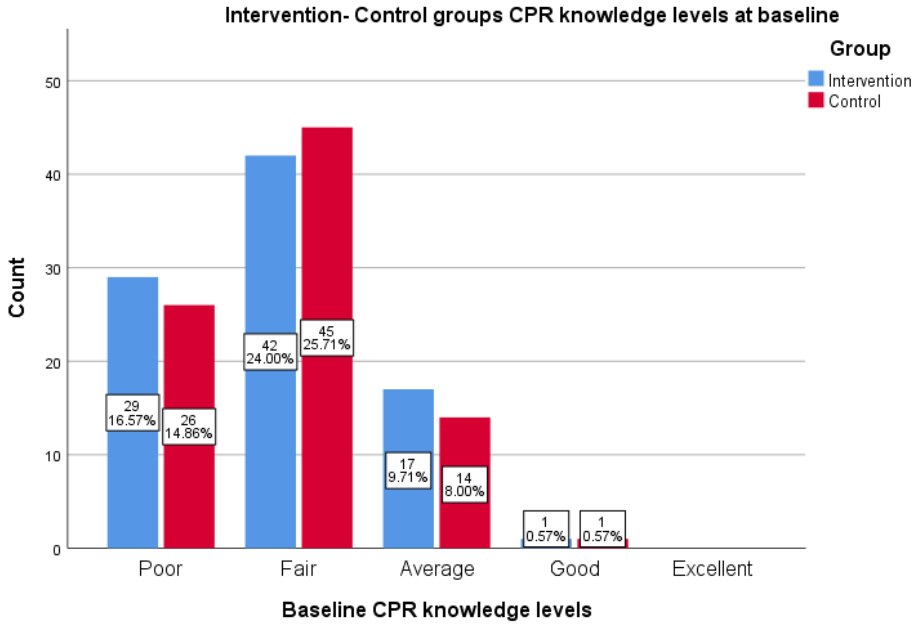

Figure 4.1: CPR knowledge levels at pretest

4.4 Baseline assessment of cardiopulmonary resuscitation skills

The participants were assessed on CPR skills where Little Ann manikins, bag valve mask and an automated external defibrillator were used. A case scenario of a patient who suffers sudden cardiac arrest was used to direct the skills assessment. A customized tool from American Heart Association 2020 BLS training manual for health providers was used to score the participants. The tool had five sections; victim assessment and activation of the emergency system, performance of high quality chest compressions, provision of breaths using a barrier device and the use of an automated external defibrillator.

4.4.1 Baseline evaluation of victim assessment and activation of the emergency system

Table 4.9 presents participants skills on victim assessment and activation of the emergency response system.

When there is a suspected case of sudden cardiac arrest, the first rescuer should scan the scene to ensure safety of the victim and the responder. A majority of the participants in both groups; intervention 65(73%) and control 53(62%) did not assess this first step. After scanning for scene safety the rescuer should asses for the victim responsiveness. A majority of the participants in both groups; intervention 71(80%) and control 61(71%) did not assess for responsiveness. If the victim is not responsive the rescuer should shout for help and if there is another person send them to get an AED. Most of the participants in both groups; intervention 79(89%) and control 75(87%) did not perform this step.

The next step the rescuer should assess for carotid pulse and breathing for not more than 10 seconds. A proficient rescuer should assess the two simultaneously. A majority of the participants in both groups; intervention 69(78%) and control 46(53%) did not assess for breathing. Similarly a majority in both groups; intervention 74(83%) and control 47(55%) did not assess for the pulse.

Table 4.9: Pretest skills on victim assessment and activation of emergency system

Parameter of assessment		**Group**			
		Intervention		**Control**	
		Count	**Column N %**	**Count**	**Column N %**
1. Scans for scene safety	Not performed	65	73%	53	62%
	Performed	24	27%	33	38%
2. Check for responsiveness	Not performed	71	80%	61	71%
	Performed	18	20%	25	29%
3. Shout for help and send someone to get AED	Not performed	79	89%	75	87%
	Performed	10	11%	11	13%
4. Assess for breathing	Not performed	69	78%	46	53%
	Performed	20	22%	40	47%
5. Assess for carotid pulse	Not performed	74	83%	47	55%
	Performed	15	17%	39	45%

4.4.2 Baseline evaluation of high quality chest compressions skills

Table 4.10 presents participants skill's on chest compression

The hands must be positioned at the lower half of the sternum to have optimal chest compression. Most of the participants in both groups; intervention 68(76%) and control 58(67%) had the right skill. To ensure adequate perfusion the chest compression rate must be maintained at a rate of 100-120 compressions per minute. A majority of the intervention group; 50(56%) were able to compress at the recommended rate while a majority 64(74%) of the control group participants did not.

The recommended adult compression depth is 2-2.4 inches. A majority 52(58%) of the intervention group participants were able to perform the recommended compression depth while a majority 63(73%) of the control group participants were not able to achieve the desired depth. There should be minimized interruptions to less than 10 seconds between compressions and ventilations to maintain the perfusion. 51(57%) of the intervention participants were able to limit the interruptions while 60(70%) of the control group were not.

Table 4.10: Pretest chest compression skills

Parameter of assessment		**Group**			
		Intervention		**Control**	
		Count	**Column N %**	**Count**	**Column N %**
1. Correct hand placement	Not performed	21	24%	28	33%
	Performed	68	76%	58	67%
2. Compression rate	Not performed	39	44%	64	74%
	Performed	50	56%	22	26%
3. compression depth	Not performed	37	42%	63	73%
	Performed	52	58%	23	27%
4. Minimize interruptions	Not performed	38	43%	60	70%
	Performed	51	57%	26	30%

4.4.3 Baseline assessment of airway and breathing management skills

Table 4.11 presents participants skills on airway and breathing management at pretest.

Before delivering breaths, the airway must be adequately opened through head tilt chin lift or jaw thrust maneuver depending on the neurological status of the patient. A majority of the participants in both groups; intervention 59(66%) and control 54(63%) were not able to perform this step. Each breath should be delivered within one second. Most 57(64%) participants in the intervention group were able to deliver the breaths as recommended while 49(57%) of the control group were not able.

An effective breath should make the chest to rise. A majority of the participants in both groups; intervention 61(69%) and control 70(81%) were not able to give effective breaths. Two breaths should be delivered after 30 compressions to avoid over ventilation. Most 53(60%) of the intervention group participants were able to perform this step while 54(63%) of the control group were not able to give recommended breaths. After delivering breaths the rescuer should resume chest compressions. Most of the participants in both groups; intervention 45(51%) and 56(65%) did not resume performing chest compressions.

Table 4.11: Airway and ventilation skills assessment at pretest

Parameter of measure		Group			
		Intervention		Control	
		Count	Column N %	Count	Column N %
1. Open airway adequately	Not performed	59	66%	54	63%
	Performed	30	34%	32	37%
2. Deliver each breath within one second	Not performed	32	36%	49	57%
	Performed	57	64%	37	43%
3. Deliver breaths that make chest to rise	Not performed	61	69%	70	81%
	Performed	28	31%	16	19%
4. Avoid excess ventilation	Not performed	36	40%	54	63%
	Performed	53	60%	32	37%
5. Resume compressions in less than 10 seconds	Not performed	45	51%	56	65%
	Performed	44	49%	30	35%

4.4.4 Baseline assessment of automated external defibrillation skills

An automated external defibrillator should be used as soon as possible to restore cardiac rhythm. All the participants in both groups had no skill on using the defibrillator (Table 4.12).

Table 4.12: Pretest AED skills assessment

Steps		Group			
		Intervention		Control	
		Count	Column N %	Count	Column N %
1. Power on the AED	Not performed	89	100%	86	100%
	Performed	0	0%	0	0%
2. Attach the pads	Not performed	89	100%	86	100%
	Performed	0	0%	0	0%
3. Clear rescuers for analysis	Not performed	89	100%	86	100%
	Performed	0	0%	0	0%
4. Clear rescuers to safely deliver shock	Not performed	89	100%	86	100%
	Performed	0	0%	0	0%
5. Deliver shock	Not performed	89	100%	86	100%
	Performed	0	0%	0	0%
6. resume chest compressions	Not performed	89	100%	86	100%
	Performed	0	0%	0	0%

4.4.5 Total baseline CPR skill scores

The total pretest scores out of 20 items were converted into percentage. The mean skills percent score for the intervention group was 29.27 $\pm$ 14.86 and a mode of 15 while the mean of the control group was 24 $\pm$ 12.73 and a mode of 30. The maximum score for the intervention group was 60 with a minimum of 0. The control group had a maximum score of 55 and a minimum score of 55 (Table 4.13).

Table 4.13: Overall CPR skills statistics

Pretest CPR knowledge descriptive statistics		
	Intervention(N=86)	**Control (N=89)**
Mean	29.27	24.65
Median	30.00	25.00
Mode	15	30
Std. Deviation	14.858	12.737
Variance	220.767	162.230
Range	60	55
Minimum	0	0
Maximum	60	55

4.4.6 Baseline level of cardiopulmonary resuscitation skills at levels at baseline

The second objective of the study was to evaluate the level of CPR skills among the senior nursing students. The performance scores were graded according to KMTC examination policy guideline. A score of 0-39 was graded as poor, 40-49 fair, 50-64 average, 65-74 good and 75-100 excellent. In the intervention group, 63(70.8%) had poor level of skills, 13(14.6%) had fair level while 13(14.6%) had average level of CPR skills. The control group; 74(86.0%) had poor level, 9(10.5%) had fair level while 3(3.5%) had average level of CPR skill (Table 4.14).

Table 4.14: CPR skill levels at pretest

Total CPR skill levels			
Group		**Frequency**	**Percent**
Intervention	Poor	63	70.8
	Fair	13	14.6
	Average	13	14.6
	Good	0	0.0
	Excellent	0	0.0
	Total	89	100.0
Control	Poor	74	86.0
	Fair	9	10.5
	Average	3	3.5
	Good	0	0.0
	Excellent	0	0.0
	Total	86	100.0

4.5 Factors influencing CPR knowledge and skills

Table 4.15 presents findings on factors influencing acquisition of CPR knowledge and skills.

The third objective of the study was to evaluate factors influencing CPR knowledge and skills. The participants were issued with a predetermined three point likert scale on factors influencing CPR knowledge and skills acquisition. These factors were further cross tabulated with summated totals scores of CPR knowledge and skills. A Spearman Rho correlation was done to evaluate the association between the two ordinal data.

Cardiopulmonary resuscitation theory is simple and easily understood. Slightly above a third of the participants 67(38.3%) agreed that CPR knowledge was complex to acquire, 63(36%) scored neutral while a quarter 45(25.7%) disagreed that CPR was complex. The association between CPR knowledge being complex and the overall CPR scores did not yield statistical significance ($p>0.05$). The highest observed category that the participants' perceived CPR skills to be complex was neutral with 65(37.1%). However, there was a significant association between the participants' perception that the CPR skill was complex and the overall CPR performance.

Nearly half of the participants 77(44.0%) indicated that the CPR learning materials at the colleges were not limited however this yielded a significant statistical association ($p<0.05$) with the overall CPR performance. A majority of the participants 100(57.1%) indicated that the CPR lecture hours were limited however this did not yield a statistical significant association ($p>005$) with the overall CPR scores. Similarly a majority 103(58.9%) of the responded indicated that the skills lab session offered were limited to acquire the desired skills; however, this did not yield a significant statistical association with overall CPR scores ($p>0.05$).

To acquire the CPR skills the students require a lot of guidance in the skills lab. A majority of the participants (99(56.6%) disagreed that there was minimal guidance from

the instructors; however, this yielded a significant statistical association with the overall CPR scores. To perform CPR effectively, a responder must be confident enough to handle the situation. Nearly half 71(40.65%) of the participants agreed that they were deficient on the desired confidence to perform the skill. There was a significant statistical association ($p<0.05$) between the perceived confidence and the overall CPR performance.

Simulated manikins are the best in training since they offer prompt feedback. A majority 134(76.6%) of the participants agreed that the manikins used in the skills lab were not simulated, however this did not yield statistical significance ($p>0.05$) with the overall scores. To enhance the skills, it is required that each student does an individual practical exam. A majority 90(51.4%) agreed that they did not do an individual CPR skills examination; however, this did not yield statistical significance with the overall CPR scores.

Table 4.15: Factors influencing acquisition of CPR knowledge and skills at baseline

		Combined groups responses			Spearman *rho* correlation	
	Factors	**Disagree (1 point)**	**Neutral (2 points)**	**Agree (3 points)**	**Rs statistic**	***P* value**
1	CPR knowledge is complex	45(25.7%)	63(36.0%)	67(38.3%)	-0.12	0.12
2	CPR skills are complex	46(26.3%)	65(37.1%)	64(36.6%)	-0.17	0.02*
3	Limited CPR learning materials	47(26.9%)	51(29.1%)	77(44.0%)	-0.21	0.01*
4	Limited CPR lecture hours	34(19.4%)	41(23.4%)	100(57.1%)	0.10	0.18
5	Limited skills lab sessions	29(16.6%)	43(24.6%)	103(58.9%)	0.10	0.19
6	Minimal guidance in the skills lab	99(56.6%)	33(18.9%)	43(24.6%)	-0.15	0.04*
7	Lack of confidence in performing CPR	51(29.1%)	53(30.3%)	71(40.6%)	-0.17	0.03*
8	Content assessed at pretest from AHA manual 2020 not taught	32(18.3%)	41(23.4%)	102(58.3%)	-0.03	0.68
9	Few CPR equipments	20(11.4%)	21(12.0%)	134(76.6%)	-0.07	0.33
10	Mannequins are not simulated	33(18.9%)	40(22.9%)	102(58.3%)	0.05	0.48
11	No individual practical exam	63(36.0%)	22(12.6%)	90(51.4%)	0.10	0.18

4.5.1 Linear regression analysis on factors influencing CPR knowledge and skills

The factors were further subjected to a linear regression analysis on how they affected the CPR performance. Summation of CPR knowledge scores and skills was used for cross tabulation. Among the factors only the factor that the mannequins were not simulated had a significant association $p<0.05$ on the acquisition of CPR knowledge and skills. All the other factors had no significant statistical significance (Table 4.16).

Table 4.16: Regression analysis on factors influencing CPR knowledge and skills acquisition

Coefficients[a] Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.	95.0% C I for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
(Constant)	26.728	5.964		4.482	.000	14.951	38.504
CPR knowledge is complex	-.853	.705	-.139	-1.210	.228	-2.246	.539
CPR skills are complex	-.111	.731	-.018	-.152	.879	-1.555	1.333
learning materials	-.290	1.288	-.049	-.225	.822	-2.833	2.254
Limited CPR learning materials	-.304	.566	-.047	-.537	.592	-1.420	.813
Limited CPR lecture time	-.852	.545	-.138	-1.562	.120	-1.929	.225
Skills lab sessions were limited	-.214	.620	-.033	-.346	.730	-1.438	1.010
No skills lab technicians	.790	.489	.137	1.617	.108	-.175	1.755
Lack of confidence	.313	1.260	.053	.248	.804	-2.175	2.801
Content assessed in the pretest was not taught in class	-.386	.516	-.062	-.748	.456	-1.405	.633
Skills lab have few mannequins and ventilators as compared to students	.618	.611	.086	1.011	.313	-.589	1.826
Mannequins are not simulated	-1.284	.553	-.207	-2.320	.022*	-2.376	-.191
There was no individual practical exam	.185	.511	.035	.362	.718	-.824	1.194

a. Dependent Variable: total scores

4.6 Effect of the certified CPR training on knowledge among the senior diploma nursing students

After six months of the certified cardiopulmonary resuscitation training, a post test examination was carried out. The performance at post test was compared with the

performance at pre test and comparisons made. Inferential statistics were used to compare the mean performance on the specific knowledge components as well as the general concepts.

4.6.1 Effect of CPR training on general cardiopulmonary resuscitation knowledge principles

Table 4.17 presents findings on effects of the certified training on the general CPR principles. The participants were to expand the BLS initials. In the intervention group, there was an increase of correct responses with 2% from 85(96%) to 89(98%) while the control group had a 10% increase from 74(86%) to 80(96%). The participants were to choose the correct BLS sequence which is circulation, airway and breathing. In the intervention group, there was a 38% increase in correct responses from 2(2%) to 32(40%) while the control group there was 14% increase from 2(2%) to 13(16%).

One rescuer ventilation compression ratio is 30:2. Among the intervention participants, there was an increase of 61% correct responses from 25(28%) at pretest as compared to 72(89%) at post test. The control group had 11% increase in correct responses from 31(36%) to 39(47%). The two rescuers compression ventilation ratio remains 30:2. There was a 13% decrease on the correct responses from 53(60%) at pretest to 38(47%) at post test among the intervention participants while there was a 4 % increase of correct responses from 48(56%) in pretest to 50(60%) at post test.

Two rescuers are expected to alternate roles after 5 cycles or two minutes. There was 46% increase of correct responses among the intervention participants from 12(13%) at pretest to 48(59%) at post test. The control group participants had an increase of correct responses with 3% from 26(30%) at pretest to 27(33%) at post test. The participants were to choose the correct steps of in-hospital chain of survival. There was 23 % increase in correct responses among the intervention participants from 50(56%) at pretest to 64(79%) at posttest. The control group participants had 3% decline from 32(37%) at pretest to 28(34%) at post test.

Most sudden cardiac arrest deaths occur at homes. There was 28% increase in correct responses among the intervention group participants from 39(44%) at pretest to 58(72%) at post test while the control group participants had 5% increase from 40(47%) at pretest to 43(52%) at post test. The foundation of CPR is chest compressions. There was 53% increase in correct responses among the intervention participants from 24(27%) at pretest to 65(80%) at post test. The control group had 9 % decrease in correct responses from 19(22%) at pretest to 11(13%) at post test.

A single rescuer positions him/herself at the side of the victim while performing CPR. There was 19% increase in correct responses from 62(70%) at pretest to 72(89%) at post test among intervention group participants. The control group participants had 2% decrease in correct responses from 63(73%) at pretest to 59(71%) at post test as. The first step in a case of cardiac arrest is to check for scene safety. There was 63% increase in correct responses among the intervention group members from 28(31%) at pretest to 76(94%) at post test. The control group members had a 10% increase in correct response from 33(38%) at pretest to 40(48%) at post test.

Before initiating CPR a rescuer must check for victim's responsiveness. There was 12% increase in correct response from 75(84%) at pretest to 78(96%) at post test among the intervention participants. In the control group, there was 8% increase in correct responses from 73(85%) at pretest to 77(93%) at post test. During CPR there should be minimal interruptions between compressions and ventilations not exceeding 10 seconds. In the intervention group there was 8% decrease in making the correct response from 30(34%) at pretest to 23(28%) at post test while in the control group participants there was 8% increase in choosing the correct response from 16(19%) to 22(27%).

Most novice rescuers fear causing trauma to the victims during CPR. There was 25% increase in intervention group participants who made the correct choice from 54(61%) at pretest to 70(86%) at post test. Within the control group, there was 7% decrease in participants who made the correct response from 65(76%) at pretest to 58(70%) at post test.

Table 4.17: Comparison of pretest post test CPR knowledge on general principles

Questions	Response	Intervention group		Control group	
		Pretest Count (%)	Posttest Count (%)	Pretest Count (%)	Posttest Count (%)
1. Expanding BLS initials	Correct response	85(96%)	89(98%)	74(86%)	80(96%)
	Wrong response	4(4%)	2(2%)	12(14%)	3(4%)
2. BLS sequence	Correct response	2(2%)	32(40%)	2(2%)	13(16%)
	Wrong response	87(98%)	49(60%)	84(98%)	70(84%)
3. One rescuer adult compression ventilation ratio	Correct response	25(28%)	72(89%)	31(36%)	39(47%)
	Wrong response	64(72%)	9(11%)	55(64%)	44(53%)
4. Two rescuers adult compression ventilation ratio	Correct response	53(60%)	38(47%)	48(56%)	50(60%)
	Wrong response	36(40%)	43(53%)	38(44%)	33(40%)
5. CPR cycles to alternate roles	Correct response	12(13%)	48(59%)	26(30%)	27(33%)
	Wrong response	77(87%)	33(41%)	60(70%)	56(67%)
6. In hospital chain of survival steps	Correct response	50(56%)	64(79%)	32(37%)	28(34%)
	Wrong response	39(44%)	17(21%)	54(63%)	55(66%)
7. Where out of hospital cardiac arrest occur commonly	Correct response	39(44%)	58(72%)	40(47%)	43(52%)
	Wrong response	50(56%)	23(28%)	46(53%)	40(48%)
8. Foundation of CPR	Correct response	24(27%)	65(80%)	19(22%)	11(13%)
	Wrong response	65(73%)	16(20%)	67(78%)	72(87%)
9. Position for a lone rescuer during resuscitation	Correct response	62(70%)	72(89%)	63(73%)	59(71%)
	Wrong response	27(30%)	9(11%)	23(27%)	24(29%)
10. First step in a case of cardiac arrest	Correct response	28(31%)	76(94%)	33(38%)	40(48%)
	Wrong response	61(69%)	5(6%)	53(62%)	43(52%)
11. Checking for responsiveness before doing CPR	Correct response	75(84%)	78(96%)	73(85%)	77(93%)
	Wrong response	14(16%)	3(4%)	13(15%)	6(7%)
12. Limit interruptions to less than 10 seconds	Correct response	30(34%)	23(28%)	16(19%)	22(27%)

	Wrong response	59(66%)	58(72%)	70(81%)	61(73%)
13. Fear holding responders from doing CPR	Correct response	54(61%)	70(86%)	65(76%)	58(70%)
	Wrong response	35(39%)	11(14%)	21(24%)	25(30%)

4.6.2 Overall effect of CPR training on CPR knowledge

The pretest and post test subsection summaries on CPR general principles knowledge were subjected to a paired t test to evaluate the effects of the intervention. Each correct choice was awarded one mark. The maximum marks for the subsection was 13. In the intervention group, the mean changed from 6.05±1.55 at pretest to 9.57±1.56 at post test. This yielded to a significant statistical difference between pretest and post test scores with a big effect size measured using Cohen d; t (80) =13.95, p=0.00, d=1.6. In the control group, the mean changed from 6.11 to 6.59. This change was statistically significant however of a very small effect size; t (83) = 2.167, *p* =0.03, d= 0.2 (Table 4.18).

Table 4.18: Paired t test for CPR general principles

Paired Samples Statistics for general CPR principles knowledge						
		Mean (13 points)	**N**	**Std. Deviation**	**Std. Error Mean**	**Paired t test**
Intervention group	General CPR principles (pretest)	6.05	81	1.548	.172	t= -13.95 d.f. = 80 **p= 0.00*** **Cohen d= 1.6***
	General CPR principles (post-test)	9.57	81	1.557	.173	
Control group	General CPR principles (pretest)	6.11	83	1.668	.183	t= - 2.167 d.f. = 82 p= 0.03 Cohen d= 0.2
	General CPR principles (post test)	6.59	83	1.506	.165	

4.6.2.1 Effect of certified CPR training on circulation knowledge

Table 4.19 presents findings on the effect of CPR training on circulation knowledge.

This subsection had nine questions. Each correct choice was awarded a mark. Maximum score for the sub section was 9. The recommended depth of adult chest compression is 2.4 inches. In the intervention group, 26(29%) of participants made the right choice at pretest and 63(78%) at post test. This was an increase of 49%. In the control group, 22(26%) made the right choice at pretest and 19(23%) at post test. This was a decrease with 3%.

The duration of pulse check should not exceed 10 seconds. Among the intervention participants, 25(28%) made correct choice at pretest and 51(63%) at post test. This was an increase of 35% post intervention. Within the control group participants 23(27%) made correct choice at pretest and 24(29%) at post test which was a 2 % increase. The carotid artery is the recommended one for measuring an adult pulse when a case of sudden cardiac arrest is suspected. Within the intervention group participants, 18(20%) made the right choice at pretest and 73(90%) at post test. This was 70% increase post intervention. In the control group, 36(42%) made the correct choice at pretest and 34(41%) at post test which was a decrease with 1 % at post test.

The recommended chest compression rate is 100-120 compressions per minute. There was 77% increase in correct response made by the intervention group participants from 16(18%) at pretest to 77(95%) at post test. In the control group, there was 8% decrease in those who made the correct response form 21(24%) at pretest to 13(16%) at post test. Upon confirmation of cardiac arrest, CPR should be initiated within 10 seconds. Within the intervention population, 51(57%) made the right choice at pretest and 72(89%) at post test. This was 32% increase post intervention. The control group had 12% increase in making the right choice from 40(47%) at pretest to 49(59%) at post test.

CPR is done on flat firm surface to ensure that the chest compressions are effective. At pretest, 47(53%) of the intervention participants had this knowledge which increased by 31% to 68(84%) at post test. In the intervention group 54(63%) were knowledgeable at pretest which remained constant at post test. During CPR the hands are positioned at the lower half of the sternum. At pretest, 72(81%) of the intervention participants had this

knowledge which increased by 18% at post test to 79(98%). In the control group, 66(77%) participants made the right choice which increased by 15% to 76(92%).

Chest compressions facilitate blood circulation within the heart manually. Within the intervention population, 65(73%) were knowledgeable on this concept at pretest. This increased with 25% at posttest to 77(5%). Among the control group participants, 48(56%) were knowledgeable at pretest which increased with 10% at posttest to 55(66%).

Table 4.19: Pretest post test comparison of circulation knowledge

Questions	Response	Intervention group		Control group	
		Pretest Count (%)	**Posttest Count (%)**	**Pretest Count (%)**	**Posttest Count (%)**
1. Depth of adult chest compression	Correct response	26(29%)	63(78%)	22(26%)	19(23%)
	Wrong response	63(71%)	18(22%)	64(74%)	64(77%)
2. Duration of pulse check	Correct response	25(28%)	51(63%)	23(27%)	24(29%)
	Wrong response	64(72%)	30(37%)	63(73%)	59(71%)
3. Artery to check for pulse in an adult	Correct response	18(20%)	73(90%)	36(42%)	34(41%)
	Wrong response	71(80%)	8(10%)	50(58%)	49(59%)
4. Compressions rate/min	Correct response	16(18%)	77(95%)	21(24%)	13(16%)
	Wrong response	73(82%)	4(5%)	65(76%)	70(84%)
5. Start CPR if no breathing and pulse within 10 seconds	Correct response	51(57%)	72(89%)	40(47%)	49(59%)
	Wrong response	38(43%)	9(11%)	46(53%)	34(41%)
6. Resume CPR after 10 sec if no pulse	Correct response	41(46%)	46(57%)	42(49%)	32(39%)
	Wrong response	48(54%)	35(43%)	44(51%)	51(61%)
7. CPR should be done on a firm service	Correct response	47(53%)	68(84%)	54(63%)	52(63%)
	Wrong response	42(47%)	13(16%)	32(37%)	31(37%)
8. Hands position In CPR	Correct response	72(81%)	79(98%)	66(77%)	76(92%)
	Wrong response	17(19%)	2(2%)	20(23%)	7(8%)
9. Chest recoil facilitates blood circulation (T/F)	Correct response	65(73%)	77(95%)	48(56%)	55(66%)
	Wrong response	24(27%)	(4(5%)	38(44%)	28(34%)

4.6.2.2 Overall effect of certified CPR training on circulation knowledge

This sub-section had 9 questions. Each correct response was awarded a mark. Maximum score for the sub section was 9.The mean score for intervention group at pretest was 2.67 $\pm$ 1.13 out of 9 and 4.33 $\pm$ 1.17 at post test. The scores were subjected to a paired t test which yielded a significant difference of large effect size measured using Cohen d; t (80) = 9.785, p= 0.00, d=1.09. In the control group, the mean was 2.66 $\pm$ 1.47 at pretest and 2.95 + 1.46 at post test. The scores on a further paired t test analysis showed no significant statistical difference between the pretest and post test scores; t (82) = 1.28, p= 0.21, d= 0.14 as indicated in table 4.20.

Table 4.20: Paired t test on circulation knowledge

Paired Samples Statistics for circulation knowledge						
		Mean	**N**	**Std. Deviation**	**Std. Error Mean**	**Paired t test**
Intervention	Circulation concepts (pretest)	4.06	81	1.560	.173	t= -16.639 d.f. =80
	Circulation concepts (posttest)	7.48	81	1.074	.119	**p< 0.001*** **Cohen d= 2.55***
Control	Circulation concepts (pretest)	4.05	83	1.489	.163	t= -0.997 d.f. = 82
	Circulation concepts (posttest)	4.27	83	1.362	.150	p= 0.322 Cohen d=0.15

4.6.2.3 Effect of certified CPR training on airway knowledge

Table 4.21 presents findings on the effects of CPR training on participant's knowledge on airway management.

The participants answered 6 questions on airway management. Each correct answer was awarded a mark. When opening the airway for a patient with suspected neck injury, a jaw thrust maneuver is recommended to avoid further injury. In the intervention population 29(33%) made the correct choice at pretest and 54(67%) at post test. This was 34 % increase post intervention. The control group also had 9% increase in making the right choice on this concept from 27(31%) at pretest to 33(40%) at post test. In case

of adult chocking, abdominal thrusts are recommended to relieve the obstruction. Among the intervention group participants, 31(35%) were knowledgeable about this concept at pretest which increased by 58% at post test to 75(93%). Within the control group, 29(34%) of the participants were knowledgeable on this concept at pretest which increased by 8% to 35(42%) at post test.

In the scenario delivery of oxygen by a mask fails, the rescuer should reposition the airway o facilitate oxygen entry. There was 26% increase in intervention group members who made the right choice from 22(25%) at pretest to 41(51%) at posttest. Among the control group participants, 21(24%) were knowledgeable on this concept at pretest. This increased by 7% to 26(31%) at posttest. Similarly, if the chest is not inflating during ventilation, the rescuer should reevaluate the airway. In the intervention group, 49(55%) of the participants made the right choice at pretest and 64(79%) at posttest. This was 24 % increase after the training intervention. Within the control group, 57(66%) were knowledgeable on this concept at pretest which increased by 1 % at posttest to 56(67%).

The participants were to choose signs of airway obstruction. In the experimental group, 51(57%) of the participants made the right choice at pretest which increased by 15% after the training intervention to 61(75%). Within the control group, 48(56%) of the members were knowledgeable at pretest which increased by 5% to 51(61%) at post test. A bag valve mask device is best controlled by two rescuers during resuscitation. Among the intervention group participants, 32(36%) were knowledgeable at pretest on this concept that later decreased by 5 % to 25(31%) at posttest. Within the control group 37(43%) of the participants made the right choice on this concept that increased by 4% to 39(47%).

Table 4.21: Comparison of pretest-posttest knowledge on airway knowledge

Questions	Response	Intervention group		Control group	
		Pretest Count (%)	**Posttest Count (%)**	**Pretest Count (%)**	**Posttest Count (%)**
1. Maneuver of opening the airway in a neck injury patient	Correct response	29(33%)	54(67%)	27(31%)	33(40%)
	Wrong response	60(67%)	27(33%)	59(69%)	50(60%)
2. Adult chocking management	Correct response	31(35%)	75(93%)	29(34%)	35(42%)
	Wrong response	58(65%)	6(7%)	57(66%)	48(58%)
3. Action to take when delivering oxygen by mask fails	Correct response	22(25%)	41(51%)	21(24%)	26(31%)
	Wrong response	67(75%)	40(49%)	65(76%)	57(69%)
4. Action to take if chest is not inflating	Correct response	49(55%)	64(79%)	57(66%)	56(67%)
	Wrong response	40(45%)	17(21%)	29(34%)	27(33%)
5. Signs of severe airway obstruction	Correct response	51(57%)	61(75%)	48(56%)	51(61%)
	Wrong response	38(43%)	20(25%)	38(44%)	32(39%)
6. Number of rescuers best to control bag valve mask	Correct response	57(64%)	56(69%)	49(57%)	44(53%)
	Wrong response	32(36%)	25(31%)	37(43%)	39(47%)

4.6.4 Overall effect of certified CPR training on airway knowledge

This section had 6 questions. Maximum score for the subsection was 6 marks since each correct response was awarded a mark. The intervention group had a mean of 2.67$\pm$1.13 at pretest which increased to 4.33$\pm$1.17 at posttest. The scores were subjected to a paired t test analysis that yielded a significant statistical difference of very large magnitude measured using Cohen d; t (80) =9.79, p=0.00, d=1.09.

The control group had a mean score of 2.66 $\pm$ 1.48 at pretest which increased to 2.95$\pm$ 1.46 at posttest. The scores when subjected to a paired t test, there was no significant

statistical difference between the pretest and posttest performance; t (82) =1.28, p=0.21, d=0.14(table 4.22).

Table 4.22: Paired t test on airway concepts

Paired Samples Statistics for airway concepts knowledge						
		Mean (6 points)	**N**	**Std. Deviation**	**Std. Error Mean**	**Paired t test**
Intervention group	Airway concepts (pretest)	2.67	81	1.129	.125	t= -9.785 d.f. =80 **p= 0.00***
	Airway concepts (posttest)	4.33	81	1.173	.130	**Cohen d=1.09***
Control group	Airway concepts (pretest)	2.66	83	1.476	.162	t= -1.277 d.f. = 82 p= 0.205
	Airway concepts (posttest)	2.95	83	1.464	.161	Cohen d=0.14

4.6.4.1 Effect of certified CPR training on breathing knowledge

Table 4.23 presents findings on the effects of certified CPR training on breathing knowledge. This subsection had five questions evaluating on knowledge of breathing concepts. Agonal breaths are a sign of cardiac arrest. When identified the rescuer should deliver rescue breaths if the pulse is present. However, if the pulse is absent the rescuer should initiate CPR. During the baseline assessment, 19(21%) of the intervention participants were knowledgeable on this concept which increased by 36% after the training intervention to 46(57%) at posttest. Each breath should be delivered within one second. Among the intervention group participants, 11(12%) were knowledgeable on this recommendation which increased by 20% after the training to 26(32%) at post test. Within the control group there was a slight increase by 6% from 11(13%) at pretest to 16(19%) at post test.

The indicator of effective breaths is good chest rise. Within the experimental group, 31(35%) made the right choice at pretest which increased by 39% after the training

intervention to 60(74%) at post test. The control group members had 44(51%) who made the right choice at pretest and 53(64%) at posttest having 13% increase. The second rescuer delivering the breaths should be positioned at the head of the victim. In the intervention group, 57(64%) were knowledgeable on this concept at pretest which increased by 32% after the intervention to 78(96%) at posttest. The control group participants made 19% increase in making the right choice on this concept from 33(38%) at pretest to 47(57%) at posttest.

The rationale for chest compression is to facilitate blood circulation but not to promote breathing. In the experimental group, 4(4%) of the participants knew about this fact which increased by 37% to 33(41%) at posttest following the education intervention as indicated in table 35. Within the control group, 6(7%) knew about this concept at pretest which increased by 11% to 15(18%) at posttest.

Table 4.23: Pretest posttest comparison of breathing knowledge

Questions	Response	Intervention group		Control group	
		Pretest Count (%)	**Posttest Count (%)**	**Pretest Count (%)**	**Posttest Count (%)**
1. Action to take on identifying agonal breaths	Correct response	19(21%)	46(57%)	26(30%)	22(27%)
	Wrong response	70(79%)	35(43%)	60(70%)	61(73%)
2. Duration of delivering a breath	Correct response	11(12%)	26(32%)	11(13%)	16(19%)
	Wrong response	78(88%)	55(68%)	75(87%)	67(81%)
3. Indicator of effective breaths	Correct response	31(35%)	60(74%)	44(51%)	53(64%)
	Wrong response	58(65%)	21(26%)	42(49%)	30(36%)
4. Position of a second rescuer delivering breaths	Correct response	57(64%)	78(96%)	33(38%)	47(57%)
	Wrong response	32(36%)	3(4%)	53(62%)	36(43%)
5. Compressions do not promote breathing (T/F)	Correct response	4(4%)	33(41%)	6(7%)	15(18%)
	Wrong response	85(96%)	48(59%)	80(93%)	68(81%)

4.6.4.2 Overall effect of CPR training on breathing knowledge

This sub- section had a maximum of five marks. The mean score of the intervention group at pretest was 1.42 $\pm$ 0.91 which increased to 3.00 $\pm$ 0.98 at posttest. The scores were subjected to a paired t test that yielded a significant statistical difference between the pretest and posttest scores with a very large effect size measured using Cohen d; t (80) = 10.919, p = 0.00, d=1.2.

In the control group the pretest mean score was 1.45 $\pm$ 0.91 and the posttest mean was 1.84$\pm$ 0.96. On further analysis using a paired t test, there was a significant statistical difference in the scores but of a small magnitude measured using Cohen d; t (82) = 2.75, p = 0.01, d= 0.3 (Table 4.24).

Table 4.24: Paired t test on breathing knowledge

Paired Samples Statistics for breathing knowledge						
		Mean	**N**	**Std. Deviation**	**Std. Error Mean**	**t test**
Intervention group	Breathing concepts (pretest)	1.42	81	.906	.101	t= -10.919 d.f. =80
	Breathing concepts (posttest)	3.00	81	.975	.108	**p= 0.00*** **Cohen d=1.2***
Control group	Breathing concepts (pretest)	1.45	83	.914	.100	t= -2.754 d.f. = 82
	Breathing concepts (posttest)	1.84	83	.956	.105	**p= 0.01*** Cohen d=0.3

4.6.5 Effect of certified CPR training on AED knowledge

Table 4.25 presents findings on effects of CPR training on learner's knowledge on the use of an automated external defibrillator.

This section evaluated knowledge on automated external defibrillator. Seven questions were administered giving rise to a maximum of 7 marks for the sub section. The first question evaluated on the universal steps of operating an automated external defibrillator. In the experimental group 28(31%) of the participants answered the question correctly which increased by 57% to 71(88%) at posttest. Similarly in the control group, 27(31%) of the participants knew about the AED steps at pretest but increased by 4 % to 29(35%) at post test.

After delivering a shock, the rescuer should resume CPR immediately. In the experimental group 22(25%) of the participants knew about this concept at pretest which increased by 55% after the education intervention to 57(70%). Within the control group, 21(24%) of the members were knowledgeable on this concept at pretest however there was a decrease by 6% to 15(18%) as indicated in table 37. If no shockable rhythm is advised by the AED, the rescuer should continue with CPR immediately. There was 33% increase among the intervention group participants who were knowledgeable on

this concept from 31(35%) at pretest to 55(68%) at post test. In the control group 25(29%) were knowledgeable at pretest but decreased to 18(22%) at posttest.

The adult defibrillator pads should be used from victims of 8 years and above. In the experimental group, 7(8%) of the participants knew about this concept at pretest. After the education intervention 62(77%) at pretest knew about this recommendation. Within the control group population, similarly 7(8%) knew about the recommendation at pretest but increased by 4% to 10(12%) at posttest as indicated in table 4.25. There are two shockable rhythms; ventricular fibrillation and pulseless ventricular tachycardia. In the experimental group, 27(30%) of the participants made the right choice at pretest which increased by 27% at post test to 46(57%) after the education intervention. In the control group 15(17%) of the members made the right choice at pretest and increased by 8% to 20(24%) at post test.

In the scenario if a victim has a pacemaker, medication patch or any other implantable device, the rescuer should not place the AED pads on top of the devices. A percentage of 37(42%) among the intervention group members knew about the concept at pretest. After the education intervention this increased by 51% to 75(93%) as indicated in Table 4.25. In the control group 45(52%) of the participants knew about the concept at pretest and decreased by 6% to 38(46%) at posttest. Upon confirmation of a sudden cardiac arrest case, defibrillation should be initiated promptly to restore the cardiac rhythm. In the experimental group at pretest, 75(84%) of the participants were knowledgeable on this concept. After the education intervention, this increased by 15% to 78(96%) at posttest. In the control group, 75(87%) of the participants knew about this concept at pretest which increased by 3% at posttest to 75(90%).

Table 4.25: Pretest posttest comparison of automated external defibrillator knowledge

Questions	Response	Intervention group		Control group	
		Pretest Count (%)	**Posttest Count (%)**	**Pretest Count (%)**	**Posttest Count (%)**
1. Universal steps in operating an AED	Correct response	28(31%)	71(88%)	27(31%)	29(35%)
	Wrong response	61(69%)	10(12%)	59(69%)	54(65%)
2. Action after delivering a shock	Correct response	22(25%)	57(70%)	21(24%)	15(18%)
	Wrong response	67(75%)	24(30%)	65(76%)	68(82%)
3. Action if no shockable rhythm is advised	Correct response	31(35%)	55(68%)	25(29%)	18(22%)
	Wrong response	58(65%)	26(32%)	61(71%)	65(78%)
4. Age of using adult defibrillator pads	Correct response	7(8%)	62(77%)	7(8%)	10(12%)
	Wrong response	82(92%)	19(23%)	79(92%)	73(88%)
5. Shockable rhythms	Correct response	27(30%)	46(57%)	15(17%)	20(24%)
	Wrong response	62(70%)	35(43%)	71(83%)	63(76%)
6. Avoid putting defibrillator pads on top of a pacemaker (T/F)	Correct response	37(42%)	75(93%)	45(52%)	38(46%)
	Wrong response	52(58%)	6(7%)	41(48%)	45(54%)
7. Duration between collapse and defibrillation determines survival (T/F)	Correct response	75(84%)	78(96%)	75(87%)	75(90%)
	Wrong response	14(16%)	3(4%)	11(13%)	8(10%)

4.6.5.1 Overall effect of CPR training on AED knowledge

This section had seven questions giving rise to a maximum of 7 points. At pretest, the experimental group had a mean score of 2.49 $\pm$ 1.14 that changed to 5.48$\pm$ 1.23 at posttest after the education intervention. The pretest posttest scores were subjected to a

paired t test analysis. There was a significant statistical difference of very high magnitude measured using the Cohen d statistics; t (80) = 15.69, p= 0.00, d= 1.7

In the control group, the mean at pretest was 2.46± 1.13. This remained nearly the same at posttest with a mean of 2.47± 1.05. After comparing the pretest and posttest means using paired t test, there was no significant statistical difference between the two performances; t (82) = 0.07, p = 0.94, d=0.01 as indicated (Table 4.26).

Table 4.26: Paired t test on AED knowledge acquisition

Paired Samples Statistics for AED concepts knowledge						
		Mean	**N**	**Std. Deviation**	**Std. Error Mean**	**t-test & effect size**
Intervention group	AED concepts (pretest)	2.49	81	1.142	.127	t= -15.689 d.f. =80
	AED concepts (posttest)	5.48	81	1.226	.136	p= 0.00* Cohen d=1.7*
Control group	AED concepts (pretest)	2.46	83	1.129	.124	t= -0.073 d.f. = 82
	AED concepts (posttest)	2.47	83	1.052	.115	p= 0.942 Cohen d= 0.01

4.6.6 Overall comparison of pretest-post test CPR knowledge

The 40 questions were marked and the performance converted into percentage. In the intervention group, the mean percent at pretest was 41.80 ±8.71, with a median of 42.50 and a mode of 40. The lowest score was 25 and a maximum of 65. After the education intervention, the mean score rose to 74.66±8.39 at posttest with a median of 75% and a mode of 73%. The minimum score was 48 and a maximum score of 98.

The control group participants had a mean percentage of 41.86% ±7.89 at pretest with a median score of 42.50 and a mode of 40. The minimum score was 23% and the maximum score was 65. After six months at post test the mean score had risen to 45.30% ± 7.8 with a median of 45% and a mode of 48. The minimum score was 18% and a maximum of 68% (Table 4.27).

Table 4.27: Overall Comparison of pretest - posttest CPR knowledge

Statistics	Intervention group		Control group	
	Pretest (N=89)	Post test (N=81)	Pretest (N=86)	Post test (N=83)
Mean	41.80	74.66	41.86	45.30
Median	42.50	75.00	42.50	45.00
Mode	40[a]	73	40	48
Std. Deviation	8.709	8.392	7.889	7.996
Minimum	25	48	23	18
Maximum	65	98	65	68

4.6.6.1 Intervention – control groups inferential comparison of pretest-post test knowledge

Since the pretest and posttest data was not all normally distributed, a non parametric test (Wilcoxon rank test) was used as an equivalent of paired t test to compare individual group pretest and posttest performance. In the rank test, all the participants in the intervention group had an increase of scores from pretest to posttest as indicated by 81 positive ranks with no negative or tie ranks.

In the control group, 46 participants bettered their performance at post test as compared to the pretest as indicated by 46 positive ranks. 28 participants performed lower at posttest as compared to pretest as indicated by 28 negative ranks. 9 participants maintained their pretest performance at posttest (Table 4.28).

Table 4.28: Wilcoxon rank test

Ranks				
		N	**Mean Rank**	**Sum of Ranks**
Intervention group	Negative Ranks	0[a]	.00	.00
Pretest – Posttest CPR knowledge	Positive Ranks	81[b]	41.00	3321.00
	Ties	0[c]		
	Total	81		
Control group	Negative Ranks	28[d]	31.68	887.00
Pretest – Posttest CPR knowledge	Positive Ranks	46[e]	41.04	1888.00
	Ties	9[f]		
	Total	83		

a. posttest CPR knowledge intervention < pretest CPR knowledge intervention
b. posttest CPR knowledge intervention > pretest CPR knowledge intervention
c. posttest CPR knowledge intervention = pretest CPR knowledge intervention
d. posttest CPR knowledge control < pretest CPR knowledge control
e. posttest CPR knowledge control > pretest CPR knowledge control
f. posttest CPR knowledge control = pretest CPR knowledge control

4.6.6.2 Wilcoxon statistics

In the intervention group, there was significant statistical difference between pretest and posttest knowledge that was rated to be of large effect size measured using Cohen d; Z=7.82, d=0.8. Likewise in the control group participants, there was a significant statistical difference between posttest and pretest performance though was of small effect size; Z=2.70, p= 0.007, d=0.3 as indicated in table 4.29.

Table 4.29: Wilcoxon statistics

Test Statistics[a]		
	Intervention group	Control group
	posttest CPR knowledge VS pretest CPR knowledge	**posttest CPR knowledge VS pretest CPR knowledge**
Z	-7.826[b]	-2.704[b]
Asymp. Sig. (2-tailed)	0.000*	0.007*
Effect size (Cohen d) $r = z/\sqrt{N}$	0.8*	0.3

a. Wilcoxon Signed Ranks Test
b. Based on negative ranks.

4.6.7 Hypothesis testing on CPR knowledge after intervention

One of the null hypotheses was that a certified CPR training among nursing students did not have effect on knowledge. Since the posttest data was not normally distributed, Mann Whitney U test was done as an equivalent of independent t test to compare the group's performance at pretest and at posttest. At the baseline stage the intervention and control groups had no significant statistical difference in their CPR knowledge; Z=0.159, p=0.87, d =0.01. After the certified CPR training, there was a significant statistical difference of large effect size (Z = 10.9, p<0.001, d= 0.85) between the performance of the intervention and the control groups at posttest (Table 4.30).

From the Mann Whitney U and Cohen d tests done, the researcher thus rejected the null hypothesis since there was a significant (P<0.001) difference in the CPR mean post intervention. The inference made was that the certified CPR training and certification enhanced CPR knowledge acquisition among the senior diploma nursing students.

Table 4.30: Hypothesis testing on CPR knowledge acquisition

Independent Test Statistics[a]			
	Pretest CPR knowledge percentage	**Intervention**	**Posttest CPR knowledge**
Mann-Whitney U	3774.000		53.000
Wilcoxon W	7779.000		3539.000
Z	-.159		-10.899
Asymp. Sig. (2-tailed)	.874		<0.001*
Effect size $r = z/\sqrt{N}$	0.01		0.85*

4.7 Effect of certified training on CPR skills

The fifth objective of the study was to assess the outcome of a certified training on the CPR skills among the senior nursing students. After the certified cardiopulmonary resuscitation training, a post test evaluation was done after six months. An observation checklist was used to evaluate the performance of the CPR skill. The components of the evaluation included assessment of the victim, chest compressions, delivering ventilations and the use of an automated external defibrillator.

4.7.1 Effect of CPR training on victim assessment and activation of emergency system

Table 4.31 presents findings on the effects of CPR training on victim assessment and activation of the emergence response system skills.

Before commencing CPR, the rescuer must scan for scene safety to prevent any danger to them and also to the victim. In the experimental group, 24(27%) of the respondents were knowledgeable about this at pretests which increased by 64% to 76(94%) at post test. In the control group, 33(38%) were aware of this safety precaution at pretest which increased by 28% to 55(66%) at posttest. Upon the collapse of a victim, the rescuer has to check for responsiveness by calling the victim and also applying some pressure. Within the intervention group, 18(20%) of the respondents were aware of this action at pretest which increased by 75% to 77(95%) at posttest as indicated in table 45. In the

control group, 25(29%) know about this step at pretest and increased by 17% to 38(46%) at post test.

In the case a victim is unresponsive; the rescuer calls for help and sends someone to get an automated external defibrillator. In the experimental group, 10(11%) of the participants performed this step which increased by 67% to 33(78%). In the control group, 11(13%) of the participants performed this action which increased by 4% at post test to 14(17%). After calling for help the rescuer then assesses for breathing. Slightly above a fifth 20(22%) of the intervention group members were able to perform this step at pretest and increased by 74% to 78(96%) at posttest after the intervention. In the control group 40(47%) performed this step at pretest and decreased by 7% to 33(40%) at posttest.

The rescuer is supposed to assess for carotid pulse simultaneously as they assess the breathing. In the experimental group, 15(17%) assessed for the pulse at pretest and nearly all 78(96%) performed the step at posttest. Within the control group, 39(45%) assessed the pulse at pretest and decreased by 2% to 36(43%) at posttest.

Table 4.31: Pretest-posttest comparison on victim assessment skills

	Performance steps	**Action**	**Intervention group**		**Control group**	
			Pretest Count (%)	**Posttest Count (%)**	**Pretest Count (%)**	**Posttest Count (%)**
1.	Scans for scene safety	Performed	24(27%)	76(94%)	33(38%)	55(66%)
		Not performed	65(73%)	5(6%)	53(62%)	28(34%)
2.	Check for responsiveness	Performed	18(20%)	77(95%)	25(29%)	38(46%)
		Not performed	71(80%)	4(5%)	61(71%)	45(54%)
3.	Shout for help and send someone to get the AED	Performed	10(11%)	63(78%)	11(13%)	14(17%)
		Not performed	79(89%)	18(22%)	75(87%)	69(83%)
4.	Assess for breathing	Performed	20(22%)	78(96%)	40(47%)	33(40%)
		Not performed	69(78%)	3(4%)	46(53%)	50(60%)
5.	Assess for carotid pulse	Performed	15(17%)	78(96%)	39(45%)	36(43%)
		Not performed	74(83%)	3(4%)	47(55%)	47(57%)

4.7.2 Overall effect of CPR training on victim assessment skill

This sub section had 6 steps evaluated. Each correct step performed was awarded a point. The maximum score was 6. The intervention group has a mean score of 1.04± 1.08 at pretest and 4.59±0.79 at post test. The difference between the pretest and posttest mean scores was statistically significant with a very large effect size measured using Cohen d [t (80) =21.45, p<0.001, d=2.4]. The control group had a mean core of 1.71± 1.33 at pretest and 2.12±1.35 at posttest. The difference was not statistically significant and had a small effect size [t (82) =1.93, p=0.06, d=0.2] (Table 4.32).

Table 4.32: Paired t test on victim assessment skill

Paired Samples Statistics for assessing victim skills						
		Mean (5 points)	**N**	**Std. Deviation**	**Std. Error Mean**	**Paired t test**
Intervention group	Assessing victim skills - pretest	1.04	81	1.078	.120	t= -21.45 d.f. =80 p< 0.001*
	Assessing victim skills- posttest	4.59	81	.787	.087	Cohen d=2.4*
Control group	Assessing victim skills- pretest	1.71	83	1.330	.146	t= - 1.932 d.f. = 82 p= 0.06
	Assessing victim skills - posttest	2.12	83	1.347	.148	Cohen d= 0.21

4.7.3 Effect of CPR training on performance of high quality chest compressions

Table 4.33 presents findings on the effects of CPR training on chest compression skills. This subsection evaluated the performance of high quality chest compressions. The hands should be well positioned at the lower half of the sternum during compressions. A majority 68(76%) of the intervention group participants positioned the hands correctly at pretest. This further increased by 20% at posttest to 78(96%). 'Similarly, a majority 58(67%) of control group members positioned the hands correctly at pretest, however this decreased by 8% at posttest to 49(59%). The chest compression rate should be

within 100-120 per minute. In the experimental group, 50(56%) of the participants compressed the chest at the recommended rate at pretest. This further increased 33% to 72(89%) at posttest. The control group compression rate was low at 22(26%) at pretest and increased by 8% to 34(41%) at post test.

The recommended adult chest compression depth is 2-2.4 inches. In the intervention group 52(58%) of the participants at pretest made the right compression depth. This increased by 25% to 67(83%) at posttest. Slightly above quarter of the control group participants (23(27%) made the right chest compression at pretest. This further increased by 20% to 39(47%) at posttest. The rescuer should minimize interruptions between the compressions and ventilations to less than 10 seconds. In the experimental group 51(57%) observed this recommendation at pretest. Following the intervention, nearly all 77(95%) observed the recommendation at posttest. Nearly a third of the control group participants 26(30%) observed the recommendation at pretest. This increased by 3% to 27(33%) at posttest.

Table 4.33: Pretest-posttest comparison of chest compression skills

		Intervention group		**Control group**	
Performance steps	**Action**	**Pretest Count (%)**	**Posttest Count (%)**	**Pretest Count (%)**	**Posttest Count (%)**
Correct hand placement	Performed	68(76%)	78(96%)	58(67%)	49(59%)
	Not performed	21(24%)	3(4%)	28(33%)	34(41%)
Compression rate	Performed	50(56%)	72(89%)	22(26%)	48(58%)
	Not performed	39(44%)	9(11%)	64(74%)	35(42%)
Compression depth and recoil	Performed	52(58%)	67(83%)	23(27%)	39(47%)
	Not performed	37(42%)	14(17%)	63(73%)	44(53%)
Minimizing interruptions	Performed	51(57%)	77(95%)	26(30%)	27(33%)
	Not performed	38(43%)	4((5%)	60(70%)	56(67%)

4.7.4 Overall effect of CPR training on chest compression skills

Table 4.34 presents findings on overall effect of CPR training on chest compression skills.

This subsection had four observable steps. Each correct step performed was awarded a point. The maximum score was 4. The experimental group had a mean score of 2.43 at pretest and 3.63 at posttest. On further t test analysis, the difference in the scores was statistically significant with a large effect size measured using Cohen d; [t (80) =6.546, p<0.001, d=0.73]. The control group had a mean score of 1.43± 1.12 at pretest and increased to 1.96± 1.48 at posttest. On further analysis the difference was statistically significant however the effect size was very small as measured by Cohen d; [t (80) = 2.41, p=0.02, d=0.3].

Table 4.34: Paired t test on chest compression skills

Paired Samples Statistics for high quality chest compression skills						
		Mean (4 points)	**N**	**Std. Deviation**	**Std. Error Mean**	**Paired t test**
Intervention group	Chest compression skills- pretest	2.43	81	1.303	.145	t= -6.546 d.f. =80 p<0.001* Cohen d=0.73*
	Chest compression skills- posttest	3.63	81	.901	.100	
Control group	Chest compression skills -pretest	1.43	83	1.117	.123	t= -2.405 d.f. = 82 p= 0.02* Cohen d= 0.26
	Chest compression skills - posttest	1.96	83	1.477	.162	

4.7.3.1 Effect of CPR training on ventilation skills

Table 4.35 presents findings on the effects of CPR training on ventilation skills.

This subsection evaluated the skills on delivering breaths. Five steps were evaluated. Each correct step was awarded a mark. The rescuer is expected to open the airway adequately to facilitate oxygen entry. At pretest a third 30(34%) of the intervention group members opened the airway adequately. This increased by 18% to 42(52%) at posttest. In the control group 32(37%) of the participants performed the step successfully. However this reduced by 8% to 24(29%) at posttest. Each breath should be

administered within a second. A majority of the experimental group members 57(64%) derived the breaths as recommended. This further increased by 24% to 71(88%) at post test. In the control group 37(43%) delivered the breaths as recommended. This however reduced at post test to 21(25%).

Effective breaths should make the chest to rise. Nearly a third of the intervention group members 28(31%) made effective breaths at pretest and increased by 27% to 47(58%) at posttest. In the control group nearly a fifth 16(19%) made effective breaths at pretest reduced by 6% to 11(13%) at post test. The rescuer should avoid excess ventilation by delivering only 2 breaths after 30 compressions. A majority of the intervention group participants 53(60%) delivered adequate ventilations at pretest. This further increased significantly to 74(91%) at posttest. In the control group, 32(37%) of the members administered adequate breaths at pretest but at posttest the performance reduced to 14(17%).

After delivering breaths, the rescuer should resume chest compressions within 10 seconds. Nearly a half of the experimental group members 44(49%) observed this timing at pretest which increased by 42% to 74(91%) at posttest. Within the control group, slight above a third 30(35%) of the participants observed this timing at pretest. However this reduced by 22% to 11(13%) at posttest.

Table 4.35: Pretest-posttest comparison of ventilation skills

		Intervention group		Control group	
Performance steps	**Action**	**Pretest Count (%)**	**Posttest Count (%)**	**Pretest Count (%)**	**Posttest Count (%)**
Opens airway adequately	Performed	30(34%)	42(52%)	32(37%)	24(29%)
	Not performed	59(66%)	39(48%)	54(63%)	59(71%)
Delivers each breath within a second	Performed	57(64%)	71(88%)	37(43%)	21(25%)
	Not performed	32(36%)	10(12%)	49(57%)	62(75%)
Deliver breaths that make chest to rise	Performed	28(31%)	47(58%)	16(19%)	11(13%)
	Not performed	61(69%)	34(42%)	70(81%	72(87%)
Avoid excess ventilation	Performed	53(60%)	74(91%)	32(37%)	14(17%)
	Not performed	36(40%)	7(9%)	54(63%)	69(83%)
Resume chest compressions in less than 10 seconds	Performed	44(49%)	74(91%)	30(35%)	11(13%)
	Not performed	45(51%)	7(9%)	56(65%)	72(87%)

4.7.3.2 Overall effect of CPR training on ventilation skills

Table 4.36 presents findings on the overall effects of CPR training on ventilation skills. The sub-section had 5 observable steps evaluated. Each correct step was awarded a mark. Maximum score for the sub-section was 5. The mean score for the intervention group members was 2.36$\pm$1.74 at pretest and increased to 3.80$\pm$1.35 at posttest. On further analysis using paired t test, the difference in the pretest posttest performance had a significant statistical difference with a medium effect size measured using Cohen d; [t (80) = 6.01, $p<0.001$, d= 0.67].

The control group had a mean score of 1.70$\pm$1.49 at pretest and decreased to 0.98$\pm$1.38 at posttest. The lowered performance had a significant difference as measured by a paired t test though of a small effect size as measured using Cohen d; [t (82) = 3.49, p= 0.01, d=0.3].

Table 4.36: Paired t test on ventilation skills

Paired Samples Statistics for delivering breaths skills						
		Mean (5 points)	**N**	**Std. Deviation**	**Std. Error Mean**	
Intervention group	Ventilation skills -pretest	2.36	81	1.741	.193	t= -6.029 d.f. =80
	Ventilation skills -posttest	3.80	81	1.346	.150	p< 0.001* Cohen d=0.67*
Control group	Ventilation skills -pretest	1.70	83	1.488	.163	t= 3.486 d.f. = 82
	Ventilation skills- posttest	.98	83	1.379	.151	p= 0.01* Cohen d=0.30

4.7.4 Effect of CPR training on Automated External defibrillator skills

Table 4.37 presents findings on the effects of CPR training on AED skills.

This subsection evaluated the skills on the use of an AED. Six steps were evaluated. The first step is switching on the AED. In the pretest stage, both the experimental and the control groups none of the participant had operated an AED and thus none 0(100%) powered it on. At posttest stage all the intervention group members 81(100%) powered it on but the control group members remained at 0%. The second step is attachment of the defibrillator pads. In the pretest stage again, all the participants in both groups were at 0% performance. At posttest stage nearly all 79(98%) of the intervention group members were able to attach the pads. However, the control group members remained at 0% performance.

The third step in operating an AED is to clear the rescuers for analysis. Similarly at the pretest stage all the members in both groups were at 0% performance. After the education intervention, 57(70%) of the intervention group members performed the task. Similarly at posttest, the control group performance remained at 0%. The fourth step is to clear the rescuers to safely deliver the shock. Like the previous steps, all the members in both groups were at 0% performance. After the intervention, the experimental group

performance raised to 68(84%) at posttest. Likewise the control group performance remained at 0% at posttest.

The fifth step is to press the shock button once and deliver the shock. In the pretest stage all the members in both groups were at 0% performance of this step. Following the intervention, all the members 81(100%) in the experimental group were able to deliver the shock at posttest. The control group members remained at 0% performance. The last step after delivering the shock is the rescuer to resume CPR. Again at pretest all participants in both groups were at 0% performance. Likewise after the education intervention, 73(90%) of the experimental group members were able to perform the activity at posttest. Similarly the performance of the control group was at 0% at posttest.

Table 4.37: Pretest-posttest comparison of AED skills

Performance steps	Action	Intervention group		Control group	
		Pretest Count (%)	**Posttest Count (%)**	**Pretest Count (%)**	**Posttest Count (%)**
1. Power on AED	Performed	0(0%)	81(100%)	0(0%)	0(0%)
	Not performed	89(100%)	0(0%)	86(100%)	83(100%)
2. Attach the pads	Performed	0(0%)	79(98%)	0(0%)	0(0%)
	Not performed	89(100%)	2(2%)	86(100%)	83(100%)
3. Clear rescuers for analysis	Performed	0(0%)	57(70%)	0(0%)	0(0%)
	Not performed	89(100%)	24(30%)	86(100%)	83(100%)
4. Clear rescuers to safely deliver the shock	Performed	0(0%)	68(84%)	0(0%)	0(0%)
	Not performed	89(100%)	13(16%)	86(100%)	83(100%)
5. Delivers shock	Performed	0(0%)	81(100%)	0(0%)	0(%)
	Not performed	89(100%)	0(0%)	86(100%)	83(100%)
6. Resume CPR	Performed	0(0%)	73(90%)	0(0%)	0(0%)
	Not performed	89(100%)	8(10%)	86(100%)	83(100%)

4.7.5 Overall effect of CPR training on automated electrical defibrillation

The subsection had 6 observable steps. Each correct step was awarded a mark. The maximum score was 6. The experimental group mean at pretest was 0.00 at rose to 5.32± 1.11 at posttest. The difference was statistically significant with a very large effect size measured using Cohen d; [t (80) = 43.35, p <0.001, d=4.82]. The control group's mean score remained at 0 and thus there was no computable change as indicated in table 4.38.

Table 4.38: Paired t test on AED skills

Paired Samples Statistics for AED skills						
		Mean (6 points)	**N**	**Std. Deviation**	**Std. Error Mean**	**Paired test**
Intervention group	AED skills pretest intervention	.00	81	.000	.000	t= -43.345 d.f. =80 p= 0.00*
	AED skills posttest intervention	5.32	81	1.105	.123	Cohen d=4.82*
Control group	AED skills pretest control	.00	83	.000	.000	No change for computation
	AED skills posttest control	.00	83	.000	.000	

4.7.6 Overall comparison of pretest-posttest CPR skills performance

Table 4.39 presents descriptive findings on the effects of CPR training on resuscitation skills.

The total performance of skills out of 20 was converted into percentage. The intervention group had a mean score of 29.21% ± 14.79 at pretest and a median of 30%. The minimum score was 0 and a maximum of 60%. At post test the mean score rose to 86.73%± 13.76 with a median of 90%. The minimum score was 25% and the maximum score was 100%.

The control group had a mean percent of 24.65±12.74 at pretest with a median of 25%. The minimum was 0% and maximum of 55%. At posttest, the mean rose to 25.54%±16.86 with a median score of 20%. The minimum score was 0% and maximum was 65%.

Table 4.39: Overall pretest posttest CPR skill descriptive statistics

CPR skill Statistics	Intervention group		Control group	
	Pretest (N=89)	Post test (N=81)	Pretest (N=86)	Post test (N=83)
Mean	29.21	86.73	24.65	25.54
Median	30.00	90.00	25.00	20.00
Mode	15	100	30[a]	15
Std. Deviation	14.788	13.765	12.737	16.857
Minimum	0	25	0	0
Maximum	60	100	55	65

4.7.5.1 Overall effect of the training intervention on CPR skills

Table 4.39 presents inferential findings on the effects of CPR training on resuscitation skills.

The data having been not normally distributed, non parametric Wilcoxon rank test was used as an equivalent of paired t test. On the rank test, there were 82 positive ranks and 4 negative ranks in the intervention group. In the control group, there were 40 negative ranks, 36 positive ranks with 5 ties as indicated in table 4.40.

Table 4.40: CPR skills Wilcoxon rank test

Ranks				
		N	**Mean Rank**	**Sum of Ranks**
Total skills posttest intervention - Total skills pretest intervention	Negative Ranks	4[a]	5.88	23.50
	Positive Ranks	82[b]	45.34	3717.50
	Ties	0[c]		
	Total	86		
Total skills posttest control - Total skills pretest control	Negative Ranks	40[d]	36.66	1466.50
	Positive Ranks	36[e]	40.54	1459.50
	Ties	5[f]		
	Total	81		

4.7.5.2 Comparison of pretest-posttest CPR skills

There was a significant difference between the pretest and posttest scores in the experimental group that had very large effect size measured using Cohen d; (Z=7.96, p=0.00, d=0.86). In the control group, there was minimal change that was not statistically significant (Z=0.018, p= 0.99, d=0.11) as indicated in table 4.41.

Table 4.41: Wilcoxon test

Test Statistics[a]		
	Total CPR skills posttest intervention - Total skills pretest intervention	**Total CPR skills posttest control - Total skills pretest control**
Z	-7.962[b]	-.018[c]
Asymp. Sig. (2-tailed)	<0.001*	.986
Effect size (Cohen d) $r = z/\sqrt{N}$	0.86*	0.11

a. Wilcoxon Signed Ranks Test
b. Based on negative ranks.
c. Based on positive ranks.

4.7.6 Test of CPR skills acquisition hypothesis

Though there was significant difference at pretest and posttest between the intervention and control groups ($p<0.05$), the null hypothesis was rejected based on effect size change from 0.15(small effect) to 0.85 (large effect) as indicated in table 4.42.

Table 4.42: Test of CPR skill hypothesis

Independent Test Statistics[a]		
	Pretest CPR Intervention percentage Intervention vs. control	Posttest CPR skill Intervention vs. control
Mann-Whitney U	3150.500	59.500
Wilcoxon W	6891.500	3545.500
Z	-2.031	-10.892
Asymp. Sig. (2-tailed)	**.042***	**.000***
Effect size **r = z/√N**	0.15	**0.85***

CHAPTER FIVE

DISCUSSION, CONCLUSION AND RECOMMENDATIONS

This chapter discusses the deductions made from the results of the study. The findings of the study are compared with local, regional and global finding of similar studies. The discussion is based on the research objectives.

5.1 Discussion

5.1.1 Participants demographic characteristics

The study participants were majorly mid aged females aged 21-25 years. This study finding concurs with a study that nursing profession is female dominated (Barrett-landau et al., 2014). However, this dominance does not have influence on the performance of cardiopulmonary resuscitation (Barrett-landau et al., 2014). Nursing has been regarded as a female career and thus the population at the nursing institutions their numbers remain high as compared to the males (Guy et al., 2022)

Though the participants had some prior knowledge on cardiopulmonary resuscitation from teachings in first year and also in the clinical settings, all the participants had not done a formal certified cardiopulmonary resuscitation course. This finding is mirrored in a study done in Iran where almost all students had not done a certified CPR course (Akhlaghdoust et al., 2021). This could be attributed to lack of mandatory certified CPR training in the country for the nursing students and also for those practicing (Baldi et al., 2019). The curriculum also lacked refresher trainings to prevent knowledge deteriorate which has been proven to be rapid if not utilized. This finding is contrary to the scenario in high income countries where all nursing students and practicing nursing are required to acquire and maintain the CPR certification (Florida, 2018).

5.1.2 Level of CPR knowledge of senior diploma nursing students at baseline

Generally, the senior nursing students' knowledge on cardiopulmonary resuscitation was below average. This could be attributed to the fact that the students had not done a certified BLS examination. It could also be attributed to the fact that curriculum used does not have a refresher course that could improve on the students knowledge. The students only got some basic life training in their first semester of first year of study. Studies indicate that CPR knowledge deteriorates fast with no refresher and practice (Sand et al., 2021). The findings mirrored a study done in Iran where the nursing students had low levels of CPR knowledge (Akhlaghdoust et al., 2021). This finding can be attributed to the observation made that no student had done any formal training on cardiopulmonary resuscitation. Institutions that fail to have planned refresher and mandatory CPR training like what was observed in this study may have their students performing sub optimally (Sand et al., 2021). The findings are contrary to a study done in Turkey that showed that the nursing students had an above average score of 64% (Vural et al., 2017) . Professionally developed countries mandate that basic life support is trained at elementary levels and it's a requirement for joining a nursing training institution. This makes the nursing students perform better since they had a better knowledge base.

The finding of the current study revealed that majority of the students in both experimental and control groups had below average level of CPR knowledge. No student answered all the questions correctly as would have been expected at senior level of training. Qualifying students are expected to have adequate knowledge and skills to put into practice once employed. This finding is comparable with several studies. A study done in Korea showed the CPR knowledge was average with a mean of 5.42 ± 1.69 out of 10 (Roh & Issenberg, 2014).

In a related study done at a medical polytechnic university in Erbil, almost all of the medical students (95.3%) had poor level of CPR knowledge. Their mean knowledge was 11.85 ± 4.772 out of 38 which was 31.18%. These findings of this study are similar to a

study done at a University in Turkey where the mean CPR knowledge of the nursing students was 40.3% (Kose et al., 2019). Similarly a study done at selected colleges of nursing in Salem among senior nursing students indicated that the mean knowledge on CPR was 46.73% (Kumudha., 2021). The findings also mirror a study done in Iran where more than 70% of the students had a low CPR score (Akhlaghdoust et al., 2021).

Similarly, in a study done in China among nursing students on offering cardiopulmonary resuscitation to trauma patients revealed that the students had unsatisfactory level of CPR knowledge. Their mean score was 7.51 ± 1.93 out of 15 (Baldi et al., 2019). The findings are also mirrored in a study evaluating medical and nursing interns where 46% of the nurse intern students had poor level of knowledge (Mendhe et al., 2018). Another related study done in Tanta University among nursing students, 89.3% of the participants had poor level of CPR knowledge (Ahmed & Farag, 2018). The low CPR scores in this study are closely related to a study done in Nigeria among medical students where 97.1% scored less than 50% (Aliyu et al., 2019). These findings of low CPR scores are associated with the fact that most institutions do not offer programmed CPR retraining.

The study also found out that majority of the students had poor to fair level of knowledge which was below 50% performance as compared to local and international standards. There was no single student who achieved the desired mark of competence by AHA which is 84%. The findings are closely related to another study in Kenya among post basic students who had prior clinical experience where only 7.1% of the students achieved the recommended competence score by AHA (Kipsang & Bruce, 2011).

Low levels of knowledge among students graduating to offer nursing care to patients is worrying since CPR is done frequently. The similarity in performance between the basic and post basic students is attributable to lack of mandatory CPR trainings at work place and also not a requirement for licensure renewal in Kenya currently (Qadir et al., 2017).

The finding of low CPR knowledge level is contrary to other studies that showed nursing students having higher levels of CPR knowledge. A study conducted at a University in Brazil revealed that 35.3% of the nursing students had a high score of above 70% contrary to this study where only 1.1% had a score above 65% (Pelek, 2021). The findings also differ from a study done in Kolkata India where the students had a higher mean of 61.1% though below the desired AHA pass mark (Syeda, 2020). These findings are contrary to a cross international study done in three countries that showed better performance among the nursing students (Kwiecień-Jaguś et al., 2020). In a related study done at a Brazilian university among health sciences students, the nursing students had high levels of CPR knowledge with a majority scoring above 70% (Pelek, 2021). The high performance among these groups could be associated with the bachelors' level of training whereby the curriculum could have retraining courses.

In a similar study done in Kolkata among third year nursing students indicated that they had a baseline CPR knowledge of 15.83 equivalent to 61% (Syeda, 2020). In a related study done in India among diploma nursing students, the student's performance was commendable as 38% had average score while 62% had good knowledge level. No single student in the study had poor knowledge level (Vandali et al., 2018). Another study done in Istanbul Turkey among nursing students indicated that the students CPR knowledge was above average. The mean score was 64.62±17.84 out of 100 points (Vural, 2017). The high scores in these studies could be attributed to the fact that there are frequent CPR refresher trainings and CPR certification is maintained in their institutions. Sustainable education program facilitates the learners CPR knowledge, skills and attitude (Pei et al., 2019).

Almost all of the participants were able to expand the BLS abbreviation which is expected for students in the health profession. This indicated that the students had learned at retained some basics of CPR. The finding was similar to a study done in India assessing BLS knowledge among medical and nursing students where 82.6% of the nursing students were able to expand the BLS initials (Vausedvan et al., 2016). In a similar study done in three European countries among undergraduate nursing students,

66.5% of the respondents were able to expand the BLS abbreviations (Kwiecień-Jaguś et al., 2020). In a related study in India among health sciences students, almost all (95%) of the participants knew how to expand the BLS initials (Sangamesh et al., 2017b). All nursing and other health related students should be aware of these initials since BLS course in taught in the first year of study (Vural et al., 2017).

Contrary to these findings, a study done among medical, nursing and midwifery students done at an Islamic university in Iran revealed that only 23.1% of the students who were able to expand the BLS initials correctly (Akhlaghdoust et al., 2021). In a study done in Nigeria among senior medical and nursing students, 12 % did not expand the BLS abbreviations correctly. This was identified as a major gap for senior health sciences students (Okonta & Okoh, 2015). A related study done in India assessing nursing students knowledge on CPR revealed that 62.5 % of the students defined CPR correctly (Syeda, 2020). The low performance in these institutions could be probably be attributed to lack of refresher trainings or lack of mandatory CPR training (Tirado, 2016)

Majority of the participants in this study were not aware of the recommended adult compression depth of 2-2.4 inches. This implied that senior students at that moment could not have performed effective compressions to promote resumption of spontaneous circulation. The findings are similar to the study done at Istanbul University where only a fifth of the nursing students were sure of the recommended depth (Kose et al., 2019). The findings also mirror a study done in Iran where only 11.3% the medical, nursing and midwifery students knew the recommended depth (Akhlaghdoust et al., 2021). This finding could be as a result of the students not having done the training by American Heart Association which emphasizes on high quality chest compression (Panchal et al., 2020).

Chest compressions are the foundation of successful CPR. However, a majority of the students were not conversant with this fact. Contrary to the low knowledge on adult chest compression deduced in this study, a study done in Turkey indicated that three quarters (74.7%) of the nursing students knew about the recommended chest

compression depth of 2-2.4 inches (Oktay, 2019). Lack of emphasis on chest compression could lead to poor resuscitation outcomes since the rescuer does not achieve and maintain the desired cardiac output(Harris & Kudenchuk, 2018). Senior nursing students prepared to offer emergency care should be aware that when a victim is suspected to have spinal cord injury, the airway should be opened using a jaw thrust maneuver to prevent further injury to the cord. A majority of the respondents in this study were not aware of this safety maneuver. This could be attributed to lack of adequate skills lab sessions which lay emphasis on the specific resuscitation skills (Santos et al., 2015). This was a serious omission since without this knowledge, the students could cause further trauma to a patient with spinal injury especially at the cervical level. Contrary to the findings of this study a research done in Spain among nursing students indicate that nearly all (98%) knew about the jaw thrust maneuver (Carlos et al., 2019). The senior nursing students ought to know the importance of minimizing interruption during CPR.

Majority of the students did not know that pulse and respiration check should be done simultaneously within ten seconds. The clinical implication is that if the students were to perform CPR by then, there could be reduced chances of survival because of the time lost. The results are comparable to the study done at Turkey where three quarters of the nursing students were not aware of this recommendation (Kose et al., 2019). Minimizing interruptions is of essence during resuscitation. Lack of observing these golden minutes may impair the patient outcomes. Lack of mandatory CPR training for the participants could be the cause for the students not to know these foundations facts as emphasized by American Heart Association training manuals on resuscitation (Panchal et al., 2020).

Two thirds of the participants were not aware of the recommended adult pulse check at the carotid. This could have been associated with lack of using current guidelines by American Heart Association since they a lot of emphasis of pulse check among various age groups (AHA, 2020) This finding was similar with the study at Turkey where a third of the nursing students knew about the correct pulse assessment (Kose et al., 2019) . Another related study still in Turkey indicated that 37.3% of the health sciences students

were aware of the adult pulse to check (Oktay, 2019). Contrary to the findings of this study other studies indicate high knowledge score on pulse assessment. A similar study in Europe indicated that more than three quarter of the nursing students were aware of the carotid pulse check (Kwiecień-Jaguś et al., 2020). This is attributable to the fact that European Resuscitation Council emphasizes greatly on CPR in health related trainings (Semeraro et al., 2021)

The recommended BLS sequence is circulation, airway and then breathing. This sequence was changed in American Heart Association basic life support training manual 2010. Majority of the respondents still held the older sequence of airway breathing and circulation. This was mostly like to be associated with the use of old training manuals. In a similar pattern, a cross international study also revealed that only 22.6% of the respondents were aware of the updated sequence (Kwiecień-Jaguś et al., 2020). Similarly a study by Vausedvan (2016) in India showed that 40.7 % of the nursing students did not know on the updated sequence of circulation, airway and breathing. Another study done in a Saudi Arabian University, 59% of the nursing students were not aware of the updated BLS sequence (Alsharari et al., 2018). Contrary to the finding that the students were not updated on the sequence, a study done in Nigeria among health sciences students indicated that 80.8% knew about the BLS sequence (Ativie et al., 2018). In a related study done in India among health science students, 71.8% of them knew about the recommended BLS sequence (Sangamesh et al., 2017b). Students who are taught using the updated basic life support curriculum are expected to know the updates since the sequence is greatly emphasized (Panchal et al., 2020)

The adult compression ventilation ratio is 30:2 for single or multiple rescuers. Most participants in the study were aware of the recommended ratio for two rescuers. However, a majority were not aware of the recommended ratio for one rescuer. The findings from this study are also consistent with a study in Europe whereby nearly all the nursing students were aware of the recommended compression to ventilation ratio (Kwiecień-Jaguś et al., 2020). A study done in a turkey university revealed that nearly all (90.7%) of the health science students knew on the adult compression ventilation

ratio (Oktay, 2019). The findings are comparable to the study in Turkey where three quarters of the nursing students did not know on the recommended compression to ventilation ratio (Kose et al., 2019). Similarly in the study done in Iran among medical, nursing and midwifery students, only 14.8% were aware of the recommended ratio (Akhlaghdoust et al., 2021). In developed countries, the lay people are taught on chest compression only resuscitation thus students undertaking a nursing course are expected to be conversant with the compression ventilation ratio. Students who are taught using the updated basic life support curriculum are expected to know the updates since high quality chest compressions are greatly emphasized (Panchal et al., 2020).

The in-hospital adult chain of survival steps are important to ensure the rescuer does the procedure with efficiency that produces favorable outcomes. In this study, a majority of the senior nursing students were not aware of the chain of survival. Failure to know chains of survival is big clinical gap since the steps in the chain facilitate efficient offering of CPR and handing over the victim to the advanced life supporters. This may reduce the chance of survival of a victim. Contrary to this finding, a majority (68.5%) of nursing students in a similar cross international study were knowledgeable about the chain of survival (Kwiecień-Jaguś et al., 2020). This means that in a scenario of resuscitation the students may not perform the procedure efficiently. Lack of formal CPR training is the most attributable cause since the formal BLS training lays emphasis on the chains of survival (Saramma et al., 2016).

More than three quarters of the participants in this study were not aware of the recommended adult chest compression rate of 100-120 compressions per minute. This could still be associated with lack of retraining and use of the resuscitation manuals. This means that if the students were to offer CPR, they could not have achieved the desired cardiac output to ensure proper tissue perfusion. This finding is congruent with the findings in a research done in Europe where a majority of the nursing students in those three countries were not knowledgeable of the recommendation (Kwiecień-Jaguś et al., 2020). Similarly, the study done in Iran at an Islamic university indicated that only 15.2% of the study participants were knowledgeable about this recommendation

(Akhlaghdoust et al., 2021). In a related study done in Nigeria among health sciences students, only 15.7% of participants knew on the recommended chest compression rate (Ativie et al., 2018). This means that if the students were to perform a resuscitation procedure the prognosis wound be poor since the cardiac output would be sub optimal (Harris & Kudenchuk, 2018).

Majority of the participants in this study were not aware of the recommended time to deliver each breath. The findings resonate to a study done in Turkey only a third (34%) of the health sciences students were knowledgeable about the duration of administering a breath (Oktay, 2019). This implies that if the students were to perform ventilations they would either over ventilate or under ventilate. Students who are undertaken through updated BLS curriculum are expected to have basic resuscitation principles (Ruangrit &Keawpimon 2021).

Majority of the respondents in both experimental and control groups were not aware of the first step during resuscitation of checking for the scene safety. The students may expose themselves into risks if they are not aware of the importance of conducting scene assessment (Sabir, 2017). The findings are congruent to a study done in a Muslim university in Iran indicated where only 12.3% of the medical, nursing and midwifery students were aware of this safety step. Contrary to the findings in this study, a research done in three European countries revealed that majority of the nursing students in those countries knew about the first step (Kwiecień-Jaguś et al., 2020).

A senior nursing student prepared on the use of an automated external defibrillator is expected to know the shockable rhythms which are ventricular fibrillation and ventricular tachycardia. Three quarters of the respondents in this study were not aware of the two rhythms. This finding is attributable to the fact that the students had not learned about automated defibrillation. Contrary to this finding, a study done among medical students in Italy indicate that 88.8 % if the students knew about the shockable rhythms (Baldi et al., 2019). The low knowledge on defibrillation could be attributed to

the lack of training using updated curriculums that incorporate AED training (Panchal et al., 2020).

If the chest is not inflating upon delivering a breath, the rescuer should reposition the airway to align it. Three fifths of the participants in this study were aware of the corrective measure of repositioning the airway. The clinical implication is that if two fifths could not have ventilated a patient adequately since successful ventilation is measured by a chest rise. This finding resonates similarly In a study in Nigeria among health sciences students where 54.8% of the respondents knew about repositioning the airway to facilitate oxygen entry (Ativie et al., 2018).

It is expected that all rescuers should know the correct position of offering chest compressions. A majority of the respondents above three quarters were aware that the lower sternum is the correct position to perform the chest compressions. Failure to have correct hand placement will not have adequate chest compression. In a similar study in Europe, a majority of the nursing students were aware of the correct hand position during compression (Kwiecień-Jaguś et al., 2020). This finding can be related to Okonta and Okoh (2015) study on theoretical knowledge of CPR that found out that 78% of the students were aware on the recommended position for placing hands during CPR. In a similar study by Sangamesh et al. (2017), 67% of the students were aware of the recommended hand position during CPR. Similarly a study by Vausedvan et al. (2016) found that 61% of the nursing students were aware of the correct lower half of the sternum position. This finding implies that the students would have had correct had placements during resuscitation. This also implies that the students had retained the knowledge learned during the first aid course (Mokhtari et al., 2012).

This finding was contrary to a research done at Istanbul turkey where only 15.4% of the respondents knew the correct position (Kose et al., 2019). In a another study done in Iran, only 27.4% of the medical, nursing and midwifery students knew about the correct hand position during chest compressions (Akhlaghdoust et al., 2021). Similarly a study

done in Nigeria revealed that only 22.2% of the health science students knew the correct hand placement at the lower sternum during chest compressions (Ativie et al., 2018).

Three quarters of the participants in this study were not aware of abdominal thrust maneuver technique. This could be attributed to the lack of using the updated resuscitation manuals. The clinical implication is that the students could not have relieved a patient with chocking. The findings are similar to the study done in Iran Islamic university where 33.1% of health sciences students knew about the recommendation (Akhlaghdoust et al., 2021). In a related study done in Nigeria among nursing students and other health sciences students, only 28.4% who knew about the abdominal thrust maneuver (Ativie et al., 2018). This finding is unexpected for senior nursing students since this is an elementary procedure. Majority of the students would not have saved a life in a case of chocking (Garc et al., 2019).

Above two third of the students in this study were not aware of the universal AED steps. Contrary to this observation, nearly three quarters (73.6%) of nursing students in a cross international study knew about these universal steps (Kwiecień-Jaguś et al., 2020). Students who are trained using the current updated curriculums on BLS would be updated on AED knowledge since it has been incorporated in the BLS curriculum (Panchal et al., 2020).

5.1.3 Level of CPR skills among senior diploma nursing students at baseline

Generally, the study found that the senior nursing students had below average level of CPR skills. The study found that no student had done a certified CPR course within the three years of their study. The observed finding is a replica of a study done in Iran where no student nurse had done a certified CPR course (Akhlaghdoust et al., 2021). In a related study in Tanta University among nursing students, 88.7% had unsatisfactory levels of CPR skill. However, the findings from this study are contrary to recommendations from institutions like Washington University where it is expected that nursing students have valid CPR cards throughout the course of the study (*CPR*

Training | School of Nursing, n.d.). Similarly in developed countries it is mandatory for nursing students and other health related students to undertake a certified CPR course during the training (Baldi et al., 2020). Lack of a certified CPR course by the students could be attributed to the fact that there is no regulation requiring the nursing students to have a certified CPR course during training. There is also need for revising curriculum to include new teaching methods that facilitate knowledge acquisition (Ahmed & Farag, 2018).

In the initial step of victim assessment, only a third of the participants scanned for scene safety. Contrary to this observation, a study done in Spain showed very high performance scores as 99% of the nursing students scanned for scene safety before assessing the victim (Carlos et al., 2019). The low performance of this skill may expose the rescuers to risks since they will not verify scene safety (AHA, 2020).

After verifying scene safety it is expected that a rescuer checks for responsiveness. A quarter of the participants in this study assessed victim responsiveness. This implies that many students would have risked their lives in some emergencies (AHA, 2020). Contrary to this finding the study done in Spain by Carlos revealed that 96% of the nursing students had the skill of checking for responsiveness (Carlos et al., 2019). If a victim is unresponsive a rescuer should shout/ call for help to be delivered and AED and also to be assisted in performing CPR. Only a few of the participants in this study shouted for someone to help and deliver an AED. The same study from Spain indicated that 96% of the students performed this step (Carlos et al., 2019).

The rescuer is supposed to check for breathing and pulse simultaneously for not more than 10 seconds. In this study only a third of the participants assessed for breathing and pulse. This is low performance as these are the key indicators to diagnose a patient who has sudden cardiac arrest. Similarly to this study, a practical study in Egypt by Mohamed (2017) showed that 81.8% of the students could not effectively assess for the pulse in the case scenario given of cardiac arrest. The findings are also mirrored in a study by Kose et al. (2019) on nursing students CPR skills where 76% could not

sufficiently assess the pulse. Contrary to the low performance in this study, the study done in Spain indicated that 91% of the students assessed for breathing and 80% assessed for the pulse (Carlos et al., 2019).

Chest compressions remain the foundation of cardiopulmonary resuscitation. It is recommended even for the lay rescuers to do chest compressions only resuscitation. It is thus expected that senior diploma nursing students exiting college for workforce to be excellent in performing high quality chest compressions. This study deduced that senior nursing students were deficient in CPR compression skills. A majority of the participants were able to do compressions at the right position but did not achieve the recommended rate and depth. This finding can be attributed to the fact that the students lacked adequate skills lab practice and also lacked refresher training in their course of study. The findings of this study nearly mirrors a study done in Harvard where 59% of the nursing students compressed the chest at the right depth and 42% compressed at the right rate (Oermann et al., 2020). In a practical study done in Egypt by Mohamed (2017), 81.8% of the students did not have the correct hand placement and 75% did not perform the recommended chest compressions. In a related study done in Turkey, at pretest 81.5% of the students did not perform effective chest compressions at the recommended rate and depth (Kose et al., 2019). The low performance of chest compression among the students was unexpected since they ought to have had high quality chest compression skills at senior years of training. This is highly attributable to lack of timed refresher trainings (Sun & Young, 2016).

The findings contrasts a study done in a University in Brazil where more than 60% of the nursing students were competent in delivering high quality chest compressions at the right position, depth and the rate (Saad et al., 2019). A similar study done in Spain indicated that the nursing students had very high skills on chest compression where all of the students (100%) performed correct compression rate, 94% had the right hand placement and 98% performed the recommended ratio of 30 compressions to 2 breaths (Carlos et al., 2019). Another study done in Korea indicated that 75.8% of the nursing students did CPR with correct hand placement, 58.1% compressed at the right rate and

70.2% observed the recommended compression to ventilation ration (Roh & Issenberg, 2014).

To support oxygenation, ventilations have to be effectively delivered since a patient in sudden cardiac arrest have abnormal/ no breathing. Students were found to have low skills in adult ventilation. This implies that by this time the students would not have ventilated the victims adequately resulting in poor outcomes. About three quarters 131(74.9%) of the students delivered ventilations that did not make the chest to rise. This finding is closely related to the study done in Brazil where 81% of the senior medical students delivered ineffective breaths (Saad et al., 2019). Similarly in another study in United States, nursing students in ten schools of nursing were rated to have low skills in delivering ventilations (Oermann et al., 2020). In a related study done in Harvard, only 52% of the nursing students were able to deliver effective breaths (Oermann et al., 2020). The learners having missed refresher trainings on CPR may have been the cause as the refresher trainings enhance the learners to perfect the resuscitation skills (Mokhtari et al., 2012).

The only action that restores the abnormal heart rhythm is defibrillation. Surprisingly from this study, all the students had not seen an AED and thus were not able to operate it. Similarly, a study done in Korea indicated that undergraduate students have very low competence in the utilization of AED whereby 77% had not seen or heard about AED (Kim et al., 2016). Contrary to the findings of this study, a study done in Thailand indicated that 54.29% of the nursing students had good AED skills while 34.29 had excellent skills (Ruangrit & Keawpimon , 2021). Similarly the study done in Spain by Carlos et al. indicated that above 95% of the nursing students were able to operate an AED effectively from powering on to delivering the shock (Carlos et al., 2019). The zero competence among the senior nursing students could be attributed to the fact that first aid and basic life support curricula taught in their first year of study did not have the AED concepts. Current BLS curriculums incorporate AED training and thus the learners able to offer defibrillation (Panchal et al., 2020).

Generally the senior nursing students in the selected study sites lacked effective CPR skills. The low CPR skills scores can be attributed to the fact that students had not done a certified CPR course. The findings from the study are backed up by a systematic review study done in Central University of Florida that showed the retention rate for CPR knowledge and skills among nursing students is very low. The review indicated the need for frequent refresher trainings (Tirado, 2016). A similar study among senior undergraduate nursing students and other health related students indicated that 80% had poor CPR skills (Oermann et al., 2020). A similar study in Ethiopia indicated that, 98.7% of the nursing students cited lack of CPR training as a major cause of the low performance of the vital CPR skill (Pract et al., 2015). Mandatory certified CPR training should be enhanced through regulation and review of curricula just like it happens in the developed countries (Baldi et al., 2020). The low cardiopulmonary resuscitation skills level finding is also mirrored in a study done in Ethiopia where graduate health professionals were found to have low CPR resuscitation skills with a mean of 2.6±1.97 out of 8 (Gebremedhn et al., 2017). The findings concur with a study done in Nakuru County referral Hospital among health care workers that showed that 61.1% of the health care workers had poor CPR skills. This is unexpected finding since the workers were from emergency and critical care departments. This is attributable to lack of refresher trainings for the workers.

5.1.4 Factors influencing CPR knowledge and skills acquisition

The main identifiable reason for the low performance among the students was lack of simulated manikins. Cardiopulmonary resuscitation knowledge and skills have been proven to deteriorate rapidly if not in use. All the students had not done a certified CPR course nor any form of refresher training. A majority of the students indicated that the lecture hours and the practical sessions at the skills lab were limited. A majority pointed out that the content taught in class was not updated as some concepts assessed in the pretest were new to them. The resuscitation curriculum is updated every five years as per the American Heart Association. There is a possibility that the curriculum reviews may be taking longer that the five years. The findings of this study contravene the research

study findings in Korea that recommends that the CPR curriculum should be adequate enough in terms of learning hours to facilitate knowledge and skills acquisition (Sun & Young, 2016).

A majority of the participants cited lack of confidence to perform the procedure as a major factor influencing their skill. CPR performance is greatly affected by the self confidence of the learners. Despite the nursing students having learned CPR in class and skills laboratory settings, studies have demonstrated that students are fearful to do the procedure and also lack confidence. In a study in Wuhan China, it was found that students lack the confidence to do CPR thus its required that they have more practice to boost on their confidence and eliminate fear (Huang et al., 2016). According to a study done in Taiwan assessing final year medical students on readiness to perform CPR upon a cardiac arrest case, the study reveals that only 20.4% of the 255 students who demonstrated confidence to undertake the live saving procedure. It was recommended that students should have simulated trainings to build up on the confidence levels (Guner et al., 2017)

The factor that that CPR skill is complex had significance in affecting the CPR performance. The perception that the CPR skill is complex can be attributed to the fact that the students may not have adequate actual performance in the clinical areas or even out of hospital. The findings of this study mirror a study done in Taiwan among undergraduate nursing students where they rated CPR procedure among the three most complex skills (Liou et al., 2020).

Lack of adequate CPR equipments and mannequins that were not simulated was also pointed at as a factor affecting CPR skill acquisition. The simulated mannequins provide prompt feedback to the learners and promote skill.

5.1.5 Effect of certified CPR training on CPR knowledge

The effect of the certified CPR training on knowledge was assessed six months after the intervention. The comparisons were made on both the intervention and the control groups. Appropriate and significant tests were applied to test the effects. Paired parametric and non parametric tests were applied.

From the findings of this study, the certified CPR intervention had a significant effect on the levels of knowledge of the experimental study participants. There was statistically significant change in the performance of the experimental group from a mean of 41.80 $\pm$8.71 to 74.66$\pm$8.39. The control group's mean score on knowledge changed from 41.86% $\pm$7.89 at pretest to 45.30% $\pm$ 7.8 at posttest. The increase in the control group's mean can be attributed to the fact that the students after the challenging pretest were able to revise on some concepts. Despite the fact that the changes in the two groups were statistically significant, the effect size of the experimental group was large (0.8) as compared to a small effect size of 0.3 made by the control group.

The findings of this quasi experimental study are comparable to various studies globally. In a related study done in India among bachelors of Science in nursing students, the structured education program increased the mean knowledge score from 39.6% to 55.08 % with t value of 5.7 and $P<0.05$ (Gurung et al., 2020). The findings also mirror a study done in Spain among nursing students where a similar intervention changed the mean knowledge from 12.61 at pretest to 15.60, $p<0.001$(Alarc & Garc, 2021). In a related one group pretest posttest study at Kolkata India among third year nursing students, a structured education plan was deduced to be effective as it changed the mean CPR knowledge scores from 15.83 to 24.75 (Syeda, 2020).

In another one group pretest post test study among diploma nursing students in India, the education program intervention was considered effective as it changed the level of CPR knowledge of the nurses. At pretest 64% had poor level, 16% average and to 20% good. This changed to 68% with good levels of CPR knowledge and 32% with average

knowledge (Abdul-wahhab & Ahmed, 2020). Similarly, a study done in Brazil among undergraduate nursing students evaluating the effectiveness on an online training program showed significant improvement in the CPR knowledge and efficacy. The mean scores changed from 6.4±1.61 out of 10 at pretest to 9.3±0.82 at posttest (Tobase et al., 2017).

In another related study in Tanta University in Egypt, a similar intervention was effective in changing the levels of knowledge of the nursing students. At pretest stage, 89.3% had poor level, 8.7% average level and 2.0% good. Following the education program, 0.7% had poor level, 12.7% were average and 86.7 had good levels of CPR knowledge (Ahmed & Farag, 2018). The findings also get along with a study done in Baghdad among nursing students where the mean knowledge changed from 23.18% to 52.58% following a structured education program (Abdulwahhab, 2017).

The effectiveness of the intervention is also mirrored in a study done in India among first year nursing students. At the pretest stage, 96.3% had poor level, 3.7% average and no student had good level of CPR knowledge. At posttest, the performance increased to 7.4% had poor levels, 30.9% had average level and 61.8% had good levels of CPR knowledge (Sharma & Sharma, 2017).

The research findings also concur with a quantitative experimental study in a teaching hospital at Lahore Pakistan where sixty student nurses were taken through a formal workshop on cardiopulmonary resuscitation. A similar pretest post test design was applied that yielded some statistical significance ($p=0.000$) in improving the students CPR knowledge (Sabir, 2017). In a similar outcome pattern, a study done at Taiwan through a quasi experimental design, revealed that after randomization of 169 nursing students into experimental and control groups, the experimental group later had better ($p=0.01$) knowledge as compared to the control group. The author from the study advocates for programmed CPR training on the nursing students to improve on their knowledge, attitude and skills towards CPR (Lin, 2017).

In a similar quasi experimental study applying a certified CPR training as the intervention in a turkey hospital, it was found out that certification of nurses on CPR improves on their knowledge and skills. A sample of 404 nurses was enrolled in the study where a pretest post test evaluation was done. Upon analysis using a paired t –test, the results yielded statistical significance ($p < 0.05$) indicating that the certification program was effective. From the study the recommendations are that hospitals should have regular effective BLS education programs for nursing students and staffs based on their unique role of responding to sudden cardiac arrest cases as compared to other health care workers (Terzi et al., 2017).

The increase in the CPR performance after the certified training can be attributed to the fact that the training was conducted using American Heart Association manual for health provider's 2020 edition that laid all emphasis on all resuscitation basics (Panchal et al., 2020). Despite the general significant increase in CPR knowledge, the intervention group members had a decrease in the knowledge of chest compression to ventilation ratio in two rescuers. This could have been confusion with changes in resuscitation ratios in children and infants where the ratio is 15 compressions to two breaths for two rescuers.

5.1.6 Effect of certified CPR training on CPR skills

The outcomes of the intervention were compared in both experimental and the control groups after six months of training the intervention group.

The findings of the study indicate that the certified CPR training program was effective in enhancing the learner's skills. As compared to the control group, the intervention group performance in all the subsections; victim assessment, chest compressions, ventilation and AED scores increased significantly at posttest. Overall, the intervention group scores changed from 29.21% at pretest to 86.73% at posttest. The control group scores changed from 24.65% at pretest to 25.54% at posttest. The difference in intervention group scores had statistical significance $p<0.001$ with a very large effect

size of d= 0.86. As compared to the control group, their difference was not statistically significant p=0.986 with a very small effect size of d=0.11.

The findings of this study are comparable to various studies done to evaluate the effectiveness of planned education programs in enhancing CPR skills. In a related study in Kolkata India, the CPR education intervention among nursing students increased their infant CPR skills from 15.58 at pretest to 25.41 at post test with a t value of 19.89. The author of this study recommended that such trainings should be replicated to enhance the learners CPR skills (Syeda, 2020). The improved skills performance at posttest are comparable to a study done in brazil among nursing students where 90% assessed responsiveness, 98% exposed the chest, 97% assessed breathing, 76% shouted for help, 92% requested for a defibrillator, 77% checked for pulse, 87% had the correct hand placement, 95% made the right compression to ventilation ratio, 89% compressed at the recommended depth, and 97% operated the AED effectively (Tobase et al., 2017).

The findings also mirror a study done in Uganda among qualified nurses where the CPR skill performance increased from46% at pretest to 81.5% at posttest following a CPR training (Munezero et al., 2018). In a similar fashion, a study done in Ethiopia in Tanta University deduced that a similar education program as being effective in improving the CPR skills among the nursing students. In the study at pretest, 88.7% had unsatisfactory scores, 10% had satisfactory scores and only 1.3% had good scores. After the education program, only 3.3% had unsatisfactory scores, 16.7 had satisfactory scores and 80% had good scores at posttest (Ahmed & Farag, 2018).

Correspondingly, a study done in Harvard showed similar outcome results after a programmed intervention. The overall compression scores were 42.76 at pretest and significantly p<0.0001 improved to 77.87. The compression depth increased significantly p<0.0001 from 58.98% to 88.69%. The compression rate increased significantly p<0.0001 from 42.03 to 54.74. Concerning the ventilations, the overall score increased from 19.06 to 70.61. The ventilation volume increased from 52.46% to 67.52% (Oermann, et al., 2020).

The increase in the CPR performance after the certified training can be attributed to the fact that the training was conducted using American Heart Association manual for health provider's 2020 edition that laid all emphasis on all resuscitation basics (Panchal et al., 2020).

5.2 Conclusions

5.2.1 Level of CPR knowledge of senior nursing students at selected KMTC campuses.

The senior diploma nursing students had below average level of CPR knowledge. A majority scored between 40-49% at baseline. On general CPR knowledge, the intervention group had a mean of 6.05 ±1.55 and control group 6.11 ± 1.57 out of 13. On circulation knowledge out of 9 questions, the intervention group had a mean of 2.67 ± 1.13 while the control group had a mean of 2.66 ± 1.48. On airway management knowledge out of 6 questions, the intervention group had a mean of 2.67 ± 1.13 while the control group had a mean of 2.66 ± 1.48. On breathing knowledge out of 5 points, the intervention group had a mean of 1.42 ± 0.91 while the control group had a mean of 1.45 ± 0.91. On automated external defibrillation out of 7 points, the intervention group scored 2.49 ± 1.4 while the control group scored 2.46 ± 1.13.

5.2.2 Level of CPR skills of senior nursing students at selected KMTC campuses

Majority of the students were challenged in performing the CPR skill at baseline. Their level of CPR skills was below average. All the students in both groups scored less than 50% at baseline. On victim assessment out of 6 points, the intervention group scored 1.04 ± 1.08 while the control group scored 1.71 ±1.30. On chest compressions out of 4 points, the intervention group scored 2.43 ± 1.07 while the control group scored 1.43 ± 1.12. On ventilations and breathing out of 5 points, the intervention group scored 2.36 ±1.74 while the control group scored 1.70 ± 1.49. On the use of automated external defibrillation, both groups scored 0.00.

5.2.3 Factors influencing knowledge and skills acquisition among senior nursing students at selected KMTC campuses.

Various factors were identified to have significant effect in influencing CPR knowledge and skills acquisition; learner's perception that CPR is complex, limited CPR materials, minimal skills laboratory guidance, lack of confidence and lack of simulated manikins.

5.2.4 Effect of certified refresher training on CPR knowledge among senior nursing students at selected KMTC campuses.

The certified CPR training was very effective as the learner's knowledge increased significantly in the experimental group from a mean of 42% to 75% ($p<0.05$). The intervention program transformed the intervention group participants from novice stage to advanced beginners as guided by the theoretical framework of Patricia Benner's theory

5.2.5 Effect of certified refresher training on CPR skills among senior nursing students at selected KMTC campuses

The certified CPR training was effective as the learner's skills performance increased significantly in the experimental group from a mean of 29% to 87% ($p<0.05$). The intervention program transformed the intervention group participants from novice stage to advanced beginners as guided by the theoretical framework of Patricia Benner's theory.

5.3 Recommendations

5.3.1 Level of CPR knowledge of senior nursing students at selected KMTC campuses.

There is need to have timed retraining on CPR and update the curriculum to cater for automated external defibrillation

5.3.2 Level of CPR skills of senior nursing students at selected KMTC campuses

There nursing training institutions need to add more skills hours and evaluate the students individually on CPR ensure that the students master the skill. They should also update the curriculum to cater for automated external defibrillation.

5.3.3 Factors influencing knowledge and skills acquisition among senior nursing students at selected KMTC campuses

The institutions need to upgrade the manikins to have the simulated ones that would improve on the leaner's knowledge, skills and boost the confidence to practice CPR. The institutions also need to add learning materials and add more skills laboratory hours to enhance the learners' skills.

5.3.4 Outcome of certified refresher training on CPR knowledge among senior nursing students at selected KMTC campuses.

The training institutions should have mandatory certified CPR training since it was proved to be effective in enhancing leaner's knowledge on cardiopulmonary resuscitation

5.3.6 Outcome of certified refresher training on CPR skills among senior nursing students at selected KMTC campuses

The training institutions should have mandatory certified CPR training since it was proved to be effective in enhancing leaner's skills on cardiopulmonary resuscitation.
The researcher also recommends that the Nursing Council of Kenya adds BLS certification as a requirement for licensing newly qualified nurses.
The researcher also recommends that a study can be done in future comparing a certified CPR training and a BLS training with refresher courses in the curriculum.

5.4 Areas for further study

The study lacks generalisability since the selected study sites are not representative of all KMTC. The researcher recommends for a wider study that will have representative campuses countrywide that enhance the generalisability. Despite this limitation, the researcher may recommend nursing and other medical related institutions to replicate the study as it has scientifically proved that the certified CPR training enhances the knowledge and skills significantly.

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APPENDICES

Appendix I: Respondent consent form

Serial no…….date…….

My name is Paul Wambugu Ndung'u. I am a PhD student at Jomo Kenyatta University of Agriculture and Technology. I am conducting a study titled;

Enhancing adult cardiopulmonary resuscitation knowledge and skills among Kenya registered community health nursing students in selected Kenya medical training college campuses

The purpose of the study is aimed at enhancing cardiopulmonary resuscitation knowledge and skills among KRCHN students in Kenya Medical Training College

Procedures to be followed

A mixture of multiple choice and True/False questions will be administered at the beginning and the end of the semester to evaluate on knowledge acquisition. A practical CPR (Cardiopulmonary resuscitation) examination will also be administered at the beginning and at the end of the semester to evaluate on CPR skills acquisition.

Voluntarism

Participation in the study is purely voluntary. You may decline to participate or withdraw your consent to participate. Your withdrawal from the study or failure to participate is your right and shall not affect your academic performance. You have a right to information at any stage of the study.

Risks

The study poses absolute no risk to you as a participant

Benefits

You will acquire CPR knowledge and skills that will improve patients' outcomes following cardiac arrest in the near future.

Confidentiality

All the information gathered from the respondents will be held in confidence. Your identification particulars will not be used. New serial codes will be used for the purposes of the study. The raw data will be safely secured and electronic data will be safeguarded through encryption.

Covid 19 considerations

To ensure safety of the participants, the training will be done in subgroups to ensure safe distancing is maintained. You will be provided with surgical masks and sanitizers.

Contact information

Principal investigator

Mr. Paul Wambugu Ndung'u
Mobile: 0712658487
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Supervisors

1. Dr. Albanus Mutisya Kyalo
School of Nursing Sciences
Jommo Kenyatta University of Agriculture and Technology
Mobile: 0721484869
2. Dr. Grace Githemo
School of Nursing Sciences

Kenyatta University
Mobile: 0722787862

However, if you have questions about your rights as a study participant: You may contact Kenyatta University Ethical Review Committee Secretariat on chairman.kuerc@ku.ac.ke

Participant's statement

The above information regarding my participation in the study is clear to me. The study has been explained to me and I have been given a chance to ask questions and my questions have been answered to my satisfaction. My participation in this study is entirely voluntary. I understand that my records will be kept private and that I can leave the study at any time. I understand that I will be treated like other students in case I withdraw from the study.

Name of Participant: _____

Signature_____ Date _____

Appendix II: Cardiopulmonary resuscitation knowledge assessment tool

QUESTIONNAIRE SERIAL NUMBER …….

Instructions: only tick one answer on the check boxes

A: Demographic Data

A. Age _____
B. Gender _____ Male ☐ female ☐
C. KMTC college _____
D. Have you ever learned about cardiopulmonary resuscitation?
   Yes ☐ No ☐
E. If Yes above indicate where the training was done _____
F. If trained, do you have a BLS health provider's certificate?
   Yes ☐ No ☐

B: **Cardiopulmonary Resuscitation Knowledge**

1. BLS initials stand for
   a) Breathing life support ☐
   b) Basic life support ☐
   c) Brain life support ☐
   d) Brain and lungs support ☐
2. What is the correct depth of adult chest compressions
   a) 4- 4.5 inches ☐
   b) 3-3.5 inches ☐
   c) 2-2.4 inches ☐
   d) 1-1.5 inches ☐
3. What is the correct way of opening the airway for a patient suspected to have neck injury

a) Jaw thrust maneuver ☐
b) Head tilt chin lift ☐
c) Heimlich maneuver ☐
d) Head twist maneuver ☐

4. The pulse check should last for how many seconds
   a) As long as you get a pulse ☐
   b) Not more than 5 seconds ☐
   c) Not more than 10 seconds ☐
   d) Not more than 15 second ☐
5. One of the following is the artery to check for adult pulse
   a) Radial ☐
   b) Brachial ☐
   c) Carotid ☐
   d) Femoral ☐
6. The best response for a patient who has choking is
   a) Cardiopulmonary resuscitation ☐
   b) Back blows ☐
   c) Abdominal thrusts ☐
   d) Chest upward thrusts ☐
7. The correct current sequence for BLS is
   a) Airway – breathing – circulation ☐
   b) Circulation - breathing – airway ☐
   c) Circulation – airway – breathing ☐
   d) Airway – circulation – breathing ☐
8. One rescuer chest compression to ventilation ratio for adult CPR should be
   a) 15:1 ☐
   b) 15:2 ☐
   c) 30:1 ☐
   d) 30:2 ☐

9. Two rescuers chest compression to ventilation ratio for adult CPR should be
    a) 15:1 ☐
    b) 15:2 ☐
    c) 30:1 ☐
    d) 30:2 ☐

10. How often should the two rescuers alternate roles during CPR
    a) After one cycle ☐
    b) After two cycles ☐
    c) After five cycles ☐
    d) After ten cycles ☐

11. One of the following is the correct sequence while operating an AED (automated external defibrillator)
    a) Check pulse, attach electrode pads, analyze rhythm, and shock the patient ☐
    b) Attach electrode pads, check pulse, check pads, and analyze rhythm ☐
    c) Power on AED, attach electrode pads, analyze rhythm, clear individuals, shock the patient ☐
    d) Power on AED, attach electrode pads, shock the individual, analyze the rhythm

12. One of the following is **NOT** a step in adult chain of survival ☐
    a) Rapid defibrillation ☐
    b) Early CPR ☐
    c) Integrated post cardiac arrest care ☐
    d) Use of cardiovascular drugs ☐

13. The following activity should be done immediately after delivering shock using AED(Automated external defibrillator)
    a) Resume CPR ☐
    b) Do ventilations only ☐
    c) Reassess for pulse ☐
    d) Do chest compressions only ☐

14. Out of hospital cardiac arrests mostly occur in

a) recreation facilities
b) homes
c) health clinics
d) shopping centers

15. Upon finding a patient with agonal (gasping) breathing, what is the correct action to take

a) Check on the pulse
b) Put the patient on a recovery position
c) Activate emergency team
d) Give two rescue breaths

16. The foundation of CPR is

a) Cardiac drugs
b) Rapid activation of EMS (Emergency Medical Services)
c) Chest compressions
d) Maintaining an open airway

17. The chest compressions should be within a rate of

a) 60-72 per minute
b) 100-120 per minute
c) 80-90 per minute
d) 90-100 per minute

18. When performing CPR as a lone rescuer, the following is the best position

a) At the side of the patient
b) At the head side
c) At the leg side
d) Straddle the patient

19. When performing two rescuer CPR, each breath should be delivered within

a) One second
b) Two seconds
c) Three seconds
d) Five seconds

20. When using AED, if no rhythm is advised what should be the next action
    a) Press reanalyze button
    b) Immediately resume CPR
    c) Check pulse
    d) Check if the pads are well placed
21. Adult defibrillator pads should be used to victims above the age of
    a) 8 years
    b) 10 years
    c) 12 years
    d) 14 years
22. As a rescuer, if you encounter a suspected patient with cardiac arrest, what is the first step to take
    a) Open the airway
    b) Get the AED
    c) Ensure that the scene is save
    d) Activate emergence medical services
23. If the attempt to deliver the air by mask fails what is the next action to take
    a) Hyperextend the neck
    b) Reposition the airway
    c) Blow harder
    d) Discard mask and use mouth to mouth
24. The following are shockable rhythms identified by an AED
    a) Asystole and ventricular fibrillation
    b) Ventricular tachycardia and asystole
    c) Pulseless electrical activity and ventricular tachycardia
    d) Ventricular fibrillation and ventricular tachycardia

25. During CPR , If the chest is not inflating what is the necessary action to take
    a) Check for responsiveness ☐
    b) Check for pulse ☐
    c) Evaluate the airway ☐
    d) Continue inflating ☐
26. You should always check for patients responsiveness before doing CPR
    a) True ☐
    b) False ☐

27. If a patient has a pacemaker, the automated external defibrillator pads should be placed directly on top of the device
    a) True ☐
    b) False ☐
28. In the scenario as a rescuer you miss the pulse within 10 seconds you should continue with CPR
    a) True ☐
    b) False ☐
29. During CPR the interruptions should be limited to less than 15 seconds
    a) True ☐
    b) False ☐
30. Once a victim is identified as pulseless, CPR should start within 20 seconds
    a) True ☐
    b) False ☐
31. The period between collapse of a patient and defibrillation is an important determinant of survival
    a) True ☐
    b) False ☐
32. The best indicator for effective breathing during ventilation is
    a) Abdominal rise ☐
    b) Chest rise ☐

c) Abdominal and chest rise ☐

d) No chest movement ☐

33. CPR should be done on a soft mattress

a) True ☐

b) False ☐

34. One of the following is a sign of severe airway obstruction

a) High pitched noise on inhalation ☐

b) Wheezing ☐

c) Forceful cough ☐

d) All of the above ☐

35. One of the following fears holds people from attempting CPR

a) Fear of not having an assistant ☐

b) Fear of doing CPR and hurting the patient ☐

c) The fear of not getting a reward for good CPR ☐

d) The fear of disturbing a patient ☐

36. During CPR, the bag valve mask is best controlled by

a) One rescuer ☐

b) Two rescuers ☐

c) Three rescuers ☐

d) Four rescuers ☐

37. When having two rescuers during CPR, the one delivering ventilations should be positioned

a) At the patients side ☐

b) At the patient foot ☐

c) At the patients head ☐

d) Behind the first rescuer ☐

38. The correct position for placing the hands during CPR is

a) At the left nipple ☐

b) At the right nipple ☐

c) At the sternum ☐

d) At the trachea ☐

39. Chest compressions promotes breathing of a patient

a) True ☐

b) False ☐

40. Chest recoil facilitates blood circulation in the heart

a. True ☐

b. False ☐

C. **Cardiopulmonary resuscitation performance confidence**

In a cardiac arrest scenario, how confident would you be to perform the procedure?

Not confident at all ☐

Slightly confident ☐

Somewhat confident ☐

Fairly confident ☐

Completely confident ☐

D: **Cardiopulmonary resuscitation knowledge and skills challenges** (to be administered at pre test only)

Having gone through the basic life support unit, what are some of the challenges that hindered you from acquiring the desired knowledge and skills? (Tick only once)

	Parameter	**Agree**	**Neutral**	**Disagree**
1	The CPR knowledge is complex			
2	The CPR Skills are complex			
3	There were limited learning materials (manuals, videos)			
4	Lecture time was limited on CPR			
5	Skills lab session were limited			
6	There was no skill lab technician to guide on the skills			
7	There is lack of confidence to perform CPR			
8	Some content assessed in this pretest were not taught in class			
9	The skills lab has few mannequins and artificial ventilators as compared to the number of students			
10	The mannequins are not simulated to give prompt feedback			

11	The students did not have an opportunity to do a practical examination individually			
12	Do you plan to undertake a certified CPR course privately after completing KMTC			
13	In your opinion, should KMTC offer a certified American Heart Association BLS course for health providers?			

Appendix III: CPR Skills observation check list

ADULT CPR AND AED OBSERVATION CHECK LIST

(Customized from aha 2015 health providers manual)

NB: The students will be issued with a cardiac arrest scenario

	SKILLS ASSESSED	**PERFORMED**	
		YES	NO
1	**Assess victim and activate emergency system**		
a	Scans for scene safety		
b	Check whether patient is responsive by tapping or shouting		
c	Shouts for help or direct someone to shout for help and get an AED		
d	Assess for breathing (5-10 sec)		
e	Assess for carotid pulse (not more than 10 seconds)		
2	**Performance of high quality chest compressions**		
a	Correct hand placement (lower half of the sternum)		
b	Compression rate (100-120 compressions/minute, 30 compression in 15-18 seconds		
c	Compression depth and recoil(2 – 2.4 inches, 5-6 cm)		
d	Minimizes interruptions (delivers 2 breaths in less than 10 seconds		
3	**Provides two breaths using a barrier device**		
a	Opens airway adequately(head tilt chin lift/jaw thrust maneuver)		
b	Deliver each breath over one second		
C	Deliver breaths that make the chest to rise		
d	Avoid excess ventilation		
e	Resume chest compressions in less than 10 seconds		
4	**Use of AED (ask the students to describe key steps)**		
a	Power on the AED		
b	Correctly attach the pads		
c	Clear rescuers for analysis		
d	Clear rescuers to safely deliver shock		
e	Deliver shock		
f	Resume high quality chest compressions		

Appendix IV: Sample size calculation table

APPENDIX 6A

Sample Size Required per Group When Using the *t* Test to Compare Means of Continuous Variables

TABLE 6A Sample Size *per Group* for Comparing Two Means

One-sided α =	0.005			0.025			0.05		
Two-sided α =	0.01			0.05			0.10		
*E/S** β =	0.05	0.10	0.20	0.05	0.10	0.20	0.05	0.10	0.20
0.10	3,585	2,978	2,338	2,600	2,103	1,571	2,166	1,714	1,238
0.15	1,586	1,325	1,040	1,157	935	699	963	762	551
0.20	893	746	586	651	527	394	542	429	310
0.25	572	478	376	417	338	253	347	275	199
0.30	398	333	262	290	235	176	242	191	139
0.40	225	188	148	164	133	100	136	108	78
0.50	145	121	96	105	86	64	88	70	51
0.60	101	85	67	74	60	45	61	49	36
0.70	75	63	50	55	44	34	45	36	26
0.80	58	49	39	42	34	26	35	28	21
0.90	46	39	21	34	27	21	28	22	16
1.00	38	32	26	27	23	17	23	18	14

* E/S is the standardized effect size, computed as E (expected effect size) divided by S (SD of the outcome variable). To estimate the sample size, read across from the *standardized effect size* and down from the specified values of α and β for the required sample size in each group.

Appendix V: Ethical Approval

KENYATTA UNIVERSITY
DIRECTORATE OF ETHICS REVIEW COMMITTEE

Fax: 8711242/8711575
Email: chairman.kuerc@ku.ac.ke
Nairobi, 00100

P. O. Box 43844,

Tel: 8710901/12

Website: www.ku.ac.ke
Our Ref: KU/ERC/APPROVAL/VOL.1

Date: 12th November, 2020

Paul Wambugu Ndungu
P.0 Box 43844-00100
NAIROBI

Dear Mr. Ndungu,

RE: APPLICATION NUMBER: PKU/2166/E1310 ENHANCING ADULT CARDIOPULMONARY RESUSCITATION KNOWLEDGE AND SKILLS AMONG KENYA REGISTERED COMMUNITY HEALTH NURSING STUDENTS IN SELECTED KENYA MEDICAL TRAINING COLLEGE CAMPUSES

This is to inform you that ***KENYATTA UNIVERSITY DIRECTORATE OF ETHICS REVIEW COMMITTEE*** has approved version 4 of the study protocol together with the attached consent forms dated 12.09.2020. Your application approval number is **PKU/2166/E1310** The approval period is ***12th November, 2020 TO 12th November, 2021.***

This approval is subject to compliance with the following requirements;

i. Only approved documents including (informed consents, study instruments, MTA) will be used
ii. All changes including (amendments, deviations, and violations) are submitted for review and approval by ***KENYATTA UNIVERSITY DIRCTORATE OF ETHICS REVIEW COMMITTEE.***
iii. Death and life threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to ***KENYATTA UNIVERSITYDIRECTORATE OF ETHICS REVIEW COMMITTEE*** within 72 hours of notification
iv. Any changes, anticipated or otherwise that may increase the risks or affected safety or welfare of study participants and others or affect the integrity of the research must be

reported to ***KENYATTA UNIVERSITY DIRECTORATE OF ETHICS REVIEW COMMITTEE*** within 72 hours

v. Clearance for export of biological specimens must be obtained from relevant institutions.
vi. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. Attach a comprehensive progress report to support the renewal.
vii. Submission of an executive summary report within 90 days upon completion of the study to ***KENYATTA UNIVERSITY DIRECTORATE OF ETHICS REVIEW COMMITTEE***.

Prior to commencing your study, you will be expected to obtain a research license from National Commission for Science, Technology and Innovation (NACOSTI) https://oris.nacosti.go.ke and also obtain other clearances needed.

Yours sincerely

12 NOV 2020

Prof. Judith Kimuyu

DIRECTOR- KENYATTA UNIVERSITY ETHICS REVIEW COMMITTEE.

Appendix VI: Nacosti Permit

REPUBLIC OF KENYA

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Ref No: **430422**

Date of Issue: **26/November/2020**

RESEARCH LICENSE

This is to Certify that Mr.. PAUL WAMBUGU NDUNG'U of Jomo Kenyatta University of Agriculture and Technology, has been licensed to conduct research in Embu, Kiambu, Muranga, Nyeri on the topic: ENHANCING ADULT CARDIOPULMONARY RESUSCITATION KNOWLEDGE AND SKILLS AMONG KENYA REGISTERED COMMUNITY HEALTH NURSING STUDENTS IN SELECTED KENYA MEDICAL TRAINING COLLEGE CAMPUSES for the period ending : 26/November/2021.

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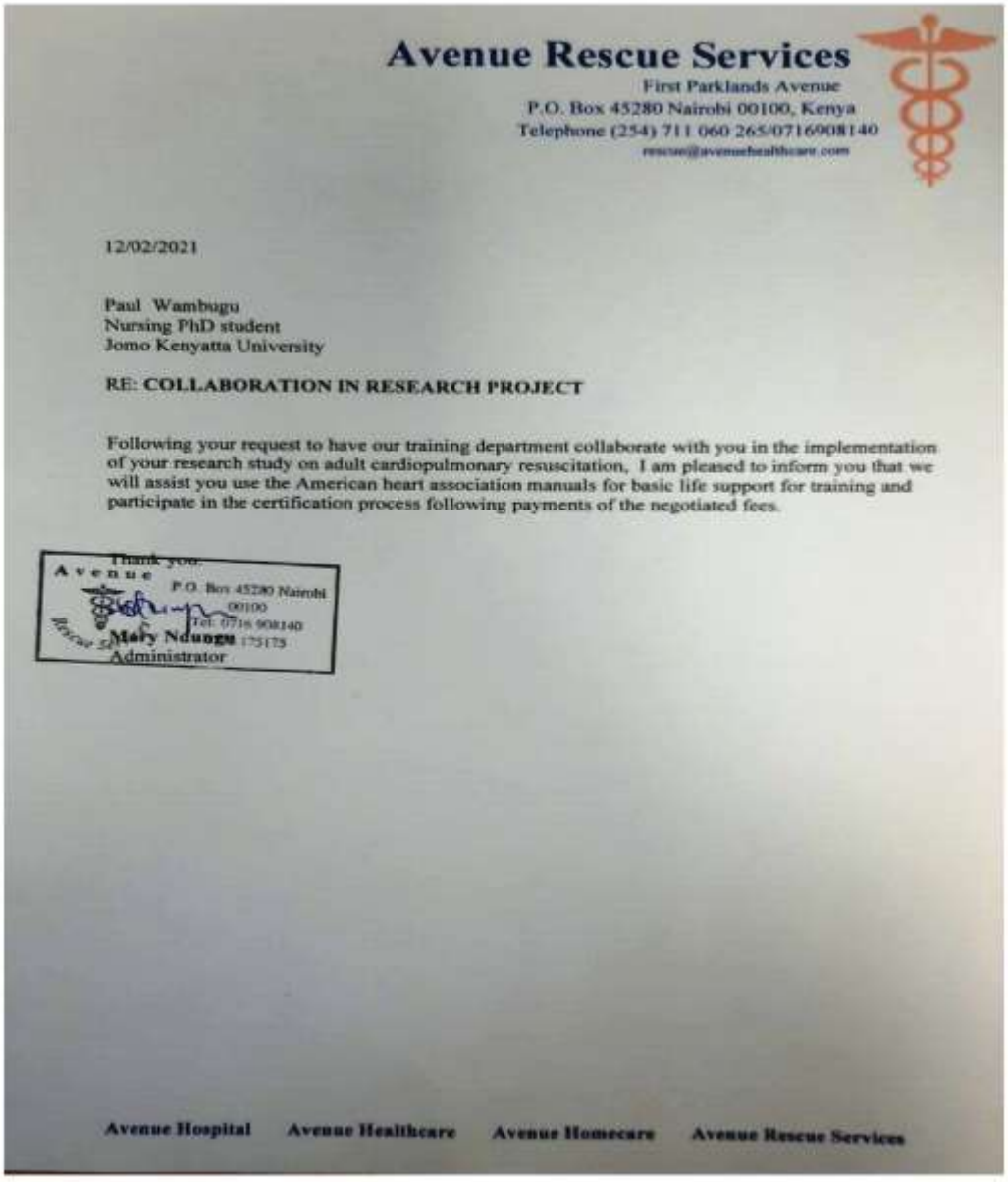
Appendix VII: Avenue Rescue Services Collaboration letter



Avenue Rescue Services

First Parklands Avenue
P.O. Box 45280 Nairobi 00100, Kenya
Telephone (254) 711 060 265/0716908140
rescue@avenuehealthcare.com

12/02/2021

Paul Wambugu
Nursing PhD student
Jomo Kenyatta University

RE: COLLABORATION IN RESEARCH PROJECT

Following your request to have our training department collaborate with you in the implementation of your research study on adult cardiopulmonary resuscitation, I am pleased to inform you that we will assist you use the American heart association manuals for basic life support for training and participate in the certification process following payments of the negotiated fees.

Thank you.

Avenue
P.O. Box 45280 Nairobi
00100
Tel: 0716 908140
Rescue Services

Mary Ndungu 175175
Administrator

Avenue Hospital **Avenue Healthcare** **Avenue Homecare** **Avenue Rescue Services**

Appendix VIII: East African Medical Journal Publication

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ADULT CARDIOPULMONARY RESUSCITATION SKILLS AMONG SENIOR DIPLOMA NURSING STUDENTS IN SELECTED NURSING COLLEGES IN KENYA: A CROSS SECTIONAL STUDY

P. W. Ndung'u, A. Mutisya and G. Githemo

ABSTRACT

Introduction: Cardiovascular disorders remain a global challenge with approximately 17.7 million deaths annually. Prompt initiation of cardiopulmonary resuscitation (CPR) ultimately saves lives following sudden cardiac arrest.
Objective: The study aimed at evaluating adult CPR skill among the senior diploma nursing students in selected campuses of Kenya Medical Training College (KMTC)
Design: The study applied a descriptive and analytical cross-sectional design
Setting: Selected campuses of Kenya Medical Training College (KMTC)
Participants: Senior Kenya Registered Community Health Nursing students (KRCHN)
Method: Data was collected using American Heart Association (AHA) basic life support (BLS) skills assessment tool in collaboration with Avenue Rescue Services an accredited AHA training organization. Data was then analyzed using statistical package for social sciences (SPSS) version 26.0 for descriptive and inferential statistics.
Results: A total of 175 nursing students were assessed for the CPR skill. The overall mean (SD) percent was 27% ±14, with a minimum of 0 % and maximum of 60%. The mean was compared to AHA competence score of 84% using a one sample t test that showed a significant difference of very large magnitude measured using Cohen d; $t(174) = -53.82$, $p<0.001$, $d= 4.1$
Conclusion: The mean CPR skill level among the nursing students was below average as compared to local and international standards. There is need for

Appendix IX: African Journal of Health Sciences Publication

Knowledge of Adult Cardiopulmonary Resuscitation among Nursing Students in Selected Nursing Colleges in Kenya

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Abstract

BACKGROUND

Sudden cardiac arrest remains a global health concern. In Kenya 25% of all hospital admissions are related to cardiovascular diseases thus all healthcare workers and trainees should have updated cardiopulmonary resuscitation knowledge and skills. Despite Cardiopulmonary resuscitation knowledge and skills being life-saving, global and local research findings indicate that nursing students are deficient in this life-saving procedure. The objective of the study was to evaluate the senior diploma nursing student's knowledge of adult cardiopulmonary resuscitation.

MATERIALS AND METHODS

The study adopted a cross-sectional design, a pre-intervention phase of a quasi-experimental study. Four high-volume nurse training colleges were conveniently sampled. A total of 175 senior nursing students in their final year of study were recruited through the census. A questionnaire was used to evaluate their knowledge of adult basic life support which included; general principles, circulation, airway, breathing and automated external defibrillation concepts. Data was in a period of one month and analysed using SPSS version 26. Descriptive statistics were used to summarize the findings while one sample t-test was used to compare the means. According to American Heart Association, the study applied 84% as the competence score. A p-value less than 0.05 was considered significant

RESULTS

The mean knowledge scores for CPR were; general CPR principles 6.06±1.6 out of 13, circulation 4.07±1.51 out of 9, airway 2.69±1.30 out of 6, breathing 1.38±0.93 out of 5 and AED 2.69±1.30 out of 7. The overall mean per cent for CPR knowledge score was