

# Effective Strategies for Global Health Training Programs *A Systematic Review of Training Outcomes in Low and Middle Income Countries*

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## Abstract

**Introduction:** Low and middle-income countries face a continued burden of chronic illness and non-communicable diseases while continuing to show very low health worker utilization. With limited numbers of medical schools and a workforce shortage the poor health outcomes seen in many low and middle income countries are compounded by a lack of within country medical training.

**Methods:** Using a systematic approach, this paper reviews the existing literature on training outcomes in low and middle-income countries in order to identify effective strategies for implementation in the developing world. This review examined training provided by high-income countries to low- and middle-income countries.

**Results:** Based on article eligibility, 24 articles were found to meet criteria. Training methods found include workshops, e-learning modules, hands-on skills training, group discussion, video sessions, and role-plays. Of the studies with statistically significant results training times varied from one day to three years. Studies using both face-to-face and video found statistically significant results.

**Discussion:** Based on the results of this review, health professionals from high-income countries should be encouraged to travel to low- middle-income countries to assist with providing training to health providers in those countries.

**Keywords:** global health, training outcomes, workforce training, effective strategies

## 1. Introduction

Non-communicable diseases (NCDs) caused about 35 million deaths in 2005, 80% of which occurred in low- and middle-income countries (World Health Organization, 2010). Many of these non-communicable diseases are chronic illnesses, which have negative effects on the quality of life of individuals, and often lead to premature death (World Health Organization, 2005). Chronic diseases reduce life expectancy and economic productivity. This reduction in life expectancy leads to a decrease in workforce and in turn may result in lower gross domestic product (GDP) and gross national income (GNI) (Abegunde, 2006). Low- and middle-income countries are facing a growing burden of chronic illness and NCDs, in addition to an ongoing need to address traditional communicable diseases (World Health Organization, 2009). Africa has 24% of the world's global burden of disease but only 3% of the world's health workers, utilizing less than 1% of world health expenditures (World Health Organization, 2006). Often, countries with the lowest need have the highest numbers of health workers and countries with the greatest burden of disease are equipped with a much smaller health workforce (World Health Organization, 2006). The global shortage of healthcare workers is approximately 4.3 million with the greatest shortage in South East Asia and in sub-Saharan Africa (World Health Organization, 2006). In addition,

there are only 168 medical schools in sub-Saharan Africa, eleven countries do not have a medical school, and 24 countries only have one medical school (Mullan et al., 2011).

Beyond a workforce shortage, one of the most common barriers faced by healthcare providers of developing countries is inadequate training and skills (Knight et al., 2013). Objectives of training are to increase knowledge, improve attitudes, strengthen skills, and improve work behavior (Holland et al., 2012). A review by Knight et al. illustrates the need for proper training and dissemination of guidelines to health care workers in developing countries (Knight et al., 2013). Without these things healthcare workers are treating patients with antiquated methods and recommendations (Knight et al., 2013). For example, in Latin America there was frequent improper use of magnesium sulphate in capacities that did not align with best-practice guidelines (Aaserud et al., 2005). With quality training, healthcare workers can effectively work to improve the health of citizens in their country. Healthcare workers who perform at their best are able to produce health services at a level and rate that matches their training and ability. Therefore, as the quality of training improves the potential quality of health-service delivery also improves (Scheffler et al., 2012).

Analysis of training outcome data is not generally practiced in many countries (Reij et al., 2013). Some countries have begun implementation of innovative medical education, however few outcomes have been recorded (Celletti et al., 2011). Outcomes of training data can provide information on the effectiveness of the training provided, performance of individuals who have been trained, and appropriate dissemination of training programs can be determined (Reij et al., 2013). Given the limited resources in low- and middle-income countries, outcomes of training data can also offer insight into resource prioritization and best practices to ensure the highest quality training is available given resource availability (Mullan et al., 2011).

This review focused on training provided by high-income countries to low- and middle-income countries. Through a systematic review of the available literature, this study aimed to review the existing literature on training outcomes in low and middle income countries in order to identify effective strategies for implementation in the developing world and provide recommendations to researchers and healthcare workers on strategies to employ when providing training in developing countries.

## 2. Methods

A systematic approach was taken to identify peer-reviewed articles on training provided by high-income countries to low- and middle-income countries. Medline was searched on 2 October 2014 for articles published in English between 2000 and 2014. Medline was selected as the most widely available public database, and therefore the most likely to be accessed by researchers, physicians, and trainers. The search terms were determined based on keywords found in papers by Cho et al. (2013) and van Lonkhuijzen et al. (2010). Some of the keywords found in the articles were not used due to the goals of this paper. For example Cho et al suggested using “advisor”, “mentor”, “mentee”, and “support” in addition to the words we selected in Training Group 2. We omitted these words because we wanted to focus on training of medical doctors and not provision of training through mentorship or support programs. All authors reviewed the possible keywords, and agreed on the final keywords prior to searching. The search terms and strategy is provided in Table 1.

Table 1. Search strategy

Search Term	Key Words
Global Health	global health, international health
Low Resource Country	low income, middle income, developing country, low resource
Training (Group 1)	train, education, staff development, patient simulation, in-service training
Training (Group 2)	supervise, teach, train, coach

*Note.* Papers used: any in ‘global health’ category and any in ‘low resource country’ category and any in ‘training (group 1)’ and any in ‘training (group 2)’ category.

A total of 9897 papers were retrieved and imported into EndNote software. After removing duplicates 9889 titles were reviewed. Eligibility criteria included: 1) published in English, 2) published between the years 2000 and 2014, 3) training interventions, studies in low- or middle- income countries, 4) adult patient population. Interventions used for care, studies conducted in high-income countries, and systematic reviews were excluded. Title review excluded 8725 articles for reasons such as written prior to the year 2000, not peer-reviewed, studied children, or were not in English. The remaining 1164 were reviewed by abstract and 1106 were excluded.

Articles were excluded for reasons such as did not provide outcome data, or conducted in high income countries. Fifty-eight full text outcome articles were assessed for final eligibility. Thirty-four were excluded for the following reasons: 11 – no training was provided, 9 – training was provided by citizens of the low-resource country, 3 – pilot studies, 3 – no outcome data or statistical analysis, 1 – trained nurses, 1 – works in progress, 1 – developed country, 2 – lab training, 1 – study was conducted across multiple countries, 1 – protocol, 1 – article was retracted.

For purposes of this review we operationalized major terms as: training outcomes – outcomes as chosen by the study under review for the outcome of their training program (ie. skills, knowledge); chronic illness – diseases that are not passed from person to person and that last a long time or progress slowly (World Health Organization, 2016); effective strategies – training that produced statistically significant changes in identified outcomes; low- and middle- outcome countries – countries with a gross national income per capita for the previous year of \$12,736 or less (The World Bank, 2015).

Data were collected from each manuscript including the country where the training was provided, trainers' country of origin, training length of time, specialty, study type and the outcome that was measured. Data were also collected regarding training outcomes, including pre-training levels, post-training levels, and the statistical significance. Due to the systematic nature of the search, the results were structured to provide more comprehensive information than a narrative review. However, due to the heterogeneity of the results, including study design, sample size, and training outcomes selected by authors, we did not conduct a meta-analysis upon conclusion of the review. As very few studies used a randomized controlled design, and a large amount of heterogeneity existed in the amount of information provided on details surrounding the training program, we chose to provide the information in the results rather than measuring study rigor.

### 3. Results

#### 3.1 Study Selection and Data Collection

Articles were reviewed for eligibility in a systematic fashion. After duplicates were removed, 9889 articles remained for review. Fifty-eight articles were assessed for final eligibility and fully reviewed. Thirty-four additional papers were excluded from the final synthesis, resulting in twenty-four eligible studies identified based on the pre-determined eligibility criteria.

Data collected from the eligible articles are shown in Tables 2 and 3. The number of study participants ranged from 12 to 12,795, training duration ranged from one day to three years. There were also a variety of study designs used for the papers reviewed including: 12 pre-post-test, 5 quasi-experimental, 1 randomized control trial, 3 cluster randomized control trials, 1 prospective comparison, and 2 cross-sectional designs. Due to the heterogeneity of the studies reviewed we did not conduct an assessment of the risk of bias.

Table 2. Characteristics of studies meeting eligibility criteria

Study Author, Year	Country where training was provided	Trainer country of origin	Participants (Completed)	Specialty	Training duration	Training setting	Study design	Outcome measured
Ajuwon, 2008	Nigeria	Not Specified	133 (97)	Research Ethics	3 rounds of 3 days, 7 hours/day	Workshops, group sessions	Pre-Post Test	Knowledge
Arreola-Risa, 2007	Mexico	Not Specified	3726 trauma patients	Emergency Medical Services (EMS)	3 – 11 months, 2-3 hours/day	Classes	Quasi-experimental	Mortality rate
Autry, 2013	Uganda	United States	18 (15)	Obstetrics and Gynecology	4 weeks	Remote, video teaching	Randomized Control Trial, Pre-Post Test	Two-handed knot tying
Baig, 2008	Malawi	Scotland and Norway	57 Malawi students, 71 Univ. of Edinburgh students	Psychiatry	2 weeks	Classes	Quasi-experimental	Student performance

Bedada, 2015	Botswana	Canada	12	Surgery	3 days	Workshops	Quasi-experimental	Patient safety and sustainability of MAS program
Brown, 2000	Honduras	Not Specified	87 (79)	Ambulatory Care	3 ½ day sessions	Workshops	Pre-Post Test	Interpersonal communication, patient satisfaction
Dizon, 2014	Philippines	Not Specified	31	Variety of health professionals	1 day	Lectures, practice sessions, and small group discussion	Pre-Post Test	Knowledge and skills in Evidence-Based Practice
Dodani, 2008	Pakistan	United States	80 (56)	Healthcare Physicians	9 days	Face-to-face and video-conferencing	Quasi-experimental, Pre-Post Test	Short- and long-term effectiveness of research training
Goodwin, 2012	India	Not Specified	160 (143)	Paramedic students	2 days	Classes	Prospective comparison	ACLS cognitive exam scores
Goudar, 2012	India	United States	12795 babies	Physicians, Nurse Mid-wives, TBAs	1, 3, 5 days	Trainer of trainers – Didactic and practice sessions	Cluster – Randomized and Control Trial	Perinatal and neonatal mortality
Hashmi, 2013	Pakistan	Not Specified	1227	Anesthesiology, Emergency Medicine, Surgical subspecialties	2 days	Classes (modified current curriculum)	Pre-Post Test	In-hospital complication and mortality
Hoban, 2013	Ethiopia	United States and Europe	111 (69)	Health Educators	2 days	Lecture and skills practice	Pre-Post Test	Resuscitation knowledge
Husum, 2003	Cambodia and Iraq	Norway	44 (42)	Village healthcare workers	3 years	Classes	Pre-Post Test	Health effects and sustainability
Husum, 2003	Cambodia and Iraq	Norway	44	Paramedics	3 years	Classes	Pre-Post Test	Pre-hospital physiologic severity levels, trauma mortality, infectious complications
Kauye, 2014	Malawi	United Kingdom	22	Primary healthcare workers	3, 5 days	Training sessions	Random allocation with repeated cross-sectional surveys	Diagnosis and management of cases
Kebede, 2012	Ethiopia	United States	24 hospitals	Hospital CEOs	3 – 3 week blocks over 2 years	MHA program	Pre-Post Test	Adherence to management standards
Kulier, 2012	Argentina, Brazil, Dem. Rep. of Congo, India, Philippines, S.	Not Specified	60 clinical training units (46)	Obstetrics and gynecology	8 weeks	e-learning self-directed course	& International cluster randomized control trial	Knowledge, skills, educational environment

Africa, Thailand									
Levine, 2011	Uganda, El Salvador	United States	45 (42 initial posttest, 18 at 6 month follow-up)	Healthcare providers	5 days	Lectures and practice	Pre-Post Test	Knowledge and comfort level	
Lewin, 2005	S. Africa	Not Specified	24 clinics	Primary care clinic staff	6 weeks	Experiential learning sessions	Cluster randomized control trial	Patient adherence, treatment outcomes	
Makaniuala, 2012	Nigeria	Not Specified	24	Teachers who train primary care providers	5 days	Workshop	Pre-Post Test	Knowledge, beliefs, and attitudes	
Tomatis, 2011	Peru	Not Specified	220	Physicians in training, practicing physicians, allied health professionals	3 days	Lectures and workshops	Pre-Post Test	Competence and importance to practice	
vanHeng, 2008	Cambodia	Europe	21	Assistant medical officers, trauma care providers	3 weeks	Classes	Pre-Post Test	Self-confidence, surgical skill, teamwork	
Wang, 2014	Ghana and Liberia	United States	15	Medical doctors	2 days	Didactic lectures, hands on practice, discussion sessions	Quasi-experimental	Surgical capacity	
Wee, 2011	Singapore	Not Specified	658	Medical students	½ academic year	Comparison of students who participated in PHS, NHS, or both.	Cross-sectional	Leadership, communication, teamwork, critical thinking skills	

Table 3. Summary of intervention and outcomes for studies meeting eligibility criteria

Author, Year	Intervention Description	Outcome Measured	Statistical Significance
Ajuwon, 2008	Three sets of training workshops lasting 21 hours over 3 days. Workshops were facilitated by 7 individuals with previous training and experience in research ethics. Techniques included: lecture, Q&A, group discussion of case studies. Information covered included: research ethics, principles of research ethics, ethics in research design, ethical issues in drug trials, confidentiality, informed consent, conflicts of interest, and scientific misconduct.	Knowledge	Knowledge of principles of research ethics increased from 0.67 to 2.25 out of 3(p<0.05) Application of research ethics increased from 2.64 to 3.05 (p<0.05) Knowledge about IRB operations increased from 6.05 to 6.29 out of 7 (p<0.05)
Arreola-Risa, 2007	Green Cross – 3 month programs provided by the Green Cross Red Cross – 11 month programs provided by the Red Cross. Taught pre-hospital care skills like rescue and extrication In both programs students went to classes for 2-3 hours per day	Mortality Rate	Mortality – decreased from 6.3% to 2.5% (p<0.001)

Autry, 2013	Three faculty members at the University of California, San Francisco led the video teaching sessions for 1hour. 3:1 student to faculty ratio. A Ugandan faculty member facilitated the teaching sessions only by offering technical support and keeping track of the time. Each intern had 3 different teaching sessions with different faculty	2 – handed knot tying	Score improvement of 50% or more in 6 out of 8 in the intervention group compared with 1 out of 7 in the control group (p=0.04)
Baig, 2008	Two weeks of theoretical teaching to students in Malawi. Edinburgh students received theoretical teaching spread over 5 months in the 3 <sup>rd</sup> year.	Exam in Malawi comparable to that given in Scotland	There was no significant difference between the scores on the exams taken by the Malawi students and the Scotland students
Bedada, 2015	A minimal access surgery training program was developed in 2006 that was composed of knowledge and skills training. An initial 3-day workshop was carried out in 2006. Emphasis was placed on teaching at psychomotor and cognitive levels. This was a training of the trainers workshop. Trainers then went on to train junior level colleagues	Patient safety, technical independence and sustainability of the minimal access surgery (MAS) program	Shorter length of stay in laparoscopic group (p<0.001) Increased proportion of laparoscopic cases completed without the presence of expatriate surgeons (p=0.001)
Brown, 2000	Nine local trainers participated in a 2-day training-of-trainers and helped deliver the intervention. Interpersonal Communication (IPC) training was conducted in 3 – ½ day sessions with a maximum of 20 participants. The course focused on communication methods and skills were grouped into: overall socio-emotional communication, problem-solving skills, and counseling.	Communication practices by trained and untrained providers	Trained providers communicated more (p=0.001) Trained providers had more positive talk (p=0.001) Criticism and negative talk was less common in trained providers (p=0.018) Trained providers used 3 times more emotional talk (p=0.021) Trained providers were more likely to ask the patient if they understood instructions (p=0.025) Medical counseling was more frequent in trained providers (p=0.026) Improvements in provider communication resulted in an increase in patient communication, and provision of more medical information Trained providers received higher patient satisfaction ratings
Dizon, 2014	1 day face-to-face training with lectures, practical sessions, and small group discussion. Online support was also included in the program	Evidence-based practice knowledge and skills	Knowledge and skills in EBP significantly improved from pre- to post-training in both groups (P<0.05 in both groups)
Dodani, 2008	9 day research training workshop using face-to-face, traditional classroom method at one medical university; and video-teleconferencing at a different medical university. In the video-teleconferencing, students can see their teachers and teachers can see students and their body language or facial expressions to gage understanding or confusion. Information covered included: epidemiology, biostatistics, genetic epidemiology, international health and cardiovascular epidemiology. Each module was made up of 9 1-hour lectures.	The short- and long-term effectiveness of research training	The workshop was found to be effective in both groups (post-test 1, p<0.0001). 36% increase in knowledge in the F2F group, and 24% increase in the VTC group.
Goodwin, 2012	Students from India were enrolled in a 2 year paramedic training program and certified in the ACLS course within the prior 3 months. US students were enrolled in 1 of 2 accredited paramedic training programs in the US and	ACLS cognitive examination scores	Overall there was no significant difference in test score between the Indian and US paramedic

	were certified in the ACLS course within the prior 3 months.		students. The international ACLS course is effective in an international setting.
Goudar, 2012	The study was conducted in 26 clusters of Karnataka, India. A trainer of trainers model was developed and experienced trainers trained a lead investigator and 2 site coordinators as national trainers. The national trainers were assisted by 2 more trainers and 1 or more cluster coordinator (CC) per community. Each of the training courses were 1-5 days held at different times. The CC's trained all active birth attendants in each community. Training of the CC was for 5 days, the Auxiliary Nurse Midwives and Traditional Birth Attendants for 3 days, and physicians for 1 day. After ENC data collection, clusters were randomized to NRP training or control.	Perinatal and neonatal mortality	There was a significant increase in the proportion of infants who received bag and mask ventilation in the post ENC period.  There was a significant decrease in perinatal mortality rate in the post ENC period (RR 0.69, 95% CI 0.53,0.90).  Skin-to-skin contact significantly increased in the NRP group (p=0.004)
Hashmi, 2013	Trauma quality improvement program components that were implemented include: development of a multidisciplinary trauma team centered around a surgeon, mandatory 2 day training in western style trauma care, and a trauma outcomes feedback program was established.	Occurrence of in-hospital complication and mortality	Unadjusted patient mortality decreased from 9.6% to 4.9% (p<0.05); Unadjusted complication rate decreased from 13.5% to 9.8% (p<0.05).
Hoban, 2013	Trainings were held in 7 Ethiopian cities. The individuals who were trained were going to serve as trainers for others. Two day training of lecture and skill practice.	Resuscitation knowledge	Significant improvement in resuscitation knowledge mean score improvement from 8.7/10 to 9.4/10 (p=0.003)
Husum, 2003a	Training program consisted of three 150-hours courses with working periods in between. A teaching manual in local languages was developed along with large posters with step-by-step instructions. Locally available animals were used for advanced life support training. These trained individuals then provided first responder training with a 2-day basic first aid training followed by a 1 day rehearsal training after 6 months.	Health effects and sustainability	Study reported significant reduction in overall mortality rate from 40% to 15.7%
Husum, 2003b	Training program consisted of three 150-hours courses with working periods in between. A teaching manual in local languages was developed along with large posters with step-by-step instructions. Locally available animals were used for advanced life support training. These trained individuals then provided first responder training with a 2-day basic first aid training followed by a 1 day rehearsal training after 6 months.	Effect of treatment on pre-hospital physiologic severity levels, trauma mortality, infectious complications	The mortality rate decreased from 40% to 14.9%. Significant reduction in fatalities for injured torso from 61.5% to 19.1%
Kauye, 2014	The intervention was composed of a 5 day training program in mental health using a 5 unit tool-kit divided into 30 minute sections. Each section consisted of lecture, group discussion and role-plays. The control group participants received 3 days of training using an existing lecture based syllabus.	Diagnosis and management of cases	32 times greater odds of diagnosing patients with depression in the intervention group
Kebede, 2012	The training received was from a Masters of Healthcare and Hospital Administration degree program.	Adherence to management standards	Percent of management standards met increased from 27% to 51% (p<0.001)
Kulier, 2012	The intervention group received elearning of Evidence-Based Medicine (EBM) principles consisting of 5 recorded video sessions, and face-to-face teaching and learning with a clinical trainer. The control group participated in a self-directed learning course consisting of PowerPoint slides that were available online with the same learning objectives and content as the elearning materials; they also had a facilitator. The control and intervention	Knowledge, skills, educational environment	After education there were significant increases in overall knowledge in the intervention group (38.1 vs 43.1; adjusted mean difference 4.9, p<0.001) and in skills measured (8.3 vs 9.1; adjusted mean difference 0.7, p=0.02)

activities were given in addition to the local teaching programs.

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Levine, 2011	Training was provided by 2 visiting Ob/Gyn's over a 5 day series of lectures and interactive training. Participants observed screening upon completion of each lecture; and then performed the screening while being monitored	Knowledge and comfort level	Average score significantly increased from 62% to 81% (p<0.001); self-reported comfort levels of identifying abnormalities significantly increased from 2.1 to 3.3 (p<0.001)
Lewin, 2005	Primary care clinic staff met with trainers for one 3-hour session weekly for 6 weeks. The training encouraged participants to think about their past experiences caring for patients with TB. Training was provided by two experienced nurse practitioners, and training was conducted in the preferred language of the staff	Patient adherence, treatment outcomes	There were no statistically significant differences. However, the rate for successful treatment completion improved in the intervention clinic, and the cure rate improved by 2.5% in the intervention clinic and decreased by 7.9% in control clinic.
Makanjuola, 2012	One week training structured into 5 units: core concepts, core skills, common neurological disorders, WHO primary guidelines for mental health, health and policy issues. Each unit was divided into 30-minute modules delivered over 5 days. Modules consist of theory, discussion and role play	Knowledge, beliefs, and attitudes	Overall knowledge of mental health issues increased from 60.4% to 73.7% (p=0.001)
Tomatis, 2011	Researchers conducted 5 EBM courses over 5 years. One course was made up of 3 consecutive days of lectures and workshops on basic principles of EBM. There were 2 or 3 45-minute interactive lectures each day. Each lecture was followed by a 45-minute interactive workshop consisting of 3 parts: discussion of a case scenario, critical appraisal of a published study, guided discussion	Competence and importance to practice	Self-reported competence increased from 2 to 3 (p<0.001)
Van Heng, 2008	Training was provided during 5 consecutive 150 hour courses and followed the "Village University" model. This model consists of 4 concepts: 1) confidence, 2) troubleshooting, 3) Learning by doing, and 4) This is a university. Live injured animals that were under anesthesia were used for training surgical techniques.	5 consecutive 150 hour courses based on 4 principles: confidence, troubleshooting, learn by doing, this is a university. Trained using local animals	There were 4 deaths in the control group hospitals, and 2 in the intervention group. 22% had post-operative wound infections in the control group and 10.3% had infections in the intervention group
Wang, 2014	A team of 2 attending general surgeons and 1 advanced-year general surgery resident from US academic institutions taught a 2-day course. The course consisted of didactic lectures, hands-on practice of mesh repair in the operating room, and discussion sessions. On average trainees participated in or observed a total of 6 six cases.	Increase surgical capacity	Mesh repairs had a significantly higher rate of orchitis compared to the non-mesh group 5.7% vs 1.3% (p=0.03)
Wee, 2011	No training intervention was provided. This study compared the survey results of two different service learning programs at a medical school in Singapore.	Skills and application of knowledge	For students who participated in both PHS and NHS the rating of the NHS was significantly higher (p=0.032)

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Studies were conducted in Argentina, Botswana, Brazil, Cambodia, Democratic Republic of Congo, El Salvador, Ethiopia, Ghana, Honduras, India, Iraq, Liberia, Malawi, Mexico, Nigeria, Pakistan, Peru, Philippines, Singapore, South Africa, Thailand, and Uganda. Trainers came from Canada, England, Norway, Scotland, United States, and other countries in Europe. Papers focused on specialties in anesthesiology, ambulatory care, Emergency Medical Services, health education, midwifery, obstetrics and gynecology, physicians, psychiatry, surgery, research ethics. Outcomes measured include: knowledge, mortality rate, skills such as 2-handed knot tying, interpersonal communication, short- and long-term effectiveness of research training, health effects and sustainability, diagnosis and management of cases, adherence to standards, educational environment, comfort level, patient adherence, treatment outcomes, beliefs and attitudes, errors, competence and importance to practice, self-confidence, surgical skill, teamwork, leadership skills, ability to identify social issues, gaining and

application of knowledge.

### 3.2 Study Characteristics and Results of Individual Studies

Study characteristics and results of individual studies are shown in Tables 2 and 3. Sample sizes ranged from 12 to 12795. Samples included physicians/healthcare workers being trained and clusters of regions where trainings were conducted (Ajuwon et al., 2008; Arreola-Risa et al., 2007; Autry et al., 2013; Baig et al., 2008; Bedada et al., 2015; Brown et al., 2000; Dizon et al., 2014; Dodani et al., 2008; Goodwin et al., 2011; Goudar et al., 2011; Hashmi et al., 2013; Hoban et al., 2013; Husum et al., 2003a; Husum et al., 2003b; Kauye et al., 2014; Kebede et al., 2012; Kulier et al., 2012; Levine et al., 2011; Lewin et al., 2005; Makanjuola et al., 2012; Tomatis et al., 2011; van Heng et al., 2008; Wang et al., 2014; Wee et al., 2011). Intervention duration ranged from one day to three years. Twelve of the studies were pre-post- test design (Ajuwon et al., 2008; Brown et al., 2000; Dizon et al., 2014; Hashmi et al. 2013; Hoban et al., 2013; Husum et al., 2003a; Husum et al., 2003b; Kebede et al., 2012; Levine et al., 2005; Makanjuola et al., 2012; Tomatis et al., 2011; vanHeng et al., 2008), 5 were quasi-experimental design (Arreola-Risa et al., 2007; Baig et al., 2008; Bedada et al., 2015; Dodani et al., 2008; Wang et al., 2014), three were Cluster randomized control trials (Goudar et al., 2011; Kulier et al., 2012; Lewin et al., 2011), 2 were cross-sectional design (Kauye et al., 2014; Wee et al., 2011), 1 randomized control trial (Autry et al., 2013), and 1 prospective comparison study (Goodwin et al., 2011).

Of the 24 eligible studies, 1 conducted 1 day training, 13 conducted 2-30 day trainings, 3 conducted 1-3 month trainings, 1 conducted 3-6 month training, and 6 conducted trainings that lasted longer than 6 months, 1 did not report any training methods. Twenty-one of the studies had significant results, 2 studies had results that were not significant, and 1 study did not state whether the result were significant or not as reported in Table 4. One study with insignificant results indicate that there was no significant difference between similar methods of instructions used between two different populations of students indicating that the method can effectively be used amongst a variety of groups (Baig et al., 2008; Goodwin et al., 2011). The second study did not produce statistically significant results however being able to increase the rate of treatment completion and the cure rate of tuberculosis may be clinically significant (Lewin et al., 2011).

Out of the 24 articles, four measured knowledge (Ajuwon et al., 2008; Baig et al., 2008; Dodani et al., 2008; Goodwin et al., 2011), eight measured skill (Brown et al., 2000; Goudar et al., 2011; Hashmi et al., 2013; Husum et al., 2003a; Husum et al., 2003b; Kauye et al., 2014; Kebede et al., 2012; Lewin et al., 2005), seven measured knowledge and skill (Autry et al., 2013; Dizon et al., 2014; Hoban et al., 2013; Kulier et al., 2012; Levine et al., 2011; Wang et al., 2014; Wee et al., 2011), two measured mortality and skill (van Heng et al., 2008; Arreola-Risa et al., 2007), one measured knowledge and attitudes (Makanjuola et al., 2012), and two measured knowledge, skill, and attitudes (Kulier et al., 2012; Tomatis et al., 2011).

Table 4 provides a comparison of the training methods used in eligible studies. Training methods included workshops, e-learning modules, hands-on skills training, group discussion, video sessions, and role-plays. Of the studies with statistically significant results training times varied from one day to three years. Studies using both face-to-face and video found statistically significant results.

Table 4. Summary of significant training programs

Author, Year	Trainer from DC Only	Trainer from HC and DC	Trainin g 1 day	Trainin g 2 - 30 days	Trainin g 1 - 3m	Trainin g 3 - 6 m	Training >6 months	T T	FFT	VT	ST	KT	SIM
Ajuwon, 2008	*	*		x					x			x	x
Arreola-Risa, 2007		x				x	x		x		x		x
Autry, 2013	x				x					x	x		x

Author, Year	Trainer from DC Only	Trainer from HC and DC	Trainin g 1 day	Trainin g 2 - 30 days	Trainin g 1 - 3m	Trainin g 3 - 6 m	Training >6 months	T T	FFT	VT	ST	KT	SIM
Baig, 2008	x			x					x			x	
Bedada, 2015		x		x				x	x		x	x	x
Brown, 2000		x		x				x	x		x	x	x
Dizon, 2014		x	x						x				x
Dodani, 2008	x			x					x	x		x	x
Goodwin, 2011	*	*					x		x			x	
Goudar, 2011		x		x				x	x		x	x	
Hashmi, 2013	*	*		x					x		x	x	x
Hoban, 2013		x		x				x	x			x	x
Husum, 2003		x					x		x		x	x	x
Husum, 2003		x					x		x		x	x	x
Kauye, 2014		x		x					x			x	x
Kebede, 2012		x					x		x		x	x	x
Kulier, 2012		x							x	x	x	x	x
Levine, 2011	x			x					x		x	x	x
Lewin, 2005		x				x			x		x	x	
Makanjuola, 2012		x		x					x			x	x

Author, Year	Trainer from DC Only	Trainer from HC and DC	Trainin g 1 day	Trainin g 2 - 30 days	Trainin g 1 - 3m	Trainin g 3 - 6 m	Training >6 months	T T	FFT	VT	ST	KT	SIM
Tomatis, 2011		x		x					x			x	x
van Heng, 2008	x				x				x		x	x	x
Wang, 2014	x			x					x		x	x	x
Wee, 2011	N/A	N/A					x						x

x Study had that criteria, \* Trainer country of origin was not specified, N/A Training was not provided.

DC=Developed Country, HC=Host Country, TT=Train the trainer, FFT=Face to Face training, VT=Video Training, ST=Skills Training, KT=Knowledge Training, SIM=Significant improvement measured.

#### 4. Discussion

The purpose of this paper was to review the existing literature on training outcomes in low and middle-income countries in order to identify effective strategies for implementation in the developing world. Based on the literature and small number of eligible studies for this review, few studies have examined the effectiveness of training and how to integrate information found in research into training practice or programs. Measuring quality has also proven to be a challenge due to the lack of a universal definition (World Health Organization, 2014). This review found that using a train-the-trainer model was effective in producing statistically significant improvements in the skill and knowledge of healthcare workers in low- and middle- income countries. In addition, studies with varied length of times were able to effectively train staff and result in positive changes in outcomes. Using both face-to-face and video or e-learning training was shown to be effective training methods. Additionally, based on the findings we recommend that both skill and knowledge training be provided simultaneously, if possible.

The finding that little has been published surrounding the effectiveness of training is supported by prior reviews of the literature. A review by Innvaer et al. found 24 studies that addressed decision makers using science based evidence to affect health policy decisions (2002). Only four of the studies included in the review were conducted in low- and middle- income countries, limiting the recommendations for developing countries (Innvaer et al., 2002). Due to the lack of evidence it is challenge to implement policy to address the training needs of low- and middle-income countries. This review, focused only on training completed in low- and middle-income countries, finding a similar lack of evidence. More needs to be done to ensure that research evidence is translated into practice and policy in developed and developing countries. Measuring the outcomes of training is important to ensure the most effective methods are disseminated and used.

Based on the papers that were reviewed in this study, a number of best practices should be considered by developing countries. Many studies report providing training by a trainer from a developed country along with a facilitator or moderator from the country where the training was being conducted. The relationships that are established in this manner may allow for more culturally appropriate delivery of the instructional material and enable those being trained to fully reap the benefits of the information being provided. A review by Pearce et al. found that 13 out of 18 studies noted that train-the-trainer programs were effective in disseminating knowledge and in improving patient outcomes (Pearce et al., 2012). Studies using a train-the-trainer model of training produced significant positive results in three studies in this review. This suggests that with effective train-the-trainer strategies low- and middle-income countries can continue to provide their healthcare staff with training in a sustainable manner. Fewer resources would be needed to train cohorts of trainers who in turn will be able to continue to provide training to incoming healthcare workers and refresher courses to veteran workers. Both face-to-face and video training were shown to be effective in the studies reviewed, increasing the options for offering training or follow-up sessions.

The length of training did not seem to influence the significance of the results, with trainings as short as 1 day or up to 3 years showing statistical significance in improving outcomes in the healthcare system of low-middle-income countries. This indicates that cost-effective training can be provided through shorter courses and reduce strain on the health system by taking providers away from patients for extended periods of time. Long-term training is more likely to be used in academic institutions and is useful for very specialized subject areas. Short-term training can be done in community or academic environments. In order for short-term training to be effective the training should be provided in the native language, use training modules that allow for flexibility to meet the goals of the trainees, and sufficient follow-up of individuals who complete the training program (Holland et al., 2012). Many studies reviewed combined both knowledge and skills training, which is supported by theory and evidence to result in better outcomes (Yamhill et al., 2001). This is recommended for future training to ensure healthcare providers have the knowledge and skills necessary to change their practice.

#### 4.1 Limitations

Though a systematic process was used to limit the likelihood of missing articles, some limitations exist. First, missing information was noted for some studies. For instance, some studies did not indicate the number of healthcare workers that were trained, only the number of facilities or communities that received the intervention. Other papers report numbers in terms of patients prior to training and post training (Hashmi et al., 2013), which may not be an effective measure if trained staff left the facility. Additional information would be beneficial to help determine the cost-effectiveness and true success or lack thereof of the interventions. Second, the search was limited to articles that were only published in English. Since the review is on low- and middle-income countries were frequently English is not the official or first language, studies with valuable information may have been excluded from this review. Third, studies with negative training outcomes may not have been published due to the results. Lastly, only 3 studies were randomized control trials. Other study designs may increase the risk of bias.

#### 4.2 Conclusions

Based on the results of this review, health professionals from high-income countries should be encouraged to travel to low- middle-income countries to assist with providing training to health providers in those countries. The trainers traveling from developed countries should work with experienced healthcare providers within the country to ensure the provision of culturally appropriate training experience. Effective training programs with significant outcomes can be provided in one week or less; providing cost effective and time efficient training options for those with access to limited resources. Using both face-to-face and video or e-learning training was shown to be effective training methods. Additionally, based on the findings we recommend that both skill and knowledge training be provided simultaneously if possible. Finally, effort should be made to implement a train-the-trainer model of training to allow for a cost effective and sustainable method of training in low- and middle- income countries.

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#### Conflict of Interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

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