2015

# Continuing Education Outcomes In The Medical And Health Professions: A Meta-Analysis

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# CONTINUING EDUCATION OUTCOMES IN THE MEDICAL AND HEALTH PROFESSIONS: A META-ANALYSIS

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A thesis

Presented to

The College of Graduate and Professional Studies

Department of Applied Medicine and Rehabilitation

Indiana State University

Terre Haute, Indiana

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In Partial Fulfillment

of the Requirements for the Degree

Master of Science in Athletic Training

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by

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May 2015



Keywords: continuing medical education, continuing education outcomes, athletic training, continuing education, health professions





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ABSTRACT

**Context:** Limited and conflicting data exist examining the relationship between continuing education (CE) on actual clinician knowledge. A quantitative examination of the literature is warranted to better understand how CE influences actual clinician knowledge. **Objective:** To determine if continuing education improves actual clinician knowledge. **Data Sources:** We searched the following databases between March and June 2014 for the relevant articles: Academic Search Premier, Biomedical Reference, CINHAL, EBSCOhost, Google Scholar, Health Business FullTEXT, Health Source, Medline, and Sports Discuss. No date range was specified and searches were conducted to include all possible years of publication in each respective database. Key terms searched included continuing medical education, continuing education, outcomes of continuing education, effectiveness of continuing education, physicians, athletic trainers, physical therapists, occupational therapists, physician assistants, and nursing. We used single and combined key terms. **Study Selection:** Studies must of met four inclusion criteria: (1) reported outcomes related to actual knowledge of clinicians; (2) examined one or more of the following professions: athletic training, nursing, occupational therapy, physician, physician assisting or physical therapy (3) utilized a pre/post research design; and(4) reported include sample size and either means and standard deviation or interferential statistics. **Data Extraction:** Data were extracted from text, tables and figures. ImageJ was used to extract data from figures. Funnel plots were completed to check for publication bias at the outcome level. A

fail-safe N was calculated for both overall analyses and sub-analyses to assess the number of unpublished works needed to nullify the statistical significance of the analysis. After data extraction, the data was examined by two trained investigators (E.M. and K.G.) to ensure all data is entered accurately. Data then were placed into a custom spreadsheet database. A weighted, random-effects meta-analysis using the Hedges' g metric was completed for CE effect on actual knowledge. All statistical analyses were performed with Comprehensive Meta-Analysis. Statistical significance was set a priori at $\alpha \leq 0.05$ for all analyses. **Data Synthesis:** We found 18 potential articles. Further examination yielded 9 studies meeting the inclusion criteria. CE was shown to positively affect actual clinician knowledge (Hedges' g =0.73; 95% CI = 0.60-0.85). It appears from the funnel plot analysis that there is a publication bias towards dissemination of works that CE is effective. **Conclusions:** CE improves actual clinician knowledge. After analyzing the literature, articles measuring the relationship between CE and actual clinician knowledge only exists in the field of physicians. Future research needs to be completed examining CE across the health professions.

# ACKNOWLEDGMENTS

I would like to thank Dr. Lindsey Eberman for all the support over the years. Thank you for giving me many different opportunities. I am grateful for everything you have done to help me succeed in my career. If it were not for you, I would not have been able to experience so many new things in life. Also, to Dr. Kenneth Games and Dr. Leamor Kahanov, thank you for all your guidance and support throughout this process. I would also like to thank my family for all the love and advice that has been provided to me during this time. I cannot say thank you enough for the patience you have extended to me though everything. Also, I would like to thank the School of Graduate and Professional Studies at Indiana State University for providing me with fiscal support of this research thesis.

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# CHAPTER 1

## INTRODUCTION

Continuing education (CE) is an important method to ensure clinicians retain current medical practice in a field that is constantly evolving. Continuing education is defined as any way in which clinicians learn and the knowledge acquired after formal training completion.[1] CE was intended to promote continued competence, development of current knowledge and skills, and to enhance professional skills and judgment beyond the levels required for entry-level practice.[2] Continued learning and maintaining competence as a healthcare provider are important aspects of professionalism[2] and public safety.

Continuing education requirements vary among medical and health professions as a requirement to maintain clinician certification.[2-7] Different laws govern the requirements of CE among health care professions ranging from no mandate for CE to maintain licensure and/or certification to a mandate of a certain number of CE for maintenance.[2-7] Although some professions require proof of a certain amount of CE and retesting, other professions may only require the payment of dues for recertification. Regardless of state requirement, clinicians in the medical and health professions should demonstrate continued competence, development and enhancement of new skills, not only to maintain public safety but to improve patient care.

Because CE requirements vary greatly, feedback regarding perceived and actual knowledge and competence also varies. The relationship between perceived and actual knowledge, known as a knowledge gap, is often poor and can be hazardous to patients.[8] Actual knowledge refers to possession of information that a learner comprehends and uses to make decisions.[9] Perceived knowledge is the perception of knowing that the learner has or one's self-assessment, and has also been defined as the illusion of knowing.[9] Often CE is driven by the perceived knowledge or learner preferences,[8] rather than outcomes of knowledge gained through improved patient health outcomes. Without feedback, or a mechanism to test actual knowledge (before and after CE activities), practitioners may be unaware of personal weaknesses.[10] As such, practitioners may not select or acquire appropriate CE to fill the knowledge gap (KG).[10] Inadequate knowledge or competence can negatively impact patients, and in some of the health care fields, particularly those acting in life-saving roles, could have life altering results.

## Statement of Purpose

A lack of consistency exists in the literature linking CE to clinician performance and patient outcomes.[11] A quantitative examination of the literature is needed to assist in our understanding of how CE influences clinical performance. This study will use meta-analytics to quantitatively assess the research literature to date on the effects CE on actual clinician knowledge.

## Research Questions

What effect does continuing education have on actual clinician knowledge?

# CHAPTER 2

## REVIEW OF LITERATURE

The purpose of this literature review is to discuss the current literature on continuing education (CE), the requirements of CE in the different scopes of practices, and the outcomes CE can have on clinician practice. Understanding the impact of CE on clinician knowledge and patient outcomes to help determine the effectiveness of CE is critical to assessing patient care. CE is also understood as an effective method of bridging knowledge gaps between actual and perceived knowledge in clinicians. Differences among the requirements for mandated CE and the methods used for CE exist.

### Continuing Education

CE was founded in the 1970's as a belief that if physicians were up-to-date on medicine, they could change and improve their practice, resulting in better physician performance.[1] CE is defined multiple ways, dependent upon which scope of clinical practice is referenced. According to Davis, continuing education is any attempt to persuade physicians to modify their practice performance by communicating clinical information.[12] Mansouri and Lockyer describe CE as any and all the ways by which physicians learn after formal completion of their training.[1] The Board of Certification for athletic trainers (ATs) describes CE as the intention to promote continued competence, development of current knowledge and skills and to enhance professional

skills and judgment beyond the levels required for entry-level practice.[2] Tassone and Speechley define CE in Physical Therapy as a systematic effort to provide education beyond formal education and initial entry into a profession.[13] Furze and Pearcey quoted the American Nurses Association on the definition of CE stating that continuing nursing education is planned activities that intend to build upon educational and experiential basis of the professional nurse for the enhancement of practice, education, administration, research or theory development to the end of improving the health of the public.[14] Regardless of clinical practice, CE is a means of developing advanced learning after the completion of formal training. Also, CE is intended to increase clinician knowledge and skills to better patient care outcomes throughout all health professions.

*CE Requirements*

As mentioned, each profession has its own definition of CE, and as such, regulations vary as well (Table 1). The Board of Certification for AT mandates 50 CE units (CEUs) every two years as of January 2014.[2] Within the profession of athletic training, one CEU is equal to one contact hour of CE.[2] This means for every hour spent in a CE course that equals to one CEU. Prior to January 2014, ATs had to complete 75 CEUs every 3 years to maintain their certification.[2] Currently, ATs must complete 50 CEUs every two years. If ATs do not complete the required amount by the end of second year their certification will expire. If they do not complete the number of CEUs required, ATs must pay a renewal fee within two months of their certification lapsing in order to keep their certification. If they do not pay after 2 months and complete the required, their certification will be terminated.

The American Nurses Credentialing Center has mandated that nurses complete 150 CE hours every five years.[3] Every one hour spent on CE is equal to 10 contact hours.[3] If a registered nurse does not complete 1000 practice hours either as an employee or volunteer, a recertification exam is required at the end of the fifth year.[3] If the practice hours are reported, the nurse would have to also report their CEs and pay a renewal fee.[3]

As an occupational therapist (OT), each state regulates the continuing competency requirements, the fees of the licensure and the type of licensure that each state mandates.[5] The American College of Physicians has a similar regulation of CE, that is, each state regulates its own CE requirements, additional CEs that might be mandatory, and also the different types of certificates or awards that are accepted.[6] Also, the specialty that is being practiced may change the number of CEs required, and whether or not a recertification exam is mandatory.[15]

Physician assistants (PA) are regulated through the National Commission on Certification of Physician Assistants (NCCPA). As of January 2014, PAs must complete 100 CME every two year cycle.[7] After ten years of certification, a total of five cycles, PAs are required to take the certification exam as part of the recertification process.[7] Before January 2014, PAs had to retake the PANRE exam every six years.[7]

The Federation of State Boards of Physical Therapy states that there are many ways to maintain and acquire new skills that are just as effective as CE.[4] Therefore, they do not regulate CE. However, each state regulates the amount of CE needed and the length of the licensure.[16] Each state also determines the relationship of CE and contact hours.[16]

In regards to CE regulation, there are several differences among health professions in the amount of CE that is required. As stated before, there are some states that do not require CE. Therefore, the professions that do not require CE could potentially harm their patients if they do not keep up with the evolution of medicine.

*CE Interventions*

Different educational models are used in the delivery of CE. These models include passive, active, web-based or multifaceted educational techniques. A passive educational technique can be defined as any presentation or lecture that does not include any audience interaction. Active educational techniques can be defined as any workshops, conferences, role-play, group discussions, hands-on practice, seminars and symposia that include audience interaction. Web-based educational techniques include any sort of web-based CE courses, lectures, and webinars. Multifaceted educational program is any combination of two or more of the educational techniques mentioned above. Knowing what educational techniques demonstrate the most improvement could be beneficial to future CE courses.

## Continuing Education Outcomes and Effectiveness

For more than two decades, researchers and health care providers have questioned whether or not CE works.[12] CE is considered a logical method to enhance clinical practice to improve the quality of patient care.[17] It is important to know whether there is a positive effect from CE, if not, professions have no justification to require them.

Within the current literature, a meta-analysis was performed on CE outcomes within physicians. Mansouri et al.[1] looked at three outcomes, physician knowledge, physician

performance, and patient outcomes.[1] From this study, the researchers indicated that there could be a moderate positive correlation between CE and physician performance, however, there was a small positive correlation between CE and physician performance or patient outcomes.[1]

Research indicates that a CE course significantly enhances physician knowledge and attitude.[18] Other research also showes an increase in physician knowledge after a CE course on domestic violence.[19] Not only has there been increased physician knowledge and attitude reported in research, but prescribing behavior has also been a reported outcome of CE.[18-22] In the current literature, there is a reported increase in patient satisfaction and an increase of patient health outcomes following CE intervention.[23-25]

Even though several studies indicate improved outcomes from continuing education, there are studies that also show no benefit in CE outcomes. Dolan et al.[26] reported no changes in clinician beliefs, behaviors, or knowledge.[26] Physician attitudes, knowledge, and practice behaviors increase immediately after a CE intervention but did not have a long term effect on the increased outcomes according to Gerstein et al.[27] In current literature, there is a lot of research completed on CE, however, there has not been a sufficient amount of literature to support an effect between CE, clinician knowledge and patient outcomes.[11]

Attitudes toward continuing education is important when considering the outcomes of CE because if the learner is unmotivated to learn, then the effectiveness of the CE intervention will not be successful. In current literature, there are many favored attitudes toward CE.[8,28] In a study that was performed, several PTs reported that they take more than the mandated CEs in their state because they are self-motivated to continue to learn.[17]

## Actual and Perceived Knowledge

Clinicians can have a knowledge gap between actual knowledge and perceived knowledge.[10] The knowledge gap between actual and perceived knowledge can be hazardous to patients being treated. Actual knowledge refers to possession of information that a learner actually knows while making a decision.[9] Perceived knowledge is the feeling of knowing that the learner has, or one's self-assessment, as also has been defined as the illusion of knowing.[9]
In current literature, there are two validated tools that have been developed t to measure perceived knowledge of diabetes mellitus. These tools include the Diabetes Self Report Tool (DSRT) and the Diabetes: Basic Knowledge Test (DBKT).[29] With the use of these tools, investigations reveal that there was not a statistically significant relationship between actual knowledge and perceived knowledge of diabetes mellitus among nurses.[29,30] With this non-statistical significance, this shows that there is a knowledge gap between what clinicians perceive they know and what they actually know. Another study compares patient's knowledge, self-care behavior and disease perception about diabetes mellitus. Within this study, the participants completed a validated questionnaire pre-intervention, 6 months post-intervention and 12 months post-intervention.[31] This study showed that there was no change in disease perception, however an increase in patient's knowledge and self-care behavior.[31] This increase was found post-intervention but the patient's failed to retain the knowledge over a long period of time.[31] If this type of gap exists, the clinician may put the patient at risk for harm.

# CHAPTER 3

## METHODS

The methodology and presentation of results in this meta-analysis conformed with the PRISMA statement, with the exception that the review protocol was not registered.[32] We searched the following databases: Academic Search Premier, Biomedical Reference, CINHAL, EBSCOhost, Google Scholar, Health Business FullTEXT, Health Source, Medline, and Sports Discuss. We searched these databases between March 2014 and June 2014 for the relevant articles. The keywords for the searches included: *continuing medical education, continuing education, outcomes of continuing education, effectiveness of continuing education, continuing medical education and physicians, continuing education and athletic training, continuing education and physical therapists, continuing education and occupational therapists, continuing medical education and physician assistants, continuing education and nursing.* The searches utilized single and combined keywords.

### Inclusion Criteria

Included in this analysis, studies must have meet four inclusion criteria: (1) the studies must have focused on the of the following outcomes: actual knowledge; (2) the studies must have included one or more of the following professions: athletic training, nursing, occupational

therapy, medicine, physician assistant studies or physical therapy; (3) the studies must have utilized a randomized control or a pre/post (before and after) design; and (4) the studies must have reported quantitative analysis which include sample size; and either means and standard deviation, or interferential statistics.

## Data Extraction

Data was extracted from the text, tables and figures of each study. ImageJ (National Institute of Health, Bethesda, MD, USA) was used to extract data from tables and figures. We also extracted the sample size, means, standard deviation, and inferential statistics from the text.

A funnel plot was completed to check for publication bias at the outcome level. A fail-safe N was calculated for the overall analyses to assess the number of unpublished works needed to nullify the statistical significance of the analysis.

## Statistical Analysis

After data extraction, the data was examined by two trained investigators (E.M. and K.G.) to ensure all data is entered accurately. Data was then be placed into a custom spreadsheet database (Microsoft Excel 2010, Microsoft Corp., Redwood, WA, USA). A standard effect size metric was determined appropriately based on the type of raw data collected. All statistical analyses were performed with Comprehensive Meta-Analysis software (Version 2.0, Biostat Inc., Englewood, NJ, USA). Statistical significance was set *a priori* at $\alpha \leq 0.05$ for all analyses.

# CHAPTER 4

## MANUSCRIPT

### Introduction

Treatment of injuries and illnesses is continually changing in medicine based on new evidence, the acquisition and use of contemporary procedures by practitioners. At least 25 percent of care provided by clinicians is reported as potentially harmful to the patient, with 30-40 percent of patients lacking evidence based care.[1] This gap between the real and ideal performance of health care increases concerning questions about the role of CE. Continuing education (CE) is the primary mechanism by which new information is distributed in medical and allied health professional communities; however the effect of CE on changes in knowledge, behavior, and patient outcomes is conflicting. Understanding if and how CE influences any number of metrics is important, not only for patients, but also for public and practitioners. The increased cost of care and the introduction of the Affordable Care Act in the United States has led to an increased demand for safe, effective, and cost-conscious treatment.[33] Without a mechanism to educate health care providers in a way which leads to knowledge gain, behavioral change, and improved patient outcomes, the health care system may be unduly burdened with

ineffective and outdated treatment. This may have a negative impact on patient care and the overall healthcare system.

CE is defined as any and all learning and knowledge acquired after formal training completion.[12] CE is intended to promote continued competence, develop current knowledge and skills, and enhance professional skills and judgment beyond the levels required for entry-level practice.[2] CE is also known as continuing medical education.[3,6,7] and continued competence[5] across the different health professions. Not only does the name vary, but CE requirements differ among provider type, as well as state and federal regulatory bodies.[2] Regardless of state or national requirement, clinicians in the medical and health professions should demonstrate continued competence,[2] development and enhancement of new skills, not only to maintain public safety[3] but to improve patient care.[17] To maintain these requirements, healthcare providers have the ability to choose CE courses on the topic of their choice,[2-7] which may not address competency or knowledge needs of the practitioner.

CE is often driven by perceived knowledge or learner preferences rather than outcomes of knowledge gained through improved patient health outcomes.[8] Without feedback, or a mechanism to test actual knowledge (before or after CE activities), practitioners may be unaware of personal weaknesses.[10] Actual knowledge refers to possession of information that a learner comprehends and uses to make decisions.[9] Perceived knowledge is the perception of knowing that the learner has or one's self-assessment.[9] Feedback regarding perceived and actual knowledge and competence is inconsistent.[10] The relationship between perceived and actual

knowledge, known as a knowledge gap, is often poor and can negatively impact patient care.[8] As such, practitioners may not select or acquire appropriate CE to fill the knowledge gap.[10]

A lack of consistency exists in the literature linking CE to clinician performance and patient outcomes.[11] A quantitative examination of the literature was needed to assist in our understanding of how CE influences clinician actual knowledge. The purpose of this study was to quantitatively assess the research literature to date on the effects CE had on actual clinician knowledge.

## Methods

### *Literature Search*

The methodology and presentation of results in this meta-analysis conforms to the PRISMA statement, with the exception that the review protocol was not registered.[32] We searched the following databases between March 2014 and June 2014 for the relevant articles: Academic Search Premier, Biomedical Reference, CINHAL, EBSCOhost, Google Scholar, Health Business FullTEXT, Health Source, Medline, and Sports Discuss. No date range was specified, and searches were conducted to include all possible years of publication in each respective data base. Key terms for the searches included: *continuing medical education, continuing education, outcomes of continuing education, effectiveness of continuing education, physicians, athletic trainers, physical therapists, occupational therapists, physician assistants,* and *nursing*. We used single and combined key terms for our searches.

*Study Selection*

Studies must have met four criteria for inclusion in the analysis: (1) studies must focus on the outcome actual knowledge; (2) studies must include one or more of the following professions: athletic training, nursing, occupational therapy, medicine, physician assistant studies or physical therapy; (3) studies must utilize a randomized control or a pre/post experimental design; and(4) studies must report a quantitative analysis which include sample size and either means and standard deviation or interferential statistics. Two readers (E.M. and K.G.) screened the articles to ensure that met all of the inclusion criteria. In the event a disagreement existed, a third reader (L.E.) participated until consensus was reached.

*Data Extraction*

Data from the text, tables and figures of each study were extracted. ImageJ (National Institutes of Health, Bethesda, MD, USA) was used to extract data from figures. We also extracted the sample size, mean, standard deviation, and inferential statistics from tables and text. A fail-safe N and funnel plot to identify potential publication bias were calculated to determine the number of unpublished works that would need to exist to nullify the findings of the analysis.

Two trained investigators (E.M. and K.G.) examined the data to ensure all data were entered accurately. Data were then placed into a custom spreadsheet database (Microsoft Excel 2010, Microsoft Corp., Redwood, WA, USA). To standardized measures among studies, a Hedges' *g* effect size metric was utilized. All statistical analyses were performed with

Comprehensive Meta-Analysis software (Version 2.0, Biostat Inc., Englewood, NJ, USA). Statistical significance was set *a priori* at $\alpha \leq 0.05$ for all analyses.

*Data Synthesis*

A weighted, random-effects meta-analysis using the Hedges' *g* metric to examine the effect of CE on actual knowledge was completed. The Hedges' *g* metric is based on a standardized (pooled variation) difference of paired means between pre-intervention and post-intervention measures. A correlation was also completed between pre-intervention and post-intervention measures. The confidence interval of 95% was set around the mean effect sizes. Mean effect sizes and 95% CIs above zero indicated that CE increases actual clinician knowledge. Mean effects and 95% CIs below zero indicated that CE have a negative effect on actual clinician knowledge. Mean effect sizes and 95% CIs that crossed zero indicated that CE had no effect on clinicians' actual knowledge. Data extracted from the articles included the sample size, mean, standard deviation, and inferential statistics from the text, figures and tables. A funnel plot was completed to check for publication bias at the outcome level. A fail-safe N was calculated for the analyses to assess the number of unpublished works needed to nullify that a finding was different.

## Results

Eighteen potential articles examined actual clinician knowledge. After further examination of these articles, nine met the inclusion criteria (Figure 1). The nine articles excluded from this analysis were due to insufficient reporting of the statistics needed. The nine

articles that were included in this study examined actual knowledge of physicians (4), nurses (2), occupational therapists (1) and combined training of physicians and nurses (2) (Table 2).

CE was beneficial (Hedges' $g = 0.73$, $n = 9$, $P < 0.001$; 95% CI = 0.60-0.85) suggesting that CE positively affects actual clinician knowledge (Figure 2). A statistically significant weak, positive correlation between CE and clinician actual knowledge ($r = 0.347$, $n = 9$, $P < 0.001$; 95% CI = 0.29-0.40) existed. Results of the funnel plot analysis indicated that a publication bias exists toward positive results (Figure 3). A fail-safe N revealed that over 8,000 unpublished data points would need to be present to alter the significant results of the present analysis.

## Discussion

### *Actual Knowledge*

Results indicate that CE has a positive influence on actual clinician knowledge. It has been suggested that CE improves physician knowledge, performance and patient outcomes.[1] The correlation suggests that CE improves clinicians' actual knowledge, although weakly correlated. Actual knowledge refers to the possession of information the learner comprehends and uses to make decisions.[9] Perceived knowledge is the perception of knowing that the learner has or one's self-assessment.[9] The relationship between perceived and actual knowledge, known as knowledge gap,[10] is often poor and can be hazardous to patients.[8] To maintain public safety and optimal care, clinicians awareness of knowledge gap and amelioration through CE is important.[3]

Individuals often over estimate their own actual knowledge creating a barrier to acquire new knowledge.[34] Maintaining CE requirements is achieved by attending CE opportunities[2-7] which is intended to aid clinicians acquire new knowledge after the formal completion of their

training.[12] Practitioners may not self-select or acquire appropriate CE to complete their knowledge gap.[10] However, once clinicians are confronted with a knowledge gap, they are likely to re-evaluate their perception on knowing.[35-38] Providers usually choose topics for which they are familiar; however clinicians need to attend courses to augment areas of less acuity.

*Types of Interventions*

Although we did not evaluate different modes of instruction, previous literature suggests active learning is most effective. CE is delivered through different methods; active, passive and mixed methods.[39] A passive educational technique can be defined as any presentation or lecture that does not include any audience interaction. Active educational techniques can be defined as any workshops, conferences, role-play, group discussions, hands-on practice, seminars and, symposia that include audience interaction. Mixed methods technique is described as any combination of active and passive techniques. The data included in our study utilized one or more of these various methods. Five studies used mixed methods such as lectures and breakout sessions, two studies employed an active method such as workshops, and two exercised a passive method such as lecture.

Seven of the nine studies examined the positive effect CE had on actual clinician knowledge with each of the various methods. Bell et al.[40] and Markert et al.[41] found no effect that CE had on actual knowledge; the CE intervention that the participants attended did not increase their actual knowledge post-conference. Bell et al.[40] used mixed methods to present the intervention and Markert et al.[41] employed a passive method for the intervention. Previous research suggests that passive sessions do not influence change in actual clinician knowledge.[39]

However, mixed methods promoted a positive effect of CE on actual clinician knowledge.[1] Further research needs to be completed to determine the best organization and delivery of CE for maximal learning. The literature inconsistency necessitates further examination of CE delivery mode.

*Publication Bias*

According to our analysis, the current state of the literature favors significant results over non-significant results, resulting in a publication bias. In the context of the present study, results demonstrating a significant positive effect of CE on actual clinician knowledge are published more often than non-significant results. While the aim of the current study was not to identify bias, future CE related publications may increase practitioner knowledge benefits by disseminating negative and non-significant results in addition to "positive" results. The medical community may inappropriately conclude that CE improves clinician knowledge without a full complement of completed research. While this finding was the result of our study, overreaching of the results should be tempered. More research focus should be conducted in the area of CE and effects on clinician knowledge.

*Limitations*

Our sample may not be representative of all health care professions due to limitations in the literature. Evidence has only been reported within physicians, nurses and occupational therapists. Although CE requirement differ between professions, CE delivery may affect actual knowledge rather than the CE mandates. This was a limitation because we could not gain insight about CE throughout other health professions or within the educational methods. Publication bias

is also an issue due to the literature. Assessing the overall effect of CE has on actual clinician knowledge may be misleading until additional high quality research is published.

## Conclusion

This study demonstrates that continuing education increases actual clinician knowledge. Positive results can be realized utilizing current CE opportunities. Analysis of the literature states that articles measuring the relationship between CE and actual clinician knowledge are limited across professions. Future research examining CE across the different health professions is needed to better assess actual knowledge outcomes. Future research should focus on analyzing the delivery methods of CE among professions.

## Funding

This study was funded by the Indiana State University College of Graduate School and Professional Studies.

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## APPENDIX A: REQUIREMENTS

Table 1 CE Requirements.

| **Profession** | **Requirement** | **Regulatory Board** |
|---|---|---|
| Athletic Training | 50 CEU's in 2 years | BOCATC |
| Nursing | 150 CE in 5 years or recertification exam | ANCC |
| Physician | Varies | State of Licensure |
| Physician Assistant | 100 CE in 2 years | NCCPA |
| Physical Therapist | Varies | State of Licensure |
| Occupational Therapist | Varies | State of Licensure |

Legend: Board of Certification for Athletic Trainers (BOCATC), American Nurses Credentialing Center (ANCC), National Commission on Certification of Physician Assistants (NCCPA)

## APPENDIX B: RAW DATA

Table 2 Raw Data of Included Articles (Actual Knowledge).

| **Study** | **Sample Size** | **Mean** | **Lower Limit** | **Upper Limit** | **Intervention** |
|---|---|---|---|---|---|
| Bell et al. | n = 119 | 0.247 | 0.192 | 0.302 | Mixed |
| Bell et al. | n = 119 | 0.026 | -0.031 | 0.083 | Mixed |
| Bell et al. | n = 119 | 0.207 | 0.151 | 0.262 | Mixed |
| Bell et al. | n = 119 | 0.047 | -0.009 | 0.102 | Mixed |
| Bell et al. | n = 119 | 0.267 | 0.212 | 0.321 | Mixed |
| Bell et al. | n = 119 | 0.082 | 0.025 | 0.138 | Mixed |
| Bell et al. | n = 119 | 0.175 | 0.119 | 0.231 | Mixed |
| Bell et al. | n = 119 | 0.135 | 0.078 | 0.191 | Mixed |
| Bell et al. | n = 119 | 0.037 | -0.020 | 0.094 | Mixed |
| Bell et al. | n = 119 | 0.117 | 0.060 | 0.173 | Mixed |
| Bell et al. | n = 119 | 0.273 | 0.218 | 0.327 | Mixed |
| Butler et al. | n = 15 | 0.432 | 0.232 | 0.597 | Active |
| Butler et al. | n = 15 | 0.443 | 0.280 | 0.581 | Active |

| Study | Sample Size | Mean | Lower Limit | Upper Limit | Intervention |
|---|---|---|---|---|---|
| Butler et al. | n = 15 | 0.524 | 0.259 | 0.716 | Active |
| Butler et al. | n = 15 | 0.524 | 0.259 | 0.716 | Active |
| Butler et al. | n = 15 | 0.443 | 0.280 | 0.581 | Active |
| Butler et al. | n = 15 | 0.497 | 0.348 | 0.622 | Active |
| Butler et al. | n = 15 | 0.406 | 0.309 | 0.494 | Active |
| Butler et al. | n = 15 | 0.467 | 0.369 | 0.554 | Active |
| Cheng et al. | n = 69 | 0.217 | 0.028 | 0.391 | Passive |
| Cheng et al. | n = 69 | 0.373 | 0.241 | 0.492 | Passive |
| Doucet et al. | n = 34 | 0.647 | 0.567 | 0.715 | Mixed |
| Doucet et al. | n = 29 | 0.632 | 0.543 | 0.707 | Mixed |
| Gerstein et al. | n = 290 | 0.120 | 0.006 | 0.231 | Active |
| Hergenroeder et al. | n = 75 | 0.269 | 0.076 | 0.477 | Mixed |
| Hergenroeder et al. | n = 75 | 0.489 | 0.312 | 0.633 | Mixed |
| Hergenroeder et al. | n = 75 | 0.436 | 0.247 | 0.593 | Mixed |
| Hergenroeder et al. | n = 75 | 0.431 | 0.241 | 0.590 | Mixed |
| Hergenroeder et al. | n = 75 | 0.406 | 0.211 | 0.570 | Mixed |
| Lyons et al. | n = 33 | 0.455 | 0.257 | 0.616 | Mixed |
| McCluskey et al. | n = 106 | 0.360 | 0.272 | 0.442 | Mixed |

| Study | Sample Size | Mean | Lower Limit | Upper Limit | Intervention |
|---|---|---|---|---|---|
| Markert et al. | n = 325 | 0.239 | -0.065 | 0.503 | Passive |
| Markert et al. | n = 325 | -0.113 | -0.295 | 0.077 | Passive |
| Markert et al. | n = 325 | 0.498 | 0.286 | 0.663 | Passive |
| Markert et al. | n = 325 | 0.561 | 0.367 | 0.709 | Passive |
| Markert et al. | n = 325 | -0.102 | -0.337 | 0.145 | Passive |
| Markert et al. | n = 325 | 0.586 | 0.390 | 0.732 | Passive |
| Markert et al. | n = 325 | 0.539 | 0.436 | 0.628 | Passive |
| Markert et al. | n = 325 | 0.731 | 0.605 | 0.822 | Passive |
| Markert et al. | n = 325 | 0.631 | 0.495 | 0.736 | Passive |

# APPENDIX C: STATISTICAL ANALYSIS

Figure 1. Data Collection Procedures

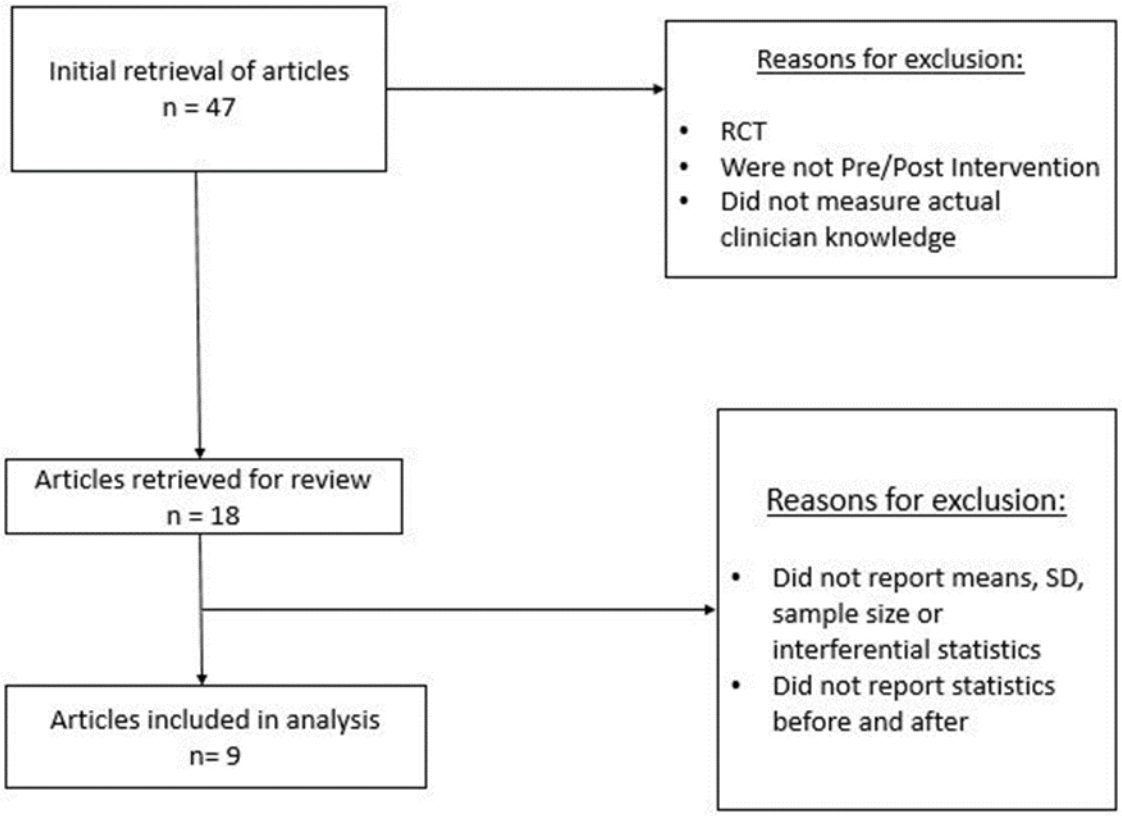

Figure 2. Forest Plot

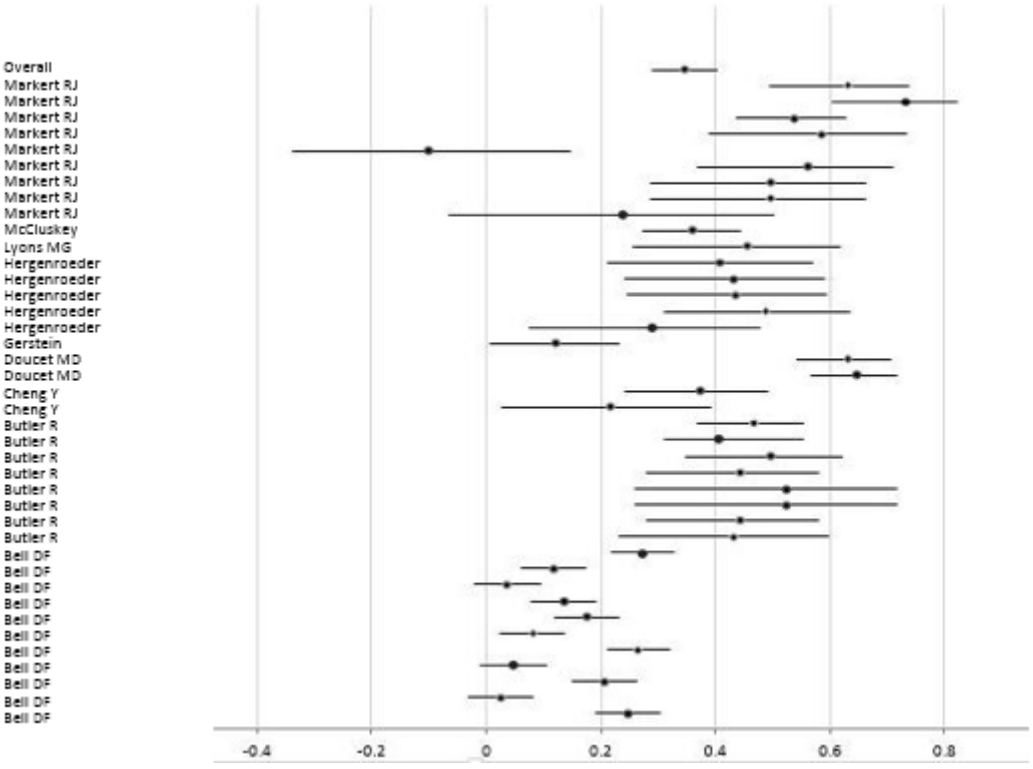

Figure 3. Funnel Plot