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Meta-analysis
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Effects of Knowledge and Training on the Readiness of Electronic Medical Record Use in Health Workers: Meta-Analysis

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ABSTRACT

Background: Globally, more than half of electronic medical record (EMR) projects face the potential problem that only 35% of lower-middle-income countries and 15% of low-income countries have implemented national electronic health record systems. This study aims to estimate the effect of training and knowledge on health workers' readiness to use EMR.
Subjects and Method: This was a systematic review and meta-analysis using the PRISMA flow diagram and PICO model. Population: health workers. Intervention: EMR training and good knowledge. Comparison: no EMR training, poor knowledge. Outcome: readiness to use EMR in health workers. The databases used were Google Scholar, Pubmed, ScienceDirect, Taylor & Francis, Springer Link, Plos One, and BioMed Central, with the keywords ("Willingness" OR "Readiness" OR "Utilization" AND "Electronic Medical Records" OR "EMR" AND "Training" OR "EMR Training" AND "Knowledge" AND 46 "Health Professionals" AND "Cross Sectional" AND "Adjusted Odds Ratio" OR "AOR"). There were 9 cross-sectional studies published in 2015-2023 that met the inclusion criteria. Data analysis using RevMan 5.4.
Results: Meta-analysis of 9 of cross-sectional studys from Ethiopia consisted of of 3,996 health workers. EMR training (aOR= 2.62; 95% CI= 2.01 to 3.42; p= 0.001) and good knowledge (aOR= 1.83; 95% CI= 1.50 to 2.24; p= 0.001) significantly increased the readiness of health workers to use EMR.
Conclusion: EMR training and good knowledge significantly increase the readiness of health workers to use EMR.

Keywords: electronic medical record, readiness, health workers

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BACKGROUND

Throughout the world, health information systems and technologies are increasingly used and viewed as a useful approach to improving the effectiveness of healthcare systems and standards of patient care. Healthcare organizations use HIS such as electronic medical records (RME), telehealth, mobile health, and health information management systems to achieve these

outcomes. The national e-health approach tool developed through the World Health Organization (WHO) and the International Telecommunication Union (ITU) defines EMR as "a computerized medical record used to capture, store, and share information among health care providers within an organization, supporting services health to patients" (Senishaw et al., 2023).

The use of information technology in the health sector has been used quite widely, starting from health planning to providing various health data at both individual and community levels. The role of information technology in health can increase the ease and speed of input, process and output so that the information produced is faster, more complete and accurate (Ningsih et al., 2022). There are many benefits obtained from using electronic medical records which are useful for improving the quality of health services (Asih and Indrayadi, 2023).

Globally, more than a few EMR projects face potential problems. Especially in low- and middle-income countries, adoption of EMR systems is much lower than expected. Evidence shows that only 35% of lower middle-income countries and 15% of low-income countries have implemented national electronic health record systems. One factor contributing to low rates of EMR system implementation is that implementers in low- and middle-income countries fail to properly assess organizational and staff readiness for implementation and use of EMR systems. Before implementing an EMR, it is important to understand the managerial readiness and literacy of the medical digital community. This is because when implementers are aware of the problem, everyone can work together to keep the implementation running (Yilma et al., 2023). Additionally, a large number of medical errors worldwide are caused by weak functioning of EMR programs and data systems and the willingness of healthcare professionals to use EMRs (Berihun, 2020).

EMR utilization can be influenced by various factors. A variety of complex factors determine the adoption and use of EMRs by healthcare professionals even when EMRs are in place and functioning. Attitude and awareness level of health professionals, lack of proper management, lack of resources, skill-related issues, user resistance, policy-related issues, low staff commitment, and poor maintenance services are other reasons why limited implementation and use of EMR systems in countries developing (Oumer et al., 2021).

Research identifies several reasons for the need to implement EMR in hospitals. EMR systems will help achieve improved patient care in terms of safety, efficiency, and quality. It has been noted that adopting and implementing an EMR can facilitate access to patient information, reduce errors, improve quality of care, improve documentation, save time, and increase receipt and acceptability of laboratory tests and diagnostic images. On the other hand, EMR systems facilitate appointment management, scheduling, registration, admission, discharge, and transfer of patients (Bisrat et al., 2021).

Implementing electronic medical record can provide great benefits. advantages and benefits for basic health service facilities and referral health facilities. Patients will also experience significant benefits due to efficiency in the health service process (Sinaga et al., 2023). This study aims to analyze previous primary studies in assessing the influence of electronic medical record training and level of knowledge on health workers' readiness to use electronic medical records.

SUBJECTS AND METHOD

This was a systematic review and meta-analysis using. Article searches used Google Scholar, Pubmed, ScienceDirect, Taylor &

Francis, Springer Link, Plos One, and BioMed Central databases. The keywords used in this research are "Willingness" OR "Readiness" OR "Utilization" AND "Electronic Medical Records" OR "EMR" AND "Training" AND "EMR Training" AND "Knowledge" AND "Health Professionals" AND "Cross Sectional" AND "Adjusted Odds Ratio" OR "AOR".

1. Steps of Meta-Analysis

Meta-analysis analysis was carried out through 5 steps as follows:

1) Formulate PICO format research questions (Population, Intervention, Comparison, Outcome).
2) Search for primary study articles from various electronic and non-electronic databases such as PubMed, ScienceDirect, Google Scholar, Science Direct, Springer Link and so on.
3) Conduct screening to determine inclusion and exclusion criteria and carry out critical assessments.
4) Extract data from primary studies and synthesize effect estimates using the RevMan 5.4 application.
5) Interpret the results and draw conclusions.

2. Inclusion Criteria

Full-text paper research article with Cross-Sectional study design, analysis using multivariate with adjusted Odds Ratio (aOR), research subjects health workers, intervention providing RME training and level of knowledge, research outcomes are willingness, readiness, utilization of health workers in using records electronic medical.

3. Exclusion Criteria

Articles published before 2015, articles published in languages other than English, outcome measures in research are incomplete or do not describe the results clearly.

4. Operational Definition

RME training is providing the concept, implementation and governance of electronic medical record management in primary to tertiary health services to health workers, to improve services in the field of medical records.

Knowledge Level is the knowledge that health workers have regarding electronic medical records.

Health Worker Readiness is the condition of health workers to respond to and practice the use of electronic medical records.

5. Istrument

The quality assessment of the main article in this research used the Primary Study Quality Assessment for Analytical Cross-Sectional Study Design for Meta-Analytical Research which was sourced from the Public Health Masters Program at the Graduate School of Sebelas Maret University.

6. Data Analysis

The articles in this research were collected using PRISMA diagrams and analyzed using the Review Manager 5.4 (RevMan5.4) application by calculating effect size and heterogeneity (I^2) to determine the combined research model and form the final results of the meta-analysis research. The results of data analysis are presented in the form of forest plots and funnel plots.

RESULTS

The search process for primary articles related to the influence of electronic medical record training and level of knowledge on readiness to use electronic medical records among health workers in this meta-analysis research was carried out in several databases and the results obtained were 9 articles (Figure 1). The total number of articles in the initial search process was 83,900 articles. After carrying out the process of deleting published articles, researchers found 2,040 articles, of which 70 articles met the full text review requirements. Next, 9 articles that met the quality assessment were included in a quantitative synthesis using meta-analysis.

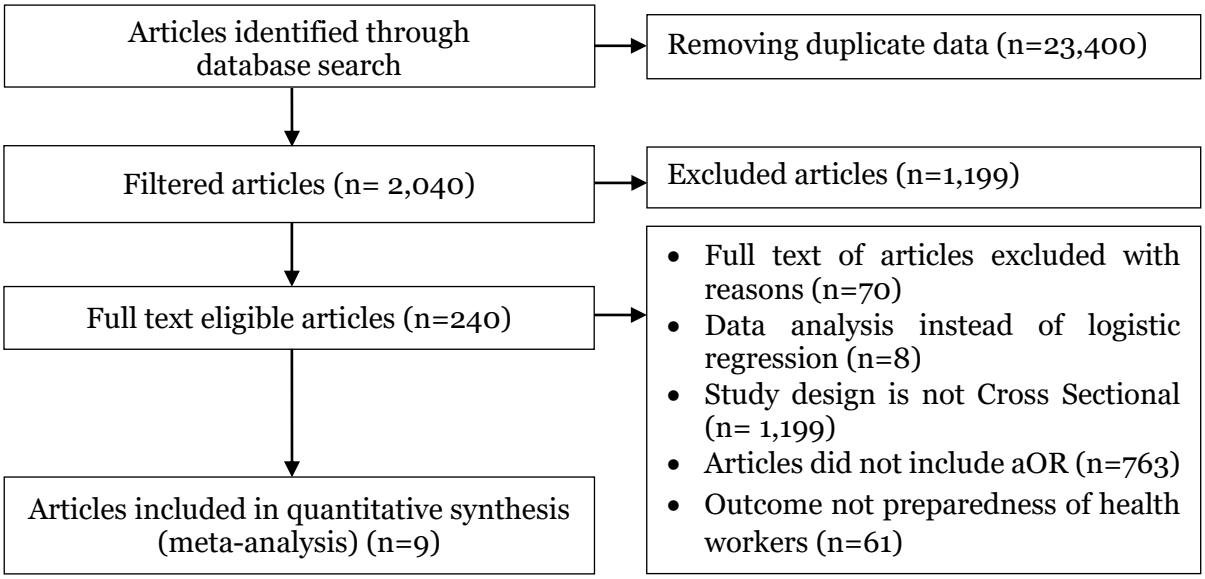

Figure 1. PRISMA Flow Diagram of the influence of electronic medical record training and level of knowledge on health workers' readiness to use electronic medical records

Figure 2. Map of the research area on the influence of electronic medical record training and level of knowledge on readiness to use electronic medical records among health workers

Figure 2 shows the regional distribution of the 9 primary articles used in this research, namely from the African continent. There are 9 research articles originating from the African continent.

Table 1. Results of critical appraisal (critical appraisal) of the quality of analytical cross-sectional studies of the influence of electronic medical record training and level of knowledge on readiness to use electronic medical records among health workers)

Author (Years)	Question Criteria													Total
	1a	1b	1c	1d	2a	2b	3a	3b	4	5	6a	6b	7	
Oumer *et al.* (2021)	2	2	2	1	2	2	2	2	2	2	2	2	2	25
Yilma *et al.* (2023)	2	2	2	2	2	2	2	2	2	2	2	2	2	26
Senishaw *et al.* (2023)	2	2	2	2	2	2	2	2	2	2	2	2	2	26
Yehualashet *et al.* (2015)	2	2	2	1	1	2	2	2	2	2	2	2	2	24
Awol *et al.* (2022)	2	2	2	2	1	2	2	2	2	2	2	2	2	25
Berihun *et al.* (2020)	2	2	2	2	2	2	2	2	2	2	2	2	2	26
Keleb *et al.* (2023)	2	2	2	1	2	2	2	2	2	2	2	2	2	25
Ngusie *et al.* (2022)	2	2	2	2	2	2	2	2	2	2	2	2	2	26
Hailegebreal *et al.* (2023)	2	2	2	2	2	2	2	2	2	2	2	2	2	26

Description of the answer score:

1 = Yes

0 = No

Question criteria descriptions:

1. Formulation of research questions in the acronym PICO

a. Is the population in the primary study the same as the population in the PICO meta-analysis?

b. Is the operational definition of intervention, the exposed status in the primary study, the same as the definition intended in the meta-analysis?

c. Is the comparison, namely the unexposed status used by the primary study, the same as the definition intended in the meta-analysis?

d. Are the outcome variables examined in the primary studies the same as the definitions intended in the meta-analysis?

2. Methods for selecting research subjects

a. In analytical cross-sectional studies, do researchers choose samples from the population randomly?

b. As an alternative, if in a cross-sectional analytical study the sample is not selected randomly, does the researcher select the sample based on outcome status or based on intervention status?.

3. Methods for measuring exposure (intervention) and outcome

a. Are the exposure and outcome variables measured with the same instruments (measuring tools) in all primary studies?

b. If the variable is measured on a categorical scale, are the cutoffs or categories used the same across primary studies?

4. Design-related bias

If the sample was not selected randomly, has the researcher made efforts to prevent bias in selecting research subjects? For example, selecting subjects based on outcome status is not affected by exposure status (intervention), or selecting subjects based on exposure status (intervention) is not affected by outcome status.

5. Methods for controlling confusion

Whether the primary study investigators have made efforts to control the influence of confounding (for example, conducting a multivariate analysis to control for the influence of a number of confounding factors).

6. Statistical analysis methods

a. Did the researcher analyze the data in this primary study with a multivariate analysis model (for example, multiple linear regression analysis, multiple logistic regression analysis)

b. Does the primary study report effect sizes or relationships resulting from multivariate analysis (e.g., adjusted OR, adjusted regression coefficient)

7. Conflict of interest

Is there no possibility of a conflict of interest with the research sponsor, which could cause bias in concluding the research results?.

Assessment instructions

1. Total number of questions = 13 questions.
2. Answer "Yes" to each question gives a score of "2". The answer "Undecided" gives a score of "1". The answer "No" gives a score of "0".
3. Maximum total score= 13 questions x 2= 26
4. Minimum total score = 13 questions x 0= 0. So the range of total scores for a primary study is between 0 and 26.
5. If the total score of a primary study is ≥22, then the study can be included in the meta-analysis. If the total score of a primary study was <22, then the study was excluded from the meta-analysis

Table 2 Primary studies of electronic medical record training included in the meta-analysis (n=3,161)

Author (Year)	Country	Sample	Population	Inter-vention	Comparison	Outcome
Senishaw *et al.* (2017)	Ethiopia	406	Health Expert (Medical records officer)	Get EMR Training	Didn't Get EMR Training	Readiness to Use EMR
Yehualashet *et al.* (2015)	Ethiopia	501	Health Expert (Medical records officer)	Get EMR Training	Didn't Get EMR Training	Readiness to Use EMR
Awol *et al.* (2022)	Ethiopia	414	Health Expert (Medical records officer)	Get EMR Training	Didn't Get EMR Training	Readiness to Use EMR
Berihun *et al.* (2020)	Ethiopia	634	Health Expert (Medical records officer)	Get EMR Training	Didn't Get EMR Training	Readiness to Use EMR
Keleb *et al.* (2023)	Ethiopia	367	Health Expert (Medical records officer)	Get EMR Training	Didn't Get EMR Training	Readiness to Use EMR
Ngusie *et al.* (2022)	Ethiopia	423	Health Expert (Medical records officer)	Get EMR Training	Didn't Get EMR Training	Readiness to Use EMR
Hailegebreal *et al.* (2023)	Ethiopia	416	Health Expert (Medical records officer)	Get EMR Training	Didn't Get EMR Training	Readiness to Use EMR

Table 1 shows the results of the critical appraisal of primary research used for this research. Primary research quality assessment in this study was carried out using Primary Research Quality Assessment for analytical cross-sectional research design in meta-analysis research using a checklist sourced from the Master of Public Health Science Study Program, Postgraduate School, Universitas Sebelas Maret (Munawaroh & Murti, 2023).

Based on the assessment of research quality, the lowest total score was 24 and the highest score was 26, and all articles had a total score of more than 22, which shows that each study has good quality so it is suitable to be included in the meta analysis.

Table 2 presents a description of 7 cross-sectional observational articles as a source of meta-analysis of the effect of electronic medical record training on health workers' readiness to use electronic medical records.

Based on Table 2, a description of primary research regarding electronic medical record training on readiness to use electronic medical records among health workers, a meta-analysis of 7 articles was carried out. The research location is in Ethiopia. In this study, similarities were found, namely a cross-sectional research design, the research subjects were health workers/health experts, the intervention provided was electronic medical record training compared to not having electronic medical record training. In this study, there were differences in the number of samples used, namely the smallest was 367 and the largest sample was 634. The total number of samples included in the meta-analysis of the effect of electronic medical record training on readiness to use electronic medical records among health workers was 3,161 health experts

Table 3. Data on adjusted odds ratio (aOR) and 95% confidence interval (CI 95%) on the effect of workload on job satisfaction in health workers (n=8.455)

Author (Year)	aOR	95% CI	
		Lower Limit	Upper Limit
Senishaw *et al.,* (2023)	3.29	1.35	8.00
Yehualashet et al (2015)	2.14	1.32	3.26
Awo *et al.*, (2022)	3.63	1.69	7.82
Berihun *et al.*, (2020)	3.75	1.73	8.12
Keleb *et al.,* (2023)	3.23	1.57	6.63
Ngusie *et al.,* (2022)	1.92	0.61	6.01
Hailegebreal *et al.*, (2023)	1.98	1.06	
Tongtong *et al.*, (2017)	0.51	0.39	0.68

Table 3 lists the statistical summary results of effect estimates with the highest aOR value, namely 3.75 and the lowest aOR value, namely 1.92. The 95% CI with the largest range is 1.73 to 8.12, while the smallest range is 0.61 to 6.01.

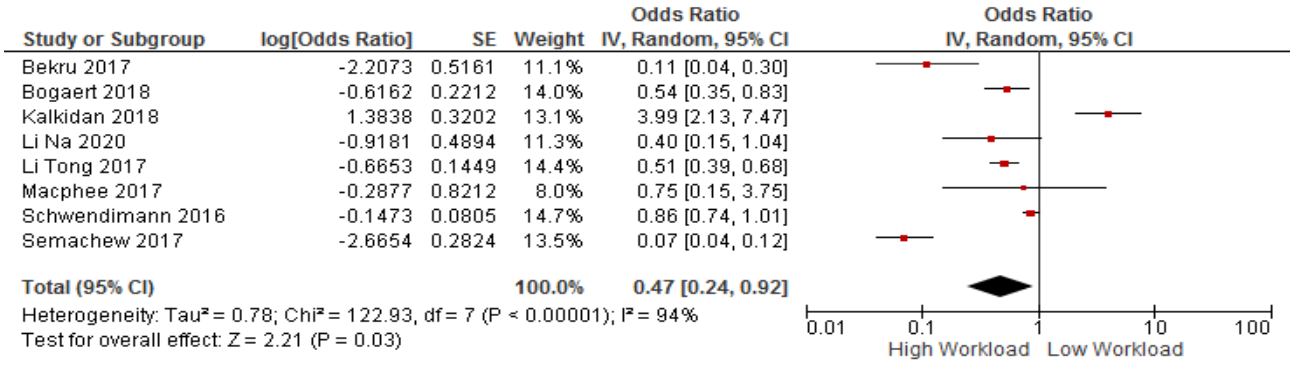

Figure 3. Forest plot of the effect of of workload on job satisfaction in health workers

a. Forest plot

Forest Plot Figure 3 shows that RME training increases the readiness to use electronic medical records among health workers. Health workers who received RME training were 2.62 times more prepared to use electronic medical records compared to health workers who did not receive EMR training, and this result was statistically significant (aOR= 2.62; 95% CI= 2.01 to 3.42; p= 0.001). Effect estimates between studies showed low heterogeneity (I^2= 0%; p= 0.70), with calculation of the average effect estimate using the Fixed Effect Model (FEM) approach.

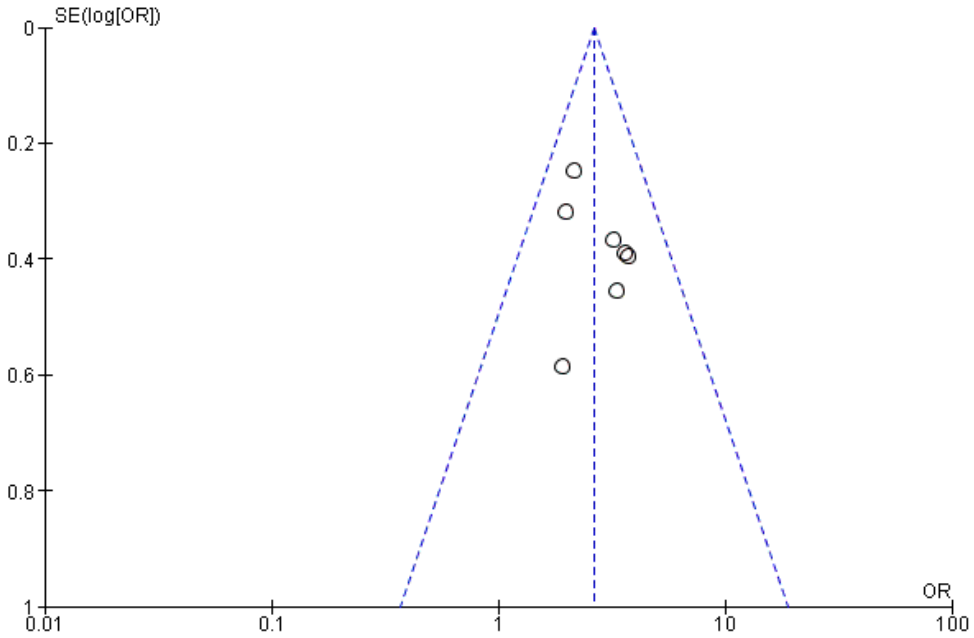

Figure 4. Funnel plot of the effect of workload on job satisfaction in health workers

b. Funnel plot

The funnel plot in Figure 4 shows that the distribution of effect estimates lies more to the right than to the left of the average vertical line for primary studies with small samples, thus indicating that there is publication bias. Because the distribution is more to the right of the vertical line of the average estimated effect which is also the same as the location of the diamond shape in the forest plot which is also located to the right, the publication bias tends to exaggerate the true effect (overestimate).

Table 4. PICO summary of cross-sectional studies level of knowledge included in the meta-analysis (n= 3,128)

Author (Year)	Country	Sample	Population	Intervention	Comparison	Outcome
Oumer *et al.* (2021)	Ethiopia	412	Health Expert (Medical records officer)	Good Knowledge Level	Poor Knowledge Level	Readiness to Use EMR
Yilma *et al.* (2023)	Ethiopia	423	Health Expert (Medical records officer)	Good Knowledge Level	Poor Knowledge Level	Readiness to Use EMR

Author (Year)	Country	Sample	Population	Inter-vention	Compa-rison	Out-come
Senishaw *et al.* (2023)	Ethiopia	406	Health Expert (Medical records officer)	Good Knowledge Level	Poor Knowledge Level	Readiness to Use EMR
Awol *et al.* (2022)	Ethiopia	414	Health Expert (Medical records officer)	Good Knowledge Level	Poor Knowledge Level	Readiness to Use EMR
Berihun *et al.* (2020)	Ethiopia	634	Health Expert (Medical records officer)	Good Knowledge Level	Poor Knowledge Level	Readiness to Use EMR
Ngusie *et al.* (2022)	Ethiopia	423	Health Expert (Medical records officer)	Good Knowledge Level	Poor Knowledge Level	Readiness to Use EMR
Hailegebreal *et al.* (2023)	Ethiopia	416	Health Expert (Medical records officer)	Good Knowledge Level	Poor Knowledge Level	Readiness to Use EMR

Based on Table 4, a description of primary research regarding the level of knowledge regarding readiness to use electronic medical records among health workers, a meta-analysis of 7 articles was carried out. The research location is in Ethiopia. In this study, similarities were found, namely a cross-sectional research design, the research subjects were health workers/health experts, the intervention provided was a good level of knowledge compared to a poor level of knowledge. In this study, there were differences in the number of samples used, namely the smallest was 406 and the largest sample was 634. The total number of samples included in the meta-analysis of the influence of knowledge level on readiness to use electronic medical records among health workers was 3,128 health experts.

Table 5. Data on adjusted odds ratio (aOR) and 95% confidence interval (95% CI) on the effect of knowledge on job satisfaction in health workers (n=4,497)

Author (Year)	aOR	CI 95%	
		Lower Limit	Upper Limit
Oumer et al., (2021)	1.52	0.92	2.51
Yilma *et al.*, (2022)	1.88	1.19	2.97
Sensihaw *et al.*, (2023)	1.85	1.00	3.40
Awol *et al.*, (2022)	2.64	1.62	4.29
Berihun *et al.*, (2020)	2.11	1.02	4.37
Ngusia *et al.*,(2022)	1.20	0.71	2.05
Hailegebreal *et al.*,(2023)	2.01	1.19	3.39

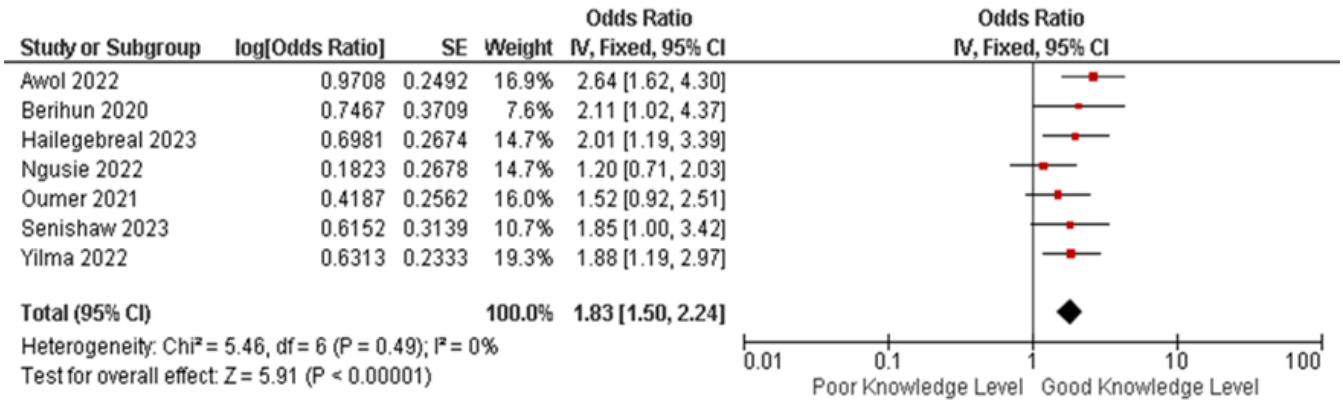

Figure 5. Forest plot of the influence of knowledge level on job satisfaction in health workers

c. Forest Plot

The forest plot in Figure 4 shows that health workers who have good knowledge can increase the readiness of health workers to use electronic medical records. Health workers who have good knowledge can increase readiness to use electronic medical records by 1.83 times compared to health workers who have poor knowledge, and this result is statistically significant (aOR= 1.83; 95% CI= 1.50 to 2.24; p= 0.001) . Effect estimates between studies showed low heterogeneity (I2 = 0%; p= 0.49), with calculation of the average effect estimate using the Fixed Effect Model (FEM) approach

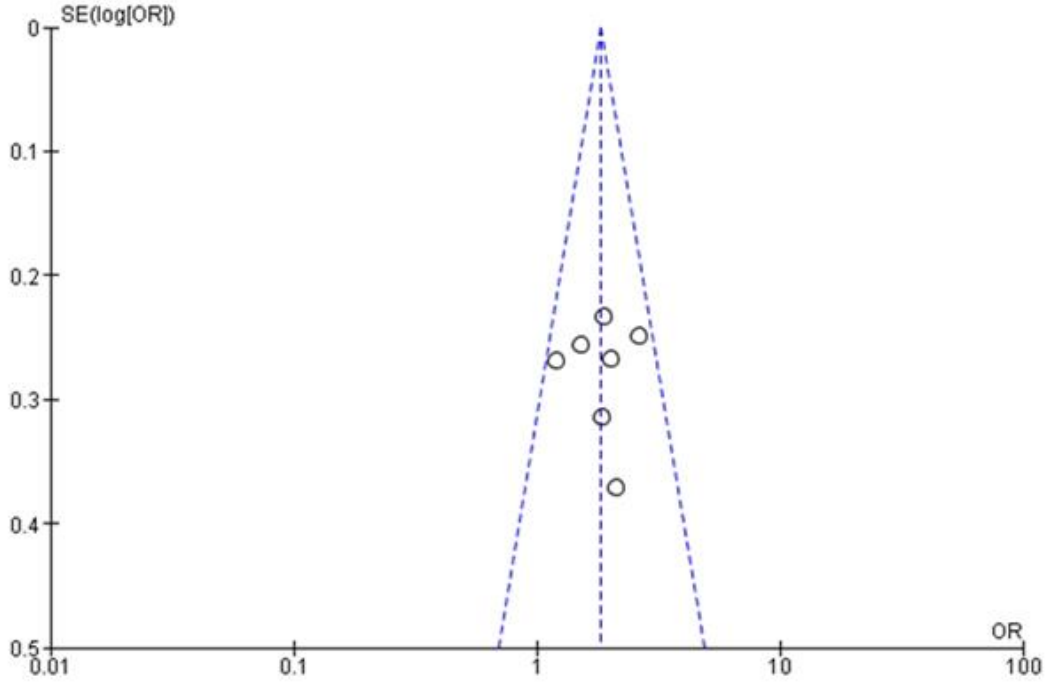

Figure 6. Funnel plot of the influence of knowledge on job satisfaction in health workers

d. Funnel plot

The funnel plot in Figure 5 shows that the distribution of effect estimates lies more to the side than to the left of the vertical line of the average for primary studies with small

samples, thus indicating that there is publication bias. Because the distribution is more to the right of the vertical line, the average estimated effect is also the same as the location of the diamond shape in the forest plot which is also located to the right, the publication bias tends to exaggerate the true effect (overestimate)

DISCUSSION

The Effect of Electronic Medical Record Training on Readiness to Use Electronic Medical Records among Health Workers

Health workers who underwent electronic medical record training were 2.62 times more prepared to use electronic medical records compared to health workers who did not undertake electronic medical record training, and this result was statistically significant (aOR= 2.62; 95% CI= 2.01 to 3.42; p= 0.001).

In general, determining the intention of health service providers in North-West Ethiopia referral hospitals to use electronic medical records is due to several factors, one of which is health workers' computer skills or computer literacy (Ahmed et al., 2019).

Research by Berihun et al. (2020) in Bahir Dar City, showed results that electronic medical record training for health workers could increase the use of electronic medical records by 3.8 times. Apart from that, the obstacle in Berihun's research was the lack of access for health workers to electronic medical record training (74.4%).

According to the research results of Sabran et al. (2023) through their survey results showed that as many as 14 hospitals in East Java, Indonesia expressed the belief that training would increase the likelihood of success of electronic medical records in hospitals. Another thing shown is that medical, paramedical and medical support personnel have a positive attitude towards various aspects related to the implementation of electronic medical records.

The research results of Ratnaningsih et al. (2023) at Dr. Hospital. Soetomo Indonesia shows that the success of implementing RME for hospital nutrition services is supported by the digital competence of Human Resources (HR) or staff who are RME users. This competency can be improved by providing regular training regarding the use of RME. The quality of RME such as the interface and features of RME must adapt to user needs in order to encourage increased utilization of RME in hospitals.

The Influence of Knowledge Level on Readiness to Use Electronic Medical Records among Health Workers

Health workers who have good knowledge are 1.83 times more ready to use electronic medical records compared to health workers who have poor knowledge, and this result is statistically significant (aOR= 1.83; 95% CI= 1.50 to 2.24; p= 0.001).

These results are in line with the research of Berihun et al. (2020) in Bahir Dar City which showed that there was a positive relationship between the level of knowledge about EMR of 2.1 times and willingness to use electronic medical records, and this study, as a result, identified that health professionals who had good knowledge of EMR systems were more likely to be willing to use electronic medical records. to use electronic medical record systems compared to those with poor knowledge. This may be due to the fact that well-informed healthcare professionals tend to accept the benefits of technology and are more willing to use EMR systems.

Research by Afolaranmi et al. (2020) at Jos University Teaching Hospital, Plateau State Nigeria showed that the level of good knowledge regarding EMR is relatively high with variations existing among categories of

health workers indicating the existence of a good knowledge base with regard to future implementation of EMR, with statistical value (OR=1.37; 95% CI=1.007–1.865; p=0.045).

Research shows that Walle et al. (2023) in Ethiopia showed that having good knowledge was 2.54 times a significant factor associated with readiness to use electronic medical record systems among healthcare professionals in Ethiopia.

Wubante et al.'s research (2023) in a teaching hospital in the Amhara region of northwest Ethiopia, showed that health workers who had a good understanding of the use of the EMR system tended to have good knowledge of the EMR compared to their colleagues. This may be because individual awareness of the benefits of new, innovative digital technology will increase the desire to use electronic personal health record technology.

AUTHOR CONTRIBUTION

Agus Syukron Ma'ruf as a researcher who selected topics, searched for and collected data. Hanung Prasetya and Bhisma Murti analyzed data and reviewed research documents.

CONFLICT OF INTEREST

There is no conflict of interest in this study.

FUNDING AND SPONSORSHIP

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