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Masters Program in Public Health, Universitas Sebelas Maret

Meta-Analysis

Effectiveness of Telehealth in Improving Quality of Life and Lowering Depression in Post-Stroke Patients: A Meta-Analysis

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ABSTRACT

Background: People who have a stroke are generally more likely to have difficulty managing daily activities such as walking, bathing, dressing, and participating in activities in the community and showing symptoms of depression that affects the quality of life. Telehealth is here to help people communicate with health workers without having to come directly to health facilities. The study aims to analyze how much effect telehealth has in improving the quality of life and reducing the risk of depression in post-stroke patients.
Subjects and Method: This was a meta-analysis study using PICO. Population: post-stroke patients. Intervention: telehealth. Comparison: no telehealth. Outcome: quality of Life and depression. This study used articles from several databases namely Pubmed, Google Scholar, Science Direct, and Cochrane Library using the keywords "Stroke" AND "telehealth" OR "Telerehabilitation" OR "Telemedicine" OR "Mobile health" OR "mHealth " OR "eHealth" AND "Quality of Life" OR "Health-Related Quality of Life" AND "Depression" AND "Randomized Controlled Trial" OR "RCT" to identify relevant studies. The articles included in the study were articles in English with RCT study design, published between 2012 and 2022. Steps in the systematic review were carried out based on guidelines from PRISMA flow diagram. Quantitative analysis was performed using Revman 5.3.
Results: 8 RCTs article from America, Asia, and Europe showed that post-stroke patients who obtained telehealth services on average had 0.87 units higher quality of life than those without telehealth (SMD=0.87; 95% CI =0.30 to 1.44; p=0.003). 8 RCTs article from America and Europe showed that post-stroke patients who obtained telehealth services on average had 0.44 units lower depression than those without telehealth (SMD= -0.44; 95% CI=-0.79 to -0.09; p= 0.010).
Conclusion: Telehealth can improve quality of life and lower the risk of depression in post-stroke patients.

Keywords: telehealth, post-stroke, quality of life, depression

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BACKGROUND

troke is a non-communicable disease and a common cause of disability in adults. Stroke is a disease of cerebral blood vessels, this occurs when the blood vessels of the brain are blocked or ruptured resulting in part of the brain not getting the blood supply that carries the necessary oxygen so that it experien-

ces cell/tissue death (Kemenkes RI, 2019). According to WHO non-communicable diseases collectively contributes 74% of deaths worldwide in 2019, stroke alone is the second leading cause of death after heart disease as well as the cause of disability in adults (Ajcevic et al., 2021). About 15 million people experience new or recurrent strokes worldwide and about two-thirds of stroke patients experience motor deficits, which is associated with reduced quality of life (Saposnik et al., 2016).

Based on the Basic Health Research in 2018, the prevalence of stroke in Indonesia increased compared to the results of basic health research in 2013, from (7%) to (10.9%). In general, patients stoke are more likely to have difficulty managing daily activities such as walking, bathing, dressing, and participating in community activities. A systematic review by Linder et al. (2015) reports that about a third of all people with stroke show signs of depressive symptoms.

Many people need post-stroke rehabilitation, this rehabilitation is usually provided by healthcare professionals in hospitals or clinics and other health facilities. Stroke patients really need medical rehabilitation interventions to regress patients to be able to self-care and carry out daily life activities without being a burden to their families (Setiawan and Barkah, 2022). In addition, stroke patients need rehabilitation to regain their functional independence after hospitalization (Asano et al., 2021). Therefore, it is necessary to develop an effective and cost-effective approach to strengthen the primary health care system in the management of non-communicable diseases, in this case, stroke. An approach using technology such as the phone or the internet to help people communicate with health workers without having to leave their homes is called telehealth, a more convenient and cheaper way to provide rehabilitation. Telehealth which includes telerehabilitation, is a method of providing care that improves access to healthcare services and can support and facilitate patient-centered care (Tenforde et al., 2017). Telehealth is the use of digital information and communication technology that allows the provision of health services to patients and individuals without clinical visits, through the use of online health services using internet access on computers or smartphones (Murti, 2022). The implementation of telehealth provides greater benefits in the long run and helps to deal with daily challenges in healthcare (Smith et al., 2020).

Based on the background description, it needs a comprehensive study of various primary studies on the effectiveness of telehealth in improving the quality of life and lowering the risk of post-stroke depression. The study aimed to analyze how much effect telehealth has in improving the quality of life and reducing the risk of depression in post-stroke patients by synthesizing the results of previous primary studies.

SUBJECTS AND METHOD

1. Study Design

The study was used a systematic review and meta-analysis method. The articles used were obtained from several electronic databases including PubMed, Google Scholar, Science Direct, and Cochrane Library with a Randomized Control Trial study design, published in the period 2012 to 2022. The keywords used in the search were "Stroke" AND "telehealth" OR "Telerehabilitation" OR "Telemedicine" OR "Mobile health" OR "m-Health" OR "eHealth" AND "Quality of Life" OR "Health-Related Quality of Life" AND "Depression" AND " Randomized Controlled Trial" OR "RCT". The articles were identified using a PRISMA flowchart.

2. Steps of Meta-Analysis

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

1) Defining research questions in the form of PICO (Population, Intervention, Comparison, Outcome).
2) Searching for primary study articles from various electronic databases such as Google Scholar and PubMed.
3) Conducting screening and Critical Appraisal of primary study articles.
4) Performing data extraction and synthesizing effect estimates into RevMan 5.3.
5) Interpreting and making conclusions

3. Inclusion Criteria

The inclusion criteria were a full-paper article using the randomized control trial study design, used mean SD, study subjects were post-stroke patients, the intervention given was the use of telehealth, and the outcomes were quality of life and depression.

4. Exclusion Criteria

The exclusion criteria in this study were articles published in a non-English language, published before 2012.

5. Operational Definition of Variables Vaccines

The independent variable was telehealth, the dependent variables were quality of life and depression.

Telehealth is an effective and efficient way to implement digital information and communication technology that allows the provision of health services to patients and individuals without the need for clinical visits, through the use of online health services with internet access on computers, tablets, (smart phones), video conference, electronic messages, or digital monitoring.

Quality of life is the level at which the individual can maximize his physical, psychological, vocational, and social life function in order to achieve a quality life.

Depression is an emotional state disorder that is generally characterized by a sense of sadness, apathy, pessimism, loneliness, and moodiness arising from an event

6. Study Instruments

The study used systematic study guidelines PRISMA flow diagram and Critical Appraisal Skills Program (CASP) for Randomized Controlled Trial Standard Checklist for the assessment of the study articles quality).

7. Data Analysis

Quantitative analysis in this study was carried out using the Review Manager (RevMan) 5.3 application. To determine the size of the relationship level and heterogeneity of the data the study used the results of forest plots and funnel plots.

RESULTS

The meta-analysis process began with determining research questions. The question in this study is whether telehealth is effective in improving the quality of life and lowering the risk of depression in post-stroke patients. Subsequently, PICO was formulated to be used as a reference for the search for relevant articles.

The article search was conducted through several electronic databases which included: Pubmed, Google Scholar, Science Direct, and Cochrane Library. 15 articles come from Canada, Taiwan, Austria, China, Spain, Turkey, the United States, California, Germany, the United Kingdom, and Italy. The article review process can be seen in the PRISMA flow diagram as follows

Figure 1. is the process of reviewing articles using PRISMA flow diagram. A total of 15 articles of study reviews related to the effectiveness of telehealth in improving quality of life and lowering the risk of post-stroke depression. In the initial search process, it obtained 625 articles, after the process of removing published articles, 616 articles were obtained with 39 of them eligible for full-text review, as for full-text articles there were some excluded due to the following:

1) The intervention from the RCT study was not telehealth but rather other interventions such as the partnership care model.

2) The population was not post-stroke patients but rather patients with hypertension and heart failure.
3) The article did not list mean values and standard deviations.
4) Outcomes did not match the PICO formulation such as the Wolf Motor Function Test (WMFT) and self-management

Articles that met the qualitative requirements were reviewed and only a total of 15 articles met the quantitative requirements and would be included in the meta-analysis synthesis.

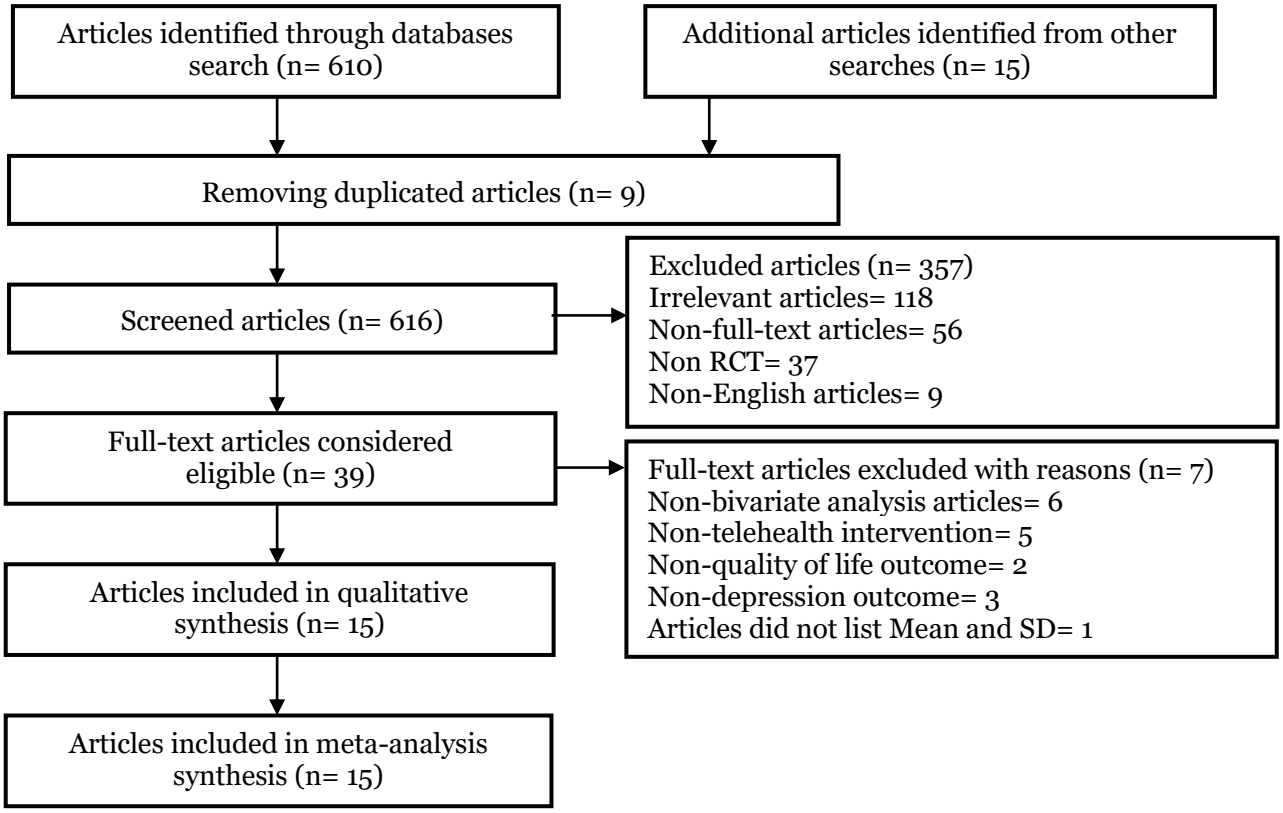

Figure 1. PRISMA Flowchart diagram

Figure 2. Map of study area of telehealth effectiveness in improving quality of life and lowering risk of post-stroke depression

Figure 2. shows the research location of the effectiveness of telehealth in improving the quality of life and lowering the risk of post-stroke depression consisted of America with 5 studies (2 studies from Canada, 2 studies from the United States, 1 study from California), Europe with 5 studies (1 study from Germany, 1 study from the UK, from Italy 1 study, 1 study from Austria, 1 study from Spain) and Asia with 5 studies (2 studies from China, 2 studies from Turkey and 1 study from Taiwan). Assessment of the quality of the study used the Critical Appraisal Skills Program (CASP) Randomized Controlled Trial Standard Checklist on research on the effectiveness of telehealth in improving quality of life in post-stroke patients (Table 1).

Table 1. Results of the quality assessment of the cohort randomized control trial of telehealth effectiveness in improving quality of life and lowering risk of post-stroke depression (n=1698)

Author (Year)	Question Criteria											
	1	2	3	4	5	6	7	8	9	10	11	Total
Rochette et al. (2013)	1	1	1	1	1	1	1	1	1	1	0	10
Kang et al. (2019)	1	1	1	1	1	1	1	1	1	1	1	11
Kotzian et al. (2019)	1	1	1	1	1	1	1	1	1	1	1	11
Wu et al. (2020)	1	1	1	1	1	1	1	1	1	1	1	11
Yan et al. (2021)	1	1	1	1	1	1	0	1	1	1	1	10
Henandez et al. (2021)	1	1	1	0	1	1	1	1	1	1	1	10
Ozen et al. (2021)	1	1	1	0	1	1	1	1	1	1	1	10
Kalav et al. (2022)	1	1	1	1	1	1	1	1	1	1	1	11
Smith et al. (2012)	1	1	1	1	1	1	1	1	1	1	1	11
Bishop et al. (2014)	1	1	1	1	1	1	0	1	1	1	1	10
Saal et al. (2015)	1	1	1	1	1	1	0	1	1	1	1	10
Rodgers et al. (2019)	1	1	1	1	1	1	1	1	1	1	1	11
Manuli et al. (2020)	1	1	1	1	1	1	0	1	1	1	1	10
Burdea et al. (2020)	1	1	1	1	1	1	0	1	1	1	1	10
Bannon et al. (2020)	1	1	1	0	1	1	1	1	1	1	1	10

Description of the question criteria:

1 = Does this study clearly answer the research question?
2 = Were the assignments of the participants for interventions randomized?
3 = Were all participants included in the study taken into account in the conclusions?
4 = Were people who analyzed the results and the researchers blinded toward the participants?
5 = Were the study groups similar at the beginning of the randomized controlled trial?
6 = Despite the experimental intervention, did each study group receive the same level of care (i.e., were they treated equally)?
7 = Are the effects of the intervention comprehensively reported?
8 = Are the accuracy of intervention estimates or treatment effects reported?
9 = Do the benefits of experimental intervention outweigh its disadvantages and costs?

10 = Can the results be applied to your local population or in your context?
11 = Will the experimental interventions provide greater value to the people in your care than any intervention that exists?

Answer score description:

0 = No
1 = Yes

Table 2. Summary of primary randomized control trial articles with each PICO of telehealth effectiveness in improving the quality of life in post-stroke patients (N=1,698)

Authors (Years)	Countries	Sample Size	P	I	C	O
Rochette et al. (2013)	Canada	186	Post Stroke	Multi-mode intervention (phone, internet) "We Call"	Conventional treatment	Quality of life
Kang et al. (2019)	Taipei, Taiwan	61	Post Stroke	Stroke health education mobile app	Traditional stroke health education	Quality of life
Kotzian et al. (2019)	Austria	23	Post Stroke	Positive airway pressure telemedical	Conventional treatment	Quality of life
Wu et al. (2020)	Jiangsu, China	61	Post Stroke	TC video conference Meeting v6.0	Conventional treatment	Quality of life
Yan et al. (2021)	Hebei, China	1,226	Post Stroke	Integrated System and technology enabled model of care	Conventional treatment	Quality of life
Henandez et al. (2021)	Reina, Spanyol	43	Post Stroke	Virtual reality based therapy	Conventional rehabilitation	Quality of life
Ozen et al. (2021)	Ankara, Turki	30	Post Stroke	computer game assisted task specific exercises	Conventional rehabilitation	Quality of life
Kalav et al. (2022)	Antalya, Turki	68	Post Stroke	Chronic care model dan telepon	Conventional treatment	Quality of life

Table 3. Mean SD study of telehealth effectiveness in improving the quality of life in post-stroke patients (N=1,698)

Authors (Years)	Intervention		Control	
	Mean	SD	Mean	SD
Rochette et al. (2013)	25.6	3.6	25.7	3.5
Kang et al. (2019)	0.62	0.29	0.46	0.41
Kotzian et al. (2019)	7.7	1.4	7.7	1.6
Wuet al. (2020)	190.57	5.09	175.9	5.78
Yan et al. (2021)	0.01	0.15	-0.03	0.14
Henandez et al. (2021)	86.5	7.1	57	4.7
Ozen et al. (2021)	175.66	31.41	161.6	32.98
Kalav et al. (2022)	0.44	0.67	0.54	0.79

Table 2. is a description of the primary study included in the meta-analysis, a total of 8 articles that was qualified to be used as meta-analyses on the effectiveness of telehealth in improving the quality of life in post-stroke patients with diverse study locations, i.e Canada, Taiwan, Austria, China, Spain, Turkey. The relationship sizes used in the meta-analysis study on the effectiveness of telehealth in improving quality of life in post-stroke patients were Mean and Standard Deviation (Table 3).

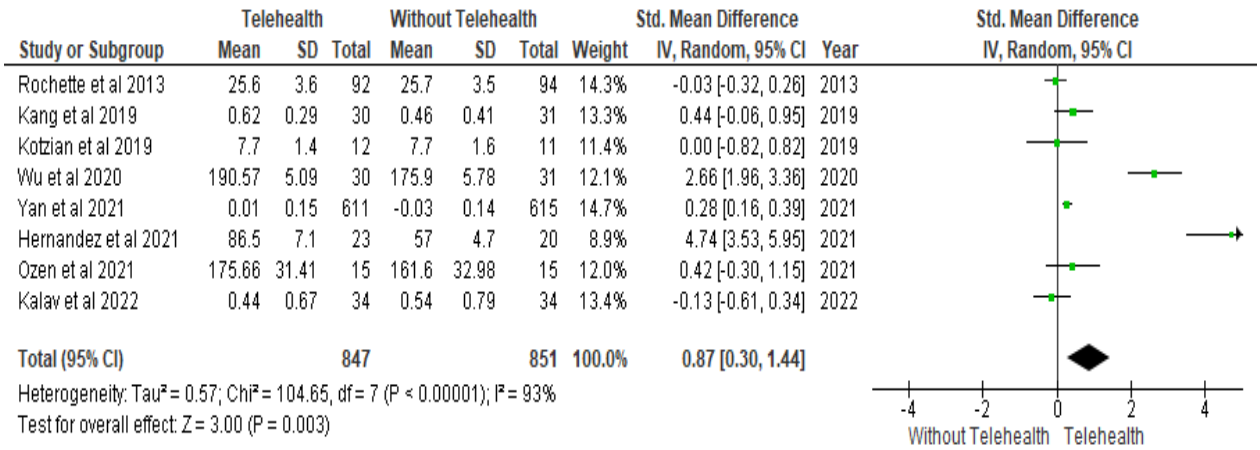

Figure 3. Forest plot meta-analysis of telehealth effectiveness in improving the quality of life in post-stroke patients

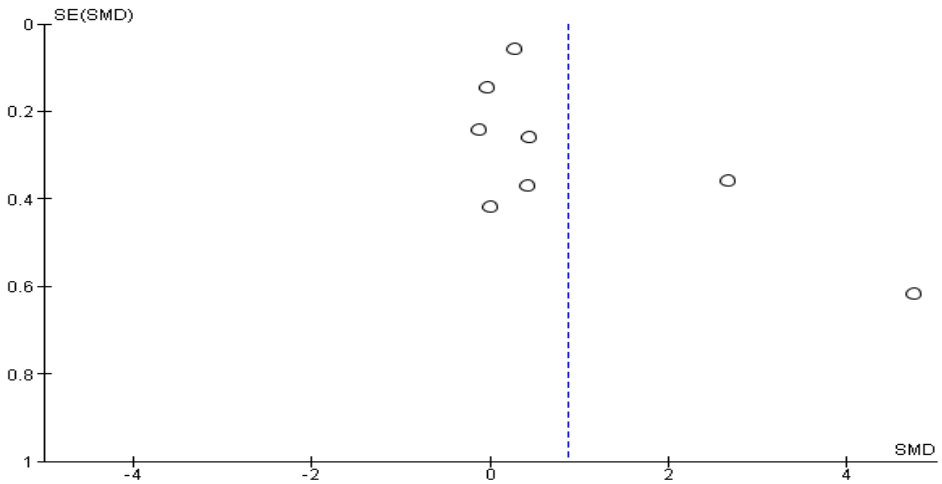

Figure 4. Funnel plot of meta-analysis of telehealth effectiveness in improving the quality of life in post-stroke patients

Based on the forest plot in Figure 3. Telehealth was effective in improving the quality of life of post-stroke patients and that effectiveness was statistically significant. Post-stroke patients who obtained telehealth services on average had a 0.87-unit higher quality of life than those who did not obtain telehealth (SMD=0.87; CI 95%=0.30 to 1.44; p=0.003). The forest plot also indicated very heterogeneous variations in telehealth effect

estimates across primary studies conducted by this meta-analysis (I2= 93%; p<0.001), thus the calculation of the average estimates used the Random Effect Model (REM) approach.

Funnel plot in Figure 4. does not indicate any publication bias in the distribution. The effect estimates of the small-sampled primary study were symmetrical at the right and left of the vertical line of the average estimates

Table 4. Summary of primary randomized control trial articles with each PICO of telehealth effectiveness in lowering the risk of depression in post-stroke patients (N=1,334)

Authors (Years)	Countries	Sample Size	P	I	C	O
Smith et al. (2012)	USA	32	Post-stroke	Web-based intervention	Conventional Treatment	Depression
Rochette et al. (2013)	Canada	186	Post-stroke	Multi-mode intervention (phone, internet) "We Call"	Conventional Treatment	Depression
Bishop et al. (2014)	California	49	Post-stroke	Family Intervention Telephone Tracking	Regular treatment	Depression
Saal et al. (2015)	Germany	230	Post-stroke	Telephone, home visit and training through online portal	Standard treatment	Depression
Rodgers et al. (2019)	UK	447	Post-stroke	Rehabilitation Service through telephone	Regular treatment	Depression
Manuli et al. (2020)	Messina, Italy	60	Post-stroke	Robotic Neuro rehabilitation using lokomat with virtual reality	Regular treatment	Depression
Burdea et al. (2020)	USA	16	Post-stroke	Bright Brainer and therapeutic game controller	Regular treatment	Depression
Bannon et al. (2020)	USA	14	Post-stroke	Recovery Together by phone	Regular treatment	Depression

Table 5. Mean SD study of telehealth effectiveness in lowering the risk of depression in post-stroke patients (N=1,334)

Authors (Years)	Intervention		Control	
	Mean	SD	Mean	SD
Smith et al. (2012)	14	2.1	17.9	1.9
Rochette et al. (2013)	6	8.3	7	9.1
Bishop et al. (2014)	0.69	3.5	-1.12	2.8
Saal et al. (2015)	3.2	3.2	3.6	3.9
Rodgers et al. (2019)	5.9	4.3	6.7	4.6
Manuli et al. (2020)	5.6	3.2	9.8	4.9
Burdea et al. (2020)	6.14	3.53	9.57	5.41
Bannon et al. (2020)	3	3.89	8.63	2.88

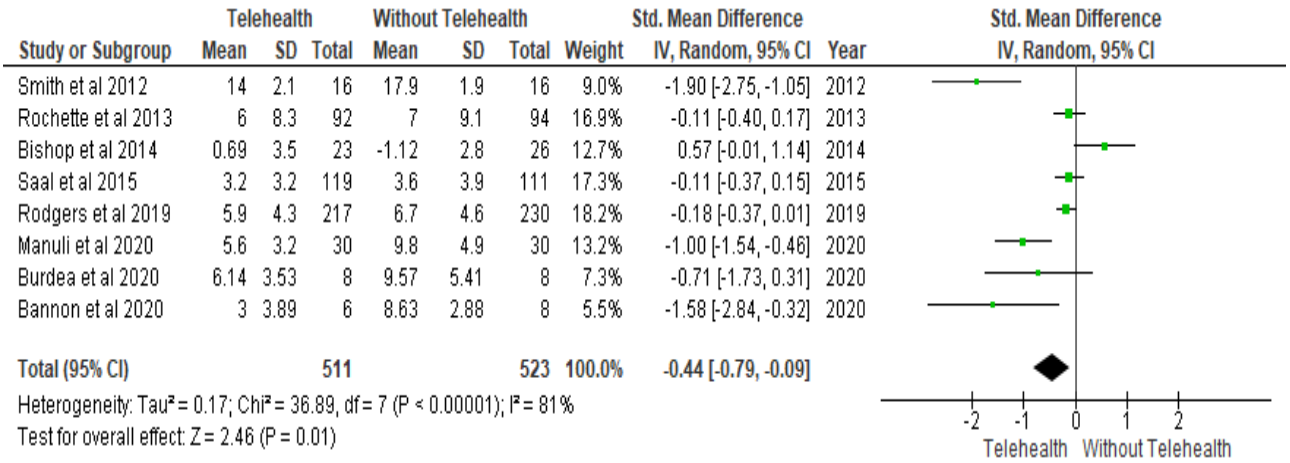

Figure 5. Forest plot of meta-analysis of telehealth effectiveness in lowering the risk of depression in post-stroke patients

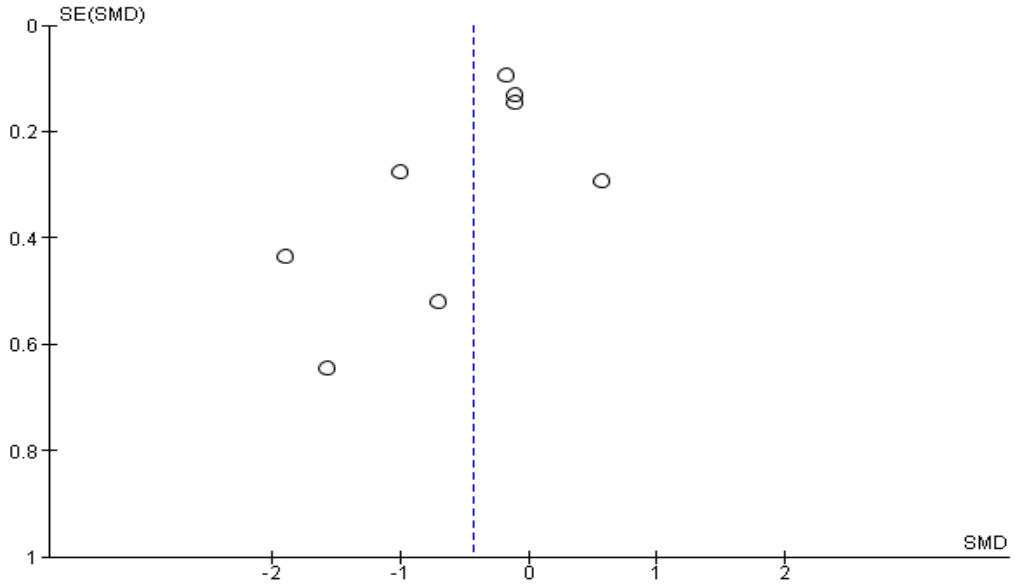

Figure 6. Funnel plot of meta-analysis of telehealth effectiveness in lowering the risk of depression in post-stroke patients

Based on Table 4. about the description of the primary study "The Effectiveness of Telehealth in Reducing the Risk of Post-Stroke Depression" a meta-analysis of 8 articles was conducted with diverse research locations, namely the United States, Canada, California, Germany, United Kingdom, and Italy. There were similarities in the primary studies, namely the research design using a Randomized Controlled Trial (RCT), the study subjects were post-stroke patients, interventions were administered via telehealth with a comparison without *telehealth* (regular treatment) with the duration of intervention was at least 3 months. However, there are differences in the number of samples, the smallest number was 6 and the largest sample was 230. The relationship size used

in the meta-analysis study on the effectiveness of telehealth in lowering the risk of depression in post-stroke patients are Mean and Standard Deviation (Table 5).

Based on the funnel plot in Figure 6. it shows a distribution of effect estimates more on the left than the right of the vertical line of the average effect estimate, indicating publication bias. Because the distribution of effect estimates in the funnel plot is more on the left of the average vertical line which was equal to the average location of the effect estimates on the forest plot which was also located on the left of the vertical line of hypothesis 0, thus the publication bias exaggerates the actual effect (over estimate).

DISCUSSION

Telerehabilitation (TR) through telehealth systems enables remote data exchange between patients and health workers for digital long-term health diagnosis and monitoring by utilizing information and communication technologies such as telephone, video conferencing, and electronic messaging. It bring health services closer so they do not need to come in person to health facilities.

1. The effectiveness of telehealth in improving the quality of post-stroke life

The results of this study discovered that post-stroke patients who obtained telerehabilitation treatment had a higher quality of life compared to those who obtained conventional treatment. 3 primary study articles showed significant p-value in telehealth effectiveness study on post-stroke quality of life characterized by the horizontal line of each study did not touch the vertical line on the forest plot. This significance value was influenced among others by the number of samples between the intervention group and the control group which was almost the same so that the proportion of the two was relatively balanced.

Linder et al. (2015) state that completing a 3-hour/day home workout program has a greater impact on quality of life, furthermore, the regular phone contact between therapists and patients has a positive impact on quality of life as they look forward to weekly phone calls, not only as a way to advance their exercise program but also as a social channel.

Virtual reality-based rehabilitation with smart gloves combined with standard occupational therapy is more effective than conventional rehabilitation to improve health related quality of life function, mean and standard deviation (Mean= 33.5; SD= 19.9) in the intervention group and (Mean= 22.9; SD=4.8) in the control group (Shin et al., 2016).

Sakakibara et al. (2022) in this study states that the secondary results show a statistically significant increase in HRQoL between 6 and 12 months of lifestyle coaching through a stroke coach which is a telehealth intervention to promote healthy lifestyle behavior after a stroke.

Research conducted by Ajcevic et al. (2021) mentions that e-Health and telemonitoring protocols are useful for early post-acute remote patient management, thus supporting constant monitoring and patient adherence to treatment. Significant improvement in quality of life is measured by EQ-5D-5L The effect of telemonitoring on improved quality of life is due to the fact, that patients feel closely cared for and monitored, even at a distance, after life-threatening acute events.

Several articles show that telehealth can affect the improvement of post-stroke quality of life through remote monitoring systems such as regular telephone contact between therapists and patients, game-based virtual reality, and e-health for telemonitoring which in its implementation requires an internet network to facilitate communication, examination, and monitoring

2. The effectiveness of telehealth in reducing the risk of post-stroke depression

The results of a this study found that telehealth is effective in reducing the risk of post-stroke depression. Telehealth through a virtual reality game system using MOTOmed provides detailed biofeedback, software-controlled therapy programs, motivational games, and training. The results shows a bigger decrease in depression level in the intervention group compared to the control group with mean and standard deviation (Mean= 14.1; SD= 2.4) in the intervention group and (Mean= 17.5; SD=2.7) in the control group (Song and Park, 2015).

A study by Ajcevic et al. (2021) shows that through e-health and telemonitoring protocols in post-stroke patients, the patients experience a significant decrease in anxiety and depression status, as measured by EQ-5D-5L. Significant reduction in anxiety (p = 0.016) and depression (p= 0.031).

Patient social networks are also an important factor in post-stroke telerehabilitation, patients who obtain telerehabilitation have a larger and more open social network compared to patients who do not receive TR. Patients with larger social networks showed greater functional improvement and decreased depressive symptoms post-intervention (Podury et al., 2021).

Telehealth interventions focus on reducing post-stroke depressive symptoms through the components of phone calls, SMS, push notifications, messaging devices, and online platforms (Hwang et al., 2021).

A study by Anderson et al. (2022) suggests that messages delivered using video teleconferencing are effective for managing post-stroke depression and anxiety. Regular interventions and patient adherence to interventions can reduce depressive symptoms in post-stroke patients.

The meta-analysis study of 8 Randomized Controlled Trial studies that came from Canada, Taiwan, Austria, China, Spain, and Turkey concludes that telehealth is effective in improving the quality of life of post-stroke patients with 0.87 units higher quality of life than those without telehealth (SMD= 0.87; 95%CI =0.30 to 1.44; p= 0.003).

The meta-analysis study of 8 Randomized Controlled Trial studies that came from the United States, Canada, California, Germany, the United Kingdom, and Italy concludes that telehealth is effective in reducing the risk of depression in post-stroke patients. In post-stroke patients who obtained telehealth services, they had an average of 0.44 units lower depression than those who did not obtain telehealth (SMD= -0.44; 95% CI=-0.79 to -0.09; p= 0.010).

AUTHOR CONTRIBUTION

Siti Luluk Khamidahtun Ni'mah was the main researcher who selected topics, searched, and collected study data. Meanwhile, Didik Gunawan Tamtomo and Bhisma Murti were the supervisors in analyzing study data and compiling publications.

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CONFLICT OF INTEREST

There is no conflict of interest in this study.

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