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Effectiveness of Cardiac Telerehabilitation After Aortic Valve Replacement on Physical Performance: A Systematic Review

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ABSTRACT

Background: Cardiac rehabilitation (CR) advantages are widely known. For patients recuperating from major heart procedures like AVR, exercise-based rehabilitation enhances cardiovascular endurance, muscle strength, and general physical fitness.

Objective: This systematic review aimed to evaluate the effectiveness of cardiac telerehabilitation (CTR) in enhancing physical performance after AVR.

Methods: A systematic review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Six electronic databases, including PubMed, Web of Science, Scopus, Cochrane, VHL, and PEDro, were searched for studies published from 2010 to 2024. The inclusion criteria focused on clinical trials involving post-AVR patients and comparing the effects of CTR with traditional or no rehabilitation. The methodological quality of the studies was assessed using the modified Downs and Black checklist, and meta-analyses were performed where applicable.

Results: The review included 6 studies that demonstrated significant improvements in physical function, exercise capacity (i.e., six-minute walk test and VO2 peak), The pooled standardized mean difference (SMD) for all studies was 0.79 (95% CI: 0.26 to 1.33), indicating a statistically significant overall effect in favor of cardiac telerehabilitation, with **a** moderate improvement in gait speed compared to the control group. The test for overall effect returned Z = 2.89 (P = 0.004), confirming statistical significance at the 0.05 level.

Conclusion: Cardiac telerehabilitation is an effective alternative to traditional rehabilitation for patients recovering from AVR, offering comparable improvements in physical performance.

Keywords: Aortic valve replacement, Cardiac telerehabilitation, Cardiac rehabilitation, Remote rehabilitation.

INTRODUCTION

Aortic valve replacement (AVR) is a crucial surgical procedure used to address severe regurgitation or aortic valve stenosis. Aortic valve constriction or leakage is a defining feature of these disorders, which can cause severe symptoms like syncope, shortness of breath, and chest discomfort as well as substantial impairment of heart function [(1)]. As people age, the prevalence of aortic stenosis increases, impacting between 2–7% of those over 65 [(2)].

In order to restore physical function, improve cardiovascular health, and promote general well-being, rehabilitation is crucial for patients after AVR. To help patients manage their illness and lower their risk of future cardiac events, traditional cardiac rehabilitation (CR) programs usually include psychological support, instruction on heart-healthy living, and supervised exercise training [(3)].

CR's advantages are widely known. For patients recuperating from major heart procedures like AVR, exercise-based rehabilitation enhances cardiovascular endurance, muscle strength, and general physical fitness [(4)]. However, a number of obstacles, such as budgetary limitations, logistical difficulties, and regional restrictions, may restrict access to traditional CR programs. These obstacles frequently lead to less than ideal rates of rehabilitation participation, especially among underprivileged and rural populations [(5)]. To get beyond the drawbacks of conventional CR programs, cardiac telerehabilitation (CTR) shows promise. CTR

makes rehabilitation services more accessible and convenient for patients by using telecommunication technologies to provide them remotely [(6)].

Improvements in telehealth technology and the growing prevalence of internet connectivity have sped up the incorporation of CTR into cardiac treatment. Real-time monitoring and feedback are made possible by wearable technology and mobile health apps, which allow medical professionals to monitor patients' progress and modify rehabilitation regimens as necessary [(7)].

For patients recovering from major cardiac procedures like AVR or those with complex medical demands, CTR can offer early interventions and continuous monitoring [(7)].

This systematic review aimed to evaluate the effectiveness of CTR in enhancing physical performance after AVR.

MATERIALS AND METHODS

The present analysis only included randomized controlled trials (RCTs).

a) The layout of the clinical study was prospective and compared different groups.

b) Quantitative metrics did not appear in the trials.

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c) Evidence based physical therapy interventions for aortic valve replacement.

Inclusion criteria:

In this study, we had included only randomized control studies and clinical trials. Studies were included if the following criteria achieved:

- English clinical trials published between 2010 and 2024.
- Included post-aortic valve replacement (AVR) patients.
- Used cardiac telerehabilitation techniques either alone or as adjuvant therapy.
- Used traditional or conventional cardiac rehabilitation, placebo, no intervention, or any other type of rehabilitation modalities for comparison.
- Measured the impact of the intervention using any outcome.
- The participants were aged 25 years old and above.

Exclusion criteria:

- Studies that are observational.
- Studies written in languages other than English.
- Abstracts that have been published but lack full-text articles.

Information sources and search strategy:

Our search strategy encompassed six major online databases: PubMed, Web of Science (WOS), Scopus, the Physiotherapy Evidence Database (PEDro), Virtual Health Library (VHL), and Cochrane Central Register of Controlled Trials (CENTRAL), covering the period from inception until the date of search. We employed specific keywords including "Cardiac Telerehabilitation", "Aortic Valve Replacement", "Remote Rehabilitation", "Heart Valve Surgery", and "Telehealth". Boolean operators were used to combine these keywords, and the search technique was customized for each database. Only English-language articles with human subjects were included by applying filters. Furthermore, we carefully examined the included studies' reference lists by hand to find any pertinent papers that were overlooked during the first search.

Study selection:

Two reviewers separately assessed the retrieved papers' titles and abstracts against established qualifying criteria. Any arguments or discrepancies were handled by a third reviewer until consensus was achieved.

Data extraction:

The complete text of the included papers was examined further, and the following information was extracted: sample size, participant age and gender, type and dose of intervention, virtual reality equipment (if applicable), diagnosis, outcome measures, and key results. A third reviewer resolved any possible disputes.

Risk of bias assessment:

Two reviewers independently evaluated the included studies' methodological quality using the modified Downs and Black scale for clinical trials. Four factors are rated by the 27-question scale: 1) reporting, 2) external validity, 3) internal validity, and 4) power. Excellent quality studies were defined as those with a final score between 26 and 28, good quality studies were defined as those with a score between 20 and 25, fair quality studies were defined as those with a score between 19 and 15, and bad quality studies were defined as those with a score of 14 or below. Discussions were held to settle any differences or arguments until an agreement was achieved.

Ethical approval:

The study was authorized by the Ethics Committee of Cairo University's Faculty of Physical Therapy [No: P.T.REC/012/005443]. The Helsinki Declaration was followed throughout the course of the investigation.

Statistical analysis

Version 24.0 of the SPSS program was used to do the statistical analysis. Meta-analyses are carried out when two or more studies compare the effectiveness of various cardiac telerehabilitation programs or examine the impact of telerehabilitation in comparison to traditional intervention, no intervention, or a placebo. The random-effects model of analysis was used to compare the change in outcomes between the telerehabilitation and control groups in order to compute the SMD, 95% CI, and P-value.

RESULTS

Selection of the study:

451 studies were discovered and reviewed, duplicates were deleted there were 422 studies, 416 studies excluded after abstract, title and full text screening resulting in 6 studies (Figure 1 and Table 1).

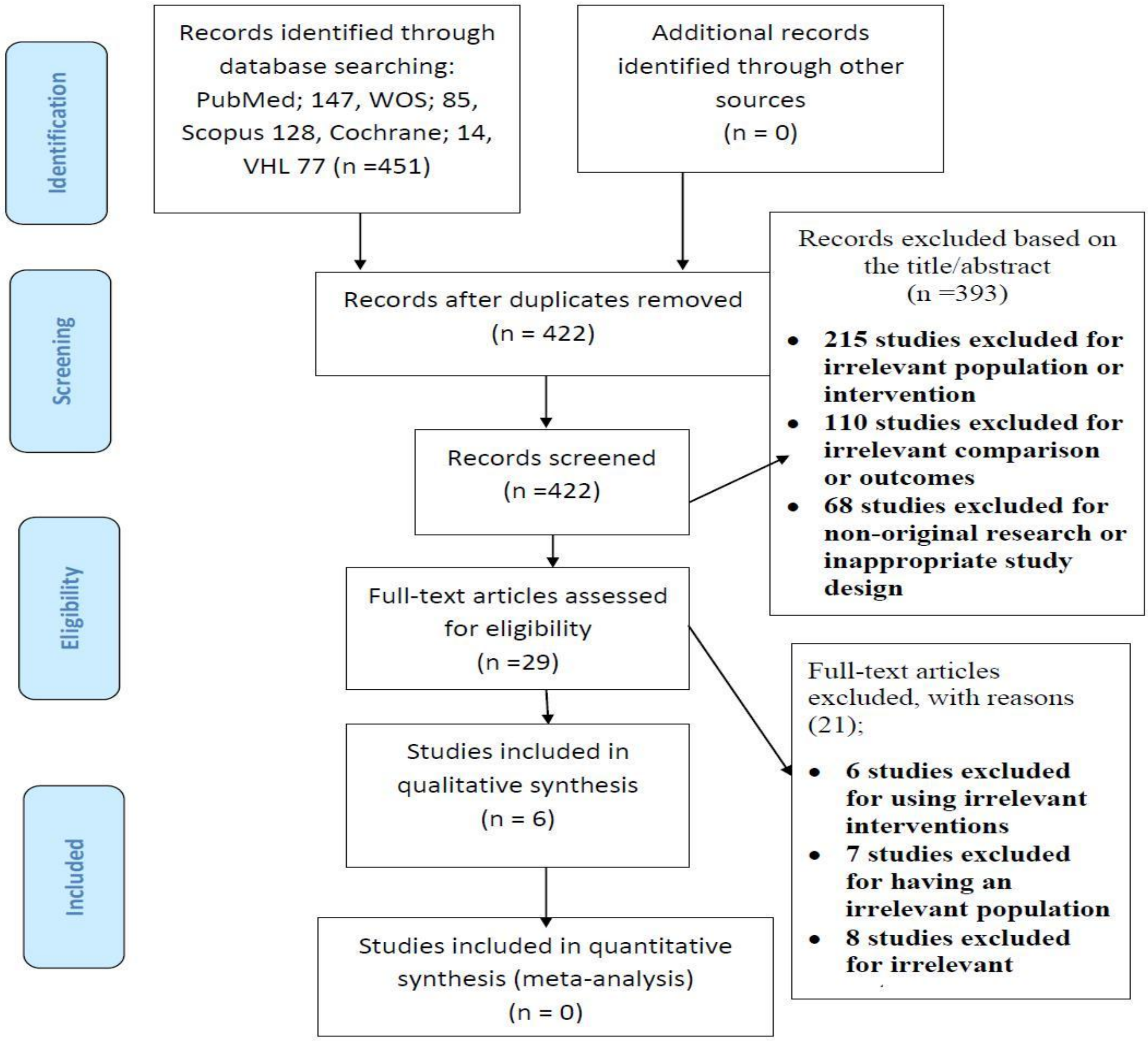

Figure (1): PRISMA flowchart of studies search and selection

Table (1): The current systematic review trials:

No.	Authors; year	Title
1	**Thorup *et al.* 2022** [8]	Perspectives on Participation in a Feasibility Study on Exercise-Based Cardiac Telerehabilitation After Transcatheter Aortic Valve Implantation: Qualitative Interview Study Among Patients and Health Professionals
2	**Spindler *et al.* 2019** [9]	Conventional Rehabilitation Therapy versus Telerehabilitation in Cardiac Patients: A Comparison of Motivation, Psychological Distress, and Quality of Life
3	**Brocki *et al.* 2023**[10]	Exercise-based real-time telerehabilitation for older patients recently discharged after transcatheter aortic valve implantation: An extended feasibility study
4	**Brocki *et al.* 2022** [11]	Exercise-Based Real-time Telerehabilitation for Older Adult Patients Recently Discharged After Transcatheter Aortic Valve Implantation: Mixed Methods Feasibility Study
5	**Ashikaga *et al.* 2023** [12]	Efficacy and Safety of Home-Based Cardiac Telemonitoring Rehabilitation in Patients After Transcatheter Aortic Valve Implantation: Single-Center Usability and Feasibility Study
6	**Lindman *et al.* 2021** [13]	Effect of a Pragmatic Home-Based Mobile Health Exercise Intervention After Transcatheter Aortic Valve Replacement: A Randomized Pilot Trial

Table (2): Baseline characteristics of included studies:

Study ID	Thorup *et al.* 2022[8]	Spindler *et al.* 2019[9]	Brocki *et al.* 2023[10]	Brocki *et al.* 2022[11]	Ashikaga *et al.* 2023[12]	Lindman *et al.* 2021[13]
Country	**Denmark**	**Denmark**	**Denmark**	**Denmark**	**Japan**	**USA**
Design	Clinical trial	RCT	Single-center RCT	Single-center RCT	Single-center RCT	RCT
Type of AVR / TS AVR	TAVR / Time since AVR not specified	Not specified	TAVR / 1 week post-TAVR, supervised for 8 weeks, 4 weeks self-training	TAVR / 1 week post-discharge	TAVR / Post-TAVI, prior to discharge	TAVR / 1 month post-TAVR
Sample Size	N=11 (7 patients, 4 health professionals)	N=134 (TR: 69, CR: 65)	Screened: 41; Enrolled: 15; Completed: 7; Excluded: 8	N=13 (5 completed, 8 dropped out)	N=17 (HBTR: 11, Control: 6)	N=50 (25 control, 25 intervention)
Age / Sex Distribution	74-90 years (Median: 84); 4 males, 3 females. Health professionals: 25-42 years	TR: 61.86 ± 12.46; CR: 62.68 ± 11.95; TR: 54% male, CR: 50% male	Median age: 83 [81–87]; 3 men, 4 women	Median age: 83 (range: 74-87); 8 males, 5 females	HBTR: 80.4 ± 6.0; Control: 79.0 ± 3.9 HBTR: 6 males (55%); Control: 3 males (50%)	Average age: 76 years; 34% female (17 participants)
Platform / Delivery Mode	Tablet (Apple iPad), Videosamtal app for video training, Outlook (Microsoft 365 Office), web-based platform, activity tracker	Blood pressure monitor, scales, heart rate monitor, digital step counter, tablet PC with mobile network, e-rehabilitation plan, ActiveHeart web portal	Web-based platform, tablet (Apple iPad), activity tracker (Beurer AS97), booklet, Open Telehealth (OTH) app, web-based supervised exercise sessions	Web-based platform, supervised home-based web exercise via tablet (iPad), real-time video calls, activity tracker, project website	23 females, 17 males Telemonitoring system with video calls via tablet PC, ECG monitoring, mobile app (Heart-Line, Nipro Co., Ltd)	Home-based mobile health, Fitbit Alta HR activity monitor, iPad with data package, customized app for exercise tracking and daily/weekly questions

RCT: Randomized Controlled Trial, AVR: Aortic Valve Replacement, TAVR: Transcatheter Aortic Valve Replacement, TS AVR: Time Since Aortic Valve Replacement, TR: Telerehabilitation, CR: Cardiac Rehabilitation, PC: Personal Computer, OTH: Open Telehealth, HBTR: Home-Based Telerehabilitation, ECG: Electrocardiogram, TAVI: Transcatheter Aortic Valve Implantation

Table (3): Study characteristics of included studies:

Study ID	Thorup *et al.* 2022[8]	Spindler *et al.* 2019[9]	Brocki *et al.* 2023[10]	Brocki *et al.* 2022[11]	Ashikaga *et al.* 2023[12]	Lindman *et al.* 2021[13]
Intervention of TR	Participants were provided with an activity monitor (Fitbit Alta HR), which displayed daily steps, time, distance moved, heart rate, and battery level. They received a personalized daily step goal (10% higher than their average daily step count from Phase 1) and were prompted to perform daily resistance exercises (e.g., chair sit-to-stands, chair push-ups, stress ball squeezes) via the iPad app.	The TR group followed a personalized 12-week telerehabilitation program using a Teledialog toolbox (e.g., blood pressure monitor, heart rate monitor, step counter). Data were uploaded and monitored by healthcare staff twice weekly. Participants had access to an interactive web portal (ActiveHeart) for educational materials and communication.	A web-based TR program post-TAVI, including home exercise training, an activity tracker, an informative website, and one online session with a nurse. Exercises were individualized and supervised.	A home-based, web-based exercise training program delivered via tablet. Participants received supervised web-based exercise sessions, an activity tracker, an informative website, and one online session with a nurse. Exercises were conducted via videoconference, and participants were instructed to walk daily.	TR group used a telemonitoring system and a cycle ergometer at home. Medical staff conducted video calls before, during, and after exercise to monitor ECG, blood pressure, and pulse rate. Resistance training (e.g., calf raises, sit-to-stands) was performed daily. Participants were trained on equipment use during hospitalization.	Participants in the telemedicine group received a wearable activity tracker (Fitbit Alta HR) and an iPad with a data plan. They were assigned personalized daily step targets (set 10% higher than their average step count from Phase 1) and were prompted to perform resistance exercises (e.g., sit-to-stand, chair push-ups, stress ball squeezes). The wearable also provided feedback on their daily steps and sent hourly reminders to encourage movement. Their activity was monitored remotely via the iPad.
Intervention of CG	The control group was also given an activity monitor but it only displayed the time. They received no feedback, reminders, or	The CG followed a 12-week conventional cardiac rehabilitation program, including physical visits to healthcare centers. The program involved physical training, education on lifestyle	No conventional group (CG) was mentioned in the study as it focused on the feasibility of the telerehabilitation program without comparison to a conventional treatment	No conventional group (CG) was described, as the study focused solely on the feasibility of the tele-TAVI rehabilitation program.	The CG participated in standard outpatient CR at least once a week, involving aerobic exercise (e.g., cycle ergometer, treadmill) and mild-to-moderate	Participants in the control group were also given a wearable activity tracker, but it only displayed the time and provided no feedback or reminders. They received no exercise instructions

Study ID	Thorup *et al.* 2022[8]	Spindler *et al.* 2019[9]	Brocki *et al.* 2023[10]	Brocki *et al.* 2022[11]	Ashikaga *et al.* 2023[12]	Lindman *et al.* 2021[13]
	prompts for exercise. No specific instructions, reminders, or queries about exercise were provided.	changes (e.g., diet, smoking cessation), and both individual and group sessions.	group.		resistance training. Participants were instructed to perform daily resistance training at home.	or prompts.
Frequency and Duration	6 weeks/ 6 out of 7 days per week.	Both TR and CG programs lasted 12 weeks. TR: Data were monitored twice a week. CG: Based on in-person visits, but specific session frequency was not indicated.	2 supervised exercise sessions per week for 8 weeks, followed by 4 weeks of self-training.	The intervention lasted 3 weeks. Web-based exercise training was conducted twice a week for 30-45 minutes. Participants were instructed to take a 30-minute daily walk.	TR: Twice a week for 12 weeks (24 sessions). CG: Once or twice weekly for 12-16 weeks.	6 weeks. They were expected to perform resistance exercises daily for 6 days each week and to meet their individualized step goals.
Outcome Measures	• Average daily steps, • SPPB • KCCQ • Daily active minutes, moderate-to-intense active minutes, and sedentary minutes.	• HADS • QoL • SF-36	• 6MWT • 30STS • 4-meter walk test. • Hand grip strength. • Heart-QOL • MMSE • FSI	• 6MWT • 30STS, • 4-meter walk test • hand strength • FSI • QOL • Patient satisfaction, • Steps (activity tracker), and technical issues.	• Peak oxygen uptake (VO2), • 6MWT • SPPB • hand grip strength, quadriceps isometric strength • 10mWT	The main outcome measures included average daily steps, the Short Physical Performance Battery (SPPB) score, and the Kansas City Cardiomyopathy Questionnaire (KCCQ) overall summary score. Secondary outcomes included time spent in daily physical activity, moderate-to-vigorous physical activity, and sedentary time.
Results	No significant	Both groups showed	Recruitment and	5 out of 13 patients	TR group showed	In the entire study

Study ID	Thorup *et al.* 2022[8]	Spindler *et al.* 2019[9]	Brocki *et al.* 2023[10]	Brocki *et al.* 2022[11]	Ashikaga *et al.* 2023[12]	Lindman *et al.* 2021[13]
	improvement in co-primary endpoints (daily steps, SPPB, KCCQ) for the overall cohort. However, the intervention improved daily active minutes and moderate-to-intense active minutes, especially for participants who did not attend cardiac rehabilitation (CR).	comparable motivation levels and improvements in anxiety, depression, and quality of life. TR was found to be a viable alternative to CR, yielding similar outcomes to conventional rehabilitation.	retention were low (36% recruitment, 47% retention). Physical improvements in 6MWT (median increase of 82.5 meters) and hand grip strength (median increase of 4%). Compliance: 6 out of 7 patients met the 60% adherence rate. No adverse events.	completed the study. Participants who completed the study appreciated real-time feedback and activity tracking. 60% dropped out due to technical issues (e.g., poor data coverage, limited IT skills). TR was not feasible for most participants.	significant improvement in peak VO2 (from 12.0 to 14.3 mL/min/kg, P=0.03) and 6MWT (from 267.0 to 345.0 meters, P=0.04). No significant adverse events. No significant differences between TR and CG in peak VO2 changes (P=0.64).	population, there were no significant differences in daily steps (+769 steps), SPPB (+0.68), or KCCQ (-1.7) between the intervention and control groups. However, for participants who did not engage in cardiac rehabilitation, the intervention led to improvements in daily steps (+1730 steps), active time (+66 minutes), moderate-to-vigorous activity time (+53 minutes), and a reduction in sedentary time (-157 minutes).

TR: Telerehabilitation, CG: Control Group , SPPB: Short Physical Performance Battery , KCCQ: Kansas City Cardiomyopathy Questionnaire, CR: Cardiac Rehabilitation, HADS: Hospital Anxiety and Depression Scale, QoL: Quality of Life, SF-36: 36-Item Short Form Survey, 6MWT: 6-Minute Walk Test, 30STS: 30-Second Sit-to-Stand Test, MMSE: Mini-Mental State Examination, FSI :Fatigue severity index, VO2: Peak Oxygen Uptake, 10mWT: 10-Meter Walk Test, IT: Information Technology, ECG: Electrocardiogram.

Table (4): Questions and answers using the modified downs and black checklist

Domain/Question	Thorup *et al.* (2022)[8]	Spindler *et al.* (2019)[9]	Brocki *et al.* (2023)[10]	Ashikaga *et al.* (2023)[12]	Lindman *et al.* (2021)[13]	Brocki *et al.* (2022)[11]
Reporting (10 Items)	**7/10**	**9/10**	**9/10**	**10/10**	**9/10**	**10/10**
1. Is the hypothesis/aim clearly described?	1	1	1	1	1	1
2. Are the main outcomes clearly described?	1	1	1	1	1	1
3. Are patient characteristics clearly described?	1	1	1	1	1	1
4. Are interventions clearly described?	1	1	1	1	1	1
5. Are confounders clearly described?	1	1	0	1	1	1
6. Are main findings clearly described?	1	1	1	1	1	1
7. Does study provide estimates of variability?	1	1	1	1	1	1
8. Are adverse events reported?	0	0	1	1	0	1
9. Are characteristics of patients lost to follow-up described?	0	1	1	1	1	1
10. Are actual probability values reported?	0	1	1	1	1	1
External Validity (3 Items)	**3/3**	**2/3**	**2/3**	**2/3**	**3/3**	**3/3**
11. Are subjects representative of the population?	1	1	1	0	1	1
12. Are participants representative of the invited population?	1	0	0	0	1	1
13. Are staff, places, and facilities representative of care?	1	1	1	1	1	1
Internal Validity - Bias (7 Items)	**4/7**	**4/7**	**5/7**	**5/7**	**5/7**	**5/7**
14. Were study subjects blinded?	0	0	0	0	0	0
15. Were outcome assessors blinded?	0	0	0	0	0	0
16. Was data dredging avoided?	1	1	1	1	1	1
17. Were analyses adjusted for follow-up length?	0	0	1	1	1	1
18. Were statistical tests appropriate?	1	1	1	1	1	1
19. Was compliance with intervention reliable?	1	1	1	1	1	1
20. Were outcome measures accurate and reliable?	1	1	1	1	1	1
Internal Validity - Confounding (5 Items)	**3/5**	**3/5**	**1/5**	**4/5**	**5/5**	**1/5**
21. Were patients recruited from the same population?	1	1	0	1	1	0
22. Were subjects recruited over the same period?	1	1	0	1	1	0
23. Were subjects randomized to intervention groups?	0	0	0	0	1	0
24. Was there adequate adjustment for confounders?	0	0	0	1	1	0
25. Were losses to follow-up taken into account?	1	1	1	1	1	1
Power (1 Item)	**1/1**	**0/1**	**0/1**	**0/1**	**1/1**	**0/1**
Total Score	**19/27**	**17/27**	**17/27**	**18/27**	**23/27**	**21/27**

1.Effect of cardiac telerehabilitation on 6-minute walk test: Figure (2)

This forest plot summarizes the results of four studies that evaluated the impact of cardiac telerehabilitation (CTR) on gait speed in comparison to conventional rehabilitation or usual care. Each study contributes a SMD with 95% CI, which represent the effect size and statistical uncertainty for each individual study.

The pooled SMD for all four studies was -0.23 (95% CI: -0.60 to 0.15), indicating a statistically significant overall effect in favor of cardiac telerehabilitation, with a moderate improvement in gait speed compared to the control group**.** The test for overall effect returned Z = 1.19 (P = 0.24)**,** confirming statistical significance at the 0.05 level.

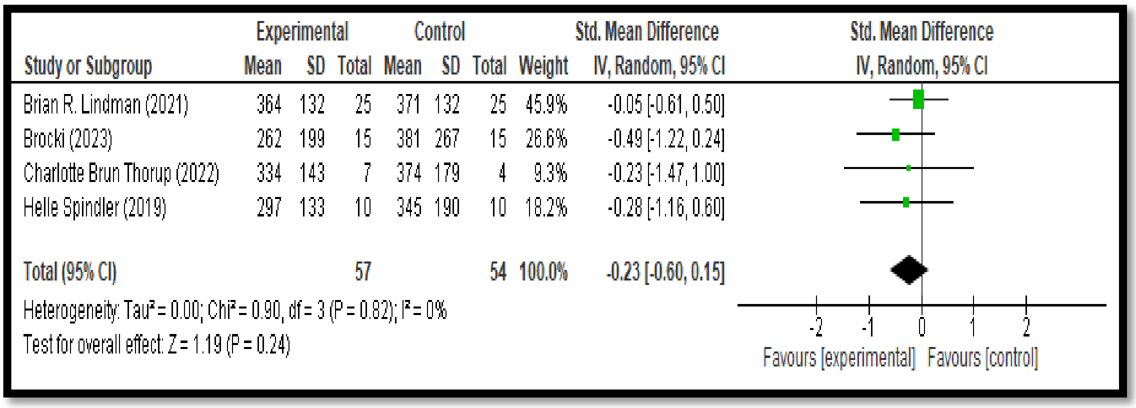

Figure (2): Effect of cardiac telerehabilitation on 6-Minute Walk Test (6MWT)

2.Effect of Cardiac Telerehabilitation on Gait Speed (m/s): Figure (3)

This forest plot summarizes the results of four studies that evaluated the impact of cardiac telerehabilitation (CTR) on gait speed in comparison to conventional rehabilitation or usual care. Each study contributes a SMD with 95% CI, which represent the effect size and statistical uncertainty for each individual study.

The SMD for all four studies was 0.79 (95% CI: 0.26 to 1.33), indicating a statistically significant overall effect in favor of cardiac telerehabilitation, with a moderate improvement in gait speed compared to the control group**.** The test or overall effect returned Z = 2.89 (P = 0.004)**,** confirming statistical significance at the 0.05 level.

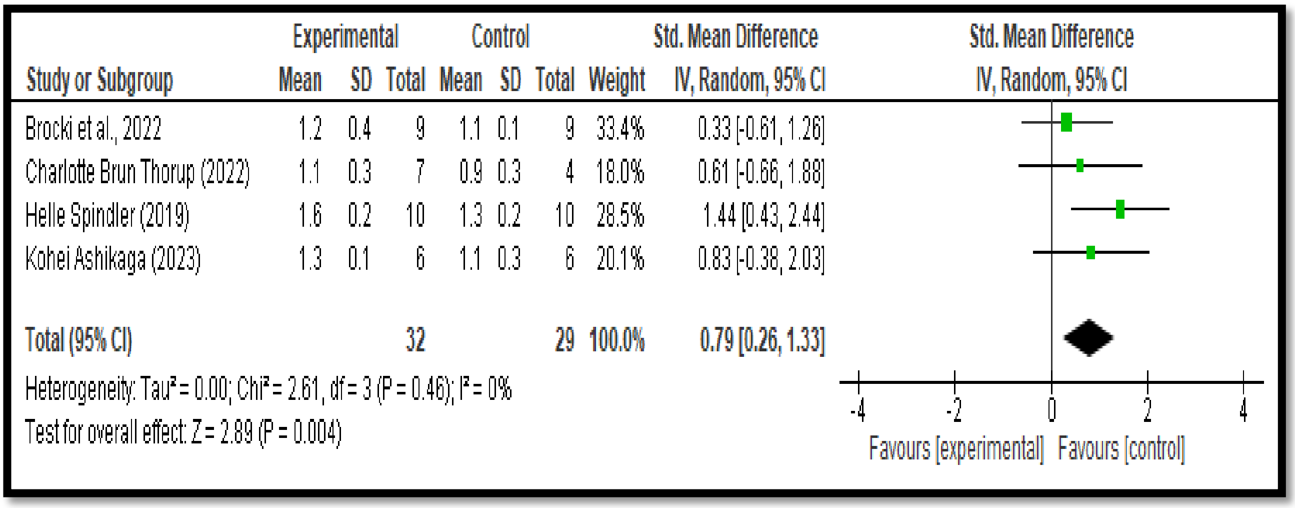

Figure (3): Effect of cardiac telerehabilitation on gait speed (m/s)

3.Effect of Cardiac Telerehabilitation on Handgrip Strength (kg): **Figure (4)**

This forest plot summarizes the findings of four studies evaluating the effect of cardiac telerehabilitation (TR) on handgrip strength compared to conventional rehabilitation or usual care. Each study contributes a SMD along with a 95% CI, which reflects the precision and range of the estimated effect.

The pooled SMD for all four studies was 0.12 (95% CI: **-**0.25 to 0.50), indicating a very small and statistically non-significant effect of cardiac telerehabilitation on handgrip strength. The test for overall effect resulted in Z = 0.65 (P = 0.52), which confirms that there was no statistically significant benefit for handgrip strength from cardiac telerehabilitation.

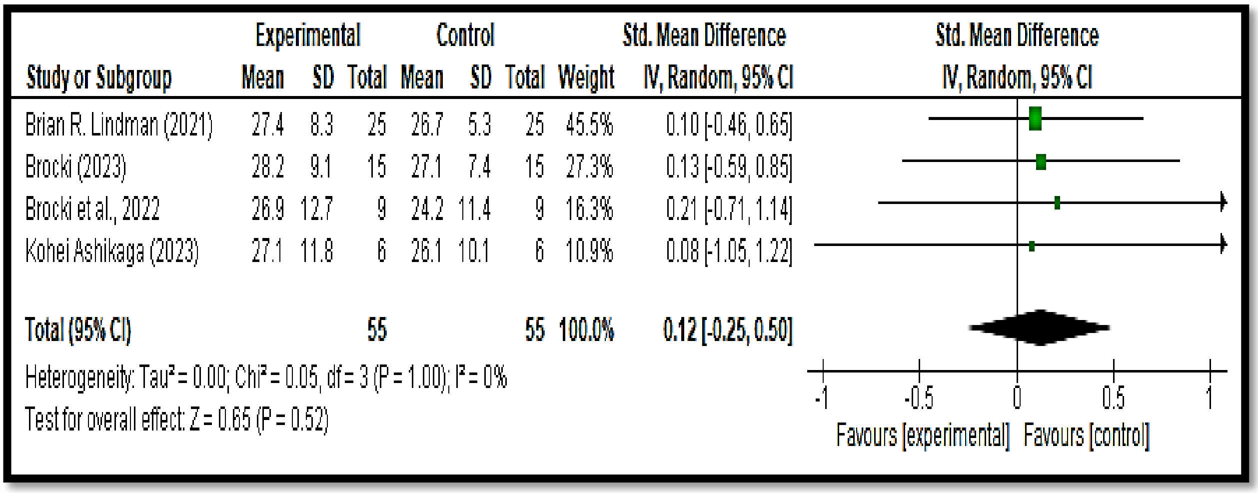

Figure (4): Effect of cardiac telerehabilitation on handgrip strength (kg).

DISCUSSION

Aortic valve replacement (AVR) is a critical surgical intervention designed to treat severe aortic valve stenosis or regurgitation. These disorders, which are typified by the aortic valve narrowing or leaking, can cause serious symptoms including syncope, shortness of breath, and chest pain, as well as a major decrease in heart function [1].

Cardiac telerehabilitation (CTR) emerges as a promising solution to overcome the limitations of traditional CR programs. CTR utilizes telecommunication technologies to deliver rehabilitation services remotely, enhancing accessibility and convenience for patients **[6].**

This systematic review aimed to evaluate the effectiveness of CTR in patients recovering from aortic valve replacement (AVR) on physical performance.

The current systematic review was based on inclusion of 6 RCTS; **Thorup *et al.*[8]**, **Spindler *et al.*[9], Brocki *et al.* [10,11], Ashikaga *et al.* [12] and Lindman *et al.* [13]** using modified downs and black scale for quality assessment.

Outcomes that were assessed in the current review related to physical performance:

- 6MWT.
- Gait speed.
- Hand grip strength.
- Peak vo2.
- Daily steps.

Outcomes that related to quality of life:

- Hospital Anxiety and Depression Scale (HADS).
- Heart-Related Quality of Life (Heart-QOL).
- Mini-Mental State Examination (MMSE).
- Fatigue Severity Index (FSI).
- Kansas City cardiomyopathy questionnaire (KCCQ).

Other outcomes:

- Technological challenges and barriers.
- Safety and Adverse Events.

Ashikaga *et al.* **[12]** found that there was no discernible difference in the two groups' hand grip strength, and reported a non-significant trend favoring the experimental group in gait speed, regarding physical performance the HBTR group, mean (±SD) showed significant improvement in peak oxygen uptake (VO_2), increasing. The control group demonstrated a smaller, non-significant change in VO_2 and significant improvements were also seen in the 6-minute walk test (6MWT). Their study confirmed that no adverse events occurred in either the HBTR or control groups during the intervention. They showed that all patients in the home-based telemonitoring rehabilitation (HBTR) group completed 24 sessions over 12 weeks, while the control group completed an average of 19 sessions.

Lindman *et al.* **[13]** reported a small, differences between the experimental and control groups in 6MWT that are not statistically significant, indicating no clear advantage of telerehabilitation over conventional rehabilitation. In their study, when compared to the control group, the intervention group's daily step count increased, albeit not significantly. However, in terms of hand grip, a notable increase in steps was noted in the subgroup of patients who did not participate in cardiac rehabilitation. The study found that, the two groups' hand grip strength did not differ statistically significantly. They found no significant difference in Kansas City cardiomyopathy questionnaire (KCCQ) scores between the intervention and control groups, suggesting that the intervention may not have had a substantial impact on perceived quality of life**.** They also found that the home-based mobile health intervention did not result in any adverse events, adherence to the intervention was relatively high, with 85-90% of participants consistently wearing the activity monitor, and exercise compliance averaged between 85-90%.

In the study by **Brocki *et al.*** **[10],** the mean 6MWT distance indicated no statistically significant difference between groups regarding daily steps. They reported that daily steps during the intervention ranged from 933 to 2635 steps, with only 4 patients exceeding 5000 steps at least once, indicating room for improvement in promoting more sustained physical activity and reported that there is no statistically significant effect on hand grip strength **[10]**.

Spindler *et al.* **[9]** reported that there is no statistically significant overall effect of cardiac telerehabilitation on 6MWT performance compared to usual care. The experimental group's gait speed improved statistically significantly. Psychological outcomes, such as reductions in anxiety and depression, were observed. Both the telerehabilitation (TR) and conventional rehabilitation (CR) groups experienced significant reductions in anxiety and depression over time**.** Their study also reported notable advancements in a number of areas, such as social functioning, mental health, and physical functioning. In terms of motivation, they reported that autonomous motivation remained stable across both the TR and CR groups, though the CR group had higher baseline motivation **[9]**.

The study by **Thorup *et al.*** **[8]**, reported that there is no clear evidence of an effect of cardiac telerehabilitation on gait speed and reported that a mean 6MWT distance indicating high uncertainty, likely due to its small sample size. They reported that many patients struggled with the activity tracker, with some opting to manually record their steps due to difficulties syncing the device with their smartphones via Bluetooth. Patients also expressed anxiety about using the program website, fearing mistakes or technical issues. As a result, most avoided using the website altogether.

The research by **Brocki *et al.*** **[11]** reported a non-significant positive effect favoring the experimental group on gait speed. In their research, they showed that no clear evidence of benefit on hand grip strength. They found that while participants appreciated the activity tracker for monitoring their steps, many found the device difficult to manage. Additionally, the program website was rarely used, with patients citing a lack of interest or difficulty in navigating the platform, technical issues, along with other factors like fatigue and hospital readmissions, led to a significant dropout rate. These technological challenges highlight the need for more user-friendly systems and better support for older patients who may struggle with digital tools.

Physical performance improvements were consistently observed across the studies. In **Ashikaga's *et al.*** **[12]** study, the HBTR group, mean (SD) showed significant improvement in peak oxygen uptake (VO_2), increasing from 12.0 (1.7) to 14.3 (2.7) mL/min/kg (P = 0.03). The control group demonstrated a smaller, non-significant change in VO_2, from 13.2 to 14.5 mL/min/kg (P = 0.64). Significant improvements were also seen in the 6MWT, with the HBTR group improving by 78 meters (P = 0.04) **[12].** In **Brocki's *et al.*** **[10]** study, the 6MWT showed a significant improvement, with walked distance increasing from 262 meters to 381 meters (P = 0.03)**.** However, **Lindman's *et al.*** **[13]** study found an increase of 14 meters in the 6MWT between the intervention group and the control group was not statistically significant.

Improvements in daily activity levels were observed in several studies. In **Lindman's *et al.*** **[13]** study, the intervention group showed a non-significant increase of 769 daily steps compared to the control group. However, a significant increase of 1730 steps was observed in the subgroup of patients who did not attend cardiac rehabilitation (95% CI: 100 to 3360). This suggests that TR may be particularly beneficial for those who are not enrolled in formal rehabilitation programs. **Brocki's 2023** study reported that daily steps during the intervention ranged from 933 to 2635 steps, with only 4 patients exceeding 5000 steps at least once, indicating room for improvement in promoting more sustained physical activity **[10].**

Lindman's *et al.* **[13]** study also found notable improvements in the intervention group's daily activity minutes that ranged from moderate to intensive (P < 0.05), with the non-cardiac rehab subgroup showing an increase of 66 active minutes (95% CI: 28 to 105). Additionally, this subgroup experienced a significant reduction in sedentary time by 157 minutes (95% CI: -265 to -50), further highlighting the potential of TR to reduce sedentary behavior in patients not attending traditional rehabilitation programs.

These findings demonstrate that TR can lead to increased daily activity and exercise compliance, especially in populations that may not have access to or participate in traditional rehabilitation options.

Overall, telerehabilitation (TR) showed consistent improvements in physical performance metrics, particularly in the 6MWT and chair sit-to-stand time, though changes in other measures such as handgrip strength were less significant.

Overall, the findings indicate that, in comparison to traditional rehabilitation, cardiac telerehabilitation did not considerably increase functional walking ability as determined by the 6-minute walk test. Narrow confidence intervals surrounding the pooled estimate and consistent results across trials lend credence to the idea that any potential advantages of telerehabilitation in this situation are probably minimal or nonexistent.

Study Strength sand limitations:

- This review revealed good quality evidence to support the usage of cardiac telerehabilitation (CTR) for AVR patients as by using modified downs and black checklist scores.
- The inclusion of only six research restricts the conclusions' generalizability.
- One major limitation of the included studies was their variability with regard to patient groups, intervention strategies, and outcome measures.

CONCLUSION

The findings of this systematic review conclude that cardiac telerehabilitation (CTR) is a viable and effective alternative to traditional cardiac rehabilitation (CR) for AVR patients on physical performance making it an excellent option for patients who face barriers to attending in-person rehabilitation programs. The flexibility and increased adherence associated with CTR make it a promising tool for improving rehabilitation participation rates, particularly among patients who face logistical or geographic challenges.

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