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Prospective case series on home-based handgrip resistance training with WhatsApp monitoring in patients with newly created arteriovenous fistulas

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Abstract. Successful maturation of arteriovenous fistulas (AVFs) remains a challenge for patients with end-stage kidney disease, particularly in resource-limited settings. Handgrip resistance training may enhance vascular hemodynamics and support AVF maturation. This prospective uncontrolled case series evaluated the feasibility, safety, and vascular changes of a four-week home-based handgrip program in patients with new AVFs.

Methods. Twenty-eight adults with recent radiocephalic AVF creation performed daily handgrip training for four weeks (three sets of 10 contractions, 10 seconds each with 2-second rests; ~3–5 minutes/day). Adherence was tracked via logbooks and weekly WhatsApp submissions. Feasibility outcomes included adherence, completion, safety, and patient acceptability. Hemodynamic parameters (vein diameter, vein depth, and blood flow volume) were measured using Doppler ultrasonography before and after the intervention.

Results. Of 28 participants, 23 (82.1%) completed the program with high adherence ($\geq 85\%$ sessions). No AVF-related adverse events occurred. Significant vascular changes were observed: vein diameter increased from 3.1 ± 0.4 mm to 5.5 ± 0.6 mm ($p < 0.001$), vein depth decreased from 2.5 ± 0.3 mm to 2.1 ± 0.4 mm ($p = 0.002$), and blood-flow volume increased from 180 ± 55 mL/min to 565 ± 110 mL/min ($p < 0.001$).

Conclusions. Home-based handgrip training with digital monitoring is feasible, safe, and well accepted in patients with new AVFs. The observed vascular changes suggest this low-cost intervention may support AVF maturation and is suitable for integration into dialysis care in resource-limited settings.

Keywords: arteriovenous fistula, renal dialysis, exercise therapy, resistance training, hemodynamics.

Conflict of interest. The authors declare no conflict of interest.

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Проспективна серія клінічних випадків домашнього тренування кисті з дистанційним контролем через WhatsApp у пацієнтів із новоствореними артеріовенозними фістулами

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Резюме. Успішне дозрівання артеріовенозної фістули (АВФ) залишається складним завданням у пацієнтів із термінальною стадією хронічної хвороби нирок, особливо в умовах обмежених ресурсів. Тренування із стискання кисті з опором може поліпшити судинну гемодинаміку та сприяти дозріванню АВФ. У цьому проспективному неконтрольованому дослідженні серії клінічних випадків оцінювали здійсненність, безпеку та судинні зміни після чотири тижневої програми домашніх вправ із використанням стискання кисті у пацієнтів із новоствореними АВФ.

Методи. Двадцять вісім дорослих пацієнтів із нещодавно сформованою радіоцефалічною АВФ виконували щоденні вправи на стискання кисті протягом чотирьох тижнів (три підходи по 10 скорочень тривалістю 10 секунд із 2-секундними інтервалами; загалом приблизно 3–5 хвилин на день). Дотримання програми відстежували за допомогою щоденників і щотижневих звітів через WhatsApp. Основними критеріями здійсненності були дотримання, завершення програми, безпека та прийнятність для пацієнтів. Гемодинамічні параметри (діаметр і глибина вени, об'єм кровотоку) вимірювали за допомогою доплерівського ультразвукового дослідження до та після інтервенції.

Результати. Із 28 учасників 23 (82,1%) завершили програму з високим рівнем дотримання ($\geq 85\%$ занять). Ускладнень, пов'язаних з АВФ, не виявлено. Відзначено значущі зміни судинних параметрів: діаметр вени збільшився з $3,1 \pm 0,4$ мм до $5,5 \pm 0,6$ мм ($p < 0,001$), глибина вени зменшилася з $2,5 \pm 0,3$ мм до $2,1 \pm 0,4$ мм ($p = 0,002$), а об'єм кровотоку зріс із 180 ± 55 мл/хв до 565 ± 110 мл/хв ($p < 0,001$).

Висновки. Домашня програма вправ на стискання кисті з дистанційним контролем через цифрові платформи є здійсненною, безпечною та добре сприймається пацієнтами з новоствореними АВФ. Отримані судинні зміни свідчать, що це недороге втручання може сприяти дозріванню АВФ і може бути інтегроване у практику діалізного догляду в умовах обмежених ресурсів.

Ключові слова: артеріовенозна фістула, гемодіаліз, лікувальна фізкультура, силові тренування, гемодинаміка.

Introduction. Chronic kidney disease (CKD) remains a major global health burden, with a prevalence estimated at 18.4% between 2005 and 2015 [1]. The number of people with end-stage kidney disease is estimated to reach more than 2 million by 2030 [2] there were 406,081 patients who received treatment for end-stage renal disease (ESRD). Hemodialysis is the primary treatment option for ESKD. The adequacy of this treatment is greatly influenced by adequate vascular access [3] peritoneal dialysis (PD).

Compared to other options, Arteriovenous Fistulas (AVF) are more commonly chosen because they have a low complication rate, good long-term patency, and a low mortality rate [4]. However, previous studies have reported that AVFs take 6-12 weeks to mature and have a failure rate of 20-50%, especially in patients with small vein diameters and other comorbidities such as diabetes mellitus [5]. Failure to mature will delay dialysis initiation, reduce adequacy, and increase morbidity and mortality [6].

Exercise has been recognized as a non-invasive intervention that can stimulate vascular remodeling [7]. Muscle contractions increase blood flow and shear stress on the endothelium, promoting vasodilation and vessel enlargement. Previous studies demonstrate that forearm resistance exercises, especially with handgrip devices, can improve vein diameter, blood flow, and

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ultimately AVF maturation [8, 9]. Nonetheless, exercise protocols vary widely in intensity, frequency, and supervision. More importantly, little attention has been given to whether patients can consistently and safely follow such training outside of hospital settings.

In many low- and middle-income countries, including Indonesia, the practical barriers of repeated hospital visits, limited rehabilitation staff, and patients' socioeconomic constraints make home-based exercise programs an appealing alternative. Digital platforms such as WhatsApp have been increasingly used in chronic disease management to support adherence, provide reminders, and enable remote monitoring [10]. However, the feasibility and patient acceptability of this model in the specific context of AVF rehabilitation remain underexplored.

Therefore, the study aimed to evaluate the feasibility, adherence, safety, and hemodynamic changes of a structured, home-based handgrip resistance training program in patients with newly created AVFs, using WhatsApp for remote monitoring. By focusing on implementation outcomes, this study complements previous efficacy trials and provides practical insights into how exercise can be integrated into routine care for dialysis patients.

Materials and methods. This was a prospective uncontrolled case series designed to evaluate feasibility and vascular changes rather than establish causality. This study was conducted from September to October 2024 at Universitas Hasanuddin Teaching Hospital and Wahidin Sudirohusodo General Hospital, Makassar, Indonesia, with ethical approval from the Faculty of Medicine, Universitas Hasanuddin. Ethics approval was obtained (UH24010038, 14 April 2025). Written informed consent was obtained from all participants. The sample size of 28 participants was determined pragmatically, based on the expected number of eligible patients who underwent new AVF creation during the two-month recruitment period. This approach is consistent with feasibility-study methodology, which prioritizes evaluating process outcomes (adherence, safety, acceptability) over formal power calculations.

Adults aged ≥ 18 years with end-stage kidney disease (ESKD) undergoing their first radiocephalic AVF surgery, BMI < 30 kg/m², and complete clinical records were eligible. Patients with neuromuscular or orthopedic disorders of the upper limb, or those unable to perform handgrip training, were excluded. Participants were withdrawn if they trained fewer than five days per week, developed AVF complications, experienced health deterioration, or withdrew consent.

After in-clinic instruction, patients performed daily handgrip resistance training at home for four weeks. Each session: 3 sets \times 10 contractions at tolerable intensity (~ 20 – 50% MVIC), 10-second hold with 2-second rest, ~ 3 – 5 minutes/day. MVIC was measured with a handgrip dynamometer. Adherence was monitored through daily logbooks and weekly WhatsApp submissions (videos and logbook photos). WhatsApp

was also used for reminders, feedback, and reporting of problems. Each participant submitted weekly photos or short videos demonstrating their handgrip sessions through WhatsApp. Investigators reviewed these materials to verify compliance and provided short text-based feedback, encouragement, and reminders. All shared files were stored on password-protected institutional devices accessible only to the research team. To protect privacy, participants were instructed not to include identifiable personal data in their messages, and all communications followed institutional data-protection protocols.

The primary outcomes were feasibility and adherence, defined as the percentage of prescribed sessions completed, with $\geq 85\%$ considered high adherence. Adherence (%) was calculated as the number of completed sessions divided by the total prescribed sessions $\times 100$. Patients recorded daily sessions in personal logbooks, which were verified weekly through WhatsApp submissions containing photos or short videos. While this hybrid method improved monitoring feasibility, self-reported data may still introduce reporting bias, which was considered during interpretation. Additional feasibility measures included completion and dropout rates, reasons for discontinuation, safety (AVF-related or musculoskeletal complications), and patient acceptability based on logbook entries and WhatsApp feedback. Secondary outcomes were hemodynamic parameters of AVF maturation, including cephalic vein diameter (mm), vein depth (mm), and blood flow volume (mL/min), which were assessed using Doppler ultrasonography before and after the four-week intervention by a blinded radiologist. Clinical maturation was defined according to commonly accepted vascular access criteria as achieving a cephalic vein diameter ≥ 6 mm, blood flow volume ≥ 600 mL/min, and vein depth ≤ 6 mm, indicating readiness for successful cannulation for hemodialysis [11].

Statistical analysis. Descriptive statistics summarized adherence, safety, and feasibility outcomes. Continuous variables were expressed as mean \pm standard deviation (SD) or median (range), and categorical variables as frequencies and percentages. Data distribution was examined using the *Shapiro–Wilk test* to assess normality before analysis. Pre–post changes were tested using paired t-tests for normally distributed data or Wilcoxon signed-rank tests for non-normal data. Analyses were conducted using IBM SPSS version 22.0 (IBM Corp., Armonk, NY, USA).

Results. A total of 34 patients were screened for eligibility, of whom 6 were excluded for not meeting the inclusion criteria. Twenty-eight patients with end-stage kidney disease and newly created radiocephalic AVFs were enrolled. Of these, 23 (82.1%) completed the 4-week program, while 5 (17.9%) withdrew due to health deterioration ($n = 2$), low training frequency ($n = 2$), or loss to follow-up ($n = 1$). The participant flow is shown in Figure 1.

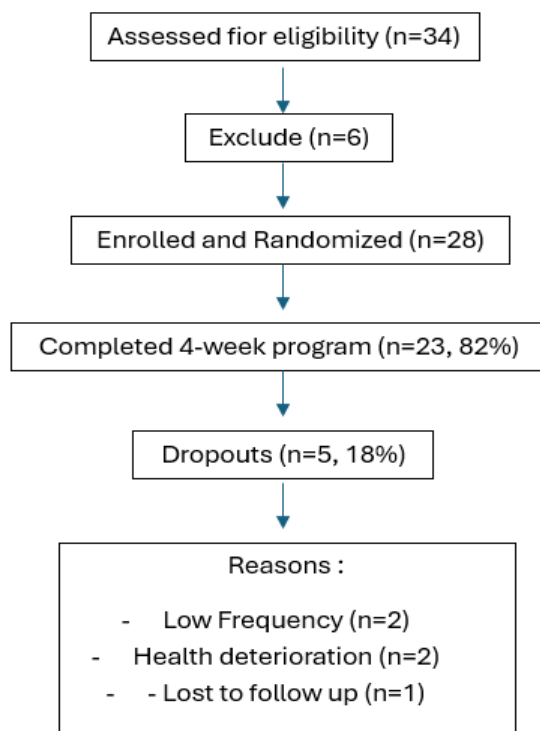


Fig. 1. The study flow chart.

Baseline demographic and clinical characteristics are shown in Table 1.

Table 1

Baseline characteristics of the study participants (n=28)

Variable	Value
Age, years (median, range)	53 (19–67)
Male sex, n (%)	15 (53.6%)
BMI, kg/m ² (mean±SD)	23.9 ± 2.5
Type 2 Diabetes, n(%)	23 (82.1%)
MVIC, kg (mean±SD)	13.3 ± 2.4

Data are presented as mean ± SD, median (range), or frequency (%).

The median age of participants was 53 years (range 19–67), 53.6% were male, and the mean BMI was 23.9 ± 2.5 kg/m². Most patients (82.1%) had type 2 diabetes mellitus, and the mean MVIC was 13.3 ± 2.4 kg.

Overall feasibility outcomes are summarized in Table 2.

Table 2

Feasibility outcomes (n=28)

Outcome	Value
Completed program, n(%)	23 (82.1%)
Dropouts, n (%)	5 (17.9%)
Adherence ≥85%, n (%)	23 (82.1%)
AVF-related adverse event	0
Clinical maturation, n (%)	23 (82.1%)

Of the 28 patients, 23 (82.1%) successfully completed the intervention, and 23 (82.1%) achieved adherence ≥85% of prescribed sessions. No AVF-related adverse events were recorded, and minor transient fatigue was reported in a few participants but resolved spontaneously. Clinical maturation was achieved in 23 patients (82.1%).

Patient feedback is presented in Table 3.

Table 3

Patient acceptability feedback

Feedback	Positive Responses, n (%)
Convenience of daily training	22 (78.6%)
Comfort with WhatsApp	23 (82.1%)
Logbook use	18 (64.3%)
Perceived Benefit	21 (75.0%)

Most participants (78.6%) reported that daily training was convenient and easy to integrate into their routine, while 82.1% found WhatsApp monitoring motivating and helpful. The majority (64.3%) considered the logbook simple to use, although some described it as tedious. Overall, 75% of patients perceived direct benefits from training, such as improved arm strength and greater confidence in fistula use.

Hemodynamic outcomes are shown in Table 4.

Table 4

Pre-post hemodynamic outcome (n=28)

Variable	Pre (M ± SD)	Post (M ± SD)	Δ (M ± SD)	p-value
Vein Diameter (mm)	3.1 ± 0.4	5.5 ± 0.6	+2.4 ± 0.5	<0.001*
Vein Depth (mm)	2.5 ± 0.3	2.1 ± 0.4	-0.4 ± 0.2	0.002*
Blood Flow Volume (mL/min)	180 ± 55	565 ± 110	+385 ± 95	<0.001*

Pre- and post-training hemodynamic parameters measured by Doppler ultrasonography. Values compared using paired t-test or Wilcoxon signed-rank test as appropriate. *p < 0.05 considered significant.

As presented in Table 4, significant changes were observed after 4 weeks of training: vein diameter increased from 3.1 ± 0.4 mm to 5.5 ± 0.6 mm ($\Delta = +2.4 \pm 0.5$ mm, $p < 0.001$), vein depth decreased from 2.5 ± 0.3 mm to 2.1 ± 0.4 mm ($\Delta = -0.4 \pm 0.2$ mm, $p = 0.002$), and blood flow volume increased from 180 ± 55 mL/min to 565 ± 110 mL/min ($\Delta = +385 \pm 95$ mL/min, $p < 0.001$).

Discussion. As a single-group prospective uncontrolled case series, the findings should be interpreted as observational and descriptive rather than causal. The study was intended to assess the feasibility and physiological changes associated with handgrip training, not to confirm the intervention's efficacy. The findings demonstrate that such an intervention is both practical and acceptable, with over 80% of participants completing the program and only a small proportion withdrawing. The five withdrawals (two due to health deterioration, two due to low training frequency, and one due to loss to follow-up) reflect challenges commonly encountered in this patient population rather than exercise-related safety issues. Importantly, no fistula-related adverse events occurred, and significant hemodynamic changes were observed after 4 weeks of training.

We observed an overall completion rate of 82%, with the majority of the patients achieving ≥85% adherence. These findings are comparable with previous studies evaluating exercise interventions in dialysis patients, where adherence rates ranged between 70% and 90% [8, 9]. Kong et al. demonstrated that regular handgrip training could enhance cephalic vein diameter and blood flow, though their study did not report adherence data [9]. Similarly, Poetra et al. found improvements in vascular parameters following exercise but did not assess patient compliance [8]. Our study, therefore, adds new evidence that such programs are not only feasible in real-world settings but also capable of inducing meaningful hemodynamic changes associated with AVF maturation.

No fistula-related adverse events were reported. Minor fatigue was the only complaint, which resolved spontaneously. These results are in line with prior studies suggesting that handgrip exercise is a safe modality for patients with end-stage kidney disease (ESKD) [6]. Chen et al. recently confirmed that both low- and moderate-intensity exercise improved vascular outcomes without complications [12] an advanced program (group B). The absence of adverse events in our study, combined with significant increases in vein diameter and blood flow, highlights that handgrip training was associated with favorable vascular changes without compromising safety.

A unique feature of this study was the use of WhatsApp for remote adherence monitoring. More than 80% of patients rated this approach as convenient and motivating. The combination of video submissions, logbooks, and real-time feedback allowed patients to feel supported while reducing the need for hospital visits. This aligns with broader evidence on the role of digital health in chronic disease management. For example, Ftouni et al. showed that telemedicine platforms such as WhatsApp has been shown to facilitate communication and improved adherence during the COVID-19 pandemic [10], while Dawson et al. demonstrated the feasibility of mobile health tools to promote physical activity in adults [13] but adherence has been poor. Newer mobile health (mHealth). To our knowledge, this is one of the first applications of WhatsApp-based monitoring for AVF rehabilitation in dialysis patients.

Our findings have several implications for clinical practice. First, handgrip training can be implemented safely at home, reducing the need for supervised in-hospital exercise programs, which are resource-intensive. Second, the significant hemodynamic changes observed suggest that even simple, low-burden daily training may support vascular remodeling and may benefit patients. Finally, the integration of digital platforms such as WhatsApp offers a low-cost, scalable solution for supporting adherence, which in turn facilitates the hemodynamic changes observed, particularly in low- and middle-income countries where dialysis services are often under-resourced.

This study has several limitations. The small sample size limits generalizability and statistical power. The intervention duration was short (four weeks), which restricts interpretation of long-term vascular and clinical outcomes such as AVF patency and dialysis adequacy. Adherence data relied partly on self-reports, which may introduce reporting bias despite digital verification. In addition, potential selection bias should be acknowledged, as patients capable of using smartphones and participating in WhatsApp monitoring may differ in motivation or socioeconomic status from those who could not participate. As a single-group case series, the findings should be interpreted descriptively and not as evidence of causality.

Future research should focus on larger multicenter trials with longer follow-up to assess the sustainability of adherence and long-term AVF outcomes. Integration of mobile health platforms into standard dialysis

care should also be explored, including cost-effectiveness analyses and measurement of patient-reported outcomes such as quality of life and satisfaction.

Conclusions. This prospective case series shows that home-based handgrip training is feasible, safe, and well accepted in patients with new AVFs, with high adherence and no complications. The observed hemodynamic changes suggest that this simple, digitally supported program may help AVF maturation and could be integrated into routine dialysis care, particularly in resource-limited settings. Future studies with larger cohorts and longer follow-up are needed to confirm these results and determine the impact of such programs on long-term fistula patency, dialysis adequacy, and patient quality of life.

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Data sharing statement. The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author contributions. All authors contributed to the research strategy, evaluations, research question design, and data analysis strategy. All authors read and approved the final manuscript.

Conflict of interest. The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

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Ethical statement. The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of the Faculty of Medicine, Universitas Hasanuddin, Makassar, Indonesia (approval number: UH24010038, date: [April 14th 2025]).

Informed consent statement. Written informed consent was obtained from all subjects involved in the study prior to participation. Patients were informed about the study objectives, procedures, potential risks, and benefits, and the confidentiality of their data was ensured.

References:

1. Neuen BL, Chadban SJ, Demaio AR, Johnson DW, Perkovic V. Chronic kidney disease and the global NCDs agenda. *BMJ Glob. Heal.* 2017;2(2):e000380. doi: 10.1136/bmjgh-2017-000380.
2. Szczech LA, Lazar IL. Projecting the United States ESRD population: Issues regarding treatment of patients with ESRD. *Kidney Int Suppl.* 2004;66(90):3–7. doi: 10.1111/j.1523-1755.2004.09002.x.
3. Mazzuchi N, Fernández-Cean J, Carbonell E. Criteria for selection of ESRD treatment modalities. *Kidney Int. Suppl.* 2000;57(74):136–143. doi: 10.1046/j.1523-1755.2000.07422.x.
4. Murad MH, Elamin MB, Sidawy AN, Malaga G, Rizvi AZ, Flynn DN, et al. Autogenous versus prosthetic vascular access for hemodialysis: A systematic review and meta-analysis. *J Vasc Surg.* 2008;48(5):34–47. doi: 10.1016/j.jvs.2008.08.044.
5. Aragoncillo I, Ligerero JM, Hevia C, Morales AL, Amézquita Y, Cervera T, et al. Rationale and design of the PHYSICALFAV trial: A randomized controlled trial to evaluate the effect of preoperative isometric exercise on vascular calibre and maturation of autologous arteriovenous fistulas. *Clin Kidney J.* 2018;11(6):841–845. doi: 10.1093/ckj/sfy046.
6. Nantakool S, Rerkasem K, Reanpang T, Worraphan S, Prasannarong M. A systematic review with meta-analysis of the effects of arm exercise training programs on arteriovenous fistula maturation among people with chronic kidney disease. *Hemodial Int.* 2020;24(4):439–453. doi: 10.1111/hdi.12875.
7. Prior BM, Yang HT, Terjung RL. What makes vessels grow with exercise training?. *J Appl Physiol.* 2004;97(3):1119–28. doi: 10.1152/japphysiol.00035.2004.
8. Poetra J, Andriati A, Poerwandari D. The Effect Of Hand Exercise On Grip Strength, Forearm Circumference, Diameter Of Vein, Blood Flow Volume And Velocity In Patient Who Underwent Arteriovenous Fistula Surgery And On Routine Haemodialysis. *Sura Phys Med Rehab J.* 2019;1(1):14. doi: 10.20473/spmrj.v1i1.2019.14-24.
9. Kong S, Lee KS, Kim J, Jang SH. The effect of two different hand exercises on grip strength, forearm circumference, and vascular maturation in patients who underwent arteriovenous fistula surgery. *Ann Rehabil Med.* 2014;38(5):648–57. doi: 10.5535/arm.2014.38.5.648.
10. Ftouni R, AlJardali B, Hamdanieh M, Ftouni L, Salem N. Challenges of Telemedicine during the COVID-19 pandemic: a systematic review. *BMC Med Inform Decis Mak.* 2022;22(1):207. doi: 10.1186/s12911-022-01952-0.
11. Lok CE, Huber TS, Lee T, Shenoy S, Yevzlin AS, Abreo K, et al. KDOQI Clinical Practice Guideline for Vascular Access: 2019 Update. *Am J Kidney Dis.* 2020;75(4):1–164. doi: 10.1053/j.ajkd.2019.12.001.
12. Chen JW, Fu HY, Hii IH, Tseng HW, Chang PY, Chang CH, et al. A Randomized Trial of Postoperative Handgrip Exercises for Fistula Maturation in Patients With Newly Created Wrist Radiocephalic Arteriovenous Fistulas. *Kidney Int Rep.* 2022;8(3):566–574. doi: 10.1016/j.ekir.2022.12.019.
13. Dawson JK, Ede A, Phan M, Sequeira A, Teng HL, Donlin A. Feasibility and Acceptability of a Mobile Health Exercise Intervention for Inactive Adults: 3-Arm Randomized Controlled Pilot Trial. *JMIR Form Res.* 2024;8:e52428. doi: 10.2196/52428.