KI REPORTS
KIReports.org

Digital Lifestyle Interventions in CKD: No Better Time Than Now

Chien-Yao Sun[1,2,3], Jessica Elia[1], Aric A. Prather[4] and Anoop Sheshadri[1,5]

[1]Department of Medicine, University of California San Francisco, San Francisco, California, USA; [2]Department of Geriatrics and Gerontology, National Cheng Kung University Hospital, College of Medicine, National Cheng Kung University, Tainan, Taiwan; [3]Institute of Allied Health Sciences, College of Medicine, National Cheng Kung University, Tainan City, Taiwan; [4]Department of Psychiatry and Behavioral Sciences, University of California San Francisco, San Francisco, California, USA; and [5]Department of Medicine, San Francisco VA Health Care System, San Francisco, California, USA

Kidney Int Rep (2024) **9,** 3358–3361; https://doi.org/10.1016/j.ekir.2024.10.017

See Clinical Research on Page 3204

Individuals with chronic kidney disease (CKD) develop deficits in physical performance and aerobic capacity which become noticeable even in earlier stages of CKD and worsen with disease progression, placing them at an increased risk for frailty compared to individuals with preserved kidney function.[1] Not only can these deficits lead to a reduction in the ability to perform activities of daily living, but also the most frail individuals are at substantially higher risk of disability, hospitalization, and institutionalization.[2] In addition to its detrimental effect on physical functioning, CKD is associated with deficits in emotional and cognitive function; the prevalence of depression is up to 3 times higher among individuals with CKD than in the general population, and the prevalence of cognitive impairment ranges from 30% to 70%, depending on the stage of CKD.[1] In the general population, we have numerous studies showing that individuals across their lifespan engaging in moderate physical activity experience clinically important gains in mental and overall health; even those with underlying medical or psychological complexity.[3] However, such interventions are rarely tailored for individuals with CKD,[3] due both to perceived and actual barriers to implementation.[4] As a consequence, CKD-specific structured lifestyle interventions, including prescription of physical activity remains underutilized.

Digital health interventions (DHIs) present an innovative and scalable approach to promoting behavioral changes essential for managing many chronic conditions, utilizing varied delivery methods such as telephone calls, text messaging, apps, websites, and wearable devices.[5] Despite their efficacy, such interventions are rarely applied to CKD care and are particularly scarce in early stage CKD, where lifestyle interventions have the potential to profoundly alter the disease's progression and its downstream effects on physical, cognitive, and emotional functioning.[6] Before deploying such interventions in CKD on a larger scale, it is critical to establish their efficacy and prudent to establish their cost-effectiveness in meeting the diverse needs of individuals with CKD, which may vary based on stage and disease severity.

The Kidney BEAM Trial was a single-blind, multicenter randomized controlled trial involving 340 adults with CKD stage 2 to 5.[7] Participants were assigned either to a program of twice-weekly, 12-week structured physical activity sessions led by kidney physiotherapists followed by a 12-week self-managed exercise period or a wait-list control group. Of the participants, 18% were receiving dialysis therapy, 35% were kidney transplant recipients, and 47% were with nondialysis dependent CKD. Adherence to the 12-week physical activity program was low at 63%, partially due to a high initial dropout rate. Participants engaged in an average of 44 minutes (1.2 sessions) per week. The trial reported short-term (3-month) improvement in mental health outcomes, physical function, and patient ability to self-manage health behaviors.[8] Moreover, the trial achieved sustainable 6-month improvements in mental health-related quality of life, as measured by the Kidney Disease Quality of Life Short Form 1.3 Mental Component Summary (5.9, 95% confidence interval [CI]: 4.4–7.5) and self-reported outcomes of general health (4.3; 95% CI: 1.7–7.0), physical functioning (6.29; 95% CI: 2.9–9.7), cognitive functioning (7.8; 85% CI: 2.6–12,9), emotional well-being (10.7; 95% CI: 3.1–18.4);

Correspondence: Anoop Sheshadri, San Francisco VA Health Care System, 4150 Clement St, Bldg 203 Rm 3A-29, San Francisco, California 94112, USA. E-mail: anoop.sheshadri@ucsf.edu

sleep (6.5; 95% CI: 3.5–9.5), fatigue (15.5; 95% CI: 12.6–18.4), and burden of CKD (5.3; 95% CI: 2.0–8.6). Other significant self-reported outcomes included improvements in quality of social interaction, physical and emotional roles, and pain. The trial maintained a strong safety profile throughout the intervention. The study estimated costs of £3445.56 per QALY and £14.44 per 1 unit increase in Kidney Disease Quality of Life Mental Component Summary, thereby demonstrating robust cost-effectiveness with probabilities of 75% and 87% below the £20,000 and £30,000 willingness-to-pay thresholds, respectively.

Overall, the Kidney Beam Trial demonstrates that multidisciplinary digital lifestyle interventions may be a cost-effective mechanism for improving clinical and quality of life outcomes in a diverse range of patients with CKD. Furthermore, the fact that individuals in the waitlist control group had a decrease in the Mental Component Summary over the trial period highlights the rapid rate of decline in well-being experienced by individuals with CKD and the potential for lifestyle interventions to mitigate these detrimental effects. Future guidelines in CKD may consider including routine screening and treatment for impairments in emotional functioning, including increased stress, depression, and anxiety. There are some notable limitations to the trial, including the relatively high dropout rate of 39.8% in the intervention group compared to 15.0% in the control group, largely driven by participants' time constraints. It is not clear which participants were most likely to drop out, because subgroup analyses were not reported. However, such information is highly relevant because dialysis-treated adults, for example, report significant barriers toward exercise and it is not clear that this intervention would be equally effective across the spectrum of CKD or whether more frail individuals derived equal benefit. Thoughtful accommodations based on baseline physical functional status may help align the intervention more closely with participants' capabilities, potentially reducing early dropout rates.

Although participants demonstrated significant mental and physical improvements, it is difficult to assess which components of the intervention were responsible for these gains, in part due to a lack of granularity in the outcomes and feedback on the intervention from participants. Future work may consider the collection of more granular objective physical performance measures and exercise metrics in consultation with physical therapy experts. For example, the collection of strength-training repetitions, sets, and intensity would allow exercise volume calculation. More specificity in outcomes, taken alongside feedback from participants, would allow for assessment of whether individual exercises were considered more beneficial or to what extent benefit was derived simply from increased engagement and attention. This is particularly relevant given the prevalence of depression among individuals with CKD, especially in later stages. Such outcomes are also necessary to establish the optimal duration (12–18 weeks) and frequency (1–3 times per week) for interventions to better cater to chronically ill populations.

Finally, future studies may consider analyzing the potential confounding effects of concurrent medication use and sleep quality on mental health outcomes. These factors are known to impact well-being and could confound results.[S1] Research suggests that physical activity interventions can improve well-being in patients with CKD in part by enhancing sleep quality, decreasing fatigue, and alleviating sleep-related symptoms such as sleep apnea and nocturnal hypertension, thereby optimizing sleep durations away from extremes of short and long sleep.[S2–S4] Further investigation is necessary to explore the distinct and complementary mechanisms through which physical activity interventions impact well-being.

The Kidney BEAM trial is an excellent step forward, showing that a DHI can be effective at safely improving quality of life in the short-term and long-term. Furthermore, few other studies have explored the cost-effectiveness of DHIs in CKD. Cost-effectiveness is a highly important consideration for scalability and adoption, especially because this area of research is expanding. Indeed, DHIs using various modalities are being increasingly explored for management of CKD globally, with improvements in activity and physical performance paralleled by improvements in patient self-efficacy, self-management, mental health, and the burden of kidney disease.[S5,S6] Still other studies have reported improvement in cognitive function and emotional functioning through use of such diverse DHIs as virtual reality exergames, cognitive behavioral therapy, or mobile applications with or without wearable components.[S7] Although such studies underscore the potential of DHIs to improve CKD management by promoting physical and emotional well-being through lifestyle and behavioral modifications, the benefits can be highly variable due less to differences in technology and infrastructure, which have already developed sufficiently for DHIs to have a wide-spread impact, but

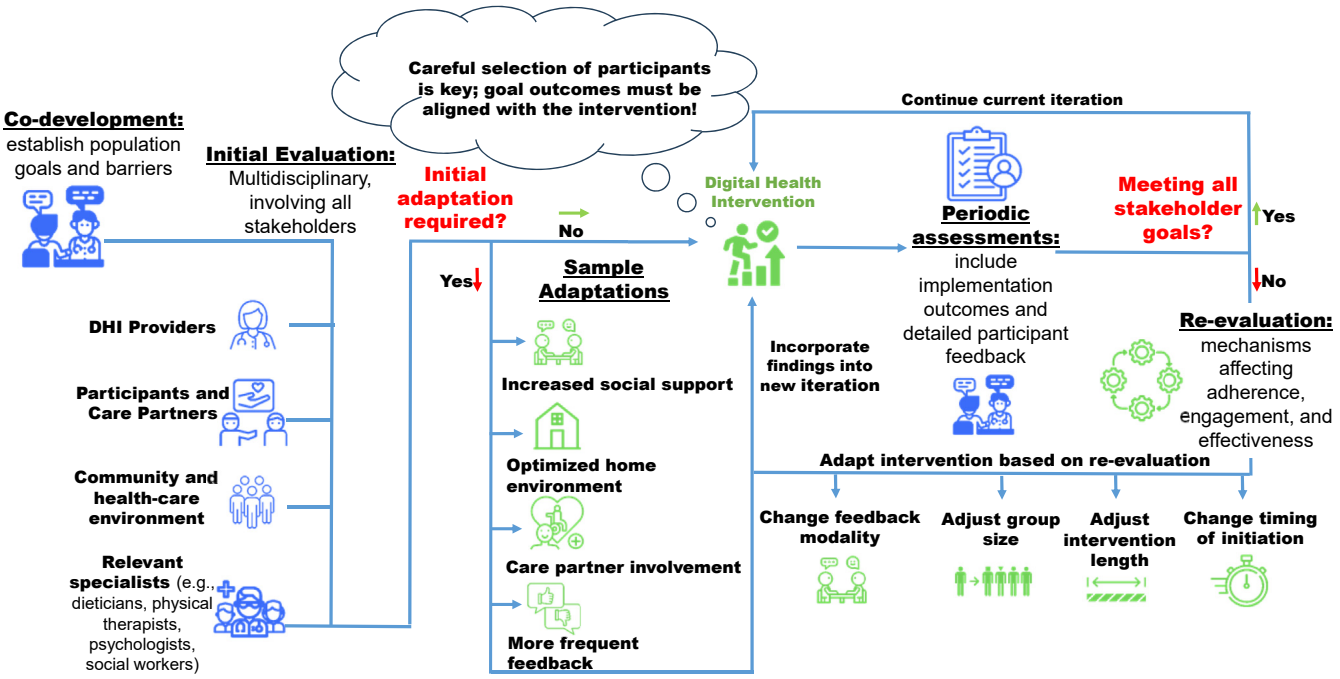

Figure 1. A schematic for developing and maintaining a DHI. This begins with codevelopment, including a careful inventory of stakeholder goals and barriers and comprehensive multidisciplinary evaluation to ensure that any necessary accommodations are in place before deploying the DHI. Crucially, even after deployment of the intervention, it is necessary for periodic assessments with detailed feedback and granular outcome assessment to understand whether the intervention is fully meeting all goals. If not, intervention providers should engage in reevaluation with all stakeholders to dissect intervention outcomes and explore mechanisms underlying variable adherence, engagement, or derived benefit to develop and implement the appropriate adaptations for the intervention. DHI, digital health intervention.

more due to heterogeneity in design and implementation.[S8]

In their current iteration, many DHIs are less effective in engaging and benefiting individuals from older populations, minority ethnic groups, or socioeconomically disadvantaged backgrounds. In the ideal world, such interventions would be codeveloped with the population for whom they are intended and tailored to overcome barriers such as language, lack of electronic health literacy, and disparities in access. For individuals with CKD, this may mean specific accommodation for cognitive impairment, dialysis, or post kidney transplantation. Such accommodations might include involving care partners to promote adherence or routine screening for cognitive and emotional deficits or sleep issues, with appropriate triage to specialists. DHIs also have greater potential for benefit when integrated into health care systems, thereby reducing barriers to implementation, and may have better retention if they employ gamification strategies to promote engagement. These strategies may also allow for improved maintenance of behaviors even after the intervention. Finally, such interventions should be undertaken with room for feedback from stakeholders, including not only participants but also their broader community, allowing for adaptation and evolution to fit the needs of their population. Such partnerships, if appropriately nurtured, have the potential to not only improve outcomes but also alleviate the cost burden for end users. In Figure 1, we show a schematic for how such an intervention might be developed and evolved.

Greenwood *et al.*[7,8] have shown that a thoughtfully codeveloped DHI designed to promote exercise and lifestyle change can cost-effectively improve the well-being of patients with CKD. Future interventions should consider obtaining objective outcomes and collecting specific metrics of exercise (e.g., intensity, volume) to provide more granular data, which can improve individualization of interventions and participant-level feedback to better iterate on successful intervention components. Given the increasing prevalence of CKD and the length of time necessary to develop such interventions, the time to start is already here.

DISCLOSURE

AAP reports personal fees from Headspace and Calm Health, outside the submitted work. All the other authors declared no competing interests.

SUPPLEMENTARY MATERIAL

Supplementary File (PDF)

Supplemental References.

REFERENCES

1. Kittiskulnam P, Sheshadri A, Johansen KL. Consequences of CKD on functioning. *Semin Nephrol*. 2016;36:305–318. https://doi.org/10.1016/j.semnephrol.2016.05.007
2. Mei F, Gao Q, Chen F, et al. Frailty as a predictor of negative health outcomes in chronic kidney disease: a systematic review and meta-analysis. *J Am Med Dir Assoc*. 2021;22:535–543.e7. https://doi.org/10.1016/j.jamda.2020.09.033
3. Marquez DX, Aguiñaga S, Vásquez PM, et al. A systematic review of physical activity and quality of life and well-being. *Transl Behav Med*. 2020;10:1098–1109. https://doi.org/10.1093/tbm/ibz198
4. Clarke AL, Young HML, Hull KL, Hudson N, Burton JO, Smith AC. Motivations and barriers to exercise in chronic kidney disease: a qualitative study. *Nephrol Dial Transplant*. 2015;30:1885–1892. https://doi.org/10.1093/ndt/gfv208
5. Zangger G, Bricca A, Liaghat B, et al. Benefits and harms of digital health interventions promoting physical activity in people with chronic conditions: systematic review and meta-analysis. *J Med Internet Res*. 2023;25:e46439. https://doi.org/10.2196/46439
6. Curtis F, Burton JO, Butt A, et al. Lifestyle interventions delivered by eHealth in chronic kidney disease: a scoping review. *PLoS One*. 2024;19:e0297107. https://doi.org/10.1371/journal.pone.0297107
7. Greenwood SA, Briggs J, Walklin C, et al. Kidney beam-a cost-effective digital intervention to improve mental health. *Kidney Int Rep*. 2024;9:3204–3217. https://doi.org/10.1016/j.ekir.2024.08.030
8. Greenwood SA, Young HML, Briggs J, et al. Evaluating the effect of a digital health intervention to enhance physical activity in people with chronic kidney disease (Kidney BEAM): a multicentre, randomised controlled trial in the UK. *Lancet Digit Health*. 2024;6:e23–e32. https://doi.org/10.1016/S2589-7500(23)00204-2