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Sou +: Reducing health inequities in rural populations with knee osteoarthritis

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Abstract

Knee osteoarthritis (OA) is a highly prevalent and disabling condition, specially in rural areas, due to the economic, social and environmental determinants that impact health and disability in these regions. Furthermore, in terms of accessibility to services, rural areas are at a disadvantage in comparison with urban areas, where accessing services beyond the basics is within reach. Due to barriers associated with isolation, residents in rural areas face greater difficulties in having an appointment with healthcare professionals and even the recognition of the need to seek this care, due to the long-standing consequences of the diagnosis. Exercise and education programs represent core interventions for the management of knee OA and digital technologies have been used to disseminate these programs, with favorable outcomes. Nevertheless, individuals that live in rural areas may have difficulty in accessing these kinds of programs, which can increase segregation and inequity in healthcare. Sou+ aims to create a solution that engages patients, social entrepreneurs, healthcare professionals, health institutions and the community in the mission of successful implementation of an innovative program for patients with knee osteoarthritis in rural areas.

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1. Introduction

Knee OA is a prevalent condition that contributes significantly to a high number of years lived with disability (YLD) worldwide¹. There is evidence that this problem is even more pronounced in rural areas, which also face geographic barriers to healthcare access^{2–4}. e-Health has been proposed as an appropriate strategy to combat these social determinants^{5,6}, but it is critical to understand how to use it in a way that doesn't widen the gap between urban and rural areas, increasing isolation and inequities⁷. The Sou+ project creates a solution that uses digital strategies to disseminate intervention programs for people with knee OA living in rural areas, but in a way that involves the community and allows access to all who can benefit from it. In this article, we present a literature review that frames the problem and possible solutions. Then we develop a theoretical proposal for intervention, specifying the benefits and success factors of the project and propose a pilot project in a rural priority region whose context is familiar to us. Finally, we provide an overview of the impacts of the project and future work.

2. Background

Health inequities are defined by the World Health Organization (WHO) as differences in health status or in the distribution of health resources among different population groups, resulting from the social conditions in which people are born, grow, live, work and age⁸. These conditions are called Social Determinants of Health (SDH) and include social and structural factors that are unevenly distributed among individuals and communities, often as a result of social policies and practices, creating an environment of inequity that negatively impacts health. SDH are believed to account for 30-55% of health outcomes and represent an important area of focus on health disparities in care delivery, policy and research⁹.

Rurality is a known SDH, with rural areas being associated with higher prevalence of different chronic diseases, including knee OA, and their residents as more vulnerable to developing related disability^{2–4}. These findings are most likely related to economic, social and environmental determinants of health that are frequently associated with this populations, such as older age and lower socioeconomic status^{4,10,11}, which is also associated with higher levels of obesity¹², a known risk factor for knee OA^{11,13}. Lower socioeconomic levels, on the other hand, are associated with greater difficulties in accessing health care¹⁴, which, in the case of rural populations, are exacerbated by barriers related to transportation difficulties and the inability to recognize the need for such care^{4,15}.

Knee OA constitutes a highly prevalent rheumatologic disease, being a leading cause of disability worldwide¹. This condition is associated with significant direct costs, particularly those associated with knee replacement surgeries, as well as indirect costs, primarily due to job loss¹⁶. Exercise, maintenance of a healthy body weight, education and self-management programs are first line interventions recommended for the therapeutic management of knee OA^{17,18}. In addition to these recommendations, and taking into account the core issues of current health policies, the role of digital interventions has been emphasized as an innovative strategy for bringing populations closer to healthcare, eliminating regional inequities, and encouraging better access to healthcare services^{5,6}. Favorable outcomes associated with e-Health programs have been reported in rural populations with a variety of health disorders and, specifically, in individuals with musculoskeletal conditions^{19,20}. In knee OA, educational and exercise digital programs were associated with improves in pain intensity, disability²¹, patient satisfaction and adherence to exercise^{22–24}. App-based interventions are the ones that report highest level of exercise adherence²⁴. Nevertheless, it is also acknowledged that individuals impacted by SDH may have difficulty accessing e-Health programs, because they are more likely to face barriers that can exist, including the need for high-level general and digital literacy⁷. In fact, all the determinants associated, in general, with health inequities, and, in particular, with rurality; such as age, socioeconomic level and education, have also been related to lower access and use of digital health²⁵. For this reason, the development of digital solutions should be planned carefully, considering the implementation context, to address the needs of the end-users, in a person-based way²⁶.

3. Sou+: the solution

3.1. Needs that support Sou+

Rural populations are highly affected by different chronic diseases, including knee OA. The therapeutic approach recommended for the management of this condition is exercise and education, as a strategy to increase self-management of these individuals, improving their functionality and reducing costs associated with knee replacement surgery and absence to work. However, these particularly vulnerable population frequently fail access to high-quality healthcare services and to these kinds of programs, which constitutes a concern for Public Health. It has been attempted to address this situation with recommendations of the use of e-Health interventions but, although the enormous

potential of these approaches, it is also acknowledged that many people still do not have easy access to digital devices or face difficulties when using them.

Sou⁺ creates a digital solution that promotes exercise and education as an intervention approach to knee OA in rural areas. Considering the determinants that characterize these populations and the potential limitations that can emerge for digital individual e-Health interventions, Sou⁺ was designed to be implemented in a perspective that promotes community involvement, support in the development of digital literacy and continued follow-up of the participants.

Table 1 provides an overview of the goals, expected benefits and success factors of the Sou⁺ project:

Table 1: Goals, benefits and success factors of the Sou⁺ project

GOALS
Pilot implementation – 2023
Final project implementation in all rural parishes of a council – 2024
At least, 6 participants in each parish until the end of the implementation phase – 2024
Individual attendance of at least 75% of the face-to-face sessions – 2023 and 2024
APP adherence (general use) of 95% - 2023 and 2024
Digital program (exercise and/or other plans) adherence of, at least, a mean of 2 weekly sessions for 90% of participants
Satisfaction level equal or greater than 3 (in a five-points scale) in 75% of participants – 2024
SUCCESS FACTORS
Involvement of different stakeholders, stimulating integrated care at an institutional and community level
Inclusion and proximity to all individuals, promoting access equity
Team expertise in knee OA, clinical pathways and e-Health programs
Continued follow-up of participants and assessment of patient satisfaction and perception of benefit
Cost-effectiveness, with minimal need for human and material resources
Absence of similar programs
MILESTONES
Kick-off event [January 2023]
Requirements Map (identification of required resources and features – space, human, material, APP) [March 2023]
Community stakeholders mapping and identification of available spaces for program implementation [May 2023]
Communication contents and assessment tools selected and prepared [April 2023]
Intervention program contents prepared [February 2023]
APP prototype prepared for pilot implementation [May 2023]
Equipped and prepared facilities [May 2023]
Procurement and contracting tenders [March 2023]
Workshops for health professionals concluded [April 2023]
Pilot implementation [June 2023]
Pilot evaluation and reformulation of the final program and APP [July 2023]
Implementation of the final program – [September 2023]
Closing Event [December 2023]
BENEFITS
Encouragement of exercise and self-management strategies in people with knee OA, living in rural areas
Reduction of inequities in healthcare access, minimizing the impact of social determinants of health in rural populations
Promotion of integrated care for knee OA, with the contribution of healthcare and community institutions
Profitability of resources, by reducing the costs associated with transportation and maximizing the number of patients treated in the same period
Reduction of waiting lists for consultations and physiotherapy

3.2. A theoretical model for successful implementation of Sou+

Sou+ consists of a hybrid program that intends to promote auto-management strategies, including personalized exercise, in rural inhabitants with knee OA. Considering the potential barriers to the use of digital devices by these populations, Sou+ was designed to be constituted by two different phases, aiming to mitigating these difficulties. In an initial phase, the program includes presential community sessions, that consist in educational and exercises classes, but also in the introduction and training of a mobile App Sou+. This App will have different functionalities (Table 2), which include, on one hand, contents that promote health literacy about knee OA, healthy living behaviour, self-management strategies, and motivation tips to increase adherence to the programme; and, in the other hand, the promotion of auto-monitoring routines with the aim of controlling several variables that will allow, with the use of machine learning algorithms, to create, in a second phase, personalized outpatient programs for each participant.

Sou+ App will be developed by a company specialized in digital programming, in partnership with the project management team and will be available for Android and IOS, for maximum reach of potential end users with low level of difficulty and maximum usability.

Phase 1 will consist in a 6-week program, with presential classes scheduled twice a week and conducted by a physiotherapist in municipal and/or community facilities suitable for this purpose. The conditions of these facilities are previously defined and checked by an implementation team, and therefore prepared with the necessary materials. During the phase 1, the participants will be trained by the physiotherapist to use the App during and after the class, which will allow them to learn how to use it and to start monitoring important variables such as level of fatigue, difficulties with a specific exercise, preferences, pain behavior, global perception of effort, among others. All of the features of the APP will be clearly explained to participants during the first face-to-face session, and informed consent will be requested.

In phase 2, after the 6-week program, the participants will be discharge from the presential phase of the program and encouraged to continue to use the APP Sou+ daily, not only to follow the exercise prescription and auto-management tips suggested, but also to continue monitoring the individual response to it. This continued symptom, preference, and satisfaction monitorization will allow the App to constantly readapt the program to the individual needs and preferences of the user.

Table 2: App Sou+ features

APP FEATURES	INDIVIDUALIZED	GENERAL
	AUTO-MONITORING	GEOLOCATION
	Number of exercises performed Exercise score (Individual Preferences) Perception of Effort (Borg Scale) Pain intensity Satisfaction Body Weight (Weekly)	Tracking outdoor activities
	EXERCISE PRESCRIPTION	HELPDESK
	Daily exercise plan (Suggested by the machine learning algorithm, based on the auto-monitoring variables)	FAQs Technical support during working hours
	AUTO-MANAGEMENT TIPS	VIDEOCALLS
	Advice on solutions to remain active Advice on diets plans to reduce bodyweight (when applicable)	Scheduled monthly appointments with physiotherapist
APP SPECIFICATIONS	Android and IOS compatibility Access to Camera, Microphone, Location, Contacts Live Streaming Compatible with wearable devices (eg. Smartwatch) – Possibility of monitoring other variables, such as: calories consumption, heart and respiration rate, VO2 max,...	

Participants can be referred to the program by hospital or primary health care center professionals, namely general practitioners, specialists, family nurses or physiotherapists. Individuals with knee OA may also seek the program spontaneously, by contacting their local parish council. The inclusion criteria for joining the program are: 1) clinical criteria for knee OA - age ≥ 45 years, activity-related knee pain, and morning knee stiffness ≤ 30 minutes); 2) knee pain on most days for 3 months or more; 3) ability to consent, participate, and complete assessments; 4) ability to walk independently²³ and residence in the rural area where the programme is taking place. Participants with 1) active inflammatory arthritis; 2) neurological comorbidity (stroke, spinal cord disease, etc.) or 3) uncontrolled cardiovascular or metabolic diseases²⁷ are excluded.

Once referred to the program, a physiotherapist of the project team does an initial assessment, that intends to confirm inclusion criteria, collect physical and functional data, and check the appropriateness of the participant mobile phone to use the App Sou⁺. Smartphones will be provided for all the participants who do not have cell phones suitable for App installation. As soon as a minimum of three participants is reached, the exercise classes begin. The maximum number of participants in each class depends on the conditions of the facilities and is evaluated case by case. New requests to join the classes are evaluated monthly (Figure 1).

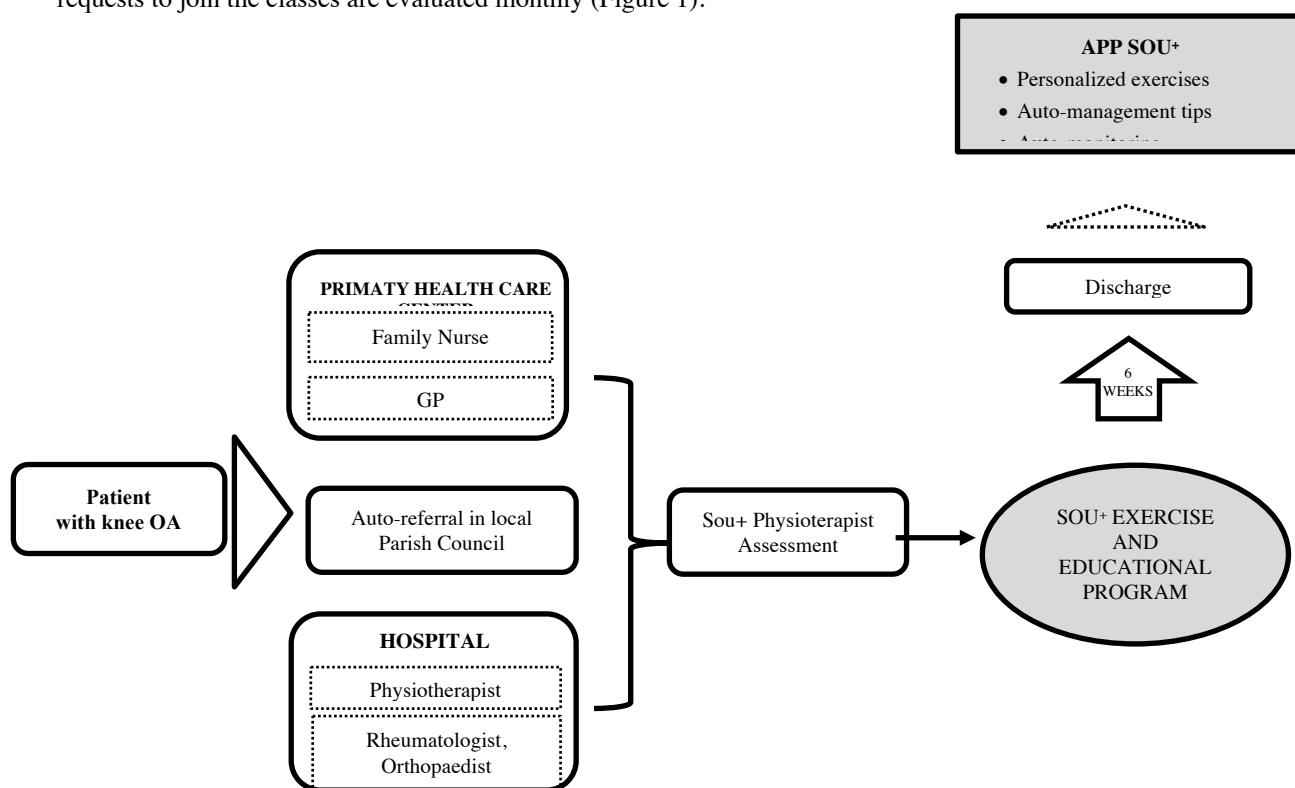


Figure 1: Referral and Sou⁺ pathway

Sou⁺ will also organize community actions creating general awareness about the relevance of physical exercise in lifestyles. The project will engage a wide range of stakeholders in dynamic activities to undertake relevant community actions in connection with SDG 3 (health and well-being). The following levels are considered in the framework that measures the project impact: in health and safety, which focuses on reduced mortality, reduced morbidity and disability, and improved life expectancy; in quality of life, from improved access to healthcare services and reduced inequalities; in sustainable development, in terms of contribution to the sustainable development goals and specific targets.

The activities will also serve the purpose of providing data to public authorities and policy makers about the problem and impact of Sou⁺, giving them relevant knowledge to replicate the project in other regions.

In summary, the project promotes a connection between people with knee OA, health institutions and community services, as municipalities and local services (e.g., geriatric residences). The business model of Sou⁺ is considering different alternatives for funding – tenders from clinical settings or municipalities, competitive calls (Portugal 2030, Resilience and Recovery Plan, Horizon 2020, EiT Health, Portugal Inovação Social), social entrepreneurship

programmes, etc. Hospitals, Town Halls and rural Parish Councils, Primary Health Care Centers, with their extensions in the different rural parishes, Universities and Research Centers, are considered major stakeholders. Rural inhabitants diagnosed with knee OA are the end users of the Sou⁺ solution. The management team is constituted by project and quality managers, experts in applications for funding, PhD students, healthcare professionals, and includes physiotherapists, marketers, public relations specialists, and computer technicians.

3.3 The Pilot

We intend to implement a pilot project in the municipality of Fundão. Fundão is a small city in interior center of Portugal, with 23 parishes, 22 of them considered rural areas. Fundão has 26464 inhabitants, 54,01% of them living out of the urban area.

The health units that serve this populations are the Hospital and the Primary Health Care Center of the city of Fundão. The Hospital has a physiotherapy service with three physiotherapists, one of whom working part-time. This service covers all users in the municipality who are followed up at the Hospital for whom physiotherapy treatments are requested. In the case of knee OA, due to its high prevalence and not being a problem that requires immediate intervention, many patients end up on a waiting list, often for months or even years. When called to start treatment, some of them, namely those residing in rural areas, are faced with the problem of distancing. Advanced age, disability resulting from the condition and low socio-economic status mean that these users are rarely able to travel in their own or public transports, which, in turn, are also very limited in terms of supply. The alternative is ambulance transportation, which significantly increases hospital expenses and which, sometimes, does not cover all patients (due to non-eligibility) and all areas of the municipality, as it is also limited to the availability of the providers. The Fundão Health Center does not have any physiotherapist neither any physical activity or exercise program.

In Table 3, we identify some possible risks for the project implementation and predefined the corresponding management strategies.

Table 3: Potential risks and management strategies

RISK	P	I	RISK MANAGEMENT STRATEGIES
Low adherence of participants	0,3	0,8	Focus on communication plan and follow up of the participants
Low referral by health professionals	0,3	0,2	Focus on workshops for health professionals and community actions for disseminating the project
IT problems	0,3	0,4	Previous technical tests Computer technician available during pilot sessions. Then IT helpdesk.
Pandemic situation that limits group classes	0,3	0,4	Increasing the number of sessions while reducing the number of participants per group
Lack of funding for further development of Sou ⁺	0,5	0,7	Inclusion of experts of public applications for funding in the project team

P: Probability I: Impact

4. Conclusions and future work

Rural populations are in a vulnerable position when it comes to social and environmental determinants and the impact these have on their health status and access to care. e-Health has been emphasized as a way of combating this reality, but no strategies have yet been proposed for instances in which the use of digital interventions becomes, itself, a barrier for these populations. Sou⁺ is a solution that maximizes the benefits of e-Health while defining mitigation strategies for people with low digital literacy. The project involves the community and health providers in the process of promoting knee OA patients' self-management, while creating messages that promote the practice of physical exercise by the general population.

In a recent future, we aim to expand the programme to other rural areas in different municipalities and promote the scale up and massive use of it, so that communities became ambassadors of public health and actively contribute to the implementation of the Sustainable Agenda 2030 in an equitable manner.

5. References

1. Safiri S, Kolahi AA, Smith E, et al. Global, regional and national burden of osteoarthritis 1990-2017: A systematic analysis of the Global Burden of Disease Study 2017. *Ann Rheum Dis*. Published online 2020:1-10. doi:10.1136/annrheumdis-2019-216515
2. Tehrani-Banihashemi A, Davatchi F, Jamshidi AR, Faezi T, Paragomi P, Barghamdi M. Prevalence of osteoarthritis in rural areas of Iran: A WHO-ILAR COPCORD study. *Int J Rheum Dis*. 2014;17(4):384-388. doi:10.1111/1756-185X.12312
3. Boring MA, Hootman JM, Liu Y, et al. Prevalence of Arthritis and Arthritis-Attributable Activity Limitation by Urban-Rural County Classification — United States, 2015. *MMWR Morb Mortal Wkly Rep*. 2017;66(20):527-532. doi:10.15585/mmwr.mm6620a2
4. Shaw KM, Theis KA, Self-Brown S, Roblin DW, Barker L. Chronic disease disparities by county economic status and metropolitan classification, behavioral risk factor surveillance system, 2013. *Prev Chronic Dis*. 2016;13(9):1-12. doi:10.5888/pcd13.160088
5. World Health Organization. *Health 2020. A European Policy Framework and Strategy for the 21st Century*; 2008.
6. World Health Organization. Seventy-First World Health Assembly. *71st World Heal Assem*. 2018;(May):4. http://apps.who.int/gb/ebwha/pdf_files/WHA71/A71_R7-en.pdf?ua=1
7. Smith B, Magnani JW. Health and Digital Health Literacy. *Int J Cardiol*. 2019;Oct 1(292):280-282. doi:10.1016/j.ijcard.2019.05.066.New
8. World Health Organization. Health Inequities and their causes.
9. World Health Organization. Social Determinants of Health.
10. Ali SA, Walsh KE, Kloseck M. Patient perspectives on improving osteoarthritis management in urban and rural communities. *J Pain Res*. 2018;11:417-425. doi:10.2147/JPR.S150578
11. Liu Y, Zhang H, Liang N, et al. Prevalence and associated factors of knee osteoarthritis in a rural Chinese adult population: an epidemiological survey. *BMC Public Health*. 2016;16(1):1-8. doi:10.1186/s12889-016-2782-x
12. Campos-Matos I, Russo G, Perelman J. Connecting the dots on health inequalities - A systematic review on the social determinants of health in Portugal. *Int J Equity Health*. 2016;15(1):1-10. doi:10.1186/s12939-016-0314-z
13. Pereira D, Ramos E, Branco J. Osteoarthritis Osteoartrite. *Osteoarthritis*. 2015;28(enero-febrero):99-106. www.actamedicaportuguesa.com
14. Dimitrovová K, Perelman J. Changes in access to primary care in Europe and its patterning, 2007-12: A repeated cross-sectional study. *Eur J Public Health*. 2018;28(3):398-404. doi:10.1093/eurpub/cky019
15. Cromer KJ, Wofford L, Wyant DK. Barriers to Healthcare Access Facing American Indian and Alaska Natives in Rural America. *J Community Health Nurs*. 2019;36(4):165-187. doi:10.1080/07370016.2019.1665320
16. Salmon JH, Rat AC, Sellam J, et al. Economic impact of lower-limb osteoarthritis worldwide: a systematic review of cost-of-illness studies. *Osteoarthr Cartil*. 2016;24(9):1500-1508. doi:10.1016/j.joca.2016.03.012
17. Kolasinski SL, Neogi T, Hochberg MC, et al. Foundation Guideline for the Management of Osteoarthritis of the Hand, Hip, and Knee. *Arthritis Rheumatol*. 2020;72(2):220-233. doi:10.1002/art.41142
18. Bannuru RR, Osani MC, Vaysbrot EE, et al. OARSI guidelines for the non-surgical management of knee, hip, and polyarticular osteoarthritis. *Osteoarthr Cartil*. 2019;27(11):1578-1589. doi:10.1016/j.joca.2019.06.011
19. Speyer R, Denman D, Hons B, et al. Effects of telehealth by allied health professionals and nurses in rural and remote areas: A systematic review and meta-Analysis. *J Rehabil Med*. 2018;50(3):225-235. doi:10.2340/16501977-2297
20. Cottrell MA, Galea OA, O’Leary SP, Hill AJ, Russell TG. Real-time telerehabilitation for the treatment of musculoskeletal conditions is effective and comparable to standard practice: A systematic review and meta-analysis. *Clin Rehabil*. 2017;31(5):625-638. doi:10.1177/0269215516645148
21. Bennell KL, Nelligan R, Dobson F, et al. Effectiveness of an internet-delivered exercise and pain-coping skills training intervention for persons with chronic knee pain: A randomized trial. *Ann Intern Med*. 2017;166(7):453-462. doi:10.7326/M16-1714
22. Aily JB, Barton CJ, Mattiello SM, Silva D de O, DE NORONHA M. Telerehabilitation for knee osteoarthritis in Brazil: A feasibility study. *Int J Telerehabilitation*. 2020;12(2):137-148. doi:10.5195/ijt.2020.6323

23. Nelligan RK, Hinman RS, Teo PL, Bennell KL. Exploring attitudes and experiences of people with knee osteoarthritis toward a self-directed ehealth intervention to support exercise: Qualitative Study. *JMIR Rehabil Assist Technol*. 2020;7(2). doi:10.2196/18860
24. Patten RK, Tacey A, Pile R, et al. Digital self-management interventions for osteoarthritis: a systematic scoping review of intervention characteristics, adherence and attrition. *Arch Public Heal*. 2022;80(1):1-13. doi:10.1186/s13690-022-00854-x
25. Cheng C, Beauchamp A, Elsworth GR, Osborne RH. Applying the Electronic Health Literacy Lens: Systematic Review of Electronic Health Interventions Targeted at Socially Disadvantaged Groups. 2020;(May 2021). doi:10.2196/18476
26. Yardley L, Morrison L, Bradbury K, Muller I. The person-based approach to intervention development: Application to digital health-related behavior change interventions. *J Med Internet Res*. 2015;17(1):e30. doi:10.2196/jmir.4055
27. Oh S-L, Kim D-Y, Bae J-H, Lim J-Y. Effects of rural community-based integrated exercise and health education programs on the mobility function of older adults with knee osteoarthritis. *Aging Clin Exp Res*. 2020;(0123456789). doi:10.1007/s40520-020-01474-7