



HAL
open science

The interest to expand group-based studies with single-case experimental design studies in the investigation of the effects of physical exercise in frail older adults: an opinion article

Nounagnon Frutueux Agbangla, Caby Isabelle, Cédric T. Albinet

► To cite this version:

Nounagnon Frutueux Agbangla, Caby Isabelle, Cédric T. Albinet. The interest to expand group-based studies with single-case experimental design studies in the investigation of the effects of physical exercise in frail older adults: an opinion article. *Frontiers in Public Health*, 2023, 11, <https://doi.org/10.3389/fpubh.2023.1256645>. <hal-04269189>

HAL Id: hal-04269189

<https://hal.science/hal-04269189v1>

Submitted on 3 Nov 2023

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire HAL, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons CC BY 4.0 - Attribution - International License



OPEN ACCESS

EDITED BY

Mario Bernardo-Filho,
Rio de Janeiro State University, Brazil

REVIEWED BY

José Alexandre Bachur,
University of Franca, Brazil
Vanessa Amaral Mendonça,
Federal University of Jequitinhonha and Mucuri
Valleys (UFVJM), Brazil

*CORRESPONDENCE

Nounagnon Frutueux Agbangla
✉ nounagnon.agbangla@univ-artois.fr

RECEIVED 11 July 2023

ACCEPTED 23 October 2023

PUBLISHED 03 November 2023

CITATION

Agbangla NF, Caby I and Albinet CT (2023) The interest to expand group-based studies with single-case experimental design studies in the investigation of the effects of physical exercise in frail older adults: an opinion article. *Front. Public Health* 11:1256645. doi: 10.3389/fpubh.2023.1256645

COPYRIGHT

© 2023 Agbangla, Caby and Albinet. This is an open-access article distributed under the terms of the [Creative Commons Attribution License \(CC BY\)](https://creativecommons.org/licenses/by/4.0/). The use, distribution or reproduction in other forums is permitted, provided the original author(s) and the copyright owner(s) are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

The interest to expand group-based studies with single-case experimental design studies in the investigation of the effects of physical exercise in frail older adults: an opinion article

Nounagnon Frutueux Agbangla^{1*}, Isabelle Caby¹ and Cédric T. Albinet²

¹Univ. Artois, Univ. Lille, Univ. Littoral Côte d'Opale, ULR 7369 - URePSSS - Unité de Recherche Pluridisciplinaire Sport Santé Société, Liévin, France, ²Laboratoire Sciences de la Cognition, Technologie, Ergonomie (SCoTE-EA7420), Université de Toulouse, INU Champollion, Albi, France

KEYWORDS

nursing homes, long-term care homes, SCED, physical activity, frailty, aging

Introduction

Human population aging is among the most important transformations of the 21st century. The number of older adults will increase significantly in the coming decades (1). While some older adults will experience successful aging that allows them to be physically, cognitively, and socially active (2), others will develop a pathological aging process that could make them frail. “*Frailty is a condition in which the individual is in a vulnerable state at increased risk of adverse health outcomes and/or dying when exposed to a stressor [. . .] Frailty is either physical or psychological or a combination of the 2 components and is a dynamic condition that can improve or worsen over time*” (3). The care of frail older adults has become a public health and policy priority, as shown by the report of the French Economic, Social, and Environmental Council (4). This care, particularly for older adults with special needs living in institutions, involves several interventions: non-medicinal interventions grouped into psychological interventions (art therapy, health education, psychotherapy, zootherapy), physical interventions (physical activity, physiotherapy, manual therapy, thermalism), nutritional interventions (food supplements, nutritional therapy), digital interventions (connected object, video game therapy, virtual reality therapy), and other more or less scientifically validated interventions (lithotherapy, mycotherapy, ergonomic adjustments, phytotherapy, wave therapy, cosmetic therapy, among others) (5). Concerning physical interventions, the synthesis of work in this population shows the beneficial effect of exercise on mental health, cognition (6), and physical health (7). However, an in-depth review of the reported studies examining exercise effects on frail older adults in care settings reveals two major limitations, as outlined in the following section.

Limitations of group-based studies and interest of single-case experimental design in investigating the effects of physical exercise on frail older adults

The first limitation is a lack of individualization of the exercise program in terms of intensity, the type of physical activity, duration, and frequency. For methodological reasons, the exercise programs in different studies have been standardized and offered to older adults participating in the programs. However, older adults in care settings are confronted with varied problems (osteoarticular, sensorimotor, sensory, cognitive, and emotional) and present very different profiles. This difference in profiles should be considered and should not lead to the exclusion of some older adults through inclusion or exclusion criteria. For instance, as recently reported by Brach et al. (8), research in this field is typically biased toward healthy and relatively young older adults, with often the exclusion of individuals as a function of chronological age, particular pathologies or disabilities or even social barriers. The second limitation concerns the experimental design used in most studies in the literature. Most research work in this field consists of randomized controlled, cross-sectional, or longitudinal studies, which are group-based methodologies (9–11). The group-based methodologies focus on the average (or median) of the statistically or empirically constructed groups to perform inferential analyses. This is well-justified to draw conclusions about the effects of physical exercise and to generalize them. However, while group-based methodologies have statistical and methodological strengths that allow reliable and useful conclusions to be drawn for the care of frail older adults, they mask the specificities of each single older individual. In addition, the average person presented in the results does not exist and cannot be equated with all participants or the rest of the population that did not participate in the studies (12). Moreover, one must acknowledge that it appears paradoxical to seek individualization of health care and to use group-based treatments to draw conclusions applicable to each individual. Finally, implementing a group-based interventional study with frail older adults in care settings is often complicated, yet sometimes unfeasible, by methodological, ethical, and practical considerations. Actual randomization beyond participants' wishes, the constitution of experimental and control groups, and individual compliance rates to the programs are some of the problems faced by researchers in this field, which sometimes compromise the quality and validity of group-based studies.

To optimize the effects of physical exercise on older adults in care settings, individualization is often implemented by professionals based on the needs and capabilities of frail older adults. Individualization consists in proposing a physical practice by considering the particularities of each person in terms of needs, abilities, and desires (13). However, once the program has been individualized, it remains difficult to draw causal links of individualized intervention programs. For this reason, the Single-Case Experimental Design (SCED) can be used. SCED is defined as “*designs that are applied to experiments in which one entity is observed repeatedly during a certain period of time under*

different levels of at least one independent variable” [(12), p. 3]. It differs from the case study, where “*single entity is studied intensively, but there is not necessarily a purpose manipulation of an independent variable, nor are there necessarily repeated measures*” [(12), p. 3]. During SCED, comparison between various experimental phases (baseline, treatment, and follow-up phases) allows us to explore a causal or functional relationship between an independent variable and a significant change in the dependent variable (12, 14). According to Tate et al., four types of SCED can be encountered such as withdrawal/reversal design, multiple baseline design, changing design, and alternating treatment design (15). In withdrawal/reversal, an intervention is applied and withdrawn sequentially, whereas multiple baseline design comprises several baselines and allows sequential application of an intervention, which is also introduced in a staggered manner for a specific parameter. For changing design, several hierarchical criteria levels are established and implemented sequentially. Lastly, alternating treatment design enables us to compare several interventions concomitantly, by alternating the application of the interventions (15). From a methodological point of view, each type of SCED demonstrates its strengths and weaknesses. In terms of strengths, the withdrawal/reversal design enables systematic intra-subject replication by including several treatment phases. With respect to the multiple baseline design, it is found to be robust against the adverse effect of non-controllable variables on internal validity. The alternating treatment design and the changing-criterion design avoid the ethical problem of interrupting effective interventions in the withdrawal/reversal design (16). Finally, SCEDs put the individual at the center of the protocol, reduce the gap between researchers and participants, and provide immediate feedback during the intervention to ensure that adjustments can be made if necessary (12). They appear thus particularly appropriate to evaluate the potential effects of individualized programs in care settings. Despite these strengths, each SCED may present specific weaknesses. Disadvantageous effects during withdrawal/reversal design and alternating treatment design include sequential confounding, carryover, and alternation. Indeed, the sequential confounding effect refers to the influence that the order of introducing the interventions may have on the efficacy of one or both interventions. The carryover effect is the influence of one treatment on an adjacent treatment, whatever the influence of the overall sequence. Finally, the alternation effect occurs because the time between interventions is short (16). Concerning the multiple baseline design, repeated measurement of the target behavior over a long baseline period can be difficult and may result in participant reactivity, but draw the participant's attention to an erroneous performance model (16). Finally, the changing-criterion approach applies to a relatively small range of situations (16), such as behavioral problems in autism for example. Furthermore, SCEDs can pose several difficulties for researchers, such as establishing a representative reference base, managing the non-independence of sequential observations, interpreting the effect size of a single subject, and multiplying measurements (at least 3) during each phase. Finally, SCEDs appear appropriate for research questions and contexts where wider generalization is not the main objective. Considering these mentioned strengths and weaknesses, the SCED may present valuable interests in the field of exercise sciences

in the frail population (14). These include the effective study of the individual in the true sense of the word, the control of the practical modalities of an intervention, and the possibility to make necessary adjustments based on continuously collected data (12). In sum, the individualization of the exercise program and the use of the SCED to test its effects in each individual or a homogeneous small group of individuals, with reference to well-defined characteristics, could counteract the principal limitations that we have raised above concerning the group-based designs. Moreover, a new meta-analysis methodology of SCED data has been recently proposed (17) that should stimulate the development of such studies in this field. Nevertheless, the SCED is not exempt from methodological limitations and progress should continue to better increase the quality of experimental protocols, as well as data analyses and study reporting, following recommendations and guidelines (14, 15, 18–20).

Literature reports a tentative use of SCED in frail older adults with dementia and Parkinson's disease (21–25). These studies have tested the effects of cognitive therapies (Psychosocial intervention, Gestalt therapy, Cognitive-behavioral therapy) (21–24) and multimodal therapies (25) on the perceived stress, global cognitive functioning, behavioral and psychological symptoms, depression, anxiety, and independent outdoor activities. One important point is that the results showed that these therapies are efficient for some but not all participants. This kind of findings cannot be reported by group-based studies and calls for developing such SCED studies to better understand qualitatively why and how such programs are beneficial or not to some individuals according to their individual characteristics. However, one must note that, among these reviewed studies, only the study by Yorozuya et al. was conducted in a nursing home and included physical exercises (gymnastics and stretching), which, unfortunately, were not individualized (25). Again, this shows the need to develop more SCED studies to examine the effects of physical exercise in frail older adults.

Conclusion

To sum up, SCED vis-a-vis frail older adults in care settings is rare. Moreover, the few studies in that domain have not directly tested the effects of an individualized physical exercise program on the physical and mental health of frail older adults. Researchers should mobilize to conduct more SCEDs when appropriate, particularly in care settings where they appear relevant. The

multiplication of SCEDs in this research field will enable the supplementation of studies using group-based methodologies to better integrate the quality of individualized care for frail older adults. It will also encourage appreciation of the beneficial therapeutic effects of the intervention (physical exercise) or of individual-level failures, in order to better adjust and regulate the care. SCEDs should target frail older adults suffering from pathologies such as osteoarticular, sensorimotor, sensory, cognitive, and emotional diseases, and those who are typically excluded from group-based studies. This would make it possible to extend existing data on the effects of physical activity in frail older adults.

Author contributions

NA: Conceptualization, Writing—original draft, Writing—review & editing. IC: Writing—review & editing. CA: Writing—review & editing.

Funding

The author(s) declare that no financial support was received for the research, authorship, and/or publication of this article.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The author(s) declared that they were an editorial board member of Frontiers, at the time of submission. This had no impact on the peer review process and the final decision.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

References

1. United Nations Department of Economic and Social Affairs Population Division. *World Population Prospects 2022: Summary of Results*. DESA/POP/2022/TR/NO.2 3. New York, NY: UN (2022).
2. Rowe JW, Kahn RL. Successful aging. *Gerontologist*. (1997) 37:433–40. doi: 10.1093/geront/37.4.433
3. Morley JE, Vellas B, Van Kan GA, Anker SD, Bauer JM, Bernabei R, et al. Frailty consensus: a call to action. *J Am Med Dir Assoc*. (2013) 14:392–7. doi: 10.1016/j.jamda.2013.03.022
4. Chassang M, Economic, Social and Environmental Council. *Prevention of Loss of Autonomy Due to Aging*. Paris: les éditions des journaux officiels. Report No: 2023–009 (2023).
5. Ninot G. *Non-Pharmacological Interventions An Essential Answer to Current Demographic, Health, and Environmental Transitions*. Cham: Springer (2021).
6. Da Silva JL, Agbangla NF, Le Page C, Ghernout W, Andrieu B. Effects of chronic physical exercise or multicomponent exercise programs on the mental health and cognition of older adults living in a nursing home: a systematic review of studies

- from the past 10 years. *Front Psychol.* (2022) 13:888851. doi: 10.3389/fpsyg.2022.888851
7. Wang F, Tian B. The effectiveness of physical exercise type and length to prevent falls in nursing homes: a systematic review and meta-analysis. *J Clin Nurs.* (2022) 31:32–42. doi: 10.1111/jocn.15942
 8. Brach M, de Bruin ED, Levin O, Hinrichs T, Zijlstra W, Netz Y. Evidence-based yet still challenging! Research on physical activity in old age. *Eur Rev Aging Phys Act.* (2023) 20:7. doi: 10.1186/s11556-023-00318-3
 9. Navarrete-Villanueva D, Gómez-Cabello A, Marín-Puyalto J, Moreno LA, Vicente-Rodríguez G, Casajús JA. Frailty and physical fitness in elderly people: a systematic review and meta-analysis. *Sports Med.* (2021) 51:143–60. doi: 10.1007/s40279-020-01361-1
 10. Weng WH, Cheng YH, Yang TH, Lee SJ, Yang YR, Wang RY. Effects of strength exercises combined with other training on physical performance in frail older adults: a systematic review and meta-analysis. *Arch Gerontol Geriatr.* (2022) 102:104757. doi: 10.1016/j.archger.2022.104757
 11. Zhao J, Chau JPC, Lo SHS, Choi KC, Liang S. The effects of sitting Tai Chi on physical and psychosocial health outcomes among individuals with impaired physical mobility: a systematic review and meta-analysis. *Int J Nurs Stud.* (2021) 118:103911. doi: 10.1016/j.ijnurstu.2021.103911
 12. Vlaeyen JWS, Onghena P, Vannest KJ, Kratochwill TR. Single-case experimental designs: clinical research and practice. In: Asmundson GJG, editor. *Comprehensive Clinical Psychology*. Vol. 3, 2nd ed. Elsevier (2022). p. 1–28.
 13. Simard C. *Guide d'intervention en activités physiques adaptées à l'intention des kinésiologues*. 1st ed. In: Maiano C, Hue O, Moullec G, Pepin V, editors. Presses de l'Université du Québec (2020). doi: 10.2307/j.ctv1n35dcr
 14. Smith JD. Single-case experimental designs: a systematic review of published research and current standards. *Psychol Methods.* (2012) 17:510–50. doi: 10.1037/a0029312
 15. Tate RL, Perdices M, Rosenkoetter U, Shadish W, Vohra S, Barlow DH, et al. The single-case reporting guideline in behavioural interventions (SCRIBE) 2016 statement. *Aphasiology.* (2016) 30:862–76. doi: 10.1080/02687038.2016.1178022
 16. Tate R, Perdices M. *Single-Case Experimental Designs for Clinical Research and Neurorehabilitation Settings: Planning, Conduct, Analysis and Reporting*. 1st ed. New York, NY; London: Routledge (2018). doi: 10.4324/9780429488184
 17. Moeyaert M, Manolov R, Rodabaugh E. Meta-analysis of single-case research via multilevel models: fundamental concepts and methodological considerations. *Behav Modif.* (2020) 44:265–95. doi: 10.1177/0145445518806867
 18. Ganz JB, Ayres KM. Methodological standards in single-case experimental design: raising the bar. *Res Dev Disabil.* (2018) 79:3–9. doi: 10.1016/j.ridd.2018.03.003
 19. Lane JD, Gast DL. Visual analysis in single case experimental design studies: brief review and guidelines. *Neuropsychol Rehabil.* (2014) 24:445–63. doi: 10.1080/09602011.2013.815636
 20. Tanious R, Onghena P. A systematic review of applied single-case Research published between 2016 and 2018: Study designs, randomization, data aspects, and data analysis. *Behav Res Methods.* (2021) 53:1371–84. doi: 10.3758/s13428-020-01502-4
 21. Jeste DV, Glorioso DK, Depp CA, Lee EE, Daly RE, Jester DJ, et al. Remotely administered resilience- and wisdom-focused intervention to reduce perceived stress and loneliness: pilot controlled clinical trial in older adults. *Am J Geriatr Psychiatry.* (2023) 31:58–64. doi: 10.1016/j.jagp.2022.07.006
 22. Merizzi A, Biasi R, Zamudio JFÁ, Spagnuolo Lobb M, Di Rosa M, Santini S. A single-case design investigation for measuring the efficacy of gestalt therapy to treat depression in older adults with dementia in Italy and in Mexico: a research protocol. *Int J Environ Res Public Health.* (2022) 19:3260. doi: 10.3390/ijerph19063260
 23. Olsson A, Engström M, Åsenlöf P, Skovdahl K, Lampic C. Effects of tracking technology on daily life of persons with dementia: three experimental single-case studies. *Am J Alzheimers Dis Other Dement.* (2015) 30:29–40. doi: 10.1177/1533317514531441
 24. Reynolds GO, Saint-Hilaire M, Thomas CA, Barlow DH, Cronin-Golomb A. Cognitive-behavioral therapy for anxiety in Parkinson's disease. *Behav Modif.* (2020) 44:552–79. doi: 10.1177/0145445519838828
 25. Yorozuya K, Tsubouchi Y, Kubo Y, Asaoka Y, Hayashi H, Fujita T, et al. Effect of a multimodal non-pharmacological intervention on older people with dementia: a single-case experimental design study. *BMC Geriatr.* (2022) 22:906. doi: 10.1186/s12877-022-03501-w