

CA20104 – Network on evidence-based physical activity in old age (PhysAgeNet)

Deliverable D2.3

D2.3. Open data framework including PA intervention and multiple data sources and biomarkers

RCO 2 Provide a consistent open data framework for all relevant biomarkers and other factors from RCO 1

Contributors

Working Group 2

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Participants in the expert discussions and review groups have all contributed to these results.

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1. INTRODUCTION

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The United Nation's decade of Healthy Ageing highlights the growing importance of addressing the challenges associated with the ageing population. Health benefits of physical activity in old age are well accepted, but there is no consensus on specific concepts and measures to be used for assessing intervention outcomes, leading to a wide variety of reporting. When implementing physical activity interventions in real-life settings, various factors affect the uptake of the intervention, adherence to the protocol, and sustained participation. Thus, research on physical activity interventions should assess not only outcomes, but also other factors functioning as moderators or mediators of the interventions. This requires a holistic focus, encompassing not only more traditional physical or biological biomarkers, but also behavioral and environmental markers.

To advance the measurement and monitoring of (technology-assisted) physical activity intervention outcomes as well as factors related to their uptake and maintenance in old age, the PhysAgeNet COST action network brought together researchers from different European Universities. In 2022, experts collaborating in workgroup 2 started to discuss and clarify biological and behavioral biomarkers and environmental factors comprehensively. Jointly the results of WG2 will establish requirements and a roadmap for future monitoring of interventions and eventually lead to a framework for open data and multiple source data for utilizing comprehensive and relevant assessments in multiple domains, i.e., a large variety of biomarkers and behavioral markers, as well as environmental factors, in technology-assisted physical activity (PA) and exercise interventions.

To conceptualize and order the comprehensive assessments relevant for (technology-assisted) physical activity interventions in a theoretical framework, it was decided to use the Healthy Ageing framework developed by the WHO (2015). While developed to map the aging process, it focuses on healthy aging, that is, maintaining functional ability and overall well-being in older age, rather than solely focusing on disease management. The framework identifies intrinsic and extrinsic factors and linked functional domains, and according to the literature and experts involved, these capture concepts relevant to physical activity interventions.

To facilitate topical discussions on the broad range of parameters in the Healthy Aging Framework, WG2 was split into more specific expert groups. Three groups focus on intrinsic capacity: 1) Locomotor and vitality capacity and function, 2) Cognitive capacity and function, and 3) Psychological factors; and one group on external factors: 4) Environmental factors. Some of these groups were further divided into subgroups working on reviews focusing on specific topics. In total, 8 reviews have been or will be submitted until late 2024/early 2025, providing the basis to develop a data framework.

We acknowledge that while targeting a holistic approach, it was not possible to cover all aspects of the Healthy Aging Framework. However, the reviews cover various topics from biomarkers to behavioral and environmental factors, leading to the possibility of compiling evidence from different aspects relevant to physical activity and exercise interventions.

The results of searches and analyses for each review have been compared to each other and used to generate lists of concepts and variables relevant to assess in the context of physical activity interventions or technology-assisted physical activity interventions in older adults. Based on the expert discussions, we decided to categorize the concepts and variables into three categories.

. Variables have been categorized as:

1. Universal and essential concepts or variables to assess and report when conducting physical activity interventions in general. These are variables found to be relevant for all or almost all review groups, regardless of the review topic. These variables are essential to be collected in studies and reported when planning data sharing.
2. Novel and promising concepts or variables to assess when conducting physical activity interventions in general. These are identified based on existing literature as well as expert opinions during the review processes.
3. Recommended variables in particular physical activity intervention contexts.

2. RESULTS

2.1. Universal and essential concepts or variables

Table 1. Universal and essential concepts or variables to assess and report when conducting technology-assisted physical activity intervention

Study information	Details or examples
Name / title	
Authors / Contact person	
Objectives	
Study design	
Design	E.g. RCT
Number of assessment time points; and time points	
Setting	Home vs. Community vs. Institution etc.
Country	
Participants	
Participants total	
N	
Age	in years: mean, sd, range
Gender/sex ratio	%female
Inclusion criteria	
Exclusion criteria	
Participants intervention group	
N	
Age	in years: mean, sd, range
Gender/sex ratio	%female
Participants control group	
N	
Age	in years: mean, sd, range
Gender/sex ratio	%female
Intervention	
Duration	Overall intervention duration
Frequency	Number of sessions per week
Supervision	No or yes; if yes: how
Physical activity components	Types of exercises, intensity
Technology: device	E.g., computer, smartphone, wearable device, smartwatch
Technology: function	Specify what the technology does
Outcomes	
Primary outcomes	e.g. motor capacity
Primary outcome measurements	e.g. SPPB

2.2. Novel and promising concepts and recommended variables from each review group

2.2.1. LOCOMOTOR AND VITALITY CAPACITY AND FUNCTION

Author: Emelyn Mathot

A key concept in Healthy ageing is intrinsic capacity, referring to the physical and mental capacity an individual can draw on at any given time and consists of 5 domains including locomotor, psychological, sensorial, cognitive, and vitality domains. Locomotor and vitality capacity are two domains of intrinsic capacity and have recently been redefined by an expert taskforce initiated by the WHO. A new WHO working definition of vitality capacity (VC) has been proposed by 20 international experts in an expert meeting, defining VC as "a physiological state (due to normal accelerated biological ageing processes) resulting from the interaction between multiple physiological systems, reflected in (the level of) energy and metabolism, neuromuscular function, and immune and stress response functions of the body" (Bautmans et al., 2022).

Our umbrella review focused on the effects of exercise on the most prominent circular pro- and anti-inflammatory markers, biomarkers which are part of the third domain of vitality capacity, namely the immune and stress response functions of the body. When reporting on these biomarkers, it is crucial to report the timing of blood sampling, as a timing within 24 hours after the last exercise session still encompasses the acute effects of exercise, while sampling 24 hours after the last exercise session is generally accepted to represent the effects on basal levels. Although several reviews and primary research articles, included in our umbrella review, have been published reporting these biomarkers, the timing of sampling is often not reported clearly yet. Moreover, although in the past, biomarkers were usually measured in blood samples, a rise in articles describing the use of alternative biological materials, such as saliva or breath condensate, have been described. Moreover, a rise in papers describing often less invasive sampling methods, such as finger pricks for blood or saliva swab have also been observed. It will thus become increasingly important to consistently describe both biological materials and sampling methods since differences in outcome compared to classical blood sampling methods may arise.

2.2.2. NEUROMUSCULAR FUNCTION

Author: Orgesa Qipo

As mentioned above, another construct of vitality capacity is neuromuscular function (Bautmans et al., 2022). Neuromuscular function, often assessed through grip strength (Dodds et al., 2014) using a hand-held dynamometer, has been proposed as a biomarker of aging. In community-dwelling older adults, it serves as a strong predictor for outcomes such as disability, falls and mortality (Bohannon et al., 2019).

We focused on the effects of technology-assisted physical activity interventions on a) muscle mechanical function and b) on circulating biomarkers of neuromuscular function in community-dwelling older adults aged 60 years old and above.

2.2.3. COGNITIVE CAPACITY AND FUNCTION

Author: Wouter Vints

The cognitive domain of intrinsic capacity is well studied previously. In general, cognitive decline starts from the age of 20-25 (Tucker-Drop 2019). At a certain age, nearly 100% of individuals will suffer functional ability losses due to cognitive impairment (Petersen 2011). An increasing number of studies have shown that physical exercise can prevent or delay the process of cognitive decline and decades of research has led to fulfilling Hill's criteria for causality (Dupuy et al. 2024). However, despite the vast amount of work that has already been done and several hypotheses that have been postulated concerning the mechanisms of the beneficial effect of physical exercise on cognition, there remains lack of consensus regarding the role of each of these postulated mechanisms. Evidence, yet mostly from animal research, suggests that exerkines (all of the peptides, metabolites, and nucleic acids released into the bloodstream during and following physical exercise) can activate neurophysiological processes related to neuroplasticity, underlying the beneficial effect of physical exercise on cognitive function (Vints et al. 2022). A challenge in this area is that the number of discovered exerkines is rapidly growing, most with unknown effects. Considering only the exerkines released from muscle cells (i.e. myokines), more than 1,000 putative myokines have been reported in literature (Vints et al. 2023).

We are presently conducting a living meta-analysis in which we plan to perform a mediation analysis on the role of myokines in the effect of physical exercise on cognitive function. After publication, the results of this meta-analysis will continuously be updated every six months for a time period of at least 5 years. The review is ongoing for about two years and since then 4 to 6 new studies were added to the review yearly. A total of 40 studies are now included. The myokines most commonly evaluated in studies that reports physical exercise effects on cognitive function are: BDNF, IGF-1, VEGF, Irisin (neurotrophic factors), IL-6, TNF- α and CRP (pro-inflammatory factors) measured from blood samples. In general, cognitive functions improved, neurotrophic factors increased and pro-inflammatory factors decreased following physical exercise. Mediation analysis is now ongoing, and results are expected by December 2024.

Next, we are conducting a scoping review on the effect of physical exercise on muscle and brain metabolites measured with Magnetic Resonance Spectroscopy (MRS). This technique allows the examination of metabolic changes at muscle and brain level. MRS is not commonly used yet and our goal is to compile all the findings from exercise-induced changes in MRS metabolites, irrespective of the intended outcome, both in muscle and brain. This work is aimed to be published early 2025 and will hopefully allow us to make recommendations for the use of this technique in research, address knowledge gaps and future directions.

2.2.4. PSYCHOLOGICAL FACTORS

Author: Tiia Kekäläinen and David Beckwée

Physical activity (PA) is a proven method to enhance the health of older adults, but following the intervention protocols is crucial for achieving optimal results. According to the World Health Organization (WHO), adherence is defined as the 'extent to which a person's behaviour corresponds with agreed recommendations from a healthcare provider' (WHO 2003). This means that adherence reflects how well the target intensity and volume of physical exercises are maintained over time (Hawley-Hague et al. 2016). Patients often face multiple barriers that hinder their ability to follow intervention plans effectively, which are typically linked to various aspects of the issue. Therefore, adherence to exercise is deeply rooted in the participant's psychological determinants and behaviour (Collado-Mateo et al. 2021).

Adherence to technology is even more critical for achieving better intervention outcomes. Technologies can enhance exercise uptake and long-term adherence by overcoming many perceived barriers to exercise. Additionally, compared to traditional rehabilitation, technologies such as serious games can use engaging videos and images, making them more attractive and acceptable, as well as more effective due to the higher diversity of tasks that can be trained. These technologies can provide timely feedback, continuous monitoring, and outcome assessment, thereby informing the instructor for personalized adaptations.

However, when using technology, users' adherence to the technology itself (in addition to the intervention) is a distinct factor that needs to be considered (Payne et al. 2015). Technological interventions often suffer from rapidly declining retention rates (Chen et al. 2015). Moreover, many commercially available health technologies are not well-grounded in behavioural theory and have not been thoroughly tested for their efficacy (Payne et al. 2015). The rapid pace of new technology development makes it increasingly challenging for researchers to develop, pilot-test, and evaluate interventions before such technologies become outdated or obsolete (Baker et al. 2014).

Hence, the aim of our scoping review is to identify psychological and motivational factors that contribute to older people's adherence when they use technology to support physical activity interventions. This work is currently (in November 2024) in progress and aimed to be submitted in early 2025.

2.2.5 ENVIRONMENTAL FACTORS

Author: Carl-Philipp Jansen

Despite the fast-growing domain of technology-assisted PA interventions in older adults, the role of environmental factors is still emerging in this field. Studies identified in this scoping review mainly focused on social environmental factors, followed by physical environmental factors. Studies that integrate socioeconomic and systemic environmental factors in technology-assisted PA interventions are scarce. Included environmental factors were found to play a supportive role in achieving beneficial effects of technology-assisted PA interventions. Studies reviewed were, however, heterogeneous in that environmental factors included were part of the experimental design, effect modifiers, or outcomes. There is a significant potential for a better understanding of intervention outcomes, and better tailoring of intervention programs when systematically including environmental aspects in technology-assisted PA interventions in older adults.

From this review, the training delivery modes (individual vs. group and independent vs. face-to-face vs. remote/virtual support) seems to be an important contextual factor to consider. Furthermore, perceived social support and social interactions during training facilitate intervention adherence and outcomes.

3. CONCLUSIONS

Author: Tiia Kekäläinen

The PhysAgeNet COST action network WG2 has focused on understanding relevant concepts and factors to assess and report in (technology-assisted) physical activity interventions for older adults. These concepts and variables provide a basis for an open data framework.

It is important to note that most of the reviews are still in progress, and the final remarks, particularly for variable categories 2 (novel and promising concepts) and 3 (recommended variables in specific contexts), will be reported later. Preliminary results suggest that more research is needed in most areas to identify and recommend specific variables. We will continue the expert discussions and open data framework development when the results of the reviews are ready in 2025. This ongoing work will continue to refine these concepts and contribute to the development of robust, evidence-based strategies for improving the health and well-being of older adults through technology-assisted physical activity interventions.

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