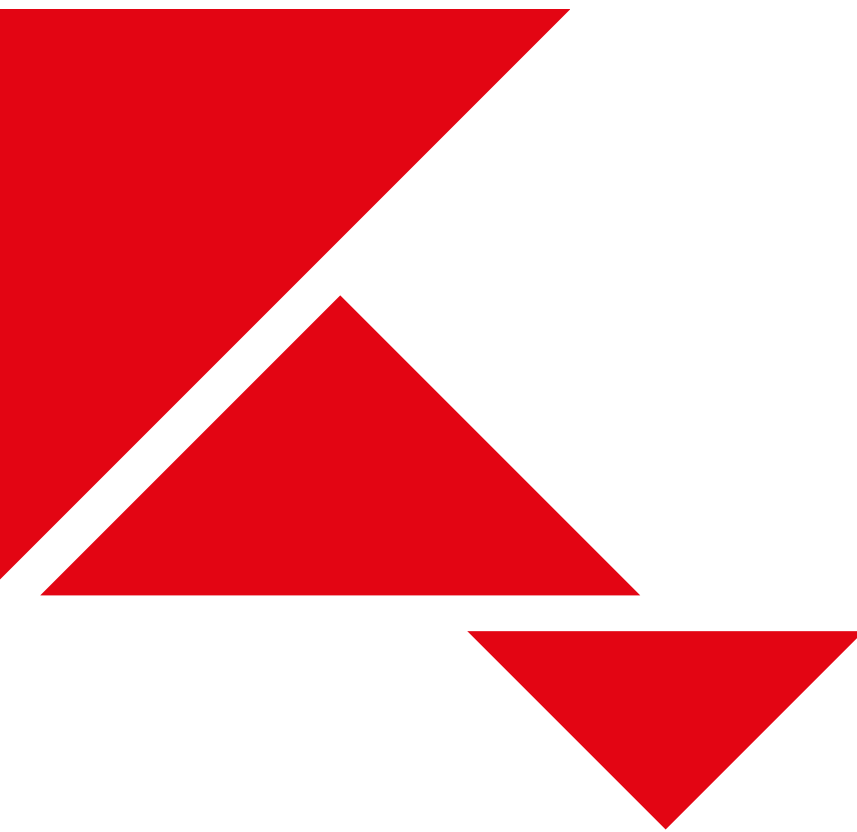# Informing optimal strategies for public health interventions targeting mental health and cognitive functioning for older adults in Switzerland: A co-creation guided desk review

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Abstract

Objective:This desk review was conducted as part of the ADVANCE project, which aims to enhance our understanding of mental health promotion and prevention. The review's objective was to evaluate the current state of interventions that address mental health and cognitive functioning among older adults in Switzerland, focusing on the features of these interventions as well as Swiss-specific contextual factors that contribute to vulnerability and stigma.

Methods: We searched PubMed, PsycINFO, and Scopus for eligible studies from January 2018 until September 27th, 2023. We reviewed studies investigating interventions targeting mental health and cognitive functioning in older adults living in Switzerland and grey literature reporting on mental health, well-being, cognitive functioning, stigmatization, and stigma mitigation strategies. Core features of the interventions (intervention type, efficacy, delivery modes, recruitment, stigma-related aspects) and targeted populations (vulnerable groups and stigma sources) were extracted and descriptively summarised. In a co-creation process with different stakeholder the extracted data resulted in four potential intervention scenarios depicting the different key-design features target group, modality, recruitment.

Results: A comprehensive search resulted in 1046 records, with 25 peer-reviewed articles and five grey literature reports meeting the inclusion criteria. The population of older adults included in the studies encompassed a heterogeneous group, characterized by various vulnerabilities and stigma associated with age-related stereotypes and discrimination. Accordingly, the intervention types were also diverse, including mainly process based cognitive training or multimodal interventions. The interventions were implemented through a range of delivery modes, involving different combinations of location (on-site vs. digital) and format (individual vs. group). Participants recruitment included a wide range of recruitment sites and strategies. All four resulting potential intervention scenarios aimed to include a representative sample to encompass a broad range of vulnerabilities. The scenarios vary in their delivery modes, ranging from a 'fully digital - individual' mode to a more diverse mode that integrates various combinations of location and format. However, 'offliners' would currently be excluded from these scenarios.

Conclusion: The review highlights the complex nature of mental and cognitive health challenges along with the implementation of effective public health interventions. A key challenge highlighted is the inclusion of 'offliners' in scalable interventions. Addressing this issue is crucial for comprehensive public health strategies.

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1. Introduction

1.1. Conceptional background of the study

This desk review was conducted within the scope of the EU Horizon Europe-funded ADVANCE project (https://advancementalhealth.ku.dk/). ADVANCE is a project that aims to improve our understanding on mental health promotion and prevention. It will develop guidance and methodologies for creating, adapting, implementing, assessing, and expanding effective mental health initiatives for key vulnerable groups in different European countries: migrant in Italy and Denmark, youth in Lithuania and Germany, working adults in The Netherland, and older adults in Switzerland.

At the start of the project, the ADVANCE consortium initiated a co-creation process aimed at jointly identifying key characteristics of vulnerable target groups, as well as potential interventions. Therefore, as a first step, a country-specific desk review was conducted for each vulnerable target group. A desk review is a timely targeted literature review that synthesizes available information from existing sources. The scope of desk reviews is defined by the need for specific knowledge to inform program design and service delivery. This type of review offers an efficient means of consolidating accessible knowledge to support programmatic decision-making within a short timeframe: (1) it offers external stakeholders a concise summary of extensive literature, (2) it produces a well-crafted document authored by experts skilled in the research topic and the review methodologies, and (3) it minimizes the necessity for on-site practitioners to gather background information, allowing them to allocate more time to their primary service delivery responsibilities. Desk reviews can serve as an important first step in achieving balance between internationally recommended interventions and appropriate local practices. Unlike broader scoping reviews which map key concepts to identify research gaps, or systematic reviews that offer detailed analyses with explicit methods, desk reviews are faster and more cost-effective, making them suitable for projects that require rapid, preliminary insights on specific topics (Greene et al., 2017). This working paper is the result of the desk review conducted by the authors, who are the scientific leaders of Work Package 5 (WP5), focusing on mental and cognitive health in older adults.

1.2. Older adults living in Switzerland

As the tide of global aging rises, the urgency for informed public health interventions and policy development in the domain of gerontology becomes paramount. This desk review sets out to assess the current state of the art in interventions targeting mental health and cognitive functioning in older adults living in Switzerland. Mental health in the elderly is characterized

not only by the absence of mental disorders but also by the presence of emotional resilience and the capacity to navigate life's challenges. Cognitive functioning, encompassing memory, attention, language, and problem-solving abilities, is equally vital for autonomy and well-being in later life. Vulnerability, within this context, denotes the susceptibility of older individuals to mental and cognitive decline, a concern that must be addressed proactively in policy frameworks.

Many studies have shown that mental health and cognitive functioning are pivotal determinants of quality of life in older adults, a group that is steadily increasing, particularly in highly developed nations such as Switzerland. Switzerland, with its high standard of living and robust social security and health care systems, presents a unique showcase for examining how mental health in older adults is both protected and challenged within Europe. As the most recently published Swiss Health Survey 2022 (Federal Statistical Office, 2022) shows, aging in the Swiss context does not shield one from the vulnerabilities associated with declining mental health and cognitive functioning. Biological aging, psychological stress, socioeconomic inequality and even the potential social isolation in a society as diverse as Switzerland's, are all factors that can affect an older adult's mental and cognitive health. As revealed by the survey, 13% of the population state that their state of health is worse than before the COVID-19 pandemic, an effect that is dramatically increased among the population with lower educational background. This assessment is particularly common among people aged 75 and over. Moreover, even though the majority of older people are in good mental health, 10% of men and 17% of women state that they present with a medium or even high mental health burden.

A particular challenge in this context is the well documented increase in problems regarding cognitive functioning, from normal age-related decline in central cognitive functions that underlie independent and autonomous everyday life in the digital era to the dramatic rise of age-associated neurodegenerative diseases such as Alzheimer's dementia or Parkinson. Currently, about 153,000 people are living with dementia in Switzerland. Each year, there are 32,900 new cases (Alzheimer Schweiz, 2023). These developments not only represent one of the key threats to well-being in old age but are also responsible for billions of Euros in health care costs in old age (Kraft & Simon, 2019; Wieser et al., 2014). Knowing that mental health, depression and stress critically interact with cognitive health, and doing so particularly in subpopulations with lower educational background and compromised socioeconomic reserves, underlines the multifaceted challenges in this area for healthcare

systems, policymakers, and society at large (Bauermeister & Bunce, 2014; Ihle et al., 2018; Wang & Blazer, 2015).

1.3. Interventions targeting mental health and cognitive functioning

Worldwide, a variety of interventions aimed at stabilizing and promoting mental health in older adults have been studied and demonstrated to be effective. Interventions targeting mental health include for instance psychological process-focused interventions. Those are often inspired by cognitive-behavioural therapy principles, where the goal is to reframe problematic thoughts and cognitions or teach strategies to mitigate their negative psychological impact, as seen in the Self-help + program for stress management (World Health Organisation, 2021). Another approach is to employ behavioural activation and strategy training to improve behavioural adaptability and by that supporting resilience (Brinkhof et al., 2023). Alternatively, because they improve regulation of physiological stress in the central nervous system and emotional processes, mindfulness-based training and mind-body approaches have demonstrated efficacy in reducing depressive and anxious symptoms in older adults (Kishita et al., 2017; Laird et al., 2018). Other multimodal interventions harness several lifestyle factors, including physical activity, social connectedness, and routines and habits (Bigarella et al., 2022; Clark et al., 2012), with or without additional cognitive training. These multimodal interventions aim at optimizing several factors, each individually contributing to older adults' ability to pursue their personal goals and sense of flourishing, hence ultimately improving their well-being. Finally, interventions focused on environmental factors may seek to create a more age-friendly society on a global scale (Fulmer et al., 2020) or address mental health stigma and ageist attitudes (Burnes et al., 2019; De Mendonça Lima et al., 2003). For cognitive functioning, one axis of interventions that has been of central interest to past research is cognitive training programs (Karbach & Verhaeghen, 2014; Kliegel et al., 2017). They involve structured exercises and video game-like digitized cognitive tasks that target specific cognitive functions like memory, attention, executive functions, and problem-solving, with the aim of enhancing these skills and maintaining cognitive abilities. Relatedly, engaging in music training, such as learning to play an instrument or participating in choir activities, can stimulate various cognitive functions, including memory, attention, and problem-solving (Kim & Yoo, 2019; Marie et al., 2023). Similarly, metacognitive training programs have been developed to ameliorate older adults' cognitive functioning (Hertzog et al., 2012). These interventions targeted (1) metacognitive knowledge and beliefs about one's own cognitive abilities and cognitive task requirements

(Lachman et al., 1992) and (2) metacognitive regulatory processes to select and execute effective strategies to achieve the cognitive goal at hand (Dunlosky et al., 2003). Metacognitive training programs have been shown to elicit improvements in older adults' metacognitive beliefs, strategy use, self-efficacy, and well-being (Sella et al., 2022).

Another one of the most frequently proposed interventions targets physical exercise, encompassing activities like aerobic exercise, walking, swimming, or strength training (Coelho-Junior et al., 2022; Falck et al., 2019; Gheysen et al., 2018). Physical exercise aims to enhance cognitive functioning and to reduce the risk of cognitive decline in older adults by activating the cardiovascular system in general and thereby boosting blood flow to the brain specifically. Relatedly, exergames – which combine physical exercise with video games – and balance training programs are used to improve coordination, spatial awareness, and cognitive skills, particularly in individuals with balance and mobility issues (Gouveia et al., 2020; Stojan & Voelcker-Rehage, 2019). Similarly, mind-body practices have also been used as interventions for older adults (Lannon-Boran et al., 2023; Taylor-Piliae et al., 2010). For example, Tai-Chi, mindfulness meditation, and yoga involve focused breathing and relaxation techniques that can reduce stress, promote emotional well-being, and thus could potentially enhance cognitive function by reducing cognitive load and promoting a calm mental state. Also based on links between mind and body, neuroscientific interventions – such as biofeedback and neurofeedback – provide real-time information about physiological processes, allowing individuals to learn how to control physiological functions like heart rate and brainwave activity, potentially leading to improved cognitive control and focus (Tinello et al., 2022). Additional approaches have been studied with the aim of improving or maintaining cognitive functioning in healthy older adults through changes in everyday activities and healthy lifestyles.

Similar to the interventions that targeted mental health, the cognitive research has also focused on examining the efficacy of combined or multimodal interventions that incorporate several of the above approaches, such as physical activity, cognitive training, and dietary modifications, to create comprehensive programs that may offer greater cognitive benefits than single interventions by targeting multiple aspects of cognitive health simultaneously (Law et al., 2014). Similarly, studies have also aimed to examine the efficacy of combining specific interventions with social engagement among older adults (Kuo et al., 2018). Today, certain meta-analytical research suggests that combined approaches may be more promising to improve cognitive functioning compared to applying any of the interventions separately (Gavelin et al., 2021; Rieker et al., 2022), whereas other research does not find consistent

evidence that combined interventions are superior to single-type (Guo et al., 2020; Karssemeijer et al., 2017; Zhu et al., 2016).

1.4. Rationale of the review

Available studies provide evidence for beneficial effects of a broad range of interventions on both mental health and cognitive functioning in older adults. Thereby, the intervention approaches targeting mental health and cognitive functioning tend to share common features such as the inclusion of metacognitive components, exercise, or social engagement. This is coherent with the substantial interplay between mental health and cognitive functioning in older adults, such as, that deterioration of mental health and cognitive functioning often occur simultaneously. However, despite the variety of interventions available, older adults often encounter barriers to access, such as a shortage of (mental) health professionals, financial constraints, and lingering stigma surrounding mental health and cognitive functioning (Elshaikh et al., 2023; Sanchini et al., 2022). Therefore, the development of cost-effective and easily scalable interventions targeting mental health and cognitive functioning to a broader audience, such as self-help programs or technology-based solutions, emerges as a pressing challenge for the future (Bartels et al., 2019; Corpas et al., 2022).

However, different countries exhibit distinct challenges regarding mental health and cognitive functioning, which vary among different populations within those countries, influenced by factors such as urbanization, migration patterns, socio-demographic transitions, socio-economic inequalities, and access to healthcare services. Taking these contextual variations into account would enable the design of context-sensitive strategies for implementing and scaling up mental health promotion and prevention interventions, ultimately strengthening mental health support systems (World Health Organisation, 2021). A significant limitation of international evidence is the inability to draw conclusions about inter- and intra-national differences in cultural, social, and economic contexts, which are crucial for developing sustainable interventions which target the most vulnerable populations within specific countries. Besides general evidence of the effectiveness of interventions, context-specific information is of paramount importance.

Therefore, this desk review aimed to dissect and analyse key components of existing interventions that have targeted the enhancement of mental health and cognitive functioning in the older population, drawing on internationally published scientific studies including a Swiss population, and national grey literature. Thereby, a particular focus was placed on the vulnerability associated with ageing and the question of how vulnerable groups can

specifically benefit from these interventions. Through a systematic examination of core features of these interventions and the targeted population, the review provides a knowledge base from which policymakers, researchers, and practitioners can extrapolate effective strategies and identify gaps in current approaches. It seeks to chart a course for the creation of robust, evidence-based interventions and policy strategies that ensure older adults in Switzerland not only live longer but also enjoy better mental health and cognitive functioning.

1.5. Research questions

The desk review aimed to address the overarching research questions of how psychological distress affects mental health and cognitive functioning in older adults living in Switzerland, and how to promote improvement and/or prevent a decline in these two outcomes. Specific research sub-questions focusing on problem analysis and implementation strategies aim to provide evidence directly relevant to the design of intervention scenarios and stigma mitigation strategies. The problem-analysis questions seek to clarify the contextual factors affecting the population of older adults in Switzerland regarding mental and cognitive health challenges. The implementation questions delve deeper into the characteristics of interventions targeting mental health and cognitive functioning.

Problem-analysis questions:

- Which groups of older adults living in Switzerland are particularly vulnerable to threats related to mental health and cognitive functioning?
- Which types of adversity compound to render those groups especially vulnerable?
- Which groups are most stigmatized amongst older adults living in Switzerland?

Implementation questions:

- Which interventions targeting mental health and cognitive functioning have been successfully implemented to address the needs of older adults living in Switzerland (e.g., efficacy studies, moderator/mediator studies, implementation research)?
- Which strategies have proven most effective in recruiting older adults, and particularly the most vulnerable groups to these interventions in Switzerland?
- Which barriers and facilitators were identified regarding the implementation process?
- Which modes of delivery are most suited to deliver an intervention to older adults living in Switzerland?
- Which practices have been most effective in preventing stigma among older adults living in Switzerland?

2. Method

This desk review draws on the guidance developed for scoping reviews (Levac et al., 2010) and it is based on the methodological framework for scoping studies developed by Arksey & O'Malley (2005). Our review is further informed by the toolkit on mental health needs assessment in humanitarian settings developed by the World Health Organization (WHO) and the United Nations High Commissioner for Refugees (UNHCR) and by key desk review parameters discussed for situations of humanitarian crises (Greene et al., 2017). A research team from the Center for the Interdisciplinary Study of Gerontology and Vulnerabilities (CIGEV) of the University of Geneva was assembled to conduct the desk review. The desk review followed the structure outlined by guidelines developed within the ADVANCE project.

2.1. Eligibility criteria for publications

We included both scientific and grey literature (e.g., information distributed outside of traditional academic peer-reviewed publishing channels) in our review. Publications were eligible if they met the inclusion criteria depicted in Table 1. We further included grey literature where appropriate (1) addressing the impact of threats for mental health and cognitive functioning; and/or (2) reporting on mental health or well-being or cognitive functioning outcomes of target groups in Switzerland; and/or (3) referring to stigmatization and stigma mitigation strategies.

2.2. Information sources and search strategy

PubMed, PsycINFO and Scopus databases were searched from January 2018 until September 27th, 2023. The 5-year time frame was applied to limit findings to the most up-to-date literature. The basic search strategy was developed by a research team of the ADVANCE project responsible for guiding the desk reviews of all included countries. It was then adapted by five researchers from the CIGEV (Geneva, Switzerland). The search strategy included the following search terms: ("older adults") AND ("prevention" OR "intervention" OR "promotion") AND ("mental" OR "cognition") AND ("Switzerland"). Search parameters were adapted to database requirements. The complete search strategy can be found in the supplementary material (S1). Grey literature was identified by a Google search using the keywords described above and by manually searching the included studies.

Table 1. Inclusion and exclusion criteria.

	Inclusion criteria	Exclusion criteria
Year of publication	Between January 2018 until September 27th 2023	Before January 2018
Language of the publication	English or one of the main local languages of Switzerland (German, Italian, French)	Any other language than English, German, Italian, or French
Type of publications	Systematic/scoping reviews, and meta-analyses; original observational or experimental studies, including quantitative, qualitative or mixed methods research; study protocols	Publications not referring specifically on our target population (e.g., meta-analysis and reviews reporting data from Swiss older adults beneath others, to draw conclusions on the general population of older adults)
Participants /population	Mean age of the population is ≥ 60 years* AND the minimal age is ≥ 50 years; age-adapted normal cognitive functioning (MMSE > 27, MoCa > 22); living in Switzerland	Mean age of the population is < 60 years OR the minimal age is < 50 years; any neurological disease leading to age-adapted non-normal cognitive functioning (mean MMSE ≤ 27, mean MoCa ≤ 22); not living in Switzerland
Intervention	Any intervention, program or project related to promotion or prevention of mental health and cognitive functioning: exercise, cognitive training, cognitive-behavioral programs, cognitive enrichment, multimodal programs	Interventions including ONLY pharmaceutical treatment, TCDS, neurofeedback; interventions for rehabilitation; cross-sectional or longitudinal studies showing association between "lifestyle" and mental health/cognitive functioning
Outcomes	Well-being, self- and provider stigma, quality of life, cognitive health, but also functional health and independence	Physical fitness, motor functions, falls, (neuro-) biological marker

Note. *People aged 60 or over are considered older adults according to the United Nations definition, which is commonly used as a threshold in aging research.

2.3. Study selection

Study selection was performed using the reference management system Rayyan (Ouzzani et al., 2016). Search results were imported into Rayyan, and any duplicate entries were eliminated. Study selection was carried out in two distinct steps. During the first step, pairs of reviewers independently screened the titles and abstracts of their assigned studies. In the event of any discrepancies or disagreements between the two reviewers, a third reviewer conducted an independent evaluation based on the eligibility criteria. Studies that met the inclusion criteria in this first step were then assigned to other pairs of reviewers for a comprehensive

review of the full-text articles. This second step followed the same process as the title and abstract screening. To ensure adherence to the established workflow and eligibility criteria, detailed guidelines for the study selection process were provided to reviewers, and training sessions were conducted as necessary. The studies selected during these different steps were organized and saved within Rayyan in designated directories.

2.4. Data extraction

For each included study, we extracted the following information if available: (1) author names; (2) year published; (3) profile of the population (diseases; cognitive, physical and mental status; education); (4) types of adversity experienced; (5) cognitive and mental issues addressed by the study; (6) number of participants; (7) sociodemographic characteristics (age, % female, % Swiss); (8) intervention aim; (9) intervention characteristics (intervention duration, number of sessions, session duration, mode of delivery, setting of delivery; recruitment strategy); (10) intervention compliance; (11) stigma (type of stigma, source of stigma, stigma prevention); (12) cultural aspects related to mental health issues; idioms of distress; (13) psychosocial service (available, target population); (14) economic evaluation; (15) barriers and facilitators of the intervention implementation process; (16) study type. These information/dimensions were extracted by one author, and further crosschecked by the research team. To ensure adherence to the established workflow and eligibility criteria, detailed guidelines for the data extraction process were provided to reviewers, and training sessions were conducted.

2.5. Collating, summarizing, and reporting the results

The data collected was summarized descriptively and in response to the sub-questions presented in the section "Research question". The characteristics of studies was framed according to five overarching themes: (1) vulnerable groups; (2) Sources of stigma; (3) interventions targeting mental health and cognitive functioning; (4) intervention delivery modes, (5) stigma-related aspects and stigma mitigation strategies; (6) recruitment strategies.

Based on the results, four different intervention scenarios were identified as potentially relevant for implementation. The preliminary results of the desk reviews, including the identification of potential intervention scenarios, were further shared with the SAGs for feedback and adjustment where necessary. The results were summarized and reported in the "Consultation" section. The final intervention scenarios (see section "Key elements of intervention scenarios built upon the desk review results considering the SAG feedback") will

be used to determine an optimal intervention scenario for implementation in Switzerland through a Delphi survey and a scenario-based workshop with members of the Society Advisory Group (SAG) and the local research teams.

3. Results

An overview of the search and the selection process can be found in Figure 1. After removal of duplicates, a total of 1046 records identified through database search were screened for inclusion. 25 articles were included in the final synthesis. Of those 25 articles, 20 were scientific reports and 5 were study protocols. In addition, we identified five grey literature sources as relevant to our review (Bundesamt für Gesundheit BAG, 2019; Jacobshagen, 2020; Kessler & Bürgi, 2019; Seifert et al., 2020; Weber, 2022). From the identified studies, eleven scientific reports and four of the study protocols were randomized controlled trials, three scientific reports and 1 study protocols were intervention studies without a control group, two scientific reports were qualitative studies, one scientific report was a position paper, and one scientific report was a non-randomized trial (see Table 2).
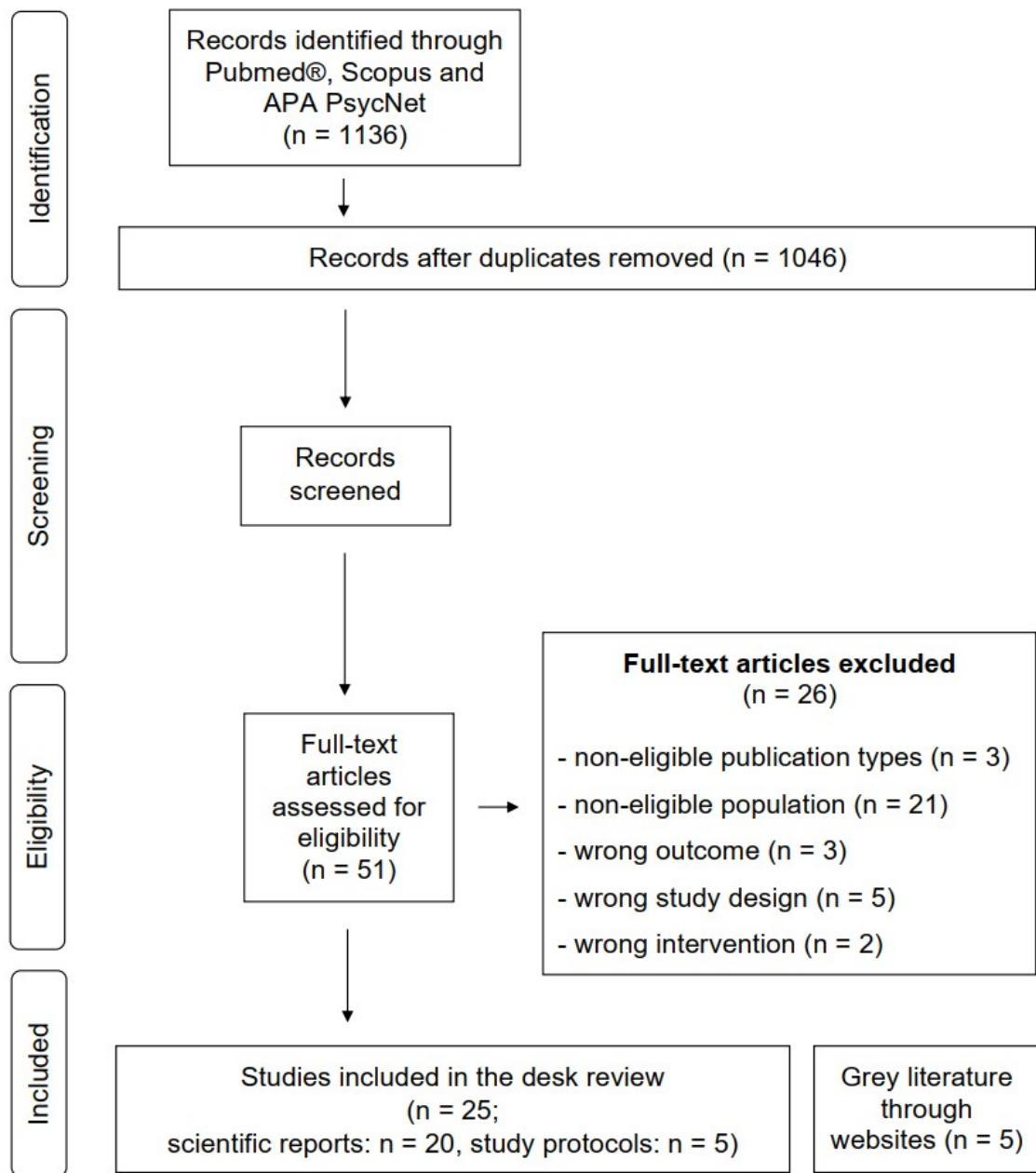
Figure 1. Desk review flowchart

Table 2. Overview of scientific studies included in the desk review.

Article	No. parti-cipants	Mean age	Type of intervention	Intervention duration	Outcome	Study design	Delivery location	Setting	Social interaction
Kliesch et al. (2021)	61	68.40	Language training	30 weeks	CF (+)	Non RCT	On site & at home (digital)	Individual & group	Independent & supervised
Adcock et al. (2019)	21	75.69	Multimodal training	8 weeks	CF (+)	Intervention study (pilot study)	On site	Individual	Independent
Adcock et al (2020a)	31	73.85	Multimodal training	16 weeks	CF (+)	RCT	At home (digital)	Individual	Independent
Adcock et al. (2020b)	19	71.40	Exergame	7 weeks	CF (+)	Intervention study (pilot study)	On site	Individual	Independent
Belleville et al (2023)	110	71.33	Exergame	26 weeks	CF (+)	RCT	At home (digital)	Individual	Independent
Brasser et al (2022)	82	71.54	Multimodal training	5/10 weeks	MH (+), CF (+)	RCT	At home (digital)	Individual	Independent
Dziemian et al (2021)	20	69.07	Cognitive training	4 weeks	CF (+)	RCT	At home (digital)	Individual	Independent
Krebs et al (2021)	59	71.70	Transcranial stimulation + cognitive training	5 weeks	CF (+)	RCT	On site	Individual	Independent
Lenouvel et al (2021)	NA	NA	Multimodal training	NA	MH[+]	Position paper	On site & at home (digital)	Individual & group	Independent & supervised
Najberg et al (2021)	57	67.08	Cognitive training	3 weeks	CF (+), MH (-)	RCT	On site	Individual	Independent
Neumann et al (2018)	12	70.27	Exergame	12 weeks	MH (-)	Intervention study	At home (digital)	Individual	Independent
Ringgenberg et al. (2022)	12	75.70	Exergame	NA	CF[+]	Qualitative study	At home (digital)	Not reported	Not reported
Schättin et al. (2019)	42	67.23	Exergame	10 weeks	CF (+)	RCT	On site	Individual	Supervised

Schmitt et al. (2023)	62	69.54	Speechtraining	3 weeks	CF (+)	RCT	At home (digital)	Individual	Independent
Seinsche et al. (2023)	18 (7 Swiss)	72.00	Exergame	NA	CF	Qualitative study	At home	Individual	Independent & supervised
Studer-Luethi et al. (2021)	542	71.47	Multimodal training	5 months	CF (+), MH(+)	Cross-sectional study	At home (digital)	Individual & group	Independent & supervised
Studer-Luethi et al. (2023)	78	70.50	Cognitive training	4 weeks	CF (+)	RCT	At home (digital)	Individual	Independent
Thalmann et al. (2021)	13	80.50	Multimodal training	NA	CF[+]	Qualitative study	On site	Individual	Independent
Tinello et al. (2023)	34	70.84	Multimodal training	10 weeks	CF (+)	RCT	On site	Individual	Independent
Zuber et al. (2021)	90	64.10	Cognitive training	3 weeks	CF (+), MH(-)	RCT	At home (digital)	Individual	Independent
Belleville et al (2020)*	128	NA	Multimodal training	26 weeks	CF, MH	RCT	On site & at home (digital)	Individual & group	Independent & supervised
Brodbeck et al. (2022)*	85	NA	Psychol. intervention	10	MH	RCT	At home (digital)	Individual	Independent & supervised
Ledermann et al. (2021)*	30	NA	Psychol. intervention	8 weeks	MH	Intervention study	At home (digital)	Participant + caregiver / nurse	Independent
Pereira et al. (2023)*	30	NA	Psychol. intervention	5 weeks	CF, MH	RCT	At home (digital)	Participant + caregiver / nurse	Supervised
Van Velsen et al. (2020)*	315	NA	Psychol. intervention	NA	MH	RCT	On site	Individual	Independent & supervised

Note. CF = cognitive functioning; MH = mental health; (+) / (-) = beneficial effect / no beneficial effects of the intervention; psychol. Interventions were based on strategy- and process-based principles and includes psychoeducational activities; Articles marked with * are study protocols, all other articles are scientific reports. Outcomes marked with [+] means that no outcomes were measured but potential effects on possible outcomes were discussed.

3.1. Vulnerable groups

In general, older age can be divided into two phases, the so-called *third age*, which is characterized by high life satisfaction, and active participation in social life, and the *fourth age*, which is more likely associated with vulnerability because there is an increase in health issues and a higher need for care (Jacobshagen, 2020; Weber, 2022). Furthermore, older adults are a very heterogeneous group. Health is not equally distributed in old age and depends on a series of factors such as education, income, gender and, migratory status, which might contribute to older adults' vulnerability (Weber, 2022). In line with what has been observed in the international literature (Sanchini et al., 2022), out of the 25 studies included in our review, the majority (n = 16) aligned with the basic human vulnerability view and considered older adults a vulnerable population in general. The remaining studies (n = 9) investigated specific situational vulnerabilities (Table 4). In particular, these studies focused on pre-frail older adults (Belleville et al., 2020, 2023), mobility-impaired older adults (Thalmann et al., 2021), older adults with fear of falling (Lenouvel et al., 2022), older adults affected by age-related hearing loss (Schmitt et al., 2023), older adults with chronic pain (Ledermann et al., 2021), and older adults developing a prolonged grief disorder (Brodbeck et al., 2022; van Velsen et al., 2020).

By analyzing the 25 studies included in this desk review, we identified three dimensions of older adults' vulnerability: cognitive function, physical abilities and health, and mental health. A first element of vulnerability in later adulthood is represented by a decline in cognitive function and the risk of developing dementia (Brasser et al., 2022; Dziemian et al., 2021; Krebs et al., 2021; Najberg et al., 2021; Schättin et al., 2019; Studer-Luethi et al., 2021, 2023; Tinello et al., 2023; Zuber et al., 2021). This vulnerability includes age-related declines in processing speed (Studer-Luethi et al., 2023) and executive functions (Schättin et al., 2019), in particular, working memory (Dziemian et al., 2021; Zuber et al., 2021) and inhibitory control (Najberg et al., 2021; Tinello et al., 2023).

A second element of older adults' vulnerability relates to a decline in physical abilities, such as reduction in movement ranges, muscular strength, and endurance (Neumann et al., 2018). Degenerative changes in motor and sensory systems entail difficulties in the performance of daily activities, including gait issues, falls, injuries, and mobility restrictions (Adcock et al., 2019; Adcock et al., 2020a; Adcock et al., 2020b; Ringgenberg et al., 2022). Lenouvel et al. (2021) further discussed fear of falling as a critical element of vulnerability, associated with social, functional, physical, and psychological symptoms. In this regard, other studies also identified pre-frailty - a state of functional decline which can lead to a loss of

autonomy and functional capacity (Belleville et al., 2020, 2023), and mobility limitations as risk factors for older adults (Thalmann et al., 2021). Another element of vulnerability in the physical health domain is hearing loss (Schmitt et al., 2023), the most prevalent sensory impairment in older adults, which when untreated, has been linked to depression, reduced quality of life, and increased risk for dementia. Similarly, chronic pain was identified as a complex problem for many older adults that affects both physical functioning and psychological well-being (Ledermann et al., 2021). Furthermore, older adults might be affected by multiple chronic health conditions, which can increase the risk of medication-related problems and adverse health outcomes, with potential repercussions on physical and cognitive functioning (Pereira et al., 2023).

Table 3. Information endorsing the selection of vulnerable groups according to adversity and stigma.

	Vulnerable groups	Types of adversity	Types of stigma
1	Older adults in general	Decline in cognitive function (Brasser et al., 2022; Dziemian et al., 2021; Kliesch et al., 2022; Krebs et al., 2021; Najberg et al., 2021; Schättin et al., 2019; Seinsche et al., 2023; Studer-Luethi et al., 2021, 2023; Tinello et al., 2023; Zuber et al., 2021)	
		Decline in physical abilities and physical health (Adcock et al., 2019; Adcock et al., 2020a, Adcock et al., 2020b; Neumann et al., 2018; Ringgenberg et al., 2022; Schättin et al., 2019 ; Seinsche et al., 2023)	Self-stigma (Adcock et al., 2019) and public stigma (Adcock et al., 2019; Neumann et al., 2018)
		Impaired mental health (Krebs et al., 2021; Najberg et al., 2021; Seinsche et al., 2023)	
2	Pre-frail older adults	Frailty risk state associated with one or two of the following criteria: unintentional weight loss; weakness or poor handgrip strength; self-reported exhaustion; slow walking speed; and low physical activity (Belleville et al., 2020, 2023)	Public stigma (Belleville et al., 2023)
3	Mobility impaired older adults	Mobility limitations are usually accompanied by physical and cognitive decline and can be further associated with gait changes, which might be the reason for the increased risk of falling (Thalmann et al., 2021)	Self-stigma and public stigma (Thalmann et al., 2021)

4	Older adults with fear of falling	Lasting concern about falling that leads to an individual avoiding activities that they could otherwise perform (Lenouvel et al., 2021)	Self-stigma and public stigma (Lenouvel et al., 2021)
5	Older adults affected by age-related hearing loss	Hearing loss (Schmitt et al., 2023)	
6	Older adults with chronic pain	Chronic pain (Ledermann et al., 2021)	Self-stigma (Ledermann et al., 2021)
7	Polymedicated older adults	Multiple chronic conditions (Pereira et al., 2023)	
8	Older adults developing a prolonged grief disorder	Older adults developing experiencing divorce or marital bereavement (Van Velsen et al., 2020; Brodbeck et al., 2022)	Self-stigma and public stigma (Van Velsen et al., 2020)

A third element of vulnerability identified in the literature relates to a deterioration of older adults' mental health. In particular, two studies focused on prolonged grief (Brodbeck et al., 2022; van Velsen et al., 2020). When older adults lose their partner, they often lose the most important person in their life. Some of them develop severe or persistent grief symptoms, with a clinical diagnosis of a prolonged grief disorder. Prolonged grief is associated with other mental health issues such as depression and post-traumatic stress disorder, as well as physical problems, risk behaviors, and increased mortality.

Overall, the literature highlights specific events or conditions, such as the loss of the partner, which can lead to older adults' situational vulnerability. However, there seems to be consensus in recognizing older adults as vulnerable population in general because of documented age-related changes at structural, functional, and metabolic levels (Kliesch et al., 2022). Along with deteriorations of cognitive functions (Schättin et al., 2019), these age-related changes are associated with adverse outcomes, a decrease in older adults' quality of life (Seinsche et al., 2023), and an impairment in the performance of daily tasks.

3.2. Sources of stigma

The aging process is often associated with a negative view: older people are perceived as dependent, expensive, inactive and a burden on society. Stereotypes, prejudices, and discrimination against a person or a group of people because of their age, also known as ageism, are widespread in society (Bundesamt für Gesundheit BAG, 2019). This is particularly true in the workplace where it becomes difficult to find a job from a certain age onwards, even with the required qualifications. Ageism is also frequent in the health sector

and the community, where older adults are sometimes not treated as full persons by family members and health professionals.

Among the articles included in the desk review, only seven identified stigma-related issues concerning older adults. Among the sources of stigma, four studies highlighted the individual (Adcock et al., 2019; Ledermann et al., 2021; Lenouvel et al., 2022; van Velsen et al., 2020), five studies discussed public institutions and the community (Adcock et al., 2019; Belleville et al., 2023; Lenouvel et al., 2022; Neumann et al., 2018; Thalmann et al., 2021), and two studies further mentioned health professionals (Lenouvel et al., 2022; Thalmann et al., 2021).

Most of the articles identified elements of self-stigma as the main source of stigma, by which older people internalize negative stereotypes. For example, Lenouvel et al. (2021) argued that older adults might deny or underestimate the risk of falling and the presence of fear of falling. They are fatalist, and their resigned passivity, such as feeling too old to start, makes them less likely to participate in interventions. In addition to stigmatizing themselves, from a social perspective older adults might be reluctant to participate in mental health interventions because they fear stigmatization by others (Ledermann et al., 2021; Lenouvel et al., 2022).

Public institutions and the community are other identified sources of older adults' stigma. This can be in terms of inaccessible information, lack of services and resources, costly interventions, and the lack of federal directives specific to the old age (Adcock et al., 2019; Ledermann et al., 2021; Lenouvel et al., 2022). Another element of stigma that emerged from the studies relates to older adults' mobility. Face-to-face interventions are less accessible to older adults living in remote areas with no or scarce access to community resources and to older adults with mobility impairments (Belleville et al., 2023).

Concerning the stigma coming from health professionals, Lenouvel et al. (2021) highlighted that physicians are sometimes pressed for time or lack of resources and vary in their attitudes towards mental health. Furthermore, it is also unfortunately common for health professionals to infantilize or patronize their older patients (Jacobshagen, 2020; Zhang et al., 2020). This translates to health providers using "elderspeak" (i.e., speaking slowly, with simple sentences like one would do with a child), not taking the time to explain the situation to the patient (e.g., giving a medication without explaining why or what the risks and benefits are), or ignoring the patient and mainly asking questions to their children or younger caregivers. This may constitute a barrier to older adults' participation in interventions and restrict individuals' motivation to seek professional help. Furthermore, health promotion and

prevention measures tend to reach out more easily to groups of the population with a medium or high socio-economic status (Bundesamt für Gesundheit BAG, 2019)

Overall, aging is associated with multiple stereotypes and discrimination. Furthermore, older adults are a highly heterogeneous group as the old age actually encompasses several generations with different life experiences, values and needs. Because of different life paths and different socioeconomic conditions, inequalities between individuals persist in later adulthood. Therefore, a concomitantly inclusive and differentiated approach is essential to ensure that older people have some representation, empowerment, and true social participation.

3.3. Interventions targeting mental health and cognitive functioning

3.3.1 Interventions targeting mental health

Reviewing the evidence from the 25 articles retained for our review with regard to interventions targeting mental health showed that out of the 25 articles retained for this review, only five reported results on the efficacy of various interventions on mental health (Brasser et al., 2022; Neumann et al., 2018; Studer-Luethi et al., 2021; Zuber et al., 2021). An Additional four articles described protocols of interventions without reporting specific results (Belleville et al., 2020; Brodbeck et al., 2022; Ledermann et al., 2021; van Velsen et al., 2020). Two studies reported results from cognitive trainings (Najberg et al., 2021; Zuber et al., 2021), two from multimodal interventions (Brasser et al., 2022; Stueder-Luethi et al., 2021; targeting both lifestyle factors and cognitive tasks), and one from a physical exergame training (Neumann et al., 2018). Two protocol studies described a CBT inspired intervention to support acceptance of the loss of a spouse (or divorce) and adaptation to a new life in older adults showing prolonged grief symptoms (Brodbeck et al., 2022; van Velsen et al., 2020). The third study protocol described a combined physical and cognitive training (Belleville et al., 2020), while the last protocol study described a psychoeducational intervention for teaching self-management of pain and reducing pain-related disability in older adults with chronic pain (Ledermann et al., 2021).

Only two of these interventions targeted mental health as primary outcome of interest (Brodbeck et al., 2022; van Velsen et al., 2020). Yet, they only described their research protocol but did not examine any effects of their intervention. None of the studies reporting results considered mental health as the primary focus and outcome of the intervention. Instead, mental health was only a secondary outcome, in addition to primary outcomes such as cognitive fitness, loss of balance or autonomy in daily life, or pain-related disability. Thus,

empirical evidence in Swiss-based populations was only found for a limited subset of all the possible mental health interventions described above.

In terms of efficacy, cognitive training interventions alone did not significantly improve mental health as reported by Najberg et al. (2021) and Zuber et al. (2021), who found no sizable improvements on impulsivity, depression, anxiety of stress after training cognition for three weeks (for a total duration of 5h15 and 8h, respectively). Only a negligeable improvement for quality of life was found in Najberg et al. (2021) in the classic working memory training group, whereas participants from the gamified cognitive training intervention showed a slight decline in quality of life. Similarly, an intensive exergaming training targeting daily tasks at home for at least 18h over 12 weeks did not show any improvement on subjective quality of life or restrictions to their participation in everyday living (Neumann et al., 2018).

In contrast, multimodal interventions, targeting both lifestyle factors and cognitive training, proved successful in improving mental health. A first, cross-sectional, study from Stueder-Luethi et al. (2021) showed that participants who underwent a 5-month long educational program targeting (1) physical health; (2) cognitive training; (3) social activity; (4) mindfulness; (5) creativity delivered through ICT at home subjectively reported that this improved their well-being and their confidence in their brain ability to still learn and perform well. Brasser et al. (2022) then followed up on this study using a proper randomized controlled single-blind trial design to compare the efficacy of a multimodal intervention to a classical cognitive training and a waitlist control group. For the multimodal interventions, participants were asked to perform several small tasks throughout the day including physical health-related tasks, nutrition recommendations, cognitive tasks, mindfulness, creativity, or communication skills. This equated to a total of ten hours of training over 10 weeks (1h/week). Although all three groups decreased their stress levels in the first 5 weeks of the intervention, this improvement was stronger for the multimodal intervention. Unfortunately, all groups showed an increase in their stress levels during the last 5 weeks of the intervention (most probably due to external COVID-19-related circumstances), and that increase was not significantly mitigated for individuals who received the multimodal intervention. Importantly, the multimodal intervention group was the only one to show a significant increase in their confidence in their brain ability to still learn and perform well over the 10 weeks of intervention. Thus, with a relatively short amount of training and significant improvements on stress levels and confidence in one's abilities, the multimodal intervention described by Brasser and colleagues appeared to be the most cost-effective intervention to improve mental

health in healthy Swiss-older adults during the last five years. Interestingly, the intervention described by Brasser and colleagues largely overlaps with recommendations from the Swiss Health Promotion organization (Jacobshagen, 2020) for possible interventions targets to improve mental health in older age that we found in the grey literature.

Overall study dropouts were relatively low (i.e., less than 12%), except for Zuber et al., (2021) who's participants retention was strongly impacted by the COVID-19 outbreak. In terms of duration, the studies varied between three weeks up to six months, but most of studies lasted between 3 and 12 weeks of intervention. However, given the vast heterogeneity in intervention type and the small number of studies available, we currently cannot conclude in terms of dose-response relationship for effectiveness to improve mental health.

3.3.2 Interventions targeting cognitive functioning

Regarding interventions targeting cognitive functioning, we found 18 articles that assessed cognitive functioning as outcome – either separately or in combination with other target outcomes (see Table 1). In terms of frequency of the different interventions, within these 18 articles, cognitive trainings and multimodal interventions were the most frequently applied approaches (with five and seven articles, respectively (Adcock et al., 2019; Adcock et al., 2020a; Belleville et al., 2023; Brasser et al., 2022; Dziemian et al., 2021; Najberg et al., 2021; Schättin et al., 2019; Schmitt et al., 2023; Seinsche et al., 2023; Studer-Luethi et al., 2021, 2023; Zuber et al., 2021), whereas physical exercise, isolated exergames, bio- and neurofeedback each was only applied within one of the articles. Four of the seven multimodal interventions included exergaming in combination with other interventions (e.g., nutritional supplements, cognitive training, Tai-Chi, and dancing), whereas the remaining three relied on combinations of other modalities. Further interventions aiming to improve cognitive functioning were transcranial stimulation (Krebs et al., 2021), a Spanish language training (Kliesch et al., 2022), and a multicomponent interprofessional intervention for which informal caregivers and health care professionals supported older adults to reduce medication-related problems (Pereira et al., 2023).

In terms of potential benefits and costs of the interventions, certain articles were study protocols and thus did not yet allow to evaluate benefits or costs of the interventions. Of the studies that already reported pre- and post-intervention performance, the majority found benefits of the intervention – at least for certain target outcomes (typically in the domains that were trained) or regarding participants' evaluation of the intervention. Performance improvements were observed in cognitive domains such as memory, attention and executive

functions (inhibitory control, working memory, cognitive flexibility), and even in global cognition. However, based on what we know from the international cognitive training literature, it will be important to continue examining the extent to which cognitive domain-specific improvements may translate to more general benefits of (non-trained domains of) cognitive functioning. As previous research often suggests that farther transfer and broader benefits of these interventions may be relatively limited, it will be crucial to study in more detail whether training-specific improvements actually increase older adults' cognition and functioning beyond the laboratory in their everyday lives.

In terms of study feasibility and participant retention, overall study dropouts were relatively low, except for certain of the multimodal interventions where dropout rates of 10-30% or higher were observed (Belleville et al., 2023; Brasser et al., 2022; Schättin et al., 2019). In terms of duration, the studies varied between three weeks up to five months, with the majority of studies including between 3 and 10 weeks of intervention. Again, benefits were observed in most studies (the shorter as well as the longer ones), thus, shorter solutions may further reduce costs without losing efficacy.

3.3.2. Intervention delivery modes.

The included studies covered a broad range of delivery modes varying in terms of delivery location, setting, and social interaction.

3.4 Delivery location

Fourteen of the reviewed studies included intervention approaches that were or will be exclusively administered within participants' homes (Adcock et al., 2020a; Belleville et al., 2023; Brasser et al., 2022; Brodbeck et al., 2022; Dziemian et al., 2021; Ledermann et al., 2021; Neumann et al., 2018; Pereira et al., 2023; Ringgenberg et al., 2022; Schmitt et al., 2023; Seinsche et al., 2023; Studer-Luethi et al., 2021, 2023; Zuber et al., 2021). In contrast, nine studies included intervention approaches that were or will be exclusively delivered on site, typically in university laboratories (Adcock et al., 2020b; Krebs et al., 2021; Najberg et al., 2021; Schättin et al., 2019; Thalmann et al., 2021; Tinello et al., 2023; van Velsen et al., 2020). In three studies a hybrid approach was or will be implemented, with some intervention components conducted at home and others on-site (Belleville et al., 2020; Kliesch et al., 2022; Lenouvel et al., 2022). Specifically, Belleville et al. (2020) provided comprehensive introduction sessions in the laboratory, followed by at-home intervention. Kliesch et al. (2021) and Lenouvel et al. (2021) included a mix of at-home and on-site training sessions.

3.5. Setting

Among the examined studies, there was a noteworthy divergence in the settings in which the interventions were or will be implemented. The predominant approach in most studies involved individualized intervention delivery, wherein participants take on a self-managed role (Adcock et al., 2019; Adcock et al., 2020a; Adcock et al., 2020b; Belleville et al., 2023; Brasser et al., 2022; Brodbeck et al., 2022; Dziemian et al., 2021; Najberg et al., 2021; Neumann et al., 2018; Schmitt et al., 2023; Seinsche et al., 2023; Studer-Luethi et al., 2023; Thalmann et al., 2021; Tinello et al., 2023; van Velsen et al., 2020; Zuber et al., 2021). Participants typically enjoyed a degree of flexibility in determining the timing of task execution, with the primary requirement being adherence to prescribed session frequencies and durations. In two studies, the intervention was conducted in an individual setting, however the sessions took place on-site in small groups (Krebs et al., 2021; Schättin et al., 2019). In the study by Schättin et al. (2019), for example, several participants were invited to the laboratory at the same time to carry out their training sessions individually on a separate exergame device. Furthermore, several studies have adopted, or are planning to adopt a hybrid approach, integrating both group and individual settings into their intervention protocol. These group settings exhibit variability in their composition and structure. In some studies, the group setting consisted of a group of participants or participants were asked to engage with friends or family members (Kliesch et al., 2022; Lenouvel et al., 2022; Studer-Luethi et al., 2021), in other studies the reported group setting included the participant alongside a research nurse and/or an informal caregiver (Ledermann et al., 2021; Pereira et al., 2023). In one study, only the comprehensive introductory sessions take place in groups, while the subsequent training sessions are conducted individually (Belleville et al., 2020).

3.6. Social interaction

Regarding the incorporation of social interaction within the context of the interventions, it is noteworthy that 15 studies adopted an approach without social interaction (Adcock et al., 2019; Adcock et al., 2020a; Adcock et al., 2020b; Belleville et al., 2023; Brasser et al., 2022; Dziemian et al., 2021; Krebs et al., 2021; Ledermann et al., 2021; Najberg et al., 2021; Neumann et al., 2018; Schmitt et al., 2023; Studer-Luethi et al., 2023; Thalmann et al., 2021; Tinello et al., 2023; Zuber et al., 2021). In these studies, the intervention protocols were structured such that tasks and exercises were performed independently by each participant. In contrast, only two studies reported that they exclusively incorporated social interaction within a laboratory environment (Pereira et al., 2023; Schättin et al., 2019). Five studies adopted a

more comprehensive approach, encompassing both individual activities and activities that take place in online group settings (Belleville et al., 2020; Brodbeck et al., 2022; Seinsche et al., 2023; Studer-Luethi et al., 2021; van Velsen et al., 2020), often facilitated through mediums such as chatrooms, as exemplified in the work by Belleville et al. (2020). One study reported including both individual activities and social interaction in present in their intervention program (Kliesch et al., 2022) and one study reported including all three, individual activities, social interaction online and in-person (Lenouvel et al., 2022).

3.7. Barriers and facilitators

Since nearly all studies reported beneficial effects in either the cognitive outcomes or the mental health outcomes, no conclusion can be drawn concerning the beneficial effects of the different delivery modes. However, some studies discussed the facilitators and barriers of different delivery modes, even if only to a limited extent. As facilitator, certain studies have pointed out that the use of computerized remote approaches, which allow interventions to be conducted entirely in the participants' homes, may reach a larger audience than face-to-face interventions. In-home interventions therefore can be facilitators because they are cost-effective in the long term, they increase accessibility and flexibility, and they allow for the personalization of activities (Belleville et al., 2023). In contrast, barriers were especially discussed for delivery modes at home with digital devices such as exergames, including technical issues during the intervention activities (Adcock et al., 2020b), general discomfort with technology (Ledermann et al., 2021; Ringgenberg et al., 2022; Thalmann et al., 2021), and fear of feeling unsafe while performing the activities.

Health Promotion Switzerland (Weber, 2022) highlighted that for the delivery of interventions in Switzerland, and therewith also the modes of delivery, a variety of factors play a role. Municipal administrations as well as cantonal and federal governments are particularly involved in planning, coordinating, and financing. Meanwhile, non-governmental organizations such as Pro Senectute, Caritas, and regional health leagues play a primary role in the implementation of interventions. For successful implementation, good collaboration among all actors is crucial.

Health Promotion Switzerland (Weber, 2022) also noted that digital technology is increasingly being used by older adults, although there are age-related and sociocultural differences. In 2019, 95% of people aged 65 to 69 used the internet regularly (several times per week). However, frequency of use decreases with age, and particularly individuals aged 80 and older use these technologies less frequently. In addition to age, education, income, and

interest in technology also influence internet use (Seifert et al., 2020). People with lower educational status, lower income, and little interest in technology are among the infrequent internet users. The main reasons for not using the internet in old age include security concerns and the belief that use is too complicated or learning to use the internet is too difficult. Costs are less of a factor. A similar pattern is observed for the use of smartphones and tablets. In 2019, 63.7% of people used a smartphone, and 40% used a tablet. Here, too, there is a difference between younger and older individuals (Seifert et al., 2020). While the use of wearables (e.g., smart watches, bracelets) is increasing, it is still significantly lower than for younger people. Only 8% of people over 65 won a fitness tracker, and only 3% use a smartwatch (Seifert et al., 2020).

3.8. Stigma-related aspects and stigma mitigation strategies

As seen in the vulnerability section above, the promotion of mental and cognitive health can encounter several challenges, among which age-related stigma plays a central role. However, it is also possible to identify effective practices to prevent or reduce the stigma experienced by older adults. In particular, the studies included in the current desk review pointed to the use of strategies that do not reinforce the age stereotype and support older adults, such as the provision of transcripts for individuals with a hearing impairment, a simple layout of written materials, no time restrictions, and orientation sessions where older adults can learn to navigate the materials of the intervention (Ledermann et al., 2021). Another key aspect highlighted by Ringgenberg et al. (2022) was the importance of social interactions, both with the person leading the intervention and with other older adult peers with whom they can confront experiences and build a feeling of connectedness.

A key element that emerged from literature relates to the promotion of equality, diversity, and inclusion. Considering the heterogeneity among older people, it is important to promote a differentiated image of old age, particularly in social debate, in professional contexts that are in direct contact with older people, but also among older people themselves and in their social context (Weber, 2022).

The design of interventions targeting older adults should focus on the high inter-individual variability in later adulthood, including differences in health and sociodemographic characteristics, and the development of personalized interventions and adapt activities to the age, needs, and wishes of the participants (Belleville et al., 2023; Neumann et al., 2018). Similarly, a gamification of the interventions can increase older adults' motivation (Ringgenberg et al., 2022). Neumann et al. (2018) also recommended the use of new

technologies, such as communication technologies and digital electronics, to facilitate cooperative care and training between older individuals and their nonprofessional caregivers.

The use of technological devices is discussed both as a barrier and facilitator of interventions for older adults. On one hand, older adults can struggle with the use of new technologies and be reticent to use them (Seinsche et al., 2023). On the other hand, digital and remote interventions confer similar benefits as in-person interventions but can reach a larger audience (Ledermann et al., 2021). Furthermore, they are cost-effective in the long-term (Belleville et al., 2023). Therefore, it is important to use digital media wisely: while they are becoming an integral part of older adults' daily life, analog solutions should be made available to the so-called *offliners* (Weber, 2022).

Different authors also highlighted the relevance of a co-creation phase preceding the intervention, where older adults can contribute to the design of the activities (Ledermann et al., 2021; Neumann et al., 2018). For example, Neumann et al. (2018) involved older adults in the design of the exercises used in their interventions and older adults appreciated this cooperative approach. That is, older people and other stakeholders should be involved as early as during the conception and planning stage and continue to do so during the implementation and evaluation of the intervention (Bundesamt für Gesundheit BAG, 2019).

Furthermore, Brasser et al. (2022) discussed the importance of a multimodal intervention, which can be combined easily with other daily activities. In particular, they pointed to the relevance of an autonomy-supportive, psychoeducational approach targeting age stereotypes, in light of the association between positive attitude and a slower and smaller amount of cognitive decline. Mental health, physical activity and cognitive functioning are closely related, suggesting that they can promote each other. Therefore, it seems important to develop holistic interventions that take into account and promote these interactions.

Finally, it is important to support the transition from the third to the fourth age and the progressive decline and increasing frailty that characterize the fourth age, strengthen interpersonal relationships, and enhance structural measures, as a person's individual resources are closely related to the environmental resources (Gesundheitsförderung Schweiz, 2022).

Overall, it is not possible to identify a single solution to promote older people' mental health and cognitive functioning. The appropriate form of engagement depends on the objectives and the target group of the intervention. The fundamental element is to recognize the value of everyone involved.

3.9. Recruitment strategies

Recruitment of participants was done by a broad range of recruitment endeavors. In ten of 25 studies, participants were and will be recruited with the help of / in different senior organizations including (1) consulting and service organizations for older adults such as "Senioren- und Selbsthilfe-Organisationen der Schweiz" (VASOS) and "Pro Senectute" (Belleville et al., 2020; Neumann et al., 2018); (2) communities for older adults such as the "pensioner community ETH Zurich" (Adcock et al., 2019; Adcock et al., 2020b), sport and leisure clubs for older adults (Kliesch et al., 2021; Zuber et al., 2021), self-help groups (Kliesch et al., 2022), and senior universities (Brasser et al., 2022; Kliesch et al., 2022; Schättin et al., 2019; Seinsche et al., 2023); and (3) senior residencies / nursing homes (Brasser et al., 2022; Schättin et al., 2019). Seven studies reported that they recruited or will recruit their participants with the help of / in a variety of primary and secondary care services including (1) clinics (Adcock et al., 2020a); (2) physiotherapist (Adcock et al., 2020a; Thalmann et al., 2021); (3) rehabilitation centers (Ringgenberg et al., 2022); (4) memory clinic (Belleville et al., 2023); (5) or not further specified (Brodbeck et al., 2022; Pereira et al., 2023).

Thereby, the type of recruitment was mostly not further specified. Only Brasser et al. (2022) and Schättin et al. (2019) reported using flyers, and Brasser et al. (2022) additionally using a newsletter. In seven studies, participants were or will be recruited by public advertisement in local newspapers (Adcock et al., 2019; Adcock et al., 2020a; Adcock et al., 2020b; Brodbeck et al., 2022; Kliesch et al., 2022; Thalmann et al., 2021), in supermarkets (Adcock et al., 2020a), in public transportation (Zuber et al., 2021), on websites (Kliesch et al., 2022), or on social media (Brasser et al., 2022; Brodbeck et al., 2022; Ledermann et al., 2021; Zuber et al., 2021). Two studies reported recruiting participants by word-of-mouth, such as through friends (Brasser et al., 2022; Studer-Luethi et al., 2023), and one study reported reviewing patient lists to find eligible participants (Ringgenberg et al., 2022). Five studies did not report how they did or plan to do the participant recruitment (Krebs et al., 2021; Lenouvel et al., 2022; Schmitt et al., 2023; Studer-Luethi et al., 2021; van Velsen et al., 2020).

Almost no information was reported on the effectiveness of the recruitment strategies. Only Neumann et al. (2018), who recruited their participants using the VASOS, reported that they had recruitment problems in Switzerland because the older adults considered themselves independent and fit (Neumann et al., 2018). Health Promotion Switzerland (Kessler & Bürgi, 2019) pointed out that for health promotion and prevention programs, the recruitment of older men is especially difficult and differ from the recruitment of older women. Thereby, several

approaches seem to be effective. The peer approach via typical "male settings" such as (senior) organizations or clubs, and family members have proven particularly effective. Likewise, addressing them through general practitioners or other professionals, as well as access via the media, are suitable methods. Moreover, older men should be particularly addressed following significant social or health changes. Without support, they often permanently change their behavior to the detriment of their health in such moments. Many men have fewer coping strategies in stressful situations and are less able to express their feelings than women. However, it is precisely in such situations that they are more receptive to support. The aspect of language is also central. "Psycho-language" (the use of psychological terminology) is generally not well-received by healthy men aged 65 and over. It is recommended to use terms such as "lectures," "health management," or "training" instead of "courses," "prevention," or "exercise." In communication with older men, conveying simple technical solutions has proven effective. However, the message should not only be dry and factual, but should also address the pleasure and fun factor. Emphasizing aspects of "activity," "performance," and "movement" tends to be well-received. Furthermore, men should be directly addressed in the offer advertisement. Terms like "age" or "older men" can be a deal-breaker in the promotion of an offer. This should also be taken into account in the visual language of advertising materials and presentations (Kessler & Bürgi, 2019).

4. Limitations of the desk review

The results of the desk review exhibit several limitations. Firstly, the majority of the studies included in the review are characterized by either a short intervention duration, a limited number of participants, or a lack of proper randomized controlled trial (RCT) design with a control group. As such, the findings from these studies should be approached with caution.

Secondly, the studies included in the review do not prioritize topics such as vulnerability, stigma, delivery modalities, or recruitment strategies as the main focus of research interest. Instead, these aspects were merely touched by briefly mentioning them in the introduction or discussion sections (vulnerability, stigma, recruitment strategies, delivery modalities), or by including them as subordinate elements in the overall concept of the intervention (delivery modalities), without being specifically examined or manipulated in the studies.

Third, the results of the review highlight a notable absence of certain intervention approaches that are prominent in the international research landscape. Specifically, none of the reviewed articles from Switzerland utilized isolated balance training or mind-body

practices aimed at maintaining or enhancing cognitive functioning, although these approaches were sometimes incorporated into multimodal interventions. Additionally, interventions including meta-cognitive training and interventions based on principles of cognitive-behavioural therapy or acceptance commitment therapy to improve overall mental health are missing.

In conclusion, the limitations of the reviewed articles must be carefully considered when interpreting the results. The lack of studies with proper RCT design, the limited focus on key topics such as vulnerability and stigma, and the absence of certain main intervention approaches all contribute to a less comprehensive understanding of the subject matter. Further research, especially high-quality RCTs, addressing these gaps and limitations is necessary to provide a completer and more reliable picture of the field. In addition, more structured reviews (e.g., by following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines), that consider a wider time frame than five years, include additional European countries, and assess the methodological quality of the included studies would provide further insights.

5. Consultation

The results of the literature review as well as the key elements of intervention scenarios built upon the desk review results (see below) were presented and discussed with the SAG. Insights from the discussion informed the development of the intervention scenarios. The main points of discussion focused on the key elements of the intervention scenarios: 'vulnerable groups', 'delivery modes', and 'recruitment'.

With respect to the 'vulnerable groups' element, we agreed that the intervention's aim is not to treat a clinical condition (due to the grant's focus as well as ethical and regulatory considerations), but rather to prevent decline, stabilize or perhaps even enhance mental and cognitive health of healthy older adults. With that, the sample should cover a variety of vulnerabilities on a continuous spectrum, such as different levels of education, socio-economic status, and mental, cognitive, and physical health without focusing on a specific vulnerability in old age. Furthermore, in the context of discussing the concept of 'healthy aging', the need to establish appropriate inclusion and exclusion criteria as well as suitable measurement instruments was emphasized.

Regarding the 'delivery modes' element, it was observed that with our currently predefined scenarios (see Table 4), 'offliners' are excluded from the intervention. This led to questions about whether the intervention should provide a choice between online and offline

activities, for example, by offering 'offliners' the opportunity to participate in digital activities on site. A proposed idea was to assign a spokesperson for the 'offliners' who could communicate digitally and provide information to a smaller on-site group of older adults. Overall, the SAG seemed to prefer a combination of on-site group sessions and digital activities that are self-administered (see option 3 in Table 4 below; partly on site – group setting AND partly digital – individual setting). This choice was favored due to the importance of human contact and its balance of time commitment between on-site group sessions and individual activities. It was further considered less complex than a combination of partly on site – group setting and partly digital – group & individual activities (see option 4 in Table 4 below). However, the SAG also recognized that this option might be more suitable for certain groups, such as lonely individuals or those with mobility limitations, as well as in larger group sizes.

When discussing the 'recruitment' element, the SAG suggested that recruiting a representative sample through the Swiss Federal Office of Statistics could be a viable option for our intervention study. This method involves contacting potentially eligible participants who accurately represent the characteristics of the Swiss population aged 65 years or older, using letters, e-mails, phone calls, or combinations of these methods. The reasons for favoring this approach include its cost-effectiveness and the ability to avoid inadvertently excluding specific populations, such as men or lonely individuals. Should this method not yield a sufficiently large sample, the proposed alternative would be to initially recruit through the Swiss Federal Office of Statistics and then supplement the sample with more traditional recruitment methods through various channels (as detailed in Table 4). Additionally, it was emphasized that the language used in the invitation letter should be appropriate to avoid any stereotypical age connotations. It was particularly considered important to avoid portraying older adults as unhealthy or old, and the key message should be clear, highlighting that the program is not therapy.

5.1. Key elements of intervention scenarios built upon the desk review results considering the SAG feedback

We identified four potential intervention scenarios (see Table 4). Those intervention scenarios depict a combination of (1) the vulnerable group which should be targeted by the intervention, (2) the different modes of delivering the intervention to the respective groups, and (3) the recruitment approach.

The different scenarios are hypothesized to be effective in terms of intervention outcomes, financial viability (ability to implement interventions within each partner's country budgets), and implementation (ability to reach and engage target groups in sufficient numbers and within a reasonable time frame).

Overall, the studies included in our review indicate that older adults can be defined as a vulnerable group per se comprising a very heterogeneous distribution of different subdimensions of vulnerability such as cognitive functioning, physical abilities and health, as well as mental health which often interact with each other. These results suggest one vulnerable group comprising older adults of 65 years or above living in Switzerland, without focusing on any particular vulnerability, but rather covering a variety of vulnerabilities on a continuous spectrum.

With regards to the delivery modes of interventions, we paired two primary components: setting (individual vs. group) and location (digital vs. on site). We have excluded the 'on site – individual setting' modality due to its low cost-effectiveness and the considerable challenges associated with upscaling, and the ' fully digital – group setting' as well as the 'on site – group setting + digital – group setting' due to incompatibilities with the planned intervention program. The pairing provides the following possible delivery modes:

- Fully digital – individual setting: Interventions are disseminated online, with participants independently engaging with tasks on their digital devices such as smartphone or computer (e.g., cognitive games conducted on the digital device or instructions on stress-management exercises given via the digital device).

- Fully digital – individual & group setting: Interventions are disseminated online. They include both independently conducted activities AND activities in groups disseminated via platforms such as Zoom (e.g., stress-management session or meta-cognitive strategy session is conducted by an experienced instructor via Zoom, dyads of participants meet via Zoom to assist each other to successfully complete the intervention).

- Partly on site – group setting AND partly digital – individual setting: Interventions are disseminated online AND at a specific location in present (i.e., on site; location need to be determined). Online, participants perform activities independently. On site, participants engage in group activities (e.g., stress-management session or meta-cognitive strategy session conducted by an experienced instructor, dyads of participants meet to assist each other to successfully complete the intervention).

- Partly on site – group setting AND partly digital – group & individual setting: Interventions are disseminated online AND on site. On site, participants engage in group

activities. Online activities include both independently conducted activities and activities conducted in groups. For group activities, this means they will be conducted both online and on site. This could entail some participants performing all group activities online while others do so on site. Alternatively, it might mean that certain group activities, such as stress-management sessions or meta-cognitive strategy sessions led by an experienced instructor, are held on site, while others, like pairs of participants meeting via Zoom to support each other in completing the intervention, take place online.

It is important to note that in all our current scenarios, 'offliners' are completely excluded from the intervention.

In our recruitment endeavors, we aim for a as representative sample as possible of older adults of 65 years and older living in Switzerland. This should be achieved through a two-step recruitment approach. First, a representative sample will be recruited through contacts provided by the Swiss Federal Office of Statistics (note that this approach needs a detailed application procedure and is subject to not being granted). Assuming a possible sign-up rate of 20%, we will ask for 5000 addresses. If the target sample size of 1000 participants is not reached in this first step, the sample will be complemented by employing traditional recruitment methods including a wide range of recruitment sites and strategies.

Our recruitment sites will cover the following wide spectrum of platforms: (1) participant pool from the University of Geneva; (2) associations serving older adults; (3) doctors' clinics; (4) sport- and leisure courses and clubs for older adults; (5) community centers. Our recruitment strategies will cover the following wide range of approaches: (1) newspaper articles and advertisements; (2) flyers; (3) posters; (4) social media campaigns; (5) word-of-mouth recommendations; (6) newsletters; (7) advertisement in public transportation.

Table 4. Key elements of intervention scenarios built upon the desk review results.

Scenario ID	Vulnerable groups	Delivery modes	Recruitment
1	Older adults over the age of 65, without taking a specific vulnerability into consideration (in addition to "age" as vulnerability, this will cover a variety of vulnerabilities on a continuous spectrum, such as different levels of education, SES, and mental, cognitive, and physical health).	Fully digital – individual setting	Two-step recruitment approach: 1. Recruitment of a representative sample through the Swiss Federal Office of Statistics 2. If the target sample size of 1000 participants is not reached with the first step, complementation of the sample by employing traditional recruitment methods. This includes recruitment through a wide range of recruitment sites (e.g., participant pool from the University of Geneva, Swiss memory clinics, associations serving older adults, doctors' clinics, rehabilitation centers, sport- and leisure courses and clubs for older adults, community centers) and a wide range of recruitment strategies (newspaper articles and advertisements, flyers, posters, social media campaigns, word-of-mouth recommendations, newsletters, advertisement in public transportation).
2		Fully digital – individual & group setting	
3		Partly on site – group setting AND partly digital – individual setting	
4		Partly on site – group setting AND partly digital – group & individual setting	

Note. Pictures designed by Freepik.

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