

RESEARCH ARTICLE - METHODOLOGY

REMINDER randomized controlled study: Feasibility and impact of an online multimodal mind–body intervention in older adults

Miranka Wirth¹  | Selina Stamer^{1,2} | Odile Podolski¹  | Annemarie Maßalsky¹ | Sabine C. Koch^{3,4,5} | Olga Klimecki^{1,2} 

¹German Center for Neurodegenerative Diseases (DZNE) Dresden, Dresden, Germany

²Faculty of Psychology, Technische Universität Dresden, Dresden, Germany

³Research Institute for Creative Arts Therapies (RIArT), Alanus University, Alfter/Bonn, Germany

⁴Faculty of Therapy Sciences, SRH University Heidelberg, Heidelberg, Germany

⁵Faculty of Fine Arts and Music, University of Melbourne, Parkville, Victoria, Australia

Correspondence

Miranka Wirth, Deutsches Zentrum für Neurodegenerative Erkrankungen e. V. (DZNE), Standort Dresden, Tatzberg 41, 01307 Dresden, Germany.
Email: Miranka.Wirth@dzne.de

Olga Klimecki (-Lenz), Universität der Bundeswehr Hamburg, Postfach 700822, 22008 Hamburg, Germany.
Email: Olga_Maria.Klimecki-Lenz@tu-dresden.de

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Abstract

INTRODUCTION: The increasing prevalence of age-related diseases, including Alzheimer's disease, underscores the need for accessible, cost-effective lifestyle interventions to reduce modifiable dementia risk factors and support healthy aging.

METHODS: REMINDER is a randomized controlled pilot trial evaluating the feasibility and impact of a 6-week online, home-based, live-streamed multimodal group intervention delivered via videoconferencing. The program, designed for older adults, integrates music, dance movement, and mindfulness. Using a cross-over design (AB-BA), participants ($N = 50$) are randomized to receive the intervention with two 60-min sessions per week or a passive control (with delayed intervention).

RESULTS: Digital outcome assessments were conducted remotely at baseline, post-intervention, and follow-up. Primary outcomes include feasibility (adherence rate) and changes in mental and physical well-being (SF-12). Secondary outcomes include changes in multi-domain health and lifestyle behaviors.

DISCUSSION: REMINDER will provide evidence on the feasibility and preliminary effectiveness of a scalable online multimodal intervention to support healthy aging and reduce dementia risk.

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Protocol: SR-EK-477112023

KEYWORDS

aging, dance movement, lifestyle, mind–body intervention, online, prevention, randomized controlled trial, well-being

Highlights

- Randomized controlled pilot trial of an online multimodal mind–body group intervention for older adults.
- Primary outcomes: Feasibility and changes in mental and physical well-being.

Miranka Wirth and Selina Stamer authors have contributed equally to this work and share first authorship.

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- Secondary outcomes: Changes in multi-domain health and lifestyle behaviors.
- Remote lifestyle intervention to promote healthy aging and prevent dementia.

1 | BACKGROUND

1.1 | Rationale

Age-related neurodegenerative diseases, including Alzheimer's disease (AD), are increasing rapidly and represent a significant public health and societal challenge. Cases of dementia, with AD being the most prevalent type, are expected to triple by 2050, placing a high burden on patients, caregivers, and society.¹ Even though there is progress regarding disease-modifying therapies, it is important to pursue non-pharmacological options for the prevention and early intervention of dementia. A large proportion of the risk factors for developing AD are related to potentially modifiable lifestyle factors, including physical, cognitive, psychological, and social factors.² Low-threshold, accessible, and cost-efficient lifestyle interventions are needed to effectively reduce the adverse effects of aging and prevent AD in the long term.

1.1.1 | Multimodal interventions: Rationale and motivation

To achieve long-term health benefits in older adults and eventually prevent AD, intervention strategies that simultaneously target multiple cognitive, physical, psychological, and social risk factors may be most effective (for review, see Livingston et al.²) Multimodal or multidomain lifestyle interventions that address multiple risk factors are therefore considered a promising strategy to mitigate the impact of age- and disease-related adversities on the brain.^{3,4} In animal models, environmental enrichment that involves enhanced multimodal—motor, cognitive, sensory, and social—stimulation has been shown to have far-reaching benefits on the brain, including hippocampal neurogenesis, synaptogenesis, and expression of brain-derived neurotrophic factor, compared to low-enrichment (standard housing) conditions.^{5–7} However, translating animal models of enriched environments to human behaviors and lifestyle is complex and requires careful consideration.⁶

Improving mental health and well-being of older adults must be another important goal of lifestyle interventions. The World Health Organization (WHO)⁸ defines health as “a state of complete physical, mental, and social well-being,” highlighting the importance of mental health in overall well-being and health promotion. Mental health factors, including anxiety, depression, and loneliness, have been identified as risk factors for the development and progression of cognitive impairment and dementia,^{9–11} and often emerge during the pre-symptomatic stages of AD.¹² In this context, greater emphasis should be placed on prevention and intervention strategies that integrate lifestyle activities fostering “depth, purpose, meaning, and social embedding” to

support healthy aging of the body and mind.^{13,14} Holistic or integrated interventions that promote an “embodied mind in motion” could be particularly effective in addressing the multiple health challenges associated with aging and age-related diseases.^{15,16}

1.1.2 | Dance: A multimodal health promoter

A “naturalistic” translation of environmental enrichment or an “embodied mind in motion” is offered by arts-based activities, including music and dance.^{13,16} Dancing has been associated with a reduced risk for developing dementia.¹⁷ It provides an inherent, simultaneous integration of multimodal—motor, cognitive, sensory, emotional, and social—stimulations, thereby engaging distributed brain networks involved in perception, cognition, emotion, and action.^{18–20} Dance-based interventions have been proposed as an effective tool for embodied prevention and early intervention strategies in diverse older populations, including older adults at risk of or living with dementia.^{19,21–23} As an inherently multimodal enrichment, these interventions are thought to offer greater ecological validity²⁴ and promote far transfer effects^{24,25} in humans.

Dance-based interventions, including various dance types, dance-based mind-body practices, and dance/movement therapy (DMT), can improve health and well-being across multiple domains in cognitively unimpaired and impaired older adults. As shown by evidence syntheses, these benefits encompass improvements in physical,^{26,27} cognitive,^{28–33} and psychological^{22,28,34,35} health-related outcomes. Some of these beneficial effects have been observed even after short-term dance-based interventions lasting 6–8 weeks.^{36–41} Nevertheless, the available evidence on the benefits of these interventions on mental health and well-being in older adults without dementia remains limited.^{22,35,42} Given the critical role of psychosocial risk factors in aging and dementia risk, randomized controlled studies are needed to further assess the effects of dance-based interventions on mental health outcomes.^{21–23}

1.1.3 | Online multimodal interventions for older adults

To effectively reach older people from diverse ethical, economic, and geographical backgrounds, including those in rural and underserved areas, access to and delivery of lifestyle interventions must be as low-threshold as possible.⁴³ A few studies have investigated online, supervised multimodal interventions that combine dance-based movement, music and/or mindfulness, delivered through real-time

RESEARCH IN CONTEXT

1. **Systematic review:** The authors reviewed the literature from PubMed and clinicaltrials.gov on non-pharmacological interventions in the areas of healthy aging and prevention of dementia, including Alzheimer's disease. Randomized controlled studies of interventions targeting multiple lifestyle risk factors of dementia are typically in-person, logistically complex, and location-bound.
2. **Interpretation:** *REMINDER* is a randomized controlled pilot study of an online multimodal intervention to promote mental and physical well-being of older adults. The study will evaluate a 6-week home-based, live-streamed, mind-body group intervention compared to a delayed-intervention group for feasibility, self-reported well-being, cognition, and lifestyle behaviors across multiple health domains.
3. **Future directions:** *REMINDER* will provide preliminary evidence on the feasibility and impact of an online multimodal intervention targeting well-being and dementia risk factors in older adults. It may facilitate future research and development of accessible lifestyle interventions to improve the mental health and well-being of older adults from diverse ethnic, socioeconomic, and geographic backgrounds.

videoconferencing platforms. These interventions have included online dance programs, mind-body movement programs, and mindfulness-based DMT, targeting healthy younger⁴⁴ and older^{45–47} adults, as well as older individuals with cognitive impairment^{48–50} and Parkinson's disease.^{41, 51–53} While some of these studies are still ongoing, the available findings suggest that online dance-based interventions are feasible, safe, and effective in clinical and non-clinical older populations.^{41, 45, 48, 49, 51}

In general, remotely delivered lifestyle interventions are increasingly recognized as accessible, potentially scalable, and cost-effective tools for promoting health and well-being in clinical and non-clinical older populations.^{43, 54–56} However, robust evidence on the effectiveness of teleinterventions, as well as their direct comparison to in-person interventions, remains limited.^{54, 56, 57} Seidler and colleagues⁵² showed that an online dance-based intervention led to improvements in physical functioning comparable to those of an in-person program in individuals with Parkinson's disease. As technology continues to advance, supervised interventions delivered through real-time videoconferencing are likely to become increasingly accessible to older adults. High-quality studies are needed to further assess the feasibility, applicability, and effectiveness of these teleinterventions.

1.2 | REMIND: A novel multimodal mind-body group intervention

We have recently developed and documented a multimodal mind-body group intervention, called *REMIND* (“An *Environmental Enrichment Intervention* to Prevent *Dementia*”). The program is specifically tailored for older adults and is available as a structured open-access manual (in German).⁵⁸ The multimodal design of the *REMIND* intervention is intended to foster active engagement and adherence, while promoting long-term effectiveness across multiple domains of healthy aging. The program is built around three core components—music, movement, and mind—incorporating mindfulness practices. These core components are integrated simultaneously to generate multimodal stimulation across motor, cognitive, sensory, emotional, and social domains. Each of these core components has been linked to multiple health benefits, including improved brain function, cognitive, and mental health in older adults. This is shown by a large body of studies and evidence syntheses for music,^{59–61} dance movement,^{22, 62, 63} and mindfulness^{64–66} activities. Another key element of *REMIND* is its interactive group format, which promotes social integration and connectedness—factors that have been associated with improved brain and mental health in older adults.^{67, 68}

The *REMIND* intervention uses a combined or integrated intervention approach. The multimodal enrichment provided by the program is designed to foster an “embodied mind in motion,” which serves as a guiding principle in holistic strategies for dementia prevention.¹⁵ The core components of the *REMIND* program are designed to work synergistically by engaging complementary motor, cognitive, sensory, emotional, and social pathways, thereby targeting multiple risk factors associated with aging and AD. Existing research shows that combined physical and cognitive interventions can yield greater benefits than single-component programs.^{69–71} The combined intervention approach can promote positive brain plasticity through complementary pathways, generating synergistic effects that support reserve and resilience.^{7, 24, 72, 73} As a lifestyle activity that inherently integrates physical activity, cognitive engagement, and social interaction, dance-based activities can promote a broad spectrum of neuroprotective, neurobehavioral, and therapeutic benefits.^{18–20}

1.3 | Objectives

The present randomized controlled pilot study will evaluate the *REMIND* program as a short-term online intervention. This intervention, thereafter referred to as *REMINDER* (*REMIND* - *electronic trial*), will be delivered as a home-based live-streamed interactive group program via two-way real-time videoconferencing over 6 weeks with two 60-minute sessions per week. The *REMINDER* intervention is designed to facilitate broad accessibility, active engagement, and social participation among older adults in the online environment.

Previous studies have shown that in-person dance-based interventions over 6 weeks (between one and three sessions per week and 30–60 minutes per session) can improve multiple health aspects

in older adults. These include improved physical and physiological functioning^{39,40} as well as cognitive functioning, psychological well-being, and quality of life.³⁸ Our decision to implement a 6-week online format with two 60-minute sessions per week in the present pilot study was based on the existing findings as well as practical considerations, including availability of participants and resources such as study personnel and facilitators. Additionally, the short-term duration was expected to minimize dropout rates and improve adherence in older adults.

The main objective of this study is to evaluate the feasibility and preliminary effectiveness of the online intervention (*REMINDER*) in promoting health and well-being in cognitively unimpaired older adults. This study will evaluate adherence to the intervention and changes in self-reported mental and physical well-being as primary outcomes. In addition, this study will evaluate changes across multiple—cognitive, motor, sensory, emotional, and social—health domains as well as healthy lifestyle behaviors, to capture the broad effects of the multimodal enrichment provided by the online intervention. This comprehensive approach aligns with the multidimensional lifestyle risk factor model of dementia² and the principles of environmental enrichment. As a result, the *REMINDER* study will provide novel insights into remotely delivered multimodal lifestyle interventions for older adults as an accessible, low-threshold, and potentially scalable prevention and early intervention tool.

1.4 | Trial design

A fully online monocentric, randomized controlled pilot study with blinded outcome assessment will be conducted to evaluate the online (home-based and live-streamed) multimodal mind-body group intervention in cognitively unimpaired older adults ($N = 50$). The 6-week intervention program (*REMINDER*), consisting of two 1-hour sessions per week, will be compared to a passive control group (waitlist with delayed intervention). Participants will be assessed at weeks 0, 6, and 12 using remote unsupervised digital assessments. Feasibility will be measured by adherence rates, while intervention impact will be evaluated based on mental and physical well-being, as assessed by the 12-item Short-Form Health Survey (SF-12).⁷⁴ In addition, secondary self-reported outcomes will be included to explore the broader multimodal benefits of the online multimodal mind-body group intervention and to refine a subset of key secondary outcomes for future trials.

2 | METHODS: PARTICIPANTS, INTERVENTIONS, AND OUTCOMES

2.1 | Study setting

The *REMINDER* study will be conducted at the German Center for Neurodegenerative Diseases (DZNE) Dresden, Dresden, Germany. The recruitment area is Saxony and Thuringia in particular, and Germany in general. Based on previous research^{75,76} and feasibility considerations, this pilot study will include a shorter-term intervention duration

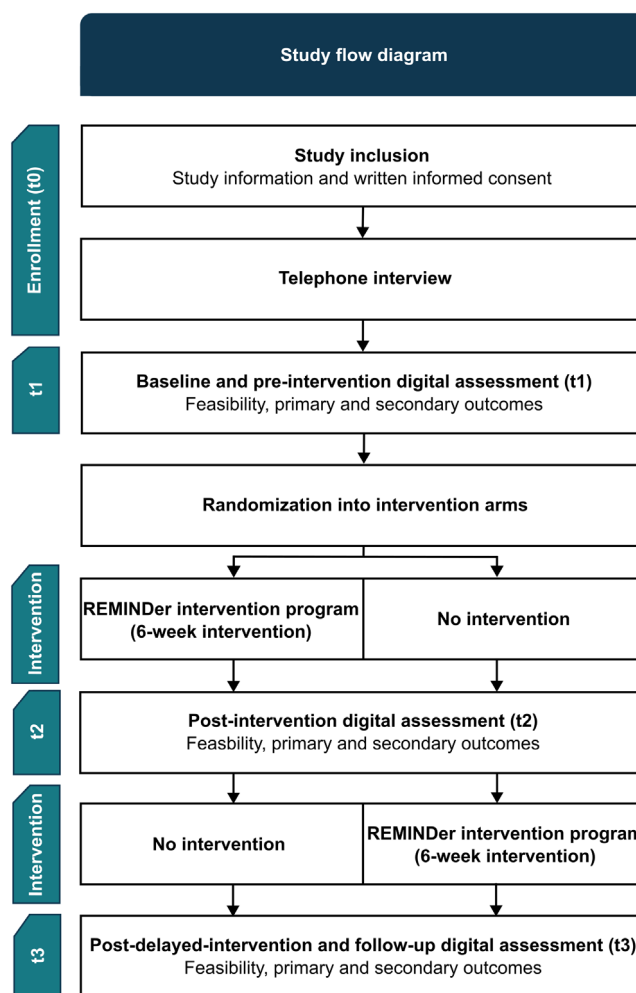


FIGURE 1 Flowchart of the *REMINDER* study.

of 6 weeks with a moderate frequency of two sessions per week and 60-minute duration per session, conducted as an AB-BA crossover study design with the following intervention sequences: (1) Sequence: Beginning with the online multimodal intervention (*REMINDER*) and then transitioning to a no-intervention phase (sequence: early intervention, AB); and (2) Sequence: Starting with a no-intervention phase and subsequently moving to the online multimodal intervention (*REMINDER*) (sequence: delayed intervention, BA).

A comprehensive overview of the intervention groups is displayed in Figure 1. In the AB-BA study design, the participants in the “intervention, no-intervention” (AB) group will participate in the 6-week online multimodal mind-body group intervention (*REMINDER*) between t1 and t2. Conversely, the participants in the “no-intervention, intervention” (BA) group will participate in the 6-week online multimodal intervention (*REMINDER*) between t2 and t3.

2.2 | Participant recruitment

A random sample of cognitively healthy older adults will be recruited from the general community across Germany. The recruitment strategy will include diverse recruitment sources, including announcements

TABLE 1 Eligibility criteria.

Inclusion criteria	Exclusion criteria
- Retired older adults (aged > 60 years^a) - Fluency in German language - Cognitively unimpaired, as assessed via the Six-Item Screener (SIS) ≥ 4 points (out of 6) - Access to a stable Internet connection and a digital device equipped with speakers, a screen, and a camera at home - Access to a personal e-mail address - Sufficient in-home space (approximately 2m $\times$ 2m) - Availability throughout the study and its measurement time points - Ability to provide written informed consent	- Regular rigorous physical exercise as defined by regular aerobic exercise (> 1.5 h/week) during the last 6 months - Regular prior experience (> 1 h/week) with Tai Chi, dance movements, or other mind-body practices during the past 6 months - Disabilities that limit participation in online movement interventions: Presence of physical ineligibility or mobility restrictions through a history of falls, not being able to walk, reliance on a walking aid, etc. - Severe uncorrected auditory or visual impairments that limit the ability to listen to online instructions or to observe online movements - Diagnosis of cognitive impairment and any type of dementia - Diagnosis of motor disorders (e.g., Parkinson's disease, multiple sclerosis) - History of cerebral disease (e.g., brain tumor) - Severe neurological disorders (e.g., epilepsy) - Diagnosis of psychiatric disorders (e.g., depression) - Other chronic medical disorders that limit physical activity (e.g., advanced cardiac or respiratory disease, severe hypertension) - Substance abuse (excessive smoking, alcohol consumption, drug abuse) - Current participation in another research study (Note: Subclinical comorbidities of psychological symptoms will not lead to exclusion.)

^aNote: An earlier version of the study protocol included older adults aged 60–80 years.

on online social media platforms and online communities, newspaper articles, and study flyers.

2.3 | Eligibility criteria

The list of inclusion and exclusion criteria is provided in Table 1. Participants will provide written informed consent during study enrollment. Participants will be informed that they can discontinue participation at any time during the study period without negative consequences.

2.4 | Participant timeline

The *REMINDER* study will include the following phases for each participant: study enrollment (t0), baseline/pre-intervention assessment (t1), the 6-week intervention or no-intervention period, and post-intervention assessment (t2). Subsequently, participants will transition to the next 6-week period (either moving from intervention to no-intervention or vice versa), concluding with a post-delayed intervention or follow-up assessment after 6 weeks (t3).

For the AB group ("early intervention, no-intervention"), t1 serves as baseline assessment for the intervention period, t2 as post-intervention assessment, and t3 is the follow-up. For the BA group ("no-intervention, delayed intervention"), t1 serves as baseline assessment for the no-intervention period, t2 concludes the no-intervention period, and t3 is the post-delayed intervention. Study flow and participant timeline are provided in Figure 1.

2.4.1 | Study visits

Enrollment (t0)

The enrollment procedure for the online *REMINDER* study will include the following steps. First, public advertisements for the study including

eligibility criteria will be placed. Individuals interested in participating in the study will visit the registration website (via URL or QR-Code) and register contact information. Second, each registered person will receive the Participant Information Sheet with study information and eligibility criteria, together with the written informed consent form, by email or post. Persons interested in study participation will sign the consent form and return it to the study team by post. Note that the Participant Information Sheet states that participation in the *REMINDER* study requires the validation of eligibility criteria by the study personnel during the telephone interview (see below).

Telephone interview (t0)

After written informed consent is obtained, participants will be assessed by telephone interview according to the eligibility criteria listed in Table 1. The interview will take approximately 20 minutes and includes standardized questions related to medical, cognitive, and physical eligibility validation. Medical conditions are assessed by questions related to serious physical, neurological, and/or psychiatric disorders, and substance abuse. Cognitive normality is assessed by the Six-Item Screener (SIS). A person is eligible to participate in the study if at least four out of six items are scored.⁷⁷ The Physical Activity Readiness Questionnaire (PAR-Q)⁷⁸ is administered to assess potential physical constraints. If one or more questions on the PAR-Q are answered "yes," the individual will be asked to seek medical advice and provide confirmation that the current health status meets the requirements for participation in the study. If, during the telephone interview, it becomes apparent that the person meets exclusion criteria that preclude study participation, the respondent will be excluded from the study.

Note that during study enrollment, participants will have the possibility to clarify any unanswered questions about participating in the *REMINDER* study via email or phone. Additionally, standard operating procedures (SOPs) on setting up and handling the videoconference system (e.g., onboarding, audio- and video-settings, break out rooms)

will be issued. Participants will then be randomized to the intervention arms according to the procedure described in the sections Randomization and Blinding and will proceed to the baseline assessment.

Baseline/pre-intervention (t1)

Baseline and pre-intervention assessment will take place in close temporal proximity before the start of the intervention. In the baseline assessment, data on detailed demographic and psychometric characteristics that may influence or moderate the outcome of the intervention are collected. In the pre-intervention assessment, all primary and secondary outcomes are collected using established and valid questionnaires (Table 2).

Post-intervention (t2) and post-delayed intervention and follow-up (t3)

The assessments are similar to the pre-intervention (t1) assessment. As shown in Table 2, the digital assessments (t1, t2, and t3) are almost identical for both study arms, except for the evaluation of the intervention, which is provided after completion of the *REMINDER* program. The baseline variable survey is omitted at t2 and t3.

2.5 | Intervention

2.5.1 | Description of intervention

In the *REMINDER* study, the participants will be offered an online multimodal mind-body group intervention. The intervention is based on the *REMIND* program that was previously developed for older adults by our research group in cooperation with experts in dance and dance/movement therapy.^{58,112} A short introduction and overview of the intervention is provided below.

The overarching goal of the *REMIND* program is to activate and strengthen reserve and resilience of older adults, which can be defined as the capacity of the brain to withstand the effects of aging and the onset of dementia.^{113,114} To this aim, the intervention uses a multimodal enrichment strategy, consisting of the three core components “music, movement, and mind”. These core components are practiced simultaneously to generate a complex multimodal motor, cognitive, sensory, emotional, and social stimulation or enrichment (Table 3). Through this distinct synthesis of perception, action, and reflection, the intervention is intended to promote health and well-being across multiple (mental, physical, cognitive, and social) domains.

The *REMIND* program integrates principles and techniques from dance/movement therapy, Argentine Tango using the “*Sistema Dinzel*” method,¹¹⁵ and mindfulness practice. The structured intervention includes guided dance movements designed to enhance body awareness, posture, balance, and coordination. The program further facilitates conscious and attentive listening to and experiencing of music. Participants engage with music by expressing melody and rhythm through creative dance movement. Mindfulness practices, including the body scan, are used to support the awareness of sensory experiences, enhance the perception of movement, and foster empathy toward oneself and others. The group completes the entire program

together to foster social interaction and connectedness. Individual and group exercises are designed to create positive learning experiences, stimulate creativity, and build self-confidence in one's own abilities.

2.5.2 | Description of online delivery

For the present study, the original *REMIND* program (36-week duration)^{58,112} will be delivered as an online (home-based and live-streamed) 6-week intervention, called *REMINDER*. This short-term online version has been specifically adapted to address the needs and challenges faced by older adults in the online setting. The online intervention will be conducted in an interactive group environment via a licensed videoconference system (i.e., Zoom) in compliance with data protection regulations. Specifically, the present study will utilize two-way real-time videoconferencing, incorporating interactive group components to facilitate social interaction among facilitators and participants, similar to in-person group interventions. The participants will attend the live-streamed sessions from their home using their own technical devices. To ensure social interaction opportunities and participants' safety in the online environment, the intervention group will be divided into two smaller groups of about equal size.

The present online multimodal intervention will be delivered using videoconferencing (home-based and live-streamed) with a duration of 6 weeks, two online sessions per week, and 60 minutes each session. Two trained facilitators with educational backgrounds and certifications in dance/movement therapy and mindfulness practice will guide the online intervention with exercises presented and performed in the live-streamed online environment. The program requires no previous experience. Most of the exercises are performed while sitting or standing and involve light to moderate physical activity. Single training sessions are divided into three phases: a welcome/warm-up (~10 minutes), training (~40 minutes), and relaxation/interactive feedback (~10 minutes) phase. During each online session, participants will perform activities that integrate music, dance movement, and mind activities, based on our structured open-access manual.⁵⁸

2.5.3 | Strategies to improve adherence to intervention

To facilitate adherence and active engagement in the online intervention and reduce potential barriers, the study implements multiple strategies:

- Technical familiarization and try-out sessions: Standard operating procedures (SOPs) and try-out sessions will be provided before the start of the intervention to ensure familiarization with the videoconferencing platform. Specifically, two try-out sessions will be offered, where participants can ask questions about study procedures and technical setup. Study personnel will guide participants through Zoom functions, such as breakout rooms, muting/unmuting, using emotional reactions, and sending chat messages.

TABLE 2 REMINDER study assessments.

Time point	Measurement	Mode	t0 Enroll-ment	t1 Baseline and pre-intervention	t2 Post- interven-tion	t3 Post-delayed intervention/ Follow-up
Study enrollment						
Public advertisement and online registration		Online	x			
Signed informed consent		Paper written	x			
Validation of eligibility criteria						
Inclusion/exclusion criteria	Questionnaire	Telephone interview	x			
Cognitive normality	6-item cognition screen SIS ⁷⁷	Telephone interview	x			
Physical safety	PAR-Q ⁷⁸	Telephone interview	x			
Allocation/ Randomization				x		
6-week intervention						
	Intervention, no intervention group (n = 25)					
	No intervention, intervention group (n = 25)					
Baseline (trait) variables						
Demographics	age, sex, education, anthropometry, lifestyle and health behaviors	Online		x		
Stress resilience	BRS, ⁷⁹ 6-item form	Online		x		
Depression	GDS, ^{80,81} 15-item short form	Online		x		
Cognitive flexibility	SAI-12, ⁸² 12-item form	Online		x		
Primary outcomes:						
Feasibility, acceptance	Adherence rate = ([number of sessions attended/total number of sessions] x 100)				x	x
Mental and physical well-being	SF-12, ⁷⁴ 12-item form	Online		x	x	x
Secondary outcomes						
Feasibility, credibility						
Feasibility measures, adapted to study procedure	Reach = ([participants enrolled / participants interested or consented] × 100)					x
	Retention rate = ([participants completing post- assessment/participants randomized to intervention] × 100)				x	x

(Continues)

TABLE 2 (Continued)

Time point	Measurement	Mode	t0 Enroll-ment	t1 Baseline and pre-intervention	t2 Post- interven-tion	t3 Post-delayed intervention/ Follow-up
	Dropout rate = ([participants dropping out /participants randomized to intervention] × 100)				x	x
Credibility and acceptance	CEQ, ⁸³ 6-item form, German version, ⁸⁴ instruction adapted	Online		x	x	x
Multimodal (self-reported)						
Cognitive						
Subjective cognition	ECog-12, ⁸⁵ 12-item short form ⁸⁶	Online		x	x	x
Objective cognition	CERAD, ⁸⁷ subtest: Word list memory test (WLMT), instruction adapted	Online		x	x	x
Motor						
Frailty	TFI, ⁸⁸ 15-item form	Online		x	x	x
Sensory						
Interoceptive awareness	MAIA-2, ^{89,90} 4-item subscale: Noticing (German: Bemerken)	Online		x	x	x
Body self-efficacy	BSE, ⁹¹ 10-item form	Online		x	x	x
Emotional/affective						
Well-being						
Psychological well-being	PWB, ⁹² 18-item short form	Online		x	x	x
General well-being	HSI-24, ^{84,93} 24-item form	Online		x	x	x
Positive emotion						
Life satisfaction	L1, ⁹⁴ 1-item short form	Online		x	x	x
Mindfulness	FFA, ⁹⁵ 14-item short form ⁹⁶	Online		x	x	x
Negative emotion						
Perceived stress	PSS-10, ⁹⁷ 10-item form	Online		x	x	x
Anxiety	STAI, ⁹⁸ 5-item short form ⁹⁹	Online		x	x	x
Social						
Loneliness	LS-S, ^{100,101} 3-item form	Online		x	x	x
Social connectedness	IOS, ¹⁰² 1-item form, instruction adapted (close: family/friends and far: community)	Online		x	x	x
Lifestyle (current)						
Social engagement	LSNS-6, ^{103,104} 6-item short form	Online		x	x	x
Physical activity	PASE, ¹⁰⁵ 8-item form, German version ¹⁰⁶	Online		x	x	x

(Continues)

TABLE 2 (Continued)

Time point	Measurement	Mode	t0 Enroll-ment	t1 Baseline and pre-intervention	t2 Post- interven-tion	t3 Post-delayed intervention/ Follow-up
Sleep quality	JSS-4, ¹⁰⁷ 4-item form	Online		x	x	x
Exploratory outcomes						
General self-efficacy	SWE, ¹⁰⁸ 10-item form	Online		x	x	x
Outcome framework for dance movement therapy	DOF-BREVE-SR, ¹⁰⁹ 18-item short form	Online		x	x	x
Monitoring and evaluation						
Monitoring of intervention	For Participants: Weekly evaluation, WHO-5 ^{110, 111} ; For facilitators: intervention logs, self-constructed	Online, during intervention		x	x	x
Monitoring of safety	Adverse events and serious adverse events	Telephone interview			x	x
Evaluation of intervention	Intervention evaluation questionnaire, self-constructed	Online			x	x

Abbreviations: BSE, Body Self-Efficacy Scale; BRS, Brief Resilience Scale; CERAD, Consortium to Establish a Registry for Alzheimer's Disease; CEQ, Credibility Expectancy Questionnaire; DOF-BREVE-SR, Dunphy Outcomes Framework, self-reported short form; Ecog, Everyday Cognition Scale; FFA, Freiburger Fragebogen zur Achtsamkeit; GDS, Geriatric Depression Scale; HSI, Heidelberg State Inventory; IOS, Inclusion of Other in the Self; JSS-4, Jenkins Sleep Scale 4; L1, Kurzsкала zur Erfassung der Allgemeinen Lebenszufriedenheit; LSNS, Lubben Social Network Scale; LS-S, Loneliness Scale-SOEP, Version of the German Socio-Economic Panel Study (SOEP); MAIA-2, Multidimensional Assessment of Interoceptive Awareness, Version 2; PAR-Q, Physical Activity Readiness Questionnaire; PASE, Physical Activity Scale for the Elderly; PSS, Perceived Stress Scale; PWB, Ryff's Psychological Well-Being Scales; SAI, Scope-of-Action Index; SF, Short-Form Health Survey; SIS, 6-item cognition screen; STAI, State-Trait Anxiety Inventory; SWE, Skala zur Allgemeinen Selbstwirksamkeit; SWLS, Satisfaction With Life Scale; TFI, Tilburg frailty Indicator; WHO-5, World Health Organization-Five Well-Being Index.

- Real-time participant support: Real-time assistance and support will be available for participants before and during each training session. More specifically, a team member will be present in the background of each session to address technical difficulties and enhance user applicability. This team member can be contacted immediately via Zoom chat, email, or phone for support, if needed. Participants are instructed to keep their cameras activated throughout the live-streamed training sessions to facilitate real-time monitoring and ensure participant safety.
- Structured real-time facilitation and interactive group activities: Trained facilitators will guide sessions interactively, ensuring that participants stay engaged and actively involved. Interactive group activities, such as music-based activities and jointly performed movement sequences, will encourage participation and supportive group dynamics. Online features like breakout rooms will be used to promote social interaction, and enhance motivation and participant adherence.
- Consistent scheduling and session reminders: Sessions will be held at the same time each week to promote compliance and reliability. Participants will receive access details and session reminders via email before each session to support commitment and adherence.

2.5.4 | Choice of comparator

The comparator of this pilot study is a passive control group (waitlist with delayed intervention). Participants will be randomized to either the *REMINDER* group or the delayed-intervention group.

The present study includes a passive control based on following methodological and practical considerations: (1) The primary aim of this study is to assess the feasibility and preliminary effectiveness of the *REMINDER* program, rather than to compare it against an active control intervention. (2) The implementation of an active control would have required additional resources, such as trained facilitators and adherence monitoring, that were beyond the scope this pilot study. Future larger-scale trials should include an active control group to account for placebo effects and non-specific factors.

2.5.5 | Relevant care or interventions that are permitted during the trial

During the no-intervention periods, the participants are permitted to engage in their daily activities and lifestyle. Specifically, participants

TABLE 3 Multimodal enrichment in the *REMIND* Program.

Parameter	Motivation	Implementation
Motor stimulation	Enhance conscious perception of movement Facilitate kinaesthesia, proprioception, and motor skill learning Improve movement self-awareness, posture, balance, and coordination	Practice of conscious movement perception and action Exercises focused on balance, coordination, and postures Utilization of imaginative movement exercises to enhance internal awareness and embodiment
Cognitive stimulation	Enhance cognitive skills by integrating physical and mental activities Engage multiple cognitive domains such as memory, attention, awareness, and visuomotor skills Facilitate neuroplasticity in brain networks associated with higher-order cognitive functions	Practice of movement sequences, such as basic dance steps, and interactive group exercises Practice of creative movements to music to stimulate cognitive flexibility and creativity Promote multimodal integration by engaging in interactive dance movements
Sensory stimulation	Enhance sensorimotor skills through the integration of sensory perception and physical engagement with music Promote awareness of internal and external environments through the embodied experience of music and movement Integrate sensory experience, interpretation, and dance movements	Practice of directing awareness to internal sensations and external stimuli Facilitate the expression of feelings and moods through movement inspired by music Facilitate the awareness and reflection of sensory experiences and emotional responses through introspection
Emotional stimulation	Stimulate emotional awareness through the dialogue between internal and external awareness Activate emotions and influence feelings and moods Express sensations and emotional perceptions through movement	Practice of interactive exercises with music to influence mood and emotional states Encourage self-reflection on emotions such as fear, joy, sadness, and anger
Social stimulation	Stimulate social interaction and connectedness Encourage a sense of trust, social support, and empathy Promote interpersonal learning and emotional sharing	Facilitate individual and group exercises designed to promote social stimulation and interaction Practice of "mirroring" to enhance self-awareness in social contexts Facilitate self-awareness through the engagement in social interaction and communication

will be asked not to take up physical activities beyond inclusion criteria. No other restrictions will be applied.

2.6 | Study outcomes

2.6.1 | Remote data collection

A comprehensive battery of validated behavioral questionnaires will be assessed online at all stages (Table 2). Note that existing German versions of the questionnaires are implemented. Additional measures will be obtained at baseline to characterize participants and identify potential confounders. The outcome measures will be obtained using remote unsupervised digital assessments via the LimeSurvey software in agreement with data protection regulations. Assessments take approximately 60 min (per assessment/time point). Assessments will be provided in sections of 20 minutes on 3 consecutive days to reduce the workload. An additional 20 minutes are expected for the baseline assessment as well as about 20 minutes for the telephone screening. Assessments of study measures are detailed in Table 2. Possible health risks and measures to avoid them are described in the section Monitor-

ing. Note that the outcome assessment will take place online; no visit to the study institution is required at any time point.

2.6.2 | Primary outcome

The aim of this pilot study is to determine feasibility and preliminary effectiveness of the *REMINDER* program. *Feasibility* will be assessed via adherence rates (Table 2). Adherence to the intervention per participant is defined as the number of sessions attended in relation to the total number of sessions. The change from baseline/pre-intervention to post-intervention in mental and physical well-being will be assessed as the co-primary outcome. This will be evaluated using the SF-12,⁷⁴ which is a self-report questionnaire with 12 items on mental and physical health outcomes.

2.6.3 | Secondary outcomes

A detailed overview of secondary outcome measures is provided in Table 2. Secondary outcomes include credibility and further measures concerning the feasibility of the intervention including reach, retention

rate, and dropout rate as provided in Table 2 and in previous intervention studies.^{75,116} Since the control group (waitlist with delayed intervention) will receive the intervention between t2 and t3, the cross-over design will allow for the evaluation of feasibility measures at different time points. In addition, changes from pre-intervention (t1) to post-intervention (t2) will be assessed using self-reported secondary outcomes measures of multimodal cognitive, motor, sensory, emotional, social, and lifestyle behaviors as provided in Table 2.

2.6.4 | Other outcomes, moderators, and evaluations

Other outcome measures of the present study include assessment of self-efficacy and the outcome framework for dance movement therapy (Table 2). In addition, potential moderators of the intervention will be explored. We will conduct exploratory moderation analyses, mainly focusing on psychological traits and trait-like factors, given the potential role of these factors in adherence and/or responsiveness to lifestyle interventions.¹¹⁷ Specifically, we plan to explore measures of depressive symptoms, coping skills, self-efficacy, and perceived social support (Table 2). Finally, the baseline data of the present study will be utilized for exploratory analyses beyond the scope of the intervention.

The intervention will be systematically monitored using multiple evaluation tools, including weekly self-assessments by participants, intervention logs completed by facilitators, and a comprehensive evaluation of the overall intervention program. (Table 2). More specifically, participants will complete a brief weekly evaluation questionnaire, requiring approximately 2 min. This will include the World Health Organization-Five Well-Being Index (WHO-5),^{110,111} a five-item self-report measure of well-being (instruction adapted), as well as items assessing the general satisfaction with that week's training sessions. Facilitators will complete intervention logs after each session, incorporating structured training protocols to document session delivery, as well as their experiences and observations.

After completing the entire intervention program, participants will fill in a detailed evaluation questionnaire of the *REMINDER* intervention, which was specifically designed for the present study. The first three sections of the evaluation form use a five-point Likert scale to assess: (1) satisfaction with technical aspects of the intervention such as audio and video quality, technical support, and the live-streamed videoconferencing format via Zoom; (2) satisfaction with the overall structure and content of the online program; and (3) interest in participating in similar online interventions in the future. Additionally, open-ended questions will enable participants to share personal experiences, suggestions, and general feedback.

3 | METHODS: ASSIGNMENT OF INTERVENTIONS

3.1 | Randomization

Participants will be randomly assigned to one of the two intervention arms using block randomization stratified by age and sex and a

computer-based algorithm with a 1:1 allocation ratio. We aim to enroll a total of $n = 25$ participants in the AB group, and $n = 25$ participants in the BA group, that is, $N = 50$ participants in total. Note that spouses will be allowed in the same group. After being randomly assigned to the intervention arms, participants will receive details on the intervention from the study personnel.

3.2 | Blinding

Study outcomes will be collected using remote unsupervised digital questionnaire batteries and assessed by a designated statistician blinded to the group allocation. Blinding will not be broken until the last participant has been assessed at the post-delayed intervention/follow-up assessment (t3) and the analysis of the primary outcome has been completed.

3.3 | METHODS: DATA COLLECTION, MANAGEMENT, AND ANALYSIS

3.4 | Data collection methods

In the *REMINDER* study, data will mainly be collected using remote unsupervised digital assessments (Figure 1). The behavioral data will be collected via online questionnaires facilitated by the licensed LimeSurvey software (<https://www.limesurvey.org/>). LimeSurvey is an established software utilized for the creation of online questionnaires and the collection of online data.

Data pertaining to the examination of the participants, including personal information, will be collected and recorded at the DZNE Dresden. Participant data will be collected in pseudonymized form (i.e., based on a non-personally identifiable number) on the LimeSurvey server and transferred to the secure DZNE server. The data will be managed by the study personnel via a registered LimeSurvey account. Access to this account will be restricted to study personnel. To ensure that questionnaires are correctly assigned to participants, each participant will be given a unique identification number, which will be numbered in ascending order for each participant. The identification number ensures the pseudonymization of the data.

In general, remote unsupervised digital assessments offer broad accessibility, cost-effectiveness, and scalability, while saving time and resources. However, the assessment depends on participants' engagement and accuracy, which may be affected by privacy concerns, distractions, misinterpretations or social desirability bias. To mitigate potential limitations of the remote data collection, we will provide clear instructions and use validated self-report questionnaires that are relevant to the target group. Additionally, regular check-ins and technical support will be offered to assist participants and ensure data quality. Future studies could explore alternative assessment approaches, using behavioral tracking technologies for physical functioning or and video-based evaluations for cognitive and psychological outcomes, to further enhance reliability and objectiveness in remote data collections.

3.5 | Data management

The *REMINDER* study team will be responsible for data management under the guidance of the principal investigators (OK, MW). The data collected and stored in the study will be pseudonymized, that is, the inclusion of any identifying information such as names, initials, or dates of birth will be omitted. In addition, the data will be password protected within the participant database at DZNE Dresden; thus, the data will be secured against unauthorized access. An assignment of the pseudonymized data to a person is only possible via an identification list, which contains the participant's pseudonymization (resp. identification) number and contact data (name, e-mail, telephone number). This identification list is stored separately from the study data at the DZNE Dresden and is only accessible to the study personnel. Ten years after the publication of the study, the identifying data will be deleted.

The data from the *REMINDER* study will be analyzed in pseudonymized format by qualified scientific personnel according to the analysis strategy describe above (section Data analysis). Publication of study results will not include any personal information and participants will not be identified. Given the sensitive and personal nature of the data, data from this study will not be publicly disclosed. Anonymized data will be made available to any qualified investigator upon request. The participants will be informed of their right to correct any data provided if necessary and to withdraw from the study at any time without consequence.

3.5.1 | Statistical methods

3.5.2 | Sample size

The sample size for the *REMINDER* study was determined based on the primary objective of evaluating the feasibility of the intervention, as operationalized through adherence rates. A minimum adherence rate of 60% was assumed, although adherence rates of 80% and higher have been reported in similar intervention studies.²² Sample size estimation was performed using a one-sided test for proportions against the null hypothesis of 60% adherence, assuming an effect size of $g = 0.30$. The significance level was set at 5%, with a target statistical power of at least 80%. Based on these parameters, the minimum required sample size was calculated to be $n = 14$ participants per intervention group using G*Power version 3.1.¹¹⁸ Accounting for an anticipated dropout rate of 20%, this number was adjusted to 17 participants per group. To further enhance statistical power and increase the likelihood of detecting an intervention effect, the study aims to recruit $n = 25$ participants per group, resulting in a total sample size of $N = 50$.

The estimated pilot sample size exceeds the recommended sample size for pilot studies and is appropriate to effectively assess key feasibility metrics, such as adherence, engagement, and acceptability.^{119, 120} In addition, a reserve list of consented and eligible participants will be established to replace dropouts as needed, helping to mitigate attrition and ensure optimal use of available resources. While the present study may not be powered to determine

definitive efficacy outcomes, its findings will be crucial for refining the intervention and guiding the design of future larger-scale trials.

3.5.3 | Statistical methods

The statistical analysis will be carried out using statistical software packages available in R.¹²¹ Statistical analyses of the primary outcomes will be performed by a designated statistician. Statistical analyses of secondary outcomes and additional exploratory analyses will be performed by the study investigators. Data analysis will be conducted in cooperation with and under supervision of the Institute for Medical Informatics and Biometry (IMB), Technische Universität Dresden, Dresden, Germany.

Baseline characteristics

Baseline characteristics of participants will be summarized and compared using independent t-tests for continuous variables and a χ^2 test for categorical variables. Distribution of baseline characteristics between groups will be assessed to confirm a successful randomization process.

Analysis of primary outcomes

The primary statistical objective of this pilot study is to evaluate feasibility and preliminary effectiveness of the intervention. The primary outcome is feasibility. Feasibility will be assessed via adherence rates, with a benchmark criterion of at least 60% of sessions attended. A 60% threshold was selected as a pragmatic indicator of acceptable engagement in the context of this pilot study. The co-primary outcome is the change in mental and physical well-being as operationalized with the SF-12.^{74, 122} Primary and co-primary outcomes will be assessed between t1 and t2 using an "intention-to-treat" (ITT) approach, evaluating all participants randomized into the study. Note that spouses will be allowed in the same group and statistical analyses will be adapted accordingly.

Analysis strategy

In a first step, we will perform between-group comparisons of primary and secondary outcomes after the completion of the first intervention period from t1 to t2. Specifically, changes in outcomes from pre-intervention (t1) to post-intervention (t2) from the AB intervention group will be contrasted with changes in outcomes from pre-intervention (t1) to post-intervention (t2) from the BA no-intervention group. Additionally, within- and between-group intervention effects will be explored including the post-delayed intervention and follow-up (t3) assessment, respectively. For example, we will assess whether a similar pattern of changes from t1 to t2 in the AB intervention group will be present from t2 to t3 in the BA delayed intervention group. Additionally, exploratory analyses of the longer-term (AB sequence) and delayed (BA sequence) intervention effects from t1 to t3 will be conducted in both intervention arms. Finally, we will assess potential moderation effects of pre-existing psychological traits on the outcomes of the intervention in exploratory moderation analyses.

The statistical analysis strategy of this study will be informed by our previous randomized controlled studies, in particular the Age-Well and SCD-Well trials.^{66, 123–125} Specifically, linear mixed models will be employed to assess changes in primary and secondary outcomes from t1 to t2 and from t1 to t3 as a function of the intervention arms. Overall, the statistical analysis approach will ensure a nuanced understanding of both the immediate and longer-term impacts of the intervention across both sequences (AB and BA), while leveraging the advantages of the present study design.

For each outcome, estimates with 95% confidence intervals (CIs) will be reported for the slope of change within each intervention group and the differences between the intervention groups. Effect sizes for the evaluated changes will be represented by Cohen's d ,¹²⁶ estimated using the calculated mean changes. Models will be adjusted for potential confounders; in addition, unadjusted models will be explored. The primary outcome and co-primary outcome will both be evaluated at a two-sided significance level of $\alpha = 0.05$.

We will employ an ITT approach, ensuring that all participants randomized into the study will be included in the analysis. To address missing data, appropriate statistical techniques will be applied. We will evaluate whether the data are missing completely at random (MCAR).¹²⁷ If the assumption is met, full information maximum likelihood estimation (FIML)¹²⁸ or comparable methods will be applied to obtain efficient and unbiased parameter estimates, thereby maximizing the use of available data without introducing systematic bias. In addition, sensitivity analyses will be conducted to assess the robustness of the results.

4 | METHODS: MONITORING

4.1 | Adverse event monitoring

The study follows the principles of good scientific/clinical practice and is considered to be safe for participants at any time point. Risks arising from participating in the study are considered to be low. Potential adverse events (AEs) and serious adverse events (SAEs) will be monitored throughout the *REMINDER* study. Participants will be informed to report AEs or SAEs in case of occurrence/notice. AEs and SAEs that occur during the intervention will be recorded by the study personnel in accordance with SOPs that have been established for this purpose. Participants will be given contact information in case of medical issues resulting from participation in the intervention. It is anticipated that no AEs/SAEs will result from participation in the *REMINDER* study. Written informed consent will be obtained from all participants to ensure that they are adequately informed about the safety standards in place.

4.2 | Participant safety

The *REMINDER* study serves basic research purposes and will be based on voluntary participation. The study and implementation of the intervention are conducted according to the “do no harm” principle,

meaning that the well-being and safety of participants are of highest priority. The sessions of the online intervention will be safe, as they are designed for the specific target group and will be applied by highly trained professionals. The facilitators/trainers will receive comprehensive training on the identification and mitigation of risks associated with the intervention and will collaborate with the study personnel to implement risk-mitigating procedures.

Note that for safety reasons, participants are required to keep their cameras activated at all times during the training sessions. Study personnel will be present in the background of each session to monitor participant safety and provide real-time technical support and assistance. Requiring that cameras are activated during the training sessions will allow for the immediate identification of any participant experiencing difficulties, such as sudden health issues, technical problems, or other issues requiring immediate assistance.

The *REMINDER* intervention is explicitly designed to promote positive effects on multiple health domains, including mental, cognitive, physical, and social well-being in older adults. Eligibility criteria include potential physical constraints to ensure that safety is fulfilled throughout the study. In the case of concerns due to pre-existing subclinical health problems, participants will be required to provide a statement from their physician that they are able to participate in the study. Although we do everything in our power to minimize and avoid any potential harm, we cannot rule out the possibility of accidents or injuries occurring during the sessions. However, we believe that the risks of potential harm to participants are minimized.

4.3 | Withdrawal and study termination

Participants have the option to withdraw from the *REMINDER* study at any time point. The date of termination of study participation will be recorded in writing by the study personnel. In the event of early termination, participants will not be subject to any costs or disadvantages. There is no obligation for participants to provide a rationale for early termination.

5 | ETHICS AND DISSEMINATION

5.1 | Ethical approval

The *REMINDER* study was approved by the local Ethics Committee of the Technische Universität Dresden, Dresden, Germany (SR-EK-477112023, date of approval: April 2, 2024). All procedures of the study will be carried out in compliance with the Declaration of Helsinki. Any substantial changes and additions to the study protocol will be submitted to the Ethics Committee of the Technische Universität Dresden, Dresden, as an amendment for review and approval. The study was registered on ClinicalTrials.gov (Identifier: NCT06530277, date of first submission: July 27, 2024). The protocol adheres to the Standard Protocol Items: Recommendations for Interventional Trials (SPIRIT) guidelines.¹²⁹

5.2 | Informed consent

All study participants provide written informed consent. Prior to providing written consent, participants will be informed about the goals, content, and procedures of the *REMINDer* study (section Study visits). To ensure single blinding, participants will not be informed about the detailed primary and secondary outcomes. The DZNE is covered by a public liability insurance and has undertaken an accident insurance for the *REMINDer* study. Participants will be informed of this in the consent form prior to study participation. Participants will further be informed that they can withdraw at any time during the study, without any negative consequences. In case of withdrawal, participants can demand that their existing data are completely deleted. A full disclosure of the study aims will be provided subsequent to the completion of the intervention study (after t3 assessment) via written or oral debriefing. Participants will receive a compensation in return for their participation.

5.3 | Dissemination

Results of the *REMINDer* study will be disseminated to the national and international scientific community, health care professionals, and other relevant stakeholders through publications in peer-reviewed journals and presentations at national and international scientific conferences. Publication of this study will be in accordance with the standards and recommendations of the international scientific community. The results will further be made available for both scientific and lay audiences on the ClinicalTrials.gov website. Additionally, the findings of this study will be disseminated to the general public and relevant stakeholders through media coverage including newspaper articles, social media platforms, and other dissemination channels.

6 | DISCUSSION

The *REMINDer* study constitutes an online randomized controlled pilot intervention study in older adults. The main objective of this study is to evaluate the feasibility and preliminary effectiveness of an online (home-based and live-streamed) multimodal mind-body group intervention to improve the mental and physical well-being of older participants compared to a passive control group (waitlist with delayed intervention). The intervention featured in the present study integrates arts-based activities related to music, dance movement, and mindfulness performed in an interactive group environment via two-way real-time videoconferencing. A sample of cognitively unimpaired older adults will be recruited from the general community in Germany and assessed before and after the online intervention program using remote unsupervised digital assessments with online questionnaires.

6.1 | Addressed research gaps

The *REMINDer* study addresses key research gaps in the field: First, this study evaluates engagement with and adherence to an online

multimodal mind-body group intervention designed for older adults and delivered via two-way real-time videoconferencing. The online multimodal enrichment featured in the present study integrates arts-based activities related to music, dance movement, and mindfulness in an interactive social environment that encourages social participation and connectedness. The online implementation of the multimodal mind-body group intervention represents a state-of-the-art approach for diverse older populations, including healthy older adults and individuals with health conditions (for reviews, see^{54,56,57}). Advancing knowledge in this field is important for the integration of teleinterventions into public health care and community services, especially in rural and underserved areas with limited access to in-person programs.

Second, the present study investigates the impact of the online intervention on mental and physical well-being, as well as secondary outcomes related to cognitive, motor, sensory, emotional, and social well-being and lifestyle behaviors. Other intervention studies have implemented similar online intervention programs in older adults, with some studies still ongoing.^{45–48,50–53} By investigating these multiple health domains, this study advances the understanding of the benefits associated with online lifestyle interventions, including their capacity to foster social integration—an important determinant in mitigating dementia risk.² Overall, the *REMINDer* study will provide valuable evidence and knowledge on the feasibility and impact of remotely delivered lifestyle interventions for diverse older populations.^{56,57}

6.2 | Accessibility, scalability, and applicability

Key strengths of the present study include its accessibility and potential scalability across diverse cultural, economic, and geographic backgrounds. The fully online design the *REMINDer* study offers an applicable and scalable approach for diverse older populations, similar to recent Internet-based studies.^{130–132} By using digital assessments, remote data collection, and home-based live-streamed delivery of the intervention, the present study aims to reduce geographical and logistical barriers, increase participant convenience, and optimize cost-effectiveness and resource efficiency. The integration of structured videoconferencing sessions with real-time facilitation and interactive group components facilitates active participant engagement. Findings from this small-scale pilot study will inform feasibility and refinement of the *REMINDer* intervention and lay the groundwork for larger-scale, hypothesis-testing trials. The methodology used in this study could inspire the development of scalable, remotely delivered interventions that enhance resilience and psychosocial well-being as innovative targets to promote healthy aging.¹³³ Given its fully online, scalable, and cost-effective design, *REMINDer* could be integrated into Internet-based multidomain trials, aiming to reduce multiple dementia risk factors, for example, see Poppe et al.¹³² and Heffernan et al.¹³⁴

Future studies should assess scalability, inclusivity, and real-world implementation of the online multimodal mind-body group intervention. More specifically, research should explore how to adapt the *REMINDer* intervention, or similar online dance-based programs, to

diverse socio-cultural contexts,⁴⁷ and how to engage older adults from diverse ethnic, socioeconomic, and digital literacy backgrounds.¹³⁵ Possible strategies to achieve this may include co-producing research through community partnerships, implementing user-friendly telehealth platforms, providing loaned digital devices, encouraging tandem participation with family members, and integrating the intervention into existing health care and community services.⁵⁷ Addressing these factors will enhance the scalability, accessibility, and overall impact of remotely delivered lifestyle interventions in the promotion of healthy aging and the prevention of AD.

6.3 | Risks, barriers, and mitigation strategies

In the design of the *REMINDER* study, careful consideration is given to potential risks, barriers, and challenges that could affect feasibility, safety, and effectiveness of the intervention. Potential risks may include lower adherence and participant engagement due to the absence of in-person facilitation and interaction. To mitigate these risks, the present study incorporates real-time facilitation, interactive group activities, and real-time participant support in the online environment. Previous studies have shown that similar online dance-based group programs can promote social integration and connectedness,^{44,45} which in turn may support participant adherence and active engagement. Future studies should further evaluate the impact of more extended intervention durations to optimize long-term health benefits of the online multimodal mind-body group intervention.

Potential barriers of the present online multimodal intervention may include restricted technological access and varying levels of digital literacy among older adults. To mitigate these risks, this pilot study will recruit participants with access to the necessary technology, including a stable Internet connection and a digital device along with sufficient in-home practice space. Furthermore, pre-intervention try-out sessions will be conducted, real-time technical support will be provided throughout the intervention, and standardized protocols for the structured use of the videoconferencing platform will be implemented. Note that recruitment efforts will be made to include older adults from diverse geographic regions across Germany, including those in rural and underserved areas, where access to in-person interventions might be limited.

In this pilot study, we will include healthy, well-functioning older adults. This may lead to ceiling effects in the primary outcome measures, potentially limiting the ability to detect improvements or changes in response to the intervention. The exclusion criteria were set mainly for safety reasons, as health conditions like uncontrolled hypertension or substance dependency may increase the risk of AEs. To mitigate potential ceiling effects, secondary outcome measures will assess broader impacts of the intervention and moderators will be analyzed for their influence on the intervention outcomes. If the study demonstrates feasibility, safety, and preliminary benefits in the healthy sample, future research will include more vulnera-

ble groups of older adults at higher risk for cognitive decline and dementia.

6.4 | Implications and future directions

If proven feasible and effective, online multimodal mind-body group interventions could become accessible and scalable tools for embodied prevention and early intervention strategies. Environmental enrichment through arts-based interventions, including music and dance, are key in promoting the health and well-being across diverse health conditions,¹³⁶ thereby addressing current gaps in prevention and care.¹³⁷ Arts-based interventions show benefits across multiple health domains, including mental, cognitive, physical, and social health, and encourage health-promoting behaviors.¹³⁸ Evidence syntheses of in-person dance movement interventions have demonstrated beneficial effects across various age groups and clinical conditions,^{22,23,139} supporting the transdiagnostic applicability of these arts-based interventions. Findings from the present online intervention study will help expand the existing knowledge and may inform future Internet-based trials focused on enhancing healthy aging and reducing dementia risk in older adults.

In a broader perspective, the ongoing development and refinement of feasible and effective online lifestyle interventions will help to optimize economic, social, and emotional support for older adults, caregivers, and health care providers. As digital literacy among older adults can be expected to grow, remotely delivered interventions will become increasingly accessible. Comparing online and in-person interventions will be essential to assess benefits and potential limitations of different delivery modes. Future research should further consider hybrid online and in-person interventions to promote healthy aging and reduce dementia risks.

7 | CONCLUSION

This randomized controlled study aims to provide evidence on the feasibility and impact of an online multimodal mind-body intervention delivered in an interactive group environment via two-way real-time videoconferencing. The active intervention will be compared to a passive control group (waitlist with delayed intervention). The *REMINDER* study may inform future larger-scale trials and accessible lifestyle interventions to maintain healthy aging and prevent dementia.

AUTHOR CONTRIBUTIONS

Miranka Wirth, Selina Stamer, Odile Podolski, Annemarie Maßalsky, Sabine C. Koch, Olga Klimecki: Conceptualization, design, and methodology of the study; Miranka Wirth, Selina Stamer, Olga Klimecki: Implementation, administration, and conduct of the study including data collection; Miranka Wirth, Olga Klimecki: Supervision and funding acquisition; Miranka Wirth, Selina Stamer, Odile Podolski, Annemarie Maßalsky, Olga Klimecki: Writing-Original draft preparation, Miranka

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All study participants provide written informed consent, agreeing to the collection and use of de-identified study-related information.

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CONFLICT OF INTEREST STATEMENT

All authors declare that they have no relevant conflicts of interest. Author disclosures are available in [supporting information](#).

ORCID

Miranka Wirth  <https://orcid.org/0000-0002-0725-7314>

Odile Podolski  <https://orcid.org/0000-0003-1591-414X>

Olga Klimecki  <https://orcid.org/0000-0003-0757-7761>

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