Received: 1 October 2025 | Revised: 15 January 2026 | Accepted: 11 February 2026

DOI: 10.1002/bsa3.70071

RESEARCH ARTICLE

Alzheimer's & Dementia® Behavior & Socioeconomics of Aging

Feasibility and effects of an online multimodal mind–body intervention on mental and physical well-being in older adults: The *REMIND*er randomized controlled study

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Funding information
DZNE Stiftung – Forschung für ein Leben ohne Demenz, Parkinson und ALS, Grant/Award Numbers: T0531/36311/2020/kg, T0531/41814/2002/kg

Abstract

INTRODUCTION: Aging populations require scalable, accessible, and inclusive lifestyle interventions that address multiple modifiable dementia risk factors.

METHODS: The *REMIND*er pilot randomized controlled trial, randomized (1:1) healthy older adults (≥ 60 years, retired) to a 6-week online multimodal mind–body group intervention or a delayed-intervention control group. The live-streamed, home-based, two 1-hour sessions/week program integrates music, dance movement, and mindfulness via video conferencing. Primary outcomes were feasibility (adherence benchmark: ≥ 60%) and changes in mental and physical well-being (Health-Survey SF-12). Secondary outcomes comprised feasibility metrics and safety.

RESULTS: Intention-to-treat analyses included 68 participants (mean [standard deviaton {SD}] age: 69.2 [5.2] years; 80.9% women). Mean (SD) adherence was 80% (30%), exceeding the predefined benchmark ($p = 0.010$). There were no group differences in SF-12 mental ($p = 0.827$) or physical well-being ($p = 0.656$) from pre-to-post intervention. Feasibility was high, with 95% reach, 90% retention, and 9% dropout. No serious adverse events occurred.

DISCUSSION: The scalable, accessible online multimodal intervention is feasible and safe for older adults.

TRIAL REGISTRATION: ClinicalTrials.gov (Identifier: NCT06530277) on July 27, 2024. https://clinicaltrials.gov/study/NCT06530277.

KEYWORDS
Alzheimer's disease, dance movement therapy, digital health, embodied prevention, healthy aging, mind–body intervention, mindfulness, randomized controlled trial (RCT)

1 | INTRODUCTION

With rising global life expectancy and age-related diseases, including Alzheimer's disease (AD), promoting healthy aging has become a public health priority.[1] While therapeutic advances continue,[2] non-pharmacological lifestyle interventions targeting modifiable cognitive, physical, psychological, and social risk factors are essential for the effective prevention of dementia.[3]

Maintaining mental health and well-being is a key aspect of healthy aging. The World Health Organization (WHO) emphasizes the integration of mental, physical, and social well-being into overall health.[4] Multimodal (or multidomain) interventions can promote healthy aging and potentially reduce dementia risk by supporting these multiple health domains in older populations.[5,6] However, the implementation of such interventions is challenging, particularly in rural areas.[6] Remotely delivered telehealth interventions can help overcome geographic and cultural barriers, expanding access to underserved populations and enabling real-time participation in at-home settings.[7,8]

1.1 | Dance as a multimodal intervention

Animal studies have shown that environmental enrichment promotes neuroplasticity and brain health even in late life.[9–12] Enriched environments are characterized by complex, dynamic, and simultaneous stimulation, providing novel, multimodal motor, cognitive, sensory, and social experiences that require active engagement. While leveraging enrichment-induced neuroplasticity is viewed to be relevant for aging and neurodegenerative disease, translating the findings from animal models into effective human interventions remains challenging,[9] and high-quality studies are still limited.

Arts-based interventions, such as dance and dance movement therapy, can be considered human analogs to environmental enrichment. These interventions align with the concept of an "*embodied mind in motion*"[13] as an active ingredient in holistic or integrated strategies of dementia prevention.[14,15] Dance activities simultaneously engage motor, sensory, cognitive, emotional, and social processes.[16–18] This simultaneous multimodal stimulation is thought to promote neuroplasticity by synchronizing neural activity across distributed brain networks, thereby supporting health and well-being in multiple domains in older adults.[17,19]

The capacity of dance activities to support dementia prevention and early interventions warrants further investigation.[20,21] Previous evidence has linked participation in dance to healthy aging and reduced dementia risk.[22] Meta-analyses of dance-based interventions show small-to-moderate improvements in older adults including cognitive,[23] physical,[24,25] and psychological[20,26] health domains with some effects emerging even after short-term interventions of 6 and 8 weeks.[27–32] Combining dance movement therapy with mindfulness practices has been shown to reduce depressive symptoms and loneliness while enhancing psychological well-being.[33] Dance activities could alleviate depressive symptoms more than other physical activities[34] and enhance well-being across multiple interconnected health domains,[35] offering a low-threshold accessible strategy to support healthy aging.

1.2 | Online multimodal interventions

Remotely delivered multimodal (or multidomain) interventions can target multiple dementia risk factors in older adults[36]. They can provide accessible, scalable, and inclusive strategies for dementia prevention.[37] In particular, real-time two-way video conferencing is well-suited for the home-based delivery of multimodal mind–body group interventions, including various dance types,[27,38–40] mindfulness-based dance movement therapy,[33] Tai-Chi,[41] and the mind–body PLIÉ program.[42,43] Emerging randomized controlled trials (RCT) suggest that such online multimodal interventions are feasible, safe, and effective to improve cognitive, physical, and mental health,[41,42] with some outcomes comparable to in-person delivery.[39] Further high-quality research on remotely delivered lifestyle interventions that are feasible and effective in older populations is needed.[7,44]

The *REMIND*er study addressed this research gap by evaluating a short-term online multimodal mind–body group intervention. Adapted from the 36-week *REMIND* program,[45] this 6-week online version integrates music, dance movement, and mindfulness activities, all of which have independently been shown to benefit brain, cognitive, and mental health in older adults.[20,46,47] By simultaneously engaging motor, cognitive, sensory, emotional, and social processes, multimodal interventions may generate synergistic effects that act through multiple mechanistic pathways.[16,48] On this basis, the present intervention was designed to address multiple dementia risk factors, supported by evidence showing that combined (or multimodal) interventions often outperform single-component programs in improving cognitive and physical function.[49] This approach aligns with the multifactorial dementia risk model[3] as well as with the concept of environmental enrichment.[9]

1.3 | Objectives

The main objective of this pilot randomized controlled study was to evaluate the feasibility and preliminary effects of the *REMIND*er intervention. Healthy older adults were randomized to either the 6-week online multimodal mind–body group intervention or a passive control

HIGHLIGHTS

- Randomized controlled trial (RCT) of a 6-week online multimodal mind–body group intervention
- Intervention integrates music, dance movement, and mindfulness
- High adherence, retention, and safety indicate feasibility of the intervention in older adults
- Future studies are needed to establish efficacy of the intervention
- Findings support research on scalable, accessible online multimodal interventions

RESEARCH IN CONTEXT

1. **Systematic review**: The authors systematically searched PubMed and ClinicalTrials.gov for randomized controlled trials (RCTs) of multimodal lifestyle interventions targeting multiple modifiable dementia risk factors simultaneously. Few studies have investigated remotely delivered, live-streamed, home-based interventions. Most studies were conducted in person, limiting reach and scalability.
2. **Interpretation**: Results from the *REMIND*er study indicate that the 6-week online multimodal mind–body group intervention is feasible, well-accepted, and safe for older adults. No significant changes were observed in self-reported mental or physical well-being. Further research is needed to refine the intervention duration, target population, and outcome measures.
3. **Future directions**: Future studies should investigate long-term multidimensional health outcomes, tailor the intervention to more vulnerable and heterogeneous older populations, and identify underlying mechanisms of action. Further randomized controlled trials are needed to determine efficacy of the *REMIND*er intervention in promoting well-being in older adults.

group with delayed intervention, as described in the study protocol.[50] The supervised intervention was delivered in an interactive digital social environment using live-streamed, home-based, two-way video conferencing.

We hypothesized that the *REMIND*er intervention will be feasible, safe, and show preliminary effects. Primary outcomes included feasibility (adherence rate) post-intervention and changes in mental and physical well-being, measured by the Short Form Health-Survey (SF-12),[51] pre-to-post intervention. Secondary outcomes included additional feasibility metrics and safety. The present study aims to inform future large-scale trials and contribute to evidence-based, scalable dementia prevention strategies.

2 | MATERIAL AND METHODS

Detailed information on the design, procedures, and methodology of the *REMIND*er study are documented in the study protocol.[50] The study was registered on ClinicalTrials.gov (Identifier: NCT06530277, date of first submission: July 27, 2024). The study followed the Consolidated Standards of Reporting Trials (CONSORT) reporting guideline,[52] specifically the CONSORT 2010 statement: extension to randomized pilot and feasibility.[53] The CONSORT 2025 checklist is provided in the Supplementary Material (Consort Supplementary Table S1).

2.1 | Study design

*REMIND*er was a pilot randomized controlled study with blinded primary outcome analysis to evaluate the feasibility and preliminary effects of a 6-week online multimodal mind–body group intervention on mental and physical well-being. The study was carried out fully remote under the supervision of the German Center for Neurodegenerative Diseases (DZNE) in Dresden, Germany.

Briefly, the *REMIND*er study was conducted as an AB-BA crossover study with a waitlist control group that received the *REMIND*er intervention after the early intervention group (thereafter referred to as delayed intervention group). During the intervention period, participants engaged in the 6-week *REMIND*er program consisting of two 1-hour sessions per week (12 sessions in total) delivered via real-time, two-way video conferencing.

The *REMIND*er study included the following phases: study enrollment (t0), baseline/pre-intervention assessment (t1), followed by a 6-week intervention or no-intervention period, and the post-intervention assessment (t2). Subsequently, participants transitioned to the second 6-week intervention or to the no-intervention period, concluding with a post-delayed intervention/follow-up assessment (t3) after week 12. The design allowed assessment of the *REMIND*er intervention using a crossover format. No washout period was implemented due to the low-risk, non-pharmacological nature of the intervention.

2.2 | Participants recruitment and eligibility criteria

Community-dwelling older adults were recruited from the general population across Germany via flyers, advertisements and/or posts on social media, newspapers, newsletters, websites, and online forums of public health insurances, public health associations, senior citizens associations, public outreach events, and personal contacts.

Eligible participants were retired, and over 60 years of age. The selection of this age benchmark for older adults is in line with reports by the United Nations and the World Health Organization,[54,55] and with

previous RCTs investigating lifestyle-based interventions in older adults, including large-scale multimodal,[37,56] dietary supplementation,[57] and mindfulness-based[58] interventions. Participants had to be cognitively unimpaired as assessed using the Six-Item Screener (SIS score ≥ 4),[59] German speaking, and had to have access to a digital device with camera, screen, speakers, a stable internet connection, and a personal email address. Participants further needed sufficient space at home (2 × 2 m) and needed to be available for all study procedures and assessments.

Exclusion criteria included regular aerobic exercise (> 1.5 h/week) or mind–body practices (e.g., Tai Chi, dance; > 1 h/week) in the past 6 months; physical disabilities or mobility limitations; uncorrected hearing or vision problems; diagnosed cognitive, neurological, psychiatric, or motor disorders; severe chronic medical conditions limiting physical activity; substance abuse; or concurrent participation in other research studies.

2.3 | Participant and public involvement

For this pilot study, no formal patient or public advisory group was established. Participants took part in try-out sessions prior to the start of the intervention study to familiarize themselves with the video conferencing platform and provide feedback on its usability. In addition, the implementation and delivery of the intervention program was systematically monitored using a structured evaluation strategy. This included weekly self-assessments completed by participants, intervention logs completed by facilitators, and a comprehensive assessment of the overall program. The evaluation strategy is described in the study protocol[50] and will be reported elsewhere.

2.4 | Study procedure

To participate in the *REMIND*er study, interested older adults registered via the study website and received written information about study content and procedures. Those willing to participate provided written informed consent. Eligibility was assessed via telephone interview during enrollment. Eligible participants were enrolled and randomly assigned to the intervention sequences (early intervention group [AB] or delayed intervention group [BA]) by the study coordinator. Two randomized replacement lists (one for each intervention arm) served as replacement pool for participants who dropped out before each intervention period. The study was completed as planned with no early stopping rule.

2.5 | Randomization and masking

Eligible participants were randomized by the study coordinator in monthly batches using block randomization with a 1:1 allocation ratio, stratified by age group (60–69, 70–79, and ≥80 years) and sex (women, men). Note that spouses were allowed in the same group. Randomization was performed monthly via a stratified block randomization using a computer-based algorithm (randomly generated numbers in Excel). Strata were predefined based on age group (60–69, 70–79, and ≥80 years) and sex (women, men). At each monthly randomization point, we reviewed the distribution of newly enrolled participants across these strata. Strata were considered "underrepresented", when fewer participants were enrolled relative to other strata (e.g., men aged ≥80 years vs. women aged 60–69 years). To maintain balance between intervention and control groups within each stratum despite unequal enrollment, smaller block sizes were used for strata with fewer participants.

To reduce scheduling conflicts, the randomization took place before baseline/pre-intervention assessment (t1). This procedure deviated from the study protocol,[50] which had planned randomization after baseline/pre-intervention assessment (t1). To address the issue of potential pre-intervention dropouts, we established randomized replacement lists (one for each intervention arm). These participants were randomized identically and completed behavioral assessments in parallel, enabling immediate replacement of dropouts within their assigned intervention arm.

Participants were informed of their group assignment via email. To reduce expectation effects, participants were not informed of the specific primary and secondary outcomes measures. Primary outcome data were analyzed by a designated statistician blinded to group allocation. Blinding of outcome assessment was maintained until the last participant completed the post-delayed intervention/follow-up assessment (t3) and the primary outcome analysis was completed. Due to the nature of the intervention, participants and facilitators were not blinded to group allocation. All participant codes and group assignments were stored separately in a secure, encrypted file system.

2.6 | Intervention and comparator

The 6-week online multimodal mind–body group intervention (*REMIND*er) was adapted from the open-access *REMIND* program and manual,[45] as developed previously by our team in collaboration with experts in dance movement therapy. The 36-week *REMIND* program is built around three core components *"music, movement, and mind"* using principles and elements from dance movement therapy and Tango "*Sistema Dinzel*".[60] In line with the definition of the European Association for Dance Movement Therapy (EADMT, www.eadmt.com), the program "*employs the therapeutic use of* dance and movement to promote emotional, cognitive, physical, social integration", with the aim to enhance reserve and resilience in older adults.

The 6-week online intervention (*REMIND*er) is described in more detail in our study protocol.[50] A schematic overview of the intervention format and content of is provided in Figure 1. Briefly, the supervised online mind–body group intervention integrates music, dance movement, and mindfulness practices in an interactive and socially engaging digital environment. During the 6-week duration, the intervention progresses through developmental movement patterns, which are fundamental whole-body coordination patterns that emerge during early

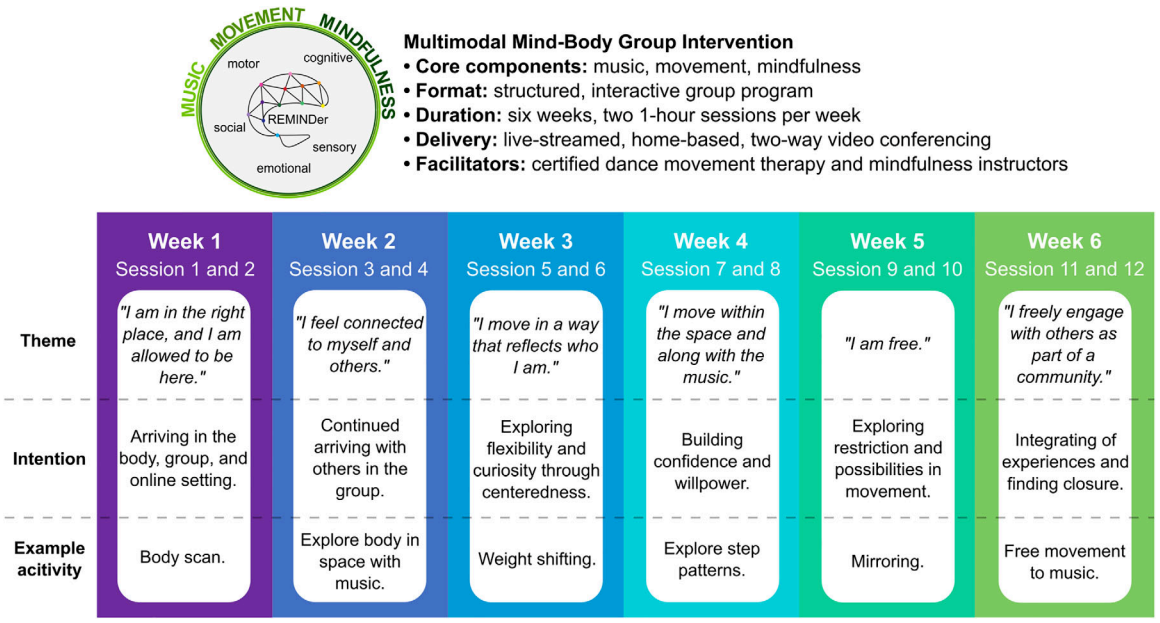

FIGURE 1 Overview of the content of the *REMIND*er intervention. The figure summarizes the key components and characteristics of the 6-week (12 sessions) online multimodal mind–body group intervention, including weekly themes, intentions, and example activities.

human motor development and support efficient, integrated movement. These patterns are central to the somatic movement system "*Bartenieff Fundamentals*" and are embedded within comprehensive movement system of "*Laban/Bartenieff Movement Studies*".[61] A brief overview of the session content is provided in the Supplementary Material (Supplementary Table S2).

The *REMIND*er intervention was delivered in 60-minute online group sessions, held twice per week over 6 weeks in small groups (12–14 participants). Sessions were led by two certified facilitators, one instructor certified in dance movement therapy and the other instructor certified in mindfulness practice. Each facilitator was experienced in facilitating mind–body group interventions for older adults. All sessions followed a structured manual with a three-phase format: welcome/warm-up (10 minutes), core training (40 minutes), and relaxation/reflection (10 minutes) to ensure consistency and equivalence across the two intervention arms.

The comparator condition was a passive control group (waitlist with delayed intervention). During the waiting phase, participants received no structured intervention and were instructed to maintain their usual routines.

2.7 | Online delivery of the intervention

The *REMIND*er intervention was delivered using live-streamed, home-based, two-way video conferencing via the licensed video conferencing platform Zoom (zoom.com) in compliance with data protection regulations. Participants attended the interactive sessions from home using their own technical devices. A structured participant support strategy included try-out sessions, structured onboarding, and real-time technical support prior to and throughout the intervention, as detailed in the study protocol.[50]

2.8 | Intervention engagement and participant support

The implemented participant support strategy served to support adherence, minimize technical barriers, and encourage active engagement. Participants received two pre-intervention try-out sessions to get familiarized with the video conferencing platform, along with real-time technical support during all sessions. In addition, consistent scheduling supported participant compliance. Participants received regular email reminders, and phone calls were made when sessions were unattended without prior notice. The facilitators fostered a motivating and psychologically safe environment and were available throughout the intervention to address questions or concerns via email. Session materials were shared upon request.

2.9 | Concomitant care

Participants were instructed to refrain from initiating any new structured physical, cognitive, or mind–body health programs during the study period. No concomitant care or additional interventions were provided in either study phase.

2.10 | Outcome measures

The primary and secondary outcome measures were assessed remotely using unsupervised digital assessments, with the exception of adherence rates. Digital assessments were conducted using the licensed survey software LimeSurvey (limesurvey.org) and consisted of online behavioral questionnaires administered at baseline/pre-intervention (t1), post-intervention (t2), and

post-delayed intervention/follow-up (t3), as detailed in the study protocol.[50]

2.10.1 | Primary outcome measures

The primary outcome measures of the *REMIND*er study were feasibility and preliminary effects of the intervention on self-reported mental and physical well-being measured from baseline/pre-intervention assessment (t1) to post-intervention assessment (t2).[50] Feasibility was assessed by the adherence rate, which was recorded by the study personnel at each training session. The adherence rate was calculated for each participant by the number of sessions attended in relation to the total number of sessions.

Mental and physical well-being were measured using the self-reported SF-12 questionnaire (version 1, 1-week recall form).[51] The SF-12 was measured at baseline/pre-intervention assessment (t1), post-intervention assessment (t2), and post-delayed intervention/follow-up assessment (t3) using digital assessments.

The SF-12 provides two composite scores called the Mental Component Summary and the Physical Component Summary. The SF-12 scores for each component were calculated based on standardized procedures using norm-based scoring, with a mean of 50 and a standard deviation of 10 in the US general population.[62] Scores above 50 on the Mental Component Summary and Physical Component Summary indicate better mental and physical well-being than the average general population. Scores below 50 on the respective component indicate lower mental and physical well-being than the average general population. More detailed information on the SF-12 are provided in the study protocol[50] and in the Supplementary Material.

2.10.2 | Selected secondary outcome measures

Feasibility outcomes

Secondary feasibility outcomes included reach, retention, and dropout rates, with formulas adapted to the study design, as described in the study protocol.[50] The reach rate was calculated as the percentage of enrolled participants relative to the following three groups: (1) those who were screened and eligible, (2) those who expressed interest and provided informed consent, and (3) those who registered on the website.

The retention rate was assessed at post-intervention assessment (t2) and post-delayed intervention/follow-up assessment (t3) as the percentage of participants who completed t2 and t3 assessments relative to those enrolled in either the early intervention group (AB) or the delayed intervention group (BA), including replacements. The dropout rate was calculated at post-intervention assessment (t2) (t1 to t2) and post-delayed intervention/follow-up assessment (t3) (t1 to t3) as the percentage of participants, who discontinued the study relative to those enrolled in either the early intervention group (AB) or the delayed intervention group (BA), excluding replacements.

Safety monitoring

Safety of participants was a key priority in the *REMIND*er study. During each online session, study personnel was present to address individual needs of the participants, monitor the risk of injury, and provide technical support. Any reported or observed adverse events (AEs) or serious adverse events (SAEs) were documented and categorized as related or unrelated to the study intervention. In line with the crossover design, AEs were recorded in each intervention period and per group (early intervention group [AB], delayed intervention group [BA]). Further details on safety monitoring were provided in the study protocol.[50]

2.10.3 | Additional measures

Information on self-reported sex and years of education was collected as demographic data at baseline/pre-intervention assessment (t1). Information on depressive symptoms was measured at baseline/pre-intervention assessment (t1) using the 15-item Geriatric Depression Scale [GDS];.[63] a self-report questionnaire, in which participants responded with "yes" or "no" to statements about how they had felt during the past week. Higher GDS scores (possible range: 0–15) indicate greater levels of depressive symptoms.

The Credibility and Expectancy Questionnaire (CEQ)[64] was used to evaluate the equivalence of intervention expectations across the two intervention arms. The CEQ is a validated 6-item self-report measure with three items assessing credibility of the intervention and three items assessing expectancy of the intervention. The CEQ items are scored on a Likert scale ranging from 1 to 9 (1 means "not at all", 5 "somewhat", and 9 "very much") or from 0% to 100% (10-point increments). Items were summed up for credibility and expectancy scales separately, with percentage-based responses converted to a 1–9 scale. Higher CEQ scores (possible range: 3–27) indicate greater intervention credibility and outcome expectancy, respectively.

2.11 | Statistical analyses

2.11.1 | Sample size

The sample size estimation was reported in detail in the study protocol.[50] Briefly, sample size was determined based on feasibility, particularly the expected adherence rate, and practical considerations. A predefined benchmark of 60% session attendance was implemented as a pragmatic indicator of feasibility, as previously described.[50] This threshold was considered sufficient to demonstrate that participants engaged with the intervention at a minimally acceptable level before progressing to a fully powered efficacy trial. This procedure aligns with accepted practices for pilot and feasibility studies, as outlined in the CONSORT 2010 statement: extension to randomized pilot and feasibility trials.[53]

Using a one-sided test for proportions ($g = 0.30$, $\alpha = 5\%$, power = 80%), a minimum sample size of $n = 14$ participants per intervention arm was estimated (G*Power, version 3.1),[65] adjusted to

$n = 17$ with an expected 20% dropout rate. To enhance statistical power, $n = 25$ participants per intervention arm ($n = 25$ early intervention group, $n = 25$ delayed intervention group, $N = 50$ total) were targeted, exceeding the typical recommendations for pilot studies.[66] Note that a greater number of participants was enrolled and included in randomized replacement lists to account for pre-intervention dropouts.

2.11.2 | Outcome analysis

The statistical analysis plan was pre-specified in the study protocol.[50] No interim analyses or stopping rules were planned or conducted. All analyses were conducted using R version 4.4.0.[67] Secondary outcome measures, not reported here, will be analyzed using similar linear mixed effects models and will be reported in future publications. Estimates for within-group changes and between-group differences including 95% confidence intervals (CIs) and p values are reported. For hypothesis testing, a significance level of 5% (two-sided) was chosen.

Sample characteristics

Demographic characteristics and baseline measures for the total sample and interventions groups are summarized as absolute frequencies and percentages, or using mean and standard deviation. p-values were estimated from parametric (t-test) or nonparametric (chi-squared) statistical comparisons.

Primary outcome analysis

Primary outcome measures were assessed from baseline/pre-intervention (t1) to post-intervention (t2) using an intention-to-treat approach. For the intention-to-treat analysis, all randomized participants with completed baseline/pre-intervention assessment (t1) data, including those from the randomized replacement lists, were included. Inclusion in the intention-to-treat sample was done regardless of adherence or availability of post-intervention data, following CONSORT guidelines. Participants from the randomized replacement lists, who were not activated into the intervention were included in the intention-to-treat sample.

The intention-to-treat analysis of primary outcome measures was conducted as follows: First, we assessed whether the adherence rate in the early intervention group (AB) measured at post-intervention assessment (t2) was significantly greater than the predefined 60% benchmark criterion. For this purpose, we used the one-sided (one sample) Wilcoxon signed-rank test. In addition, we assessed whether the adherence rate in the delayed intervention group (BA) was significantly greater than the predefined 60% benchmark criterion.

Changes in the SF-12 mental and physical well-being from baseline/pre-intervention assessment (t1) to post-intervention assessment (t2) in the early intervention group (AB) were compared to those in the delayed intervention group (BA). The analysis was conducted using a linear mixed-effects model. Fixed effects included intervention group (sequence: AB or BA) and time of assessment (coded as t1, t2), as well as their interaction. Intervention effects were compared through the interaction term between intervention group and time of assessment. Statistical models were adjusted for covariates of sex, age, and years of education, as done in our previous study,[68] and were fitted using restricted maximum likelihood estimation. A random intercept was included to model within-subject correlation across repeated measurements.

The following sensitivity analyses were conducted: The as-treated analysis was carried out based on a "minimum-dose" approach. The analysis thus included participants, who attended ≥ 6 out of 12 sessions, that is $\geq 50\%$ of the sessions, to evaluate the robustness of the results, as done in previous studies.[69,70] The as-treated analysis was carried out for the primary outcomes, measured at post-intervention assessment (t2).

Exploratory secondary outcome analyses

Following exploratory secondary analyses were conducted to investigate (1) immediate effects of the delayed intervention from post-intervention assessment (t2) to post-delayed intervention/follow-up assessment (t3), and (2) longer-term effects from baseline/pre-intervention assessment (t1) to post-delayed intervention/follow-up assessment (t3). This approach allowed for a preliminary evaluation of immediate and longer-term intervention effects across intervention groups (early intervention group [AB] and delayed intervention group [BA]).

The secondary analyses were conducted using linear mixed-effects models that accounted for the crossover design. Fixed effects included intervention group (sequence: AB or BA) and time of assessment (coded as t1, t2, t3), as well as their interaction. Models were adjusted for covariates of sex, age, and years of education and were fitted using restricted maximum likelihood estimation. A random intercept was included to model within-subject correlation across repeated measurements.

2.11.3 | Moderation analysis

Next, we examined whether the intervention effect from baseline/pre-intervention assessment (t1) to post-intervention assessment (t2) was moderated by baseline depressive symptoms, as measured by the GDS. A dichotomous variable of the total GDS score (lower with a GDS = 0 vs. higher with a GDS > 0) was included as an interaction term with time in a linear mixed-effects model. As done in previous studies,[71] the threshold was selected because GDS scores tend to be low in samples of healthy older adults.

Note that the moderation analysis was restricted to participants in the early intervention group (AB). The model included a random intercept for participants to account for within-subject correlation. Estimated marginal means and 95% CI were derived to interpret the differential change over time between GDS subgroups.

2.11.4 | Missing data strategy

Missing data occurred in the SF-12 mental and physical well-being, while all other variables were fully observed. Under the assumption of missing at random the full information maximum likelihood estimation was used to minimize bias.

2.11.5 | Sensitivity analysis

The traditional SF-12 Mental Component Summary and Physical Component Summary scores are commonly derived using regression-based weights that impose statistical constraints whereby physical and mental health dimensions are treated as separate and uncorrelated constructs.[51] While this assumption may be advantageous for cross-sectional comparisons, it can complicate the interpretation of intra-individual change over time. Previous research has shown that weighted (norm-based) SF-12 scoring can yield counterintuitive results, such as poor physical health artificially raises mental health scores.[72] Therefore, we calculated unweighted raw sum scores for the SF-12 mental and physical well-being as a complementary sensitivity analysis.

3 | RESULTS

3.1 | Participant flow and baseline characteristics

Recruitment took place from April 25, 2024 to July 31, 2024. Data collection was completed on December 05, 2024. Figure 2 shows the participant flow chart of the study. Of $n = 91$ participants assessed for eligibility, $n = 71$ were randomized into intervention arms and the randomized replacement lists. Out of these, $N = 68$ participants performed baseline/pre-intervention assessment in the two intervention arms: early intervention group (AB: $n = 28$ and AB replacement list: $n = 6$) and control group with delayed intervention (BA: $n = 28$ and BA replacement list: $n = 6$). The recruitment target of at least $N = 50$ was exceeded.

For the intention-to-treat analyses, $N = 68$ participants were included, $n = 34$ within each intervention arm. Of these, all participants (including replacement list participants) were randomized and provided baseline/pre-intervention assessment (t1). For the as-treated analysis, $n = 57$ participants were included, $n = 28$ for the early intervention group (AB) and $n = 29$ for the delayed intervention group (BA) (see Figure 2). Of these, all participants (including replacement participants) received the intervention or control condition. $N = 1$ cross-over case (i.e., participant crossing from the AB to BA intervention sequence, see Figure 2) was included in the early intervention group (AB) for intention-to-treat, and in the delayed intervention group (BA) for as-treated analyses.

Baseline characteristics of the $N = 68$ participants included in the intention-to-treat analysis are shown in Table 1. The groups (early intervention group [AB], delayed intervention group [BA]) were balanced in demographic measures, depression scores (measured by the GDS), and credibility/expectancy ratings (measured by the CEQ). Baseline characteristics of the participants included in the as-treated analysis are provided in the Supplementary Material (Supplementary Table S3).

TABLE 1 Participant characteristics from the intention-to-treat sample.

Characteristics	Total sample ($N = 68$)	Early intervention group ($n = 34$)	Delayed intervention group ($n = 34$)
Age, years	69.2 (5.2)	69.3 (5.7)	69.1 (4.8)
Sex			
Female	55 (80.9%)	28 (82.4%)	27 (79.4%)
Male	13 (19.1%)	6 (17.6%)	7 (20.6%)
Education, years	15.9 (2.5)	15.9 (2.8)	16.0 (2.1)
GDS, score	2.0 (2.7)	2.6 (3.0)	1.5 (2.2)
CEQ credibility, score	21.4 (4.3)	21.6 (4.7)	21.3 (3.9)
CEQ expectancy, score	17.2 (4.7)	17.0 (4.7)	17.3 (4.7)

Note: Data are presented as mean and standard deviation (in parenthesis) or numbers (%).
GDS: Higher scores indicate greater levels of depressive symptoms (possible range: 0–15).
CEQ: Higher scores indicate greater intervention credibility and expectancy (possible range: 3–27).
Abbreviations: CEQ, Credibility and Expectancy Questionnaire; GDS, Geriatric Depression Scale.

3.2 | Primary outcome measures

Observed norm-based SF-12 scores for mental and physical well-being (primary outcome measures) at baseline/pre-intervention assessment (t1; week 0), post-intervention assessment (t2; week 6), and post-delayed intervention/follow-up assessment (t3; week 12) assessments and observed mean changes are reported in Table 2. Complete data sets were available for $n = 68$ participants at baseline/pre-intervention assessment (t1), $n = 59$ at post-intervention assessment (t2), and $n = 53$ at post-delayed intervention/follow-up assessment (t3). In the present sample, the mean score of the SF-12 mental well-being was numerically above the U.S. general population norm of 50. The mean score of the SF-12 physical well-being was numerically below the U.S. general population norm of 50. Both SF-12 scores were within the normative range.

3.2.1 | Feasibility: Adherence rate

Results of the feasibility analysis, as derived from the Wilcoxon signed-rank test, are presented below. For the intention-to-treat sample, the *mean (SD)* adherence rate across both intervention groups was 70% (SD: 40%). The adherence rate significantly exceeded the predefined

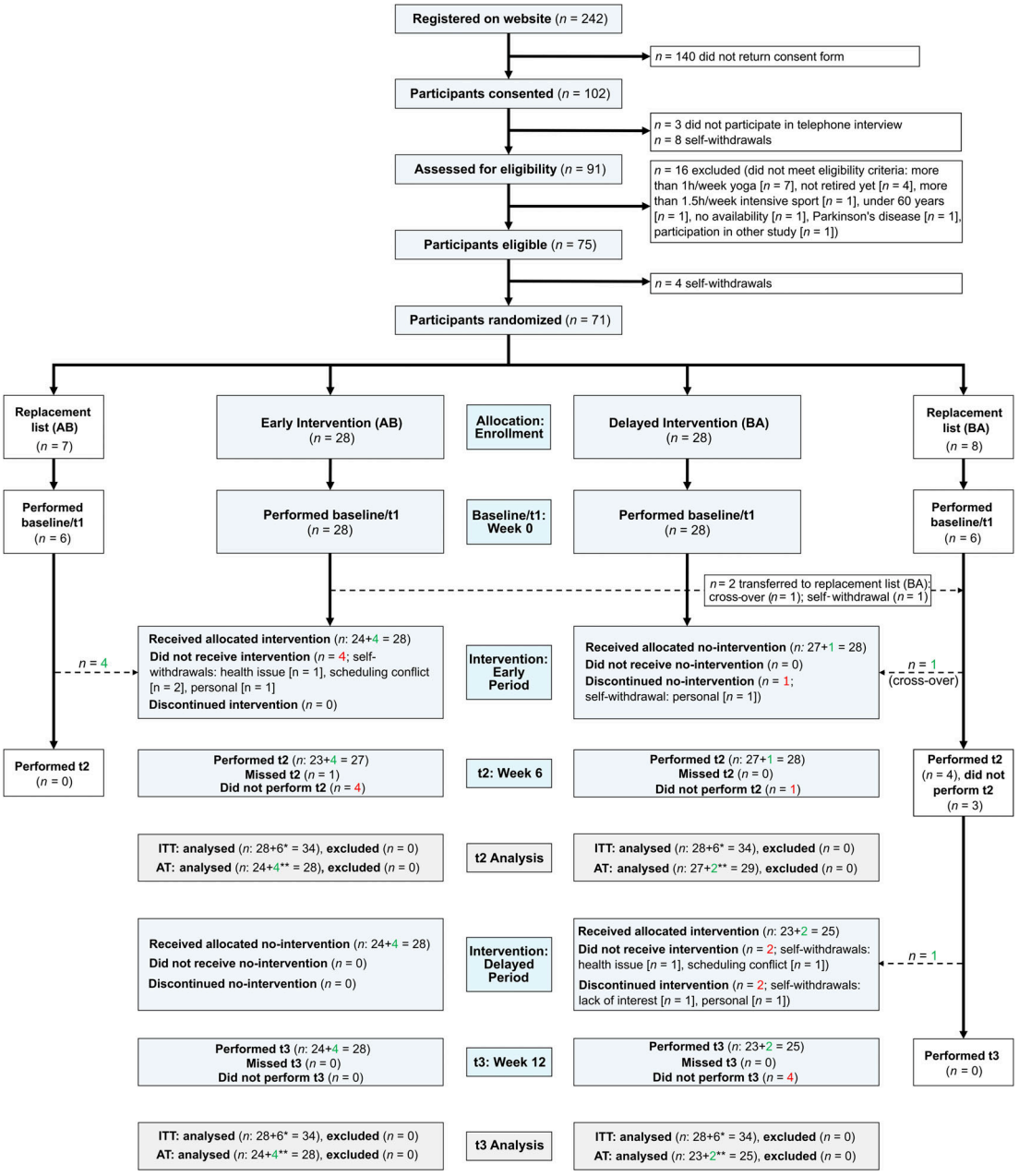

FIGURE 2 Consort flow diagram. Consort flow diagram of enrolment, randomization, and outcome analysis in the intervention arms of the *REMIND*er study. *Replacement list participants are included in the intention-to-treat analysis. **Replacement participants are included in the as-treated analysis for the respective intervention arm. Dropouts are shown in red, replacements are shown in green. Special case: $n = 1$ cross-over case (crossing from AB to BA intervention sequence) was included in the early intervention group (AB) for the intention-to-treat analysis and in the delayed intervention control group (BA) for the as-treated analysis. AB, early intervention group; AT, as-treated; BA, delayed intervention group; ITT, intention-to-treat; t1, baseline/pre-intervention assessment; t2, post-intervention assessment; t3, post-delayed intervention/follow-up assessment.

benchmark of 60% ($p = 0.042$). For the early intervention group (AB), adherence rate was 80% (30%) and significantly exceeded the predefined benchmark criterion ($p = 0.010$) post-intervention (t2). For the delayed intervention group (BA), adherence rate was 60% (SD: 40%) and did not significantly exceed the predefined benchmark criterion ($p = 0.425$) post-delayed intervention (t3).

For the as-treated sample, the *mean (SD)* adherence rate across both intervention groups was 80% (SD: 20%). This number significantly exceeded the predefined benchmark criterion of 60% session attended ($p < 0.001$). For the early intervention group (AB), adherence rate was 90% (SD: 10%) and significantly exceeded the predefined benchmark criterion ($p < 0.001$) post-intervention (t2). In the AB group, $n = 27$ (96%) participants attended ≥ 60% of the sessions; no participants discontinued the early intervention. For the delayed intervention group (BA), adherence rate was 80% (30%) and significantly exceeded the predefined benchmark criterion ($p = 0.006$) post-delayed inter-

TABLE 2 Observed scores for adherence and SF-12 mental and physical well-being in the intention-to-treat and as-treated samples.

	Adherence rate				SF-12 mental well-being				SF-12 physical well-being			
	Early intervention group		Delayed intervention group		Early intervention group		Delayed intervention group		Early intervention group		Delayed intervention group	
Parameter	*n*	Mean (SD) in %	*n*	Mean (SD) in %	*n*	Mean (SD)	*n*	Mean (SD)	*n*	Mean (SD)	*n*	Mean (SD)
Intention-to-treat												
t1					34	52.1 (8.7)	34	51.5 (8.0)	34	45.0 (8.7)	34	47.9 (8.0)
t2	34	80 (30)			28[a]	52.5 (9.9)	31	51.3 (8.5)	28[a]	44.3 (9.6)	31	47.4 (8.5)
t3			34	60 (40)	29	53.4 (9.8)	24	52.9 (7.8)	29	46.3 (8.8)	24	45.9 (11.2)
Change t1 to t2					28	−0.1 (7.6)	31	−0.5 (7.6)	28	−1.1 (6.6)	31	−0.4 (5.3)
Change t2 to t3					28	0.6 (8.5)	24	0.8 (6.9)	28	2.3 (9.5)	24	0.0 (10.1)
Change t1 to t3					29	0.7 (9.4)	24	0.9 (7.9)	29	1.4 (6.5)	24	−1.5 (10.6)
As-treated												
t1					28	52.7 (8.8)	29	51.9 (7.8)	28	45.1 (8.5)	29	47.7 (8.0)
t2	28	90 (10)			27[a]	52.5 (10.0)	29	52.0 (8.4)	27[a]	44.8 (9.3)	29	46.3 (9.1)
t3			29	80 (30)	28	53.5 (9.9)	25	52.7 (7.6)	28	46.3 (9.0)	25	45.9 (11.0)
Change t1 to t2					27	−0.1 (7.7)	29	0.1 (7.6)	27	−0.7 (6.3)	29	−1.4 (5.4)
Change t2 to t3					27	0.7 (8.6)	25	0.6 (6.8)	27	1.8 (9.2)	25	0.7 (10.5)
Change t1 to t3					28	0.9 (9.5)	25	0.7 (7.8)	28	1.3 (6.6)	25	−1.3 (10.5)

Note: SF-12 scores are norm-based with a mean of 50 and a standard deviation of 10 in the U.S. general population.
Abbreviations: SF-12, Short Form Health-Survey; t1, baseline/pre-intervention assessment; t2, post-intervention assessment; t3, post-delayed intervention/follow-up assessment.
[a]*n* = 1 participant had missing data in the SF-12 mental and physical well-being at t2.

vention (t3). In the BA group, *n* = 23 (85%) participants attended ≥ 60% of the sessions; *n* = 2 participants discontinued the delayed intervention.

3.2.2 | Mental and physical well-being

Results of the primary intention-to-treat analysis based on the linear mixed effects model (primary outcome model including t1 and t2) of the SF-12 mental and physical well-being are presented in Table 3 and Figure 3 including a spaghetti plot showing individual trajectories for the SF-12 across all assessment time points. For the as-treated analysis, a spaghetti plot for the SF-12 across all assessment time points is provided in the Supplementary Material (Supplementary Figure S1).

Mental well-being

For the intention-to-treat analysis, the estimated mean change in the SF-12 Mental Component Summary from baseline/pre-intervention assessment (t1) to post-intervention assessment (t2) was 0.1 (95% CI: −2.8 to 2.9, $p = 0.957$) in the early intervention group and -0.4 (95% CI: −3.1 to 2.4, $p = 0.796$) in the delayed intervention group (Table 3). There was no significant difference between groups in the mean change (0.4; 95% CI: −3.5 to 4.4, $p = 0.827$; Table 3). The as-treated analysis supported these findings (between-group difference in mean change: −0.1; 95% CI: −5.3 to 5.1, $p = 0.950$; Table 4).

Physical well-being

For the intention-to-treat analysis, the estimated mean change in the SF-12 Physical Component Summary from baseline/pre-intervention assessment (t1) to post-intervention assessment (t2) was -1.1 (95% CI: −3.3 to 1.2, $p = 0.340$) in the early intervention group and −0.4 (95% CI: −2.5 to 1.7, $p = 0.721$) in the delayed intervention group (Table 3). There was no significant difference between groups in the mean change (−0.7; 95% CI: −3.8 to 2.4, $p = 0.656$; Table 3). The as-treated analysis supported these findings (between-group difference in mean change: 0.9; 95% CI: -4.4 to 6.2, $p = 0.688$; Table 4).

3.3 | Secondary outcome measures

3.3.1 | Feasibility: Reach, retention, and dropout

Reach rates (percentage of persons enrolled) was 95% (*n* = 71 out of 75) of persons who were screened and eligible, 70% (*n* = 71 out of 102) of persons who provided informed consent, and 29% (*n* = 71 out of 242) of persons who initially registered on the website (see Figure 2).

Retention rate (as-treated, including replacements) was 90% (*n* = 55 out of 61) at post-intervention assessment (t2), with 84% (*n* = 27 out of 32) in the early intervention group (AB) and 97% (*n* = 28 out of 29) in the delayed intervention group (BA). At post-delayed intervention/follow-up assessment (t3), the retention rate was 100%

TABLE 3 Estimated within-group changes and between-group differences from the intention-to-treat analysis.

	Early intervention group ($n = 34$)	Delayed intervention group ($n = 34$)		
	Within-group estimated change	Within-group estimated change	Between-group estimated change	
Outcome measures	**Estimate (95%, CI)**	**Estimate (95%, CI)**	**Estimate (95%, CI)**	***p*-value**
Primary outcome measures (model including t1 and t2)				
SF-12 mental well-being t1 to t2	0.1 (−2.8, 2.9)	−0.4 (−3.1, 2.4)	0.4 (−3.5, 4.4)	0.827
SF-12 physical well-being t1 to t2	−1.1 (−3.3, 1.2)	−0.4 (−2.5, 1.7)	−0.7 (−3.8, 2.4)	0.656
Secondary outcome measures (full model including t1, t2, and t3)				
SF-12 mental well-being t1 to t2	0.2 (−3.3, 3.7)	−0.3 (−3.7, 3.0)	0.5 (−4.5, 5.5)	0.803
SF-12 mental well-being t2 to t3	0.7 (−2.8, 4.3)	1.2 (−2.5, 4.9)	−0.5 (−5.7, 4.8)	0.834
SF-12 mental well-being t1 to t3	0.9 (−2.6, 4.4)	0.9 (−2.9, 4.6)	0.1 (−5.1, 5.3)	0.979
SF-12 physical well-being t1 to t2	−1.0 (−4.6, 2.5)	−0.4 (−3.8, 3.0)	−0.6 (−5.7, 4.4)	0.756
SF-12 physical well-being t2 to t3	2.3 (−1.3, 5.9)	−0.9 (−4.7, 2.9)	3.2 (−2.2, 8.5)	0.152
SF-12 physical well-being t1 to t3	1.3 (−2.2, 4.8)	−1.3 (−5.0, 2.5)	2.5 (−2.7, 7.8)	0.246

Note: For between-group differences, positive differences favor the early intervention group, whereas negative differences favor the delayed intervention control group. All analyses included covariates of sex, age, and education, as well as random participant intercepts. Significant effects appear in bold.
Abbreviations: CI, confidence interval; SF-12, Short Form Health-Survey; t1, baseline/pre-intervention assessment; t2, post-intervention assessment; t3, post-delayed intervention/follow-up assessment.

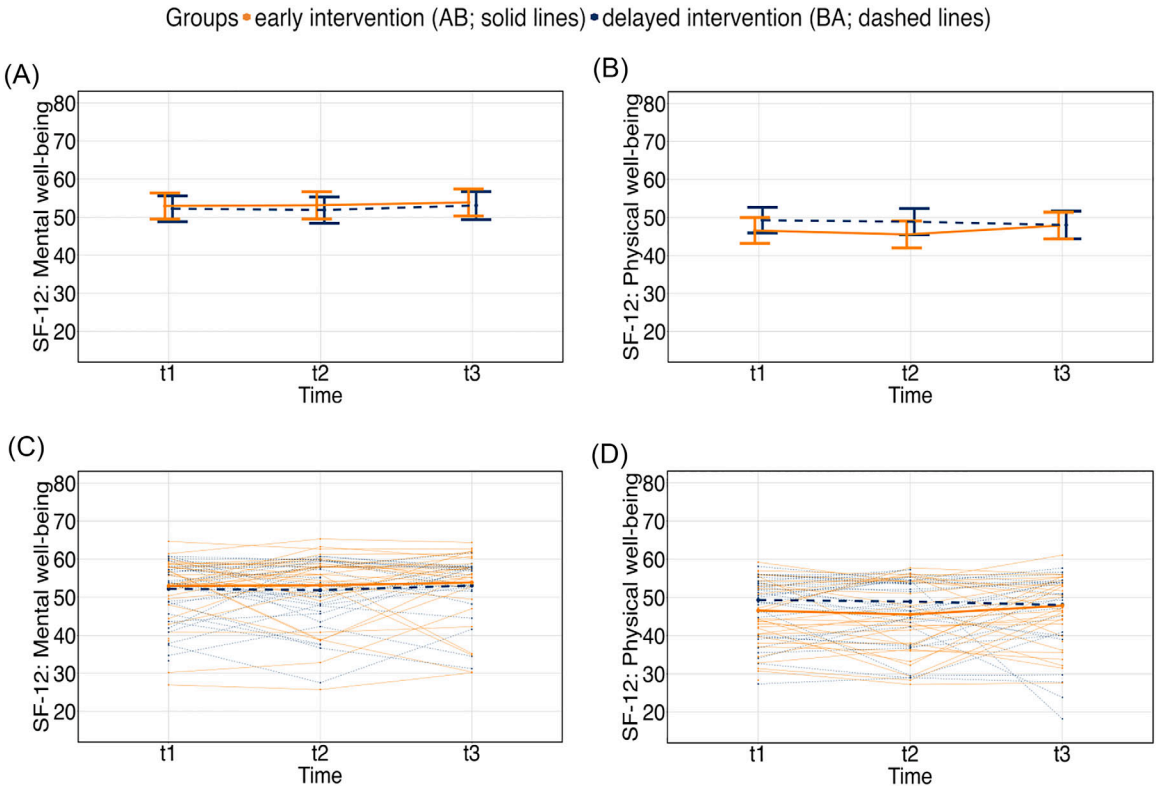

FIGURE 3 Results for the SF-12 mental and physical well-being of the intention-to-treat analysis. Average SF-12 mental (A, C) and physical well-being (B, D) scores without (A, B) and with (C, D) individual trajectories over the three assessment time points (t1, t2, t3) separated for the two intervention groups. The early intervention group ($n = 34$) is shown in orange and in solid lines, the delayed intervention group ($n = 34$) is shown in dark blue and in dashed lines. Bars represent 95% confidence intervals. Estimates were derived from the full statistical model including all three assessment time points (t1, t2, t3). AB, early intervention group; BA, delayed intervention group; ITT, intention-to-treat; n, number of participants; t1, baseline/pre-intervention assessment; t2, post-intervention assessment; t3, post-delayed intervention/follow-up assessment.

TABLE 4 Estimated within-group changes and between-group differences from the as-treated analysis.

	Early intervention group ($n = 27^a$)	Delayed intervention group ($n = 29$)		
	Within-group estimated change	Within-group estimated change	Between-group estimated change	
Outcome measures	Estimate (95%, CI)	Estimate (95%, CI)	Estimate (95%, CI)	*p*-value
Primary outcome measures				
SF-12 mental well-being t1 to t2	0.0 (−3.7, 3.6)	0.1 (−3.4, 3.7)	−0.1 (−5.3, 5.1)	0.950
SF-12 physical well-being t1 to t2	−0.5 (−4.3, 3.2)	−1.4 (−5.0, 2.2)	0.9 (−4.4, 6.2)	0.688

Note: For between-group differences, positive differences favor the early intervention group, whereas negative differences favor the delayed intervention control group. All analyses included covariates of sex, age, and education, as well as random participant intercepts. Significant effects appear in bold.
Abbreviations: CI, confidence interval; SF-12, Short Form Health-Survey; t1, baseline/pre-intervention assessment, t2, post-intervention assessment; t3, post-delayed intervention/follow-up assessment.
[a]$n = 1$ participant had missing data in the SF-12 mental and physical well-being.

($n = 28$ out of 28) in the early intervention group (AB) and 86% ($n = 25$ out of 29) in the delayed intervention group (BA).

Dropout rate (as-treated, excluding replacement) was 9% ($n = 5$ out of 56) at post-intervention assessment (t2), with 14% ($n = 4$ out of 28) in the early intervention group (AB) and 4% ($n = 1$ out of 28) in the delayed intervention group (AB). At post-delayed intervention/follow-up assessment (t3), dropout rate was 0% ($n = 0$ out of 24) in the early intervention group (AB) and 15% ($n = 4$ out of 27) in the delayed intervention group (BA). Reasons for dropout are provided in the flowchart (Figure 2).

3.3.2 | Safety

A total of $n = 2$ non-serious AEs were recorded during the study (early intervention: $n = 1$; delayed intervention: $n = 1$). No SAEs were recorded during the study. In detail, one AE in the early intervention group was judged as possibly related to the intervention. The participant reported mild dizziness during one session, which led to premature termination of the session. Reported symptoms resolved spontaneously after a short rest. No medical intervention was required. The participant continued the study without further issues. The other AE in the delayed intervention group was judged unrelated to the intervention. The participant temporarily discontinued the intervention (5 out of 12 sessions) due to a hand fracture that occurred outside the study setting.

3.3.3 | Mental and physical well-being: exploratory secondary analysis

Results of the secondary intention-to-treat analysis based on the linear mixed effects model (secondary outcome full model including t1, t2, and t3) of the SF-12 mental and physical well-being are presented in Table 3. There were no significant differences between the intervention groups from post-intervention assessment (t2) to post-delayed intervention/follow-up assessment (t3) or from baseline/pre-intervention assessment (t1) to post-delayed intervention/follow-up assessment (t3) for the Mental Component Summary (between-group differences in the mean change, all $p \geq 0.834$) and for the Physical Component Summary (between-group differences in the mean change, all $p \geq 0.152$).

3.4 | Moderation analysis

There was no significant moderation by depressive symptoms (measured by the GDS, dichotomized: lower/higher) on the intervention effects in the early intervention group (AB). In the intention-to-treat sample, the GDS did not moderate changes in SF-12 mental well-being (estimate = 0.4, 95% CI: −5.9 to 6.7, $p = 0.891$) or physical well-being (estimate = −0.3, 95% CI: −5.8 to 5.2, $p = 0.907$) measured from baseline/pre-intervention assessment (t1) to post-intervention assessment (t2). Results were similar in the as-treated analysis, with no significant moderation on changes in SF-12 mental well-being (estimate = 0.1, 95% CI: −6.5 to 6.7, $p = 0.978$) or physical well-being (estimate = 0.8, 95% CI: −4.6 to 6.1, $p = 0.765$).

3.5 | Sensitivity analysis

The sensitivity analysis using unweighted raw sum scores of SF-12 mental and physical well-being in the intention-to-treat sample showed no statistically significant within- or between-group differences from baseline (t1) to post-intervention (t2). The mean SF-12 Mental Component Summary changed from 21.2 (SD: 3.7) to 21.5 (SD: 4.0) in the early intervention group and from 21.4 (SD: 3.0) to 21.10 (SD: 3.6) in the delayed intervention group, with similar

patterns observed for the mean SF-12 Physical Component Summary for the early intervention group (15.3 [SD: 2.9] to 15.0 [SD: 2.9]) and the delayed intervention group (16.1 [SD: 2.5] to 16.0 [SD: 2.6]). Results were consistent in the as-treated sample. Detailed results are reported in Supplementary Material (Supplementary Table S4).

4 | DISCUSSION

This pilot randomized controlled study evaluated the feasibility, safety, and preliminary effects of the *REMIND*er intervention. This fully remote, supervised multimodal mind–body group intervention integrates music, dance movement, and mindfulness and was delivered over 6 weeks to healthy older adults via live-streamed, home-based, two-way video conferencing. The main findings of this study are as follows: (1) The *REMIND*er intervention showed high adherence, high retention, low dropout, and no serious adverse events. (2) There were no significant changes in mental or physical well-being, measured by the SF-12,[51] pre-to-post intervention. These findings indicate that the online multimodal intervention is feasible and safe in older adults. No preliminary effects were found with respect to self-reported mental and physical well-being.

4.1 | Feasibility and safety

As a first main finding, the present study demonstrates feasibility and safety of the online multimodal mind–body group intervention (*REMIND*er) in older adults. We observed high adherence rates post-intervention (t2), with 80% in the intention-to-treat analysis and 90% in the as-treated analysis, significantly exceeding the predefined benchmark of 60%. Other feasibility metrics were similarly favorable, including high reach (95%), high retention (90%), and low dropout (9%) across both intervention arms. Notably, when reach was calculated based on the number of enrolled participants relative to those individuals, who initially registered on the website, reach decreased to 29%. This lower proportion may in part reflect barriers, such as logistical or technological challenges, lack of motivation or interest, and/or self-selection due to strict eligibility criteria, which should be considered in fully remote future studies.[50]

Furthermore, we document a high level of participant safety throughout the online *REMIND*er intervention. The systematic safety monitoring revealed no serious adverse events in relation to the intervention. One participant reported an adverse event (mild dizziness) during a single session, with symptoms resolving quickly. No additional adverse events that were rated as intervention-related were observed.

The present findings on feasibility and safety align with and extend previous studies with similar online multimodal mind–body group interventions in different samples of older adults. Intervention studies in older adults with objective cognitive impairment[33,41,42] and Parkinson's disease[27,39] have reported high adherence/attendance rates (≥ 75%), high retention rates (≥ 80%), low dropout rates (≤ 15%), and no serious adverse events over 8–16 weeks of live-streamed video conferencing delivery. Moreover, the adherence rates recorded for the online delivery appear to be comparable to those found in in-person dance-based interventions, with evidence syntheses reporting adherence rates of ≥ 80%.[20,24,25] High-quality future studies are needed to directly compare online and in-person deliveries of multimodal mind–body interventions in older adults.[39]

4.2 | Mental and physical well-being

As a second main result, the present study did not find significant group differences or within-group changes in mental and physical well-being (measured by the SF-12) from pre-to-post intervention. In addition, there was no evidence that the presence of depressive symptoms moderated intervention effects on SF-12 outcomes. These null findings contrast prior research showing small-to-moderate improvements in mental and physical well-being after in-person dance-based interventions, including various dance types and dance movement therapy.[20,73] Reported benefits encompass reductions in anxiety and depressive symptoms as well as improvements in quality-of-life in heterogeneous samples of older adults, as reported by evidence syntheses.[26,74–76] Previous RCTs with short-term (6 to 8 weeks) dance-based interventions, using in-person[28–30,32] or online[27] delivery, have shown improvements in mental and/or physical health and well-being. In our previous RCT, an 8-week in-person mindfulness-based intervention showed improvements in anxiety symptoms and self-compassion in at-risk older adults with subjective cognitive decline.[58,77] The present null results highlight the need to refine the *REMIND*er intervention, identify key moderators of responsiveness, and target underserved or vulnerable older populations to optimize potential health benefits.[20,78,79]

Several factors may explain the present null findings of the *REMIND*er intervention in the SF-12 mental and physical well-being. (1) The relatively short intervention duration of 6 weeks, the small sample size, and a healthy target group may have limited the ability to detect subtle changes in the SF-12 outcomes. The observed high variability in SF-12 baseline scores and trajectories likely further limited the ability to capture intervention effects. (2) The safety-driven eligibility criteria favored healthy older adults with a presumably lower potential for improvements. The average baseline SF-12 mental and physical well-being scores were within the normative range for the general U.S. population and closely aligned with the SF-12 scores observed for community-dwelling older adults across six European countries.[80] In contrast, a previous RCT involving a more vulnerable group of nursing home residents reported significant improvements in the SF-12 mental and physical well-being following a dance-based intervention.[81] (3) Finally, the SF-12 may not adequately capture the specific benefits of the *REMIND*er intervention in the present target group. More specifically, the arts-based intervention may influence other dimensions of well-being, such as self-acceptance and personal growth,[82] which are not fully represented in the SF-12.

In general, previous RCTs on multimodal mind–body group interventions in older adults have provided mixed results using SF-12 outcomes. Two RCTs in sedentary or inactive older adults with

in-person dance-based interventions over 8 and 12 weeks, respectively, have failed to detect changes in the SF-12 mental and physical well-being,[29,83] despite showing improvements in physical activity, leisure activity, and/or mental health. Another RCT with an online 12-week mind–body group intervention found no effects on SF-12 outcomes among care partners, while reporting improvements of care partners' stress management.[42] In contrast, an RCT with an 18-week in-person square-dance intervention in nursing home residents showed improvements in both SF-12 physical and mental well-being.[81] Taken together, it appears that the SF-12 may lack sensitivity to the benefits of multimodal mind–body group interventions in healthy older adults, while positive effects may be detected in vulnerable older adults.

4.3 | Synopsis and outlook

Taken together, the *REMIND*er study advances the development and implementation of potentially scalable, accessible telehealth interventions. This fully remote pilot randomized controlled study provided evidence that the online multimodal mind–body group intervention *REMIND*er is feasible and safe in older adults. Future studies should consider to refine the intervention, to determine which target population can benefit from it, to evaluate multidimensional health outcomes, and to elucidate underlying mechanisms of action. Larger studies are needed to determine the efficacy of the multimodal mind–body group intervention to improve the mental health and well-being of vulnerable older adults.

First, the present null findings underscore the need to refine the *REMIND*er intervention to achieve meaningful and sustainable health benefits in older adults. Future studies should prioritize more vulnerable populations, including older adults with self-reported mental or cognitive concerns, existing brain pathology or genetic risk, or elevated modifiable dementia risks, in whom lifestyle interventions appear to exert stronger effects.[84,85] Future refinements of the intervention could incorporate more flexible delivery models (e.g., hybrid online and in-person formats) and include structured self-practice components to reinforce intervention effects. Future research could benefit from integrating principles of health communication more explicitly, for instance by using tailored loss- and gain-framed message strategies, which could strengthen engagement and adherence to the intervention.[86,87] Personalized and adaptive intervention approaches may further enhance accessibility across heterogeneous cultural, socioeconomic, and digital literacy backgrounds, which is critical for effective dementia prevention at the population level.[7,88]

Second, future studies should incorporate multidimensional outcome measures and frameworks of health and well-being,[35] moving beyond generic quality-of-life scales. In particular, arts-based interventions may influence multiple interconnected health domains, including physical, cognitive, emotional, and social well-being. To evaluate effects of multimodal mind–body interventions, multidimensional outcome frameworks, including the Dunphy Outcomes Framework (DOF), can provide structured and integrated assessment tools.[89] Outcome assessments should further include positive (e.g., purpose in life and self-efficacy) and negative (e.g., perceived stress and rumination) psychological domains,[20] as psychological factors are increasingly recognized as relevant to cognitive aging and dementia risk.[90] Consistent with this approach, planned secondary analyses of the *REMIND*er study[50] will investigate changes in multidimensional outcomes to identify potential responses to the intervention across health domains. Beyond individual health outcomes, multimodal mind–body group interventions may help reduce loneliness and foster social connectedness,[33,91] aligning with public health and community care strategies.[3,6]

Last, the *REMIND*er intervention aims to translate principles of environmental enrichment into daily practice by combining music, dance movement, and mindfulness within the framework of embodied prevention.[15] Future research should investigate how this multimodal mind–body approach can enhance neuroplasticity, brain health, and resilience in older adults by leveraging the additive or synergistic effects of targeted multimodal stimulation. Dance, music, and mindfulness activities have individually been demonstrated to benefit cognitive, brain, and mental health in older adults.[17,18,68,92] Their combined practice can be expected to yield additional advantages for healthy aging.[33] Moreover, arts-based interventions are conceived to activate specific therapeutic mechanisms, such as embodiment and interoceptive awareness.[14] The specific mechanisms of action and pathways mediating the effects of multimodal mind–body interventions remain to be clarified in future studies.[14,79]

5 | STRENGTHS AND LIMITATIONS

This pilot randomized controlled study has several strengths. *REMIND*er integrates a fully online study design with remote study enrollment, data collection, and multimodal intervention delivery. Structured onboarding, real-time technical support, and a user-friendly digital setup facilitated in-home participation and ensured smooth study conduct. The interactive group format ensured active participation and encouraged social interaction and connectedness as an important ingredient of online multimodal mind–body group interventions.[33,91]

Several limitations should be considered. The small sample, while adequate for a pilot study, limited statistical power and precluded subgroup analyses. The SF-12 may lack sensitivity to detect subtle changes in healthy older adults, while effects appear to be detectable in more vulnerable groups of older adults.[81] The use of unsupervised digital assessments may have introduced variability in measurement quality due to differences in home environments, device characteristics, and adherence to instructions. The passive control group with delayed intervention restricted causal inference, and sequence effects may have influenced participant adherence or dropout. Randomized replacement lists were used to replace pre-intervention dropouts. This approach added considerable complexity to participant flow and data analysis, but also helped achieve recruitment targets and optimize resource use. Future studies should refine intervention dose, target

population, outcome sensitivity, and follow-up duration when testing the efficacy of online multimodal interventions.

6 | CONCLUSION

The *REMIND*er study demonstrates the feasibility and safety of a scalable, online multimodal mind–body group intervention for older adults, highlighting its potential role in future health promotion and dementia prevention. However, we found no improvements in the primary outcome, which was the mental and physical health of participants. To address this lack of effects, future studies could investigate modified interventions (potentially including some in-person meetings) or the impact of similar interventions in more vulnerable groups, like older adults with subjective cognitive decline.

AUTHOR CONTRIBUTIONS

Selina Stamer, Sabine C. Koch, Olga Klimecki, Miranka Wirth: Conceptualization and methodology. **Selina Stamer, Adrianna Lipska-Dieck, Olga Klimecki, Miranka Wirth**: Investigation including data collection. **Selina Stamer**: Project administration. **Olga Klimecki, Miranka Wirth**: Supervision and funding acquisition. **Selina Stamer, Adrianna Lipska-Dieck, Maxie Luft, René Mauer**: Formal analysis and data curation. **Selina Stamer, Adrianna Lipska-Dieck, Maxie Luft, Olga Klimecki, Miranka Wirth**: Writing – Original Draft. **Selina Stamer, Adrianna Lipska-Dieck, Maxie Luft, Sabine C. Koch, René Mauer, Olga Klimecki, Miranka Wirth**: Writing – Review & Editing.

ACKNOWLEDGMENTS

We thank Clara Cornaro (Alanus University for Arts and Social Sciences, Bonn, Germany), Manuela Tobias, and Angela Nicotra for their valuable expertise and outstanding commitment, in particular C.C. and M.T. for their dedication as *REMIND*er facilitators and A.N. for her supervision of facilitators. We are grateful for the statistical advice of Dr. Ben Meuleman (University of Geneva, Genève). We thank Sinaida Kirindasov, Amina Leib, Annemarie Maßalsky, Karolin Schwellnus, and Odile Podolski (all DZNE Dresden) for their support in study conduct, database management, and/or study documentation. Finally, we are grateful to all participants of the *REMIND*er study for their time and engagement. This study received funding by the DZNE Stiftung – Forschung für ein Leben ohne Demenz, Parkinson und ALS (T 0531/36311/2020/kg and T 0531/41814/2002/kg). The funder was not involved in the study design, data acquisition, data analysis, data interpretation or manuscript writing.

Open access funding enabled and organized by Projekt DEAL.

CONFLICT OF INTEREST STATEMENT

All authors declare that they have no conflict of interest. Author disclosures are available in the supporting information.

DATA AVAILABILITY STATEMENT

De-identified individual participant data (IPD) and statistical codes used for analysis, and related study materials are available from the corresponding author upon reasonable request. Access is subject to appropriate data sharing agreements and compliance with ethical approvals to protect participant confidentiality.

ETHICS APPROVAL AND PARTICIPANT CONSENT STATEMENT

All study procedures were approved by the local Ethics Committee of the Technische Universität Dresden, Dresden, Germany (SR-EK-477112023, date of first approval: April 2, 2024). All study procedures were carried out in compliance with the Declaration of Helsinki. Changes and additions to the study protocol were submitted to the Ethics Committee of the Technische Universität Dresden as an amendment for review and approval (SR-EK-477112023_1, date of approval: November 29, 2024). All participants provided written informed consent. Participants received a voucher as compensation for their participation.

DIVERSITY, EQUITY, AND INCLUSION STATEMENT

The *REMIND*er study embedded the principles of diversity, equity, and inclusion throughout the study design, implementation, data analysis, and interpretation. Recruitment strategies were intentionally developed to engage participants from a wide range of demographic and socioeconomic backgrounds, including individuals living in rural areas. To reduce participation barriers, data collection procedures included technical support provided by the study team and the flexibility to take part in this study from any location within Germany. All research staff were trained to ensure respectful, equitable, and culturally sensitive interactions with participants. In the interpretations of the findings, structural and systemic inequities that may have influenced outcomes were carefully considered. The discussion addresses the generalizability of the results and provides recommendations to further strengthen inclusivity in future research.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Selina Stamer, Adrianna Lipska-Dieck, Maxie Luft, Karla Paola Reif, Sabine C. Koch, René Mauer, Olga Klimecki, Miranka Wirth. Feasibility and effects of an online multimodal mind–body intervention on mental and physical well-being in older adults: The *REMIND*er randomized controlled study. *Alzheimer's Dement*. 2026;e70071. https://doi.org/10.1002/bsa3.70071