

Body brain life: A randomized controlled trial of an online dementia risk reduction intervention in middle-aged adults at risk of Alzheimer's disease

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Abstract

Objective: To examine the efficacy of body brain life (BBL), a 12-week online dementia risk reduction intervention.

Methods: BBL was evaluated in a randomized controlled trial in 176 middle-aged adults with >2 risk factors and <2 protective factors for Alzheimer's disease (AD) assessed on a brief screening instrument. Participants were randomized to BBL, BBL plus face-to-face group sessions (BBL + FF) or active control (control). Score on the Australian National University-Alzheimer's disease risk index (ANU-ADRI), a validated index of AD risk, was the primary outcome measure assessed at baseline, 12, and 26 weeks.

Results: A group by time interaction at 26 weeks showed a significant reduction in ANU-ADRI score for BBL compared with control. Planned contrasts showed the BBL and BBL + FF groups had improvement in ANU-ADRI scores at 12 weeks (BBL + FF: $z = -0.25$; $P = .021$; BBL: $z = -0.25$; $P = .008$) and 26 weeks (BBL + FF: $z = -0.48$; $P < .001$; BBL: $z = -0.28$; $P = .004$) due to increase in protective factors.

Conclusions: This short intervention resulted in dementia risk reduction. Online dementia risk reduction interventions show promise for reducing the overall dementia risk in middle-aged adults with multiple risk factors.

Clinical Trial Registration: The study is registered under Trial Registration: Reg. # ACTRN12612000147886.

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Keywords:

Intervention; Dementia prevention; Risk reduction; Behavior change; Cognitive activity; Social engagement; Risk factor

1. Introduction

Dementia is highly prevalent with >30% of adults aged >80 years developing the syndrome [1]. No cure is available for neurodegenerative conditions causing dementia and recent clinical trials of potential treatments have

been disappointing [2]. It has been estimated that an achievable 10%–25% reduction in seven key risk factors could prevent 1.1–3.0 million Alzheimer's disease (AD) cases internationally per annum [3]. There is now strong evidence linking modifiable risk factors in mid-life with dementia in late-life, justifying risk reduction trials among middle-aged adults with multiple risk factors [4,5].

Despite the success of online interventions for treating depression [6], alcohol misuse [7], and preventing obesity [8], online interventions have not yet been trialed in the field of dementia risk reduction. We therefore developed and

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evaluated body brain life (BBL), a multidomain intervention, to address multiple risk factors for AD using behavior change principles. The intervention also provides education about dementia, aiming to increase dementia literacy [9]. The aim of the study was to conduct a randomized controlled trial to evaluate the effectiveness of BBL, and a version of BBL including an additional face-to-face component (BBL + FF), to reduce the risk of dementia.

2. Methods

The trial protocol was published [10]. The trial was undertaken in the city of Canberra, Australia in the community.

2.1. Study design

A randomized controlled trial to evaluate the effectiveness of BBL and BBL + FF to reduce the risk of dementia was undertaken. The trial involved three groups: (1) BBL; (2) BBL + FF; and (3) active control (control). BBL and BBL + FF undertook a 12-week intervention program. Participants were followed up immediately postintervention and 26 weeks postintervention.

2.2. Participants

Recruitment for this trial took place between July 2012 and March 2013 through advertisements to community groups via radio and print media, as well as advertising fliers in community health centers, community clubs, and through word of mouth. Participants had to be cognitively healthy; adults aged 50–60 years and living independently. Screening for inclusion and exclusion criteria was conducted using a structured telephone interview. Participants were required to obtain a score >24 on the telephonic screening [11] to exclude the presence of global cognitive impairment, have access to a computer and internet connection at home; English fluency; and a minimum of three of the following risk factors: formal educational attainment at high school level or less, overweight or obese body mass index (BMI), a history of diabetes, hypertension, high cholesterol, smoking, traumatic brain injury, and/or depression. Participants also needed to have a maximum of one protective factor for AD including a protective level of physical activity, high consumption of fish, and cognitive engagement (Supplementary Table 1). The screening method identified fewer protective factors than the full assessment. Hence, the final sample included participants with more than one protective factor.

Participants with a history of neurologic or psychiatric conditions likely to substantially affect cognition (e.g., recent stroke, epilepsy, schizophrenia), sensory deficits or mobility limitations that would prevent or substantially restrict the delivery of the assessment or intervention (e.g., uncorrected substantial loss of hearing or vision, severe physical disability), as well as other significant health problems (e.g., recent cardiovascular event, renal failure, treat-

ment for cancer) were excluded. The study protocol was approved by the ANU Human Research Ethics. Participants provided written, informed consent.

2.3. Interventions

Participants were randomized to receive BBL, BBL + FF, or the control condition (ratio 1:1:1). The control was used to counter the effects of increased computer use in the BBL condition which may be cognitively stimulating and to control for the provision of health information. In all groups, the intervention was delivered over a 12-week period.

2.3.1. Group 1: BBL

The BBL program was delivered through a dedicated and specifically designed Web site and comprised seven modules consecutively, each delivered once per week and lasting approximately 1 hour. After the first 7 weeks, participants completed self-directed online activities on the BBL Web site focused on activity and goal monitoring and revision for the remaining 5 weeks. The first two modules were educational and covered general dementia literacy issues and familiarization with risk and protective factors for dementia. Modules 3–7 each focussed on physical activity, diet, social engagement, cognitive engagement, and management of chronic conditions. They were developed in a standardized “bottom-up” fashion using a published taxonomy of behavior-change techniques (BCTs [12]) and the theoretical domains framework. The content of these modules was tailored to individuals’ profiles using an automated algorithm that selected BCTs for presentation on the basis of whether the particular risk/protective factor the module addressed applied to participants. The tailoring algorithm further used participants’ responses to several questions, presented at the start of each module, measuring 14 behavioral determinants [13]. For example, a person who was classified as sedentary on the basis of his/her responses on the Australian National University-Alzheimer’s disease risk index (ANU-ADRI) (risk factor), and who did not regard himself/herself as optimistic regarding their prospect of change in the area of physical activity (behavioral determinant in relation to physical activity), was presented with a BCT focused on learned optimism and the relationship between optimism and a range of health outcomes. The program was developed so that participants were only able to access the relevant component of the intervention at a given time. The modules became active, one per week, on the same day (usually Sunday) for the first 7 weeks. Participants received up to two automatic reminders to complete a module and were then sent a text message before finally being phoned.

2.3.2. Group 2: BBL + FF

Participants in the BBL + FF group completed the online program in the same way as the BBL-only group, and in addition attended five face-to-face sessions conducted in

small groups facilitated by a clinical psychologist (weeks 3, 5, 7, 9, and 12). The content of the group sessions was organized around the themes of the corresponding online modules. The sessions included facilitated discussions of the various risk factors for dementia, goal setting, and barriers to behavior change. To monitor and evaluate fidelity of delivery, the sessions were prescribed and a subset was recorded and subsequently analyzed.

Besides the face-to-face component, contact with participants in this group was identical to the contact made with participants in the BBL group with the exception that participants in this group also received additional emails to remind them of upcoming face-to-face sessions.

2.3.3. Group 3: Active control (control)

The control group did not access the trial Web site but received weekly emails containing links to health-related Web Sites, videos, and news items, focusing on topics related to dementia and general health and lifestyle with the material organized around the same themes as the ones included in the online BBL program. Participants were encouraged to spend an hour each week browsing through the material. Links did not lead to sites using identifiable BCTs. This group did not receive reminders or other emails, and it was not possible to assess adherence.

2.4. Randomization and blinding

A permuted block randomization sequence comprising block sizes of 30 stratified by gender was used. The allocation sequence was generated by an independent researcher following the baseline assessments and was not known to the study team at the time of enrolment and baseline assessment. To prevent evaluation bias, research staff conducting the psychological, physical, and cognitive outcome assessments, as well as those involved in the analysis of pathology data remained blind to participants' group allocation. The contact person for participants' Web site queries, access issues, and technical difficulties was independent of all baseline or follow-up data. All participants were informed that they were being randomly allocated to one of three study groups and that one group may be more effective than others. They were also notified at the start of the study that one of these groups involved several face-to-face sessions. Participants were unaware of the study hypotheses, thus reducing the chances of response bias.

2.5. Outcome measures

Assessments for outcomes were undertaken at 12 and 26 weeks postintervention (26 weeks) postbaseline.

2.5.1. Primary outcome

The primary outcome measure was the ANU-ADRI [14], a validated instrument assessing individual risk exposure profile developed after a synthesis of meta-analyses of

various risk factors for AD reported in the literature. The questionnaire covers several modifiable risk and protective factors and is based on self-report. Risk factors include age, sex, low education, diabetes, history of traumatic brain injury, smoking, pesticide exposure, low social engagement, and protective factors include high physical activity, high cognitive activity, fish consumption (three or more times per week), and light-to-moderate alcohol consumption (Supplementary Table 1). Not all factors in the ANU-ADRI were addressed by the intervention modules.

2.5.2. Secondary outcome

Dementia literacy using a previously described questionnaire [9] at the baseline, immediate postintervention, and follow-up assessments. To measure dementia recognition, participants were asked what condition the person in a vignette might have. Participants were asked whether certain behaviors would increase, decrease, or not make any difference to their chance of developing dementia. Together, these were used to measure knowledge on risk and protective factors.

Other aspects of the trial are not considered here. (See trial design article for full description [10]).

2.6. Power

Sample size calculations were estimated using G*Power (version 3.1.3). Because of the lack of published trials on AD and dementia risk reduction, power estimations were based on medium-effect sizes found for multidomain lifestyle interventions in the primary prevention of cardiovascular disease [15]. To detect a medium effect in a three-group design (1:1:1), with a 5% risk of type 1 error (α) and 80% power, a total sample size of 159 persons is required. A medium effect (0.5 standard deviation [SD]) on the ANU-ADRI is 4.25 points on the scale as described previously [14]. This figure is derived from the pooled SD of the ANU-ADRI from three cohort studies with combined n of 4301; the Rush Memory and Aging Study, the Kungsholmen Project, and the Cardiovascular Health Study. To account for attrition, a baseline sample of 176 was recruited.

2.7. Statistical analysis

Data were reviewed for outliers on the ANU-ADRI score at each wave; none were detected with the distribution (SD, range) remaining consistent at each measurement occasion. Baseline characteristics were compared with analysis of variance for continuous variables and chi-square tests for categorical variables. Using an intent-to-treat approach, random-effects linear models with random participant intercepts with factors of intervention group (reference group: active control) and occasion of measurement (reference group: baseline observation) were used to evaluate change in the ANU-ADRI. Contrasts of model parameters examined differences in odds of change between intervention groups

over time. Random-effects linear models were also used to assess change in dementia literacy. ANU-ADRI scores were standardized (mean = 0; SD = 1) to baseline to derive effect sizes.

3. Results

Participants were enrolled from July 2012 to March 2013, and data collection was completed in September 2013. The flow of participants is shown in Fig. 1. A total of 502 individuals responded to advertisements and were assessed for eligibility. Of these, 129 were excluded because they did not meet criteria or refused and 373 consented to screening. A further 10 could not then be contacted or refused screening with 363 completing phone screening. Of these, 178 did not meet screening criteria on the phone assessment and 185 were invited to assessment. A further 9 participants dropped out of the study and 176 enrolled in the trial and were randomized; 58 to BBL, 58 to BBL + FF, and 60 to the active control. A total of seven participants withdrew during the study intervention period: three reported time constraints, three cited dissatisfaction with content, and one with unknown reasons. Withdrawal patterns were similar between groups (three in BBL, three in control, and one in BBL-FF). In terms of retention, 136 (77.3% of the baseline sample) and 135 (76.7%) completed a follow-up after the 12-week intervention and at the 26-week follow-up, respectively.

Baseline characteristics are shown in Table 1. Participants had a mean age of 55.5 years (SD = 2.96) and 18.1 (SD = 3.56) years of education; 52.8% were female. The most common risk factor was high BMI, present in 77.1% of participants, followed by low cognitive engagement (61.9%). Only a small proportion of the sample did not engage in sufficient exercise to gain any protection (12.5%). Of the sample, 18.8% did not eat sufficient fish to gain any protection but only 5.7% ate enough fish to gain the optimal protection based on epidemiologic studies [16]. The BBL + FF group had significantly lower rates of smoking compared with BBL and control groups (Table 1). The groups did not differ in terms of baseline cognitive function, clinical/laboratory markers of hypertension, cholesterol, or glycemia (Supplementary Table 2).

ANU-ADRI scores for each group reported by total, protective, and risk factor scores are shown online (Supplementary Table 1). Results showed that the initial telephone screening underestimated the number of protective factors compared with the full ANU-ADRI assessment which meant the sample had than one protective factor on average. However, the sample had much higher scores on the ANU-ADRI than the population-based PATH Through Life cohort aged 60–64 years from the same region which had a mean ANU-ADRI score of -8.26 (baseline data, SD = 5.52; range -18 to 16; $n = 1638$).

Table 2 shows the effect of the intervention by group and time. A main effect of time indicated an overall improve-

ment (reduction) on the ANU-ADRI score from baseline to 12 weeks ($\beta = -0.19$; standard error [SE] = 0.17; $P < .01$) and baseline to 26 weeks ($\beta = -0.28$; SE = 0.07; $P < .001$). Although the inclusion of an interaction between intervention arm and occasion of measurement indicated both BBL and BBL-FF reported significant risk reduction compared with control, these failed to reach statistical significance and only the BBL at 26 weeks reported a statistically significant difference from control ($\beta = -0.37$ [SE = 0.16] $P < .05$). Furthermore, repeated cross-sectional analysis indicated there were no between-group differences but BBL and BBL + FF improved significantly from baseline (Fig. 2).

When broken down by risk and protective factors (Table 2), results showed that the change was due to an increase in protective behaviors. Fig. 2 shows the decline in total ANU-ADRI score by group. Planned contrasts of the changes within group indicated no significant changes in control between baseline and time at 12 ($P = .549$) and 26 weeks ($P = .388$). In contrast, significant declines for the BBL and BBL + FF groups were reported between baseline and both 12 (BBL + FF: $z = -0.25$, $P = .021$; BBL: $z = -0.25$, $P = .008$) and 26 weeks postintervention (BBL + FF: $z = -0.48$, $P < .001$; BBL: $z = -0.28$, $P = .004$). Overall, there were no significant differences between groups at each wave but there were significant within group changes for the BBL and BBL + FF groups (Supplementary Fig. 1).

Among individual protective factors, improvements were seen in reported level of fish consumption and cognitive engagement. There was a significant increase in cognitive engagement at 12 weeks postbaseline (odds ratio [OR] = 2.64; 95% confidence interval [CI], 1.21–5.77; $P = .015$) and 26 weeks postintervention (OR = 4.49; 95% CI, 1.97–10.25; $P < .001$) consistent between intervention groups. Similarly, there was a significant increase in fish consumption at 26 weeks (OR = 5.19; 95% CI, 1.51–17.91; $P = .009$) consistent between intervention groups.

All groups improved in their ability to recognize dementia symptoms depicted in a vignette (Supplementary Table 4) but BBL + FF improved more than control at 12 weeks only (Table 3). Post hoc analysis of the changes within group indicated significant changes in recognition between baseline and 12 weeks for two intervention groups (BBL: $P = .013$; BBL + FF: $P = .002$) and between baseline and 26 weeks for the BBL + FF group ($P = .028$). All groups improved on their knowledge on risk factors of dementia from baseline to 12 weeks and baseline to 26 weeks.

Most participants completed all seven online modules in the BBL + FF (81%) and the BBL (72%) groups. Number of modules completed did not differ between groups [χ^2 (6, 116) = 5.03, $P = .54$]. One participant in the BBL + FF and five participants in the BBL did not complete any modules but provided follow-up survey data and were retained in the analyses under an intention-to-treat. Participants in the BBL + FF and BBL completed more modules that were

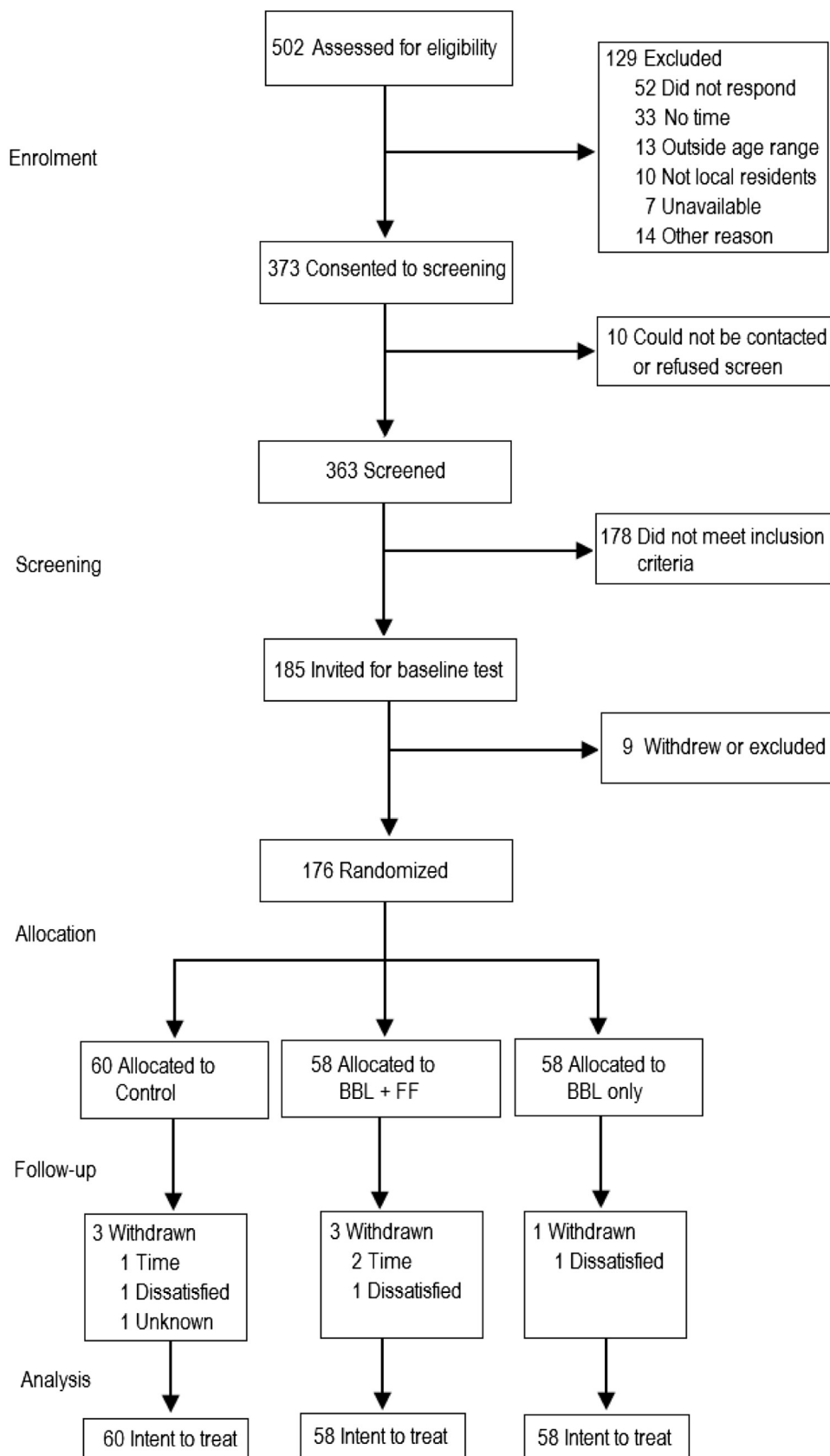


Fig. 1. Flowchart for the body brain life (BBL) dementia risk reduction trial. The BBL trial used a 1:1:1 design in which participants were randomized to either an online intervention only (BBL), an online plus face-to-face intervention (BBL + FF), or to an active control (control) (controlling for increased computer use and access to health information).

Table 1
Baseline characteristics

Characteristics	Control (n = 60)	BBL + FF (n = 58)	BBL (n = 58)	Statistic, P value
Age, mean (SD), y	55.5 (2.9)	55.4 (3.1)	55.6 (2.90)	$F(2, 173) = 0.08, P = .921$
Female sex, n (%)	32 (53.3)	31 (53.5)	30 (51.7)	$\chi^2 = 0.01; P = .993$
Education, mean (SD), y	18.6 (3.7)	18.0 (3.6)	17.7 (3.4)	$F(2, 173) = 0.99, P = .374$
Risk factors, n (%)				
Overweight/obese BMI	44 (77.2)	46 (80.7)	41 (73.2)	$\chi^2 = 1.35; P = .508$
Diabetes	14 (23.3)	11 (19.3)	12 (21.1)	$\chi^2 = 2.42; P = .298$
Traumatic Brain Injury	2 (3.3)	5 (8.6)	4 (7.0)	$\chi^2 = 2.06; P = .356$
Depression	11 (18.3)	14 (24.1)	8 (13.8)	$\chi^2 = 2.16; P = .340$
Smoking	25 (41.7)	15 (25.9)	22 (37.9)	$\chi^2 = 10.97; P = .004$
Cholesterol	25 (41.7)	18 (31.6)	19 (33.3)	$\chi^2 = 1.00; P = .607$
Low social engagement	28 (46.7)	27 (46.6)	23 (39.7)	$\chi^2 = 1.03; P = .596$
Pesticide	18 (30.0)	14 (24.1)	16 (27.6)	$\chi^2 = 0.04; P = .979$
Education	1 (1.7)	3 (5.2)	3 (5.2)	$\chi^2 = 3.17; P = .204$
Protective Factors, n (%)				
Cognitive engagement	26 (43.3)	21 (36.2)	20 (34.5)	$\chi^2 = 2.10; P = .584$
Alcohol	7 (11.7)	6 (10.34)	14 (24.1)	$\chi^2 = 3.31; P = .191$
Physical activity	54 (90.0)	50 (86.2)	50 (86.2)	$\chi^2 = 0.82; P = .662$
Fish consumption	48 (80.0)	48 (82.8)	47 (81.0)	$\chi^2 = 1.24; P = .538$
ADRI total score, mean (SD)	-1.38 (5.67)	-0.88 (4.39)	-1.07 (6.21)	$F(2, 173) = 0.13, P = .880$
Dementia literacy score, mean (SD)	5.9 (2.25)	5.95 (2.04)	6.81 (1.37)	$F(2, 173) = 4.12, P = .018$

Abbreviations: BBL + FF, body brain life plus face-to-face; SD, standard deviation; BMI, body mass index; ADRI, Alzheimer's disease risk index.

NOTE. There were no differences between groups on ADRI total score at baseline, although those in the BBL group did report slightly higher levels of dementia literacy in comparison with the control ($P = .017$) and BBL + FF ($P = .011$).

focussed on protective factors (mode = 3) than on risk factors (mode = 1), with no difference between groups on either the number of protective [$\chi^2(3, 116) = 5.50, P = .14$] or risk [$\chi^2(1, 116) = 1.16, P = .28$] modules completed. Sensitivity analyses examining the impact of the number and type of modules completed on ANU-ADRI total, protective, and risk factor scores found no effects of adherence on results.

4. Comment

In this first online trial of dementia risk reduction targeting middle-aged adults, we found high adherence to the

study protocol among participants and that scores on the ANU-ADRI reduced significantly from baseline, for both the intervention groups, with stronger effects in the BBL condition. The intervention effects were equivalent to the reduction of approximately one risk factor. A key finding from this study was that the benefits of the intervention were specific to what we defined as "protective" factors. Our findings suggest that improving protective behaviors may be the easiest target for short-term, low-cost interventions for dementia risk reduction. It is also possible to measure change in protective factors such as increasing fish consumption over short periods. In comparison, reduction in BMI and other chronic conditions is difficult to attain

Table 2
Differences in ANU-ADRI total, risk, and protective scores between randomization group and measurement occasion

	ANU-ADRI total		Risk factor score		Protective factor score	
	β (SE)	β (SE)	β (SE)	β (SE)	β (SE)	β (SE)
Constant	0.03 (0.12)	-0.05 (0.13)	0.06 (0.12)	0.02 (0.13)	0.01 (0.12)	0.09 (0.13)
Intervention group (ref. control)						
BBL + FF	-0.01 (0.17)	0.09 (0.18)	-0.07 (0.17)	-0.04 (0.18)	-0.05 (0.16)	-0.17 (0.18)
BBL	-0.09 (0.17)	0.06 (0.18)	-0.11 (0.17)	-0.02 (0.18)	0.01 (0.16)	-0.10 (0.18)
Time (ref. baseline)						
12 wk	-0.19 (0.07)**	-0.07 (0.12)	-0.02 (0.05)	0.04 (0.09)	0.24 (0.07)**	0.13 (0.13)
26 wk	-0.28 (0.07)***	-0.10 (0.12)	-0.01 (0.05)	0.07 (0.09)	0.37 (0.07)***	0.19 (0.13)
Intervention by occasion of measurement						
12 wk - BBL + FF		-0.18 (0.16)		-0.05 (0.13)		0.22 (0.18)
12 wk - BBL		-0.17 (0.16)		-0.14 (0.13)		0.10 (0.18)
26 wk - BBL + FF		-0.18 (0.13)		-0.06 (0.13)		0.20 (0.18)
26 wk - BBL		-0.37 (0.16)*		-0.18 (0.13)		0.33 (0.19)

Abbreviations: ANU-ADRI, Australian National University-Alzheimer's disease risk index; SE, standard error; BBL + FF, body brain life plus face-to-face.

NOTE. *** $P < .001$; ** $P < .01$.

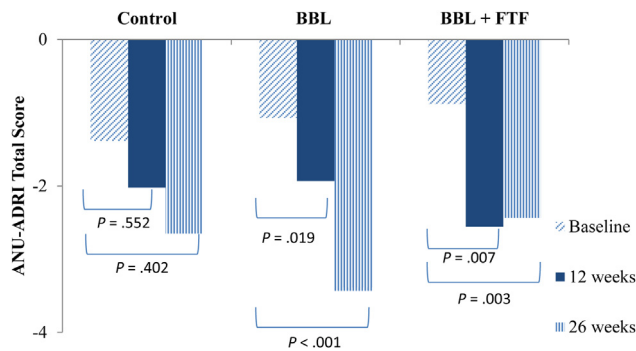


Fig. 2. Effects of interventions on the total ANU-Alzheimer's dementia risk index (ANU-ADRI) score—primary outcome of change. The ANU-ADRI scores decreased significantly over time, indicating risk reduction. Actual scores shown. An intervention by time interaction indicated significantly greater risk reduction for BBL + FF relative to control at time 3. Post hoc analyses indicated significant reduction in risk at time 2 and 3 relative to baseline for both intervention groups but not for the control group. P reflects α significance values.

over a short period and may not be detectable in a trial of 6 months.

Our data suggest that the inclusion of the face-to-face component did not increase the intervention efficacy nor did it increase adherence to the online intervention. This is in contrast to research in domains such as obesity reduction that have found that face-to-face interventions are more effective [17]. Longer term follow-up, larger sample sizes, and health economics analyses are required to further evaluate whether there are potential benefits to the additional face-to-face component of the BBL intervention to determine whether its inclusion is warranted. It is possible that the face-to-face component may benefit subgroups of participants or specific risk or protective factors.

There are no similar completed trials in the literature. The Finnish Geriatric Intervention Study to Prevent Cognitive Impairment and Disability (FINGER) trial [18] which is

currently underway also aims to reduce risk in cognitively healthy individuals, but unlike BBL, it targets older individuals (60–77 years) who were recruited from earlier cross-sectional studies. Moreover, it uses an intensive intervention involving individualized dietary counseling, a physical activity training program, monitored cognitive training sessions, and intense monitoring and management of metabolic risk factors. The Healthy Ageing Through Internet Counselling in the Elderly program is an ongoing European Union initiative to establish the efficacy of online interventions to reduce cardiovascular risk factors and cognitive decline (<http://www.hatice.eu/>). The investment in this trial signals the potential significance of online interventions and the need to evaluate their efficacy.

4.1. Strengths and weaknesses

Using a volunteer sample in this study selected out relatively highly educated participants. Comparison with population-based data showed that this sample had higher risk scores indicating that it was at a relatively higher risk of dementia compared with the population. The screening method underidentified protective factors. Future trials need to use more thorough screening methods and target samples with low education and higher ANU-ADRI risk scores for whom the intervention has been designed. We expect that the educational components of BBL will be more effective among adults who have low levels of education and health literacy and who have higher initial ANU-ADRI risk scores. The outcome measure was self-report and may have been subject to reporting bias. It is possible that time spent on the intervention influenced results. The study was not sufficiently powered to detect significant differences between BBL and BBL + FF. Although the BBL intervention is inexpensive in absolute terms, we have not evaluated its cost-effectiveness.

Table 3

Differences in the likelihood of dementia recognition and risk factor knowledge scores between randomization group and measurement occasion

	Recognition		Knowledge on risk factors	
	OR (SE)	OR (SE)	β (SE)	β (SE)
Constant			-0.16 (0.08)	-0.16 (0.10)
Intervention group (ref. control)				
BBL + FF	0.30 (0.12)**	0.14 (0.09)**	0.13 (0.11)	0.02 (0.15)
BBL	0.44 (0.18)	0.23 (0.14)	0.36 (0.11)**	0.46 (0.15)**
Time (ref. baseline)				
12 wk	4.14 (1.65)***	0.87 (0.67)	0.67 (0.08)***	0.61 (0.14)***
26 wk	2.43 (0.83)**	1.22 (0.95)	0.66 (0.08)***	0.73 (0.14)***
Intervention by occasion of measurement				
12 wk – BBL + FF		10.24 (10.28)*		0.24 (0.20)
12 wk – BBL		6.37 (6.45)		-0.05 (0.20)
26 wk – BBL + FF		2.42 (2.37)		0.10 (0.20)
26 wk – BBL		2.42 (2.24)		-0.33 (0.20)

Abbreviations: OR, odds ratio; SE, standard error; BBL + FF, body brain life plus face-to-face.

NOTE. *** $P < .001$; ** $P < .01$; * $P < .05$.

We demonstrated the feasibility of conducting an online dementia risk reduction trial with positive uptake of protective behaviors by participants. If participants do not change their risk profile as they move into older age, their ANU-ADRI scores will consequently increase. We expect that the intervention will be more effective among younger adults with high ANU-ADRI scores.

Although our outcome measure has been linked to dementia in cohort studies, it is not specifically designed to measure the more subtle aspects of behavioral and motivational change that may be precursors to risk reduction. Dementia risk reduction is a new field of research and we know of no other outcome measures that could have been used in this trial. However, there needs to be consideration of adapting measures such as the ANU-ADRI to increase their sensitivity. A limitation of our approach was that the full ANU-ADRI score includes components that were not affected by the intervention. Future research should only include the items relating to risk and protective factors targeted by the intervention.

Several of the risk factors on the ANU-ADRI are difficult to change over short periods of time (e.g. high cholesterol). It is possible that our trial elicited changes in behavior that were not captured by our outcome measure. For example, we do not know if participants became more aware of their health status and chronic conditions during the trial which may lead to healthier behavior choices and better disease management in the long term.

5. Conclusions

The study demonstrates the feasibility of an online dementia risk reduction intervention incorporating behavior change principles that resulted in a high level of adherence and an increase in dementia literacy and protective behaviors. A face-to-face component did not boost the efficacy of the online intervention. These results hold promise for the further development of online risk reduction interventions.

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Supplementary data

Supplementary data related to this article can be found at <http://dx.doi.org/10.1016/j.trci.2015.04.003>.

RESEARCH IN CONTEXT

1. **Systematic review:** We conducted a systematic review of the literature to identify dementia risk reduction trials and online dementia risk reduction trials. No other multidomain intervention to reduce risk of Alzheimer's disease or dementia has been conducted using online methodology or in middle-aged adults.
2. **Interpretation:** Our study results show for the first time that dementia risk reduction using an online intervention is possible over a 6-month period. Increasing protective factors is achievable using low-cost interventions. It is likely that this online intervention will be more effective in participants who are at greater risk and who have poorer baseline health literacy.
3. **Future directions:** Further research is required to identify the strength and length of online interventions required to reduce risk factors. Research needs to identify methods for maintaining risk reduction once it has been achieved and to develop interventions tailored for specific population groups.

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