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Raising awareness for dementia risk reduction through a public health campaign: a pre-post study

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3 **Raising awareness for dementia risk reduction through a public health**
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6 **campaign: a pre-post study**
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Abstract

Objectives: Evaluate the effect of a health promotion campaign aimed at increasing awareness about dementia risk reduction in middle-aged community-dwelling individuals in the Netherlands.

Design: A 10-month public health campaign using mass-media and community participation, supported by eHealth. Population-level difference in awareness before and after the campaign, including variation between demographic groups, was assessed in two independent cross-sectional samples from the same target population.

Setting: The public health campaign was launched in the Province of Limburg, the Netherlands, targeting all inhabitants aged 40 to 75 years old. Three specific districts within the Province were chosen for an additional community-participation approach, in which local stakeholders were invited to support the campaign.

Results: No pre-post difference was observed in people agreeing to the statement that dementia risk reduction is possible ($\chi^2(1) = 1.27, p = 0.260$). For the individual lifestyle factors, physical activity (7.6% increase ($\chi^2(1) = 7.48, p \leq 0.01$)) and health diet (10.5% increase ($\chi^2(1) = 12.37, p \leq 0.001$)) were identified more often post-campaign. The protective factor cognitive activity was identified most often as being protective against dementia at both pre- (79.4%) and post-assessment (80.4%), but there was no increase in awareness ($\chi^2(1) = 0.17, p = 0.677$). Self-reported exposure to the campaign was associated with more awareness and more motivation for behavioral change ($\chi^2(1) = 6.52, p \leq 0.05$). Compared to mass media only, the addition of community-participation resulted in better recognition of campaign-material and the eHealth-platform.

Conclusions: This study was not able to reach a population-level increase of awareness of dementia risk reduction. Two out of the three lifestyle factors that formed the foundation of the campaign were identified more often post-campaign. Those reported having been exposed to the campaign were more aware and more inclined towards behavioral change.

Strengths and limitations of this study

- This study used extensive pre- and post-campaign surveys, with large independent samples from the same target population and comparable methodology.
- The public health campaign was designed in consultation with health promotion experts (i.e. municipal health services, department of Health Promotion of Maastricht University, the Netherlands) and had a flexible design that made it possible to include local stakeholders during the campaign and alter strategies along the way.
- A positive approach was chosen for this health promotion campaign, for example by using the words “brain health” and “room for improvement” to raise awareness of dementia risk reduction, instead of focusing on unhealthy behaviors that increase the risk of dementia.
- The samples were drawn from people from a previous survey study who indicated to be interested in future research, which could have led to a pre-selection of people interested in scientific research and health and therefore could have led to selection bias (e.g. an overestimation of dementia risk reduction literacy).
- The reach and effect of the campaign was limited due to restrained resources of the research team to reach out to relevant stakeholders and due to a limited budget to cover (mass) media costs (e.g. advertisement in newspapers, billboards).

1. Introduction

Dementia is characterized by progressive decline of cognitive abilities, leading to inferences in daily living. Alzheimer's disease (AD) and vascular dementia are the most common underlying pathologies, and often co-exist.¹ Due to the aging population, the number of people living with dementia worldwide is expected to triple from 50 million in 2018 to 152 million in 2050.² This rapid global increase and the absence of a curative treatment exposes a major public health concern.

Primary prevention of dementia through lifestyle modification gains increasing attention in research and policy.^{1,3-5} Population-based estimations showed that around one-third of all dementia cases might be attributable to seven lifestyle and health-related factors, including physical inactivity, depression, and low mental stimulation.⁴ Reducing exposure to these risk factors by 10 to 20% per decade would lower the prevalence of AD by as much as 8 to 15%.⁴ These insights have led to a series of randomized controlled trials (RCTs), using lifestyle interventions to delay or prevent cognitive decline and dementia onset.⁶⁻⁹ The multidomain Prevention of Dementia by Intensive Vascular Care (preDIVA) trial, in 3,454 patients with known vascular risk factors aged 70-79 years, and the Multidomain Alzheimer Preventive Trial (MAPT) in 1,680 adults aged 70 years and older did both not result in significant reduction of incident dementia⁷ and change in memory function,⁸ or only in subgroups. In contrast, the population-based Finnish Geriatric Intervention Study to Prevent Cognitive Impairment and Disability (FINGER), starting earlier in those aged 60-77 years, was the first large-scale RCT that showed beneficial effects on cognition.^{6,10} It seems that dementia risk reduction interventions should target people in midlife to minimize lifetime accumulation of risk factor exposure and consequent brain pathology.^{1,11-13}

Recently, a global initiative aimed at harmonizing intervention studies on risk factor modification was launched, called World Wide (WW) FINGERS.¹¹ Incorporated trials include the US Study to Protect Brain Health Through Lifestyle Intervention to Reduce Risk (US POINTER) and the Singapore intervention study to prevent cognitive impairment and disability (SINGER).¹¹ The ambition of WW-

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3 FINGERS to find robust evidence for lifestyle interventions that delay or prevent dementia onset is
4 promising from a public health perspective. In addition, epidemiological studies have shown decreasing
5 incidence of dementia in high-income countries, observed in several cohorts¹⁴⁻¹⁶, probably because of
6 improved cardiovascular health, nutrition and education over the last decades.² The timeliness of
7 dementia prevention interventions was also emphasized by the Lancet Commission on Prevention,
8 Intervention and Care of 2017¹ and the publication of guidelines for risk reduction of cognitive decline
9 and dementia by the World Health Organization (WHO) in 2019.⁵

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18 It must, however, be noted that the general public is still largely unaware of the potential of dementia risk
19 reduction, let alone of specific actions to reduce dementia risk.¹⁷⁻¹⁹ In our own survey among middle-aged
20 adults (n=590), 44% were aware of dementia risk reduction, and only 20-25% considered vascular
21 conditions to increase the risk.¹⁷ Hence, despite the need for conclusive RCTs, little is known about how
22 knowledge can be translated to the general public to raise awareness, and how to engage hard-to-reach
23 subgroups (e.g. low health literacy or socioeconomic status) who are often underrepresented in clinical
24 trials, too.²⁰⁻²²

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34 Creating risk awareness at the population level is a crucial first step before behaviour-change programs
35 can be developed and implemented. Therefore, the goal of this study is to evaluate the impact of a health
36 promotion campaign aimed at increasing awareness about dementia risk reduction in middle-aged Dutch
37 community-dwelling individuals. Specifically, we tested change in the level of awareness at the
38 population-level before and after the campaign, variation between demographic groups, the effect of
39 different approaches (mass media versus additional community-participation) and the use of eHealth
40 supportive technology, in order to distil the lessons learned for future campaigns and policies.

41 42 43 44 45 46 47 48 49 50 **2. Methods**

51 52 53 *Target population*

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3 The target population were inhabitants of the Province of Limburg, the Netherlands, aged 40 to 75 years
4 old (558.535 people in total²³). The Ethics Review Committee Psychology and Neuroscience (ERCPN) of
5 Maastricht University approved this study (reference number 177-07-03-2017). All participants received
6 an information letter and signed a digital informed consent form prior to participation.
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11 12 *Awareness campaign*

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15 The primary aim of this campaign (March 2018 – January 2019) was to increase awareness on dementia
16 risk reduction. Secondary, we aimed to motivate people for behavioural change by means of eHealth. The
17 campaign was developed by the Alzheimer Centre Limburg (ACL) at Maastricht University and
18 Maastricht University Medical Centre+, in consultation with the Dutch Municipal Health Services (MHS)
19 and the Department of Health Promotion of Maastricht University. An agency for strategy and design
20 developed the campaign materials and website.²⁴ To maximize acceptance in the relatively young target
21 population, a positive phrasing was chosen with respect to the slogan (“We are our own medicine”),
22 terminology (e.g. “brain health” rather than “dementia”), and campaign material visualizing the three
23 campaign themes: “eat healthy”, “exercise regularly”, and “stay curious” (see Supplemental File 1 for
24 examples). The campaign materials were discussed with stakeholders (Dutch Alzheimer’s Association
25 and an evaluation panel of potential end-users). Two different campaign approaches were chosen in order
26 to compare the outcome. A broad campaign was launched, targeting the public via mass media such as
27 newspapers and social media (hereafter “population sample”). Three specific districts within the Province
28 (Landgraaf-Schaesberg, Brunssum-Oost, and Roermond-Hoogvonderen) were chosen for a community-
29 participation approach, in which local stakeholders (e.g. municipality, supermarkets) were invited to
30 support the campaign (hereafter “district sample”). The district samples were chosen based on variation in
31 socio-economic status and absence of other public health projects.
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51 52 *The eHealth platform*

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3 An online platform called *MijnBreincoach* (“MyBraincoach”) was developed together with two software
4 companies and made available as mobile app and web portal ²⁵. It uses the well-validated Lifestyle for
5 BRAin Health (LIBRA) score.^{12,13,26} This predictive model consists of twelve modifiable risk and
6 protective factors for dementia (e.g. smoking, physical inactivity, depression), and gives people insight
7 into their personal dementia risk profile. Detailed information can be found in Supplemental File 2.
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13 14 *Pre- and post-campaign surveys*

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17 Two cross-sectional surveys were performed: one pre-campaign (September 2017 ¹⁷) and one post-
18 campaign (February 2019). The pre- and post-campaign surveys took place in independent samples, in
19 order to ensure that the potential increase in awareness was not caused by learning effects. The
20 methodology and results of the pre-campaign survey have been described in more detail elsewhere.¹⁷
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26 27 *Recruitment process*

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29 The population samples were drawn by the MHS from participants of a previous national health survey
30 (‘*Gezondheidsmonitor 2016*’) who had agreed to be contacted for future studies. A random selection of
31 people (40-75 years) was invited to participate via email. The district samples were drawn from the
32 municipal registry by the municipality or by the MHS, based on ZIP-codes and age and received a postal
33 letter.
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41 42 *Measurements*

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44 Age, sex, marital status, educational level, self-reported knowledge of dementia and dementia risk
45 reduction were assessed both at the pre- and post-assessment. Ten items from the British Social Attitudes
46 (BSA) survey¹⁸ were used, translated into Dutch. To assess all twelve factors from the LIBRA-index,²⁶
47 custom-made items were included. The post-campaign survey included additional items concerning
48 exposure to the campaign (e.g. asking participants whether they recognized campaign material). The
49 items on exposure to the campaign were placed after the items assessing awareness, thereby not
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3 influencing one's perspective on the possibility of dementia risk reduction. Our primary outcome was the
4 difference between pre- and post-assessment in the proportion of people rejecting the statement 'There is
5 nothing I can do to reduce my dementia risk'. We presented this statement in the Results section in a
6 positive form ("dementia risk reduction is possible"). Secondary outcomes were changes in endorsement
7 of the three campaign themes physical activity, cognitive activity and healthy diet.
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13 14 *Statistical analyses*

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17 Independent groups *t*-tests and χ^2 tests were used to analyse differences between the pre- and post-
18 campaign samples, and between population and district samples, and to investigate differences in the
19 relation between socio-demographic variables and level of awareness and knowledge of risk and
20 protective factors. Analyses were performed in Stata 13.1 (StataCorp, College Station, TX, USA), with
21 the level of significance set at $p \leq 0.05$ in two-tailed tests.
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28 29 *Patient and Public Involvement*

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32 There were no patients involved in this research. Members of the public were involved in the design and
33 rollout of the public health campaign.
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37 38 *Data sharing statement*

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40 The dataset and statistical code are available upon reasonable request. No additional data available.
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43 **3. Results**

44 45 *Demographics*

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48 The response rates of the pre- and post-campaign surveys were highly comparable (population pre-
49 campaign 53.6%, post-campaign 54.8%; district pre-campaign 33.2%, post-campaign 32.2%). See
50 Supplemental File 3, 4a and 4b for flowcharts of the recruitment process. Table 1 shows the
51 characteristics of the total and the two separate samples. The characteristics of the districts can be found
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3 in Supplemental File 5. The total pre-assessment sample was highly comparable with the total post-
4 assessment sample. As expected by design, the population sample was higher educated than the district
5 sample at the pre- ($\chi^2(2) = 29.57, p \leq 0.001$) and post-assessment ($\chi^2(2) = 17.41, p \leq 0.001$). An
6 overview of the main campaign expressions are displayed in Box 1.
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Table 1. Characteristics of the two cross-sectional samples before and after the campaign, stratified by sampling frame (population and district sample).

Variables*	Total sample (n = 1,192)			Population sample (n =780)			District sample (n =412)		
	Pre-campaign (n = 590)	Post- campaign (n = 602)	p- value	Pre- campaign (n = 381)	Post- campaign (n = 399)	p- value	Pre-campaign (n= 209)	Post- campaign (n= 203)	p- value
Age, mean (SD)	60.7 (8.8)	59.9 (8.8)	0.113	61.1 (8.9)	61.2 (8.8)	0.869	60.1 (8.6)	57.4 (8.3)	≤ 0.01
Age group (years), n (%)			0.755			0.649			0.060
40 – 49	75 (13.0%)	91 (15.2%)		48 (12.9%)	52 (13.2%)		27 (13.2%)	39 (19.2%)	
50 – 59	170 (29.5%)	172 (28.8%)		101 (27.1%)	95 (24.1%)		69 (33.8%)	77 (37.9%)	
60 – 69	244 (42.3%)	246 (41.1%)		165 (44.2%)	174 (44.1%)		79 (38.7%)	72 (35.5%)	
70 – 75	88 (15.3%)	89 (14.9%)		59 (15.8%)	74 (18.7%)		29 (14.2%)	15 (7.4%)	
Female, n (%)	269 (46.2%)	293 (48.7%)	0.398	164 (44.0%)	184 (46.1%)	0.549	105 (50.0%)	109 (53.7%)	0.483
Marital status, n (%)			0.501			0.348			0.654
Married/living together	471 (80.5%)	478 (79.4%)		299 (79.5%)	321 (80.5%)		172 (82.3%)	157 (77.3%)	
Not/never been married	30 (5.1%)	34 (5.7%)		18 (4.8%)	18 (4.5%)		12 (5.7%)	16 (7.9%)	
Divorced	48 (8.2%)	61 (10.1%)		33 (8.8%)	43 (10.8%)		15 (7.2%)	18 (8.9%)	
Widowed	36 (6.2%)	29 (4.8%)		26 (6.9%)	17 (4.3%)		10 (4.8%)	12 (5.9%)	

Educational level [†] , <i>n</i> (%)			0.846		0.579		0.890
<i>Low</i>	101 (17.3%)	103 (17.1%)	46 (12.2%)	53 (13.3%)	55 (26.3%)	50 (24.6%)	
<i>Middle</i>	222 (38.0%)	238 (39.5%)	134 (35.6%)	153 (38.4%)	88 (42.1%)	85 (41.9%)	
<i>High</i>	262 (44.8%)	261 (43.4%)	196 (52.1%)	193 (48.4%)	66 (31.6%)	68 (34.0%)	
Self-reported knowledge of dementia, <i>n</i> (%)			0.780		0.668		0.944
<i>Good</i>	489 (84.5%)	506 (85.0%)	308 (83.2%)	335 (84.4%)	181 (86.6%)	171 (86.4%)	
<i>Insufficient</i>	90 (15.5%)	89 (15.0%)	62 (16.8%)	62 (15.6%)	28 (13.4%)	27 (13.6%)	

Abbreviations: SD: standard deviation; *n*: amount of people; * Maximum value does not count up due to missing values; [†] Self-reported highest finalized degree, divided into low (primary school or low vocational education), middle (intermediate secondary education or intermediate vocational or higher secondary education) and high (higher vocational education or university).

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3 **Box 1. Main expressions during the campaign (March 2018 - January 2019)**
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<p>6 Local engagement</p> <p>7 and support</p> <p>8</p> <p>9</p> <p>10</p> <p>11</p> <p>12</p> <p>13</p> <p>14</p> <p>15</p> <p>16</p> <p>17</p> <p>18</p> <p>19</p> <p>20</p>	<ul style="list-style-type: none"> • More than 140 stakeholders (municipalities, schools, health care centres, companies) committed to this campaign by distributing campaign material/messages and/or organizing public events • Distribution of 35,000 campaign leaflets and more than 1.000 campaign posters (on more than 400 locations within the Province) • Organization of more than one public event per week (n=52; lecture, workshop or other community activities)
<p>21 Campaign</p> <p>22 website²⁴</p> <p>23</p> <p>24</p> <p>25</p> <p>26</p>	<ul style="list-style-type: none"> • More than 10,000 website visits • Online campaign posters are downloaded more than 5.500 times in total
<p>27 Media</p> <p>28</p> <p>29</p> <p>30</p> <p>31</p> <p>32</p> <p>33</p>	<ul style="list-style-type: none"> • Over 65 media outlets (e.g. newspaper item, radio-interview) • Campaign tweets reached 200,000 people • Facebook messages reached more than 15,000 people
<p>34 eHealth platform²⁵</p> <p>35</p> <p>36</p> <p>37</p> <p>38</p> <p>39</p> <p>40</p>	<ul style="list-style-type: none"> • 9,000 downloads MijnBreincoach app • Ministry of Health, Welfare and Sport in The Netherlands incorporated the app on their website on innovations in health care

Difference in level of awareness before and after the campaign (total sample)

Figure 1 displays a pre- and post-campaign comparison of the percentage of participants agreeing that dementia risk reduction is possible, and the percentage of participants identifying the three campaign themes. No difference in awareness was observed ($\chi^2(1) = 1.27, p = 0.260$). Cognitive activity was identified most often as being protective against dementia at both pre- (79.4%) and post-assessment (80.4%), but there was no increase in awareness ($\chi^2(1) = 0.17, p = 0.677$). A modest increase in awareness was observed for physical activity (7.6% increase; $\chi^2(1) = 7.48, p \leq 0.01$) and healthy diet (10.5% increase; $\chi^2(1) = 12.37, p \leq 0.001$). Higher educated participants were more aware of dementia risk reduction compared to lower educated participants, both in the pre-assessment (low 18.2%, middle 38.9%, high 59.4%; $\chi^2(2) = 53.46, p \leq 0.001$) and post-assessment (low 29.3%, middle 33.9%, high 52.3%; $\chi^2(2) = 24.15, p \leq 0.001$). The same applies to the identification of the three campaign themes.

----- **Insert Figure 1 here** -----

Differences between the two campaign approaches

No significant difference in level of awareness was found for both the population (47.1% to 40.5%; $\chi^2(1) = 3.39, p = 0.066$) and district sample (39.9% to 42.7%; $\chi^2(1) = 0.33, p = 0.565$). Cognitive activity was not identified more often as a protective factor for dementia in both the population (79.9% to 81.8%; $\chi^2(1) = 0.43, p = 0.510$) and district sample (78.5% to 77.7%; $\chi^2(1) = 0.04, p = 0.844$). Physical activity was identified more often in the population (65.6% to 73.3%; $\chi^2(1) = 5.14, p \leq 0.05$), but not in the district sample (59.2% to 66.3%; $\chi^2(1) = 2.17, p = 0.141$). Healthy diet was identified more often in both the population (51.7% to 62.3%; $\chi^2(1) = 8.23, p \leq 0.01$) and district sample (47.3% to 57.4%; $\chi^2(1) = 3.99, p \leq 0.05$). An increase was found of the LIBRA factors low-to-moderate alcohol use (26.9% to 38.4%; $\chi^2(1) = 6.07, p \leq 0.05$), obesity (19.9% to 28.4%; $\chi^2(1) = 3.91, p \leq 0.05$) and smoking (29.3% to 42.9%; $\chi^2(1) = 8.15, p \leq 0.01$) in the district sample. Higher educated participants were more aware of dementia risk reduction compared to lower educated participants, both in the pre-assessment (population

low 13.7%, middle 39.1%, high 60.2%; $\chi^2(2) = 36.27, p \leq 0.001$; districts low 21.8%, middle 38.6%, high 56.9%; $\chi^2(2) = 15.41, p \leq 0.001$) and the post-assessment (population low 31.4%, middle 30.0%, high 51.0%; $\chi^2(2) = 17.49, p \leq 0.001$; districts low 27.1%, middle 41.0%, high 55.9%; $\chi^2(2) = 9.72, p \leq 0.01$). In those with a low level of education in the population, an increase in awareness of dementia risk reduction was observed (17.7% increase; $\chi^2(1) = 4.18, p \leq 0.05$), and for the campaign themes physical activity (22% increase; $\chi^2(1) = 4.35, p \leq 0.05$) and healthy diet (25.3% increase; $\chi^2(1) = 5.79, p \leq 0.05$).

Exposure to the campaign and level of awareness in the total post-campaign sample (n=602)

Of all post-campaign participants, 20% reported to have heard of the campaign, 19.7% of the slogan, and 21.8% about the eHealth platform. Awareness was higher for post-campaign participants who reported to have heard of the campaign (37.9% vs. 51.4%; $\chi^2(1) = 6.52, p \leq 0.05$), the campaign slogan (37.2% vs. 53.3%; $\chi^2(1) = 9.07, p \leq 0.01$) and the eHealth platform (36.6% vs. 54.8%; $\chi^2(1) = 12.39, p \leq 0.001$). Campaign materials were more often recognized in the districts (35.2%) than in the population sample (26.8%; $\chi^2(1) = 3.92, p \leq 0.05$). More than a third (37.2%) expressed to have become more aware of their brain health, and 30.4% stated to have engaged in a brain-healthy lifestyle. Physical activity (45.8%), eating healthy (40.9%), and weight management (39.4%) were most often engaged in during the past year.

Self-reported knowledge of dementia

Figure 2 displays the level of awareness by self-reported general knowledge of dementia in the post-assessment sample. Participants who stated that their general knowledge of dementia was considerable or good were more aware of dementia risk reduction than participants with self-reported insufficient general knowledge ($\chi^2(1) = 6.48, p \leq 0.05$). The same applies for the identification of the risk/protective factors physical activity ($\chi^2(1) = 4.59, p \leq 0.05$), healthy diet ($\chi^2(1) = 7.32, p \leq 0.01$), smoking ($\chi^2(1) = 8.18, p \leq 0.01$), depression ($\chi^2(1) = 5.44, p \leq 0.05$), diabetes ($\chi^2(1) = 8.31, p \leq 0.01$), and hypercholesterolemia ($\chi^2(1) = 6.60, p \leq 0.01$).

-----Insert Figure 2 here -----

The eHealth platform

The 12-item “quick test” was completed more than 13,300 times. The mean age of this group was 57 years (SD 14.3; range 18-94y), 68% were female and 76% were higher educated. Room for improvement (according to self-reported presence or absence of risk/protective factors) was highest for the LIBRA factors hypertension, hypercholesterolemia, and alcohol consumption. Almost 36% (n=4,755) created an account and completed the more comprehensive administration (mean age 57 years, 72% female, 78% higher educated). Room for improvement, based on the extensive LIBRA administration using validated questionnaires, was highest for physical inactivity, adherence to a Mediterranean diet, and cognitive activity. These were also the factors that were chosen most often for receiving daily notifications.

4. Discussion

This paper presents the results of the first health promotion campaign in The Netherlands aimed at increasing awareness of dementia risk reduction in middle-aged community-dwelling individuals. In general, this study was not successful since no population-level change in awareness was observed. However, two out of the three campaign themes were identified more often after the campaign. People exposed to the campaign, its slogan and the eHealth platform were significantly more aware of dementia risk reduction and the three campaign themes. Participants from the district campaign recognized campaign material and the eHealth platform more often.

Unfortunately, awareness of dementia risk reduction and knowledge of most LIBRA factors did not increase. Several reasons might exist, one of them being that, due to a limited budget, the coverage of this campaign was insufficient to reach population-level increase in awareness. In addition, it could be that the statement to assess awareness was too complex (“there is nothing anyone can do to reduce their risks of getting dementia”). A simpler, positively formulated statement might have been more suitable for our purpose. The used statement was taken from the BSA 2015¹⁸ in order to compare dementia literacy

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3 between the United Kingdom and the Netherlands. Furthermore, there was no higher endorsement of the
4 protective factor cognitive activity after the campaign. This might be explained by a ceiling effect, as
5 many people already considered it to be a protective factor at baseline.
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10 Awareness of dementia risk reduction was higher in highly educated participants. However, awareness
11 only improved in the lower educated group (particularly in the population sample). This is notable, since
12 literature suggests that health promotion campaigns tend to reach higher educated people.²⁰⁻²² Importantly,
13 the campaign was designed with differences in health literacy and socio-economic status in mind (e.g.
14 content checking by the MHS).
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21 Literature on the effect of dementia risk reduction campaigns is scarce. An Australian study using an
22 informative website on dementia risk reduction resulted in increased knowledge and motivation to engage
23 in relevant health behaviours. However, no population-level measurements for evaluation were used and
24 the study only included a post-intervention assessment of people visiting the website.²⁷
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31 Strengths of this study include the extensive pre- and post-campaign surveys, with large independent
32 samples and comparable methodology.¹⁸ Next, the consultation of experts in order to professionalize the
33 campaign have been instrumental. In line with the WHO guidelines⁵, this campaign addressed multiple
34 dementia risk factors and collaborated with stakeholders in a multidisciplinary approach.⁵ The
35 involvement of stakeholders created a “snowball effect”, as they communicated the campaign message
36 via their own channels (see Box 1). Also, although the basic framework was set beforehand, the flexible
37 design of the campaign made it possible to alter strategies along the way.
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46 This study, however, also had limitations. First, this study was not inclusive regarding non-Dutch
47 speaking individuals and individuals without Internet access. Furthermore, the population samples were
48 drawn from participants from a previous survey interested in future research. This could have led to a pre-
49 selection of people interested in scientific research and health. Last, the restrained resources of the team
50 (e.g. to contact relevant stakeholders) limited the reach and effect of the campaign.
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3 These limitations were already acknowledged beforehand. This campaign was developed as a proof-of-
4 concept study in a naturalistic setting, investigating campaign strategies and the extent of involvement of
5 the community. At this stage, some lessons learned and recommendations for future campaigns should be
6 discussed. In general, involvement of the community is an important determinant of success. Further, as
7 this study shows that individuals with self-reported sufficient knowledge of dementia are more aware of
8 dementia risk reduction, it is recommended to incorporate such a campaign into a general dementia
9 campaign, or even a broad health promotion campaign, given the overlapping risk factors for
10 cardiovascular disease and diabetes. In fact, incorporating lifestyle recommendations of various non-
11 communicable diseases is one of the recommendations of the WHO.⁵ Furthermore, it was striking that
12 campaign activities were particularly visited by the older half (60-75 years) of the targeted population,
13 despite our efforts in providing information online and using terms as “brain health” instead of “dementia
14 risk”. Reaching younger individuals, with a positively framed message that dementia risk reduction is not
15 a distant reality, is important to take into consideration. Next, it should be noted that increasing awareness
16 is an essential yet insufficient step towards behavioural change. Altering complex and entrenched
17 behaviours is very difficult, and unlikely to be sufficiently affected by this small-scale campaign. This
18 was done to some extent by prompting people with low-level, positive messages on how to engage in
19 brain-healthy activities. Yet, the main focus of this campaign was increasing awareness and not
20 behavioural change.

21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 **Conclusion**

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44 This study was not able to reach a population-level increase of awareness of dementia risk reduction, but
45 did increase awareness and willingness to take action in those exposed. Future campaigns should scale up
46 to maximize exposure and engagement in the population. More insight is needed on how increasing
47 awareness may trigger lifestyle behaviour.
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What is already known on this subject?

Mounting evidence during the last decade has shown that modifiable risk factors play an important role in the development of dementia. Population-based data estimated that around a third of all dementia cases worldwide is attributable to seven modifiable risk factors. However, recent studies show that dementia risk reduction literacy is low and not much is known on how to increase awareness on population level.

What this study adds?

Maximizing exposure to this important public health message is of great importance, for example by incorporating it in a larger campaign on dementia or general health, and develop strategies that reach younger generations. Furthermore, engaging (local) stakeholders in the organization and execution of such a campaign is of great importance. Research on dementia risk reduction literacy should incorporate comparisons between demographic subgroups (age, sex, level of education) in order to tailor campaigns to meet the needs of subgroups.

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16 interpretation of data, in the writing of the report, and in the decision to submit the paper for publication.
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21 **Competing interest:** none declared
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24 **Contributorship statement:**
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26
27 Irene Heger: study design, data collection, data analysis and interpretation, drafting the manuscript
28

29
30 Sebastian Köhler: study design, critical revision of the manuscript
31

32
33 Martin van Boxtel: study design, critical revision of the manuscript
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35
36 Marjolein de Vugt: study design, critical revision of the manuscript
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39 KlaasJan Hajema: data collection, critical revision of the manuscript
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41
42 Frans Verhey: study design, critical revision of the manuscript
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44
45 Kay Deckers: study design, data collection, data analysis and interpretation, study supervision
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3 **Figure Legends**
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6 **Figure 1. Pre- and post-campaign comparison of the total sample.**
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8 Percentage agreeing with the statement that dementia risk reduction is possible, and percentage identifying the three
9 target risk factors/themes of the campaign
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12 **Figure 2. Level of awareness by self-reported general knowledge of dementia in the post-assessment sample**
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14 The percentages reflect the percentage of participants who agreed that a particular factor is a risk or protective factor
15 for dementia.
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For peer review only

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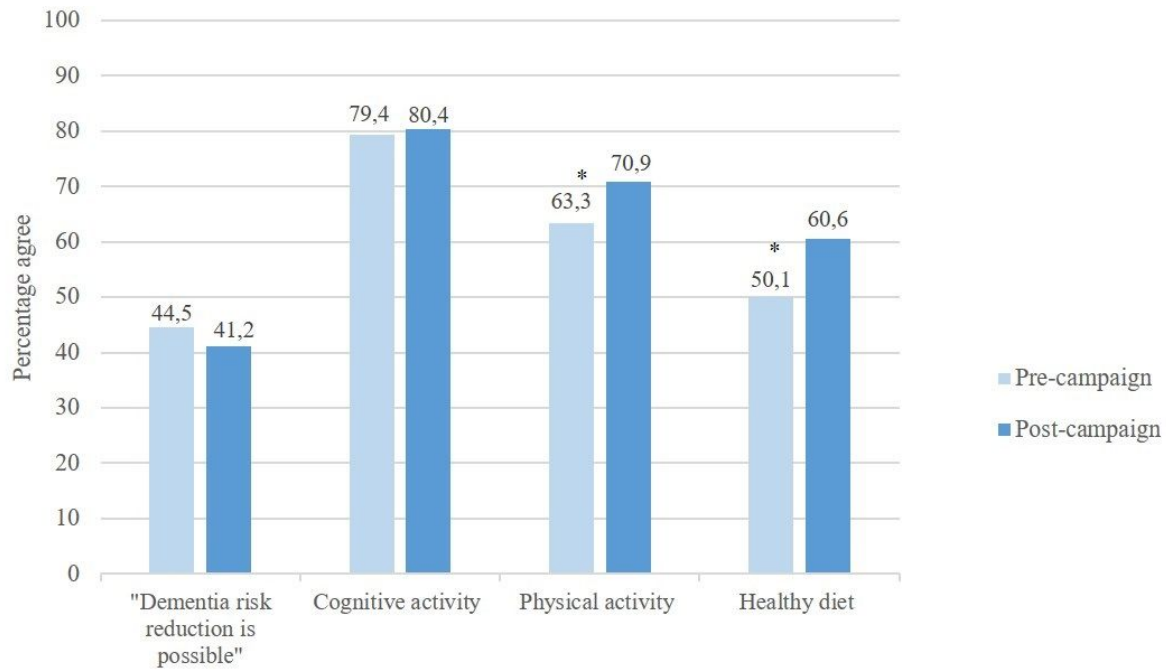


Figure 1. Pre- and post-campaign comparison of the total sample.

Percentage agreeing with the statement that dementia risk reduction is possible, and percentage identifying the three target risk factors/themes of the campaign

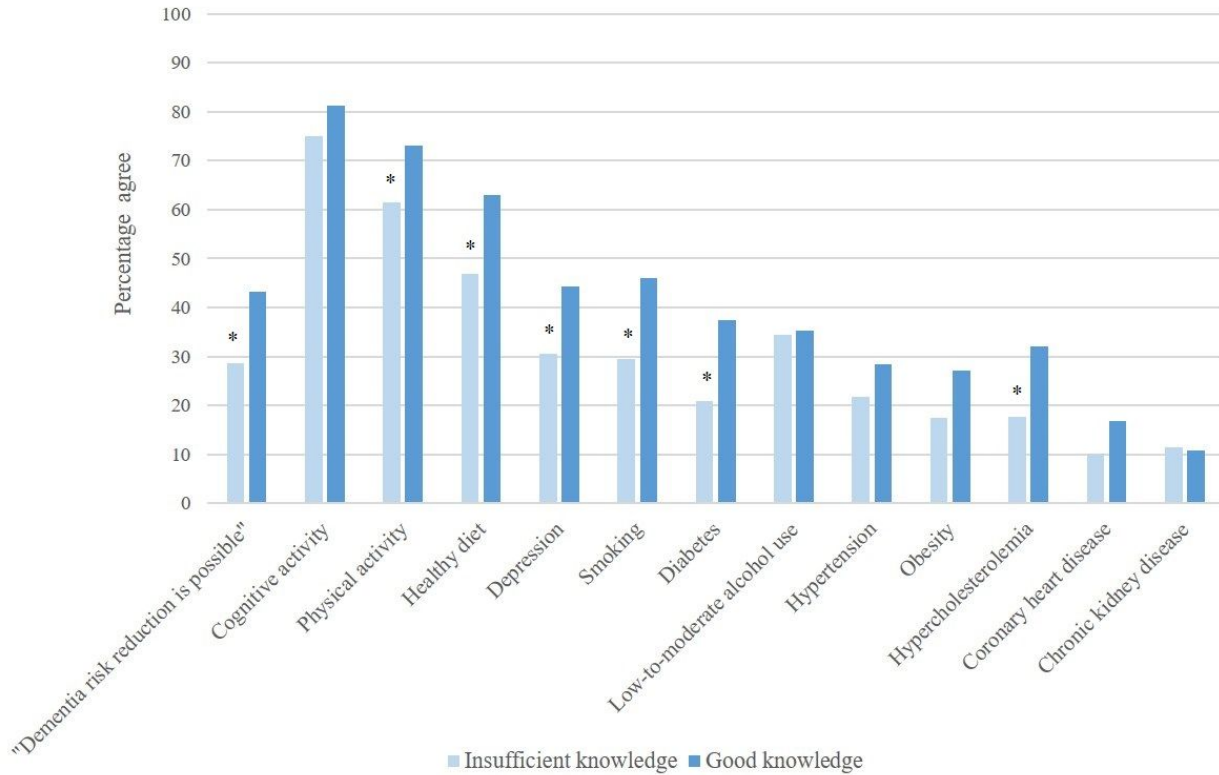


Figure 2. Level of awareness by self-reported general knowledge of dementia in the post-assessment sample

The percentages reflect the percentage of participants who agreed that a particular factor is a risk or protective factor for dementia.

Supplementary Material 1. Examples of campaign materials²⁴



Dit is een campagne van Alzheimer Centrum Limburg i.s.m. vele partners.

Campaign theme "Exercise regularly"

English translation: "Reduces walking the risk of dementia?"



Dit is een campagne van Alzheimer Centrum Limburg i.s.m. vele partners.

Campaign theme "Eat healthy"

English translation: "Reduces strawberries the risk of dementia?"



Dit is een campagne van Alzheimer Centrum Limburg i.s.m. vele partners.

Campaign theme "Stay curious"

English translation: "Reduces playing guitar the risk of dementia?"

Supplementary Material 2: The MijnBreincoach eHealth platform²⁵

The MijnBreincoach eHealth platform uses the LIBRA score [20, 21, 34-39] to give people insight into their own dementia risk profile and flags individual room for lifestyle improvement. The LIBRA index consists of 12 modifiable risk and protective factors for dementia. Users start with a 12-item “quick test” that assesses the LIBRA factors and flags personal room for improvement based on self-reported data on the presence and/or absence of the specific LIBRA factor. Next, a user can create an account and complete the more comprehensive administration that assesses the 12 LIBRA factors with follow-up questions on the “quick test” by validated questionnaires. People can get insight and feedback on their personal risk profile, identify areas of healthy behaviour (to facilitate maintenance), areas of unhealthy behaviour (to facilitate change), and identify chronic vascular/metabolic conditions (to facilitate appropriate management). A user can choose a lifestyle topic or health condition of interest (smoking, alcohol use, cognitive activity, healthy diet, physical activity, obesity, hypertension, diabetes, coronary heart disease, chronic kidney disease, depression, or hypercholesterolemia) and receives daily notifications (“nut of the day”) on how to improve brain health by means of that factor.



Personal profile with room for improvement

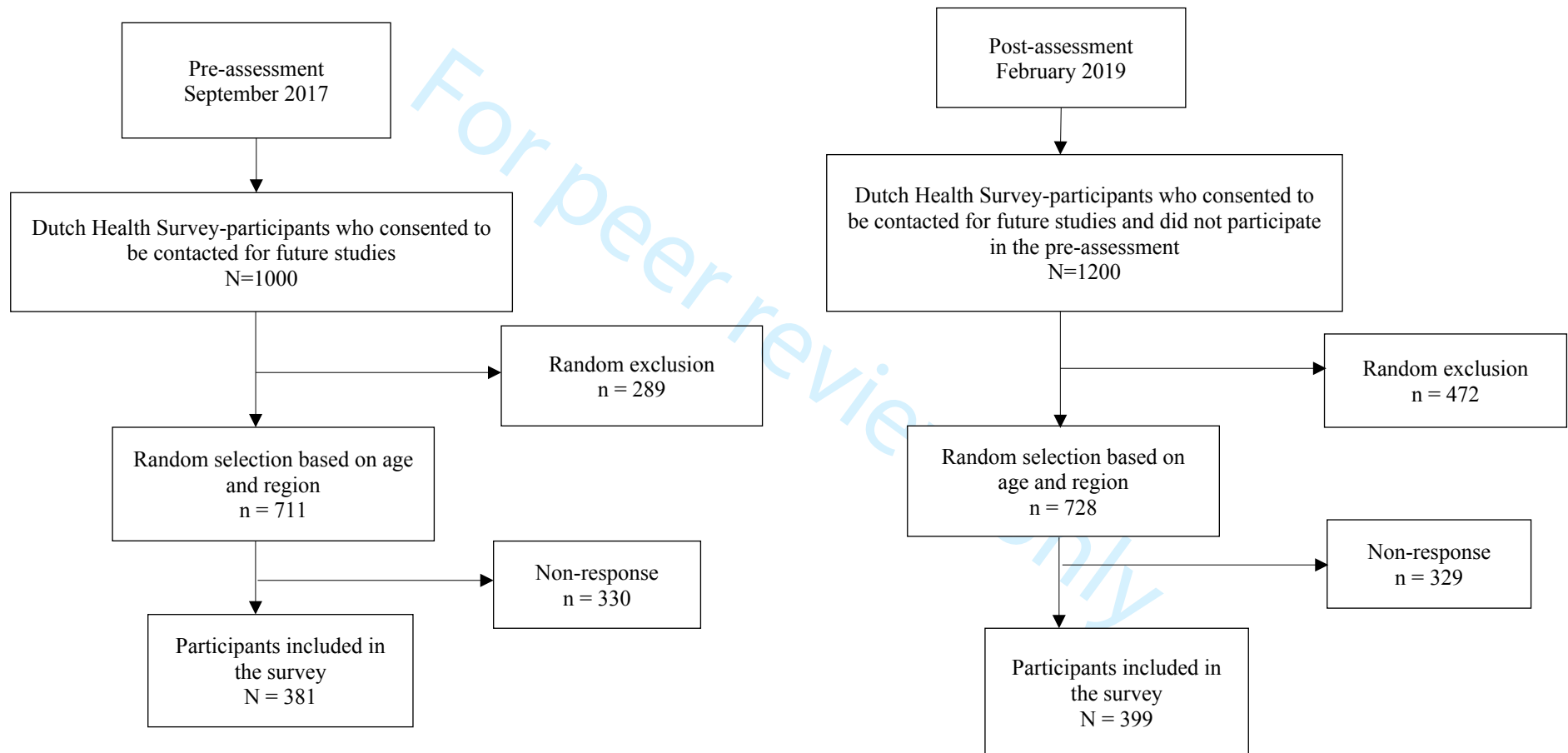


“Nut of the day”

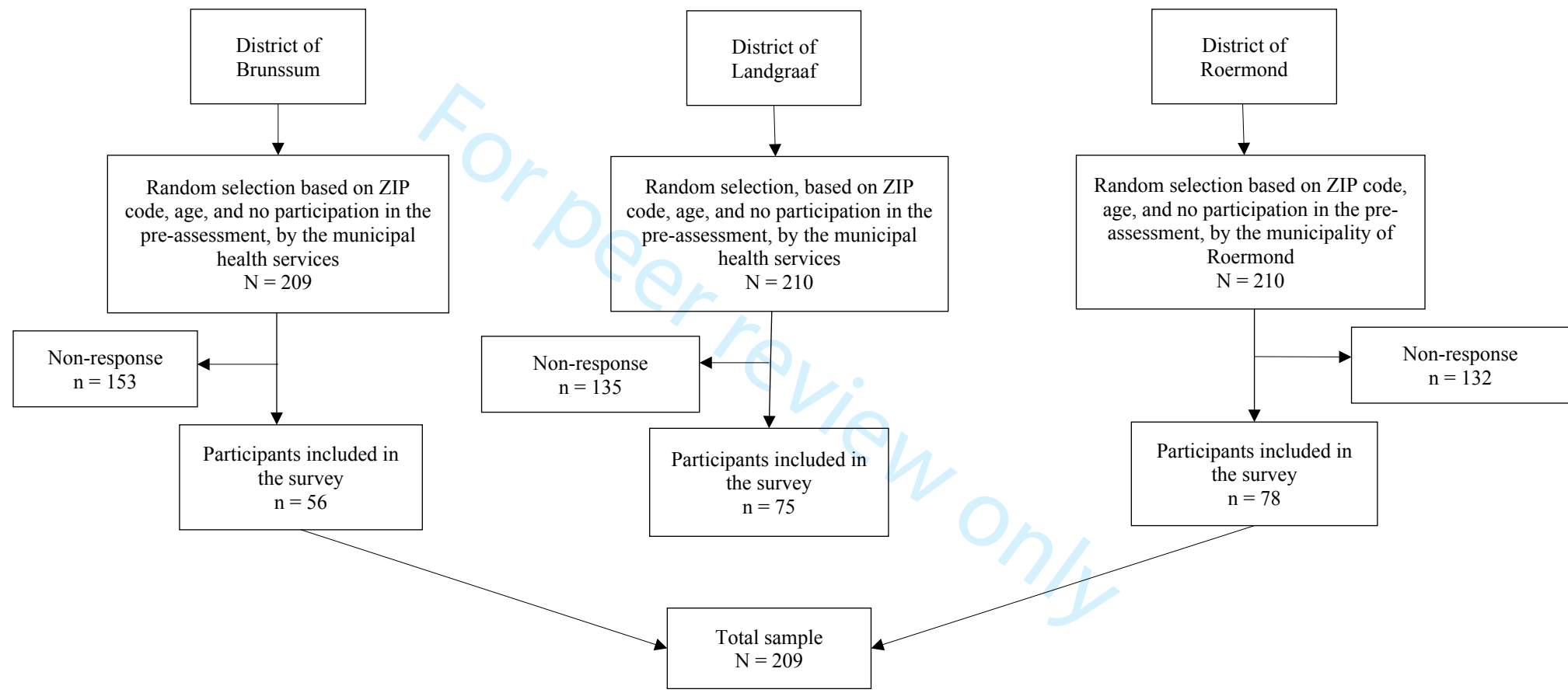


Short text message containing a recipe

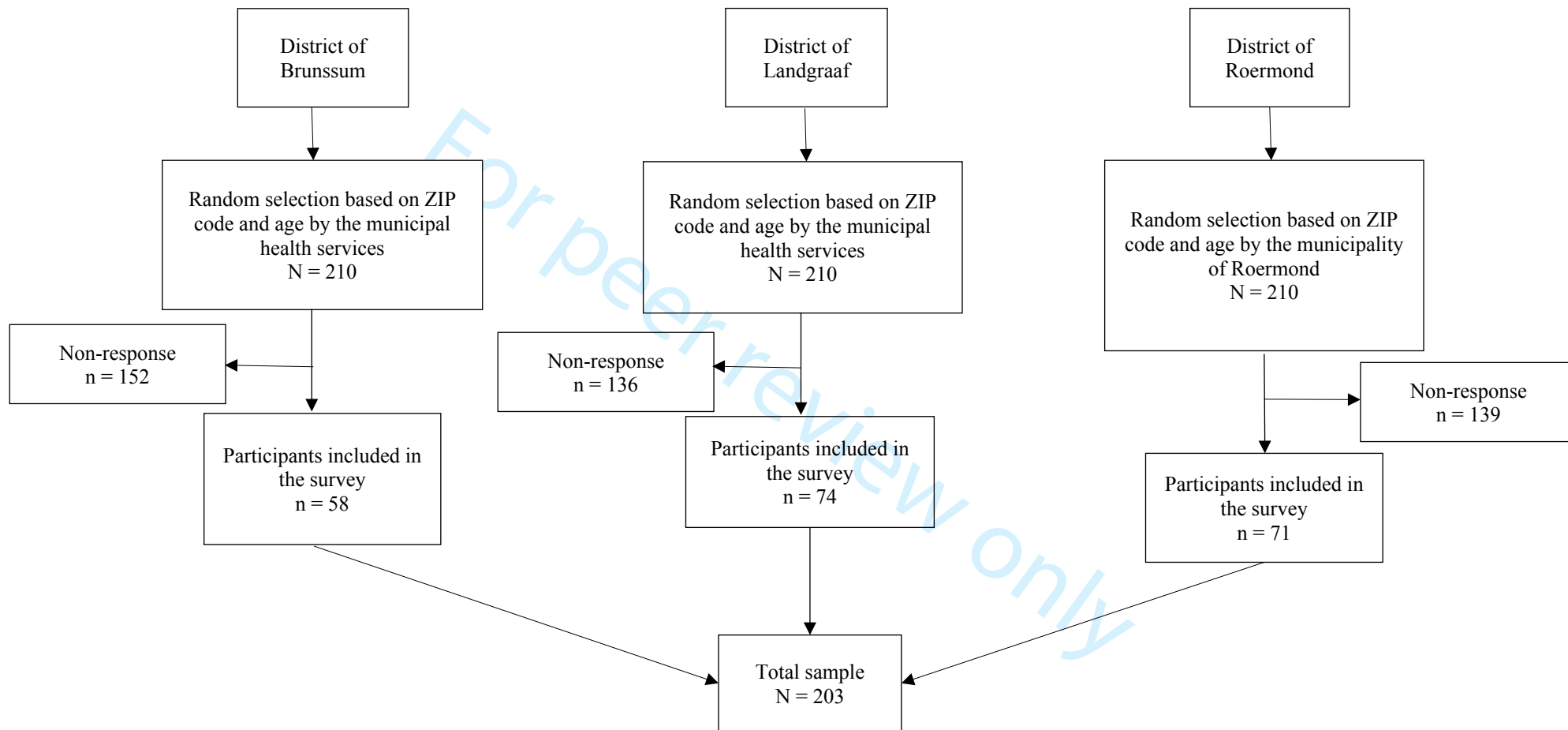
Supplementary Material 3. Flowchart of the population pre- and post-assessment



Supplementary Material 4a. Flowchart of the district pre-assessment



Supplementary Material 4b. Flowchart of the district post-assessment



Supplementary Material 5. Characteristics of the three districts before and after the campaign

Variables*	District of Roermond (n = 149)			District of Landgraaf (n = 149)			District of Brunssum (n = 114)		
	Pre-campaign (n=78)	Post-campaign (n=71)	p-value	Pre-campaign (n=75)	Post-campaign (n=74)	p-value	Pre-campaign (n=56)	Post-campaign (n=58)	p-value
Age, mean (SD)	56.9 (8.7)	55.4 (7.1)	0.247	60.9 (7.7)	59.1 (8.6)	0.177	63.3 (8.1)	57.7 (8.8)	< 0.001
Age group (year), n (%)			0.222			0.241			< 0.05
<i>40 – 49</i>	19 (24.4%)	17 (23.9%)		4 (5.6%)	12 (16.2%)		4 (7.3%)	10 (17.2%)	
<i>50 – 59</i>	30 (38.5%)	29 (40.9%)		25 (35.2%)	22 (29.7%)		14 (25.5%)	26 (44.8%)	
<i>60 – 69</i>	22 (28.2%)	24 (33.8%)		33 (46.5%)	31 (41.9%)		24 (43.6%)	17 (29.3%)	
<i>70 – 75</i>	7 (9.0%)	1 (1.4%)		9 (12.7%)	9 (12.2%)		13 (23.6%)	5 (8.6%)	
Female, n (%)	39 (50.0%)	41 (57.8%)	0.344	38 (50.7%)	37 (50.0%)	0.935	28 (50.0%)	31 (53.5%)	0.713
Marital status, n (%)			0.144			0.875			0.972
<i>Married/living together</i>	66 (84.6%)	49 (69.0%)		64 (85.3%)	64 (86.5%)		42 (75.0%)	44 (75.9%)	
<i>Not/never been married</i>	4 (5.1%)	7 (9.9%)		4 (5.3%)	4 (5.4%)		4 (7.1%)	5 (8.6%)	
<i>Divorced</i>	5 (6.4%)	11 (15.5%)		5 (6.7%)	3 (4.1%)		5 (8.9%)	4 (6.9%)	
<i>Widowed</i>	3 (3.9%)	4 (5.6%)		2 (2.7%)	3 (4.1%)		5 (8.9%)	5 (8.6%)	
Educational level†, n (%)			0.725			0.996			0.985

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3	<i>Low</i>	18 (23.1%)	13 (18.3%)	15 (20.0%)	15 (20.3%)	22 (39.3%)	22 (37.9%)
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5	<i>Middle</i>	32 (41.0%)	29 (40.9%)	33 (44.0%)	32 (43.2%)	23 (41.1%)	24 (41.4%)
6							
7	<i>High</i>	28 (35.9%)	29 (40.9%)	27 (36.0%)	27 (36.5%)	11 (19.6%)	12 (20.7%)
8							
9							
10	Self-reported knowledge of dementia, n (%)		0.186		0.475		0.634
11							
12	<i>Good</i>	72 (92.3%)	59 (85.5%)	65 (86.7%)	66 (90.4%)	44 (78.6%)	46 (82.1%)
13							
14	<i>Insufficient</i>	6 (7.7%)	10 (14.5%)	10 (13.3%)	7 (9.6%)	12 (21.4%)	10 (17.9%)
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Abbreviations: SD: standard deviation; n: amount of people; * Maximum value does not count up due to missing values; † Self-reported highest finalized degree, divided into low (primary school or low vocational education), middle (intermediate secondary education or intermediate vocational or higher secondary education) and high (higher vocational education or university).

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study’s design with a commonly used term in the title or the abstract	1 and 2
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5-6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5-7
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	7
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7
Bias	9	Describe any efforts to address potential sources of bias	7
Study size	10	Explain how the study size was arrived at	
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	7
		(b) Describe any methods used to examine subgroups and interactions	7
		(c) Explain how missing data were addressed	n.a.
		(d) If applicable, describe analytical methods taking account of sampling strategy	n.a.
		(e) Describe any sensitivity analyses	n.a.
Results			

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Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8
		(b) Give reasons for non-participation at each stage	n.a.
		(c) Consider use of a flow diagram	Supplemental File 3, 4a and 4b
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9-10
		(b) Indicate number of participants with missing data for each variable of interest	n.a.
Outcome data	15*	Report numbers of outcome events or summary measures	12
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12
		(b) Report category boundaries when continuous variables were categorized	9
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n.a.
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	12-13
Discussion			
Key results	18	Summarise key results with reference to study objectives	14
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	15-16
Generalisability	21	Discuss the generalisability (external validity) of the study results	15-16
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	18

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Raising awareness for dementia risk reduction through a public health campaign: a pre-post study

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3 **1 Raising awareness for dementia risk reduction through a public health**
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6 **2 campaign: a pre-post study**
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1
2
3 **21 Abstract**
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6 **22 Objectives:** Evaluate the effect of a health promotion campaign aimed at increasing awareness about
7
8 **23** dementia risk reduction in middle-aged community-dwelling individuals in the Netherlands.
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11 **24 Design:** A 10-month public health campaign using mass-media and community participation, supported
12
13 **25** by eHealth. Population-level difference in awareness before and after the campaign, including variation
14
15 **26** between demographic groups, was assessed in two independent cross-sectional samples from the same
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17 **27** target population.
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20 **28 Setting:** The public health campaign was launched in the Province of Limburg, the Netherlands, targeting
21
22 **29** all inhabitants aged 40 to 75 years old. Three specific districts within the Province were chosen for an
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24 **30** additional community-participation approach, in which local stakeholders were invited to support the
25
26 **31** campaign.
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29 **32 Results:** No pre- (n=590) post- (n=602) difference was observed in people agreeing to the statement that
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31 **33** dementia risk reduction is possible ($X^2(1) = 1.27, p = 0.260$). For the individual lifestyle factors, physical
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33 **34** activity (7.6% increase ($X^2(1) = 7.48, p = .006$)) and healthy diet (10.5% increase ($X^2(1) = 12.37, p \leq$
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35 **35** 0.001)) were identified more often as being protective against dementia post-campaign. Of all
36
37 **36** risk/protective factors assessed, cognitive activity was identified most often at both pre- (79.4%) and post-
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39 **37** assessment (80.4%), but there was no increase in awareness ($X^2(1) = 0.17, p = 0.677$). Self-reported
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41 **38** exposure to the campaign was associated with greater awareness and motivation for behavioural change
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43 **39** ($X^2(1) = 6.52, p = .011$). Compared to mass media only, the addition of community-participation resulted
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45 **40** in better recognition of campaign-material and the eHealth-platform.
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49 **41 Conclusions:** This study was not able to reach a population-level increase of awareness of dementia risk
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51 **42** reduction. Two out of the three lifestyle factors that formed the foundation of the campaign were
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53 **43** identified more often post-campaign. Those reported having been exposed to the campaign were more
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55 **44** aware and more inclined towards behavioural change.
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45 **Strengths and limitations of this study**

- 46 • This study used extensive pre- and post-campaign surveys, with large independent samples from
47 the same target population and comparable methodology.
- 48 • The public health campaign was designed in consultation with health promotion experts (i.e.
49 municipal health services, Department of Health Promotion of Maastricht University, the
50 Netherlands) and had a flexible design that made it possible to include local stakeholders during
51 the campaign and alter strategies along the way.
- 52 • A positive approach was chosen for this health promotion campaign, for example by using the
53 words “brain health” and “room for improvement” to raise awareness of dementia risk reduction,
54 instead of focusing on unhealthy behaviours that increase the risk of dementia.
- 55 • The samples were drawn from people from a previous survey study who indicated their interest in
56 future research, which could have led to selection bias (e.g. an overestimation of dementia risk
57 reduction literacy).
- 58 • The reach and effect of the campaign was limited due to restrained resources of the research team
59 to reach out to relevant stakeholders and due to a limited budget to cover (mass) media costs (e.g.
60 advertisement in newspapers, billboards).

67 1. Introduction

68 Dementia is characterized by progressive decline of cognitive abilities, leading to interference in daily
69 living. Alzheimer's disease (AD) and vascular dementia are the most common underlying pathologies,
70 and often co-exist.¹ Due to the aging population, the number of people living with dementia worldwide is
71 expected to triple from 50 million in 2018 to 152 million in 2050.² This rapid global increase and the
72 absence of a curative treatment exposes a major public health concern.

73 Primary prevention of dementia through lifestyle modification is gaining increasing attention in research
74 and policy.^{1,3-5} Population-based estimations show that around one-third of all dementia cases might be
75 attributable to seven lifestyle and health-related factors, including physical inactivity, depression, and low
76 mental stimulation.⁴ Reducing exposure to these risk factors by 10 to 20% per decade would lower the
77 prevalence of AD by as much as 8 to 15%.⁴ These insights have led to a series of randomized controlled
78 trials (RCTs), using lifestyle interventions to delay or prevent cognitive decline and dementia onset.⁶⁻⁹
79 Neither the multidomain Prevention of Dementia by Intensive Vascular Care (preDIVA) trial, in 3,454
80 patients with known vascular risk factors aged 70-79 years, nor the Multidomain Alzheimer Preventive
81 Trial (MAPT) in 1,680 adults aged 70 years and older resulted in significant reduction of incident
82 dementia⁷ and change in memory function,⁸ or only in subgroups. In contrast, the population-based
83 Finnish Geriatric Intervention Study to Prevent Cognitive Impairment and Disability (FINGER), starting
84 earlier in those aged 60-77 years, was the first large-scale RCT that showed beneficial effects on
85 cognition.^{6,10} It seems that dementia risk reduction interventions should target people in midlife to
86 minimize lifetime accumulation of risk factor exposure and consequent brain pathology.^{1,11-13}

87 Recently, a global initiative aimed at harmonizing intervention studies on risk factor modification was
88 launched, called World Wide (WW) FINGERS.¹¹ Incorporated trials include the US Study to Protect
89 Brain Health Through Lifestyle Intervention to Reduce Risk (US POINTER) and the Singapore
90 intervention study to prevent cognitive impairment and disability (SINGER).¹¹ The ambition of WW-

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3 91 FINGERS to find robust evidence for lifestyle interventions that delay or prevent dementia onset is
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5 92 promising from a public health perspective. In addition, epidemiological studies have shown decreasing
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7 93 incidence of dementia in high-income countries, observed in several cohorts,¹⁴⁻¹⁶ probably because of
8
9 94 improved cardiovascular health, nutrition and education over the last decades.² The timeliness of
10
11 95 dementia prevention interventions was also emphasized by the publication of guidelines for risk reduction
12
13 96 of cognitive decline and dementia by the World Health Organization (WHO) in 2019⁵ and the 2020-report
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15 97 of the Lancet Commission on Dementia Prevention, Intervention and Care¹⁷.

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17
18 98 It must, however, be noted that the general public is still largely unaware of the potential of dementia risk
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20 99 reduction, let alone of specific actions to reduce dementia risk.¹⁸⁻²¹ In our own survey among middle-aged
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22 100 adults (n=590), 44% were aware of dementia risk reduction, and only 20-25% considered vascular
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24 101 conditions to increase the risk.¹⁸ Hence, despite the need for conclusive RCTs, little is known about how
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26 102 knowledge can be translated to the general public to raise awareness, and how to engage hard-to-reach
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28 103 subgroups (e.g. low health literacy or socioeconomic status) who are often underrepresented in clinical
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30 104 trials, too.²²⁻²⁴ Creating risk awareness at the population level is a crucial first step before behaviour-
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32 105 change programs can be developed and implemented.

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36 106 Dementia awareness campaigns have focused on topics as improving recognition of dementia,²⁵ dementia
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38 107 care,²⁶ decreasing public stigma,^{27,28} and few on dementia risk reduction.^{29,30} An Australian study using an
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40 108 informative website on dementia risk reduction resulted in increased knowledge and motivation to engage
41
42 109 in relevant health behaviours. However, no population-level measurements for evaluation were used and
43
44 110 the study only included a post-intervention assessment of people visiting the website.²⁹ One population-
45
46 111 based national awareness campaign in Ireland found a significant increase in people agreeing that “there
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48 112 are things you can do to reduce your risk”. However, awareness of dementia risk reduction was not
49
50 113 associated with recognition of the advertisements used during the campaign.³⁰

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3 114 The goal of this study was to evaluate the impact of a health promotion campaign aimed at increasing
4
5 115 awareness about dementia risk reduction in middle-aged Dutch community-dwelling individuals.
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7 116 Specifically, we tested change in the level of awareness at the population-level before and after the
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9 117 campaign, variation between demographic groups, the effect of different approaches (mass media versus
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11 118 additional community-participation) and the use of eHealth supportive technology, in order to distil the
12
13 119 lessons learned for future campaigns and policies.
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16 120 **2. Methods**

17 121 *Target population*

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20 122 The target population were inhabitants of the Province of Limburg, the Netherlands, aged 40 to 75 years
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22 123 old (558,535 people in total³¹). The Ethics Review Committee Psychology and Neuroscience (ERCPN) of
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24 124 Maastricht University approved this study (reference number 177-07-03-2017). All participants received
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26 125 an information letter and signed a digital informed consent form prior to participation.
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31 126 *Awareness campaign*

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34 127 The primary aim of this campaign (March 2018 – January 2019) was to increase awareness on dementia
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36 128 risk reduction. The secondary aim was to motivate people for behavioural change by means of eHealth.
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38 129 The campaign was developed by the Alzheimer Centre Limburg (ACL) at Maastricht University and
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40 130 Maastricht University Medical Centre+, in consultation with the Dutch Municipal Health Services (MHS)
41
42 131 and the Department of Health Promotion of Maastricht University. An agency for strategy and design
43
44 132 developed the campaign materials and website.³² To maximize acceptance in the relatively young target
45
46 133 population, a positive phrasing was chosen for the slogan (“We are our own medicine”), terminology (e.g.
47
48 134 “brain health” rather than “dementia”), and campaign material visualizing the three campaign themes:
49
50 135 “eat healthy”, “exercise regularly”, and “stay curious” (see Supplemental File 1 for examples). The
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52 136 campaign materials were discussed with stakeholders (Dutch Alzheimer’s Association and an evaluation
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54 137 panel of potential end-users). We deliberately designed the campaign in a way that would address
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3 138 different people. We provided both a low-level and free app with short, simple text messages that
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5 139 appeared automatically on a daily basis, and provided an extensive website for background information
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7 140 and references to extra literature (e.g. website Dutch Alzheimer's Association). Two different campaign
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9 141 approaches were chosen in order to compare the outcome. A broad campaign was launched, targeting the
10
11 142 public via mass media such as newspapers and social media (hereafter "population sample"). Three
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13 143 specific districts within the Province (Landgraaf-Schaesberg, Brunssum-Oost, and Roermond-
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15 144 Hoogvonderen) were chosen based on varying socio-economic status, from low to middle-high, and
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17 145 absence of other public health projects (hereafter "district sample"). We worked together with key-figures
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19 146 and facilities in that district, in order to meet the specific needs and wishes of that district.
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23 147 *The eHealth platform*

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26 148 An online platform called *MijnBreincoach* ("MyBraincoach") was developed together with two software
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28 149 companies and made available as a mobile app and web portal to the general public during the
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30 150 campaign.³³ Users complete a "12-item quick test" using the well-validated Lifestyle for BRAin Health
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32 151 (LIBRA) score.³⁴ This predictive model consists of twelve modifiable risk and protective factors for
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34 152 dementia (e.g. smoking, physical inactivity, depression), and gives people insight into their personal
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36 153 dementia risk profile. Detailed information can be found in Supplemental File 2.
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39 154 *Pre- and post-campaign surveys*

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42 155 Two cross-sectional surveys were performed: one pre-campaign (September 2017¹⁸) and one post-
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44 156 campaign (February 2019). The pre- and post-campaign surveys took place in independent samples, in
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46 157 order to ensure that the potential increase in awareness was not caused by learning effects. The
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48 158 methodology and results of the pre-campaign survey have been described in more detail elsewhere.¹⁸
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51 159 *Recruitment process*

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3 160 The population samples were drawn by the MHS from participants of a previous national health survey
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5 161 ('*Gezondheidsmonitor 2016*') who had agreed to be contacted for future studies. A random selection of
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7 162 people (40-75 years) was invited to participate via email. The district samples were drawn from the
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9 163 municipal registry by the municipality or by the MHS, based on ZIP-codes and age and received a postal
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11 164 letter.

14 165 *Measurements*

16 166 Age, sex, marital status, educational level, self-reported knowledge of dementia and awareness of
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18 167 dementia risk reduction were assessed both at the pre- and post-assessment. Ten items from the British
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20 168 Social Attitudes (BSA) survey¹⁹ were used, translated into Dutch. To assess all twelve factors from the
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22 169 LIBRA-index,³⁴ custom-made items were also included.¹⁸ The post-campaign survey included additional
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24 170 items concerning exposure to the campaign (e.g. asking participants whether they recognized campaign
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26 171 material). The items on exposure to the campaign were placed after the items assessing awareness,
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28 172 thereby not influencing one's perspective on the possibility of dementia risk reduction. See
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30 173 Supplementary File 3 for the complete pre- and post-campaign survey. The primary outcome of
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32 174 awareness of dementia risk reduction was assessed as the difference between pre- and post-assessment in
33
34 175 the proportion of people rejecting the statement 'There is nothing I can do to reduce my dementia risk'.
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36 176 We presented this statement in the Results section in a positive form for reasons of clarity ("dementia risk
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38 177 reduction is possible"). Secondary outcomes were changes in endorsement of the three campaign themes
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40 178 physical activity, cognitive activity and healthy diet.

44 179 *Statistical analyses*

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46 180 Independent groups *t*-tests and X^2 tests were used to analyse differences between the pre- and post-
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48 181 campaign samples, and between population and district samples, and to investigate differences in the
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50 182 relation between socio-demographic variables and level of awareness and knowledge of risk and
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3 183 protective factors. Analyses were performed in Stata 13.1 (StataCorp, College Station, TX, USA), with
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5 184 the level of significance set at $p \leq 0.05$ in two-tailed tests.
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8 185 *Patient and Public Involvement*

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11 186 There were no patients involved in this research. Members of the public were involved in the design and
12
13 187 rollout of the public health campaign.
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15

16 188 **3. Results**

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18 189 *Demographics*

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22 190 The response rates of the pre- and post-campaign surveys were highly comparable (population pre-
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24 191 campaign 53.6%, post-campaign 54.8%; district pre-campaign 33.2%, post-campaign 32.2%). See
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26 192 Supplemental File 4, 5a and 5b for flowcharts of the recruitment process. Table 1 shows the
27
28 193 characteristics of the total and the two separate samples. The characteristics of the districts can be found
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30 194 in Supplemental File 6. The total pre-assessment sample was highly comparable with the total post-
31
32 195 assessment sample. As expected by design, the population sample was more highly educated than the
33
34 196 district sample at the pre- ($X^2(2) = 29.57, p \leq 0.001$) and post-assessment ($X^2(2) = 17.41, p \leq 0.001$). An
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36 197 overview of the forms of community engagement are displayed in Box 1.
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198 **Table 1. Characteristics of the two cross-sectional samples before and after the campaign, stratified by sampling frame (population and district sample).**

Variables*	Total sample (n = 1,192)			Population sample (n =780)			District sample (n =412)		
	Pre-campaign (n = 590)	Post- campaign (n = 602)	p- value	Pre- campaign (n = 381)	Post- campaign (n = 399)	p- value	Pre-campaign (n= 209)	Post- campaign (n= 203)	p- value
Age, mean (SD)	60.7 (8.8)	59.9 (8.8)	0.113	61.1 (8.9)	61.2 (8.8)	0.869	60.1 (8.6)	57.4 (8.3)	0.002
Age group (years), n (%)			0.755			0.649			0.060
40 – 49	75 (13.0%)	91 (15.2%)		48 (12.9%)	52 (13.2%)		27 (13.2%)	39 (19.2%)	
50 – 59	170 (29.5%)	172 (28.8%)		101 (27.1%)	95 (24.1%)		69 (33.8%)	77 (37.9%)	
60 – 69	244 (42.3%)	246 (41.1%)		165 (44.2%)	174 (44.1%)		79 (38.7%)	72 (35.5%)	
70 – 75	88 (15.3%)	89 (14.9%)		59 (15.8%)	74 (18.7%)		29 (14.2%)	15 (7.4%)	
Female, n (%)	269 (46.2%)	293 (48.7%)	0.398	164 (44.0%)	184 (46.1%)	0.549	105 (50.0%)	109 (53.7%)	0.483
Marital status, n (%)			0.501			0.348			0.654
Married/living together	471 (80.5%)	478 (79.4%)		299 (79.5%)	321 (80.5%)		172 (82.3%)	157 (77.3%)	
Not/never been married	30 (5.1%)	34 (5.7%)		18 (4.8%)	18 (4.5%)		12 (5.7%)	16 (7.9%)	
Divorced	48 (8.2%)	61 (10.1%)		33 (8.8%)	43 (10.8%)		15 (7.2%)	18 (8.9%)	
Widowed	36 (6.2%)	29 (4.8%)		26 (6.9%)	17 (4.3%)		10 (4.8%)	12 (5.9%)	

Educational level [†] , <i>n</i> (%)			0.846		0.579		0.890
<i>Low</i>	101 (17.3%)	103 (17.1%)	46 (12.2%)	53 (13.3%)	55 (26.3%)	50 (24.6%)	
<i>Middle</i>	222 (38.0%)	238 (39.5%)	134 (35.6%)	153 (38.4%)	88 (42.1%)	85 (41.9%)	
<i>High</i>	262 (44.8%)	261 (43.4%)	196 (52.1%)	193 (48.4%)	66 (31.6%)	68 (34.0%)	
Self-reported knowledge of dementia, <i>n</i> (%)			0.780		0.668		0.944
<i>Good</i>	489 (84.5%)	506 (85.0%)	308 (83.2%)	335 (84.4%)	181 (86.6%)	171 (86.4%)	
<i>Insufficient</i>	90 (15.5%)	89 (15.0%)	62 (16.8%)	62 (15.6%)	28 (13.4%)	27 (13.6%)	

199 Abbreviations: SD: standard deviation; *n*: amount of people; * Maximum value does not count up due to missing values; [†] Self-reported highest finalized degree,
 200 divided into low (primary school or low vocational education), middle (intermediate secondary education or intermediate vocational or higher secondary
 201 education) and high (higher vocational education or university).

202 **Box 1. Forms of community engagement during the campaign (March 2018 - January 2019)**

Local engagement

and support

- More than 140 stakeholders (municipalities, schools, health care centres, companies) committed to this campaign by distributing campaign material/messages and/or organizing public events
- Distribution of 35,000 campaign leaflets and more than 1,000 campaign posters (at more than 400 locations within the Province)
- Organization of more than one public event per week (n=52; lecture, workshop or other community activities)

Campaign website

- More than 10,000 website visits
- Online campaign posters are downloaded more than 5,500 times in total

Media

- Over 65 media outlets (e.g. newspaper items, radio-interviews)
- Campaign tweets reached 200,000 people
- Facebook messages reached more than 15,000 people

eHealth platform

- 9,000 downloads MijnBreincoach app
- Ministry of Health, Welfare and Sport in The Netherlands incorporated the app on their website on innovations in health care

203

204 *Exposure to the campaign*

205 Of all post-campaign participants (n=602), 20.0% reported to have heard of the campaign, 19.7% of the
206 slogan, 21.8% about the eHealth platform, and 29.8% recognized one of the campaign materials (e.g.
207 poster, flyer). Women heard more often about the eHealth platform (27.5% vs. 16.3%; $X^2(1) = 9.75, p$
208 =.002) and recognized campaign material more often (34% vs. 25.8%; $X^2(1) = 4.23, p=.040$) compared to
209 men. Lower educated participants recognized campaign material more often than more highly educated
210 participants did (33.5% vs. 25.1%; $X^2(1) = 4.28, p=.039$).

211 *Difference in level of awareness before and after the campaign (total sample)*

212 Figure 1 displays a pre- and post-campaign comparison of the percentage of participants agreeing that
213 dementia risk reduction is possible, and the percentage of participants identifying the three campaign
214 themes. No difference in the primary outcome of awareness of dementia risk reduction was observed (X^2
215 (1) = 1.27, $p= 0.260$). Cognitive activity was identified most often as being protective against dementia at
216 both pre- (79.4%) and post-assessment (80.4%), but there was no increase in awareness ($X^2(1) = 0.17, p$
217 = 0.677). A modest increase in awareness was observed for physical activity (7.6% increase; $X^2(1) =$
218 7.48, $p = .006$) and healthy diet (10.5% increase; $X^2(1) = 12.37, p \leq 0.001$). More highly educated
219 participants were more aware of dementia risk reduction compared to lower educated participants, both in
220 the pre-assessment (low 18.2%, middle 38.9%, high 59.4%; $X^2(2) = 53.46, p \leq 0.001$) and post-
221 assessment (low 29.3%, middle 33.9%, high 52.3%; $X^2(2) = 24.15, p \leq 0.001$). The same applies to the
222 identification of the three campaign themes. In men, level of awareness decreased slightly with 8% (X^2
223 (1) = 3.89, $p=.049$), but they identified the campaign theme “eat healthy” more often over time ($X^2(1) =$
224 10.99, $p=.001$). The level of awareness remained stable over time in women ($X^2(1) = 0.09, p = .770$),
225 participants under the age of 65 years ($X^2(1) = 0.78, p = .377$) and participants aged 65 and above ($X^2(1)$
226 = 1.46, $p = .227$), but over time, the theme “exercise regularly” was identified more often by participants
227 under the age of 65 years (9.4% increase; $X^2(1) = 7.13, p=.008$).

228 ----- **Insert Figure 1 here** -----

229 *Differences between the two campaign approaches*

230 No significant difference in level of awareness was found for both the population (47.1% to 40.5%; $X^2(1)$
231 = 3.39, $p=0.066$) and district sample (39.9% to 42.7%; $X^2(1) = 0.33, p=0.565$). Compared to pre-
232 assessment, cognitive activity was not identified more often as a protective factor for dementia at post-
233 assessment, either in the population (79.9% to 81.8%; $X^2(1) = 0.43, p = 0.510$) or district sample (78.5%
234 to 77.7%; $X^2(1) = 0.04, p = 0.844$). Physical activity was identified more often in the population (65.6%
235 to 73.3%; $X^2(1) = 5.14, p = .023$), but not in the district sample (59.2% to 66.3%; $X^2(1) = 2.17, p =$
236 0.141). Healthy diet was identified more often in both the population (51.7% to 62.3%; $X^2(1) = 8.23, p$
237 =.004) and district sample (47.3% to 57.4%; $X^2(1) = 3.99, p = .046$). An increase was found of the LIBRA
238 factors low-to-moderate alcohol use (26.9% to 38.4%; $X^2(1) = 6.07, p = .014$), obesity (19.9% to 28.4%;
239 $X^2(1) = 3.91, p = .048$) and smoking (29.3% to 42.9%; $X^2(1) = 8.15, p = .004$) in the district sample. More
240 highly educated participants were more aware of dementia risk reduction compared to lower educated
241 participants, both in the pre-assessment (population low 13.7%, middle 39.1%, high 60.2%; $X^2(2) =$
242 36.27, $p \leq 0.001$; districts low 21.8%, middle 38.6%, high 56.9%; $X^2(2) = 15.41, p \leq 0.001$) and the post-
243 assessment (population low 31.4%, middle 30.0%, high 51.0%; $X^2(2) = 17.49, p \leq 0.001$; districts low
244 27.1%, middle 41.0%, high 55.9%; $X^2(2) = 9.72, p = .008$). In those with a low level of education in the
245 population, an increase in awareness of dementia risk reduction was observed (17.7% increase; $X^2(1) =$
246 4.18, $p = .041$), and for the campaign themes physical activity (22% increase; $X^2(1) = 4.35, p = .037$) and
247 healthy diet (25.3% increase; $X^2(1) = 5.79, p = .016$).

248 *Exposure to the campaign and level of awareness in the total post-campaign sample (n=602)*

249 Awareness of dementia risk reduction was higher for post-campaign participants who reported to have
250 heard compared to those who have not heard of the campaign (51.4% vs. 37.9%; $X^2(1) = 6.52, p = .011$),
251 the campaign slogan (53.3% vs. 37.2%; $X^2(1) = 9.07, p = .003$) and the eHealth platform (54.8% vs.

252 36.6%; $X^2(1) = 12.39, p \leq 0.001$). Campaign materials were more often recognized in the districts
253 (35.2%) than in the population sample (26.8%; $X^2(1) = 3.92, p = .048$). More than a third (37.2%)
254 expressed to have become more conscious of lifestyle being related to their brain health, and 30.4% stated
255 to have engaged in a brain-healthy lifestyle. Physical activity (45.8%), eating healthy (40.9%), and weight
256 management (39.4%) were most often engaged in during the past year.

257 *Self-reported knowledge of dementia*

258 Figure 2 displays the level of awareness by self-reported general knowledge of dementia in the post-
259 assessment sample. Participants who stated that their general knowledge of dementia was considerable or
260 good were more aware of dementia risk reduction than participants with self-reported insufficient general
261 knowledge ($X^2(1) = 6.48, p = .011$). The same applied to the identification of the risk/protective factors
262 physical activity ($X^2(1) = 4.59, p = .032$), healthy diet ($X^2(1) = 7.32, p = .007$), smoking ($X^2(1) = 8.18, p$
263 $= .004$), depression ($X^2(1) = 5.44, p = .020$), diabetes ($X^2(1) = 8.31, p = .004$), and hypercholesterolemia
264 ($X^2(1) = 6.60, p = .010$).

265 -----**Insert Figure 2 here**-----

266 *The eHealth platform*

267 Anonymous user-tracking showed that the 12-item “quick test” was completed more than 13,300 times by
268 people from the general public during the campaign. The mean age of this group was 57 years (SD 14.3;
269 range 18-94y), 68% were female and 76% were higher educated (i.e. higher vocational education or
270 university). Room for improvement (according to self-reported presence or absence of risk/protective
271 factors) was highest for the LIBRA factors hypertension, hypercholesterolemia, and alcohol consumption.
272 Almost 36% (n=4,755) created an account and completed the more comprehensive administration (mean
273 age 57 years, 72% female, 78% higher educated). Room for improvement, based on the extensive LIBRA
274 administration using validated questionnaires, was highest for physical inactivity, adherence to a

1
2
3 275 Mediterranean diet, and cognitive activity. These were also the factors that were chosen most often for
4
5 276 receiving daily notifications.
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7

8 277 **4. Discussion**

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11 278 This paper presents the results of the first health promotion campaign in the Netherlands aimed at
12
13 279 increasing awareness of dementia risk reduction in middle-aged, community-dwelling individuals. In
14
15 280 general, this study was not successful since no population-level change in awareness was observed.
16
17 281 However, two out of the three campaign themes were identified more often after the campaign. People
18
19 282 exposed to the campaign, its slogan and the eHealth platform were significantly more aware of dementia
20
21 283 risk reduction and the three campaign themes. Participants from the district campaign recognized
22
23 284 campaign material and the eHealth platform more often.
24
25

26
27 285 Unfortunately, awareness of dementia risk reduction and knowledge of most LIBRA factors did not
28
29 286 increase. Several reasons might exist. This campaign did not use national mass media, in contrast to a
30
31 287 population-based awareness campaign in Ireland that did find a significant increase in awareness of
32
33 288 dementia risk reduction.³⁰ Due to a limited budget and resources, the coverage of our campaign might
34
35 289 have been insufficient to reach population-level increase in awareness. Interestingly, our study did find an
36
37 290 increase in awareness in those who reported to have been exposed to the campaign, while the Irish study
38
39 291 could not differentiate between the exposed and non-exposed group.³⁰ Women stated more often than men
40
41 292 to be exposed to our campaign material and to have visited the eHealth platform, which is in line with
42
43 293 previous studies stating that women participate more than men in health campaigns.³⁵ However, this did
44
45 294 not translate in an increase in awareness in women at post-assessment. In addition, it could be that the
46
47 295 statement to assess awareness was too complex (“there is nothing I can do to reduce my dementia risk”).
48
49 296 A simpler, positively formulated statement might have been more suitable for our purpose. The statement
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51 297 used was taken from the BSA 2015¹⁹ in order to compare dementia literacy between the United Kingdom
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53 298 and the Netherlands. Furthermore, there was no higher endorsement of the protective factor of cognitive
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3 299 activity after the campaign. This might be explained by a ceiling effect, as many people already
4
5 300 considered it to be a protective factor at baseline.
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7

8 301 Strengths of this study include the extensive pre- and post-campaign surveys, in which we used multiple
9
10 302 items to assess awareness of dementia risk reduction in general, and specific risk and protective factors.
11
12 303 Furthermore, we used large independent samples and comparable methodology to a previous study
13
14 304 assessing awareness of dementia risk reduction.¹⁹ Next, the intervention part (awareness campaign) of this
15
16 305 study was designed in consultation of experts, addressed, in line with the WHO guidelines,⁵ multiple
17
18 306 dementia risk factors and collaborated with stakeholders in a multidisciplinary approach.⁵ The
19
20 307 involvement of stakeholders created a “snowball effect”, as they communicated the campaign message
21
22 308 via their own channels (see Box 1). Also, although the basic framework was set beforehand, the flexible
23
24 309 design of the campaign made it possible to alter strategies along the way.
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28 310 This study, however, also had limitations. First, this study was not inclusive regarding non-Dutch
29
30 311 speaking individuals and individuals without internet access. Furthermore, the population samples were
31
32 312 drawn from participants from a previous survey interested in future research. This could have led to a pre-
33
34 313 selection of people interested in scientific research and health. Last, the restrained resources of the team
35
36 314 (e.g. to contact relevant stakeholders) limited the reach and effect of the campaign. These limitations were
37
38 315 already acknowledged beforehand. This campaign was developed as a proof-of-concept study in a
39
40 316 naturalistic setting, investigating campaign strategies and the extent of involvement of the community.
41
42

43 317 *Recommendations for future campaigns*

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46 318 In general, involvement of the community is an important determinant of success. Further, as this study
47
48 319 shows that individuals with self-reported sufficient knowledge of dementia are more aware of dementia
49
50 320 risk reduction, it is recommended to incorporate such a campaign into a general dementia campaign, or
51
52 321 even a broad health promotion campaign, given the overlapping risk factors for cardiovascular disease
53
54 322 and diabetes. In fact, incorporating lifestyle recommendations of various non-communicable diseases is
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323 one of the recommendations of the WHO.⁵ Furthermore, it is important to tailor health messages to
324 specific subgroups (e.g. based on educational level, age, sex, high/low risk group). Their needs, wishes
325 and barriers to engage in a brain-healthy lifestyle should be further explored, both prior to the execution
326 of a campaign and as a post-campaign evaluation, for example by qualitative research. To illustrate,
327 comparable to earlier studies,²²⁻²⁴ our study showed that dementia risk reduction literacy was higher in
328 more highly educated participants. However, campaign material was recognized more often and
329 awareness only improved in the lower educated group (particularly in the population sample). The
330 campaign was designed with differences in health literacy and socio-economic status in mind (e.g. content
331 checking by the MHS). Also, it was striking that campaign activities (e.g. lectures, workshops) were
332 particularly visited by the older half (60-75 years) of the targeted population, despite our efforts in
333 providing information online and using terms as “brain health” instead of “dementia risk”. Reaching
334 younger individuals, with a positively framed message on the potential of dementia risk reduction, is
335 important to take into consideration. Next, it should be noted that increasing awareness is an essential yet
336 insufficient step towards behavioural change. Altering complex and entrenched behaviours is very
337 difficult, and unlikely to be sufficiently affected by this small-scale campaign. This was done to some
338 extent by prompting people with low-level, positive messages on how to engage in brain-healthy
339 activities. Yet, the main focus of this campaign was increasing awareness and not behavioural change.

340 **Conclusion**

341 This study was not able to reach a population-level increase of awareness of dementia risk reduction, but
342 did increase awareness and willingness to take action in those exposed. Future campaigns should scale up
343 to maximize exposure and engagement in the population. More insight is needed on how increasing
344 awareness may trigger lifestyle behaviour.

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2
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10
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12
13

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19
20 355 decision to submit the paper for publication.
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22

23
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25

26
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28
29 358 additional data available.
30

31
32 359 **Contributorship statement:**
33

34
35 360 Irene Heger: study design, data collection, data analysis and interpretation, drafting the manuscript
36

37
38 361 Sebastian Köhler: study design, critical revision of the manuscript
39

40
41 362 Martin van Boxtel: study design, critical revision of the manuscript
42

43
44 363 Marjolein de Vugt: study design, critical revision of the manuscript
45

46
47 364 KlaasJan Hajema: data collection, critical revision of the manuscript
48

49
50 365 Frans Verhey: study design, critical revision of the manuscript
51

52
53 366 Kay Deckers: study design, data collection, data analysis and interpretation, study supervision
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3 **368 Figure Legends**
4
5

6 **369 Figure 1. Pre (n=590)- and post (n=602)-campaign comparison of the total sample.**
7

8 370 Percentage agreeing with the statement that dementia risk reduction is possible, and percentage identifying the three
9
10 371 target risk factors/themes of the campaign. Maximum values and percentages do not count up due to missing values.

11 372 ¹ Original statement presented to participants: “There is nothing I can do to reduce my dementia risk”. * $p < .05$;

12
13
14 373 ** $p < .01$; *** $p < .001$
15

16 **374 Figure 2. Level of awareness by self-reported general knowledge of dementia in the post-assessment sample**
17
18 **375 (n=602).**
19

20 376 The percentages reflect the percentage of participants who agreed that a particular factor is a risk or protective factor
21
22 377 for dementia. Maximum values and percentages do not count up due to missing values. ¹ Original statement

23
24 378 presented to participants: “There is nothing I can do to reduce my dementia risk”. ² Self-reported knowledge of

25
26 379 dementia, divided into “Insufficient knowledge” (answering options “I don’t know”, “Nothing at all” and “Not very

27
28 380 much”) and “Good knowledge” (“Some”, “Quite a lot” and “A great deal”). * $p < .05$; ** $p < .01$; *** $p < .001$
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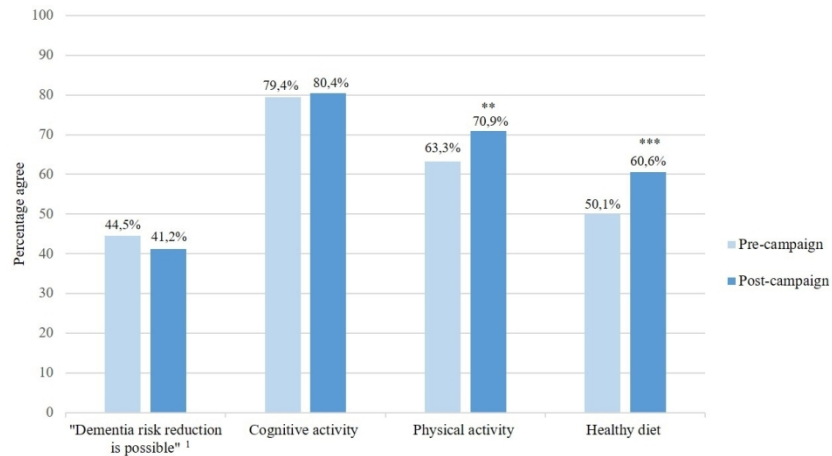


Figure 1. Pre (n=590)- and post (n=602)-campaign comparison of the total sample. Percentage agreeing with the statement that dementia risk reduction is possible, and percentage identifying the three target risk factors/themes of the campaign. Maximum values and percentages do not count up due to missing values. ¹ Original statement presented to participants: "There is nothing I can do to reduce my dementia risk". *p<.05; **p<.01; ***p<.001

255x142mm (150 x 150 DPI)

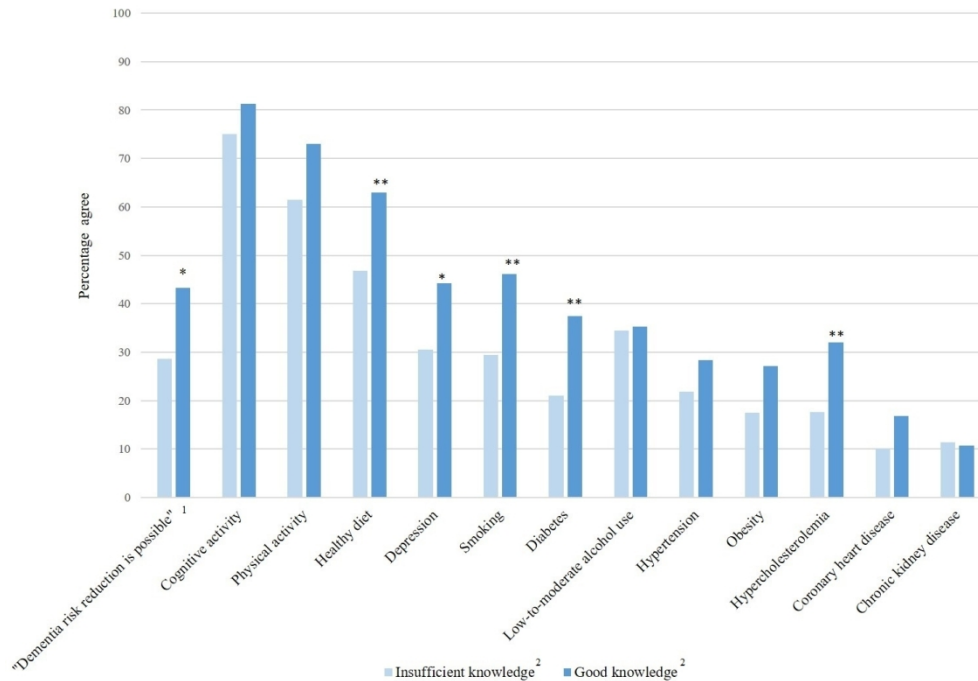


Figure 2. Level of awareness by self-reported general knowledge of dementia in the post-assessment sample (n=602).

The percentages reflect the percentage of participants who agreed that a particular factor is a risk or protective factor for dementia. Maximum values and percentages do not count up due to missing values. 1 Original statement presented to participants: "There is nothing I can do to reduce my dementia risk". 2 Self-reported knowledge of dementia, divided into "Insufficient knowledge" (answering options "I don't know", "Nothing at all" and "Not very much") and "Good knowledge" ("Some", "Quite a lot" and "A great deal").

*p<.05; **p<.01; ***p<.001

257x185mm (150 x 150 DPI)

Supplementary File 1. Examples of campaign materials



Dit is een campagne van Alzheimer Centrum Limburg i.s.m. vele partners.

Campaign theme "Exercise regularly"

English translation: "Reduces walking the risk of dementia?"



Dit is een campagne van Alzheimer Centrum Limburg i.s.m. vele partners.

Campaign theme "Eat healthy"

English translation: "Reduces strawberries the risk of dementia?"



Dit is een campagne van Alzheimer Centrum Limburg i.s.m. vele partners.

Campaign theme "Stay curious"

English translation: "Reduces playing guitar the risk of dementia?"

Supplementary File 2: The MijnBreincoach eHealth platform

The MijnBreincoach eHealth platform uses the LIBRA score to give people insight into their own dementia risk profile and flags individual room for lifestyle improvement. The LIBRA index consists of 12 modifiable risk and protective factors for dementia. Users start with a 12-item “quick test” that assesses the LIBRA factors and flags personal room for improvement based on self-reported data on the presence and/or absence of the specific LIBRA factor. Next, a user can create an account and complete the more comprehensive administration that assesses the 12 LIBRA factors with follow-up questions on the “quick test” by validated questionnaires. People can get insight and feedback on their personal risk profile, identify areas of healthy behaviour (to facilitate maintenance), areas of unhealthy behaviour (to facilitate change), and identify chronic vascular/metabolic conditions (to facilitate appropriate management). A user can choose a lifestyle topic or health condition of interest (smoking, alcohol use, cognitive activity, healthy diet, physical activity, obesity, hypertension, diabetes, coronary heart disease, chronic kidney disease, depression, or hypercholesterolemia) and receives daily notifications (“nut of the day”) on how to improve brain health by means of that factor.



Personal profile with room for improvement



“Nut of the day”



Short text message containing a recipe

Supplementary File 3 - Dementia awareness questionnaire

Pre- and post-assessment:

Demographics

1. How old are you?
[text field for number between 40 and 75]
 2. What is your gender?
 - Male
 - Female
 3. What is your zip code?
[text field of four numbers]
 4. What is your marital status?
 - Married/registered partnership
 - Living together
 - Unmarried, never been married
 - Divorced
 - Widowed
 5. What is your highest finalized degree of education?
[Six categories according to the Dutch education system, categorized into low, medium and high]
-

Dementia knowledge

1. Dementia describes a set of symptoms including loss of memory, sudden mood swings, not remembering who people are, and having trouble finding your words. Alzheimer's disease is one form of dementia. How much would you say you know about dementia?
 - A great deal
 - Quite a lot
 - Some
 - Not very much
 - Nothing at all
 - I don't know
 - I prefer not to answer this question
-

1
2
3 Dementia risk awareness
4

5 Please state how much you agree or disagree with the following statements.
6

- 7 1. 'There is nothing anyone can do to reduce their risks of getting dementia'
8 Agree strongly
9 Agree
10 Neither agree nor disagree
11 Disagree
12 Disagree strongly
13
- 14 2. 'High blood pressure increases your chances of getting dementia'
15 Agree strongly
16 Agree
17 Neither agree nor disagree
18 Disagree
19 Disagree strongly
20
21
- 22 3. 'Smoking increases your chances of getting dementia'
23 Agree strongly
24 Agree
25 Neither agree nor disagree
26 Disagree
27 Disagree strongly
28
29
- 30 4. 'No or moderate alcohol use lowers your chances of getting dementia'
31 Agree strongly
32 Agree
33 Neither agree nor disagree
34 Disagree
35 Disagree strongly
36
37
- 38 5. Regular physical activity lowers your chances of getting dementia'
39 Agree strongly
40 Agree
41 Neither agree nor disagree
42 Disagree
43 Disagree strongly
44
- 45 6. 'Depression increases the chances of getting dementia'
46 Agree strongly
47 Agree
48 Neither agree nor disagree
49 Disagree
50 Disagree strongly
51
52
- 53 7. 'Diabetes increases the chances of getting dementia'
54 Agree strongly
55 Agree
56
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59
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2
3 ○ Neither agree nor disagree
4 ○ Disagree
5 ○ Disagree strongly
6
7
8 8. 'Being overweight increases the chances of getting dementia'
9 ○ Agree strongly
10 ○ Agree
11 ○ Neither agree nor disagree
12 ○ Disagree
13 ○ Disagree strongly
14
15
16 9. 'A mentally active lifestyle lowers the chances of getting dementia'
17 ○ Agree strongly
18 ○ Agree
19 ○ Neither agree nor disagree
20 ○ Disagree
21 ○ Disagree strongly
22
23 10. 'Heart disease increases the chances of getting dementia'
24 ○ Agree strongly
25 ○ Agree
26 ○ Neither agree nor disagree
27 ○ Disagree
28 ○ Disagree strongly
29
30
31 11. 'Kidney disease increases the chances of getting dementia'
32 ○ Agree strongly
33 ○ Agree
34 ○ Neither agree nor disagree
35 ○ Disagree
36 ○ Disagree strongly
37
38 12. 'High cholesterol increases the chances of getting dementia'
39 ○ Agree strongly
40 ○ Agree
41 ○ Neither agree nor disagree
42 ○ Disagree
43 ○ Disagree strongly
44
45
46 13. 'Healthy diet lowers the chances of getting dementia'
47 ○ Agree strongly
48 ○ Agree
49 ○ Neither agree nor disagree
50 ○ Disagree
51 ○ Disagree strongly
52
53
54 14. Would you be interested in receiving information on how to improve your brain health?
55 ○ Yes
56 ○ No
57
58
59
60

- 1
2
3 ○ Maybe
4

5 15. In the case that there was a mobile application, providing you without charge with information about your
6 brain health en giving advice on how to improve your brain health, would you use this app?

- 7 ○ Yes
8 ○ No
9 ○ Maybe
10

11 *[If answer is No, go to End]*

12 *[If answer is Yes or Maybe, go the question 16]*

13
14
15 16. Maastricht University has started a research line focused on prevention of dementia, in collaboration with
16 the municipal health services. This research includes the development of an app (mobile application) that
17 could give you more insight into your own brain health and how to improve your brain health. Would you
18 be interested and do you give consent to be contacted for this research?

- 19 ○ Yes, I give consent
20 ○ No, I give no consent
21
22

23 *[If answer is No, go to End]*

24 *[If answer is Yes, go to question 17]*

25
26 17. Please leave the phone number and/or e-mail-address that we can use to contact you for this research.

27 *[Text field]*
28
29

30 **Extra items post-assessment:**

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34 Exposure to the campaign

35
36 1. From March 2018 until January 2019, the Alzheimer Center Limburg ran a campaign focused on dementia
37 prevention. Have you heard about this campaign?

- 38 ○ No
39 ○ Yes
40

41 2. Do you recognize the slogan “We are our own medicine”?

- 42 ○ No
43 ○ Yes
44

45 3. Have you heard about the MijnBreincoach (*MyBraincoach*) app? [*illustrative screenshot of the app*]

- 46 ○ No
47 ○ Yes
48

49 4. Via what sources have you heard or seen something about prevention of dementia during the last year?
50 Select all that apply.

- 51 ▪ Television
52 ▪ Radio
53 ▪ Newspaper
54 ▪ Advertisement on bus shelter
55
56
57

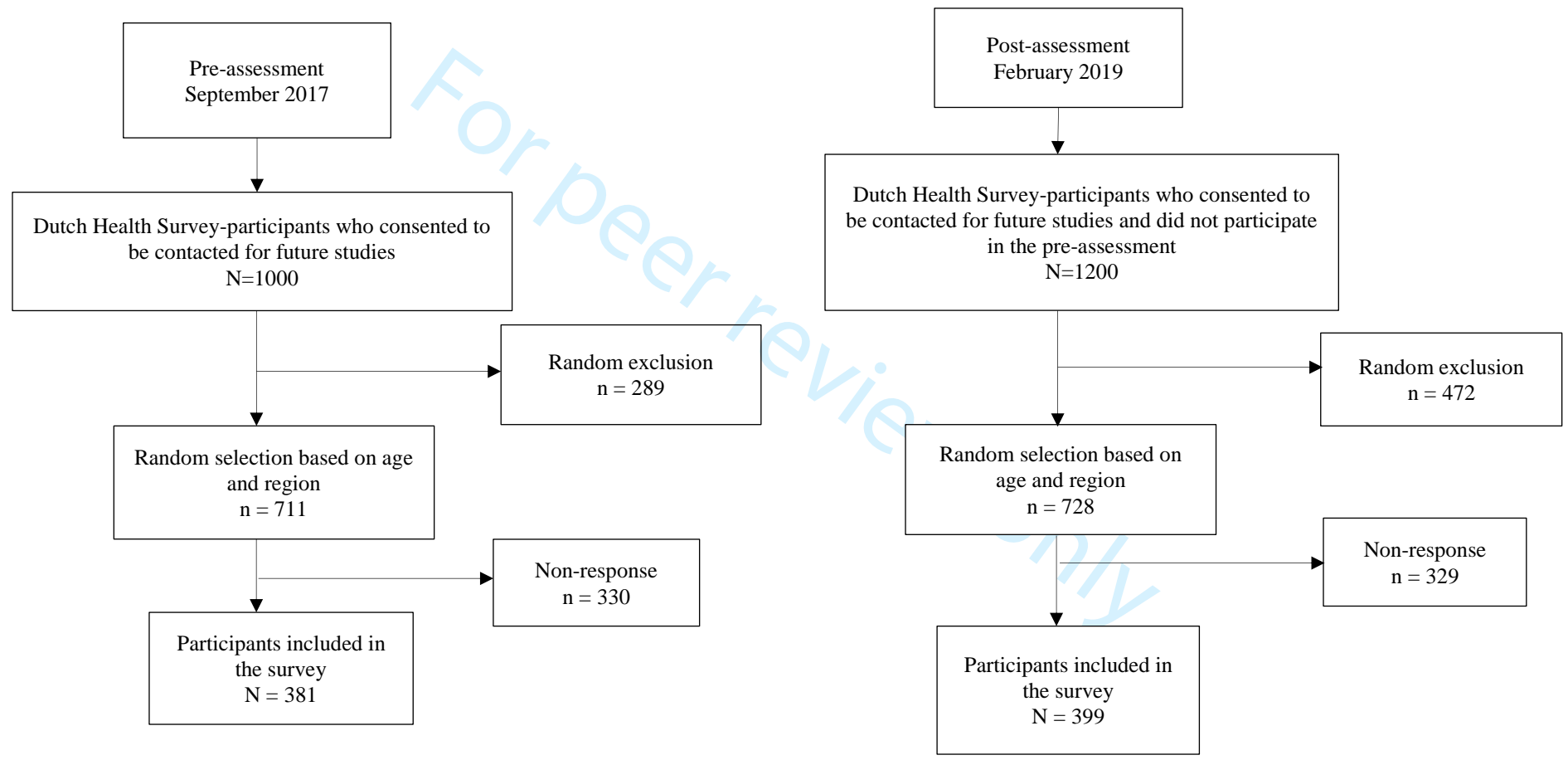
- 1
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3 ▪ Website of this campaign
4 ▪ Social media
5 ▪ Campaign activity, such as a workshop or presentation
6 ○ I have not heard or seen something of this kind during the last year
7 ▪ Other source [*open text field*]
8
9
- 10 5. Have you seen these campaign materials during the last year? [*illustrative screenshots*]
11 ▪ Campaign flyer [yes/no]
12 ▪ Campaign poster [yes/no]
13 ▪ Bus shelter advertisement [yes/no]
14 ▪ Vaccine boxes [yes/no]
15
- 16 6. Have you adopted a more healthy lifestyle during the last year? If yes, what specific changes have you
17 made? Select all that apply.
18 ○ I have not adopted a more healthy lifestyle during the last year
19 ▪ Eat more healthy
20 ▪ Exercise more
21 ▪ Consume less alcohol or stop drinking alcohol
22 ▪ Smoke less or stop smoking cigarettes
23 ▪ Be mentally more active
24 ▪ More relaxation or more adequate coping for depressive complaints
25 ▪ Monitor my glucose levels
26 ▪ Monitor my weight
27 ▪ Lowering my blood pressure
28 ▪ Monitor my kidney function
29 ▪ Monitor my heart condition
30 ▪ Other: [*open text field*]
31
32
- 33 7. Did you adopt a more healthy lifestyle during the last year in order to improve your brain health?
34 ○ No
35 ○ Yes
36
37
- 38 8. Would you say that you have become more conscious of your brain health and the relationship of your
39 brain health with your lifestyle over the last year?
40 ○ No
41 ○ Yes
42
43
-

44
45 End

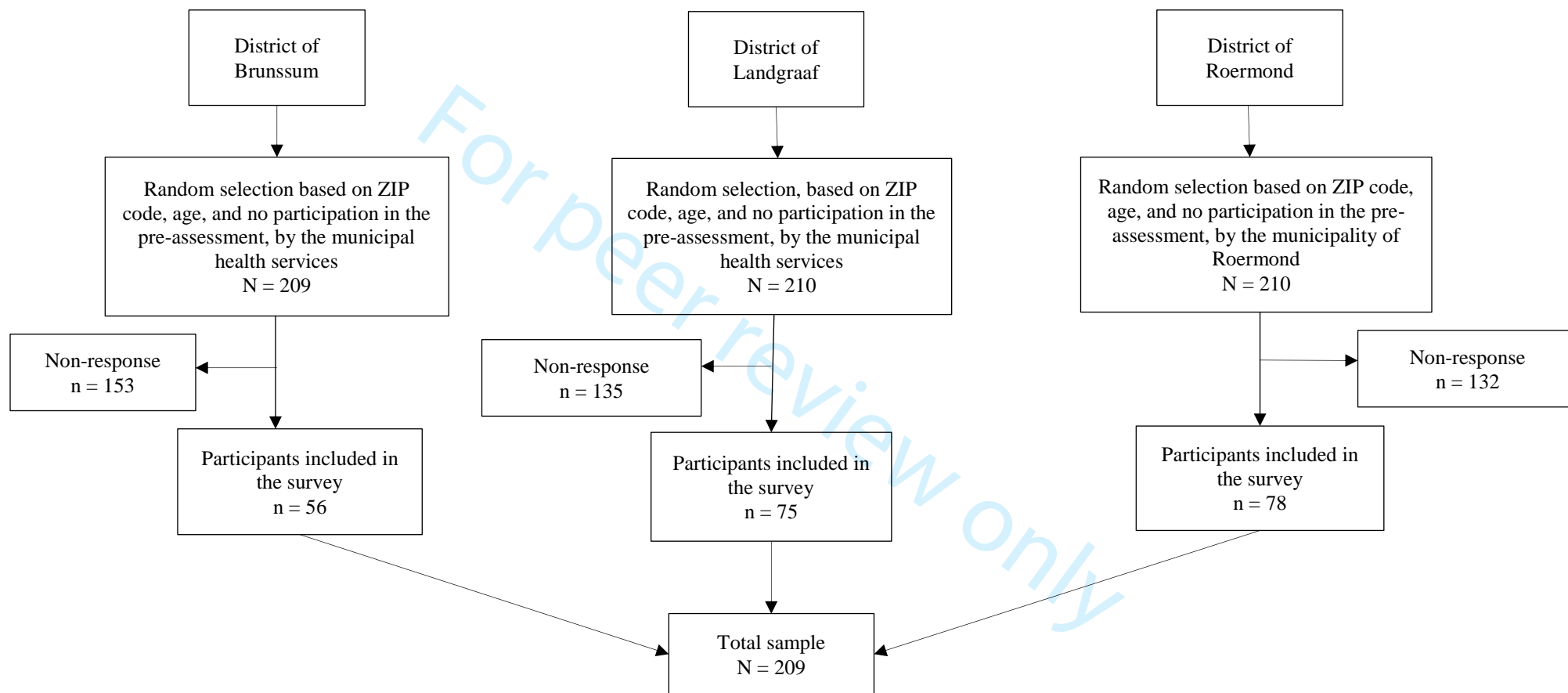
46
47 Thank you very much for filling in this questionnaire. If you have any remarks or questions regarding this study,
48 please contact us via [*email address*].
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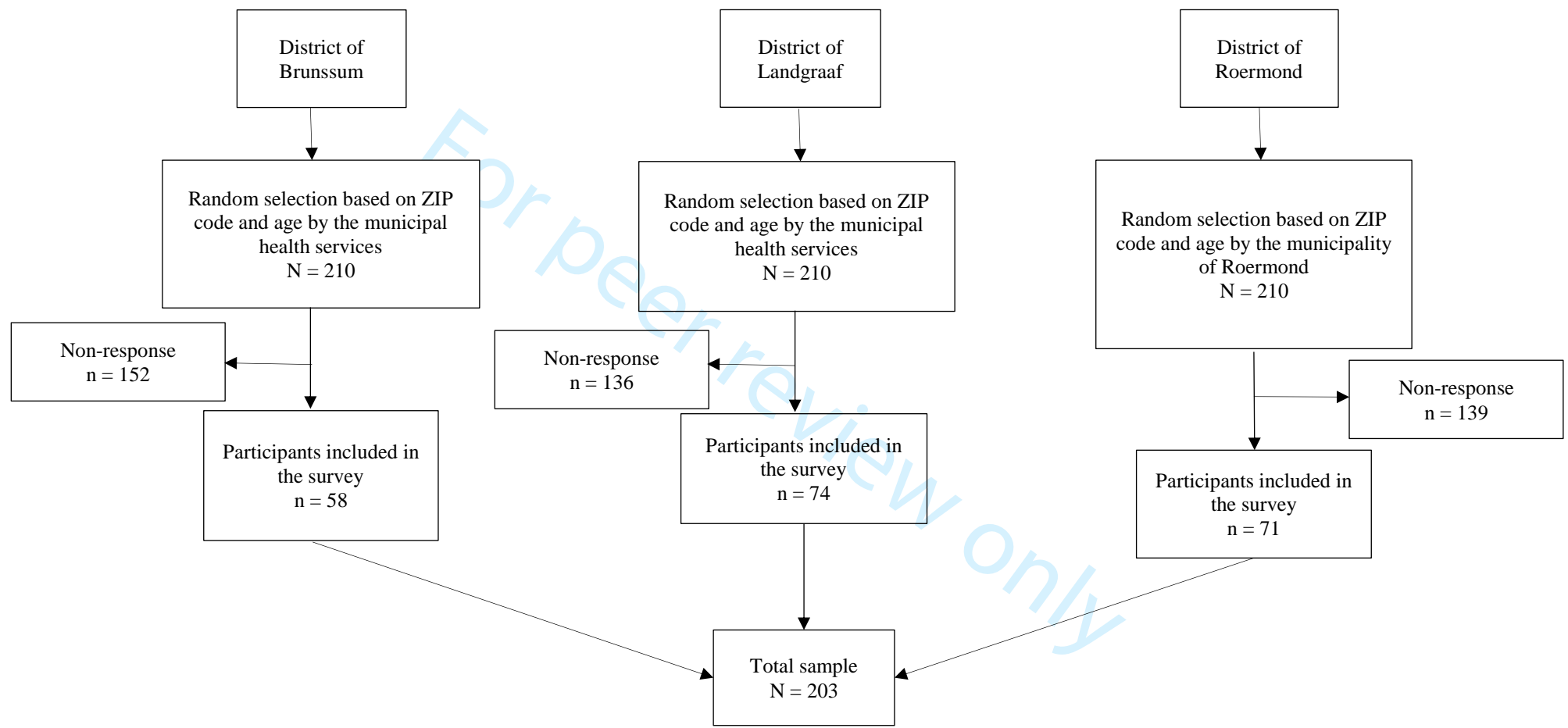
Supplementary File 4. Flowchart of the population pre- and post-assessment



Supplementary File 5a. Flowchart of the district pre-assessment



Supplementary File 5b. Flowchart of the district post-assessment



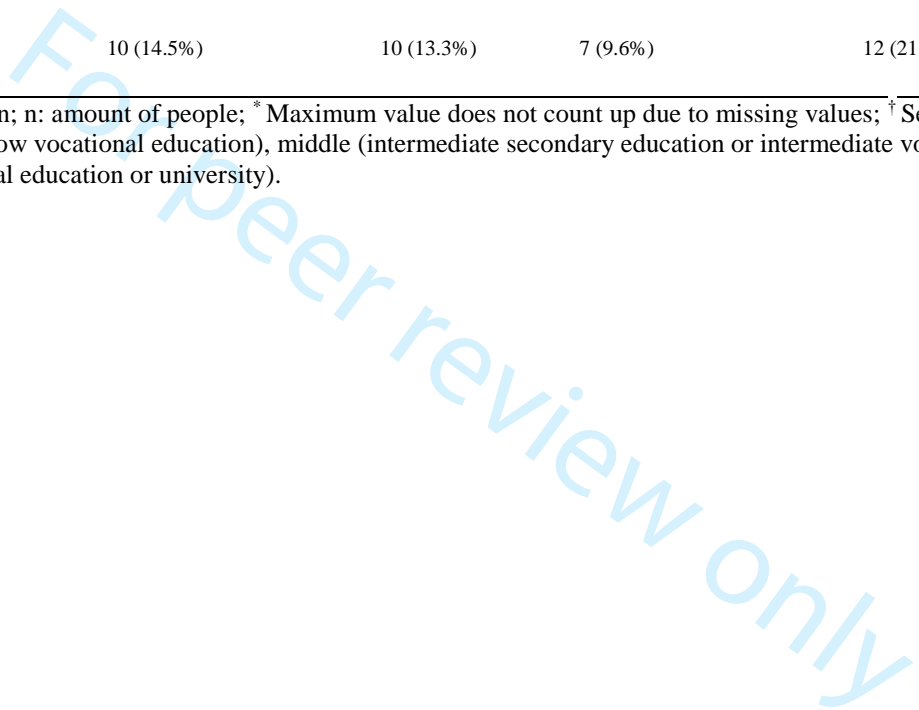
Supplementary File 6. Characteristics of the three districts before and after the campaign

Variables*	District of Roermond (n = 149)			District of Landgraaf (n = 149)			District of Brunssum (n = 114)		
	Pre-campaign (n=78)	Post-campaign (n=71)	p-value	Pre-campaign (n=75)	Post-campaign (n=74)	p-value	Pre-campaign (n=56)	Post-campaign (n=58)	p-value
Age, mean (SD)	56.9 (8.7)	55.4 (7.1)	0.247	60.9 (7.7)	59.1 (8.6)	0.177	63.3 (8.1)	57.7 (8.8)	< 0.001
Age group (year), n (%)			0.222			0.241			0.013
40 – 49	19 (24.4%)	17 (23.9%)		4 (5.6%)	12 (16.2%)		4 (7.3%)	10 (17.2%)	
50 – 59	30 (38.5%)	29 (40.9%)		25 (35.2%)	22 (29.7%)		14 (25.5%)	26 (44.8%)	
60 – 69	22 (28.2%)	24 (33.8%)		33 (46.5%)	31 (41.9%)		24 (43.6%)	17 (29.3%)	
70 – 75	7 (9.0%)	1 (1.4%)		9 (12.7%)	9 (12.2%)		13 (23.6%)	5 (8.6%)	
Female, n (%)	39 (50.0%)	41 (57.8%)	0.344	38 (50.7%)	37 (50.0%)	0.935	28 (50.0%)	31 (53.5%)	0.713
Marital status, n (%)			0.144			0.875			0.972
<i>Married/living together</i>	66 (84.6%)	49 (69.0%)		64 (85.3%)	64 (86.5%)		42 (75.0%)	44 (75.9%)	
<i>Not/never been married</i>	4 (5.1%)	7 (9.9%)		4 (5.3%)	4 (5.4%)		4 (7.1%)	5 (8.6%)	
<i>Divorced</i>	5 (6.4%)	11 (15.5%)		5 (6.7%)	3 (4.1%)		5 (8.9%)	4 (6.9%)	
<i>Widowed</i>	3 (3.9%)	4 (5.6%)		2 (2.7%)	3 (4.1%)		5 (8.9%)	5 (8.6%)	
Educational level†, n (%)			0.725			0.996			0.985
<i>Low</i>	18 (23.1%)	13 (18.3%)		15 (20.0%)	15 (20.3%)		22 (39.3%)	22 (37.9%)	

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<i>Middle</i>	32 (41.0%)	29 (40.9%)	33 (44.0%)	32 (43.2%)	23 (41.1%)	24 (41.4%)
<i>High</i>	28 (35.9%)	29 (40.9%)	27 (36.0%)	27 (36.5%)	11 (19.6%)	12 (20.7%)
Self-reported knowledge of dementia, n (%)		0.186		0.475		0.634
<i>Good</i>	72 (92.3%)	59 (85.5%)	65 (86.7%)	66 (90.4%)	44 (78.6%)	46 (82.1%)
<i>Insufficient</i>	6 (7.7%)	10 (14.5%)	10 (13.3%)	7 (9.6%)	12 (21.4%)	10 (17.9%)

Abbreviations: SD: standard deviation; n: amount of people; * Maximum value does not count up due to missing values; † Self-reported highest finalized degree, divided into low (primary school or low vocational education), middle (intermediate secondary education or intermediate vocational or higher secondary education) and high (higher vocational education or university).



STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1 and 2
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4 and 5
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	6-8
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-8
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	6-7
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	8-9
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	8
Bias	9	Describe any efforts to address potential sources of bias	8-9
Study size	10	Explain how the study size was arrived at	
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8-9
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	8-9
		(b) Describe any methods used to examine subgroups and interactions	8-9
		(c) Explain how missing data were addressed	n.a.
		(d) If applicable, describe analytical methods taking account of sampling strategy	n.a.
		(e) Describe any sensitivity analyses	n.a.
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9
		(b) Give reasons for non-participation at each stage	n.a.
		(c) Consider use of a flow diagram	Supplemental File 4, 5a and 5b
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	10-11
		(b) Indicate number of participants with missing data for each variable of interest	n.a.
Outcome data	15*	Report numbers of outcome events or summary measures	13
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	13
		(b) Report category boundaries when continuous variables were categorized	13-14
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n.a.
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	13-15
Discussion			
Key results	18	Summarise key results with reference to study objectives	16
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	17
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	16-17
Generalisability	21	Discuss the generalisability (external validity) of the study results	17-18
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	19

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.