



Syddansk Universitet

**The protective properties of Act-Belong-Commit indicators against incident depression, anxiety, and cognitive impairment among older Irish adults
Findings from a prospective community-based study**

Santini, Ziggi Ivan; Koyanagi, Ai; Tyrovolas, Stefanos; Haro, Josep Maria; Donovan, Robert J; Nielsen, Line; Koushede, Vibeke

Published in:
Experimental Gerontology

DOI:
[10.1016/j.exger.2017.02.074](https://doi.org/10.1016/j.exger.2017.02.074)

Publication date:
2017

Document version
Publisher's PDF, also known as Version of record

Document license
CC BY

Citation for published version (APA):

Santini, Z. I., Koyanagi, A., Tyrovolas, S., Haro, J. M., Donovan, R. J., Nielsen, L., & Koushede, V. (2017). The protective properties of Act-Belong-Commit indicators against incident depression, anxiety, and cognitive impairment among older Irish adults: Findings from a prospective community-based study. *Experimental Gerontology*, 91, 79-87. DOI: 10.1016/j.exger.2017.02.074

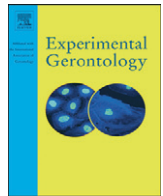
General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal ?

Take down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.



Aging Research Worldwide

The protective properties of Act-Belong-Commit indicators against incident depression, anxiety, and cognitive impairment among older Irish adults: Findings from a prospective community-based study



Ziggi Ivan Santini ^{a,*}, Ai Koyanagi ^b, Stefanos Tyrovolas ^b, Josep Maria Haro ^b, Robert J Donovan ^c, Line Nielsen ^a, Vibeke Koushede ^a

^a The Danish National Institute of Public Health, University of Southern Denmark, Oester Farimagsgade 5A, 1353 Copenhagen, Denmark

^b Parc Sanitari Sant Joan de Déu, Universitat de Barcelona, Fundació Sant Joan de Déu, CIBERSAM, Dr Antoni Pujades, 42, 08830, Sant Boi de Llobregat, Barcelona, Spain

^c School of Sport Science, Exercise and Health, University of Western Australia, 35 Stirling Highway, 6009 Perth, WA, Australia

ARTICLE INFO

Article history:

Received 19 December 2016

Received in revised form 31 January 2017

Accepted 27 February 2017

Available online 1 March 2017

ABSTRACT

The Act-Belong-Commit campaign is the world's first comprehensive, population-wide, community-based program designed to promote mental health. The campaign targets individuals to engage in mentally healthy activities, while at the same time, encouraging community organizations that offer such activities, to increase participation in their activities. Using nationally-representative data from Ireland, the aim of this study was to prospectively assess the association between indicators of the Act-Belong-Commit behavioral domains and incident depression, anxiety, and cognitive impairment.

Data from two consecutive waves of the Irish Longitudinal Study on Ageing (TILDA) were analyzed. The analytical sample consisted of 6098 adults aged ≥ 50 years. Validated scales for depression, anxiety, and cognitive impairment were used. The number of social/recreational activities engaged in was used as an indicator of Act, social network integration as an indicator of Belong, and frequency of participation in these social/recreational activities as an indicator of Commit. Multivariable logistic regression analyses were conducted to assess associations between baseline indicators of Act-Belong-Commit and incident depression, anxiety, and cognitive impairment at two-year follow-up.

The adjusted model showed that each increase in the number of social/recreational activities (Act) inversely predicted the onset of depression, anxiety, and cognitive impairment. The same was the case for social network integration (Belong); that is, being well integrated into social networks was a significant protective factor against all mental health outcomes. Finally, frequency of participation in social/recreational activities (Commit) significantly and inversely predicted the onset of depression and anxiety, while the protective effect against cognitive impairment was only marginally significant.

Act-Belong-Commit indicators are shown to be protective against mental disorders and cognitive impairment among older Irish adults. This provides further evidence for the campaign's potential efficacy and has potentially wide-ranging implications for preventing the deterioration of mental health and cognitive decline in the aging community.

© 2017 The Authors. Published by Elsevier Inc. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

1. Introduction

Globally, while the burden of mental and neurological disorders continues to grow, investments in mental health are sparse (Chisholm et al., 2016). Between 1990 and 2010, the global burden of mental and neurological disorders increased by 41%, and now accounts for one in every 10 lost years of health worldwide (Patel et al., 2016). In particular, population aging has a profound impact on the growing prevalence and

manageability of mental and cognitive disorders. By 2050, the number of people aged 60 or over will increase by 1.25 billion, accounting for 22% of the world's population (UN, 2013). Late-life depression and anxiety are major public health issues due to their high prevalence and poor outcomes (Byers et al., 2010), such as impairment in various types of functioning, self-neglect, and ultimately a risk for mortality and suicide (Fiske et al., 2009; Wolitzky-Taylor et al., 2010). Further, cognitive impairment is a particularly important issue in relation to demographic aging as this condition mainly affects older people, with dementia being a leading contributor to disability and dependence in this age group (WHO, 2012). Indeed, in 2010, 35.6 million people lived with

* Corresponding author.

E-mail address: ziggi.santini@gmail.com (Z.I. Santini).

dementia worldwide, with numbers estimated to nearly double every 20 years, to 115.4 million in 2050 (Prince et al., 2013). However, as health systems face various economic restrictions and continuing health care demands due to demographic aging (Rechel et al., 2009), it is uncertain whether the needed financial resources will be available to properly address these issues. Thus, there is a pressing need to identify possible and sustainable approaches to improve population mental health (Anwar McHenry and Donovan, 2013; EC, 2008; WHO, 2004; WHO, 2005).

Recent economic evaluations suggest that investing in mental health promotion is cost-effective as a short-term as well as a long-term solution (Zechmeister et al., 2008; McDaid and Park, 2011; Knapp et al., 2011). Mental health promotion seeks to maximize mental health and well-being in a population by increasing coping capacity and improving environments that affect mental health (WHO, 2004). However, while there are many 'frameworks' for mental health promotion, and there are a number of programs targeted at specific groups or settings, Act-Belong-Commit is the world's first comprehensive, population-wide, community-based mental health campaign (Donovan and Anwar McHenry, 2014). Act-Belong-Commit provides a practical framework for health professionals and clinicians to promote mental health, and allows for implementation at the population level as well as in specific settings. The campaign is currently diffusing throughout Australia (Donovan and Anwar McHenry, 2014) and steps to implementation are also being taken in other countries such as Denmark, where the campaign is known as *ABC for mental sundhed* (The ABC for mental health) (Koushede et al., 2015).

The Act-Belong-Commit campaign targets individuals to engage in mentally healthy activities while also encouraging community organizations to promote and increase participation in such activities. The Act-Belong-Commit principles are derived from primary research with members of the general population in Australia, regarding their beliefs about factors that promote and are protective of positive mental health, and subsequent secondary research into the scientific literature with respect to such factors (Donovan et al., 2007; Pettigrew and Donovan, 2009; Donovan et al., 2006). Act-Belong-Commit promotes three core behavioral domains that contribute to positive mental health:

Act: Encourages individuals to keep physically, mentally, socially and spiritually active for better mental health (Hamer et al., 2009; Hsee et al., 2010; Kwag et al., 2011; Darin-Mattsson et al., 2015) and cognitive functioning (Ybarra et al., 2008; Verghese et al., 2003).

Belong: Encourages keeping in contact with family and friends, joining in clubs and community events, to promote feelings of belonging and integration into social support networks, which are fundamental to better mental and cognitive health (Rosenquist et al., 2011; Cacioppo et al., 2010; Kuiper et al., 2016; Santini et al., 2015; Cohen and Janicki-Deverts, 2009; Iyer et al., 2009).

Commit: Encourages engagement and commitment to causes and challenges that provide meaning and purpose in life, and facilitate feelings of self-worth and wellbeing (Lyubomirski et al., 2005). Getting involved in meaningful activities, causes, or organizations is associated with positive mental health (Heady and Wearing, 1992; Csikszentmihalyi, 1990; Kirmayer et al., 1999).

Although Act-Belong-Commit has gained momentum internationally, more research is needed to explore how the campaign might impact not just on positive mental health but also with respect to the prevention of negative mental and cognitive health outcomes, and especially among particular age groups. Thus, the aim of the current study was to assess the extent to which Act-Belong-Commit indicators are associated with incident depression, anxiety, and cognitive impairment in an older population.

To achieve this aim, we conducted a prospective study using data from the first two waves of the Irish Longitudinal Study on Aging (TILDA). This is a nationally-representative community-based survey of the Irish older population. As predictors, we used variables for participation and frequency of social/recreational activities and social

network integration as proxies for the Act, Belong, and Commit concepts. This is the first study to prospectively assess associations between social/recreational activities and social network integration with incidence depression, anxiety, and cognitive impairment in a nationally-representative survey involving older adults. It is essential to conduct such large-scale epidemiological studies in order to inform relevant policy makers regarding the campaign's potential effectiveness in a nationwide setting. Further, the bulk of studies assessing engagement in social/recreational activities tend to focus on one particular type of activity rather than a number of diverse activities. Thus, the focus of this study is not on a particular type of activity, but rather on keeping active in a more general sense.

Based on previous literature, we hypothesized that each of the Act-Belong-Commit indicators would protect against the onset of depression, anxiety, and cognitive impairment in our sample. Determining the nature of the association between Act-Belong-Commit indicators and outcomes on mental and cognitive health could help to inform public health policy, as it would provide an indication of the campaign's potential effectiveness to reduce the burden of mental and neurological disorders and enhance mental health among older adults in the general population.

2. Methods

2.1. Study design and sample

We analyzed data from two consecutive waves of the Irish Longitudinal Study of Aging (TILDA). Full details of the survey and its sampling procedure have been described elsewhere (Cronin et al., 2013; Kearney et al., 2011; Whelan and Savva, 2013). TILDA is a nationally-representative population-based survey of older adults residing in Ireland. The survey was conducted between October 2009 and February 2011 for Wave 1 (W1), and between April 2012 and January 2013 for Wave 2 (W2). The target sample included all individuals residing in a household aged 50 and over. Nationally-representative samples were derived from clustered random sampling of all households in Ireland. The baseline survey (W1) excluded participants who were institutionalized, and those with a doctor's diagnosis of dementia. In addition, those who were unable to personally provide written informed consent to participate in the survey because of severe cognitive impairment (judged at the interviewer's discretion) were also excluded from W1.

Data collection was conducted by trained interviewers using Computer Assisted Personal Interviewing (CAPI), and by a self-completion questionnaire (SCQ) which was returned after the interview. All participants were subject to CAPI interviews and were also asked to complete the SCQ. The response rate of W1 was 62%, and of those who participated in the survey, 84% returned the SCQ at W1 (Kearney et al., 2011; Whelan and Savva, 2013). W1 comprised of 8504 people aged ≥ 50 years ($n = 8175$) and their spouses or partners younger than 50 years ($n = 329$). Of these 8504 people, follow-up data for 7207 participants were available at W2. Our analysis restricted the sample to: participants aged 50 years and above at W1; participants who returned the SCQ at W1; and those who provided information on depression or anxiety or cognitive function at W2. We used these restrictions as the data on Act-Belong-Commit indicators and some other variables used in the analysis were obtained from the SCQ at W1. Depression, anxiety, and cognitive function were the only variables from W2 that were used in our analysis. In W2, information on depression, anxiety, and cognitive function was obtained via the standard in-person CAPI interview. The sample size after restriction to these individuals was 6098, comprising 12,196 person years of follow-up. Ethical approval was obtained from the Faculty of Health Sciences Ethics Committee of Trinity College Dublin. Written informed consent was obtained from all participants.

2.2. Measures

2.2.1. Depression, anxiety, and cognitive impairment

The same scales were employed for assessing depression, anxiety, and cognitive impairment at W1 and W2. The scale used for depression was the 20-item Center for Epidemiologic Studies Depression (CES-D) (Radloff, 1977), which is a screening tool to assess depressive symptomatology experienced in the seven days preceding the survey. The 20 items were scored on scales from 0 (rarely or none of the time, less than one day in the week) to 3 (most or all of the time, five to seven days in the week) with four items reverse coded (recoded so that all items were based on the same scale). Scores were summed to create a scale that ranged from 0 to 60, with higher scores indicating more depressive symptoms. The validity of the CES-D scale as a measure of depressive symptomatology in community-dwelling older adults has been well-documented (Hertzog et al., 1990; Lewinsohn et al., 1997). Depression was defined as a score of ≥ 16 . This cut-off point has been associated with 100% sensitivity and 88% specificity for major depression in community dwelling older adults (Beekman et al., 1997).

Anxiety was assessed with the anxiety subscale of the Hospital Anxiety and Depression Scale (HADS-A) (Zigmond and Snaith, 1983). HADS-A measures the presence of anxiety symptoms with no specific time frame. The scale consists of seven items rated on a four-point scale from 0 (not at all) to 3 (very often indeed), with five items reverse coded. The scores of the seven items were summed to create a scale that ranged from 0 to 21, with higher scores indicating more symptoms of anxiety. The HADS-A has been found to have good sensitivity and specificity for assessing anxiety disorders across all ages in the general population (Bjelland et al., 2002), and among specific age groups of older adults (Spinhoven et al., 1997). Anxiety was defined as a score of ≥ 8 . This cut-off point has been associated with 89% sensitivity and 75% specificity for generalized anxiety disorder (Bjelland et al., 2002; Olsson et al., 2005).

The scale used for cognitive impairment was the Mini-Mental State Examination (MMSE) (Folstein et al., 1975), which is a screening tool for the assessment of cognitive functioning. The MMSE is a 0–30 point scale that indicates higher cognitive function with higher scores. The MMSE is the most widely used screening tool for cognitive function, and the validity of the scale has been reviewed elsewhere (Tombaugh and McIntyre, 1992). Specifically, previous research has established a cut-point < 23 , which has been validated as being optimal when screening for dementia in Irish community-based samples (Cullen et al., 2005). Thus, cognitive impairment was defined as a MMSE score of < 23 .

2.2.2. Act-Belong-Commit indicators

Participants were asked whether or not they participated in 12 different activities, and if so, how often: Going to films, plays, concerts; attending classes, lectures; traveling for pleasure; working on garden, home, car; reading books, magazines; hobbies, creative activities; playing cards, bingo, games; going to pub; eating out of house; participating in sport, exercise; visiting or calling family, friends; voluntary work. For an indicator of Act, participation in an activity was given the value 1, and non-participation was given the value 0, thus producing an overall score ranging from 0 to 12. The literature does not identify a conventional way of assessing social and recreational participation, but it is a common method to construct participation variables from summary participation indices (Cohen et al., 2000). The same can be said regarding our constructed variable for Commit.

As an indicator of Belong, we used the Berkman-Syme Social Network Index (SNI), a measure of social network integration. The SNI is a validated self-report questionnaire (Berkman and Syme, 1979) that assesses a person's degree of social integration by: marital/partnership status (married/with partner versus not); sociability (number and frequency of contact with children, close relatives, and close friends); church group membership; and membership in other voluntary organizations. The composite score ranged from 0 to 4 and was categorized

according to the standard categorization described by Berkman and Syme (Berkman and Syme, 1979) as 0–1 (most isolated), 2 (moderately isolated), 3 (moderately integrated), and 4 (most integrated). Further information about the psychometric properties and evidence for the predictive validity of the SNI is provided elsewhere (Berkman and Breslow, 1983).

Commit refers to the extent to which individuals commit to activities or challenges, set and achieve small and large goals, or become involved with causes or organizations. While the concept behind Commit implies a broad sense of involvement and commitment to activities, one indicator of Commit is the frequency with which individuals engage in activities (Donovan and Anwar McHenry, 2014; Koushede et al., 2015). Thus, in order to construct a variable for Commit, we assessed the frequency of participation in the 12 activities mentioned in the Act section. For each of the activities, participants were asked to rate how often they engaged in them, from 0 (never) to 7 (daily or almost daily). The scores were added to produce an overall score ranging from 0 to 84.

2.2.3. Control variables

Sociodemographic characteristics included gender, age (50–59, 60–69, 70–79, and ≥ 80 years), education, and employment status. Education was classified as: primary (some primary/not complete; primary or equivalent); secondary (intermediate/junior/group certificate or equivalent; leaving certificate or equivalent); and tertiary (diploma/certificate; primary degree; postgraduate/higher degree). Current employment status was categorized as: employed (employed and self-employed, including farming); retired; and unemployed (unemployed, permanently sick or disabled, looking after home or family, or in education or training).

The number of chronic medical conditions was assessed by the question “has a doctor ever told you that you have any of the conditions on this card?” Responses included 17 conditions: high blood pressure or hypertension; angina; heart attack (including myocardial or coronary thrombosis); congestive heart failure; diabetes or high blood sugar; stroke (cerebral vascular disease); ministroke or transient ischemic attack; high cholesterol; heart murmur; abnormal heart rhythm; any other heart trouble; chronic lung disease such as chronic bronchitis or emphysema; asthma; arthritis (including osteoarthritis, or rheumatism); osteoporosis; cancer or a malignant tumor (including leukemia or lymphoma but excluding minor skin cancers); cirrhosis or serious liver damage. The total number of chronic medical conditions was calculated and categorized as 0 (none), 1, or ≥ 2 .

Difficulties with six types of activities of daily living (ADL) (dressing, walking, bathing, eating, getting in or out of bed, and using the toilet (Katz et al., 1963)) were assessed by asking participants to indicate whether they had difficulty performing these activities. ADL disability was defined as having difficulty with at least one of these ADLs.

2.2.4. Statistical analysis

The statistical analysis was done with Stata version 13.1 (Stata Corp LP, College Station, Texas). A descriptive analysis was conducted to demonstrate the baseline sample characteristics. These analyses included unweighted frequencies, and weighted proportions, means, and standard deviations. For this descriptive analysis, all individuals were included regardless of whether they had depression, anxiety, or cognitive impairment at baseline. Multivariable logistic regression analysis was conducted to assess the associations between Act-Belong-Commit indicators and each of depression, anxiety, and cognitive impairment. Act-Belong-Commit indicators (exposure variable) were based on data collected at W1. The three outcomes were incident depression, anxiety, and cognitive impairment, which were assessed among those without depression, anxiety, or cognitive impairment at baseline (W1) respectively, and referred to new cases of depression, anxiety, and cognitive impairment at W2 (outcome). Thus, in the regression analyses, specifically, those with depression, anxiety, or cognitive impairment at

baseline were omitted from the analysis on incident depression, anxiety, and cognitive impairment, respectively. The models were adjusted for sex, age, education, employment status, number of chronic medical conditions, and ADL disability based on information obtained at W1. Chronic medical conditions and disability were considered as potential confounders as they may lead to higher likelihood of anxiety, mood disorders and cognitive impairment (Byers et al., 2010; Tilvis et al., 2004; Letenneur et al., 1999; Djernes, 2006; Vink et al., 2008; Beekman et al., 2000), and because they are also known to be related to social networks (Avlund et al., 2004; Stuck et al., 1999; Valtorta et al., 2016; Shankar et al., 2011) and engagement in social/recreational activities (Hubert et al., 1993; Decarlo, 1974).

With the exception of the Act and Commit indicators, all variables were included in the models as categorical variables. Sampling weights were generated with respect to age, sex, and educational attainment to the Quarterly National Household Survey 2010. In all analyses, the sample weighting and the complex study design including clustering within households were taken into account to obtain nationally-representative estimates using the Stata svy command. Results are expressed as odds ratios (ORs) and 95% confidence intervals (95% CIs). A p -value < 0.05 was considered to be statistically significant.

In order to assess the influence of multicollinearity, we calculated the variance inflation factor (VIF) value for each independent variable. All VIFs were < 2 , which is much lower than the commonly used-cut off of 10 (O'Brien, 2007), indicating that multicollinearity was unlikely to be a problem in our analyses.

3. Results

The average age (SD) of the analytical sample ($n = 6098$) was 63.3 (9.2) years, and 51.7% were females. For all respondents who had a follow-up interview at W2, the median lag between the two waves was 24 months (range 16–40 months). The prevalence (n) of depression, anxiety, and cognitive impairment at baseline were 9.8% (533), 24.9% (1418), and 2.6% (92), respectively. The baseline sample characteristics are presented in Table 1. Table 2 shows the association between Act-Belong-Commit indicators and incident depression, anxiety, and cognitive impairment estimated by multivariable logistic regression. At two-year follow-up, there were 265 (5.1%), 165 (3.8%), and 47 (1.3%) new cases of depression, anxiety, and cognitive impairment, respectively. In terms of the Act indicator, each increase in number of activities was associated with significantly lower likelihood of developing depression [OR (95%CI): 0.87 (0.81, 0.93)], anxiety [0.90 (0.83, 0.99)], and cognitive impairment [0.77 (0.65, 0.94)]. In terms of the Belong indicator, as compared to the most isolated category, significant protective associations were found for depression, specifically the moderately integrated [0.58 (0.36, 0.92)] and most integrated [0.35 (0.20, 0.59)]. Risk for developing anxiety was associated with a protective effect among the moderately integrated [0.47 (0.25, 0.86)] and most integrated [0.38 (0.20, 0.73)]. In the model assessing risk for cognitive impairment, significant protective effects were similarly found for the moderately integrated category [0.26 (0.09, 0.75)] and the most integrated category [0.15 (0.04, 0.51)]. In terms of the Commit indicator, each increase in frequency of activity engagement was associated with significantly lower likelihood of developing depression [0.96 (0.95, 0.98)] and anxiety [0.98 (0.96, 0.99)], and the inverse relationship between the Commit indicator and cognitive impairment was of borderline significance [0.96 (0.93, 1.00), $p = 0.061$].

4. Discussion

Our results show a clear dose-response pattern with a decreased risk of depression, anxiety, and cognitive impairment for each level increase in Act-Belong-Commit indicators, with the exception of Commit being only marginally significant as a predictor of cognitive impairment. To our knowledge, this is the first study to assess the predictive validity

Table 1
Baseline characteristics of the study sample.

Characteristic	Category	
Unweighted N		6098
Sex	Female	3321 (51.7)
Age (years)	50–59	2485 (41.5)
	60–69	2010 (31.4)
	70–79	1218 (19.4)
	80 +	385 (7.7)
	Education	Primary
	Secondary	2519 (44.5)
	Tertiary	1966 (19.6)
Employment status	Employed	2282 (37.3)
	Retired	2253 (34.9)
	Unemployed	1484 (27.9)
Chronic medical conditions	None	1426 (23.7)
	One	1724 (27.9)
	Two or more	2948 (48.4)
ADL disability		487 (8.7)
Depression ^a		533 (9.8)
CES-D continuous (mean \pm SD)		5.90 (7.34)
Anxiety ^b		1418 (24.9)
HADS-A continuous (mean \pm SD)		5.40 (3.70)
Cognitive impairment ^c		92 (2.6)
MMSE continuous (mean \pm SD)		28.26 (2.12)
Act (mean \pm SD) ^d		9.12 (2.40)
Belong ^e	Most isolated	380 (7.1)
	Moderately isolated	1582 (27.9)
	Moderately integrated	2525 (41.2)
	Most integrated	1611 (23.8)
Commit (mean \pm SD) ^f		41.70 (12.25)

The baseline table includes all participants, regardless of presence or absence of depression, anxiety, and cognitive impairment. Data are unweighted n (%) unless otherwise specified. Sampling weights were used for the calculation of proportions and means (SD). Abbreviations: ADL – Activities of Daily Living.

^a Wave 1 depression (based on the CES-D).

^b Wave 1 anxiety (based on the HADS-A).

^c Wave 1 cognitive impairment (based on the MMSE).

^d Number of activities engaged in. possibilities include: Going to films, plays, concerts; attending classes, lectures; traveling for pleasure; working on garden, home, car; reading books, magazines; hobbies, creative activities; playing cards, bingo, games; going to pub; eating out of house; participating in sport, exercise; Visiting or calling family, friends; voluntary work. The scale ranged from 0 to 12.

^e Based on the Social Network Index (SNI).

^f Frequency of engagement in activities listed in Act. The scale ranged from 0 to 84.

of Act-Belong-Commit indicators on mental and cognitive health in a large community-based sample of older adults.

4.1. Strengths and limitations

The strengths of the study include the large sample size, prospective design, the use of nationally-representative data, and validated scales for depression, anxiety, and cognitive function. Several limitations deserve mention before discussing the results. First, these findings were based on self-reported data, which implies the possibility for self-report bias and issues pertaining to common-methods variance. Second, we used proxies for the Act-Belong-Commit variables. The original concepts behind Act, Belong, and Commit are to some degree broader in scope, and the Australian self-assessment questionnaire includes a broad range of activities under each measure of Act, Belong and Commit. Furthermore, the Commit construct emphasizes certain activities such as volunteering and taking on personal challenges, rather than social/recreational activities in general. Thus, it is possible that our predictor variables do not fully capture the essence of the Act-Belong-Commit concepts. Third, baseline data for Act-Belong-Commit indicators were used for the analysis. Consequently, it is possible that some conditions or characteristics of the participants changed between the two waves. Fourth, while we adjusted for education and employment situation as proxies of socioeconomic status, we were unable to adjust for other indicators of socioeconomic status such as household income due to a large number of missing values. Thus, the possibility of residual

Table 2

The association between baseline Act-Belong-Commit indicators and incident depression, anxiety, and cognitive impairment among older adults estimated by multivariable logistic regression.

	Depression ^a			Anxiety ^b			Cognitive impairment ^c		
	OR	95% CI	P-value	OR	95% CI	P-value	OR	95% CI	P-value
Act ^d	0.87	0.81, 0.93	<0.001	0.90	0.83, 0.99	0.029	0.77	0.65, 0.93	0.005
Belong ^e									
Most isolated	1			1			1		
Moderately isolated	0.91	0.56, 1.47	0.691	0.64	0.34, 1.19	0.156	0.51	0.19, 1.37	0.180
Moderately integrated	0.58	0.36, 0.92	0.020	0.47	0.25, 0.86	0.014	0.26	0.09, 0.75	0.013
Most integrated	0.35	0.20, 0.59	<0.001	0.38	0.20, 0.73	0.004	0.15	0.04, 0.51	0.003
Commit ^f	0.96	0.95, 0.98	<0.001	0.98	0.96, 0.99	0.009	0.96	0.93, 1.00	0.061

Participants screening positive for depression, anxiety, or cognitive impairment at baseline were omitted from the analysis on incident depression, anxiety, and cognitive impairment, respectively. OR: odds ratio; CI: confidence interval. All models were adjusted for gender, age, education, employment status, chronic medical conditions, ADL disability. Significant results in bold.

^a Wave 2 depression (based on the CES-D).

^b Wave 2 anxiety (based on the HADS-A).

^c Wave 2 cognitive impairment (based on the MMSE).

^d Number of activities engaged in. Possibilities include: Going to films, plays, concerts; attending classes, lectures; traveling for pleasure; working on garden, home, car; reading books, magazines; hobbies, creative activities; playing cards, bingo, games; going to pub; eating out of house; participating in sport, exercise; visiting or calling family, friends; voluntary work. The scale ranged from 0 to 12.

^e Based on the Social Network Index (SNI).

^f Frequency of engagement in activities listed in Act. The scale ranged from 0 to 84.

confounding due to socioeconomic status cannot be totally dismissed. Fifth, the scale for depression was based on symptoms based in the past seven days. Using different time frames may have yielded different results. Similarly, the results may also have differed if clinical diagnoses for depression, anxiety, or cognitive impairment had been the outcomes, rather than the use of screening tools to detect cases. Last, those who were not followed at W2 were more likely to be older, unemployed, and have disability and lower education at baseline. Thus, some degree of bias might have been introduced due to loss to follow-up.

4.2. Contextualization of findings

Our results on the protective effect of Act-Belong-Commit indicators are in line with previous research suggesting that much of the deterioration in mental and cognitive health associated with aging may to some extent be prevented or at least postponed. Research has shown that of the factors that influence aging, 80% are not genetic and therefore within human control to modify (Park, 2015; Herskind et al., 1996). Within the Act-Belong-Commit framework, such modifiable factors pertain to the activities people engage in, the types of groups people join to engage in activities, and the extent to which people commit to activities that provide meaning and purpose in their lives.

In terms of engaging in activities, our results confirm previous findings that keeping oneself mentally, physically, spiritually, and/or socially active are protective factors against mental disorders and cognitive impairment (Hamer et al., 2009; Hsee et al., 2010; Kwag et al., 2011; Ybarra et al., 2008; Verghese et al., 2003; Conner et al., 2016; Gortner et al., 2006). Clinicians use the term 'behavioral activation' to refer to the engagement in such activities in the context of treatment for depression and recovery from mental and neurological conditions. A randomized controlled trial involving patients with a clinical diagnosis of major depressive disorder found that behavioral activation was not only effective in terms of alleviating depressive symptoms, but also equally effective as cognitive behavioral therapy, while less costly and without the need for highly trained health professionals (Richards et al., 2016). Our results suggest that being active, and more so when engaging in several, diverse types of activities, is beneficial to maintaining positive mental health and cognitive function.

More can be said about the potential benefit of encouraging people to engage in activities. An abundance of research has shown that being mentally active has several benefits for health. For example, studies have reported that reading a novel enhances the neural connectivity in the brain (Berns et al., 2013), and that regular book reading is associated with a 20% reduction in mortality risk over 12 years of follow-up

(Bavishi et al., 2016). Other research has reported that activities like learning a foreign language (Alladi et al., 2013; Kimppa et al., 2016; Marian and Shook, 2012), writing in a journal or diary (Klein and Boals, 2001), playing an instrument (Habibi et al., 2016; Wan and Schlaug, 2010), playing video or board games (Dartigues et al., 2013; Kuhn et al., 2014), knitting (Riley et al., 2013), or making art (Bolwerk et al., 2014) are associated with a number of benefits to brain health, pertaining to cognitive function, brain plasticity, and neurophysiology, which in turn increase the brain's processing speed and ability to learn new information.

The benefits of physical activity and exercise on mental and cognitive health are well documented. Studies have shown that regular exercise among older adults leads to higher brain volume and consequently reduces risk of dementia (Tan et al., 2016; Spartano et al., 2016). Similar findings have recently been reported specifically in terms of muscle building and resistance training (Mavros et al., 2016; Steves et al., 2016). Research has demonstrated the fundamental role of physical activity on mental and cognitive health in older adults, in that exercise can ultimately slow brain aging by 10 years (Willey et al., 2016). Importantly, large-scale studies on older adults have found that just moderate physical activity, such as an hour's walk, or even standing more frequently in an upright position can cancel out the increased risk of death associated with an otherwise sedentary lifestyle (Ekelund et al., 2016; Antikainen, 2016; Katzmarzyk, 2014). Keeping physically active becomes increasingly important for maintaining brain health in older adulthood, as research has demonstrated that physically fit older adults experience a significant decrease in blood flow to the brain only 10 days after exercise cessation (Alfini et al., 2016). The benefits of physical activity against mood and anxiety disorders have also been documented (Wegner et al., 2014; Schuch et al., 2016a; Schuch et al., 2016b; Kilpatrick et al., 2013), and one recent study showed that the simple act of walking, in and of itself, is a robust and pervasive mood lifter and facilitator of positive affect (Miller and Krizan, 2016). Further, research has reported that the protective effect against depression may be intensified when exercise is combined with meditation (Alderman et al., 2016).

Spiritual activities such as meditation, mindfulness exercises or religious involvement show promising results in terms of benefiting mental and cognitive health. Research has shown that meditation, mindfulness, and breathing exercises facilitate enhanced immune function (Davidson et al., 2003; Creswell et al., 2009; Twaal et al., 2016), improve cellular health, and are associated with a distinct cellular network of genes relevant to healthy aging (Epel et al., 2016). The effects of meditation or spirituality can be considerable, as studies have reported that such

practices are associated with increased cortical thickness (Miller et al., 2014) and gray matter density in brain areas involved in cognitive processing, emotion regulation and perspective taking (Holzel et al., 2011), and that the brains of experienced meditators appear to be 7.5 years younger than those of controls (Luders et al., 2016). A growing body of literature is documenting the vast benefits of meditative practices as a means to prevent or treat a range of mental or behavioral disorders, such as depression (Young, 2011; Sharma et al., 2016), anxiety (Holzel et al., 2013), post-traumatic stress disorder (King et al., 2016), addiction (Oikonomou et al., 2016; Glasner et al., 2016), as well complex medical conditions such as chronic pain (Zeidan et al., 2016; Cherkin et al., 2016; Zeidan et al., 2015).

While the health benefits of meditation and spiritual activities are considerable, one may not necessarily have to engage in such activities to gain the benefits. Going on a vacation can have similar positive outcomes as those gained from meditation. Epel, Puterman (Epel et al., 2016) compared a meditation-vacation group with a vacation-only group and found similar and significant, although attenuated, benefits in the vacation-only group. The authors refer to the psychological and biological benefits of vacationing as the 'vacation effect', which involves increased feelings of wellbeing, improved immune function, and a reduction of biological processes related to stress as a result of going on a vacation or retreat.

Simply spending time in nature also appears to be a viable solution for protecting against negative mental health outcomes. Studies have found that 1–1 1/2 h of walking in a natural environment is associated with reduced neural activity in brain areas linked to rumination and depression (Bratman et al., 2015a), while at the same time benefiting cognition and alleviating anxiety symptoms (Bratman et al., 2015b). Recently, a study conducted in Brisbane, Australia found that 7% of depression cases and 9% of high blood pressure cases could be prevented if all city residents were to visit a natural environment once a week for an average duration of 30 min (Shanahan et al., 2016). Further, the mental health benefits of nature walks can be enhanced when performed as part of a group. A large-scale British longitudinal study showed that group walks in nature were associated with significantly lower levels of stress, depression, and negative affect, as well as enhanced positive affect and wellbeing as compared to non-group walkers (Marselle et al., 2014).

Finally, in terms of social participation specifically, studies have reported its protective effects against depression (Glass et al., 2006), dementia (Kuiper et al., 2015), and mortality (Dalgard and Lund Haheim, 1998). Some studies have investigated the mental health benefits of social activities that also include some form of service or charity. One longitudinal study reported that volunteer work predicted better mental health and emotional wellbeing specifically among people aged 40 and continuing up to old age (Tabassum et al., 2016). According to the authors, volunteering provides opportunities for meaningful activities and social contact, which in turn have protective effects on health status. Further, the benefits of social activities may have long-lasting effects that can persist for decades. A British study recently showed that having been a member of Scouts and Guides during childhood was associated with a reduced risk of mood and anxiety disorders in middle-age (Dibben et al., 2016). Another British study involving a large longitudinal cohort showed that participation through civic group activities at age 33 were protective against cognitive impairment at age 50 (Bowling et al., 2016). Thus, the protective mental and cognitive health benefits of keeping mentally, physically, spiritually and/or socially active have been documented and our findings appear to confirm previous findings.

In our study, we found that compared to those most isolated, being well integrated into social networks was inversely related to the onset of depression, anxiety, and cognitive impairment. Our results confirm previous findings that being well integrated into social networks is a protective factor against depression (Cacioppo et al., 2010; Santini et al., 2015), and cognitive decline (Kuiper et al., 2016; Shankar et al.,

2013). Similarly, studies have found that belongingness and social identification protects against or alleviates depressive symptoms (Cruwys et al., 2014; Cruwys et al., 2013) and enhances cognitive health (Haslam et al., 2014; Haslam et al., 2016). However, fewer studies have reported significant protective effects of social network integration against the onset of anxiety. It has been argued that anxiety disorders, along with their somatic symptoms, are somewhat less sensitive to structural network factors (Beekman et al., 1998; Lindsay, 1991). However, our analysis did identify a significant protective effect of the two highest levels of social network integration against incident anxiety. Our results add to the relatively scarce amount of literature documenting associations between social networks and psychopathologies relating to anxiety.

Although our results confirmed our hypothesis in terms of the predictive validity of the Act indicator on all outcomes, the association between the Commit indicator and specifically cognitive impairment was only marginally significant. Previous research has documented that higher levels of personal meaning and sense of purpose are negatively associated with depressive symptoms (Pinquart, 2002) and cognitive decline (Lewis et al., 2016). Being committed to one or more activities is one way that feelings of personal meaning and sense of purpose can be induced, and in this study, we used frequency of activity engagement as a proxy for commitment. Given the lack of statistical significance for cognitive impairment, it may be that commitment to activities has a greater emotional value, and therefore, our outcomes on mood and anxiety disorders were more sensitive to the Commit indicator than was the case for cognitive impairment. One may also consider that even if Commit does not exert a significant direct effect on cognitive function, preventing the onset of mood and anxiety disorders may, by extension, serve to prevent cognitive impairment, as previous research has found that depression and anxiety disorders prospectively predict late-life cognitive impairment or dementia (Gulpers et al., 2016; Paterniti et al., 2002). On the other hand, if our measure of Commit had included measures only on activities more directly related to meaning and purpose, there may have been a greater effect.

4.3. Implications for policy and practice

Our results suggest that implementation of the Act-Belong-Commit campaign has wide-ranging implications for a number of psychological domains pertaining to mental health and cognitive function among community-dwelling older adults. Some important advantages may be considered. First, although such a campaign does incur costs in creating awareness of the campaign messages, the campaign does not require additional trained specialist health professionals, and hence would therefore not be associated with major additional costs to health systems. Second, the campaign may be considered a non-pharmacological approach to public mental health and gerontological intervention. Third, the literature suggests that the benefit of activities can sometimes be enhanced when different activities are combined. For example, in the reviewed literature, physical exercise was associated with additional benefit when combined with meditation, vacation, or group walks in a natural environment. One may also consider that volunteering may be beneficial particularly because it combines a meaningful activity that contributes to the community while also offering opportunity for social connectedness and interaction at the same time. The combination factor may be considered when planning and executing the campaign. Fourth, the campaign offers a sense of empowerment to people in the community, given that it involves a do-it-yourself approach to protecting and enhancing mental health. The fundamental premise of the campaign is to inform the public regarding some simple and practical steps they can take to achieve and maintain positive mental health, and to work with community organizations that offer an available setting for people to effectively take action. The basic idea of the campaign is one of a self-sustaining mechanism once the message has been received.

The Act-Belong-Commit campaign is important because it addresses a gap in health promotion specifically pertaining to mental health.

Globally, appropriate prioritization of mental health has been missing in policy frameworks for health improvement and poverty reduction, in health and social research, in targets for intervention, and in major agendas to achieve Millennium Development Goals (Prince et al., 2007; Forsman et al., 2015). On a more conceptual level, mental health promotion has not been given the same weight or emphasis as efforts to promote physical health. Neither has there been an existing practical framework to facilitate the implementation of a comprehensive, population-wide mental health promotion campaign among health professionals and policy makers. Act-Belong-Commit was designed to fill this vacuum, by providing a practical framework for actually doing mental health promotion. Importantly, given that the general population is generally not particularly knowledgeable or aware of what they could or should be doing to protect their mental or cognitive health (in contrast to the salience of and proactive intentions towards physical health) (Donovan et al., 2007; Wilcox et al., 2009), there is a pressing need to raise awareness in communities regarding the importance of maintaining or enhancing mental health, and to communicate some simple and practical steps to achieving this. So far, there is evidence to demonstrate that the Act-Belong-Commit campaign in Australia has been effective as a method to increase such awareness and to alter perceptions pertaining to mental health, along with providing techniques and opportunities to stay mentally healthy (Jalleh et al., 2013; Anwar-McHenry et al., 2012). Further, recent focus group research among lay people in Denmark has shown that people do actually know what they can do to protect and enhance mental health when given time to reflect on it (Nielsen et al., 2017). However, most tend to forget to prioritize these things in their daily lives, hence a need for reminding the public that preventing mental disorder is just as important as preventing somatic illness or physical disability. Finally, perhaps especially important to this study is that the campaign has been found to assist patients in recovery and to encourage people with a diagnosed mental illness or recent mental health problem, to do something for their mental health (Donovan et al., 2016).

5. Conclusion

This study has shown that Act-Belong-Commit indicators have significant protective properties against mental disorder and cognitive impairment in Irish community-dwelling older adults. Being mentally, physically, spiritually, or socially active (Act) was protective against incident depression, anxiety, and cognitive impairment, and the protective effect increased proportionally with increases in the number of different activities that individuals engaged in. Being well integrated into social networks (Belong) was inversely related to the incidence of all outcomes. Increasing the frequency of engaging in activities (Commit) was protective against the onset of depression and anxiety, while the effect for cognitive impairment was only marginally significant. Our study provides evidence that the Act-Belong-Commit campaign, if successfully implemented, may be effective as a public health intervention with wide-ranging implications for preventing mental disorders and cognitive impairment in the aging community.

Acknowledgements

The TILDA data have been co-funded by the Government of Ireland through the Office of the Minister for Health and Children, by Atlantic Philanthropies, and by Irish Life; have been collected under the Statistics Act, 1993, of the Central Statistics Office. The project has been designed and implemented by the TILDA Study Team© Department of Health and Children. Copyright and all other intellectual property rights relating to the data are vested in TILDA.

The research leading to these results has received funding from the People Programme (Marie Curie Actions) of the European Union's Seventh

Framework Programme FP7/2007–2013 under REA grant agreement no 316795.

Ai Koyanagi's work was supported by the Miguel Servet contract financed by the CP13/00150 project, integrated into the National R + D + I and funded by the ISCIII - General Branch Evaluation and Promotion of Health Research - and the European Regional Development Fund (ERDF).

Stefanos Tyrovolas's work was supported by the Foundation for Education and European Culture (IPEP), the Sara Borrell post-doctoral programme (reference no. CD15/00019 from the Instituto de Salud Carlos III (ISCIII - Spain) and the Fondos Europeo de Desarrollo Regional (FEDER).

References

- Alderman, B.L., et al., 2016. MAP training: combining meditation and aerobic exercise reduces depression and rumination while enhancing synchronized brain activity. *Transl. Psychiatry* 6, e726.
- Alfini, A.J., et al., 2016. Hippocampal and cerebral blood flow after exercise cessation in master athletes. *Front. Aging Neurosci.* 8, 184.
- Alladi, S., et al., 2013. Bilingualism delays age at onset of dementia, independent of education and immigration status. *Neurology* 81 (22), 1938–1944.
- Antikainen, R.L., 2016. Leisure time Physical Activity Reduces the Risk of Cardiovascular Death and An Acute CVD Event also Among Older Adults, in ESC Congress. European Society of Cardiology, Rome, IT.
- Anwar McHenry, J., Donovan, R.J., 2013. Developing the Perth Charter for the promotion of mental health and wellbeing. *Advances in Mental Health* 12 (1), 8–10.
- Anwar-McHenry, J., et al., 2012. Impact evaluation of the act-belong-commit mental health promotion campaign. *Journal of Public Mental Health* 11 (4), 186–194.
- Avlund, K., et al., 2004. Social relations as determinant of onset of disability in aging. *Arch. Gerontol. Geriatr.* 38 (1), 85–99.
- Bavishi, A., Slade, M.D., Levy, B.R., 2016. A chapter a day: association of book reading with longevity. *Soc. Sci. Med.* 164, 44–48.
- Beekman, A.T., et al., 1997. Criterion validity of the Center for Epidemiologic Studies Depression scale (CES-D): results from a community-based sample of older subjects in The Netherlands. *Psychol. Med.* 27 (1), 231–235.
- Beekman, A.T., et al., 1998. Anxiety disorders in later life: a report from the Longitudinal Aging Study Amsterdam. *Int. J. Geriatr. Psychopharmacol.* 13 (10), 717–726.
- Beekman, A.T., et al., 2000. Anxiety and depression in later life: co-occurrence and commonality of risk factors. *Am. J. Psychiatry* 157 (1), 89–95.
- Berkman, L.F., Breslow, A.S., 1983. *Health and Ways of Living*. Oxford University Press, New York, NY.
- Berkman, L.F., Syme, S.L., 1979. Social networks, host resistance, and mortality: a nine-year follow-up study of Alameda County residents. *Am. J. Epidemiol.* 109 (2), 186–204.
- Berns, G.S., et al., 2013. Short- and long-term effects of a novel on connectivity in the brain. *Brain Connect* 3 (6), 590–600.
- Bjelland, I., et al., 2002. The validity of the Hospital Anxiety and Depression Scale. *J. Psychosom. Res.* 52 (2), 69–77.
- Bolwerk, A., et al., 2014. How art changes your brain: differential effects of visual art production and cognitive art evaluation on functional brain connectivity. *PLoS One* 9 (7), e101035.
- Bowling, A., Pikhartova, J., Dodgeon, B., 2016. Is mid-life social participation associated with cognitive function at age 50? Results from the British National Child Development Study (NCDS). *BMC Psychology* 4 (1), 58.
- Bratman, G.N., et al., 2015a. Nature experience reduces rumination and subgenual prefrontal cortex activation. *Proc. Natl. Acad. Sci.* 112 (28), 8567–8572.
- Bratman, G.N., et al., 2015b. The benefits of nature experience: improved affect and cognition. *Landscape Urban Plan.* 138, 41–50.
- Byers, A.L., et al., 2010. High occurrence of mood and anxiety disorders among older adults: the National Comorbidity Survey Replication. *Arch. Gen. Psychiatry* 67 (5), 489–496.
- Cacioppo, J.T., Hawkey, L.C., Thisted, R.A., 2010. Perceived social isolation makes me sad: 5-year cross-lagged analyses of loneliness and depressive symptomatology in the Chicago Health, Aging, and Social Relations Study. *Psychol. Aging* 25 (2), 453–463.
- Cherkin, D.C., et al., 2016. Effect of mindfulness-based stress reduction vs cognitive behavioral therapy or usual care on back pain and functional limitations in adults with chronic low back pain: a randomized clinical trial. *JAMA* 315 (12), 1240–1249.
- Chisholm, D., et al., 2016. Scaling-up treatment of depression and anxiety: a global return on investment analysis. *Lancet Psychiatry* 3 (5), 415–424.
- Cohen, S., Janicki-Deverts, D., 2009. Can we improve our physical health by altering our social networks? *Perspect. Psychol. Sci.* 4 (4), 375–378.
- Cohen, S., Underwood, L.G., Gottlieb, B.H. (Eds.), 2000. *Social Support Measurement and Intervention: A Guide for Health and Social Scientists*. Oxford University Press, New York, NY.
- Conner, T.S., DeYoung, C.G., Silvia, P.J., 2016. Everyday creative activity as a path to flourishing. *J. Posit. Psychol.* 1–9.
- Creswell, J.D., et al., 2009. Mindfulness meditation training effects on CD4 + T lymphocytes in HIV-1 infected adults: a small randomized controlled trial. *Brain Behav. Immun.* 23 (2), 184–188.
- Cronin, H., et al., 2013. Health and aging: development of the Irish longitudinal study on ageing health assessment. *J. Am. Geriatr. Soc.* 61 (Suppl. 2), S269–S278.
- Cruwys, T., et al., 2013. Social group memberships protect against future depression, alleviate depression symptoms and prevent depression relapse. *Soc. Sci. Med.* 98, 179–186.

- Cruwys, T., et al., 2014. Depression and social identity: an integrative review. *Personal. Soc. Psychol. Rev.* 18 (3), 215–238.
- Csikszentmihalyi, M., 1990. *Flow: The Psychology of Optimal Experience*. Harper Perennial, New York, NY.
- Cullen, B., et al., 2005. Screening for dementia in an Irish community sample using MMSE: a comparison of norm-adjusted versus fixed cut-points. *Int. J. Geriatr. Psychopharmacol.* 20 (4), 371–376.
- Dalgard, O.S., Lund Haheim, L., 1998. Psychosocial risk factors and mortality: a prospective study with special focus on social support, social participation, and locus of control in Norway. *J. Epidemiol. Community Health* 52 (8), 476–481.
- Darin-Mattsson, A., et al., 2015. Are occupational complexity and socioeconomic position related to psychological distress 20 years later? *J. Aging Health* 27 (7), 1266–1285.
- Dartigues, J.F., et al., 2013. Playing board games, cognitive decline and dementia: a French population-based cohort study. *BMJ Open* 3 (8), e002998.
- Davidson, R.J., et al., 2003. Alterations in brain and immune function produced by mindfulness meditation. *Psychosom. Med.* 65 (4), 564–570.
- Decarlo, T.J., 1974. Recreation participation patterns and successful aging. *J. Gerontol.* 29 (4), 416–422.
- Dibben, C., Playford, C., Mitchell, R., 2016. Be(ing) prepared: Guide and Scout participation, childhood social position and mental health at age 50—a prospective birth cohort study. *J. Epidemiol. Community Health*.
- Djernes, J.K., 2006. Prevalence and predictors of depression in populations of elderly: a review. *Acta Psychiatr. Scand.* 113 (5), 372–387.
- Donovan, R., Anwar McHenry, J., 2014. Act-belong-commit: lifestyle medicine for keeping mentally healthy. *Am. J. Lifestyle Med.* 8, 33–42.
- Donovan, R., et al., 2006. Implementing mental health promotion: the act-belong-commit mentally healthy WA campaign in Western Australia. *Int. J. Ment. Health Promot.* 8 (1), 33–42.
- Donovan, R.J., et al., 2007. People's beliefs about factors contributing to mental health: implications for mental health promotion. *Health Promot J Austr* 18 (1), 50–56.
- Donovan, R., et al., 2016. Impact of a population-wide mental health promotion campaign on people with a diagnosed mental illness or recent mental health problem. *Aust. N. Z. J. Public Health* 40 (3), 274–275.
- EC, 2008. *Improving Mental Health in Population: Policy Briefs*. European Commission, Luxembourg.
- Ekelund, U., et al., 2016. Does physical activity attenuate, or even eliminate, the detrimental association of sitting time with mortality? A harmonised meta-analysis of data from more than 1 million men and women. *Lancet* 388 (10051), 1302–1310.
- Epel, E.S., et al., 2016. Meditation and vacation effects have an impact on disease-associated molecular phenotypes. *Transl. Psychiatry* 6 (8), e880.
- Fiske, A., Wetherell, J.L., Gatz, M., 2009. Depression in older adults. *Annu. Rev. Clin. Psychol.* 5, 363–389.
- Folstein, M.F., Folstein, S.E., McHugh, P.R., 1975. "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. *J. Psychiatr. Res.* 12 (3), 189–198.
- Forsman, A.K., et al., 2015. Research priorities for public mental health in Europe: recommendations of the ROAMER project. *Eur. J. Pub. Health* 25 (2), 249–254.
- Glasner, S., et al., 2016. Mindfulness-based relapse prevention for stimulant dependent adults: a pilot randomized clinical trial. *Mindfulness* 1–10.
- Glass, T.A., et al., 2006. Social engagement and depressive symptoms in late life: longitudinal findings. *J. Aging Health* 18 (4), 604–628.
- Gortner, E.M., Rude, S.S., Pennebaker, J.W., 2006. Benefits of expressive writing in lowering rumination and depressive symptoms. *Behav. Ther.* 37 (3), 292–303.
- Gulpers, B., et al., 2016. Anxiety as a predictor for cognitive decline and dementia: a systematic review and meta-analysis. *Am. J. Geriatr. Psychiatry* 24 (10), 823–842.
- Habibi, A., et al., 2016. Neural correlates of accelerated auditory processing in children engaged in music training. *Dev. Cogn. Neurosci.* 21, 1–14.
- Hamer, M., Stamatakis, E., Steptoe, A., 2009. Dose-response relationship between physical activity and mental health: the Scottish Health Survey. *Br. J. Sports Med.* 43 (14), 1111–1114.
- Haslam, C., Cruwys, T., Haslam, S.A., 2014. "The we's have it": evidence for the distinctive benefits of group engagement in enhancing cognitive health in aging. *Soc. Sci. Med.* 120, 57–66.
- Haslam, C., et al., 2016. Group ties protect cognitive health by promoting social identification and social support. *J. Aging Health* 28 (2), 244–266.
- Heady, B., Wearing, A., 1992. *Understanding Happiness: A Theory of Subjective Wellbeing*. Longman Cheshire, Melbourne, AU.
- Herskind, A.M., et al., 1996. The heritability of human longevity: a population-based study of 2872 Danish twin pairs born 1870–1900. *Hum. Genet.* 97 (3), 319–323.
- Hertzog, C., et al., 1990. Measurement properties of the Center for Epidemiological Studies Depression Scale (CES-D) in older populations. *Psychological Assessment: A Journal of Consulting and Clinical Psychology* 2 (1), 64–72.
- Holzel, B.K., et al., 2011. Mindfulness practice leads to increases in regional brain gray matter density. *Psychiatry Res.* 191 (1), 36–43.
- Holzel, B.K., et al., 2013. Neural mechanisms of symptom improvements in generalized anxiety disorder following mindfulness training. *Neuro. Clin.* 2, 448–458.
- Hsee, C.K., Yang, A.X., Wang, L., 2010. Idleness aversion and the need for justifiable busyness. *Psychol. Sci.* 21 (7), 926–930.
- Hubert, H.B., Bloch, D.A., Fries, J.F., 1993. Risk factors for physical disability in an aging cohort: the NHANES I Epidemiologic Followup Study. *J. Rheumatol.* 20 (3), 480–488.
- Iyer, A., et al., 2009. The more (and the more compatible) the merrier: multiple group memberships and identity compatibility as predictors of adjustment after life transitions. *Br. J. Soc. Psychol.* 48 (Pt 4), 707–733.
- Jalleh, G., et al., 2013. Impact on community organisations that partnered with the Act-Belong-Commit mental health promotion campaign. *Health Promot J Austr* 24 (1), 44–48.
- Katz, S., et al., 1963. Studies of illness in the aged. the index of adl: a standardized measure of biological and psychosocial function. *JAMA* 185, 914–919.
- Katzmarzyk, P.T., 2014. Standing and mortality in a prospective cohort of Canadian adults. *Med. Sci. Sports Exerc.* 46 (5), 940–946.
- Kearney, P.M., et al., 2011. Cohort profile: the Irish longitudinal study on ageing. *Int. J. Epidemiol.* 40 (4), 877–884.
- Kilpatrick, M., et al., 2013. Cross-sectional associations between sitting at work and psychological distress: reducing sitting time may benefit mental health. *Ment. Health and Phys. Act.* 6 (2), 103–109.
- Kimppa, L., Kujala, T., Shtyrov, Y., 2016. Individual language experience modulates rapid formation of cortical memory circuits for novel words. *Sci. Report.* 6, 30227.
- King, A.P., et al., 2016. Altered default mode network (dmn) resting state functional connectivity following a mindfulness-based exposure therapy for posttraumatic stress disorder (ptsd) in combat veterans of Afghanistan and I. *Depress Anxiety* 33 (4), 289–299.
- Kirmayer, L.J., et al., 1999. *Suicide Prevention and Mental Health Promotion in First Nations and Inuit Communities*. Culture and Mental Health Research Unit, Institute of Community and Family Psychiatry, Montréal, CA.
- Klein, K., Boals, A., 2001. Expressive writing can increase working memory capacity. *J. Exp. Psychol. Gen.* 130 (3), 520–533.
- Knapp, M., McDaid, D., Parsonage, M. (Eds.), 2011. *Mental Health Promotion and Mental Illness Prevention: The Economic Case*. London School of Economics and Political Science, London, UK.
- Koushede, V., et al., 2015. From rhetoric to action: adapting the act-belong-commit mental health promotion Programme to a Danish context. *Int. J. Ment. Health Promot.* 17 (1), 22–33.
- Kuhn, S., et al., 2014. Playing Super Mario induces structural brain plasticity: gray matter changes resulting from training with a commercial video game. *Mol. Psychiatry* 19 (2), 265–271.
- Kuiper, J.S., et al., 2015. Social relationships and risk of dementia: a systematic review and meta-analysis of longitudinal cohort studies. *Ageing Res. Rev.* 22, 39–57.
- Kuiper, J.S., et al., 2016. Social Relationships and Cognitive Decline: A Systematic Review and Meta-analysis of Longitudinal Cohort Studies. *International Journal of Epidemiology*.
- Kwag, K.H., et al., 2011. The impact of perceived stress, social support, and home-based physical activity on mental health among older adults. *Int. J. Aging Hum Dev* 72 (2), 137–154.
- Letenneur, L., et al., 1999. Are sex and educational level independent predictors of dementia and Alzheimer's disease? Incidence data from the PAQUID project. *J. Neurol. Neurosurg. Psychiatry* 66 (2), 177–183.
- Lewinsohn, P.M., et al., 1997. Center for Epidemiologic Studies Depression Scale (CES-D) as a screening instrument for depression among community-residing older adults. *Psychol. Aging* 12 (2), 277–287.
- Lewis, N.A., et al., 2016. Purpose in life and cognitive functioning in adulthood. *Neuropsychol. Dev. Cogn. B Aging Neuropsychol. Cogn.* 1–10.
- Lindesay, J., 1991. Phobic disorders in the elderly. *Br. J. Psychiatry* 159, 531–541.
- Luders, E., Cherbuin, N., Gaser, C., 2016. Estimating brain age using high-resolution pattern recognition: younger brains in long-term meditation practitioners. *NeuroImage* 134, 508–513.
- Lyubomirski, S., Sheldon, K.M., Schkade, D., 2005. Pursuing happiness: the architecture of sustainable change. *Rev. Gen. Psychol.* 9 (2), 111–131.
- Marian, V., Shook, A., 2012. The cognitive benefits of being bilingual. *Cerebrum* 2012.
- Marselle, M.R., Irvine, K.N., Warber, S.L., 2014. Examining group walks in nature and multiple aspects of well-being: a large-scale study. *Ecopyschology* 6 (3), 134–147.
- Mavros, Y., et al., 2016. Mediation of cognitive function improvements by strength gains after resistance training in older adults with mild cognitive impairment: outcomes of the study of mental and resistance training. *J. Am. Geriatr. Soc.* (n/a-n/a).
- McDaid, D., Park, A.L., 2011. Investing in mental health and well-being: findings from the DataPrev project. *Health Promot. Int.* 26 (Suppl. 1), i108–i139.
- Miller, J.C., Krizan, Z., 2016. Walking facilitates positive affect (even when expecting the opposite). *Emotion* 16 (5), 775–785.
- Miller, L., et al., 2014. Neuroanatomical correlates of religiosity and spirituality: a study in adults at high and low familial risk for depression. *JAMA Psychiatry* 71 (2), 128–135.
- Nielsen, L., et al., 2017. Mental health is what makes life worth living: an exploration of lay people's understandings of mental health in Denmark. *Int. J. Ment. Health Promot.* 19 (1), 26–37.
- O'Brien, R.M., 2007. A caution regarding rules of thumb for variance inflation factors. *Qual. Quant.* 41 (5), 673–690.
- Oikonomou, M.T., Arvanitis, M., Sokolove, R.L., 2016. Mindfulness Training for Smoking Cessation: A Meta-Analysis of Randomized-Controlled Trials. *Journal of Health Psychology*.
- Olsson, I., Mykletun, A., Dahl, A.A., 2005. The Hospital Anxiety and Depression Rating Scale: a cross-sectional study of psychometrics and case finding abilities in general practice. *BMC Psychiatry* 5, 46.
- Park, A. Here's Why You May Be Aging Faster Than Your Friends. 2015 [cited 2017 7/1]; Available from: <http://time.com/3946850/slow-down-aging/>.
- Patel, V., et al., 2016. Addressing the burden of mental, neurological, and substance use disorders: key messages from Disease Control Priorities, 3rd edition. *Lancet* 387 (10028), 1672–1685.
- Paterniti, S., et al., 2002. Depressive symptoms and cognitive decline in elderly people. *Longitudinal Study. Br. J. Psychiatry* 181, 406–410.
- Pettigrew, S., Donovan, R., 2009. Older audiences' responses to mental health promotion messages. *Int. J. Ment. Health Promot.* 11, 23–31.
- Pinquart, M., 2002. Creating and maintaining purpose in life in old age: a meta-analysis. *Ageing International* 27 (2), 90–114.
- Prince, M., et al., 2007. No health without mental health. *Lancet* 370 (9590), 859–877.

- Prince, M., et al., 2013. The global prevalence of dementia: a systematic review and meta-analysis. *Alzheimers Dement.* 9 (1), 63–75 (e2).
- Radloff, L.S., 1977. The CES-D scale: a self-report depression scale for research in the general population. *Appl. Psychol. Meas.* 1 (3), 385–401.
- Rechel, B., et al., 2009. How Can Health Systems Respond to Population Aging?
- Richards, D.A., et al., 2016. Cost and Outcome of Behavioural Activation versus Cognitive Behavioural Therapy for Depression (COBRA): a randomised, controlled, non-inferiority trial. *Lancet* 388 (10047), 871–880.
- Riley, J., Corkhill, B., Morris, C., 2013. The benefits of knitting for personal and social wellbeing in adulthood: findings from an international survey. *The British Journal of Occupational Therapy* 76 (2), 50–57.
- Rosenquist, J.N., Fowler, J.H., Christakis, N.A., 2011. Social network determinants of depression. *Mol. Psychiatry* 16 (3), 273–281.
- Santini, Z.I., et al., 2015. The association between social relationships and depression: a systematic review. *J. Affect. Disord.* 175, 53–65.
- Schuch, F.B., et al., 2016a. Are lower levels of cardiorespiratory fitness associated with incident depression? A systematic review of prospective cohort studies. *Prev. Med.* 93, 159–165.
- Schuch, F.B., et al., 2016b. Exercise as a treatment for depression: a meta-analysis adjusting for publication bias. *J. Psychiatr. Res.* 77, 42–51.
- Shanahan, D.F., et al., 2016. Health benefits from nature experiences depend on dose. *Sci. Report.* 6, 28551.
- Shankar, A., et al., 2011. Loneliness, social isolation, and behavioral and biological health indicators in older adults. *Health Psychol.* 30 (4), 377–385.
- Shankar, A., et al., 2013. Social isolation and loneliness: relationships with cognitive function during 4 years of follow-up in the English Longitudinal Study of Ageing. *Psychosom. Med.* 75 (2), 161–170.
- Sharma, A., et al., 2016. A Breathing-based meditation intervention for patients with major depressive disorder following inadequate response to antidepressants: a randomized pilot study. *J. Clin. Psychol.*
- Spartano, N.L., et al., 2016. Midlife exercise blood pressure, heart rate, and fitness relate to brain volume 2 decades later. *Neurology* 86 (14), 1313–1319.
- Spinoven, P., et al., 1997. A validation study of the Hospital Anxiety and Depression Scale (HADS) in different groups of Dutch subjects. *Psychol. Med.* 27 (2), 363–370.
- Steves, C.J., et al., 2016. Kicking back cognitive ageing: leg power predicts cognitive ageing after ten years in older female twins. *Gerontology* 62 (2), 138–149.
- Stuck, A.E., et al., 1999. Risk factors for functional status decline in community-living elderly people: a systematic literature review. *Soc. Sci. Med.* 48 (4), 445–469.
- Tabassum, F., Mohan, J., Smith, P., 2016. Association of volunteering with mental well-being: a lifecourse analysis of a national population-based longitudinal study in the UK. *BMJ Open* 6 (8), e011327.
- Tan, Z.S., et al., 2016. Physical activity, brain volume, and dementia risk: the Framingham study. *J. Gerontol. Ser. A Biol. Med. Sci.*
- Tilvis, R.S., et al., 2004. Predictors of cognitive decline and mortality of aged people over a 10-year period. *J. Gerontol. A Biol. Med. Sci.* 59 (3), 268–274.
- Tombaugh, T.N., McIntyre, N.J., 1992. The mini-mental state examination: a comprehensive review. *J. Am. Geriatr. Soc.* 40 (9), 922–935.
- Twal, W.O., Wahlquist, A.E., Balasubramanian, S., 2016. Yogic breathing when compared to attention control reduces the levels of pro-inflammatory biomarkers in saliva: a pilot randomized controlled trial. *BMC Complement. Altern. Med.* 16, 294.
- UN, 2013. World Population Ageing. Department of Economic and Social Affairs, Population Division.
- Valtorta, N.K., et al., 2016. Loneliness and Social Isolation as Risk Factors for Coronary Heart Disease and Stroke: Systematic Review and Meta-Analysis of Longitudinal Observational Studies. *Heart.*
- Vergheze, J., et al., 2003. Leisure activities and the risk of dementia in the elderly. *N. Engl. J. Med.* 348 (25), 2508–2516.
- Vink, D., Aartsen, M.J., Schoevers, R.A., 2008. Risk factors for anxiety and depression in the elderly: a review. *J. Affect. Disord.* 106 (1–2), 29–44.
- Wan, C.Y., Schlaug, G., 2010. Music making as a tool for promoting brain plasticity across the life span. *Neuroscientist* 16 (5), 566–577.
- Wegner, M., et al., 2014. Effects of exercise on anxiety and depression disorders: review of meta-analyses and neurobiological mechanisms. *CNS Neurol. Disord. Drug Targets* 13 (6), 1002–1014.
- Whelan, B.J., Savva, G.M., 2013. Design and methodology of the Irish Longitudinal Study on Ageing. *J. Am. Geriatr. Soc.* 61 (Suppl. 2), S265–S268.
- WHO, 2004. Promoting Mental Health: Concepts, Emerging Evidence, Practice. World Health Organization, Geneva, CH.
- WHO, 2005. Mental Health Action Plan For Europe: Facing The Challenges, Building Solutions. World Health Organization, Copenhagen, DK.
- WHO, 2012. Dementia: A Public Health Priority. World Health Organization, Geneva, CH.
- Wilcox, S., et al., 2009. Perceptions and beliefs about the role of physical activity and nutrition on brain health in older adults. *The Gerontologist* 49 (S1), S61–S71.
- Willey, J.Z., et al., 2016. Leisure-time physical activity associates with cognitive decline: the Northern Manhattan Study. *Neurology* 86 (20), 1897–1903.
- Wolitzky-Taylor, K.B., et al., 2010. Anxiety disorders in older adults: a comprehensive review. *Depress Anxiety* 27 (2), 190–211.
- Ybarra, O., et al., 2008. Mental exercising through simple socializing: social interaction promotes general cognitive functioning. *Personal. Soc. Psychol. Bull.* 34 (2), 248–259.
- Young, S.N., 2011. Biologic effects of mindfulness meditation: growing insights into neurobiologic aspects of the prevention of depression. *J. Psychiatry Neurosci.* 36 (2), 75–77.
- Zechmeister, I., Kilian, R., McDaid, D., 2008. Is it worth investing in mental health promotion and prevention of mental illness? A systematic review of the evidence from economic evaluations. *BMC Public Health* 8, 20.
- Zeidan, F., et al., 2015. Mindfulness meditation-based pain relief employs different neural mechanisms than placebo and sham mindfulness meditation-induced analgesia. *J. Neurosci.* 35 (46), 15307–15325.
- Zeidan, F., et al., 2016. Mindfulness-meditation-based pain relief is not mediated by endogenous opioids. *J. Neurosci.* 36 (11), 3391–3397.
- Zigmond, A.S., Snaith, R.P., 1983. The hospital anxiety and depression scale. *Acta Psychiatr. Scand.* 67 (6), 361–370.