



## Full length article

# The association between Act-Belong-Commit indicators and problem drinking among older Irish adults: Findings from a prospective analysis of the Irish Longitudinal Study on Ageing (TILDA)



Ziggi Ivan Santini<sup>a,\*</sup>, Line Nielsen<sup>a</sup>, Carsten Hinrichsen<sup>a</sup>, Janne S. Tolstrup<sup>a</sup>, Johan L. Vinther<sup>a</sup>, Ai Koyanagi<sup>b</sup>, Robert J. Donovan<sup>c</sup>, Vibeke Koushede<sup>a</sup>

<sup>a</sup> The Danish National Institute of Public Health, University of Southern Denmark, Oester Farinagsgade 5A, 1353 Copenhagen, Denmark

<sup>b</sup> Parc Sanitari Sant Joan de Déu, Universitat de Barcelona, Fundació Sant Joan de Déu, CIBERSAM, Dr Antoni Pujadas, 42, 08830, Sant Boi de Llobregat, Barcelona, Spain

<sup>c</sup> School of Sport Science, Exercise and Health, University of Western Australia, 35 Stirling Highway, 6009 Perth, WA, Australia

## ARTICLE INFO

## Keywords:

Alcohol drinking  
Alcoholism  
Social support  
Leisure  
Mental health  
Aging

## ABSTRACT

The Act-Belong-Commit campaign is the world's first comprehensive, population-wide, community-based program to promote mental health. However, its potential for preventing substance use disorders is unknown. Further, a literature gap is evident concerning behavioral modification strategies to prevent such disorders. The aim of this study was to prospectively assess the association between indicators of the Act-Belong-Commit behavioral domains and the development of problem drinking.

Data from two waves of the Irish Longitudinal Study on Ageing (TILDA) were analyzed. The sample consisted of 3950 adults aged  $\geq 50$  years. A validated scale for problem drinking was 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 the development of problem drinking at two-year follow-up.

Each increase in the number of social/recreational activities (Act) inversely predicted the onset of problem drinking. Similarly, being well integrated into social networks (Belong) was negatively associated with the development of problem drinking. Finally, frequency of participation in social/recreational activities (Commit) also inversely predicted the onset of problem drinking. These associations were apparent regardless of the presence of baseline common mental disorders.

Act-Belong-Commit indicators are shown to be associated with a reduced risk for problem drinking. This lends further support to the Act-Belong-Commit domains and has wide-ranging implications for preventing substance use disorders in the aging community.

## 1. Introduction

Substance use disorders contribute to a significant proportion of the global disease burden, with vast negative implications for the health and wellbeing of individuals, families, and society as a whole. In 2010, mental, neurological, and substance use disorders (MNS) together constituted the leading cause of years lived with disability worldwide (Whiteford et al., 2013). Mental and substance use disorders are further estimated to account for 60% of suicide deaths (Patel et al., 2016). Alcohol use disorders (AUDs) were responsible for 6.9% of the total proportion of MNS disability adjusted life years in 2010 (Patel et al.,

2016). Research has demonstrated that high levels of alcohol consumption have a range of negative outcomes for health. For example, it is the cause of 5.8% of all cancer deaths globally (Connor, 2017). Further, recent longitudinal neuro-imaging studies have shown that even moderate alcohol consumption levels are associated with multiple markers of adverse cognitive and structural brain outcomes (Topiwala et al., 2017). More specifically, studies have suggested that late-life AUDs differ in many aspects from those with early onset AUDs, and that a considerable proportion of older adults with AUDs begin to abuse in late life (45+ years) (Wetterling et al., 2003), with some studies suggesting that as many as  $\frac{1}{4}$  to  $\frac{2}{3}$  of AUD patients in treatment had onset

\* Corresponding author.

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

<http://dx.doi.org/10.1016/j.drugalcdep.2017.08.033>

Received 2 July 2017; Received in revised form 26 August 2017; Accepted 27 August 2017

Available online 20 September 2017

0376-8716/© 2017 The Authors. Published by Elsevier Ireland Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

after the age of 60 (Atkinson, 1994). Finally, it should be noted that the financial burden of AUDs is considerable. For the year 2010, economic costs attributable to alcohol use and AUDs are estimated to amount to 1.3–3.3% of gross domestic product in a range of high and middle-income countries, with two-thirds of the loss being represented by productivity loss (Patel et al., 2016).

As health systems face various economic restrictions and continuing health care demands due to demographic aging (Rechel et al., 2009), adequate financial resources may not be available to properly address the burden of MNS disorders. This is particularly the case for substance use disorders, which have historically been unrecognized and under-prioritized in the fields of psychiatry and health care policy (Robinson and Adinoff, 2016). More importantly, public mental health strategies designed to prevent AUDs and harmful alcohol use, specifically those pertaining to behavioral interventions, are scarce. Further, it is relevant to identify factors protective against problem drinking in the aging process, as regular alcohol consumption may progress towards harmful alcohol use and AUDs in the context of circumstances such as divorce (Leonard and Rothbard, 1999), retirement (Finlayson et al., 1988; Hurt et al., 1988), bereavement (Nicholson et al., 2017), multi-morbidity and disability (Ryan et al., 2013; Samokhvalov et al., 2010). Thus, there is a pressing need to identify possible and sustainable approaches to prevent MNS disorders, which can be incorporated into population, community, and clinical settings (Anwar McHenry and Donovan, 2013; EC, 2008; Volkow et al., 2016; WHO, 2004, 2005).

A number of relevant theories from the field of behavioral economics have been applied extensively to abnormal behavior, particularly in the area of AUDs and other substance use disorders (Vuchinich and Tucker, 1988; Vuchinich et al., 1987). Importantly, as these theories have been applied to alcohol and substance use and misuse, they have made major contributions to characterizing how the presence of alternative reinforcers affect the consumption of such substances. According to a behavioral economic approach, individuals are less likely to consume a substance if they are confronted with a number of alternative reinforcers, particularly if such reinforcers afford greater long-term advantages. Another relevant theory pertains to that of an “opportunity cost”, which refers to a situation where options are mutually exclusive, i.e., the selection of one option renders the other option unavailable. When applied to alcohol and substance use, the theory stipulates that the consumption of substances requires time and resources, and individuals are less likely to use or misuse alcohol or other substances if their time and resources are focused elsewhere (e.g., sports, hobbies, social interaction, etc.) (Bickel et al., 2014). Several studies, involving mainly adolescents and young adults have demonstrated that positive activity engagement can effectively protect against the development of alcohol and drug misuse (Audrain-McGovern et al., 2013; Leventhal et al., 2015; Murphy et al., 2006).

Act-Belong-Commit is the world’s first comprehensive, population-wide, community-based mental health campaign (Donovan and Anwar McHenry, 2014). Act-Belong-Commit is a practical framework for health professionals and clinicians to promote mental health in the overall population as well as in specific settings. 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 framework essentially promotes three behavioral domains thought to contribute to good mental health: Keeping physically, mentally, socially, and spiritually active (Act); developing a sense of belonging through social support networks and participation in group and community activities (Belong); and taking on challenges and committing to activities and hobbies that provide meaning and purpose (Commit).

Although Act-Belong-Commit has gained momentum internationally, more research is needed to explore how the campaign messages might impact not just on mental health but also with respect to the prevention of negative behavioral health outcomes. Given that intervention studies or clinical trials are not yet put in place to assess

causality, observational studies are warranted to assess risk reduction among people with lifestyles that appear to be in line with the Act-Belong-Commit messages. In contrast to extensive research reporting lifestyle and social network determinants of mental and neurological disorders, the bulk of studies investigating preventative measures against substance use disorders and harmful alcohol use do so primarily with a focus on either wider economic markers, such as alcohol pricing and availability, or individual neurobiological or socio-economic risk factors. Further, preventative measures generally include things like social skills building, emotion regulation, or educational approaches regarding the harms of substance use (Pettigrew and Donovan, 2003; Sandler et al., 2014). As a result, there is a clear gap in the literature in terms of behavioral lifestyle factors that could effectively contribute towards greater resilience against the development of AUDs, and how these, by extension, could be addressed in a population setting.

Thus, the aim of the current study was to prospectively assess the association between Act-Belong-Commit indicators and the onset of problem drinking in a population of older adults. To achieve this aim, we conducted a study using data from the first two waves of the Irish Longitudinal Study on Ageing (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 domains (Santini et al., 2017). Previous somewhat similar studies appear to only have been focused on separate isolated predictors (e.g., one type of activity), or other related but distinct outcomes (e.g., binge drinking). Further, most previous studies were not prospective. To our knowledge, this is the first study to prospectively assess associations between social/recreational activities and social network integration with the development of problem drinking in a nationally-representative sample of older adults.

It is essential to conduct such large-scale epidemiological studies in order to inform relevant policy makers regarding the potential effectiveness of the Act-Belong-Commit domains in a nation-wide setting. Based on previous research reporting benefits and protective properties of Act-Belong-Commit in the context of mental and neurological disorders (Donovan et al., 2016; Santini et al., 2017), we hypothesized that each of the Act-Belong-Commit indicators would similarly be associated with a reduced risk for developing problem drinking in our sample. Although substance use disorders are distinct phenomena from mental and neurological disorders, the reasoning behind our hypothesis was that the Act-Belong-Commit domains appear to be beneficial across a range of mental health outcomes, and this could also mean greater resilience against the development of problem drinking.

## 2. Methods

### 2.1. Study design and sample

We analyzed data from two consecutive waves of the Irish Longitudinal Study of Ageing (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 who were 50 years of age or older. 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. Those who were unable to personally provide written informed consent to participate in the survey because of severe cognitive impairment 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 baseline survey, 84% returned the SCQ at W1 (Kearney et al., 2011; Whelan and Savva, 2013). W1 comprised of 8504 people aged  $\geq 50$  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. Of those who participated at W2, 86% returned the SCQ. Our analysis restricted the sample to: participants aged 50 years and above at W1; participants not screening positive for problem drinking at baseline (given our focus on the population at risk); participants not being lifetime abstainers (abstainers are generally not at risk for developing problem drinking, and were omitted as per conventional approach) (Edens et al., 2008); participants who returned the SCQ at W1 and W2; and those who provided information on problem drinking at W2. We used these restrictions as the data on Act-Belong-Commit indicators, problem drinking, and some other variables used in the analysis were obtained from the SCQ at W1. Problem drinking was the only variable from W2 that was used in our analysis. After restriction to these individuals, the sample size was 3950 comprising 7900 person years of follow-up. Fig. 1 illustrates the process of restricting the analytical sample. 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. Problem drinking

Problem drinking was measured with the validated and reliable CAGE screening tool for previous or present alcohol problems (Chan et al., 1994; Mayfield et al., 1974). The questionnaire is not a complex psychological test, although it has a strong grounding in the psychological mechanisms involved in the development of AUDs and the behavioral effects of the drinking (O'Brien, 2008). The CAGE instrument assesses four aspects of drinking with the following questions: Have you ever felt you should Cut down on your drinking?; Have people Annoyed you by criticizing your drinking?; Have you ever felt bad or Guilty about your drinking?; and Have you ever had a drink first thing in the morning (Eye-opener) to steady your nerves or to get rid of a hangover? Individual item responses were scored 0 (no) or 1 (yes). These scores were added to create a composite score ranging from 0 to 4 and problem drinkers were defined as those with a score of  $\geq 2$  (Mayfield et al., 1974). Given that CAGE screens for previous or present alcohol problems, the elimination of CAGE problem drinkers in the baseline sample thus pertained to lifetime problem drinking.

### 2.2.2. Act-Belong-Commit indicators

We defined the Act-Belong-Commit indicators similarly to a previous publication (Santini et al., 2017). Participants were asked whether or not they generally participated in 11 different activities (i.e., not time-specific as within last week or year), and if so, how often: Going to films, plays, concerts; Attending classes, lectures; Travelling for

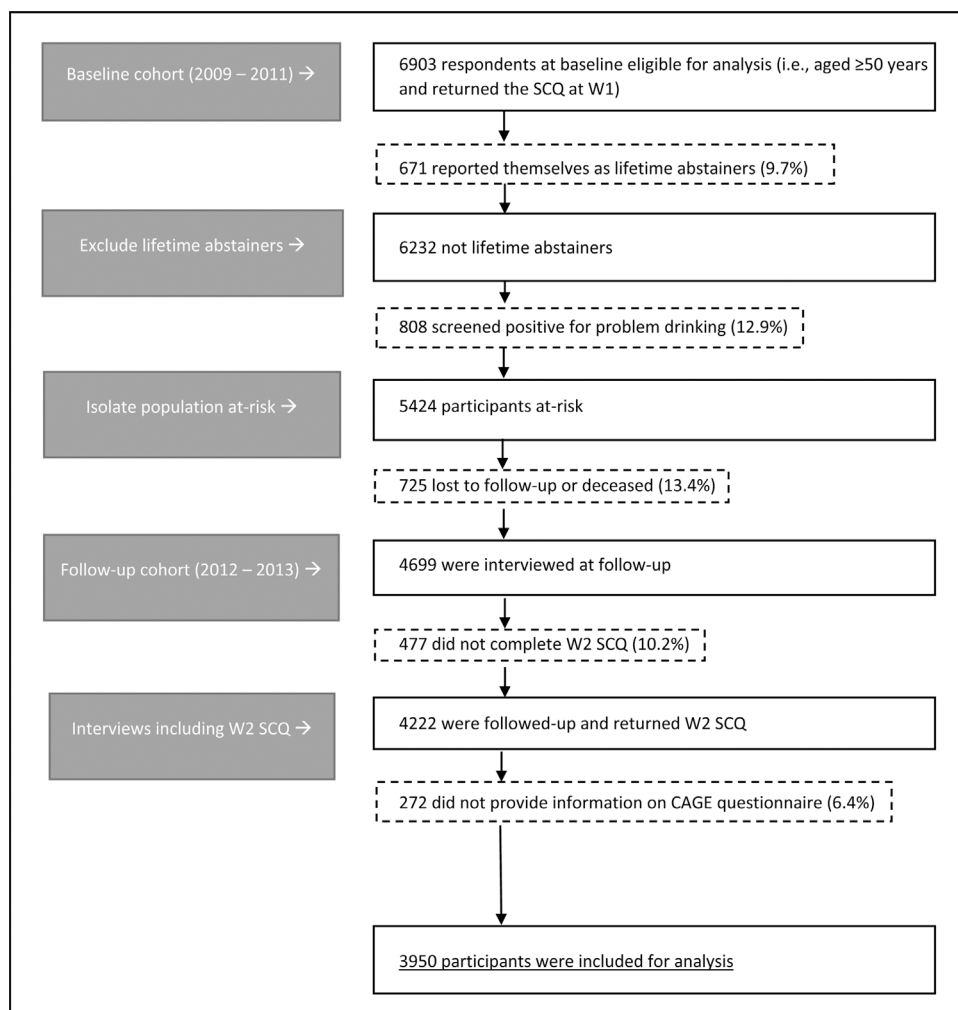


Fig. 1. Flowchart of the study sample. Abbreviations: SCQ – Self-completion questionnaire; W1 – Wave 1; W2 – Wave 2.

Abbreviations: SCQ – Self-completion questionnaire; W1 – Wave 1; W2 – Wave 2

Pleasure; Working on garden, home, car; Reading books, magazines; Hobbies, creative activities; Playing Cards, bingo, games; 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 11. Cronbach's alpha for Act items was 0.75. 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 (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 11 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 77. Cronbach's alpha for Commit items was 0.72.

### 2.2.3. Potential confounders

Sociodemographic characteristics included gender, age (50–59, 60–69, 70–79, and  $\geq 80$  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).

Smoking status was classified as: never; past; current. 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  $\geq 2$ .

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.

The existence of common mental disorders (CMD) was operationalized as including the presence of either depression, anxiety, or both. The scale used for depression was the 20-item Center for Epidemiologic Studies Depression (CES-D) (Hertzog et al., 1990; Lewinsohn et al., 1997; Radloff, 1977), where case depression was defined as a score of  $\geq 16$  (Beekman et al., 1997). The scale used for anxiety was the anxiety subscale of the Hospital Anxiety and Depression Scale (HADS-A) (Spinhoven et al., 1997; Zigmond and Snaith, 1983), where anxiety was defined as a score of  $\geq 8$  (Bjelland et al., 2002; Olsson et al., 2005).

### 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. Multivariable logistic regression analysis was conducted to assess the associations between Act-Belong-Commit indicators and problem drinking. Act-Belong-Commit indicators (exposure variable) were based on data collected at W1. The outcome was onset of problem drinking, which was assessed among those who did not screen positive for problem drinking at baseline (W1), and referred to new cases of problem drinking at W2 (outcome).

We constructed two models. First, model I was adjusted for sex, age, education, employment status, smoking status, number of chronic medical conditions, and ADL disability based on information obtained at W1. Chronic medical conditions, disability, and smoking status were considered as potential confounders as they have been associated with problem drinking (Bien and Burge, 1990; Enoch, 2011; Holst et al., 2017; Samokhvalov et al., 2010), and because they are also known to be related to social support networks (Avlund et al., 2004; Christakis and Fowler, 2008; Shankar et al., 2011; Stuck et al., 1999; Valtorta et al., 2016) and engagement in social/recreational activities (Decarlo, 1974; Dias-da-Costa et al., 2005; Hubert et al., 1993; Lindstrom et al., 2003). Next, model II adjusted for the same variables as in model I and additionally the presence of CMD at baseline. This was done as a sensitivity analysis in order to investigate the role of mental disorders (Alonso et al., 2004) in the association between predictors and the outcome. In order to assess whether the presence of CMDs at baseline modified the association between Act-Belong-Commit indicators and problem drinking, we also checked for interactions by including an interaction term between each predictor variable and common mental disorders.

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 exposure variable. All VIFs were  $< 2$ , which is much lower than the commonly used cut off of 10 (R. M. 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 ( $n = 3950$ ) was 62.4 (8.9) years, and 52.0% were females. For all respondents who had a follow-up interview at W2, the median lag between the two waves was

**Table 1**  
Baseline characteristics of the study sample.

Characteristic	Category	
Unweighted N		3950
Sex	Female	2186 (52.0)
Age (years)	50–59	1684 (44.0)
	60–69	1365 (33.2)
	70–79	716 (17.2)
	80+	185 (5.5)
Education	Primary	915 (31.7)
	Secondary	1661 (46.7)
	Tertiary	1373 (21.6)
Employment status	Employed	1567 (40.1)
	Retired	1428 (33.7)
	Unemployed	906 (26.2)
Chronic medical conditions	None	921 (23.7)
	One	1119 (28.3)
	Two or more	1910 (48.0)
ADL disability	Present	271 (7.2)
Smoking status	Never	1784 (43.5)
	Past	1580 (39.8)
	Current	586 (16.8)
Common mental disorder <sup>a</sup>	Present	971 (25.9)
Act (mean ± SD) <sup>b</sup>		9.41(2.3)
Belong <sup>c</sup>	Most isolated	225 (6.5)
	Moderately isolated	1008 (27.0)
	Moderately integrated	1623 (41.1)
	Most integrated	1094 (25.5)
Commit (mean ± SD) <sup>d</sup>		43.0(11.7)

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.

<sup>a</sup> Common mental disorder included CES-D depression and HADS-A anxiety.

<sup>b</sup> Number of activities engaged in. Possibilities include: Going to films, plays, concerts; Attending classes, lectures; Travelling for Pleasure; Working on garden, home, car; Reading books, magazines; Hobbies, creative activities; Playing Cards, bingo, games; Eating out of house; Participating in sport, exercise; Visiting or calling family, friends; Voluntary work. The scale ranged from 0 to 11.

<sup>c</sup> Based on the Social Network Index (SNI).

<sup>d</sup> Frequency of engagement in activities listed in Act. The scale ranged from 0 to 77.

24 months (range 16–40 months). The baseline sample characteristics are presented in Table 1. In the unrestricted baseline sample, 812 (11.9%) screened positive for problem drinking. This prevalence rate is similar to that reported for the Irish population in other publications (Nolan et al., 2014; WHO, 2014). The number of participants in the unrestricted sample who were not abstainers was 5092 (71.6%). The number of lifetime abstainers was 671 (12.8%). Of those who screened positive for problem drinking at W1, demographics were as follows: female 316 (4.1%), male 496 (7.8%); 50–59 years old 472 (7.1%), 60–69 years old 240 (3.5%), 70–79 years old 87 (1.1%), 80 years or above 13 (0.2%). Of those who were abstainers, demographics were as follows: female 423 (8.1%), male 248 (4.8%); 50–59 years old 137 (2.7%), 60–69 years old 221 (4.1%), 70–79 years old 228 (4.1%), 80 years old or above 85 (2.0%).

Table 2 shows the association between Act-Belong-Commit indicators and the onset of problem drinking estimated by multivariable logistic regression. At two-year follow-up, there were 257 (6.6%) new cases of problem drinking. All the following reported results pertain to those obtained in model I (i.e., unadjusted for common mental disorders). In terms of the Act indicator, each increase in number of activities was associated with significantly lower likelihood of developing problem drinking [OR (95%CI): 0.91 (0.83, 0.99)]. In terms of the Belong indicator, as compared to the most isolated category, significant reduced risk was found for all other network categories, the moderately isolated [0.45 (0.27, 0.75)], the moderately integrated [0.38 (0.23, 0.63)], and the most integrated [0.34 (0.20, 0.59)]. In terms of the Commit indicator, each increase in frequency of activity engagement was associated with significantly lower likelihood of developing problem drinking [0.98 (0.97, 0.996)].

**Table 2**  
The association between baseline Act-Belong-Commit indicators and problem drinking<sup>a</sup> among older adults estimated by multivariable logistic regression.

	Model I			Model II		
	OR	95% CI	P-value	OR	95% CI	P-value
Act <sup>b</sup>	0.91	0.83, 0.99	0.024	0.91	0.84, 0.99	0.031
Belong <sup>c</sup>						
Most isolated	1			1		
Moderately isolated	0.45	0.27, 0.75	0.002	0.41	0.24, 0.69	0.001
Moderately integrated	0.38	0.23, 0.63	< 0.001	0.34	0.21, 0.57	< 0.001
Most integrated	0.34	0.20, 0.59	< 0.001	0.32	0.19, 0.57	< 0.001
Commit <sup>d</sup>	0.98	0.97, 0.996	0.015	0.98	0.97, 0.999	0.042

Participants screening positive for problem drinking at baseline were omitted from the analysis. Model I adjusted for gender, age, education, employment status, smoking status, chronic medical conditions, activities of daily living (ADL) disability. Model II adjusted for the aforementioned as well as the presence of common mental disorders at Wave 1 (CES-D depression/HADS-A anxiety). OR: odds ratio; CI: confidence interval.

<sup>a</sup> Wave 2 problem drinking based on the CAGE screening tool for problem drinking.

<sup>b</sup> Number of activities engaged in. Possibilities include: Going to films, plays, concerts; Attending classes, lectures; Travelling for Pleasure; Working on garden, home, car; Reading books, magazines; Hobbies, creative activities; Playing Cards, bingo, games; Eating out of house; Participating in sport, exercise; Visiting or calling family, friends; Voluntary work. The scale ranged from 0 to 11.

<sup>c</sup> Based on the Social Network Index (SNI).

<sup>d</sup> Frequency of engagement in activities listed in Act. The scale ranged from 0 to 77.

The additional analysis including common mental disorders at baseline (model 2) showed that common mental disorders had little influence in the associations. We found no significant interactions between the Act-Belong-Commit indicators and common mental disorders on its association with problem drinking.

## 4. Discussion

Our results show a clear dose-response pattern with a decreased risk against the onset of problem drinking for each level of increase in Act-Belong-Commit indicators. To our knowledge, this is the first study to assess the association between Act-Belong-Commit indicators and onset of problem drinking 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 a validated scale for problem drinking. 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 (including possible reluctance to disclose problematic alcohol use due to social non-acceptance) 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. However, these were not a part of the TILDA survey, hence the use of indicators. 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, we did not have a measure to distinguish between activities that were alcohol-free or alcohol-related. This could have an influence when estimating associations between engagement in activities and risk for developing problem drinking. Fourth, the focus of the CAGE instrument is on the behavioral effects of problem drinking. However, the results would likely have

been different if we had used a different outcome for alcohol use and misuse, such quantity and frequency, especially given that light/moderate drinking may be positively associated with some Act-Belong-Commit indicators. Fifth, it is possible that problem drinking itself may have prevented some participants from being part of the follow-up survey. Thus, we may have missed some important information due to the nature of the outcome of interest. Sixth, 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, and also neighborhood characteristics. Thus, the possibility of residual confounding due to socioeconomic status cannot be totally dismissed. Last, those who were not followed at W2 were more likely to be older, unemployed, and have disability and lower education at baseline. Thus, loss to follow-up could have introduced some bias as well as affecting to some degree the extent to which the subsample is representative of Irish population.

#### 4.2. Contextualization of findings

Our results suggest that the development of AUDs and the exacerbation of problematic alcohol consumption could to some extent be prevented through behavioral factors. Research has shown that approximately 40–50% of the variability in the course and development of AUDs is not associated with genetic predisposition, and even for those genetically predisposed, environmental factors are essential (McGue, 1999). Thus, a substantial amount of risk for problem drinking is within human control. Further, studies into the psychology of addiction have shown that subjects dependent on a substance will not inevitably succumb to drug consumption – or may even decrease their consumption – if or when the subjects are confronted with an attractive or appealing alternative (Alexander et al., 1978; Hart et al., 2000; Kirkpatrick et al., 2012). In other words, those with dependence may not choose to use a psycho-active substance if there are other alternatives readily available, and this mechanism may also equally apply to the general development of substance misuse. Within the Act-Belong-Commit framework, such attractive and appealing alternatives 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. Awareness of the Act-Belong-Commit messages could potentially attract people towards engaging in mental health-promoting and meaningful activities, and ultimately away from a misuse trajectory characterized by harmful alcohol consumption.

In terms of engaging in activities, our results confirm previous results showing that participating in leisure activity tends to be negatively associated with alcohol use/abuse (Kunz, 1997; Thundal et al., 1999). That is, reduced alcohol consumption has been reported for the more active forms of leisure or for activities that require some effort or challenge, whereas this is not generally the case for more passive forms of leisure, such as television viewing or spectator sport-events (Kunz, 1997). Most other related studies on leisure activities have not used problem drinking or indicators of AUDs as outcomes, but rather binge drinking, also suggesting that some types of leisure activities may sometimes reinforce harmful alcohol use (e.g., sporting events) (Andersson et al., 2012, 2014). However, even if some leisure activities may also involve the consumption of alcohol (e.g., social gatherings), our results suggest that there is an overall reduced risk associated with keeping physically, mentally, socially and spiritually active against problem drinking. Physical activity in particular has consistently been found to prevent or reduce harmful drinking and AUDs. One large-scale 21-year follow-up study involving Danes showed that physical activity specifically was a protective factor against developing AUDs (Ejsing et al., 2015). Additionally, for those already on a path towards dependency, physical exercise appears to reduce cravings, withdrawal symptoms, and relapse rates in patients with AUDs, a so-called “anti-drug seeking” effect of exercise (Daniel et al., 2006; Olsen, 2011;

Prochaska et al., 2008).

One may also consider that a major reason for people consuming alcohol relates to its presumed potential for relaxing and reducing stress (Dawson et al., 2005a,b; Smith et al., 1993). However, there are many healthier paths to stress reduction and increasing wellbeing, such as physical exercise (Hamer et al., 2009), spending time in nature (Bratman et al., 2015a,b; Marselle et al., 2014; Shanahan et al., 2016), and spiritual or meditative practices (Grossman et al., 2004; Holzel et al., 2011). Accordingly, these types of activities also appear to be negatively associated with harmful alcohol use (Andersson et al., 2012, 2014), which may be an indication that they are in fact, among other things, used as an alternative stress-reducer to alcohol. Further, meditative practices have been found to be effective in treating both stimulant addictions (Glasner et al., 2016; Oikonomou et al., 2016) and reducing harmful alcohol consumption (along with exercise) (Murphy et al., 1986), while environmental enrichment, for example through nature or art, appears to reduce sensitivity to substance abuse and impart a “protective phenotype” to prevent or treat addiction (Olsen, 2011; Solinas et al., 2010; Thiel et al., 2009).

There is evidence that harmful alcohol use and dependence is associated with restricted social networks (Hanson, 1994; Joutsenniemi et al., 2007; Thundal et al., 1999), and that things like social isolation and loneliness are contributing factors in the growth of alcohol abuse (Åkerlind and Hornquist, 1992; Nicholson et al., 2017). Our study shows that being well integrated into social support networks is associated with considerable reduced risk for developing problem drinking. Generally, stronger support networks have been found to be beneficial for various aspects of mental health and wellbeing (Cacioppo et al., 2010; Cruwys et al., 2014; Glanville et al., 2013; Kuiper et al., 2015; Olsson et al., 2013), one reason being that people tend to make use of their social connections in order to cope with stressors and deal with negative emotions. Interestingly, research has shown that people with larger social networks also exhibit greater pain tolerance (Johnson and Dunbar, 2016), which may be explained by increased brain endorphin activity due to the influence of regular contact with socially supportive peers. Thus, being socially connected may also serve as a healthy alternative to alcohol as a way to cope with stressors and emotional or even physical pain.

In terms of frequency of activities, our results show that being more active and involved is negatively associated with the development of problem drinking. One obvious reason may be attributed to the fact that of the time and resources people have available in their everyday lives, spending a great amount of time on various leisure time activities simply leaves less room for also consuming and reinforcing alcohol use and abuse. Some activities may also require more effort or more concentration, which means that consuming alcohol would likely hinder participation or make it considerably more difficult to participate with satisfying results (Kunz, 1997). Another reason may be that people derive meaning and personal satisfaction from being involved in activities they are passionate about (Csikszentmihalyi, 1990; Heady and Wearing, 1992; Lyubomirski et al., 2005), which ultimately reduces the need or desire to alter their mood and perception with the use of alcohol. There is evidence to show that sense of meaning and purpose, quality of life, and life satisfaction predict sustained remission for patients treated for substance use disorders (Laudet et al., 2009, 2006; Laudet and Stanick, 2010; Rudolf and Watts, 2002), and it is possible that the same mechanism also applies before the onset of AUDs, effectively preventing them from developing in the first place.

Finally, our analysis indicated that the obtained results were not mediated, nor moderated by baseline common mental disorders. This suggests an independent association between baseline Act-Belong-Commit indicators and problem drinking at follow-up, which is not contingent on psychiatric morbidity. In other words, Act-Belong-Commit indicators appear to reduce risk for problem drinking prospectively, regardless of whether the individual is experiencing mental health problems. That is, the Act-Belong-Commit domains appear to

promote behavioral health, across the entire continuum from positive mental health to mental ill-health.

Future studies may examine prospective associations between specific activities that have been theoretically or empirically linked to problem drinking, such as exercise (Leasure et al., 2015), volunteer activity (Finlay et al., 2012), or goal-directed activities (Brownell et al., 1986; Moos, 2008). Such studies are scarce in population research, and could offer valuable insights into the potential of various types of activity engagement in preventing AUDs in the general population. Additionally, future studies may be improved further by including variables, such as neighborhood context variables or household income. Including such measures could provide more insight into the dynamics involved in the link between social network integration, leisure time activity, and alcohol use and misuse.

#### 4.3. Implications for policy and practice

Our results suggest that the Act-Belong-Commit campaign, if implemented successfully, could have wide-ranging implications for the prevention of problem drinking in the general population. Some important advantages may be considered. There is widespread agreement that for people with substance use disorders, the attenuated release of dopamine occurring through repeated drug or alcohol consumption renders the brain's reward system much less sensitive to both drug-related and non-drug related rewards (Olsen, 2011; Volkow et al., 2016). It is for this reason that such persons often become less motivated by everyday stimuli (for example relationships and activities) that were previously both motivating and rewarding. Importantly, these neurochemical changes become deeply engrained and cannot be immediately reversed simply by terminating drug or alcohol consumption. Therefore, it is critical to reinforce rewards associated with normal everyday stimuli for people at-risk for developing AUDs before this adaptation in neurocircuitry takes place. One such method for reinforcing such behaviors may be possible by means of an intervention approach to facilitating Act-Belong-Commit behaviors and lifestyles in the general population. However, it should also be noted that there is some evidence from self-report studies that simple awareness raising regarding the Act-Belong-Commit principles may be helpful in reinforcing mentally healthy behaviors in clinical populations (Donovan et al., 2016).

One may also consider that the protective properties of keeping active and socially engaged is likely reduced for events and activities where there is a strong social norm focused on alcohol consumption, as the risk for developing AUDs increases with increasing frequencies of alcohol intake (Dawson et al., 2005a,b; Flensburg-Madsen et al., 2007). Similarly, being very socially integrated is likely not protective against problem drinking if one is embedded in social networks with high levels of alcohol consumption or binge drinking. Public health interventions may target specific activities or social environments in order to reduce the role of alcohol (Andersson et al., 2012). It should also be noted that alcohol consumption, for better and for worse, spreads through social networks (Rosenquist et al., 2010), and it may be possible to facilitate social network contagion, thereby curbing harmful alcohol consumption levels and changing social alcohol consumption norms. Ideally, individuals should be encouraged to spend time engaging in meaningful and rewarding activities that are not based or strongly focused on alcohol consumption.

Finally, very few community-based behavioral interventions exist specifically to prevent AUDs. Most interventions focus on education about the harms of drugs and alcohol, others on social deprivation, such as poverty, crime, violence, and unemployment, yet others on economic factors, such as pricing, promotion, and availability of alcohol (NICE, 2010). However, there is very little literature to suggest: 1) how healthy and creative everyday life activities and social interactions may protect against developing AUDs; 2) how mental health and wellbeing may be enhanced, which in turn may reduce alcohol intake or substitute

activities that involve alcohol consumption; and perhaps most importantly, 3) what people can actually do themselves in order to prevent harmful alcohol use in their own lives and enhance their mental health and wellbeing. The Act-Belong-Commit framework offers one such possibility for creating awareness, and intervening in the community. Further, the Act-Belong-Commit framework does not require trained professionals (e.g., psychologists or social workers), since it focuses on harnessing resources already available in the community, such as leisure time activities, social interaction with supportive peers, and personally meaningful hobbies or causes.

## 5. Conclusion

This study has shown that Act-Belong-Commit indicators are significantly associated with a reduced risk for developing problem drinking in Irish community-dwelling older adults. Being mentally, physically, spiritually, or socially active (Act) was negatively associated with the onset of problem drinking, and the risk was reduced proportionally with more different activities that individuals engaged in. Being well integrated into social networks (Belong) was inversely related to the development of problem drinking. Finally, frequency of engaging in activities (Commit) was negatively associated with problem drinking as well. Our study provides evidence that the Act-Belong-Commit campaign, if successfully implemented, may be effective as a public mental health intervention with wide-ranging implications for preventing harmful alcohol consumption and alcohol use disorders in the aging community.

## Conflict of interest

None of the authors have any interests to declare in relation to this submission.

## Role of funding source

Nothing declared.

## Contributors

All authors approved of the manuscript before submission.

## 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<sup>©</sup> Department of Health and Children. Copyright and all other intellectual property rights relating to the data are vested in TILDA.

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).

## References

- Åkerlind, I., Hornquist, J.O., 1992. Loneliness and alcohol abuse: a review of evidences of an interplay. *Soc. Sci. Med.* 34, 405–414.
- Alexander, B.K., Coombs, R.B., Hadaway, P.F., 1978. The effect of housing and gender on morphine self-administration in rats. *Psychopharmacology (Berl.)* 58, 175–179.
- Alonso, J., Angermeyer, M.C., Bernert, S., Bruffaerts, R., Brugha, T.S., Bryson, H., de Girolamo, G., Graaf, R., Demyttenaere, K., Gasquet, I., Haro, J.M., Katz, S.J., Kessler, R.C., Kovess, V., Lépine, J.P., Ormel, J., Polidori, G., Russo, L.J., Vilagut, G., Almansa, J., Arbabzadeh-Bouchez, S., Autonell, J., Bernal, M., Buist-Bouwman, M.A., Codony, M., Domingo-Salvany, A., Ferrer, M., Joo, S.S., Martínez-Alonso, M., Matschinger, H., Mazzi, F., Morgan, Z., Morosini, P., Palacín, C., Romera, B., Taub, N., Vollebergh,

- W.A., 2004. 12-Month comorbidity patterns and associated factors in Europe: results from the European Study of the Epidemiology of Mental Disorders (ESEMeD) project. *Acta Psychiatr. Scand. Suppl.* 420, 28–37. <http://dx.doi.org/10.1111/j.1600-0047.2004.00328.x>.
- Andersson, A., Andersson, C., Holmgren, K., Mårdby, A., Hensing, G., 2012. Participation in leisure activities and binge drinking in adults: findings from a Swedish general population sample. *Addict. Res. Theory* 20, 172–182. <http://dx.doi.org/10.3109/16066359.2011.596595>.
- Andersson, A., Mardby, A.C., Holmgren, K., Hensing, G., 2014. Associations between leisure activities and binge drinking in adults: findings from a Swedish newly sick-listed sample. *Work* 48, 143–153. <http://dx.doi.org/10.3233/wor-131606>.
- Anwar McHenry, J., Donovan, R.J., 2013. Developing the Perth charter for the promotion of mental health and wellbeing. *Adv. Ment. Health* 12, 8–10. <http://dx.doi.org/10.5172/jamh.2013.12.1.8>.
- Atkinson, R.M., 1994. Late onset problem drinking in older adults. *Int. J. Geriatr. Psychiatry* 9, 321–326. <http://dx.doi.org/10.1002/gps.930090409>.
- Audrain-McGovern, J., Rodriguez, D., Cuevas, J., Sass, J., 2013. Initial insight into why physical activity may help prevent adolescent smoking uptake. *Drug Alcohol Depend.* 132, 471–478. <http://dx.doi.org/10.1016/j.drugalcdep.2013.03.006>.
- Avlund, K., Lund, R., Holstein, B.E., Due, P., 2004. Social relations as determinant of onset of disability in aging. *Arch. Gerontol. Geriatr.* 38, 85–99.
- Beekman, A.T., Deeg, D.J., Van Limbeek, J., Braam, A.W., De Vries, M.Z., Van Tilburg, W., 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, 231–235.
- 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, 186–204.
- Bickel, W.K., Johnson, M.W., Koffarnus, M.N., MacKillop, J., Murphy, J.G., 2014. The Behavioral economics of substance use disorders: reinforcement pathologies and their repair. *Annu. Rev. Clin. Psychol.* 10, 641–677. <http://dx.doi.org/10.1146/annurev-clinpsy-032813-153724>.
- Bien, T.H., Burge, R., 1990. Smoking and drinking: a review of the literature. *Int. J. Addict.* 25, 1429–1454.
- Bjelland, I., Dahl, A.A., Haug, T.T., Neckelmann, D., 2002. The validity of the Hospital Anxiety and Depression Scale. *J. Psychosom. Res.* 52, 69–77. [http://dx.doi.org/10.1016/S0022-3999\(01\)00296-3](http://dx.doi.org/10.1016/S0022-3999(01)00296-3).
- Bratman, G.N., Daily, G.C., Levy, B.J., Gross, J.J., 2015a. The benefits of nature experience: improved affect and cognition. *Landscape Urban Plan.* 138, 41–50. <http://dx.doi.org/10.1016/j.landurbplan.2015.02.005>.
- Bratman, G.N., Hamilton, J.P., Hahn, K.S., Daily, G.C., Gross, J.J., 2015b. Nature experience reduces rumination and subgenual prefrontal cortex activation. *Proc. Natl. Acad. Sci.* 112, 8567–8572. <http://dx.doi.org/10.1073/pnas.1510459112>.
- Brownell, K.D., Marlatt, G.A., Lichtenstein, E., Wilson, G.T., 1986. Understanding and preventing relapse. *Am. Psychol.* 41, 765–782.
- 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, 453–463. <http://dx.doi.org/10.1037/a0017216>.
- Chan, A.W., Pristach, E.A., Welte, J.W., 1994. Detection by the CAGE of alcoholism or heavy drinking in primary care outpatients and the general population. *J. Subst. Abuse* 6, 123–135.
- Christakis, N.A., Fowler, J.H., 2008. The collective dynamics of smoking in a large social network. *N. Engl. J. Med.* 358, 2249–2258. <http://dx.doi.org/10.1056/NEJMs0706154>.
- (Eds.). In: Cohen, S., Underwood, L.G., Gottlieb, B.H. (Eds.), *Social Support Measurement and Intervention: A Guide for Health and Social Scientists*. Oxford University Press, New York, NY.
- Connor, J., 2017. Alcohol consumption as a cause of cancer. *Addiction* 112, 222–228. <http://dx.doi.org/10.1111/add.13477>.
- Cronin, H., O'Regan, C., Finucane, C., Kearney, P., Kenny, R.A., 2013. Health and aging: development of the Irish Longitudinal Study on Ageing health assessment. *J. Am. Geriatr. Soc.* 61 (Suppl. 2), S269–S278. <http://dx.doi.org/10.1111/jgs.12197>.
- Cruwys, T., Haslam, S.A., Dingle, G.A., Haslam, C., Jetten, J., 2014. Depression and social identity: an integrative review. *Pers. Soc. Psychol. Rev.* 18, 215–238. <http://dx.doi.org/10.1177/1088868314523839>.
- Csikszentmihalyi, M., 1990. *Flow: The Psychology of Optimal Experience*. Harper Perennial, New York, NY.
- Daniel, J.Z., Cropley, M., Fife-Schaw, C., 2006. The effect of exercise in reducing desire to smoke and cigarette withdrawal symptoms is not caused by distraction. *Addiction* 101, 1187–1192. <http://dx.doi.org/10.1111/j.1360-0443.2006.01457.x>.
- Dawson, D.A., Grant, B.F., Li, T.K., 2005a. Quantifying the risks associated with exceeding recommended drinking limits. *Alcohol. Clin. Exp. Res.* 29, 902–908.
- Dawson, D.A., Grant, B.F., Ruan, W.J., 2005b. The association between stress and drinking: modifying effects of gender and vulnerability. *Alcohol Alcohol.* 40, 453–460. <http://dx.doi.org/10.1093/alcac/agh176>.
- Decarlo, T.J., 1974. Recreation participation patterns and successful aging. *J. Gerontol.* 29, 416–422. <http://dx.doi.org/10.1093/geronj/29.4.416>.
- Dias-da-Costa, J.S., Hallal, P.C., Wells, J.C., Daltoe, T., Fuchs, S.C., Menezes, A.M., Olinto, M.T., 2005. Epidemiology of leisure-time physical activity: a population-based study in southern Brazil. *Cad. Saude Publica* 21, 275–282. <http://dx.doi.org/10.1590/S0102-311X2005000100030>.
- Donovan, R., Anwar McHenry, J., 2014. Act-Belong-Commit: lifestyle medicine for keeping mentally healthy. *Am. J. Lifest. Med.* 8, 33–42.
- Donovan, R., Jalleh, G., Robinson, K., Lin, C., 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, 274–275. <http://dx.doi.org/10.1111/1753-6405.12514>.
- EC, 2008. *Improving Mental Health in Population: Policy Briefs*. European Commission, Luxembourg.
- Edens, E.L., Glowinski, A.L., Grazier, K.L., Bucholz, K.K., 2008. The 14-year course of alcoholism in a community sample: do men and women differ? *Drug Alcohol Depend.* 93, 1–11. <http://dx.doi.org/10.1016/j.drugalcdep.2007.08.013>.
- Ejlsing, L.K., Becker, U., Tolstrup, J.S., Flensburg-Madsen, T., 2015. Physical activity and risk of alcohol use disorders: results from a prospective cohort study. *Alcohol Alcohol.* 50, 206–212. <http://dx.doi.org/10.1093/alcac/agu097>.
- Enoch, M.-A., 2011. The role of early life stress as a predictor for alcohol and drug dependence. *Psychopharmacology (Berl.)* 214, 17–31. <http://dx.doi.org/10.1007/s00213-010-1916-6>.
- Finlay, A.K., Ram, N., Maggs, J.L., Caldwell, L.L., 2012. Leisure activities, the social weekend, and alcohol use: evidence from a daily study of first-year college students. *J. Stud. Alcohol Drugs* 73, 250–259.
- Finlayson, R.E., Hurt, R.D., Davis Jr., L.J., Morse, R.M., 1988. Alcoholism in elderly persons: a study of the psychiatric and psychosocial features of 216 inpatients. *Mayo Clin. Proc.* 63, 761–768.
- Flensburg-Madsen, T., Knop, J., Mortensen, E.L., Becker, U., Gronbaek, M., 2007. Amount of alcohol consumption and risk of developing alcoholism in men and women. *Alcohol Alcohol.* 42, 442–447. <http://dx.doi.org/10.1093/alcac/agn033>.
- Glanville, J.L., Andersson, M.A., Paxton, P., 2013. Do social connections create trust? An examination using new longitudinal data. *Soc. Forces* 92, 545–562.
- Glaser, S., Mooney, L.J., Ang, A., Garneau, H.C., Hartwell, E., Brecht, M.-L., Rawson, R.A., 2016. Mindfulness-based relapse prevention for stimulant dependent adults: a pilot randomized clinical trial. *Mindfulness* 1–10. <http://dx.doi.org/10.1007/s12671-016-0586-9>.
- Grossman, P., Niemann, L., Schmidt, S., Walach, H., 2004. Mindfulness-based stress reduction and health benefits. A meta-analysis. *J. Psychosom. Res.* 57, 35–43. [http://dx.doi.org/10.1016/S0022-3999\(03\)00573-7](http://dx.doi.org/10.1016/S0022-3999(03)00573-7).
- 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, 1111–1114. <http://dx.doi.org/10.1136/bjism.2008.046243>.
- Hanson, B.S., 1994. Social network, social support and heavy drinking in elderly men – a population study of men born in 1914, Malmö, Sweden. *Addiction* 89, 725–732.
- Hart, C.L., Haney, M., Foltin, R.W., Fischman, M.W., 2000. Alternative reinforcers differentially modify cocaine self-administration by humans. *Behav. Pharmacol.* 11, 87–91. <http://dx.doi.org/10.1097/00008877-200002000-00010>.
- Heady, B., Wearing, A., 1992. *Understanding Happiness: A Theory of Subjective Wellbeing*. Longman Cheshire, Melbourne, AU.
- Hertzog, C., Van Alstine, J., Usala, P.D., Hultsch, D.F., Dixon, R., 1990. Measurement properties of the Center for Epidemiological Studies Depression Scale (CES-D) in older populations. *Psychol. Assess.* 2, 64–72. <http://dx.doi.org/10.1037/1040-3590.2.1.64>.
- Holst, C., Tolstrup, J.S., Sorensen, H.J., Becker, U., 2017. Alcohol dependence and risk of somatic diseases and mortality: a cohort study in 19,002 men and women attending alcohol treatment. *Addiction*. <http://dx.doi.org/10.1111/add.13799>.
- Holzel, B.K., Carmody, J., Vangel, M., Congleton, C., Yerramsetti, S.M., Gard, T., Lazar, S.W., 2011. Mindfulness practice leads to increases in regional brain gray matter density. *Psychiatry Res.* 191, 36–43. <http://dx.doi.org/10.1016/j.psychres.2010.08.006>.
- 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, 480–488.
- Hurt, R.D., Finlayson, R.E., Morse, R.M., Davis Jr., L.J., 1988. Alcoholism in elderly persons: medical aspects and prognosis of 216 inpatients. *Mayo Clin. Proc.* 63, 753–760.
- Johnson, K.V.A., Dunbar, R.I.M., 2016. Pain tolerance predicts human social network size. *Sci. Rep.* 6. <http://dx.doi.org/10.1038/srep25267>.
- Joutsenniemi, K., Martelin, T., Kestila, L., Martikainen, P., Pirkola, S., Koskinen, S., 2007. Living arrangements, heavy drinking and alcohol dependence. *Alcohol Alcohol.* 42, 480–491. <http://dx.doi.org/10.1093/alcac/agn011>.
- Katz, S., Ford, A.B., Moskowitz, R.W., Jackson, B.A., Jaffe, M.W., 1963. Studies of illness in the aged: the index of ADL: a standardized measure of biological and psychosocial function. *JAMA* 185, 914–919.
- Kearney, P.M., Cronin, H., O'Regan, C., Kamiya, Y., Savva, G.M., Whelan, B., Kenny, R., 2011. Cohort profile: the Irish Longitudinal Study on Ageing. *Int. J. Epidemiol.* 40, 877–884. <http://dx.doi.org/10.1093/ije/dyr116>.
- Kirkpatrick, M.G., Gunderson, E.W., Johanson, C.E., Levin, F.R., Foltin, R.W., Hart, C.L., 2012. Comparison of intranasal methamphetamine and d-amphetamine self-administration by humans. *Addiction* 107, 783–791. <http://dx.doi.org/10.1111/j.1360-0443.2011.03706.x>.
- Koushede, V., Nielsen, L., Meilstrup, C., Donovan, R.J., 2015. From rhetoric to action: adapting the Act-Belong-Commit mental health promotion programme to a Danish context. *Int. J. Mental Health Prom.* 17, 22–33. <http://dx.doi.org/10.1080/14623730.2014.995449>.
- Kuiper, J.S., Zuidersma, M., Oude Voshaar, R.C., Zuidema, S.U., van den Heuvel, E.R., Stolk, R.P., Smidt, N., 2015. Social relationships and risk of dementia: a systematic review and meta-analysis of longitudinal cohort studies. *Ageing Res. Rev.* 22, 39–57. <http://dx.doi.org/10.1016/j.arr.2015.04.006>.
- Kunz, J.L., 1997. Associating leisure with drinking: current research and future directions. *Drug Alcohol Rev.* 16, 69–76. <http://dx.doi.org/10.1080/09595239700186331>.
- Laudet, A.B., Stanick, V., 2010. Predictors of motivation for abstinence at the end of outpatient substance abuse treatment. *J. Subst. Abuse Treat.* 38, 317–327. <http://dx.doi.org/10.1016/j.jsat.2010.01.007>.



- Laudet, A.B., Morgen, K., White, W.L., 2006. The role of social supports, spirituality, religiousness, life meaning and affiliation with 12-step fellowships in quality of life satisfaction among individuals in recovery from alcohol and drug problems. *Alcohol Treat. Q.* 24, 33–73. [http://dx.doi.org/10.1300/J020v24n01\\_04](http://dx.doi.org/10.1300/J020v24n01_04).
- Laudet, A.B., Becker, J.B., White, W.L., 2009. Don't wanna go through that madness no more: quality of life satisfaction as predictor of sustained remission from illicit drug misuse. *Subst. Use Misuse* 44, 227–252. <http://dx.doi.org/10.1080/10826080802714462>.
- Leasure, J.L., Neighbors, C., Henderson, C.E., Young, C.M., 2015. Exercise and alcohol consumption: what we know, what we need to know, and why it is important. *Front. Psychiatry* 6, 156. <http://dx.doi.org/10.3389/fpsy.2015.00156>.
- Leonard, K.E., Rothbard, J.C., 1999. Alcohol and the marriage effect. *J. Stud. Alcohol Suppl.* 13, 139–146.
- Leventhal, A.M., Bello, M.S., Unger, J.B., Strong, D.R., Kirkpatrick, M.G., Audrain-McGovern, J., 2015. Diminished alternative reinforcement as a mechanism underlying socioeconomic disparities in adolescent substance use. *Prev. Med.* 80, 75–81. <http://dx.doi.org/10.1016/j.ypmed.2015.05.021>.
- Lewinsohn, P.M., Seeley, J.R., Roberts, R.E., Allen, N.B., 1997. Center for Epidemiologic Studies Depression Scale (CES-D) as a screening instrument for depression among community-residing older adults. *Psychol. Aging* 12, 277–287.
- Lindstrom, M., Isacson, S.O., Elmstahl, S., 2003. Impact of different aspects of social participation and social capital on smoking cessation among daily smokers: a longitudinal study. *Tob. Control* 12, 274–281.
- Lyubomirski, S., Sheldon, K.M., Schkade, D., 2005. Pursuing happiness: the architecture of sustainable change. *Rev. Gen. Psychol.* 9, 111–131.
- 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, 134–147. <http://dx.doi.org/10.1089/eco.2014.0027>.
- Mayfield, D., McLeod, G., Hall, P., 1974. The CAGE questionnaire: validation of a new alcoholism screening instrument. *Am. J. Psychiatry* 131, 1121–1123. <http://dx.doi.org/10.1176/ajp.131.10.1121>.
- McGue, M., 1999. The behavioral genetics of alcoholism. *Curr. Dir. Psychol. Sci.* 8, 109–115. <http://dx.doi.org/10.1111/1467-8721.00026>.
- Moos, R.H., 2008. Active ingredients of substance use-focused self-help groups. *Addiction* 103, 387–396. <http://dx.doi.org/10.1111/j.1360-0443.2007.02111.x>.
- Murphy, T.J., Pagano, R.R., Marlatt, G.A., 1986. Lifestyle modification with heavy alcohol drinkers: effects of aerobic exercise and meditation. *Addict. Behav.* 11, 175–186.
- Murphy, J.G., Barnett, N.P., Colby, S.M., 2006. Alcohol-related and alcohol-free activity participation and enjoyment among college students: a behavioral theories of choice analysis. *Exp. Clin. Psychopharmacol.* 14, 339–349. <http://dx.doi.org/10.1037/1064-1297.14.3.339>.
- NICE, 2010. Alcohol-use Disorders: Prevention. National Institute for Health and Care Excellence, UK.
- Nicholson, D., McCormack, F., Seaman, P., Bell, K., Duffy, T., Gilhooly, M., 2017. Alcohol and healthy ageing: a challenge for alcohol policy. *Public Health* 148, 13–18. <http://dx.doi.org/10.1016/j.puhe.2017.02.021>.
- Nolan, A., O'Regan, C., Dooley, C., Wallace, D., Hever, A., Cronin, H., Hudson, E., 2014. The Over 50s in a Changing Ireland: Economic Circumstances, Health and Well-being. The Irish Longitudinal Study on Ageing (TILDA), Dublin.
- O'Brien, C.P., 2008. The cage questionnaire for detection of alcoholism. *JAMA* 300, 2054–2056. <http://dx.doi.org/10.1001/jama.2008.570>.
- O'Brien, R.M., 2007. A caution regarding rules of thumb for variance inflation factors. *Qual. Quant.* 41, 673–690. <http://dx.doi.org/10.1007/s11135-006-9018-6>.
- Oikonomou, M.T., Arvanitis, M., Sokolove, R.L., 2016. Mindfulness training for smoking cessation: a meta-analysis of randomized-controlled trials. *J. Health Psychol.* <http://dx.doi.org/10.1177/1359105316637667>.
- Olsen, C.M., 2011. Natural rewards, neuroplasticity, and non-drug addictions. *Neuropharmacology* 61, 1109–1122. <http://dx.doi.org/10.1016/j.neuropharm.2011.03.010>.
- 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. <http://dx.doi.org/10.1186/1471-244x-5-46>.
- Olsson, C.A., McGee, R., Nada-Raja, S., Williams, S.M., 2013. A 32-year longitudinal study of child and adolescent pathways to well-being in adulthood. *J. Happiness Stud.* 14, 1069–1083.
- Patel, V., Chisholm, D., Parikh, R., Charlson, F.J., Degenhardt, L., Dua, T., Ferrari, A.J., Hyman, S., Laxminarayan, R., Levin, C., Lund, C., Mora, M.E.M., Petersen, I., Scott, J., Shidhaye, R., Vijayakumar, L., Thornicroft, G., Whiteford, H., 2016. Addressing the burden of mental, neurological, and substance use disorders: key messages from Disease Control Priorities, 3rd edition. *Lancet* 387, 1672–1685. [http://dx.doi.org/10.1016/s0140-6736\(15\)00390-6](http://dx.doi.org/10.1016/s0140-6736(15)00390-6).
- Pettigrew, S., Donovan, R., 2003. A Literature Review of the Factors That Influence Alcohol Consumption and the Effectiveness of Past Interventions. Curtin University, Perth, AU.
- Prochaska, J.J., Hall, S.M., Humfleet, G., Munoz, R.F., Reus, V., Gorecki, J., Hu, D., 2008. Physical activity as a strategy for maintaining tobacco abstinence: a randomized trial. *Prev. Med.* 47, 215–220. <http://dx.doi.org/10.1016/j.ypmed.2008.05.006>.
- Radloff, L.S., 1977. The CES-D Scale: a self-report depression scale for research in the general population. *Appl. Psychol. Meas.* 1, 385–401. <http://dx.doi.org/10.1177/014662167700100306>.
- Rechel, B., Doyle, Y., Grundy, E., McKee, M., 2009. How Can Health Systems Respond to Population Aging? World Health Organization, Geneva, CH.
- Robinson, S.M., Adinoff, B., 2016. The classification of substance use disorders: historical, contextual, and conceptual considerations. *Behav. Sci.* 6. <http://dx.doi.org/10.3390/bs6030018>.
- Rosenquist, J.N., Murabito, J., Fowler, J.H., Christakis, N.A., 2010. The spread of alcohol consumption behavior in a large social network. *Ann. Intern. Med.* 152, 426–433. <http://dx.doi.org/10.7326/0003-4819-152-7-201004060-00007>. w141.
- Rudolf, H., Watts, J., 2002. Quality of life in substance abuse and dependency. *Int. Rev. Psychiatry* 14, 190–197. <http://dx.doi.org/10.1080/09540260220144975>.
- Ryan, M., Merrick, E.L., Hodgkin, D., Horgan, C.M., Garnick, D.W., Panas, L., Ritter, G., Blow, F.C., Saitz, R., 2013. Drinking patterns of older adults with chronic medical conditions. *J. Gen. Intern. Med.* 28, 1326–1332. <http://dx.doi.org/10.1007/s11606-013-2409-1>.
- Samokhvalov, A.V., Popova, S., Room, R., Ramonas, M., Rehm, J., 2010. Disability associated with alcohol abuse and dependence. *Alcohol. Clin. Exp. Res.* 34, 1871–1878. <http://dx.doi.org/10.1111/j.1530-0277.2010.01275.x>.
- Sandler, I., Wolchik, S.A., Cruden, G., Mahrer, N.E., Ahn, S., Brincks, A., Brown, C.H., 2014. Overview of meta-analyses of the prevention of mental health, substance use and conduct problems. *Annu. Rev. Clin. Psychol.* 10, 243–273. <http://dx.doi.org/10.1146/annurev-clinpsy-050212-185524>.
- 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. *Exp. Gerontol.* 91, 79–87. <http://dx.doi.org/10.1016/j.exger.2017.02.074>.
- Shanahan, D.F., Bush, R., Gaston, K.J., Lin, B.B., Dean, J., Barber, E., Fuller, R.A., 2016. Health benefits from nature experiences depend on dose. *Sci. Rep.* 6, 28551. <http://dx.doi.org/10.1038/srep28551>.
- Shankar, A., McMunn, A., Banks, J., Steptoe, A., 2011. Loneliness, social isolation, and behavioral and biological health indicators in older adults. *Health Psychol.* 30, 377–385. <http://dx.doi.org/10.1037/a0022826>.
- Smith, M.J., Abbey, A., Scott, R.O., 1993. Reasons for drinking alcohol: their relationship to psychosocial variables and alcohol consumption. *Int. J. Addict.* 28, 881–908. <http://dx.doi.org/10.3109/10826089309039662>.
- Solinas, M., Thiriet, N., Chauvet, C., Jaber, M., 2010. Prevention and treatment of drug addiction by environmental enrichment. *Prog. Neurobiol.* 92, 572–592. <http://dx.doi.org/10.1016/j.pneurobio.2010.08.000>.
- Spinhoven, P., Ormel, J., Sloekers, P.P., Kempen, G.I., Speckens, A.E., Van Hemert, A.M., 1997. A validation study of the Hospital Anxiety and Depression Scale (HADS) in different groups of Dutch subjects. *Psychol. Med.* 27, 363–370.
- Stuck, A.E., Walthert, J.M., Nikolaus, T., Bula, C.J., Hohmann, C., Beck, J.C., 1999. Risk factors for functional status decline in community-living elderly people: a systematic literature review. *Soc. Sci. Med.* 48, 445–469.
- Thiel, K.J., Sanabria, F., Pentkowski, N.S., Neisewander, J.L., 2009. Anti-craving effects of environmental enrichment. *Int. J. Neuropsychopharmacol.* 12, 1151–1156. <http://dx.doi.org/10.1017/s1461145709990472>.
- Thundal, K.L., Granbom, S., Allebeck, P., 1999. Women's alcohol dependence and abuse: the relation to social network and leisure time. *Scand. J. Public Health* 27, 30–37.
- Topiwala, A., Allan, C.L., Valkanova, V., Zsoldos, E., Filippini, N., Sexton, C., Mahmood, A., Fooks, P., Singh-Manoux, A., Mackay, C.E., Kivimäki, M., Ebmeier, K.P., 2017. Moderate alcohol consumption as risk factor for adverse brain outcomes and cognitive decline: longitudinal cohort study. *BMJ* 357, j2353. <http://dx.doi.org/10.1136/bmj.j2353>.
- Valtorta, N.K., Kanaan, M., Gilbody, S., Ronzi, S., Hanratty, B., 2016. Loneliness and social isolation as risk factors for coronary heart disease and stroke: systematic review and meta-analysis of longitudinal observational studies. *Heart*. <http://dx.doi.org/10.1136/heartjnl-2015-308790>.
- Volkow, N.D., Koob, G.F., McLellan, A.T., 2016. Neurobiologic advances from the brain disease model of addiction. *N. Engl. J. Med.* 374, 363–371. <http://dx.doi.org/10.1056/NEJMra1511480>.
- Vuchinich, R.E., Tucker, J.A., 1988. Contributions from behavioral theories of choice to an analysis of alcohol abuse. *J. Abnorm. Psychol.* 97, 181–195.
- Vuchinich, R.E., Tucker, J.A., Rudd, E.J., 1987. Preference for alcohol consumption as a function of amount and delay of alternative reward. *J. Abnorm. Psychol.* 96, 259–263.
- 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, 2014. Global Status Report on Alcohol and Health 2014. World Health Organization, Geneva, CH.
- Wetterling, T., Veltrup, C., John, U., Driessen, M., 2003. Late onset alcoholism. *Eur. Psychiatry* 18, 112–118. [http://dx.doi.org/10.1016/S0924-9338\(03\)00025-7](http://dx.doi.org/10.1016/S0924-9338(03)00025-7).
- Whelan, B.J., Savva, G.M., 2013. Design and methodology of the Irish longitudinal study on ageing. *J. Am. Geriatr. Soc.* 61 (Suppl. 2), S265–268. <http://dx.doi.org/10.1111/jgs.12199>.
- Whiteford, H.A., Degenhardt, L., Rehm, J., Baxter, A.J., Ferrari, A.J., Erskine, H.E., Charlson, F.J., Norman, R.E., Flaxman, A.D., Johns, N., Burstein, R., Murray, C.J.L., Vos, T., 2013. Global burden of disease attributable to mental and substance use disorders: findings from the Global Burden of Disease Study 2010. *Lancet* 382, 1575–1586. [http://dx.doi.org/10.1016/s0140-6736\(13\)61611-6](http://dx.doi.org/10.1016/s0140-6736(13)61611-6).
- Zigmond, A.S., Snaith, R.P., 1983. The hospital anxiety and depression scale. *Acta Psychiatr. Scand.* 67, 361–370.