

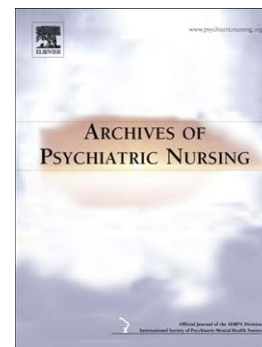
Accepted Manuscript

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PII: S0883-9417(14)00125-3
DOI: doi: [10.1016/j.apnu.2014.08.006](https://doi.org/10.1016/j.apnu.2014.08.006)
Reference: YAPNU 50647

To appear in: *Archives of Psychiatric Nursing*



Please cite this article as: Vancampfort, D., De Hert, M., Stubbs, B., Soundy, A., De Herdt, A., Detraux, J. & Probst, M., A systematic review of physical activity correlates in alcohol use disorders, *Archives of Psychiatric Nursing* (2014), doi: [10.1016/j.apnu.2014.08.006](https://doi.org/10.1016/j.apnu.2014.08.006)

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Number of words text: 3,345

Tables: 2

Figures: 1

A systematic review of physical activity correlates in alcohol use disorders

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Abstract

Background: Physical activity might promote mental and physical health in persons with alcohol use disorder. Understanding the barriers and facilitators of participation in physical activity in persons with alcohol use disorder is an essential first step in order to devise effective physical activity interventions.

Objective: The present review provides a systematic quantitative review of the correlates of physical activity in people with alcohol use disorder.

Methods: Major electronic databases were searched by two independent authors from inception till June 2014. Keywords included ‘physical activity’ or ‘exercise’ and ‘alcohol dependence’ or ‘alcohol abuse’ or ‘alcohol use disorders’ or ‘alcoholism’.

Results: Five papers evaluating 14 correlates were included. Three studies reported that alcohol dependence was unrelated to physical activity behavior, while alcohol abuse showed positive associations in 2 studies. No demographic variable was related with physical activity participation. Functional impairments and distress associated with alcohol use disorders including increased smoking rates, obesity, anxiety, depression and a lower self-efficacy may limit one’s ability to be physically active. Data on social, environmental and policy related factors are currently lacking. No included study assessed physical activity levels utilizing objective measurements (e.g. pedometers, accelerometers).

Conclusion: Although the literature on physical activity correlates in persons with alcohol use disorder still is equivocal, our varied findings support the hypothesis that the participation in physical activity by people with alcohol use disorder is determined by a range of complex factors.

Keywords: physical activity; alcohol abuse; alcohol dependence

1. Introduction

Alcohol misuse is the world's third largest risk factor for disease burden and is associated with a diverse range of adverse effects on physical and mental health and premature mortality [1]. Although still preliminary, existing studies demonstrate that physical activity might promote mental and physical health in persons with alcohol use disorder [2-5]. For example, review findings in persons with alcohol use disorder [4] indicate that physical activity might reduce drinking episodes and craving, while improving psychological outcomes like depression, anxiety and sleep quality and increasing physical fitness.

There is a continuing debate about the amount (e.g., frequency, intensity, duration) of physical activity needed for the mental and physical health benefits in persons with alcohol use disorder [3, 5]. Understanding the barriers and facilitators of participation in physical activity in alcohol use disorder is an essential first step in order to devise effective physical activity interventions. Behavioral theories, such as the social-ecological model [6] are useful in attempting to understand the factors which influence physical activity behavior. Social-ecological models posit that multiple relevant attributes influence health behavior. These include intrapersonal (demographic, biological, psychological, emotional and cognitive), interpersonal/cultural (e.g., social support), physical environment (e.g., distance to the facilities, financial costs, enjoyable scenery), and policy (laws, rules, regulations, codes) factors [6]. Intrapersonal, interpersonal, physical environment and policy related variables have demonstrated strong associations with physical activity in patients with severe mental illness [7-10]. Specifically in previous physical activity research [7-70], the correlates are collated according to the following categories: (a) demographic, (b) biological, (c) psychological / cognitive / emotional, (d) behavioral attributes/skills, (e) social/cultural factors, (f) physical environment, and (g) policy factors.

Although there seems to be an association between physical activity and alcohol use behavior in population-based samples [11, 12], it is unclear whether this relation extends to

alcohol use disorders. Two general population-based studies identified contrasting associations between levels physical activity and levels of alcohol consumption. French et al. [11] found that alcohol consumption was positively related to physical activity at vigorous intensity while Smothers et al. [12] identified an ‘inverted J’ association; that is, the likelihood of displaying a physically active lifestyle increased from abstinence to moderate drinking, then declined at heavier consumption. Differences in findings between both studies could be due to differences in physical activity measurements used.

More than 20% of inpatients with alcohol use disorders identify financial costs, a lack of motivation, the time required for the activity and the need for transportation as the key barriers to physical activity participation [13]. The participants recognized as well that engaging in regular physical activity could provide tension relief, reduce stress levels and create a more positive attitude. At the same time they suggested that fatigue and poor physical condition prevented them to participate in physical activities [13]. In order to elaborate and confirm such findings, quantitative research which is able to identify potential mediators and moderators of actual physical activity levels is also needed. This information can then be used to target future physical activity interventions for persons with alcohol use disorder [14].

A systematic review on physical activity correlates in persons with alcohol use disorder is however currently lacking. This is a significant gap in the rehabilitation literature, given that alcohol use disorders are associated with increased mental and physical morbidity [15, 16] which may result in impairments that could interfere with the ability to be physically active. In addition, physical activity is known to have a beneficial effect on the common mental health co-morbidities seen in this population, such as depression and anxiety disorders [17]. Moreover, physical activity is known to be as effective as medication in preventing mortality in several of the physical health problems seen in this population such as cardiovascular disease [18]. A systematic review of quantitative research of potential mediators and

moderators of physical activity will provide valuable information to implement physical activity in clinical practice and will inform future research. Recently, a number of such reviews have been conducted to inform clinical practice in other populations including binge eating disorder [10] and dementia [9].

The present review therefore systematically evaluates published quantitative studies on correlates of physical activity in persons with a diagnosis of alcohol use disorder. In addition to summarizing methods and results of these studies, gaps in the literature are identified and directions for future research are proposed.

2. Methods

2.1. Data sources and searches

Two independent reviewers (DV and ADH) performed an electronic search of the health-related databases PubMed, CINAHL and Embase, and this from the inception of these databases until June 2014. Manual searches were also conducted using the reference lists from identified articles. The medical subject headings used were ‘physical activity’ OR ‘exercise’

AND 'alcohol dependence' OR 'alcohol abuse' OR 'alcohol use disorders' OR 'alcoholism' in the title, abstract or index term fields.

2.2. Eligibility criteria

Inclusion criteria were as follows: (a) a diagnosis of alcohol use disorder (assessed with a structured clinical diagnostic interview), (b) participants were at least 18 years of age, (c) studies contained quantitative research and had been published in a peer-reviewed journal, (d) the dependent variable was a measure of physical activity participation. No restriction was placed on the selection of the outcome measure or the language of the article. For cohort or intervention studies, only associations of physical activity participation with baseline data were included.

We excluded articles if the dependent variable was aerobic fitness, physical activity intention, self-efficacy, or other intermediate (non-behavioral) measures because these variables are less direct indicators of actual physical activity [19]. Also, case reports, conference abstracts, and expert opinions were excluded.

2.3. Data collection

Two reviewers independently extracted data from the included studies using a predetermined form. The form captured data in 6 domains including (a) gender, (b) age, (c) ethnicity, (d) alcohol use disorder status, (e) the quality of the physical activity measure, (f) physical activity correlates.

The following categories were used to code the quality of the physical activity measure: (a) self-report with poor, unknown or not reported reliability/validity in people with alcohol use disorder, (b) self-report with reported and acceptable reliability/validity in persons with alcohol use disorder, and (c) acceptable objective measurements for people with alcohol use

disorder. Objective measurements included motion sensors such as accelerometers and pedometers, combined heart rate and accelerometer devices and the doubly labeled water method [20]. The acceptability of the psychometric properties of measurement tools was assessed according to recommendations from DeVon and colleagues [21].

In accordance with previous reviews [7-10] the following potential physical activity correlate categories were included: (a) demographic, (b) biological, (c) psychological / cognitive / emotional, (d) behavioral attributes/skills, (e) social/cultural factors, (f) physical environment, and (g) policy factors. Variables were classified as 'related' or 'not related' to physical activity based on statistical significance, and the direction of association for related variables was identified. The detailed data tables were further analyzed (see § 2.4. and 2.5) to create tables that summarized the state of the literature on different variables.

2.4. Coding associations with physical activity

A variety of statistical techniques were used to evaluate correlates, including uni-/ bivariate analyses, including correlations, t-tests, and ANOVA. If both uni-/bivariate and multivariate tests were conducted, uni-/bivariate tests were reported for consistency across studies. The column 'related to physical activity' indicates, which studies reported significant associations between the variable and the physical activity measure. Direction of association is indicated with a '+' or '-'. The column 'unrelated to physical activity' indicates which studies reported non-significant associations between the variable and physical activity.

2.5. Summary codes

A summary code for each variable was presented and calculated in accordance with the method of Sallis and colleagues [22]. The summary code column contains a code to summarize the state of the literature for that variable. The percentages refer to the number of

associations supporting the expected association divided by the total number of associations for the variable. Associations were coded with: '0' (0-33% of studies supporting association); '?' (34%-59% of studies supporting an association); or '+' or '-' (60%-100% of studies supporting an association). When correlates were reported in 4 or more studies the summary code for these correlates were considered as 'consistent'.

3. Results

3.1. Study selection

Out of 25 potentially eligible studies, 5 were included in this review [13, 23-26]. The search strategy and reasons for exclusion are shown in Figure 1.

[Insert Figure 1 about here]

3.2. Participant and study characteristics

Across all studies, the sample size of the persons with alcohol use disorder ranged from 22 to 20,046. All included participants were diagnosed according to the DSM-IV criteria of alcohol dependence or alcohol abuse.

Concerning the quality of the physical activity measure, all assessments were based on unvalidated or unreliable self-report measures of physical activity or measures with unknown psychometric properties for persons with alcohol use disorder. No study used an objective measure of physical activity.

Table 1 presents the characteristics of the included participants, the quality of physical activity assessment and statistical analysis undertaken.

[Insert Table 1 about here]

3.3. Correlates of physical activity in alcohol use disorders

Table 2 summarizes associations between potential correlates and physical activity.

Demographic correlates. For none of the 4 demographic variables there was a consistent (reported in 4 or more studies) association with physical activity behavior. Moreover, no apparent significant demographical correlates were identified.

Biological correlates. Three biological correlates were included. Physical disability, obesity and breathing frequency were negatively related to levels of physical activity participation, although data was not reported in 4 or more studies.

Behavioral attributes/skills. Four behavioral attributes were examined. Three studies reported that alcohol dependence was unrelated to physical activity behavior. While alcohol abuse showed positive associations in 2 studies, smoking behavior (in 2 studies) and nicotine dependence (in 1 study) were negatively associated with physical activity behavior.

Psychological, cognitive and emotional correlates. The presence of depressive symptoms, symptoms of anxiety and lower self-efficacy were all reported in one study as a negative correlate.

Social/cultural factors and the physical environment. No socio-cultural or environmental factors were found in the systematic review of the literature.

Policy factors. No policy-level correlates were located in the systematic review of the literature.

[Insert Table 2 about here]

4. Discussion

4.1. General findings and clinical implications

To the best of the authors' knowledge, the present review is the first to systematically document the correlates of physical activity in persons with alcohol use disorder. No consistent (i.e. reported in 4 or more studies) correlates were found for any of the categories of the socio-ecological model (i.e., demographic, biological, psychological / cognitive / emotional, behavioral attributes/skills, social/cultural factors, physical environment, and policy related factors) [6]. The lack of consistent correlates is due to (a) the paucity of

literature available and correlates studied, and (b) differences in study design, sample characteristics, choice of assessments/correlates and analysis methods.

Although the literature on physical activity correlates in persons with alcohol use disorder still is equivocal, our varied findings indicate that the participation in physical activity by people with alcohol use disorder is determined by a range of complex factors. The most reported finding was that there was a positive association between alcohol consumption and physical activity levels. However, alcohol dependence was unrelated to the level of physical activity. Research from the general population [11, 12] supports the current findings suggesting that until a certain level or a ‘ceiling effect’ is reached, higher consumption of alcohol is associated with higher levels of physical activity. Given this, it is likely that physical activity, particularly when vigorous in nature, serves as a reward by activating the same neurobiological reward systems that substance use or other rewards do [27]. Thus, in concordance with research from the general population the current review findings suggest that individuals with alcohol use disorder have an increased affinity for physical activity, perhaps because of its reward-related reinforcing effects. The clinical implication of this finding is that physical activity interventions may benefit from a treatment approach encouraging a deliberate pursuit of natural rewards, such as physical activity, to the exclusion of alcohol abuse. The current review findings do furthermore indicate that the positive association with physical activity disappears when alcohol use is excessive and associated with extreme physical and psychological consequences as in the case of alcohol dependence. This is concerning, since heavy drinkers with alcohol dependence are most likely to experience adverse health outcomes [17].

Further, based on the current review findings it might be speculated that the functional impairments and distress associated with alcohol use disorders including increased smoking rates, physical disability, obesity, anxiety, depression and a lower self-efficacy may limit

one's ability to be physically active. For example, physical health problems which may impair the ability to be physically active are extremely common in people with alcohol use disorder. Gossop et al. [15] demonstrated that 79% of those with a primary alcohol use disorder have at least one physical health problem, while 59% has two or more problems. Health problems were often serious, and 60% had at least one health problem that required treatment. The most common problems were gastrointestinal and liver disorders, but about a quarter of the sample had cardiovascular or neurological problems. Frequency of drinking, duration of alcohol use disorder, and severity of alcohol dependence were associated with increased physical morbidity [15].

Knowledge about demographic correlates of physical activity behavior will help to identify these high-risk patients with alcohol use disorder in whom physical activity is low or, even, likely to be reduced and who may therefore require intensified and targeted interventions. No significant demographic correlates were however observed. This finding should be encouraging to healthcare professionals, as it suggests that all people with alcohol use disorder can be expected to participate in some form of physical activity.

Another important observation was that, based on the current literature search, research on social, environmental and policy related factors that might be associated with physical activity behavior is lacking.

4.2. Limitations and future research

There are several limitations to this review, which should be acknowledged. First of all, the diversity of physical activity measures and analysis strategies prevented us performing a formal meta-analysis. Measuring physical activity levels poses many challenges. Self-report questionnaires are known to require motivation to complete all of the questions and often the

detail regarding the level (frequency, duration and intensity) and type of physical activity is not consistently evaluated by questionnaires [20, 28]. To the best of our knowledge, no physical activity questionnaire has been validated in people with alcohol use disorders so far. Fewer significant associations would also be expected in studies that relied on self-report measures. However, since no study used an objective measure of physical activities, we were not able to perform any additional analyses. Our findings do reveal that there is a high need for researchers to adopt a clear consensus on the assessment of physical activity in persons with alcohol use disorders, such as the European Association of Cardiovascular Prevention and Rehabilitation framework [20]. Validated physical activity measurements for persons with alcohol use disorder are highly needed. The crude measures of physical activity in our review may furthermore have led to inconsistent and false-negative results. Second, all correlates investigated were only documented in a small number of studies. Examination of the same, standardized variables in different studies is necessary in order to build a rigorous body of evidence that can support or refute the potential influence of individual variables. Future research should for example further explore in which way feelings of depression and a lower self-efficacy influence physical activity behavior. One model that links self-efficacy to physical activity participation is the exercise and self-esteem model (EXSEM) [29, 30]. The EXSEM states that increases in self-efficacy (and in particular the belief in one's capabilities to become or remain physically active) will increase physical activity participation. Various studies based on the EXEM model in the general population [29, 30] suggest that positive experiences when being physically active could enhance physical activity self-efficacy, which in turn may benefit one's physical self-perceptions. Future research should therefore investigate which techniques can stimulate these positive experiences and consequently support an enhanced sense of personal control over the body and its functioning in people with alcohol use disorder. Third, the majority of the studies investigated physical activity

correlates at one level of the social-ecological model, while no data about social, environmental and policy factors associated with physical activity behavior in alcohol use disorders was available. Future studies should therefore attempt to analyze the role of multiple correlates of physical activity from a social-ecological perspective. For example, various potential physical activity correlates have been identified at different levels of the social-ecological model, yet no research has examined as to how these interact to explain physical activity behavior. Given that research suggests that in order to maintain physical activity change, a multilevel perspective should be employed [6], exploring these interactions in persons with alcohol use disorder is highly important. Future research should also not only focus on the variables identified in the current systematic review, but for example should determine the amount and type of social support necessary to begin or maintain physical activity behavior in persons with alcohol use disorders. It should be examined if (a) the relationship between physical activity participation and professional or family support is a dynamic process in which the sources of support or need for support changes over time or not, and if (b) social barriers can be addressed by involving influential others in the rehabilitation process and by providing them with information on the importance of physical activity for persons with alcohol use disorders. The establishment of sound relationships between the physical environment and physical activity levels may also prove useful from a community planning or policy perspective. No environmental or policy-level correlates for physical activity participation in persons with alcohol use disorders were identified. Correlates at this level of the social-ecological model may be best initially explored using a qualitative approach [31]. Researchers should examine, which policies are currently in place to motivate persons with alcohol use disorders to an active and healthy lifestyle. Interviews of persons with alcohol use disorder, healthcare professionals and policy makers may provide further insight as to what is needed to stimulate an active lifestyle. Environmental modifications such

as making physical activity facilities easily accessible should be evaluated. If the purpose of this kind of physical activity research is to inform and motivate policy changes that will improve the mental and physical health of persons with alcohol use disorders merely documenting the relationship between environmental changes and physical activity behavior is likely to be insufficient. At some point, environmental and policy change research will need to include assessments of broader health outcomes in persons with alcohol use disorders, such as changes in the prevalence of chronic co-morbidities, health care service utilization, as well as the economic costs and benefits of proposed policy changes. This work should prioritize engagement with those who have alcohol dependence, since they are at particular risk of a range of physical and mental co-morbidities that might impair their daily life activities. A final limitation of this review is that the physical activity correlates literature in people with alcohol use disorder is based on cross-sectional studies, precluding the ability to infer causal relationships between the hypothesized correlates and physical activity. Cross-sectional studies are nevertheless an efficient and empirical means of screening many potential correlates, providing preliminary evidence that needs to be explored further in prospective studies.

In conclusion, our results demonstrate that the factors influencing physical activity participation in alcohol use disorders are equivocal. Alcohol dependence appears to be unrelated to participation whilst alcohol abuse is positively associated with physical activity. It appears that other factors not directly related to alcohol consumption per se including distress, smoking, obesity anxiety and depression are more important barriers to physical activity. We recommend that clinicians should consider these findings when encouraging people with alcohol use disorder to engage in physical activity. This will be particularly pertinent given that previous literature has demonstrated the positive effects of physical activity on the physical and mental health comorbidities commonly seen in this group.

Acknowledgements

XX is funded by the Research Foundation – Flanders (FWO-Vlaanderen).

References

- [1] World Health Organization. Global status report on alcohol and health 2011. Geneva: World Health Organization; 2011.
- [2] Ussher M, Sampuran AK, Doshi R, West R, Drummond DC. Acute effect of a brief bout of exercise on alcohol urges. *Addiction*. 2004;99(12):1542-1547.
- [3] Brown RA, Abrantes AM, Minami H, Read JP, Marcus BH, Jakicic J, Strong DR, Dubreuil ME, Gordon AA, Ramsey SE, Kahler CW, Stuart G. A preliminary, randomized trial of aerobic exercise for alcohol dependence. *J Subst Abuse Treat*. 2014;47(1):1-9.
- [4] Zschucke E, Heinz A, Ströhle A. Exercise and physical activity in the therapy of substance use disorders. *Scientific World Journal*. 2012; 2012: 901741.
- [5] Karoly HC, Stevens CJ, Thayer RE, Magnan RE, Bryan AD, Hutchison KE. Aerobic exercise moderates the effect of heavy alcohol consumption on white matter damage. *Alcohol ClinExp Res*.2013; 37(9):1508-1515.
- [6] Sallis JF, Cervero RB, Adcher W, Henderson KA, Kraft MK, Kerr J. An ecological approach to creating active living communities. *Annu Rev Public Health*, 2006; 27: 297-322.
- [7] Vancampfort D, Knapen J, Probst M, Scheewe T, Remans S, De Hert M. A systematic review of correlates of physical activity in patients with schizophrenia. *Acta Psychiatr Scand*, 2012; 125(5): 352-362.

- [8] Vancampfort D, Correll CU, Probst M, Sienaert P, Wyckaert S, De Herdt A, Knapen J, De Wachter D, De Hert M. A review of physical activity correlates in patients with bipolar disorder. *J Affect Disord*, 2013;145(3): 285-291.
- [9] Stubbs B, Eggermont L, Soundy A, Probst M, Vandenbulcke M, Vancampfort D. What are the factors associated with physical activity (PA) participation in community dwelling adults with dementia? A systematic review of PA correlates. *Arch Gerontol Geriatr*. 2014; 59(2): 195-220.
- [10] Vancampfort D, Vanderlinden J, Stubbs B, Soundy A, Pieters G, De Hert M, Probst M. Physical activity correlates in persons with binge eating disorder: a systematic review. *Eur Eat Disord Rev*. 2014; 22(0): 1-8.
- [11] French MT, Popovici I, Maclean JC. Do alcohol consumers exercise more? Findings from a national survey. *J Inf*. 2009; 24:1.
- [12] Smothers B, Bertolucci D. Alcohol consumption and health-promoting behavior in a US household sample: Leisure-time physical activity. *J Stud Alcohol*. 2001; 62(4):467–476.
- [13] Read JP, Brown RA, Marcus BH, Kahler CW, Ramsey SE, Dubreuil ME, Jakicic JM, Francione C. Exercise attitudes and behaviors among persons in treatment for alcohol use disorders. *J Subst Abuse Treat*. 2001;21(4):199-206.
- [14] Baranowski T, Cerin E, Baranowski J. Steps in the design, development and formative evaluation of obesity prevention-related behavior change trials. *Int J Behav Nutr Phys Act* 2009; 6: 6.
- [15] Gossop M, Neto D, Radovanovic M, Batra A, Toteva S, Musalek M, Skutle A, Goos C. Physical health problems among patients seeking treatment for alcohol use disorders: a study in six European cities. *Addict Biol*. 2007;12(2):190-196.

- [16] Conner KR, Pinquart M, Gamble SA. Meta-analysis of depression and substance use among individuals with alcohol use disorders. *J Subst Abuse Treat.* 2009;37(2):127-137.
- [17] National Institute of Clinical Health and Excellence. Alcohol-use disorders: diagnosis, assessment and management of harmful drinking and alcohol dependence. London: National Institute of Clinical Health and Excellence; 2011.
- [18] Naci H, Ioannidis JP. Comparative effectiveness of exercise and drug interventions on mortality outcomes: meta-epidemiological study. *BMJ.* 2013; 347: f5577.
- [19] Caspersen CJ, Powell KE, Christenson GM. Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. *Public Health Rep.* 1985; 100(2): 126-131.
- [20] Warren JM, Ekelund U, Besson H, Mezzani A, Geladas N, Vanhees L. Assessment of physical activity - a review of methodologies with reference to epidemiological research: a report of the exercise physiology section of the European Association of Cardiovascular Prevention and Rehabilitation. *Eur J CardiovascPrev Rehabil* 2010; 7(2): 127-139.
- [21] De Von HA, Block ME, Moyle-Wright P, Ernst DM, Hayden SJ, Lazzara DJ, Savoy SM, Kostas-Polston E. A psychometric toolbox for testing validity and reliability. *J Nursing Scholarsh*2007; 39(2): 155-164.
- [22] Sallis JF, Prochaska JJ, Taylor WC. A review of correlates of physical activity of children and adolescents. *Med Sci Sports Exerc.* 2000; 32(5): 963-975.
- [23] Chwastiak LA, Rosenheck RA, Kazis LE. Association of psychiatric illness and obesity, physical inactivity, and smoking among a national sample of veterans. *Psychosomatics* 2011;52: 230-236.

- [24] Park S, Cho MJ, Cho SJ, Bae JN, Lee JY, Park JI, Kim JY, Lee DW, Hong JP. Relationship between physical activity and mental health in a nationwide sample of Korean adults. *Psychosomatics*. 2011; 52(1): 65-73.
- [25] Herbsleb M, Schulz S, Ostermann S, Donath L, Eisenträger D, Puta C, Voss A, Gabriel HW, Bär KJ. The relation of autonomic function to physical fitness in patients suffering from alcohol dependence. *Drug Alcohol Depend*. 2013; 132(3):505-512.
- [26] Lisha NE, Sussman S, Fapa F, Leventhal AM. Physical activity and alcohol use disorders. *Am J Drug Alcohol Abuse*. 2013; 39(2): 115-120.
- [27] Greenwood BN, Foley TE, Le TV, Strong PV, Loughridge AB, Day HE, Fleshner M. Long-term voluntary wheel running is rewarding and produces plasticity in the mesolimbic reward pathway. *Behav Brain Res*. 2011; 217(2):354–362.
- [28] Soundy A, Taylor A, Faulkner G, Rowlands, A. The psychometric properties of the seven-day physical activity recall questionnaire in individuals with severe mental illness. *Arch Psychiatr Nurs*. 2007; 21: 309-316.
- [29] Sonstroem RJ, Morgan WP. Exercise and self-esteem: Rationale and model. *Med Sci Sports Exerc*. 1989; 21: 329-337.
- [30] Sonstroem RJ, Harlow LL, Gemma LM, Osborne S. Test of structural relationships within a proposed exercise and self-esteem model. *J Pers Assess*. 1991; 56: 348-364.
- [31] Petter M, Blanchard S, Kemp KR, Mazoff AS, Ferrier SN. Correlates of exercise among coronary heart disease patients: review, implications and future direction. *Eur J Cardiovasc Prev Rehabil*. 2009; 16: 515-526.

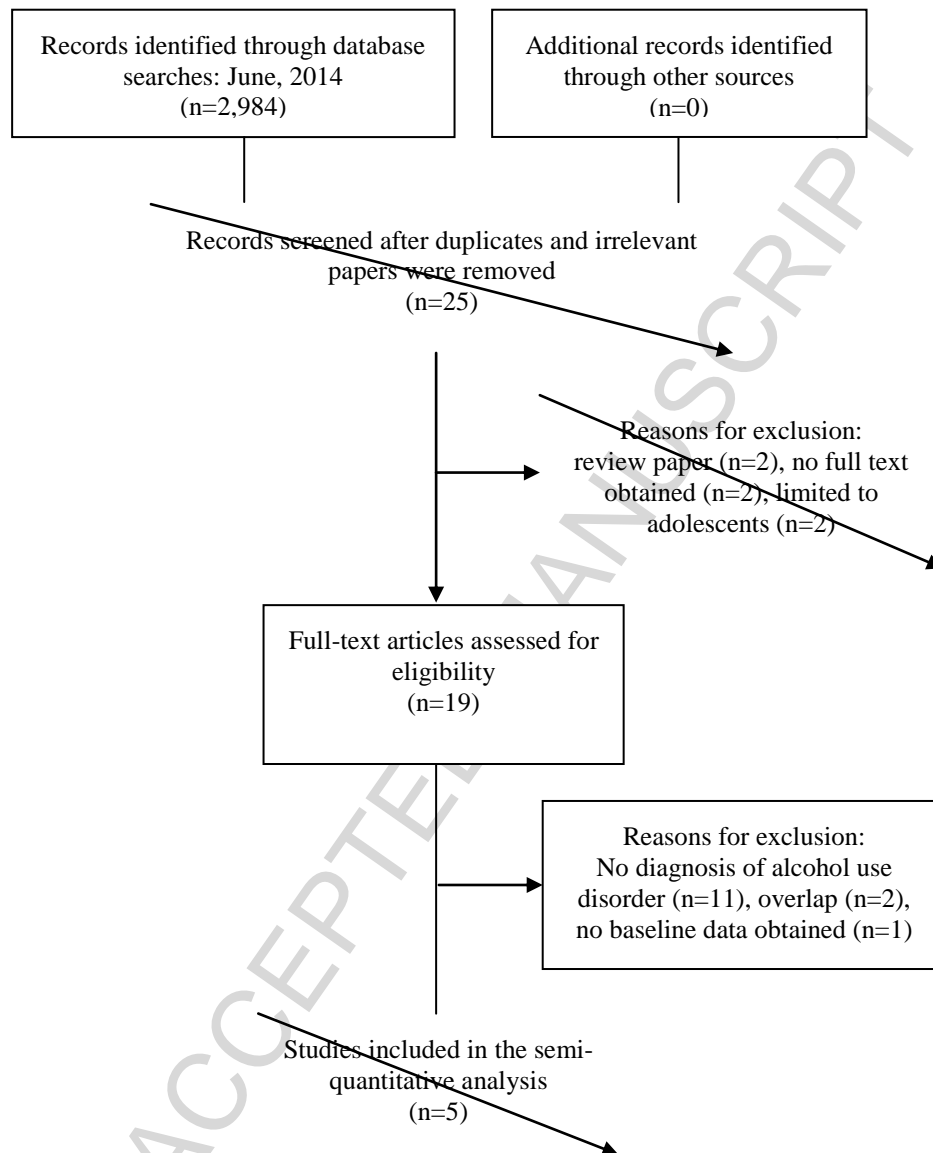
Figure 1. Flow chart of the systematic review inclusion and exclusion

Table 1. Study characteristics.

Nr.	First author / year [Ref nr]	Participants	alcohol use disorders status	PA measurement	Quality of PA Measurement	Statistical tests
1.	Read 2001 [13]	105 (35 male) in treatment; 94% White; 39.0±10.7yrs	DSM-IV alcohol abuse or dependence; ADS=18.8±9.3		A	t-tests, correlation-analysis
2.	Chwastiak 2011 [23]	20,046 Veterans (+95% male)	DSM-IV alcohol abuse or dependence	Frequency of how often patients engage in regular activities long enough to work up a sweat.	A	Chi square
3.	Park 2011 [24]	18-64yrs from general population (n=6,510)	DSM-IV alcohol abuse or dependence		A	Logistic regression analysis
4.	Herbsleb 2013 [25]	23 (19 male); 34±8yrs	DSM-IV alcohol dependence	IPAQ	A	Correlation-analysis
5.	Lisha 2013 [26]	1,433 with alcohol abuse (73.0% male; 48.98yrs; 77.74% White); 2,607 alcohol dependence (68.59% male; 48.67yrs; 67.51% White) from the general population	DSM-IV alcohol abuse or dependence		A	Logistic regression analysis

A=self-report of poor or unknown reliability/validity in persons with alcohol use disorders, B=self-report with acceptable reliability/validity in persons with alcohol use disorders, PA=physical activity, BMI=body mass index, DSM-IV= Diagnostic Statistical Manual American Psychiatric Association 4th edition, ADS=The Alcohol Dependence Scale, ANOVA=analysis of variance, IPAQ= International Physical Activity Questionnaire.

Table 2. Summary of studies of determinants of physical activity in patients with alcohol use disorders

Determinant variable	Related to		Unrelated to		Summary code	
	PA Study	Assoc.	PA Study	Assoc.	% studies reporting assoc.	
<i>Demographic</i>						
Age (Older)			Lisha 2013 [26]	0	0% (0/1)	
Gender (Male)			Read 2001 [13]; Lisha 2013 [26]	0	0% (0/2)	
Marital status (married)			Lisha 2013 [26]	0	0% (0/1)	
Education (Higher)			Lisha 2013 [26]	0	0% (0/1)	
<i>Biological</i>						
Physical disability (Yes)	Lisha 2013 [26]	-		-	100% (1/1)	
BMI (Higher) / Obesity	Chwastiak 2011 [23]	-		-	100% (1/1)	
Breathing frequency	Herbsleb 2013 [25]	-				
<i>Behavioral attributes /skills</i>						
Alcohol dependence			Read 2001 [13]; Park 2011 [24]; Lisha 2013 [26]	0	0% (0/3)	
Alcohol abuse	Park 2011 [24]; Lisha 2013 [26]	+		+	100% (2/2)	
Number of cigarettes per day (more) or smoking	Read 2001[13]; Chwastiak 2011 [23]	-		-	100% (2/2)	
Nicotine dependence	Read 2001[13]	-		-	100% (1/1)	

Table 2. Continued

Determinant variable	Related to PA		Unrelated to PA		Summary code
	Study	Assoc.	Study	Assoc.	% studies reporting assoc.
<i>Psychological, cognitive and emotional</i>					
Depressive symptoms (presence)	Read 2001[13]	-		-	100% (1/1)
Self-efficacy (lower)	Read 2001[13]	-		-	100% (1/1)
Mental co-morbidity: mood and anxiety (presence)	Lisha 2013 [26]	-		-	100% (1/1)
<i>Social and cultural</i>					
<i>Physical environment</i>					
<i>Policy</i>					

†Numbers presented are the study numbers as reported in the online supplement and are in accordance with the study numbers in table 1, PA= physical activity; Assoc=association; - = negative, + =positive; 0= no relation; ?= indeterminate.