

**This is a self-archived version of an original article. This version may differ from the original in pagination and typographic details.**

**Author(s):** Raatikainen, Ilkka; Vanhala, Mauno; Mäntyselkä, Pekka; Heinonen, Ari; Koponen, Hannu; Kautiainen, Hannu; Korniloff, Katariina

**Title:** Does level of leisure time physical activity, in a sample of patients with depression, predict health care utilization over a subsequent 5-year period? Findings from a Finnish cohort study

**Year:** 2018

**Version:** Accepted version (Final draft)

**Copyright:** © 2018 Elsevier Ltd

**Rights:** CC BY-NC-ND 4.0

**Rights url:** <https://creativecommons.org/licenses/by-nc-nd/4.0/>

**Please cite the original version:**

Raatikainen, I., Vanhala, M., Mäntyselkä, P., Heinonen, A., Koponen, H., Kautiainen, H., & Korniloff, K. (2018). Does level of leisure time physical activity, in a sample of patients with depression, predict health care utilization over a subsequent 5-year period? Findings from a Finnish cohort study. *Mental Health and Physical Activity*, 15, 40-44.  
<https://doi.org/10.1016/j.mhpa.2018.06.007>

# Accepted Manuscript

Does level of leisure time physical activity, in a sample of patients with depression, predict health care utilization over a subsequent 5-year period? Findings from a Finnish cohort study

Ilkka Raatikainen, Mauno Vanhala, Pekka Mäntyselkä, Ari Heinonen, Hannu Koponen, Hannu Kautiainen, Katariina Korniloff

PII: S1755-2966(17)30162-X

DOI: [10.1016/j.mhpa.2018.06.007](https://doi.org/10.1016/j.mhpa.2018.06.007)

Reference: MHPA 265

To appear in: *Mental Health and Physical Activity*

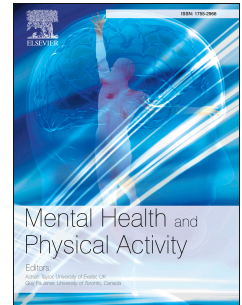
Received Date: 7 November 2017

Revised Date: 25 June 2018

Accepted Date: 26 June 2018

Please cite this article as: Raatikainen, I., Vanhala, M., Mäntyselkä, P., Heinonen, A., Koponen, H., Kautiainen, H., Korniloff, K., Does level of leisure time physical activity, in a sample of patients with depression, predict health care utilization over a subsequent 5-year period? Findings from a Finnish cohort study, *Mental Health and Physical Activity* (2018), doi: 10.1016/j.mhpa.2018.06.007.

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.



**Does level of leisure time physical activity, in a sample of patients with depression, predict health care utilization over a subsequent 5-year period? Findings from a Finnish cohort study.**

Ilkka Raatikainen<sup>1</sup>, Mauno Vanhala<sup>2,3</sup>, Pekka Mäntyselkä<sup>3</sup>, Ari Heinonen<sup>1</sup>, Hannu Koponen<sup>4</sup>,  
Hannu Kautiainen<sup>5</sup>, Katariina Korniloff<sup>1</sup>

<sup>1</sup>University of Jyväskylä, Faculty of Sport and Health Sciences, Jyväskylä, Finland; <sup>2</sup>Primary Health Care Unit, Central Hospital of Central Finland, Jyväskylä, Finland; <sup>3</sup>Unit of Primary Health Care, University of Eastern Finland and Kuopio University Hospital, Kuopio, Finland; <sup>4</sup>University of Helsinki and Helsinki University Hospital, Psychiatry, Helsinki, Finland; <sup>5</sup>Unit of Primary Health Care, Kuopio University Hospital, Kuopio, Unit of Primary Health Care, Helsinki University Central Hospital and Department of General Practice, University of Helsinki, Helsinki, Finland

Corresponding author: Ilkka Raatikainen, Ruokotie 6 c, 40250 Jyväskylä, Finland,  
email: ilkka.t.raatikainen@student.jyu.fi

**Does level of leisure time physical activity, in a sample of patients with depression, predict health care utilization over a subsequent 5-year period? Findings from a Finnish cohort study.**

ACCEPTED MANUSCRIPT

**ABSTRACT**

*Objectives:* The main aim of this study was to investigate the association between leisure time physical activity (LTPA) and health care utilization (HCU) and furthermore, socio-demographic and clinical factors according to LTPA level among depressed patients based on data drawn from the Finnish Depression and Metabolic Syndrome in Adults (FDMSA) -study (2009-2016).

*Methods:* 447 depressed patients aged 35-65 from municipalities within the Central Finland Hospital District participated in this study. Depressive symptoms (DS) were determined with the Beck Depression Inventory ( $\geq 10$  points) and the psychiatric diagnosis confirmed with a diagnostic interview (M.I.N.I.). Severity of depression was evaluated using the Montgomery-Åsberg Depression Rating Scale (MADRS). LTPA was assessed using a self-reported questionnaire. Use of health services was counted from participant's health care records.

*Results:* Of the 447 depressed patients, 25 % reported their LTPA level as low, 41% as moderate and 34% as high. Among depressed patients, higher levels of LTPA were linearly associated with lower BDI ( $p < 0.001$ ), MADRS ( $p = 0.002$ ), BMI ( $p = 0.005$ ), triglyceride ( $p = 0.025$ ) and higher HDL ( $p = 0.002$ ) values. LTPA level was not related to health care utilization among depressed patients. The health services most used were physician services.

*Conclusions:* According to this study, the level of LTPA in baseline does not predict the future use of health care services among depressed patients in Finnish adult population. Although higher levels of LTPA are positively associated with many health-related factors, promoting PA alone is not enough when aiming to manage and modify HCU among depressed patients.

**Keywords:** Depression, leisure time physical activity, health care utilization, health services

Abbreviations: BDI (-21), Beck Depression Inventory; BMI, Body Mass Index; DS, depressive symptoms; FDMSA-study, Finnish Depression and Metabolic Syndrome in Adults- study; GDP, Gross Domestic Product; HCU, health care utilization; HDL, high-density lipoprotein; LDL, low-density lipoprotein; LTPA, leisure-time physical activity; MADRS, Montgomery-Åsberg Depression Rating Scale; M.I.N.I., Mini-International Neuropsychiatric Interview; mmHg, millimeter of mercury; mmol/l, millimoles per liter; OGTT, Oral Glucose Tolerance Test; PA, physical activity; SD, standard deviation; SPI, Social Progress Index

## 1. Introduction

Depression is the leading cause of disability worldwide (Whiteford et al., 2013) and it has been estimated that it will be the most common illness globally by the year 2030 (Mathers & Loncar, 2006). People suffering from mental illnesses such as depression have over a two-fold higher mortality risk and ten years shorter life expectancy than the general population (Walker, McGee, & Druss, 2015). Depressive symptoms can also predispose to metabolic syndrome (Vanhala, Jokelainen, Keinänen-Kiukaanniemi, Kumpusalo, & Koponen, 2009). Although effective treatments are available, only a minority of people suffering from depression seek and receive appropriate treatment (Hämäläinen, Isometsä, Sihvo, Pirkola, & Kiviruusu, 2008; Kim, Cho, Park, & Park, 2015; Kleinberg, Aluoja, & Vasar, 2013). There are many reasons for this, including lack of resources, lack of trained health care providers, social stigma associated with mental disorders and inaccurate assessment (World Health Organization, 2015).

Depression is also associated with increased health care utilization. According to Kleinberg et al. (2013), depressed people use health care services from 1.5 to 3 times more often than the non-depressed. Depression has been shown to increase the risk of HCU among people with unhealthy BMI (Atlantis, Goldney, Eckert, Taylor, & Phillips, 2012) and among patients with diabetes (Chan, Lin, Chau, & Chang, 2012), cancer (Lo et al., 2013) and cardiovascular diseases (Chamberlain et al., 2011). Both hereditary and environmental factors are thought to play a role in depression (Sullivan, Neale, & Kendler, 2014). In addition, an unhealthy life style characterized, for example, by physical inactivity (Korniloff, 2013), long-lasting dissatisfaction with life (Rissanen, 2016) and many somatic diseases have been found to be associated with increased risk of depression (Ali, Stone, Peters, Davies, & Khunti, 2006; Korniloff et al., 2010; Korniloff et al., 2012).

Many recent studies have demonstrated that physically active compared to physically inactive people utilize health care services less (Fonseca, Nobre, Pronk, & Santos, 2010; Lordan & Pakrashi, 2014; Vuori, Taimela, & Kujala, 2010) and have lower lifetime net costs of health care and social services (Vuori et al., 2010). Recent studies have also demonstrated the usefulness of physical activity and exercise in the treatment and prevention of depression (Gallegos-Carrillo et al., 2013; Korniloff et al., 2012; Sieverdes et al., 2012) and that the positive effects of physical exercise can equal those of other methods of treatment or medication (Cooney, Dwan, & Mead, 2014). Souza, Fillenbaum and Blay (2015) reported an

association of physical inactivity with both higher risk of depression and higher risk of hospitalization, and also with decreased outpatient visits, among older people.

In sum, physical activity (PA) is a cheap and effective way to treat and prevent many diseases and it decreases the use of health care services. However, studies on whether increased physical activity reduces the use of health care services, and therefore health care costs, among depressed patients are lacking. As the primary aim of FDMSA Study was to investigate association between depression and metabolic syndrome, we also have studied relations between leisure time physical activity and depression. Thus, the main aim of this preset study was to investigate the association between HCU and leisure time physical activity (LTPA) and furthermore, socio-demographic and clinical factors, among depressed patients. The study was an exploration of data collected in FDMSA -study.

## **2. Materials and methods**

### *2.1. Participants*

The data used in this study were drawn from the Finnish Depression and Metabolic Syndrome in Adults (FDMSA) study and its 5-year follow-up (2012-2016). The FDMSA -study protocol/design has been reported in some earlier studies (Auvinen et al., 2018; Koponen, Kautiainen, Leppanen, Mantyselka, & Vanhala, 2015a; Koponen, Kautiainen, Leppänen, Mäntyselkä, & Vanhala, 2015b; Korniloff et al., 2017). The study was conducted in municipalities within the Central Finland Hospital District in Finland with catchment area of 274 000 inhabitants. The study population was enrolled from patients (n=730) with depressive symptoms who scored  $\geq 10$  in the 21- item Beck Depression Inventory (BDI-21), were over 35 years of age and were either self-referred or had been referred by general practitioners to depression nurse case managers, who conducted a diagnostic structured interview (M.I.N.I.). Of this study population, 447 received a diagnosis of depression. The study protocol was approved by the Ethics Committee of the Central Finland Hospital District prior to the commencement of the study. All participants signed an informed written consent.

### *2.2. Data sources*



At baseline, all the participants completed a standard self-administered questionnaire that contained questions about their health and health behavior. The questionnaire also contained questions on participants' socio-economic background such as marital status, years of education, household income, employment status, comorbid diseases, smoking habits and LTPA.

LTPA was assessed with the question: "How often do you do physical activity at least for half an hour so that you are out of breath and sweating?" Answers were classified as follows: low (twice per month or less), moderate (once or twice per week), or high (three times per week or more). Self-reported LTPA has shown a high correlation with physical fitness as measured by maximal oxygen uptake (Aires, Selmer, & Thelle, 2003)

Depressive symptoms were captured using the Beck Depression Inventory (BDI) (Beck, Ward, Mendelson, Mock, & Erbaugh, 1961) with a cut-off point of  $\geq 10$  (Koponen, Jokelainen, Keinanen-Kiukaanniemi, Kumpusalo, & Vanhala, 2008; Korniloff K et al., 2010; Väänänen, Buunk, Kivimäki, Vahtera, & Koskenvuo, 2008). The psychiatric diagnosis was confirmed with a diagnostic Mini-International Neuropsychiatric Interview (M.I.N.I.) (Sheehan et al., 1998). Severity of depression was evaluated using the Montgomery-Åsberg Depression Rating Scale (MADRS) (Montgomery & Åsberg, 1979).

Fasting blood samples were drawn after 12 h of fasting for glucose and lipid determination (Koponen, Kautiainen, Leppänen, Mäntyselkä, & Vanhala, 2015a). Glucose tolerance was tested using an oral glucose tolerance test (OGTT). The physical examination during the study visit also included measurements of the participants' weight, height, waist circumference and blood pressure. Weight and height were measured with the participant wearing light clothing and was accurate to the nearest 0.5 cm and 0.1 kg, respectively. Waist circumference was measured to the nearest 1.0 cm at the midpoint between the lateral iliac crest and the lowest rib. Blood pressure was measured twice by trained nurses after a 15-min rest time with a mercury sphygmomanometer with the participant in the sitting position.

Data on health care utilization were collected by two research nurses from participants' health care records over a 5-year period and calculated as person years. The frequency of visits and phone call contacts, and days of hospitalization were calculated separately for primary and specialized health care. Health care professionals were categorized as a physician (general, practitioner or specialized physician), psychiatrist, psychologist, depression nurse, substance abuse nurse or other (e.g. social worker, nutritionist).

### 2.3. Statistical methods

The results were presented as means with standard deviations (SD) or as counts with percentages. Statistical significance for the unadjusted hypothesis of linearity across the LTPA categories were evaluated using the Cochran-Armitage test for trend and analysis of variance with an appropriate contrast. Adjusted hypothesis of linearity (orthogonal polynomial) were evaluated using generalized linear models (e.g. analysis of co-variance and logistic models) with appropriate distribution and link function. Models included age, gender, years of education, marital status, comorbid diseases and household income as covariates. In the case of violation of the assumptions (e.g. non-normality), a bootstrap-type method was used (10 000 replications) to estimate standard errors. The normality of variables was evaluated by the Shapiro-Wilk W test. All analyses were performed using STATA 14.1.

### 3. Results

At baseline, 25 % of the 447 participants with depression reported a low level of LTPA, 41% a moderate level and 34% a high level. A lower level of LTPA was linearly associated with higher BMI ( $p=0.005$ ), triglyceride ( $p=0.025$ ), BDI ( $p<0.001$ ) and MADRS ( $p = 0.002$ ) and lower HDL ( $p=0.002$ ) values (Table 1). In turn, a higher level of LTPA was also linearly associated with decreased waist circumference among females ( $p=0.002$ ), but not males ( $p=0.22$ ).

The regression analysis revealed that LTPA level was not related to health care utilization among the depressed patients after adjusting the results for age, gender, years of education, marital status, comorbid diseases and household income. The health resources mostly used by the participants were physician services, phone calls and depression nurse services. Lesser use was made of psychologist and substance abuse nurse services (Table 2).

In addition, subgroup analyses (working vs. not at work) showed no interaction between LTPA and working status with respect to total health care visits ( $p=0.63$ ) among the depressed patients, although those not working had more total visits ( $p=0.043$ ) after the results were adjusted for age, gender, years of education, marital status, comorbid diseases and household income (Figure 1).

### 4. Discussion

#### 4.1. Main findings and study implications

This study showed that LTPA level was not associated with HCU among the studied sample of depressed individuals. This result is contrary to previous findings. Many recent studies have reported that while increased LTPA is beneficial in the care and prevention of depression (Gallegos-Carrillo et al., 2013; Korniloff et al., 2012; Sieverdes et al., 2012), it can, in general, also reduce HCU (Fonseca et al., 2010; Lordan & Pakrashi, 2014) among population. This discrepancy may be due to the multidimensional structure of health and health behavior in which PA is only one factor.

Depression can reduce a patient's overall capacity for self-care (Souza et al., 2015). It is known that depressed people seek for help poorly and that approximately only one-fifth to one-third of them have adequate treatment (Hämäläinen et al., 2008; Kim et al., 2015; Kleinberg et al., 2013). A physically active lifestyle in turn, is associated with better capacity for self-care (Hassmen, Koivula & Uutela, 2000). Level of LTPA can affect aspects of psychological well-being such as sense of coherence and feelings of social integration (Hassmen et al., 2000). In turn, a stronger sense of coherence is related to better coping with common daily activities (Portegijs et al., 2014). Thus, physically active people are likely to feel more self-confident and be more active in self-care in general. This may also lead to more effective use of health care resources (Souza et al., 2015) and, further, be one explanation for our findings of a similar frequency of health care visits regardless of the level of LTPA among depressed patients.

However, this study showed that PA was positively associated with many health-related factors such as obesity, blood fat levels and severity of depression. First, higher levels of LTPA were associated with increased HDL, decreased BMI and triglyceride, and lower waist circumference in women among the depressed participants in this study, as reported earlier (Besson et al., 2009; Sofi et al., 2007). This is important for overall health and lowering risk for metabolic syndrome and other diseases such as heart diseases and diabetes (Grundy et al., 2005). Second, and more importantly, higher levels of PA were also associated with decreased severity of depression among the depressed participants. This suggest that LTPA can be a considerable and useful method to treat and prevent depression, as has also been shown in previous studies (Gallegos-Carrillo et al., 2013; Korniloff et al., 2012; Sieverdes et al., 2012). Cicek et al. (2015) have demonstrated that average BDI scores can be over 4 points lower in participants who engaged in active exercise one hour or more per week (8.93) than in sedentary controls (13.18). However, it is important to remember that association between PA and depression is bidirectional (Sieverdes et al., 2012): physical inactivity can increase the risk for depression and depression can reduce physical activity. The present participants with

more severe depression may have been less physically active due to the severity of their depression. Additionally, any effect of LTPA may be washed out by greater effects of other physical health conditions on long-term HCU.

In contrast to some previous studies which have suggested that people with low socioeconomic status are more physically inactive (Laaksonen, Prattala, Helasoja, Uutela, & Lahelma, 2003; Souza et al., 2015) we did not find any association between LTPA level and socioeconomic factors such as marital status, years of education, household income or working status. There may be many reasons for this. For example, in Finland and the other Nordic countries social security and health insurance are in general quite good while socioeconomic differences are relatively narrow compared, for example, with some Anglo-American or Asian countries. When social progress and the distribution of social equity between its citizens is measured using the Social Progress Index (SPI) instead of Gross Domestic Product (GDP), Finland is the highest ranked country in the world while the other Nordic countries are all in the top ten (Porter, Stern, & Green, 2016). In addition, the present participants may be among the minority of depressives who have sought and received help for depression. These two factors may explain the absence of socio-economic differences in LTPA levels.

In this study, the HCU services most used by the present sample of depressed patients were physician services, phone calls and depression nurse services and, to a lesser extent, psychologist and substance abuse nurse services. These findings are in line with those of some previous studies (Kleinberg et al., 2013; Wang et al., 2005), which have demonstrated that depressed patients visited their family doctors or general practitioners more often than, for example, seeking help directly from a psychiatrist. To more effectively manage and organize health care resources to meet future demands, it is vital to know how they are currently used. This would also make it possible to better target suitable and adequate health services for depressive patients.

Subgroup analyses revealed that patients who were not working made more health care visits than those who were working. This difference could be due to utilization by the latter of occupational health care, a factor we were unable to assess. Individuals who have a comprehensive occupational health care service can choose whether to use this instead of primary health care.

Depression is world's leading cause of disability and its societal costs are huge. On the other hand, benefits of PA are well known both in prevention and healing in depression. Although this study showed many positive relationships of PA on health and depression,

these benefits did not transfer directly to HCU. Therefore, when aiming to modify and manage the HCU of depressed patients, it is not enough to promote PA alone. Alongside increasing PA, we need deeper knowledge and understanding of both the hereditary and environmental factors as well as personality traits behind illness.

#### *4.2. Study strengths and limitations*

The strengths of this study include its geographically representative sample of subjects (catchment area of 274 000 inhabitants) and its long follow-up time with exact counts and frequencies of participants' HCU extracted from health records instead of rough estimates. One strength of this study is also the use of diagnostic interview (M.I.N.I) to confirm depression diagnosis (instead using only BDI). The main limitations are the robustness of self-reported LTPA and the single baseline measurement of the levels of LTPA and depression, as they may have changed during the follow-up. Though, in this study, we didn't try to estimate exact frequency or intensity of each participants PA instead of crude categorization of LTPA lifestyle. Moreover, as already stated, this study does not include visits to occupational health care. However, we were able to conduct the analysis separately for both working and non-working depressives. The relationship between LTPA and HCU in the two subgroups was similar and no interaction was observed between working status and LTPA. Furthermore, the use of a self-reported questionnaire to assess LTPA is vulnerable to overestimation by participants. Nonetheless, as self-reported questionnaire of LTPA used in this study does not tell the exact amount, frequency or intensity of LTPA, the method is widely used in large population-based studies (Aires et al., 2003; Barengo et al., 2004; Borodulin, Laatikainen, Juolevi, & Jousilahti, 2008). Finally, the study population was middle aged and older, and thus the results cannot be generalized to younger persons. Also, health care service systems and structures are different in different countries and accessibility to health care services differs and thus, as the study was geographically representative in Finland, caution must be made for generalisability to other countries because of different health care systems and accessibility to public health care services.

#### *4.3. Conclusions*

According to this study, the level of LTPA in baseline does not predict the future use of health care services among depressed patients in Finnish adult population. Although higher levels of LTPA are positively associated with many health-related factors, these benefits do not transfer directly to HCU. It may be possible that any effect of LTPA is diminished by greater effects of other physical health conditions in long-term. Therefore, promoting PA is not enough when aiming to manage and modify HCU of depressed patients. Deeper understanding behind the illness and also further research are needed to find out how to manage the use and availability of health care services more effectively.

### **Funding**

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

### **Conflict of interest**

The authors declare that they have no conflict of interest.

### **Acknowledgements**

The authors would like to thank the depression nurse case managers who took part in the practical implementation of the FDMSA: Mari Alanko, Harri Back, Timo Hannula, Anu Holopainen, Ritva Häkkinen, Katja Johansson, Eija Kinnunen, Kaija Luoma, Hannele Niemi, Hillevi Peura, Inga Pöntiö, Kirsi Rouvinen, Tiina Silvennoinen and Marianne Vihtamäki; the FDMSA study nurses Anne Kirmanen, Seija Torkkeli, Reetta Oksanen and Olli Niemi, and Pia Jauhiainen, scientific secretary of the study.

**References**

- Aires, N., Selmer, R., & Thelle, D. (2003). The validity of self-reported leisure time physical activity, and its relationship to serum cholesterol, blood pressure and body mass index. A population based study of 332,182 men and women aged 40–42 years. *European Journal of Epidemiology*, *18*(6), 479-485.
- Ali, S., Stone, M. A., Peters, J. L., Davies, M. J., & Khunti, K. (2006). The prevalence of co-morbid depression in adults with type 2 diabetes: A systematic review and meta-analysis. *Diabetic Medicine*, *23*(11), 1165-1173.
- Atlantis, E., Goldney, R. D., Eckert, K. A., Taylor, A. W., & Phillips, P. (2012). Trends in health-related quality of life and health service use associated with comorbid diabetes and major depression in South Australia, 1998-2008. *Social Psychiatry and Psychiatric Epidemiology*, *47*(6), 871-7.
- Auvinen, P., Mantyselka, P., Koponen, H., Kautiainen, H., Korniloff, K., Ahonen, T., & Vanhala, M. (2018). Prevalence of restless legs symptoms according to depressive symptoms and depression type: A cross-sectional study. *Nordic Journal of Psychiatry*, *72*(1), 51-56.
- Barengo, N. C., Hu, G., Lakka, T. A., Pekkarinen, H., Nissinen, A., & Tuomilehto, J. (2004). Low physical activity as a predictor for total and cardiovascular disease mortality in middle-aged men and women in Finland. *European Heart Journal*, *25*(24), 2204-2211.
- Beck, A. T., Ward, C. H., MEendelson, M., Mock, J., & Erbaugh, J. (1961). An inventory for measuring depression. *Archives of General Psychiatry*, *4*, 561-571.
- Besson, H., Ekelund, U., Luan, J., May, A. M., Sharp, S., Travier, N., . . . Peeters, P. H. (2009). A cross-sectional analysis of physical activity and obesity indicators in european participants of the EPIC-PANACEA study. *International Journal of Obesity*, *33*(4), 497-506.
- Borodulin, K., Laatikainen, T., Juolevi, A., & Jousilahti, P. (2008). Thirty-year trends of physical activity in relation to age, calendar time and birth cohort in Finnish adults. *European Journal of Public Health*, *18*(3), 339-344.

- Chamberlain, A.M., Vickers, K.S., Colligan, R.C., Weston, S.A., Rummans, T.A., & Roger, V.L. (2011). Associations of preexisting depression and anxiety with hospitalization in patients with cardiovascular disease. *Mayo Clinic Proceedings*, 86(11), 1056-1062.
- Chan, H. L., Lin, C. K., Chau, Y. L., & Chang, C. M. (2012). The impact of depression on self-care activities and health care utilization among people with diabetes in taiwan. *Diabetes Research & Clinical Practice*, 98(1), e4-7 1p.
- Cicek, G., Atan, T., Kamuk, Y. U., Imamoglu, O., Yamaner, F., & Aslan, V. (2015). Effects of exercise on levels of depression. *Anthropologist*, 20(3), 670-674.
- Cooney, G. A. B., Dwan, K., & Mead, G. F. R. C. P. (2014). Exercise for depression. *Jama*, 311(23), 2432-2433.
- Fonseca, V.R., Nobre, M.R., Pronk, N.P., & Santos, L.A. (2010). The association between physical activity, productivity, and health care utilization among employees in brazil. *Journal of Occupational & Environmental Medicine*, 52(7), 706-712.
- Gallegos-Carrillo, K., Denova-Gutiérrez, E., Dosamantes-Carrasco, L., Borges, G., Macias, N., Flores, Y. N., . . . Salmerón, J. (2013). Physical activity and reduced risk of depression: Results of a longitudinal study of mexican adults. *Health Psychology*, 32(6), 609-615.
- Grundy, S. M., Cleeman, J. I., Daniels, S. R., Donato, K. A., Eckel, R. H., Franklin, B. A., . . . National Heart, Lung, and Blood Institute. (2005). Diagnosis and management of the metabolic syndrome: An American Heart Association/National Heart, Lung, and Blood Institute scientific statement. *Circulation*, 112(17), 2735-2752.
- Hämäläinen, J., Isometsä, E., Sihvo, S., Pirkola, S., & Kiviruusu, O. (2008). Use of health services for major depressive and anxiety disorders in finland. *Depression and Anxiety*, 25(1), 27-37.
- Hassmen, P, Koivula, N, & Uutela, A. (2000). Physical exercise and psychological well-being: A population study in finland. *Preventive Medicine*, 30(1), 17-25.
- Kim, J. L., Cho, J., Park, S., & Park, E. (2015). Depression symptom and professional mental health service use. *Bmc Psychiatry*, 15, 261-272.



- Kleinberg, A., Aluoja, A., & Vasar, V. (2013). Help-seeking for emotional problems in major depression. *Community Mental Health Journal*, 49(4), 427-432.
- Koponen, H., Kautiainen, H., Leppänen, E., Mäntyselkä, P., & Vanhala, M. (2015a). Cardiometabolic risk factors in patients referred to depression nurse case managers. *Nordic Journal of Psychiatry*, 69(4), 262-267.
- Koponen, H., Kautiainen, H., Leppänen, E., Mäntyselkä, P., & Vanhala, M. (2015b). Association between suicidal behaviour and impaired glucose metabolism in depressive disorders. *BMC Psychiatry*, 15(1), 163.
- Koponen, H., Jokelainen, J., Keinänen-Kiukaanniemi, S., Kumpusalo, E., & Vanhala, M. (2008). Metabolic syndrome predisposes to depressive symptoms: A population-based 7-year follow-up study. *Journal of Clinical Psychiatry*, 69(2), 178-182.
- Korniloff, K. (2013). Interrelationships of physical activity and depressive symptoms with cardiometabolic risk factors. *Studies in Sport, Physical Education and Health*; 0356-1070; 193. University of Jyväskylä.
- Korniloff, K., Häkkinen, A., Kautiainen, H., Koponen, H., Peltonen, M., Mäntyselkä, P., . . . Vanhala, M. (2010). Leisure-time physical activity and metabolic syndrome plus depressive symptoms in the FIN-D2D survey. *Preventive Medicine*, 51(6), 466-470.
- Korniloff, K., Kotiaho, S., Vanhala, M., Kautiainen, H., Koponen, H., & Mäntyselkä, P. (2017). Musculoskeletal pain in melancholic and atypical depression. *Pain Medicine*, 18(2), 341-347.
- Korniloff, K., Vanhala, M., Kautiainen, H., Koponen, H., Peltonen, M., Mäntyselkä, P., . . . Häkkinen, A. (2012). Lifetime leisure-time physical activity and the risk of depressive symptoms at the ages of 65-74 years: The FIN-D2D survey. *Preventive Medicine*, 54, 313-315.
- Laaksonen, M., Prattala, R., Helasoja, V., Uutela, A., & Lahelma, E. (2003). Income and health behaviours. evidence from monitoring surveys among Finnish adults. *Journal of Epidemiology and Community Health*, 57(9), 711-717.

- Lo, C., Calzavara, A., Kurdyak, P., Barbera, L., Shepherd, F., Zimmermann, C., . . . Rodin, G. (2013). Depression and use of health care services in patients with advanced cancer. *Canadian Family Physician, 59*(3), e168-74.
- Lordan, G., & Pakrashi, D. (2014). Make time for physical activity or you may spend more time sick! *Social Indicators Research, 119*(3), 1379-1391.
- Mathers, C. D., & Loncar, D. (2006). Projections of global mortality and burden of disease from 2002 to 2030. *Plos Med, 3*(11), e442.
- Montgomery, S. A., & Åsberg, M. (1979). A new depression scale designed to be sensitive to change. *The British Journal of Psychiatry : The Journal of Mental Science, 134*, 382-389.
- Portegijs, E., Read, S., Pakkala, I., Kallinen, M., Heinonen, A., Rantanen, T., . . . Sipilä, S. (2014). Sense of coherence: Effect on adherence and response to resistance training in older people with hip fracture history. *Journal of Aging & Physical Activity, 22*(1), 138-145.
- Porter, M. E., Stern, S., & Green, M. (2016). *Social progress index 2016*. Washington, DC: Social Progress Imperative.
- Rissanen, T. (2016). *Studies on factors related to life satisfaction. Dissertations in health sciences, no 325*. University of Eastern Finland.
- Sheehan, D. V., Lecrubier, Y., Sheehan, K. H., Amorim, P., Janavs, J., Weiller, E., . . . Dunbar, G. C. (1998). The mini-international neuropsychiatric interview (MINI): The development and validation of a structured diagnostic psychiatric interview for DSM-IV and ICD-10. *Journal of Clinical Psychiatry, 59*, 22-33.
- Sieverdes, J.C., Ray, B.M., Sui, X., Lee, D.C., Hand, G.A., Baruth, M., & Blair, S.N. (2012). Association between leisure time physical activity and depressive symptoms in men. *Medicine & Science in Sports & Exercise, 44*(2), 260-265.
- Sofi, F., Capalbo, A., Marcucci, R., Gori, A. M., Fedi, S., Macchi, C., . . . Gensini, G. F. (2007). Leisure time but not occupational physical activity significantly affects

- cardiovascular risk factors in an adult population. *European Journal of Clinical Investigation*, 37(12), 947-953.
- Souza, A. M. R., Fillenbaum, G. G., & Blay, S. L. (2015). Prevalence and correlates of physical inactivity among older adults in Rio Grande do Sul, Brazil. *Plos One*, 10(2), e0117060.
- Sullivan, P. F., Neale, M. C., & Kendler, K. S. (2014). Genetic epidemiology of major depression: Review and meta-analysis. *American Journal of Psychiatry*, 157 (10), 1552-1562.
- Väänänen, A., Buunk, A. P., Kivimäki, M., Vahtera, J., & Koskenvuo, M. (2008). Change in reciprocity as a predictor of depressive symptoms: A prospective cohort study of Finnish women and men. *Social Science & Medicine*, 67(11), 1907-1916.
- Vanhala, M., Jokelainen, J., Keinänen-Kiukaanniemi, S., Kumpusalo, E., & Koponen, H. (2009). Depressive symptoms predispose females to metabolic syndrome: A 7-year follow-up study. *Acta Psychiatrica Scandinavica*, 119(2), 137-142.
- Vuori, I., Taimela, S., & Kujala, U. (2010). *Liikuntalääketiede* (4th. ed.). Helsinki: Duodecim.
- Walker, E. R., McGee, R. E., & Druss, B. G. (2015). Mortality in mental disorders and global disease burden implications: A systematic review and meta-analysis. *JAMA Psychiatry*, 72(4), 334-341.
- Wang, P. S., Lane, M., Olfson, M., Pincus, H. A., Wells, K. B., & Kessler, R. C. (2005). Twelve-month use of mental health services in the United States: Results from the national comorbidity survey replication. *Archives of General Psychiatry*, 62(6), 629-640.
- Whiteford, H. A., Degenhardt, L., Rehm, J., Baxter, A. J., Ferrari, A. J., Erskine, H. E., . . . Johns, N. (2013). Global burden of disease attributable to mental and substance use disorders: Findings from the global burden of disease study 2010. *The Lancet*, 382(9904), 1575-1586.
- World Health Organization. (2015). Depression. fact sheet N°369. Retrieved from <http://www.who.int/mediacentre/factsheets/fs369/en/>

ACCEPTED MANUSCRIPT

ACCEPTED MANUSCRIPT

Table 1. Depressed patients' socio-demographic and clinical characteristics at baseline.

Variables	<u>Leisure-time physical activity</u>			p for linearity
	Low N=111	Moderate N=185	High N=151	
Number of females, n (%)	82 (74)	129 (70)	101 (67)	0.23
Age in years, mean (SD)	49 (9)	52 (10)	51 (10)	0.055
BMI, mean (SD)	28.9 (6.3)	28.4 (6.0)	26.9 (5.2)	0.005
Waist circumference (cm), mean (SD)				
Males	101 (11)	100 (14)	97 (14)	0.22
Females	96 (16)	93 (15)	89 (13)	0.002
Blood pressure (mmHg), mean (SD)				
Systolic	131 (15)	131 (15)	131 (17)	0.91
Diastolic	83 (12)	81 (10)	82 (11)	0.90
Plasma Glucose 0h (mmol/l), mean (SD)	5.79 (1.15)	6.12 (1.93)	5.66 (0.80)	0.85
Total cholesterol (mmol/l), mean (SD)	5.18 (1.07)	5.05 (0.91)	5.08 (1.11)	0.54
LDL cholesterol (mmol/l), mean (SD)	3.15 (0.96)	3.01 (0.84)	3.03 (1.00)	0.42
HDL cholesterol (mmol/l), mean (SD)	1.48 (0.45)	1.55 (0.46)	1.67 (0.50)	0.002
Triglyceride (mmol/l), mean (SD)	1.50 (0.88)	1.41 (0.98)	1.25 (0.62)	0.025
Smoking, n (%)	47 (42)	49 (26)	46 (30)	0.067
Years of education, mean (SD)	11.0 (2.9)	11.3 (3.0)	10.8 (3.1)	0.57
Living in a relationship, n (%)	68 (61)	103 (56)	95 (63)	0.69
Working status, n (%)				0.29
Employed	55 (50)	84 (45)	63 (42)	
Unemployed	32 (29)	41 (22)	40 (26)	
Student	4 (4)	4 (2)	3 (2)	
Retired	20 (18)	56 (30)	45 (30)	
Household income below median (<30.000), n (%)	66 (59)	108 (58)	85 (56)	0.60
Comorbidities, mean (SD)	0.56 (0.82)	0.65 (0.94)	0.75 (0.99)	0.076
BDI score, mean (SD)	25.4 (8.6)	23.4 (8.2)	21.9 (7.7)	<0.001
MADRS score, mean (SD)	23.5 (5.8)	21.5 (6.5)	21.5 (5.3)	0.002

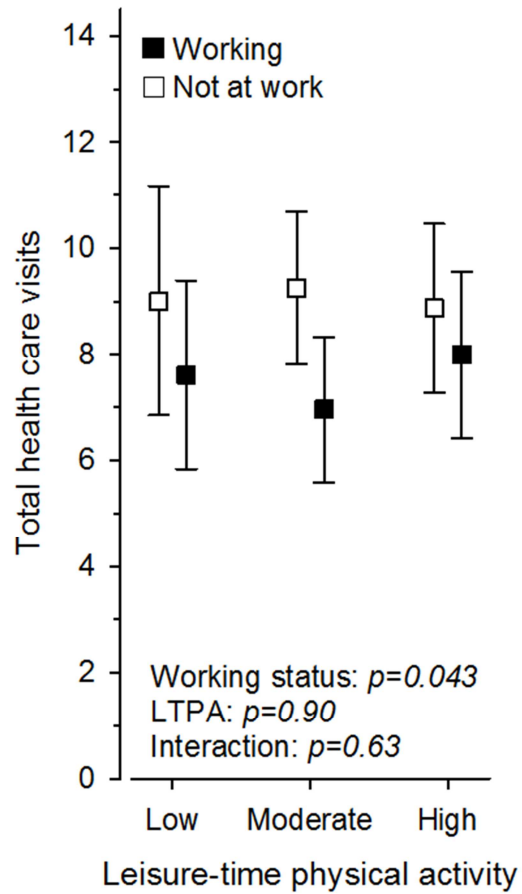
*BMI body mass index, LDL low-density lipoprotein, HDL high-density lipoprotein, BDI beck depression inventory, MADRS montgomery-åberg depression rating scale.*

Table 2. Health care utilization per person years among depressed patients according to leisure-time physical activity level during the 5-year follow-up (FDMSA follow up 2012-2016).

Variables	Leisure-time physical activity			p for linearity
	Low	Moderate	High	
	N=111 Mean (SD)	N=185 Mean (SD)	N=151 Mean (SD)	
Physician	3.57 (4.16)	3.21 (3.15)	3.70 (3.29)	0.94
Psychiatrist	0.48 (0.73)	0.38 (0.90)	0.32 (0.71)	0.37
Psychologist	0.26 (0.79)	0.41 (1.90)	0.53 (2.13)	0.14
Depression nurse	2.18 (2.12)	2.07 (2.54)	1.92 (1.95)	0.32
Substance abuse nurse	0.41 (2.18)	0.77 (4.52)	0.29 (2.25)	0.71
Other professionals	1.82 (2.64)	1.83 (2.31)	2.03 (2.62)	0.73
Hospitalization days	1.07 (4.70)	0.75 (2.03)	1.08 (3.28)	0.88
Phone calls	2.59 (3.16)	2.50 (2.75)	2.60 (3.02)	0.69

*Adjusted for age, gender, years of education, marital status, comorbid diseases and household incomes (med<30 000).*

Figure 1. Total health care visits according to LTPA and working status. Physician + Psychiatrist + Psychologist + Depression nurse + Substance abuse nurse + Other professionals. Adjusted for age, gender, education years, marital status, comorbid diseases and household income (median < 30 000).





## Highlights

- LTPA level does not predict the future HCU among depressed patients
- Heaviest burden by depressed patient is on physicians
- Health benefits of PA do not transfer to HCU.