



Association between screen time and depression among US adults

K.C. Madhav^a, Shardulendra Prasad Sherchand^b, Samendra Sherchan^{c,*}

^a Louisiana State University Health Sciences Center, School of Public Health, New Orleans, LA, United States

^b Department of Microbiology, Immunology, and Parasitology, Louisiana State University Health Sciences Center, New Orleans, LA, United States

^c Department of Global Environmental Health Sciences, Tulane University School of Public Health and Tropical Medicine, New Orleans, LA, United States

ARTICLE INFO

Keywords:

National Health and Nutritional Examination Survey
Depression
TV and computer screen time

ABSTRACT

Epidemiological surveys conducted in general populations have found that the prevalence of depression is about 9% in the United States. World Health Organization has projected that depression will be leading cause of disease burden by the year 2030. Growing evidence suggests that sedentary lifestyle is an important risk factor of depression among adults. The relationship between television watching/computer use and depression in US adults is still unknown. The objective of this study was to assess the relationship between television watching/computer use and depression. This is a cross-sectional study that used the secondary data from the National Health and Nutritional Examination Survey (NHANES) (2011/2012). Participants were 3201 US adults who were 20 years or more. Self-reported Patient Health Questionnaire-9 [PHQ-9] was used to classify depression level; self-reported hours of watching TV and use of computer/day, and demographic information were obtained from NHANES data set. SAS[®]9.4 was used to perform all statistical analyses and final model selection procedure. Depression was found to be significantly higher among female. Results showed that moderate or severe depression level was associated with higher time spent on TV watching and use of computer (> 6 h/day) (adjusted odds ratio: 2.3, 95% CI: 1.602–3.442). Duration of screen time was significantly associated when all covariates were adjusted. TV watching and computer use can predict the depression level among adults. Prospective studies and measurement of factors such as: work place sitting, social relationship, and family history of depression are warranted.

1. Introduction

Depression is one of the most common mental disorders and it is estimated that 350 million people of all ages suffer from depression globally (Marcus et al., 2016). World Health Organization predicts that depression will be the leading cause of disease burden worldwide by the year 2030 (World Health Organization, 2011). Data from the National Health and Nutrition Examination Survey, 2009–2012 has indicated that about 7.6% of people aged 12 and over had moderate or severe depression (Pratt and Brody, 2014). Studies have found that females are more likely to experience depressive symptoms than male (de Wit et al., 2011; Wang et al., 2016). Several researches have been conducted to seek the association between depression and individual characteristics such as: physical activity, socio-economic status and existing disease conditions, and reported that these factors are associated with depression (Freeman et al., 2016; Ma and Xiao, 2010; Vallance et al., 2011; Zhao et al., 2011). Research in sedentary behavior and health risk suggests that engaging in sedentary behavior is associated with depression and several chronic diseases such as: type 2 diabetes and

cardiovascular diseases (de Wit et al., 2011; Megan et al., 2014; Teychenne et al., 2010).

Sedentary behavior can be defined as behavior characterized by a seated or reclining posture and low energy expenditure (≤ 1.5 Metabolic Equivalent Task) (Teychenne et al., 2010). TV watching and computer use are common sedentary activities in United States and elsewhere. People who spend > 4 h of screen time such as: TV watching and computer use, are at higher risk of developing depression (de Wit et al., 2011; Hamer et al., 2013). While, it is also reported that people with depressive symptoms spend significantly more hours in a day, watching TV and using computer (de Wit et al., 2011).

Most of the studies have focused towards the relation of physical activity with mental health. The role of physical activity in mental health is well established in several studies and it is proven that physically active individuals are less likely to suffer from depressive symptoms (Hamer et al., 2010). However, there are a limited number of studies done to assess screen time (TV watching and computer use) and depression, controlling major demographic and socio-economic factors. This study aims to assess the relationship between screen time and

* Corresponding author at: Department of Global Environmental Health Sciences, Tulane University School of Public Health and Tropical Medicine, 1440 Canal Street, Suite 2100, New Orleans, LA 70112, United States.

E-mail address: sshercha@tulane.edu (S. Sherchan).

<http://dx.doi.org/10.1016/j.pmedr.2017.08.005>

Received 13 March 2017; Received in revised form 20 June 2017; Accepted 14 August 2017

Available online 16 August 2017

2211-3355/ © 2017 Published by Elsevier Inc. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

depression risk among U.S. adults and select the best model to predict depression.

2. Methodology

2.1. Study design and sample

This is a cross-sectional study, done using the 2011–2012 cycle of National Health and Nutrition Examination Survey (NHANES) data (Center for Disease Control and Prevention, 2012). NHANES is a cross-sectional survey, representing the no institutionalized civilian resident population of the United States. Individuals who were 20 years or more were included in this study (Center for Disease Control and Prevention, 2014). Participants who did not respond to the depression screener questionnaire (Patient Health Questionnaire-9) were excluded from the study (Loprinzi and Cardinal, 2012). Similarly, those who did not have complete data for demographic information and TV watching/computer use were also excluded. A total of 3201 adults from the United States were included in this study (Loprinzi and Cardinal, 2012).

2.2. Diagnosis and classification of depressive symptoms

Depressive symptoms were determined based on participant's responses to the PHQ-9 questionnaire in the NHANES 2011–2012 cycle. PHQ-9 is the 9-item self-report depression scale that asks questions about the frequency of symptoms of depression over the past 2 weeks (Kroenke et al., 2001; Moschos et al., 2016). Each item can be scored from 0 (not at all) to 3 (nearly every day) (Kroenke et al., 2001). The PHQ-9 score can range from 0 to 27 and thus, classified in two categories. Individual having PHQ-score < 9 were classified as “no or mild depression” and those with PHQ-score of 10 or more, were classified as “moderate to severe depression” (Rethorst et al., 2014; Wittayanukorn et al., 2014).

2.3. Screen time

Self-reported total hours per day spent on watching TV and use of computer, was calculated based on the responses on two questions: 1). “Over the past 30 days, on average how many hours per day did you sit and watch TV or video”, 2). “Over the past 30 days, on average how many hours per day did you use a computer or play computer games outside of work or school”. “Average number of hours per day watching TV or video” and “average number of hours per day using computer or playing computer games outside of work” were summed and called as “screen time”. Participants screen time was classified into two categories (Breland et al., 2013; Grontved et al., 2015). Those with > 4 h per day of screen time are categorized as high screen time and those with < 4 h per day of screen time are categorized as low screen time (Duncan et al., 2012; Shiue, 2015).

2.4. Body mass index (BMI)

Self-reported body weight and height of participants were used to determine Body Mass Index (BMI) and classified into 4 categories: 1) Underweight (< 18.5 kg/m²), 2) Normal weight (18.5 to 24.9 kg/m²), 3) Overweight (25 to 29.9 kg/m²) and 4) Obese (> 30 kg/m²) (Duncan et al., 2012).

2.5. Covariates

Based on existing literatures on screen time and depression; age, gender, sex, race/ethnicity (Non-Hispanic White, Non-Hispanic Black, Hispanic and Other race) and education were included in this study as confounding variables (Gardner et al., 2014; Owens et al., 2014; Weaver et al., 2015). Education was categorized into 2 levels: 1) Less than high school/general education development (GED) and 2) High

school graduate/GED or equivalent or more. Similarly, age was categorized into four groups: 1) 20 to 35 years, 2) 36 to 50 years, 3) 51 to 65 years, and 4) > 65 years. Since depression is more common in adult group (≥ 20 years), participants who were < 20 years were excluded for this study.

Socioeconomic status (SES) was determined based on income to poverty ratio, which was obtained from NHANES data set. Income-to-poverty ratios represent the ratio of family or unrelated individual income to their appropriate poverty threshold (Loprinzi et al., 2013). In this study, a ratio below 1.00 was categorized as below poverty threshold, while a ratio 1.00 or greater was categorized as income above the poverty threshold.

2.6. Statistical analysis

All statistical analysis was performed in SAS®9.4 software (SAS Institute Inc., 2013). Frequency and percentage of study variables were calculated. In order to observe the relationship between dependent (depression level) and independent variables (screen time including age, sex, gender, race, poverty level, education level) univariate and multivariate modeling were used.

All potential covariates were identified a priori, and a backward elimination ($p < 0.05$ for variable retention in model) procedure was performed, which removed the interaction term (BMI*screen time) and age category in step 1. Multiple logistic regression models were used to examine the associations between screen time and depression level adjusting potential confounders. Four different models were developed between screen time and depression. Model 1 was adjusted for all potential confounders: age, education, race, gender, BMI, and poverty, Model 2 was adjusted for race, gender, BMI, and poverty, and Model 3 was adjusted for gender, education, BMI, and poverty. Finally, Model 4 was adjusted for minimal set of covariates including: gender, education and poverty. Model 4 was selected to assess and predict the relationship between screen time and depression.

The model fit (covariate p-values) was tested using manual backward elimination regression methods, where all potentially confounding covariates were removed one at a time by analyzing the model fit criteria. Covariates with p-value > 0.05 were removed one by one when value of Akaike Information Criteria (Tomaic et al., 2013) and Schwarz Criterion (SC) was significantly smaller than the values as compared to the previous model. This procedure was repeated until the most parsimonious regression model was reached. Furthermore, the likelihood-ratio statistic was performed, $\Delta G^2 = (-2 \log L \text{ from reduced model}) - (-2 \log L \text{ from current model})$. Smaller value of ΔG^2 ($-2 \log L$) of the model with $p > 0.005$, which shows the insignificant result against the full model was also used as criteria for model selection.

Interaction between BMI and screen time was included in the saturated model; however, it was not significant. Thus, interaction term was deleted from the backward elimination. Statistical significance was set at $p < 0.05$ for the main effects and for the interaction term.

3. Results

The results of this study are based on the responses of 3201 US adults who participated in NHANES 2011–2012. Descriptive analyses of main exposure and study co-variables were performed.

3.1. Demographic characteristics of study population

The frequency and percentage of main exposure of interest i.e. screen time and co-variables by outcome status are presented in Table 1. Of the total respondents male and female participants were equally distributed gender wise. Majority of respondents were non-Hispanic white (42.17%), whereas Hispanic respondents were accounted for 14.50% of total respondents. About 87% of respondent had completed

Table 1
Descriptive statistics of study variables by outcome status (n = 3201).

Study variables	N	(%)	No or mild depression n (%)	Moderate or severe depression n (%)	p-Value
Gender					
Male	1602	50.05	1513 (42.27)	89 (2.78)	< 0.0001
Female	1599	49.95	1432 (44.74)	167 (5.22)	
Education level					
Less than High school graduate/GED	427	13.34	367 (11.47)	60 (1.88)	< 0.001
High school graduate/GED or equivalent or more	2773	86.66	2577 (80.95)	196 (6.13)	
Race					
Non-Hispanic White	1350	42.17	1226 (38.30)	124 (3.87)	0.0061
Non-Hispanic Black	802	25.05	739 (23.09)	63 (1.97)	
Hispanic Others	464	14.50	422 (13.18)	42 (1.31)	
Others	585	18.28	558 (17.43)	27 (0.84)	
Age					
20–35 years	1104	34.49	1018 (31.80)	86 (2.69)	0.0226
36–50 years	843	26.34	763 (23.84)	80 (2.50)	
51–65 years	777	24.27	710 (22.18)	67 (2.09)	
> 65 years	477	14.90	454 (14.18)	23 (0.72)	
BMI					
Underweight	52	1.58	46 (1.46)	6 (0.13)	< 0.0001
Normal	1074	34.03	1013 (32.10)	61 (1.93)	
Overweight	1041	32.98	970 (30.74)	71 (2.25)	
Obese	991	31.40	876 (27.76)	115 (3.64)	
Poverty					
Yes (below poverty threshold)	617	20.63	522 (17.45)	147 (4.91)	< 0.0001
No (above poverty threshold)	2374	79.37	2227 (74.46)	95 (3.18)	
Screen time					
< 4 h per day	1481	46.27	1399 (43.71)	82 (2.56)	< 0.001
4 to 6 h per day	1248	38.99	1129 (35.27)	119 (3.72)	
> 6 h per day	472	14.75	417 (13.03)	55 (1.72)	

at least high school/GED and majority (34.5%) of them were between 20 and 35 years old. Based on the self-reported height and weight of the study participants, it was found that about 64.38% of total population was overweight or obese.

About 8% of total study participants had moderate or severe depression (PHQ-9 score ≥ 10). Significantly higher proportion of women had experienced moderate or severe depression. Similarly, the proportion of moderate or severe depression was also higher in Non-Hispanic white and among those who spent > 4 h per day in watching TV and use computer outside of work or school.

3.2. Association between screen time and depression: univariate analyses

The purpose of this study was to assess whether there is an association between screen time and depression in people who spent > 4 h of screen time. To test that we conducted univariate analysis between screen time and depression in people spending > 4 h of screen time. The univariate analyses between screen time and depression indicated that individuals, who spent > 4 h per day in watching TV and using computer, are more likely to be diagnosed with moderate or severe depression than those who spent < 4 h per day in watching TV and using computer (Table 2). It was observed that the odds ratio of developing moderate or severe depression among people who spent 4 to 6 h in screen (watching TV and using computers) was 1.798 (95%

Table 2
Unadjusted ORs and CIs for moderate or severe depression among US adults.

Characteristics	Reference group	Unadjusted OR	CI (95%)	p-Value
36–50 years	20–35 years	1.241	(0.903–1.707)	< 0.0001
51–65 years		1.117	(0.800–1.559)	
> 65 years		0.600	(0.374–0.963)	
Less than HS/GED	HS or more	2.150	(1.578–2.928)	< 0.0001
NH-black	NH-white	0.843	(0.614–1.157)	
Hispanic		0.984	(0.682–1.420)	< 0.001
Other race		0.478	(0.312–0.734)	
Female	Male	1.983	(1.518–2.590)	
Underweight	Normal weight	1.444	(0.503–4.143)	< 0.001
Overweight		1.216	(0.854–1.731)	
Obese		2.180	(1.578–3.012)	
Below poverty level	Above poverty level	2.758	(2.094–3.630)	< 0.001
Screen time 4–6 h	Screen time < 4 h	1.798	(1.343–2.408)	
Screen time > 6 h		2.250	(1.572–3.221)	< 0.001

CI = 1.34–1.572); whereas the odds ratio of developing moderate or severe depression among people who spent > 6 h/day was 2.250 (95% CI: 1.572–3.221).

From the univariate logistic regression analyses, it was found that people who were > 65 years old, were at reduced risk of developing moderate and severe depression (OR = 0.600 CI = 0.374–0.963, p > 0.0001) than those, who are 20 to 35 years old (Table 2). Similarly, non-Hispanic Asians have lower odds of developing symptoms of depression than those who are non-Hispanic white (OR = 0.478 CI = 0.312–0.734, p > 0.0001). The odds ratio of developing depression among female was 1.983 (CI = 1.518–2.590, p > 0.0001). It was also observed that people who were at below poverty threshold had higher odds of developing moderate or severe depression (OR = 2.250 CI = 1.57–3.221, p > 0.0001).

3.3. Association between screen time and depression: multivariate adjusted model

Adjusted model was performed to observe the association between the screen time and depression by keeping all other study variables constant (Table 3). Like in univariate logistic regression model, screen time was found to be significantly associated with depression in adjusted model (adjusted for all potential confounder), OR = 1.943 (1.415–2.669, p < 0.0001) among those who spent 4–6 h in screen

Table 3
Association between screen time and depression: full-adjusted model.

Characteristics	Reference group	OR	95% CI	p-Value
36–50 years	20–35 year	1.234	0.867 1.757	0.2432
51–65 years		1.110	0.767 1.607	0.5807
> 65 years		0.538	0.318 0.910	0.0209
Less than HS/GED	HS or more	1.970	1.382 2.807	0.0002
NH-black	NH-white	0.613	0.434 0.867	0.0057
Hispanic		0.769	0.514 1.150	0.2014
Other race		0.541	0.336 0.872	0.0117
Female	Male	1.993	1.490 2.664	< 0.001
Underweight	Normal weight	1.50	0.501 4.504	0.4675
Overweight		1.343	0.912 1.977	0.1352
Obese		1.920	1.337 2.756	0.0004
Below poverty level	Below poverty level	2.434	1.809 3.275	< 0.0001
Screen time 4–6 h/day	< 4 h per day	1.943	1.415 2.669	< 0.0001
Screen time > 6 h/day		2.321	1.568 3.436	< 0.001

*Adjusted for age, education, race, gender, BMI, poverty.

Table 4
Association between screen time and depression: comparing 4 different models.

Screen time	Adjusted Model 1 ^a OR (95% CI)	Adjusted Model 2 ^b OR (95% CI)	Adjusted Model 3 ^c OR (95% CI)	Adjusted (final) Model 4 ^d OR (95% CI)
< 4 h/day	Reference	Reference	Reference	Reference
4 to 6 h/day	1.943 (1.415–2.669)	1.877 (1.369–2.575)	1.847 (1.348–2.531)	1.958 (1.433–2.677)
> 6 h/day	2.321 (1.568–3.436)	2.251 (1.527–3.320)	2.166 (1.472–3.186)	2.348 (1.602–3.442)

^a Adjusted for age, education, race, gender, BMI, poverty.

^b Adjusted for education, race, gender, BMI, poverty.

^c Adjusted for gender, education, BMI, poverty.

^d Adjusted for gender, education, poverty.

and OR = 2.321 (1.568–3.436, $p < 0.0001$) among those who spent > 6 h/day in screen. The interaction term of BMI and screen time in the adjusted model was found to be insignificant. Adjusting age, gender race, BMI, and poverty level there was lower odds of depression symptoms among people other than non-Hispanic white.

The adjusted OR (adjusted for race, gender, education, BMI, and socioeconomic status) of developing depression among people 36 to 50 years of age was 1.234 (CI: 0.867–1.757, $p = 0.2432$), 1.110 (CI: 0.767–1.607, $p = 0.5807$), and 0.538 (CI: 0.318–0.910, $p = 0.0209$) among 51–65 years and > 65 years age group respectively. The adjusted odds ratio among people with less than high school/GED of educational qualification was 1.970 (95% CI: 1.382–2.807, $p = 0.0002$). Unlike the univariate model, the adjusted model indicated that underweight and overweight were not significantly associated with depressions. Among underweight people the odds ratio was 1.50 (95% CI: 0.501–4.504, $p = 0.4675$), whereas the odds ratio was 1.343 (95% CI: 0.912–1.97, $p = 0.1352$) among those who are overweight. However, obese people were found to be significantly associated with depression OR = 1.920 (95% CI: 1.337–2.756, $p = 0.0004$).

3.4. Model selection

After using backward elimination procedure for best model selection; gender, education, poverty level and screen time, were found to be significantly associated with depression level at the significance level of 0.05 (Table 4). All other variables from the full model were removed in the final reduced model. In the final model, the odds ratio of developing depression was 1.958 (95% CI = 1.433–2.677, $p < 0.0001$) among those who spent 4–6 h/day on screen and the odds of developing depression were 2.348 (95% CI = 1.602–3.442, $p < 0.0001$) among those who spent > 6 h/day. Higher odds of developing depression among female than male: 2.055 (CI = 1.547–2.729, $p < 0.0001$) was observed in the final model. The OR among people with less than high school education was 1.982 (CI = 1.547–2.729, $p < 0.0001$). Similarly, people who are living below the poverty threshold have higher OR of developing depression: 2.456 (95% CI: 1.844–3.272, $p < 0.0001$).

4. Discussion

In this large population based cross-sectional study of US adult population, it was found that there was significant association between the TV watching/computer uses with moderate or severe level of depression after controlling all potential confounders. There were higher odds of developing depressive symptoms among people who spend > 6 h per day in TV watching and computer use. Like the results of previous study on depression, this study also found that, female were at higher risk of developing depression along with less educated and people below poverty level (Lepine and Briley, 2011). The higher odds of developing depression among female was may be due to the pregnancy related anxiety. Several studies conducted in pregnancy and

maternal depression has found that pregnancy reduces the physical activity and that leads towards the depression. During the period of depression, women are more likely to stay at home and spend maximum amount of time watching TV and using computer (Nordhagen and Sundgot-Borgen, 2002; Padmapriya et al., 2016; Tendais et al., 2011). The findings of this study are consisted with study conducted by Hamer et al. which indicates that spending > 4 h/day in watching TV and using computer, leads to moderate to severe level of depression (Hamer et al., 2010; Maras et al., 2015). Similarly, the results of this study are in accordance with previous studies on sedentary behavior and mental disorders that found the significant association (Primack et al., 2009).

There is a lack of research assessing the relationships between specific types of screen behavior and depression level among adults. The role of screen time in depression in individual varies with type of screen behavior and duration. In contrast to the findings of this study, the study conducted by Maras et al. on screen time and depression, found the insignificant association between TV watching and depression level. This discrepant in findings could be due to methodological differences in study and study co-variables. Study conducted on BMI and depression found that BMI was significantly associated with severity of depression (Opel et al., 2015). However, BMI was not significantly associated in this study. Another study found that people who spend more time in front of electronic screens have more sleeping problems which could compromise their ability to cope with stress, resulting in increased feelings of depression or anxiety study (Nelson and Gordon-Larsen, 2006; Van den Bulck, 2004).

This is a cross-sectional study and secondary data was used. Since cross-sectional study observes the situation at a given time period, causal relationship cannot be established between the exposure and outcome variable. The data on exposure variables were self-reported by the study participants that may introduce recall bias in the study. Furthermore, the data does not tell about the history of depression and medication, which may again influence the result. Some of the important variables such as physical activity, stress coping strategies and sleep duration were not analyzed in this study, which could have significant effect in predicting the outcome variable.

In summary, after controlling for all covariates, screen time (TV watching and computer using outside work or school) was associated with moderate or severe depression among US adults. The findings of this study suggest that duration of screen time was significantly associated when all covariates were adjusted, however, only gender, education, poverty levels were picked in the final model to predict the depression level. The finding of this study suggests that screen time is a significant risk factor or a marker of mental disorders among US adults. Since, mental health is predicted to be leading cause of disease burden by 2030; the intervention should be targeted towards the prevention of these kinds of risk factors. The finding from this study could inform individuals and policy makers to reduce the time limit of screen time.

Further prospective studies measuring all other important risk factors associated with depression such as: work place sitting, social relationship, and family history of depression are warranted to confirm causal pathways and to examine whether these common sedentary behaviors are associated to poorer mental health outcomes.

References

- Breland, J.Y., Fox, A.M., Horowitz, C.R., 2013. Screen time, physical activity and depression risk in minority women. *Ment. Health and Phys. Act.* 6 (1), 10–15. <http://dx.doi.org/10.1016/j.mhpa.2012.08.002>.
- Center for Disease Control and Prevention, 2012. National Health and Nutrition Examination Survey. 2011–2012 Overview. Retrieved from. <https://wwwn.cdc.gov/nchs/nhanes/ContinuousNhanes/Overview.aspx?BeginYear=2011>.
- Center for Disease Control and Prevention, 2014. About the National Health and Nutrition Examination Survey. Retrieved from. https://www.cdc.gov/nchs/data/nhanes/nhanes_13_14/2013-14_overview_brochure.pdf.
- Duncan, M.J., Vandelandotte, C., Capercione, C., Hanley, C., Mummery, W.K., 2012. Temporal trends in and relationships between screen time, physical activity,

- overweight and obesity. *BMC Public Health* 12, 1060. <http://dx.doi.org/10.1186/1471-2458-12-1060>.
- Freeman, A., Tyrovolas, S., Koyanagi, A., et al., 2016. The role of socio-economic status in depression: results from the COURAGE (aging survey in Europe). *BMC Public Health* 16 (1), 1098. <http://dx.doi.org/10.1186/s12889-016-3638-0>.
- Gardner, B., Iliffe, S., Fox, K.R., Jefferis, B.J., Hamer, M., 2014. Sociodemographic, behavioural and health factors associated with changes in older adults' TV viewing over 2 years. *Int. J. Behav. Nutr. Phys. Act.* 11, 102. <http://dx.doi.org/10.1186/s12966-014-0102-3>.
- Grontved, A., Singhammer, J., Froberg, K., et al., 2015. A prospective study of screen time in adolescence and depression symptoms in young adulthood. *Prev. Med.* 81, 108–113. <http://dx.doi.org/10.1016/j.ypmed.2015.08.009>.
- Hamer, M., Stamatakis, E., Mishra, G.D., 2010. Television- and screen-based activity and mental well-being in adults. *Am. J. Prev. Med.* 38 (4), 375–380. <http://dx.doi.org/10.1016/j.amepre.2009.12.030>.
- Hamer, M., Poole, L., Messerli-Burgy, N., 2013. Television viewing, C-reactive protein, and depressive symptoms in older adults. *Brain Behav. Immun.* 33, 29–32. <http://dx.doi.org/10.1016/j.bbi.2013.05.001>.
- Kroenke, K., Spitzer, R.L., Williams, J.B., 2001. The PHQ-9: validity of a brief depression severity measure. *J. Gen. Intern. Med.* 16 (9), 606–613.
- Lepine, J.P., Briley, M., 2011. The increasing burden of depression. *Neuropsychiatr. Dis. Treat.* 7 (Suppl. 1), 3–7. <http://dx.doi.org/10.2147/NDT.S19617>.
- Loprinzi, P.D., Cardinal, B.J., 2012. Interrelationships among physical activity, depression, homocysteine, and metabolic syndrome with special considerations by sex. *Prev. Med.* 54 (6), 388–392. <http://dx.doi.org/10.1016/j.ypmed.2012.03.016>.
- Loprinzi, P.D., Kane, C., Walker, J.F., 2013. Association between physical activity and major depressive disorder among current or former smokers with pulmonary disease. *Prev. Med.* 57 (5), 545–549. <http://dx.doi.org/10.1016/j.ypmed.2013.07.009>.
- Ma, J., Xiao, L., 2010. Obesity and depression in US women: results from the 2005–2006 National Health and Nutritional Examination Survey. *Obesity (Silver Spring)* 18 (2), 347–353. <http://dx.doi.org/10.1038/oby.2009.213>.
- Maras, D., Flament, M.F., Murray, M., et al., 2015. Screen time is associated with depression and anxiety in Canadian youth. *Prev. Med.* 73, 133–138. <http://dx.doi.org/10.1016/j.ypmed.2015.01.029>.
- Marcus, M., Yasamy, T., Ommeren, M., Chisholm, D., Saxena, S., 2016. Depression: A Global Public Health Concern. Retrieved from. <http://www.who.int/mediacentre/factsheets/fs369/en/>.
- Megan, T., Gavin, A., Kylie, B., Jo, S., 2014. Prospective associations between sedentary behaviour and risk of depression in socio-economically disadvantaged women. *Prev. Med.* 65, 82–86.
- Moschos, M.M., Nitoda, E., Lavaris, A., 2016. Estimation of depression prevalence in patients with Stargardt disease using PHQ-9 and Zung scores. *Eur. J. Ophthalmol.* 26 (3), 268–272. <http://dx.doi.org/10.5301/ejo.5000700>.
- Nelson, M.C., Gordon-Larsen, P., 2006. Physical activity and sedentary behavior patterns are associated with selected adolescent health risk behaviors. *Pediatrics* 117 (4), 1281–1290. <http://dx.doi.org/10.1542/peds.2005-1692>.
- Nordhagen, I.H., Sundgot-Borgen, J., 2002. Physical activity among pregnant women in relation to pregnancy-related complaints and symptoms of depression. *Tidsskr. Nor. Laegeforen.* 122 (5), 470–474.
- Opel, N., Redlich, R., Grotegerd, D., et al., 2015. Obesity and major depression: body-mass index (BMI) is associated with a severe course of disease and specific neuro-structural alterations. *Psychoneuroendocrinology* 51, 219–226. <http://dx.doi.org/10.1016/j.psyneuen.2014.10.001>.
- Owens, C.S., Crone, D., De Ste Croix, M.B., Gidlow, C.J., James, D.V., 2014. Physical activity and screen time in adolescents transitioning out of compulsory education: a prospective longitudinal study. *J. Public Health (Oxf.)* 36 (4), 599–607. <http://dx.doi.org/10.1093/pubmed/fdt123>.
- Padmapriya, N., Bernard, J.Y., Liang, S., et al., 2016. Association of physical activity and sedentary behavior with depression and anxiety symptoms during pregnancy in a multiethnic cohort of Asian women. *Arch. Womens Ment. Health* 19 (6), 1119–1128. <http://dx.doi.org/10.1007/s00737-016-0664-y>.
- Pratt, L.A., Brody, D.J., 2014. Depression in the U.S. household population, 2009–2012. *NCHS Data Brief* 172, 1–8.
- Primack, B.A., Swanier, B., Georgiopoulos, A.M., Land, S.R., Fine, M.J., 2009. Association between media use in adolescence and depression in young adulthood: a longitudinal study. *Arch. Gen. Psychiatry* 66 (2), 181–188. <http://dx.doi.org/10.1001/archgenpsychiatry.2008.532>.
- Rethorst, C.D., Bernstein, I., Trivedi, M.H., 2014. Inflammation, obesity, and metabolic syndrome in depression: analysis of the 2009–2010 National Health and Nutrition Examination Survey (NHANES). *J Clin Psychiatry* 75 (12), e1428–1432. <http://dx.doi.org/10.4088/JCP.14m09009>.
- SAS Institute Inc., 2013. *Base SAS® 9.4 Procedures Guide: Statistical Procedures, Second Edition*. Retrieved from Cary NC: SAS Institute Inc.
- Shiue, I., 2015. Duration of daily TV/screen watching with cardiovascular, respiratory, mental and psychiatric health: Scottish Health Survey, 2012–2013. *Int. J. Cardiol.* 186, 241–246. <http://dx.doi.org/10.1016/j.ijcard.2015.03.259>.
- Tendais, L., Figueiredo, B., Mota, J., Conde, A., 2011. Physical activity, health-related quality of life and depression during pregnancy. *Cad. Saude Publica* 27 (2), 219–228.
- Teychenne, M., Ball, K., Salmon, J., 2010. Sedentary behavior and depression among adults: a review. *Int. J. Behav. Med.* 17 (4), 246–254. <http://dx.doi.org/10.1007/s12529-010-9075-z>.
- Tomaic, V., Ganti, K., Pim, D., Bauer, C., Blattner, C., Banks, L., 2013. Interaction of HPV E6 oncoproteins with specific proteasomal subunits. *Virology* 446 (1–2), 389–396. <http://dx.doi.org/10.1016/j.virol.2013.08.016>.
- Vallance, J.K., Winkler, E.A., Gardiner, P.A., Healy, G.N., Lynch, B.M., Owen, N., 2011. Associations of objectively-assessed physical activity and sedentary time with depression: NHANES (2005–2006). *Prev. Med.* 53 (4–5), 284–288. <http://dx.doi.org/10.1016/j.ypmed.2011.07.013>.
- Van den Bulck, J., 2004. Television viewing, computer game playing, and Internet use and self-reported time to bed and time out of bed in secondary-school children. *Sleep* 27 (1), 101–104.
- Wang, Y., Lopez, J.M., Bolge, S.C., Zhu, V.J., Stang, P.E., 2016. Depression among people with type 2 diabetes mellitus, US National Health and Nutrition Examination Survey (NHANES), 2005–2012. *BMC Psychiatry* 16, 88. <http://dx.doi.org/10.1186/s12888-016-0800-2>.
- Weaver, A., Himle, J.A., Taylor, R.J., Matusko, N.N., Abelson, J.M., 2015. Urban vs rural residence and the prevalence of depression and mood disorder among African American women and non-Hispanic white women. *JAMA Psychiat.* 72 (6), 576–583. <http://dx.doi.org/10.1001/jamapsychiatry.2015.10>.
- de Wit, L., van Straten, A., Lamers, F., Cuijpers, P., Penninx, B., 2011. Are sedentary television watching and computer use behaviors associated with anxiety and depressive disorders? *Psychiatry Res.* 186 (2–3), 239–243. <http://dx.doi.org/10.1016/j.psychres.2010.07.003>.
- Wittayanukorn, S., Qian, J., Hansen, R.A., 2014. Prevalence of depressive symptoms and predictors of treatment among U.S. adults from 2005 to 2010. *Gen. Hosp. Psychiatry* 36 (3), 330–336. <http://dx.doi.org/10.1016/j.genhosppsych.2013.12.009>.
- World Health Organization, 2011. *Global Burden of Mental Disorders and the Need for a Comprehensive, Coordinated Response From Health and Social Sectors at the Country Level*. Retrieved from. http://apps.who.int/gb/ebwha/pdf_files/EB130/B130_9-en.pdf.
- Zhao, G., Ford, E.S., Li, C., Tsai, J., Dhingra, S., Balluz, L.S., 2011. Waist circumference, abdominal obesity, and depression among overweight and obese U.S. adults: National Health and Nutrition Examination Survey 2005–2006. *BMC Psychiatry* 11, 130. <http://dx.doi.org/10.1186/1471-244X-11-130>.