

# The Association Between Metabolic Associated Fatty Liver Disease and Depression in Adults: The Role of Physical Activity Levels and Types

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## Keywords

National Health and Nutrition Examination Survey, metabolic dysfunction associated fatty liver disease, Physical Activity Levels and Types

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## Abstract

### Introduction

At now, the association between levels of physical activity and depression is not well understood, however depressive symptoms are common in patients with metabolic dysfunction associated fatty liver disease (MAFLD).

### Material and methods

This study aims to investigate whether there is a correlation between MAFLD patients' levels of moderate to vigorous recreational exercise and depression. From the National Health and Nutrition Examination Survey (NHANES) database, 2656 individuals with MAFLD were included in this investigation. Depressive symptoms were examined in connection to varying degrees of entertainment activity using a generalized linear model that was weighted on numerous factors.

### Results

After accounting for all potential confounding factors, the weighted generalized linear model revealed a negative correlation between moderate entertainment activity and depression (OR=0.599, 95% CI: 0.475-0.755;  $P < 0.001$ ). This correlation persisted even after controlling for other variables. In spite of this, after controlling for all potential confounding variables, there was still no correlation between the intensity of entertainment activity and depression. Females who engage in moderate amounts of amusement are less likely to suffer from depression, according to subgroup analysis (OR=0.657, 95% CI: 0.440-0.983;  $P = 0.036$ ).

### Conclusions

This link persists after controlling for other variables; patients with MAFLD are more prone to depression, whereas those with higher levels of moderate recreational activity are less likely to suffer from depression. Their depressed symptoms may be treatable by modest recreational activity, according to these results.

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3 **Abstract:**

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7 there is a correlation between MAFLD patients' levels of moderate to vigorous recreational  
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21 recreational activity are less likely to suffer from depression. Their depressed symptoms

22 may be treatable by modest recreational activity, according to these results.

## 23 **Introduction**

24 **Non-alcoholic fatty liver disease (NAFLD) is a common chronic non-**  
25 **communicable disease (NCD) that excludes viral, alcoholic, drug-induced hepatitis**  
26 **and other diseases and carries the suspicion of stigma. It itself ignores correlations**  
27 **with metabolic and intra-patient heterogeneity. In 2020, experts around the world**  
28 **aiming to better understand the relationship between fatty liver and metabolism in**  
29 **the field of liver disease issued an initiative recommending that NAFLD be renamed**  
30 **as metabolic dysfunction-associated fatty liver disease (MAFLD), which is more**  
31 **beneficial in diagnosing metabolic dysfunction, extrahepatic disease, and high-risk**  
32 **liver disease, as well as predicting liver fibrosis[1].** Worldwide, metabolic associated  
33 fatty liver disease (MAFLD) has become a major public health issue due to the abnormal  
34 buildup of fat in the liver, which occurs even when alcohol intake is moderate[2]. Lifestyle  
35 changes and the worldwide obesity pandemic are fast increasing the incidence of this  
36 condition, which is intimately linked to metabolic diseases such diabetes, dyslipidemia,  
37 and obesity[3]. In addition to endangering patients' physical health, MAFLD severely  
38 affects their emotional and psychological wellbeing. Researchers and clinicians are paying  
39 more and more attention to the correlation between MAFLD and symptoms of  
40 depression[4].

41 Individuals' health, social functioning, and quality of life can be profoundly affected  
42 by depression, a prevalent mental condition[5]. When it comes to MAFLD, the metabolic

43 abnormalities might be worsened by depressed symptoms, creating a vicious cycle of  
44 worsening mental and physical health[6]. Finding modifiable risk factors for depression in  
45 MAFLD patients is, hence, of the utmost importance.

46 Regular physical exercise is one adjustable component. The many positive effects of  
47 physical and mental exercise on health have been known for a long time[7]. According to  
48 Sharifi [8], there are a lot of research showing that exercise improves health in general,  
49 including mental health issues like depression. Nevertheless, it is still not known how  
50 exactly exercise relates to the reduction of depressed symptoms in MAFLD patients.  
51 Additionally, there has been a lack of research on the best forms and intensities of physical  
52 exercise for MAFLD patients experiencing depressed symptoms.

53 In order to fill these gaps in our understanding, this research will analyse the  
54 relationship between the kinds and amounts of physical exercise and the risk of depressive  
55 symptoms in people with MAFLD. Our goal is to help MAFLD patients improve their  
56 physical and mental health by gaining a better knowledge of the correlation between their  
57 level of physical activity and their feelings of depression. In addition, this research may  
58 add to our general knowledge of how exercise might help with the treatment of long-term  
59 health conditions and the psychological issues that often accompany them.

## 60 **Methods**

### 61 **Definition of MAFLD**

62 The diagnostic methods that are used for the diagnosis of MAFLD include imaging  
63 investigations, blood biomarker testing, and liver biopsies. It is possible for dysregulation

64 of the metabolic process to result in the buildup of fat in the liver. The presence of metabolic  
65 dysregulation symptoms, being overweight or obese, or having diabetes mellitus are all  
66 variables that increase the likelihood of experiencing metabolic dysfunction[2].

### 67 **Evaluation of depression**

68 According to Maroufizadeh [9], one method for determining a person's depression  
69 level is the Patient Health Questionnaire-9 (PHQ-9). Any score between 0 and 4 indicates  
70 no depression, any score between 5 and 9 indicates mild depression, any score between 10  
71 and 14 indicates moderate depression, any score between 15 and 19 indicates moderately  
72 severe depression, and any score between 20 and 27 indicates severe depression.

### 73 **Independent variable**

74 The Global Physical Activity Questionnaire was used to gather data on the individuals'  
75 levels of physical activity each week[10, 11]. Researchers looked examined the degree of  
76 physical activity in two groups: those who engaged in moderately active leisure pursuits  
77 and those who engaged in more strenuous activities. Exercising vigorously includes any  
78 sport, fitness programme, or recreational activity that considerably increases the heart rate  
79 or breathing rate, such as running or basketball. Mildly active leisure activities included  
80 swimming, volleyball, running, or cycling for at least 10 minutes continuously.

81 According to the National Health and Nutrition Examination Survey, moderate  
82 recreational activities should be rated at 4 points, while vigorous recreational activities  
83 should be rated at 8 points. The MET for each week was determined using these results. It  
84 was possible to determine the activity's weekly metabolic equivalent by combining the

85 MET scores, daily duration, and number of days of physical activity.

## 86 **Covariates**

87 Several studies [12-16] have provided evidence that suggests a strong correlation  
88 between physical activity and depression. Other risk factors that have been identified  
89 include age, gender, race, smoking, and the family income to poverty ratio (PIR). When  
90 the weight was recorded in kilograms, the body mass index was calculated by dividing that  
91 number by the square of the height that was measured in meters. This particular set of  
92 parameters was selected because we believe that they have the potential to influence the  
93 link that exists between chromium levels and depressed symptoms.

## 94 **Statistical analysis**

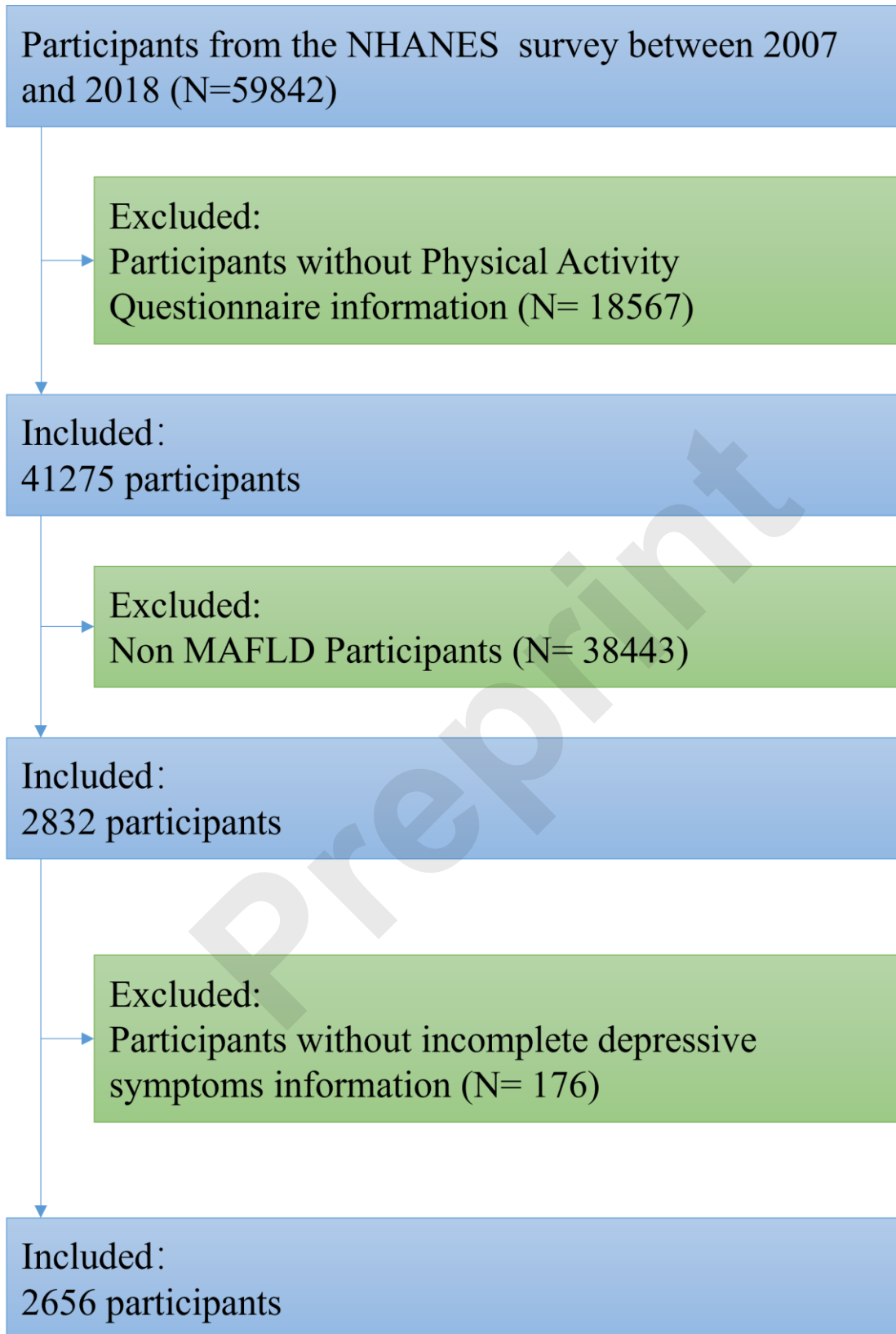
95 Data from the National Health and Nutrition Examination Survey (NHNES) from 2007  
96 to 2018 are integrated using EmpowerStats version 3.0  
97 (<http://www.empowerstats.net/analysis>). Viewable in Figure 1 is the flow diagram  
98 depicting the procedure for selecting research participants. Continuous variables are  
99 represented by the mean and standard deviation when comparing them among covariates,  
100 whereas categorical variables are represented by percentages. The National Center for  
101 Health Statistics(NCHS) Research Ethics Review Committee has approved the survey and  
102 all participants have signed an informed consent form.

103 For this research, we used generalized linear model, both univariate and multivariate.  
104 Three statistical models were created for your convenience: The first model did not account  
105 for any of the covariates; the second model adjusted for the commonly used demographic

106 variables (gender, age, and race); and the third model incorporated all of the covariates  
107 listed in Table 1. We looked at the link's threshold and saturation consequences as the study  
108 showed a nonlinear relationship. The magnitude of the influence is established in the  
109 threshold analysis by a linear relationship, or model I. But in model II, a non-linear  
110 connection is used to compute the segment and inflection point impact sizes. We checked  
111 for differences between models I and II using the log-likelihood ratio test.

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114 Fig. 1. Flow chart.



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118 Table 1 Baseline Characteristics of participants.

Characteristics	Depressive symptoms		<i>P</i> value
	No	Yes	
Age	51.342±0.860	49.587±0.885	0.115
Body mass index	32.646±0.324	34.458±0.533	0.002
Physical activity levels (met- h/week)	13.432±0.926	8.694±1.056	0.011
Family PIR	3.200±0.081	2.531±0.095	<0.001
Gender, (%)			<0.001
Female	40.965	58.019	
Male	59.035	41.981	
Race/ethnicity, (%)			0.303
Mexican American	11.847	9.458	
Non-Hispanic Black	9.495	9.836	
Non-Hispanic White	61.435	62.702	
Other Races	17.223	18.004	

Smoking status, (%)			<0.001
Never	59.525	42.507	
Former	27.627	29.881	
Now	12.848	27.612	
Moderate recreational activities, (%)665			<0.001
No	53.653	65.897	
Yes	46.347	34.103	
Vigorous recreational activities, (%)			<0.001
No	75.837	86.058	
Yes	24.163	13.942	

119 Notes: For continuous variables: survey-weighted mean (95% CI) , *P*-value was by survey-  
120 weighted linear regression (svyglm); For categorical variables: survey-weighted  
121 percentage (95% CI) , *P*-value was by survey-weighted Chi-square test (svytable).PIR:  
122 income to poverty ratio

123

#### 124 **Baseline characteristics of participants**

125 Table 1 shows the demographics and baseline characteristics of the research  
126 participants. There was no statistically significant difference in the age or race distribution  
127 of the depressed symptoms population, as shown by a *P* value greater than 0.05. There will

128 be more female participants and a higher body mass index (BMI) among those who show  
 129 symptoms of depression.

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134 Table 2 Associations between moderate/ vigorous recreational activities with depressive  
 135 symptoms among the MAFLD population

	Model 1	Model 2	Model 3
Depressive symptoms	OR (95%CI) <i>P</i> - value	OR (95%CI) <i>P</i> - value	OR (95%CI) <i>P</i> - value
Moderate recreational activities	0.599 (0.475, 0.755) <0.001	0.607 (0.468, 0.787) 0.002	0.704 (0.499, 0.994) 0.037
Vigorous recreational activities	0.508 (0.366, 0.706) 0.001	0.504 (0.334, 0.760) 0.004	0.644 (0.393, 1.054) 0.056

136 Notes: Model 1: no covariates were adjusted. Model 2: age, gender, and race were adjusted.

137 Model 3: age, gender, race, body mass index, smoking status and family PIR were adjusted.

138

139 **Moderate/ vigorous recreational activities and depressive symptoms**

140 Moderate recreational activities were negatively associated with the incidence of  
 141 depressive symptoms in Models 1-3, as shown in Table 2. There is a statistically significant

142 negative correlation between the frequency of depressive symptoms and vigorous  
143 recreational activities in Models 1 and 2, but no such difference in Model 3. According to  
144 the results of the subgroup analysis, women who engaged in moderate levels of recreational  
145 activity were less likely to have depressed symptoms.

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146 Table 3 Subgroup analysis of the association between moderate recreational activities with  
 147 depressive symptoms among the MAFLD population.

Subgroup	OR (95%CI) <i>P</i> -value
Gender	
Male	0.805 (0.529, 1.225) 0.351
Female	0.657 (0.440, 0.983) 0.036

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149

150 Table 4. The results of the two-piecewise linear regression model.

Outcome	Depressive symptoms	
	OR (95%CI)	<i>P</i> value
Fitting by linear regression model	0.996 (0.992, 1.000)	0.070
Fitting by the two-piecewise linear regression model		
Inflection point	3	
<3	0.837 (0.777, 0.902)	<0.001
≥3	1.002 (0.997, 1.007)	0.365
Log-likelihood ratio test		<0.001

151 All adjusted for age, gender, race, body mass index, smoking status and family PIR.

152

153 **Exploration of nonlinear relationships**

154 Figure 2 displays the results of a curve fitting investigation on the association between  
155 physical activity levels and the likelihood of experiencing depressed symptoms. Table 4  
156 shows the outcomes of a log-likelihood ratio test that was performed on both the linear  
157 regression model and the two-segment linear regression model at the same time. The P-  
158 value was less than 0.001. When fitting, a two-part linear regression model is necessary.  
159 Our two-segment linear regression model and recursive approach both pointed to 3 as the  
160 inflection point. To determine confidence intervals for thresholds, the Bootstrap resampling  
161 method was used. We hit a turning point at 3. Statistically, there was a 16.3% reduction in  
162 the chance of depressive symptoms for every unit increase in physical activity levels; this  
163 link was significant ( $P < 0.001$ ). The effect size and 95% confidence interval were 0.837  
164 (0.777, 0.902) to the left of the inflection point. On the right side of the inflection point,  
165 the effect size, 95% CI, and P value were 1.002 (0.997, 1.007), suggesting that there was  
166 no connection between the risk of depressive symptoms ( $P = 0.365$ ) and each unit increase  
167 in physical activity levels.

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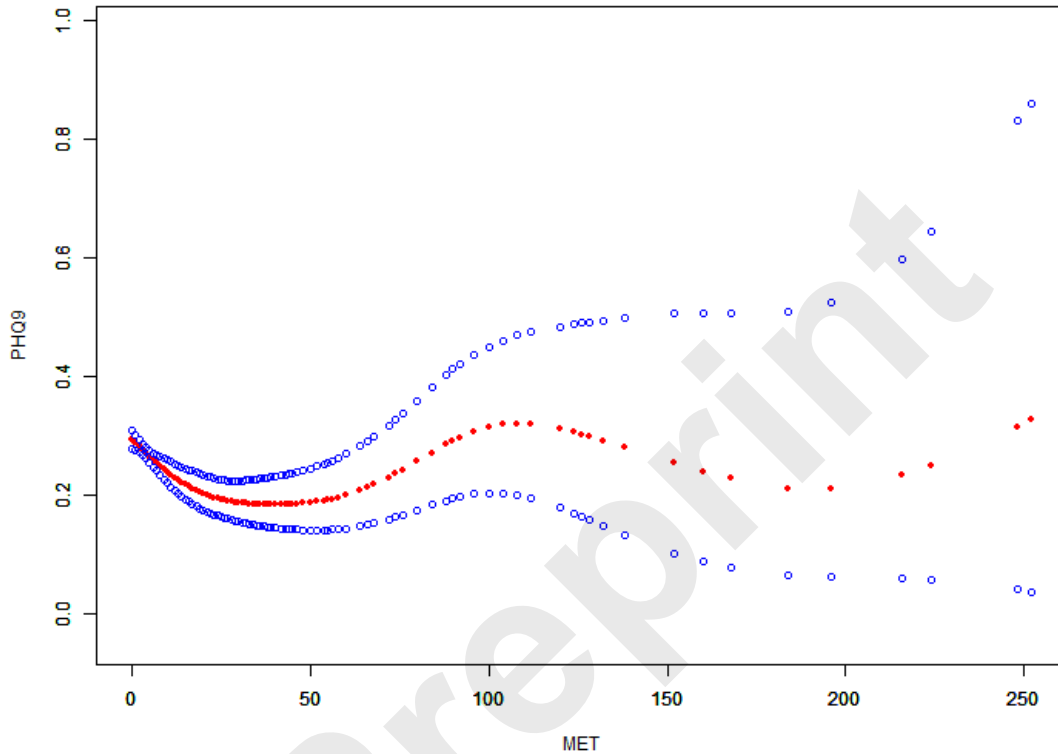
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177 Fig. 2 Association between physical activity levels and depressive symptoms.



178

179 Noted: A solid red line represents the smooth curve fit between variables. Blue bands

180 represent the 95% of confidence interval from the fit. All adjusted for age, gender, race,

181 body mass index, smoking status and family PIR.

182

183 **Discussion**

184 We discovered a non-linear connection between levels of Moderate recreational  
185 Activities and depressed symptoms in the MAFLD sample in this epidemiological study of  
186 American adults. Unlike strong recreational activities, moderate recreational activities are  
187 associated with a lower incidence of depression symptoms.

188 There were 2656 people that took part in this survey. As people's lives have changed  
189 in recent years, the compliance rate of athletic activities has become more and more  
190 negative. Table 1 shows that there is a correlation between depressed symptoms and BMI,  
191 family PIR, gender, and smoking status. Depression is linked to several ailments, according  
192 to previous research. Young people with lower levels of education and smoking are at a  
193 higher risk, according to the study.[17].

194 Many studies have shown that regular physical exercise both prevents depression and  
195 helps relieve its symptoms, thus engaging in moderate leisure activities is a great way to  
196 improve your health [18]. According to this research, mild forms of amusement were  
197 shown to alleviate depressed symptoms, however strenuous forms of entertainment did not.  
198 The frequency of depressive symptoms was not significantly different between moderate  
199 recreational activities and men when subgroup analysis was performed on the female and  
200 male populations of MAFLD. One possible explanation is that there is a lack of research  
201 on the optimal frequency, intensity, duration, and type of walking interventions, even  
202 though moderate recreational activities like walking have been found to significantly  
203 improve depressive symptoms in some populations[19]. Behavioral activation theory



204 suggests that depressive symptoms may be alleviated when people replace passive activity  
205 with recreational activities[20].

### 206 **Future Research Opportunities**

207 Based on the findings of this research, it is recommended that moderate recreational  
208 activities be classified as protective variables linked with mental health issues in the  
209 community of people with MAFLD. Furthermore, they are able to construct appropriate  
210 exercise prescriptions depending on the requirements of each person and/or the  
211 pathological problems that they are experiencing. This includes the participation of sports  
212 scientists and PA specialists from health institutions.

### 213 **Limitations**

214 The fact that the sample only contained data from the United States is one of the limitations  
215 of this study. In the future, additional data from other countries should be added for analysis,  
216 and this constraint should be taken into consideration.

### 217 **Conclusions**

218 To summarize, the purpose of this study was to investigate the impact of various levels  
219 of recreational activity on depressive symptoms in individuals diagnosed with major  
220 depressive disorder (MAFLD). The findings of this study revealed that moderate  
221 recreational activities had a protective effect on depressive symptoms, whereas vigorous  
222 recreational activities did not have a protective effect on depressive symptoms.

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282

Participants from the NHANES survey between 2007 and 2018 (N=59842)

Excluded:  
→ Participants without Physical Activity Questionnaire information (N= 18567)

Included:  
41275 participants

Excluded:  
→ Non MAFLD Participants (N= 38443)

Included:  
2832 participants

Excluded:  
→ Participants without incomplete depressive symptoms information (N= 176)

Included:  
2656 participants