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Age and Gender Differences in Trends and Impact of Depression on Quality of Life in the United States, 2008-2016

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Authors' contributions

LEE obtained funding for the study. AR, RJW, and LEE designed the study. SN acquired and analyzed the data. AR, SN, and AZD drafted the article. AR, SN, AZD, RJW and LEE critically revised the manuscript for intellectual content. All authors approved the final manuscript.

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3

Abstract

Background: We aimed to examine age and gender differences in the relationship between depression and quality of life among United States adults.

Methods: Using Medical Expenditure Panel Survey data for 2008–2016 on 227,663 adults were analyzed. The dependent variable, quality of life (QoL), included physical component summary (PCS) scores and mental component summary (MCS) scores from the Short Form Health Survey (SF-12). The key independent variable, depression, was measured using the 2-item Patient Health Questionnaire. General linear regression models examined the relationship between QoL and depression. Models were adjusted for individual and environmental characteristics, symptom status, functional and biological status, and health perceptions and were stratified by gender and age.

Results: In adjusted models, MCS scores were significantly lower among those with depression compared to those without depression (β=-0.39, 95% CI: 0.38, -1.16) and lower among women compared to men (β=-0.10, 95% CI: 0.10, -1.31). Models stratified by gender and age found women with depression ages 40–64 (β=-0.07, 95% CI: 0.07, -0.20) and ≥65 (β=-0.08, 95% CI: 0.08, -0.24) had significantly lower PCS scores compared to those without depression. Among men with depression, those ages 18–39 (β=-0.03, 95% CI: 0.03, -0.10) and 40–64 (β=-0.09, 95% CI: 0.08, -0.26) had lower PCS scores compared to those without depression. Women and men of all ages with depression had significantly lower MCS scores compared to those without depression.

Conclusions: Public health interventions and clinical approaches to address depression in women and men should target functional status in men and perceptions of health in women.

Keywords: Gender Differences, Depression, Quality of Life, Trends analysis

Background

Depression is one of the most commonly diagnosed mental health disorders and the leading cause of global disease burden, contributing 2.5% of total global Disability Adjusted Life Years (Ferrari et al., 2013). The prevalence of clinical depression in the United States (US) is 8% among US adults (Cao et al., 2020). Studies have consistently shown that there are gender differences in the burden of depression, with depression being more prevalent in women compared to men both globally and in the US (Breslau et al., 2017; Cao et al., 2020; Labaka, Goñi-Balentziaga, Lebeña, & Pérez-Tejada, 2018). Although comorbid depression contributes to increased disability related costs (Stewart, Ricci, Chee, Hahn, & Morganstein, 2003), major depressive disorders (MDDs) are responsible for a 21.5% increase in the economic burden of depression. Costs incurred by adults with MDD increased from 173 to 210.5 billion US dollars from 2005 to 2010 (Greenberg, Fournier, Sisitsky, Pike, & Kessler, 2015). In addition to direct costs, depression reduces household and workplace productivity through absenteeism (Schultz & Joish, 2009), difficulties performing social roles, and psychosomatic symptoms that worsen quality of life (QoL) (Kessler & Bromet, 2013).

Depression negatively impacts one's general wellbeing, resulting in a reduction in role functioning, role transitioning, and overall quality of life. Additionally, depression increases one's risk of suicidal ideation and other secondary disorders (Kessler & Bromet, 2013). QoL is a multidimensional, subjective assessment of the physical, social, and psychological health and satisfaction of an individual. The Wilson and Cleary model of QoL classifies and links different measures of health outcomes into five levels: biological and physiological; symptom status; functional status; general health perceptions; and overall QoL (Wilson & Cleary, 1995). Validated QoL measures and depression show strong correlations (Wisniewski et al., 2007) in individuals experiencing physical pain or activity limitation, and physical distress has been associated with having a mental health impairment, including depression (Strine, Chapman,

Kobau, Balluz, & Mokdad, 2004). However, many studies have failed to account for the multiple aspects of health as outlined by Wilson and Cleary, which limits the understanding of how depression and QoL are related.

According to the National Center for Health Statistics, there are gender differences in the burden of depression, with depression being more prevalent in women compared to men in the US, at 10.4% and 5.5%, respectively (Brody, Pratt, & Hughes, 2018). Women with depression have also been found to have higher medical expenditures (Dagher, McGovern, Dowd, & Gjerdingen, 2012) and are more likely to have undiagnosed depression (Li et al., 2009) when compared men.

While much of the literature has focused on gender differences based on increased burden in women, evidence suggests that men with depression have higher rates of suicide, alcohol abuse, and substance abuse (Cochran, 2001; Good & Brooks, 2005). In addition, men have been shown to have a higher risk of first onset major depression (Addis, 2008). Although several studies investigating depression differences by gender focus on the higher burden among women of childbearing age (Breslau et al., 2017; Kokras & Dalla, 2017; Labaka et al., 2018; Mackenzie, Visperas, Ogrodniczuk, Oliffe, & Nurmi, 2019; Rydberg Sterner et al., 2020; Skovlund, Kessing, Mørch, & Lidegaard, 2017; Vetter et al., 2020), there is paucity of research specific to differences by age and gender in the relationship between depression and QoL. Given a lack of evidence with comprehensive measures to understand possible differences by age and gender in the relationship between depression and QoL, the aim of this study was to use nationally representative data and a theoretical behavioral model to guide examination of age and gender differences in the influence of depression on QoL among adults in the US from 2008 to 2016.

Methods

Study population

78 Using the Medical Expenditure Panel Survey-Household component (MEPS-HC) consolidated
79 files for 2008 to 2016, a pooled sample of 227,663 adult women and men aged ≥ 18 years was
80 analyzed. MEPS is an ongoing national household survey for the civilian non-institutionalized
81 U.S. population, with oversampling for Black and Hispanic individuals (AHRQ, 2013). Survey
82 weights were applied to account for complex survey design, making our study sample
83 generalizable to the adult US population (AHRQ, 2013). Data are collected through in-person
84 interviews and include detailed information on demographic characteristics, health perceptions,
85 use of medical services, charges and sources of payment, access to care, satisfaction with
86 care, health insurance coverage, income, and employment for each person in the household.

87 **Study measures**

88 *Dependent variable*

89 The dependent variable was quality of life (QoL) as measured by the physical
90 component summary (PCS) scores and mental component summary (MCS) scores of the Short
91 Form – 12 Version 2 (SF -12v2) (Ware, Kosinski, Turner-Bowker, & Gandek, 2002). PCS scores
92 and MCS scores were continuous measures assessed using a 12-item scale (Resnick & Parker,
93 2001; J. Ware Jr, Kosinski, & Keller, 2002). The test-retest reliability estimates for internal
94 consistency of PCS scores and MCS scores in the general US population were 0.890 and
95 0.760, respectively (Ware Jr, Kosinski, & Keller, 1996).

96 *PCS score measurement*

97 In the MEPS-HC dataset, the PCS scores weighted responses more heavily to the
98 following items:

99 1. *In general, would you say your health is*: 1) Excellent, 2) Very good, 3) Good, 4) Fair, or 5)
100 Poor.

101 2. *During a typical day, does your health now limit you in these moderate activities such as*
102 *moving a table, pushing a vacuum cleaner, bowling, or playing golf?* 1) Yes, limited a lot, 2)
103 Yes, limited a little, or 3) No, not limited at all.
104 3. *During a typical day, does your health now limit you in climbing several flights of stairs?* 1)
105 Yes, limited a lot, 2) Yes, limited a little, or 3) No, not limited at all.
106 4. *During the past 4 weeks, have you had any of the following problems with your work or*
107 *other regular daily activities as a result of your physical health?* Accomplished less than you
108 would like: 1) Yes or 2) No.
109 5. *During the past 4 weeks, have you had any of the following problems with your work or*
110 *other regular daily activities as a result of your physical health?* Were limited in the kind of
111 work or other activities: 1) Yes or 2) No.
112 6. *During the past 4 weeks, how much did pain interfere with your normal work (including work*
113 *outside the home and housework)?* 1) Not at all 2) A little bit 3) Moderately 4) Quite a bit 5)
114 Extremely.
115 *MCS measurement*
116 Similarly, in the MEPS-HC dataset, the MCS scores weighted responses more heavily to
117 the following questions:
118 7. *How much of the time during the past 4 weeks have you felt downhearted and depressed?*
119 1) All of the time 2) Most of the time 3) A good bit of the time 4) Some of the time 5) A little
120 of the time 6) None of the time.
121 8. *How much of the time during the past 4 weeks have you felt calm and peaceful?* 1) All of the
122 time 2) Most of the time 3) A good bit of the time 4) Some of the time 5) A little of the time 6)
123 None of the time.
124 9. *During the past 4 weeks, have you had any of the following problems with your work or*
125 *other regular daily activities as a result of any emotional problems (such as feeling*
126 *depressed or anxious)?* Did work or activities less carefully than usual: 1) Yes, 2) No.

10. *During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems (such as feeling depressed or anxious)?* Accomplished less than you would like: 1) Yes, 2) No.
11. *During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting friends, relatives, etc.)?* 1) All of the time, 2) Most of the time, 3) A good bit of the time, 4) Some of the time, 5) A little of the time or 6) None of the time.

PCS and MCS scores were computed from the respective items according to standard algorithms and data imputation for missing data as previously described (Campbell, Bishu, Walker, & Egede, 2017). Algorithmic scoring generated continuous variables for PCS and MCS, with higher values indicating greater quality of life. Models were run separately for physical quality of life and mental quality of life as separate outcomes.

Primary independent variable

The primary independent variable was depression measured with the PHQ-2, a self-report of depressive symptomatology. Survey respondents were asked if they were bothered by “having little interest or pleasure in doing things” and “feeling, down, depressed, or hopeless” during the last two weeks. The measure was summed (0 – 6), and a cut point of <3 or ≥ 3 was used to dichotomize the variable as the presence/absence of depressive symptoms. The PHQ-2 has been shown to have high sensitivity and specificity for major depressive disorder, at 87% and 78%, respectively, and for any depressive disorder at 79% and 86%, respectively (Löwe, Kroenke, & Gräfe, 2005).

Covariates

A modified version of the Wilson and Cleary Model of QoL (Wilson & Cleary, 1995) underpinned the selection of covariates that were included in the final adjusted model. The variables were entered in five sequential blocks that were identified as: (1) individual characteristics, (2) environmental characteristics, (3) symptom status, (4) functional and

biological status, and (5) health perceptions. *Individual characteristics* were: age (18 – 34, 35 – 44, 45 – 64, ≥ 65 years), race/ethnicity (Hispanic, Non-Hispanic White, Non-Hispanic Black, Other), family income to poverty ratio (high [≥400%], middle [<400%-≥200%], low [<200%-≥125%], near poor [<125%->100%], or poor [<100%]), region (Northeast, Midwest, South, West), insurance (any private insurance, public only, uninsured), year (2008/10, 2011/13, 2014/16) and education level (<bachelor’s degree, ≥bachelor’s degree). *Environmental characteristics* included: difficulty accessing the usual source of care (USC) provider (yes/no) and access to USC provider. Access to USC provider was measured using two categories:1) being unable or delay in getting treatment (yes/no) and 2) being unable or delay in getting prescription (yes/no). *Symptom status* was measured as the number of self-reported comorbid conditions, including: cancer, diabetes, cholesterol, high blood pressure, and heart disease (a diagnosis of coronary heart disease, angina diagnosis, heart attack, or other heart disease). *Functional or biological status* was measured as the number of workdays or school days missed due to illness, injury, or mental/emotional problems. *Health perceptions* were measured as perceived physical and perceived mental health status as continuous variables. Perceived physical and mental health status were both assessed on a continuous scale from 1 to 5, with 1 being excellent and 5 being poor.

Statistical Analysis

First, descriptive statistics using frequencies, percentages, and means with corresponding standard deviations (SD) were computed for data from 2008 to 2016. The prevalence of depression was analyzed over time based on three-year time frames (2008-2010, 2011-2013, and 2014-2016). Second, linear trends in QoL (MCS and PCS scores) over time among men and women with depression were examined. Cochran Armitage test was used to test for significant differences in trend lines. Two general linear regression models were analyzed with 1) MCS and 2) PCS scores as dependent variables and depression as primary independent variable to investigate trend overall unadjusted relationships. Two sets of

interaction terms were run to test whether the relationship between depression and QoL (MCS and PCS scores) differed by gender and age, respectively, as described below.

Interaction between gender and depression on QoL

Prior to adjusting, interactions between depression and gender on MCS and PCS scores were assessed. The interaction between depression and gender was significant for PCS scores (p=0.01), but not for MCS scores (p=0.37); therefore, models were stratified by gender for PCS scores as an outcome, while models for MCS scores as an outcome were not stratified.

Hierarchical modeling was used for both MCS and PCS score outcomes, with covariates added to the models in five blocks: 1) Individual characteristics (age, race, gender, poverty level, region insurance coverage, education, time period), 2) environmental characteristics (having US provider, unable/delay to treatment, unable/delay to prescription), 3) symptom status (comorbidity count), 4) functional and biological status (missed work days and missed school days), and 5) Health perceptions (perceived physical and mental health).

Interaction between age and depression on QoL

The second interaction terms were run between age and depression on MCS and PCS scores. The interaction terms between depression and age on MCS scores and PCS scores, respectively, were statistically significant. Therefore, fully adjusted models were stratified by age groups for both MCS and PCS scores as outcomes while controlling for covariates. These covariates were: age, race, gender, poverty level, region, insurance coverage, education, time period, having US provider, unable/delay to treatment, unable/ delay to prescription, comorbidity count, missed work days, missed school days, perceived physical and mental health.

The analysis was weighted for US population using the survey package from CRAN repository (CRAN, 2019) and was executed in R version-4.0.0 statistical software (Team, 2019). Statistical significance was determined based on p<0.05.

Results

204 Table 1 shows the US population characteristics for 2008 to 2016 of 227,663 adult
205 respondents. Among those who had depression, 40% were aged 45-64 years, 61% were
206 female, and 42% were Non-Hispanic White. In addition, among those with depression, 42%
207 were from the South, 34% had incomes below the federal poverty level, 44% had public
208 insurance coverage only, and 84% had less than bachelor's degree.
209 Figure 1 shows trends of depression prevalence from 2008-2016. The prevalence of
210 depression did not change significantly from 2008 to 2013, and there was no significant
211 difference in depression between men and women ($p=0.93$). However, men had a significant
212 decrease in linear trend of depression ($p<0.001$), whereas women did not ($p=0.33$).
213 Table 2 shows the linear regression model for the relationship between gender and MCS
214 scores. After adjusting for covariates, MCS scores were significantly lower among those with
215 depression than those without depression ($\beta=-0.39$, 95% CI: 0.38, -1.16) and lower among
216 women compared to men ($\beta=-0.10$, 95% CI: 0.10,-0.31).
217 Table 3 shows results from the hierarchical regression modeling for the relationship
218 between depression and PCS scores stratified by gender. Model 1 was adjusted for individual
219 characteristics and found women ($\beta=-0.20$, 95% CI: 0.19, -0.59) and men ($\beta=-0.21$, 95% CI:
220 0.21, -0.63) with depression had lower PCS scores compared to women and men who did not
221 have depression. Model 2 was adjusted for individual characteristics and environmental
222 characteristics and, like model 1, found that women ($\beta=-0.17$, 95% CI: 0.17, 0.52) and men ($\beta=-$
223 0.19, 95% CI: 0.19, -0.57) with depression had lower PCS scores compared to women and men
224 who did not have depression. Model 3 was adjusted for individual characteristics, environmental
225 characteristics, and comorbidities, and found that women ($\beta=-0.15$, 95% CI: 0.15, -0.46) and
226 men ($\beta=-0.17$, 95% CI: 0.17, -0.52) with depression had lower PCS scores compared to those
227 without depression. Model 4 was adjusted for individual and environmental characteristics,
228 comorbidities, and functional status, and found that women ($\beta=-0.09$, 95% CI: 0.09, -0.28) with
229 depression had significantly lower PCS scores compared to women without depression. The

230 relationship was not statistically significant for men (β= 0.01, 95% CI: -0.01, 0.03) in model 4. In
231 the final model 5, after adjusting for individual and environmental characteristics, comorbidities,
232 functional status, and health perceptions, the relationship between depression and PCS scores
233 was no longer statistically significant for women (β= -0.08, 95% CI: 0.08, -0.24) or men (β= 0.01,
234 95% CI: -0.01, 0.04).

235 Table 4 shows results from the adjusted regression models for the relationship between
236 depression and PCS scores stratified by age. Women with depression ages 40 – 64 years (β= -
237 0.07, 95% CI: 0.07, -0.20) and ≥65 years (β= -0.08, 95% CI: 0.08, -0.24) had significantly lower
238 PCS scores compared to those without depression. However, men with depression aged 18 –
239 39 years (β= -0.03, 95% CI: 0.03, -0.10) and ages 40 – 64 years (β= -0.09, 95% CI: 0.08, -0.26)
240 had significantly lower PCS scores compared to those without depression.

241 Table 5 highlights the adjusted regression models for the relationship between
242 depression and MCS scores between men and women, stratified by age. Women with
243 depression aged 18 – 39 years (β= -0.42, 95% CI: 0.41, -1.25), 40 – 64 years (β= -0.45, 95%
244 CI: 0.43, -1.33), and ≥65 years (β= -0.36, 95% CI: 0.36, -1.08) all had significantly lower MCS
245 scores compared to those without depression. Similarly, men with depression aged 18 – 39
246 years (β= -0.38, 95% CI: 0.37, -1.14), 40 – 64 years (β= -0.40, 95% CI: 0.39, -1.20), and ≥65
247 years (β= -0.34, 95% CI: 0.33, -1.01) all had significantly lower MCS scores compared to those
248 without depression.

249 **Discussion**

250 Overall, using a nationally representative dataset, this study revealed the following key
251 findings. First, we found that MCS scores were significantly negatively associated with
252 depression, and lower for women compared to men after adjusting for possible confounders.
253 There was a differential relationship between depression and PCS scores by gender. Secondly,
254 by using a series of hierarchical models and selecting variables based on theory, we found that
255 functional status factors explained the relationship between depression and PCS scores for

256 men, whereas health perceptions explained the relationship for women. Thirdly, women with
257 depression aged 40 – 64 years and $\geq$65 years had significantly lower PCS scores compared to
258 those without depression, while men with depression aged 18 – 39 years and 40 – 64 years had
259 significantly lower PCS scores compared to those without depression. Fourth, women and men
260 with depression in all age groups had significantly lower MCS scores compared to those without
261 depression.

262 This study presents new knowledge for clinical and public health interventions by
263 providing a comprehensive analysis of the relationship between depression and QoL. Namely,
264 this study underscores the importance and need to further investigate how gender differences
265 influence QoL in women and men with depression. We found that there was no differential
266 influence between men and women in the relationship between depression and MCS scores,
267 though women did have lower MCS scores overall. It is known that individuals with lower MCS
268 scores have higher risks of suicide (Hoertel et al., 2018), obesity (Farhat, Iannotti, &
269 Summersett-Ringgold, 2015), post-traumatic stress disorders (Sareen et al., 2007), developing
270 cardiovascular diseases or stroke (Crichton, Bray, McKevitt, Rudd, & Wolfe, 2016), and work
271 productivity loss (Dewa, Hoch, Nieuwenhuijsen, Parikh, & Sluiter, 2019). These negative
272 outcomes contribute to the burden of healthcare costs and reduction of human capital,
273 negatively impacting the economy. Based on these results, efforts to address mental health
274 quality of life may not need differentiation by gender.

275 However, clinical and public health efforts to improve physical QoL may need to focus on
276 different aspects of quality of life for men and women with depression, specifically, health
277 perceptions in women and functional status in men. While the relationship between PCS scores
278 and depression was significant for both men and women when individual characteristics,
279 environmental characteristics, and comorbidities were added to the model, significance of the
280 relationship was removed for men when functional status was added to the model. Factors that
281 influence missed work or school days may explain the relationship that was seen between PCS

282 scores and depression for men. Depression is known to be associated with reduction in role
283 functioning such as poor work performance, unstable employment, reduced earnings (Parker &
284 Brotchie, 2010), more work-days missed (Booker et al., 2020; Negi, Swanberg, Clouser, &
285 Harmon-Darrow, 2020), and work impairment (Kessler, Greenberg, Mickelson, Meneades, &
286 Wang, 2001). Our findings are line with evidence from prior research that showed that major
287 depressive disorders manifested as impairment in physical wellbeing and occupational
288 performance (Lewinsohn, Rohde, Seeley, Klein, & Gotlib, 2003). Based on these results,
289 interventions to address depression should include a component that targets physical function
290 or wellbeing in men. In women, perceptions of health were more important in explaining the
291 relationship between depression and quality of life. This finding is important because of the
292 possibility that depressive symptoms lead to physical symptoms by lowering an individual's
293 mood and influencing how they view their physical health. This in turn may lead to worsening
294 depression symptoms and physical QoL due to reduced physical activity, reduced adherence to
295 anti-depressant treatment, or increased severity of depressive symptoms (Heesch, van
296 Gellecum, Burton, van Uffelen, & Brown, 2015, 2016).

297 Our study showed that depression lowered physical QoL much more in older women
298 aged 65 years or more than it lowered physical QoL among middle-aged counterparts aged 40
299 to 64 years. One review highlighted similar evidence showing that depression severity was
300 associated with poorer QoL in older persons and this relationship persisted over time (Sivertsen,
301 Bjørkløf, Engedal, Selbæk, & Helvik, 2015). Prior research highlights the negative effect of
302 comorbid depression on QoL in populations with multimorbidity (Williams & Egede, 2016) or
303 chronic conditions such as diabetes (Dismuke, Hernandez-Tejada, & Egede, 2014; Egede &
304 Hernandez-Tejada, 2013) and stroke (Ellis, Grubaugh, & Egede, 2013). This finding is of public
305 health importance because depression in older women may result from prolonged exposure to
306 high-magnitude stressors (Seib et al., 2014).

Conversely, we found that physical QoL was lower among middle-aged men (40-64 years) with depression compared to elderly men ($\geq$65 years) with depression. Stressful life events such as financial constraints and work-related events are known to have persistent negative effects on functioning among middle-aged patients (Oh & Hwang, 2017). Therefore, managing stressors may help to improve physical QoL among middle-aged men (Sherbourne, Meredith, Rogers, & Ware, 1992).

Regarding mental QoL, both women and men across all age groups with depression had lower mental QoL compared to those without depression; however, the strength of association was highest among middle-aged men and women. Prior research by Monteiro and colleagues arrived at similar findings demonstrating that middle-aged patients with fewer depressive symptoms had higher QoL, including physical QoL (Monteiro, Canavarro, & Pereira, 2016). Our findings are line with findings from prior research that showed that depressive symptoms worsened menstrual specific QoL among middle-aged women (Sohn, 2018). Among middle-aged women and men, it is likely that shorter duration of somatic depressive symptoms may contribute to better physical QoL and subsequent healthy aging.

Older women and men with depression experienced the least reduction in mental QoL. Evidence shows that suicidal rates associated with depression among older populations are declining, possibly because older adults with depression are less likely to present with affective symptoms and more likely to present with somatic symptoms (Fiske, Wetherell, & Gatz, 2009). In addition, mental wellbeing in older women and men with depression may be higher compared to younger counterparts with depression because of spousal support through caregiver or treatment support roles.

While our study's use of a nationally representative dataset is a strength, it also has two noteworthy limitations. First, comorbidities and depression were assessed by self-report, which may be subject to recall bias. However, questions used by MEPS have been based on validated questions and therefore are reliable as measures of the overall constructs being assessed.

333 Second, changes in physiological status of women like pregnancy or postpartum periods, which
334 are known to increase the risk of depression, were not included as covariates in the models.
335 Future studies should collect information specific to men and women to better understand the
336 differential relationship specifically on physical related QoL. Thirdly, the MEPS-HC dataset only
337 identifies participants as women or men, so our results cannot be generalized to people with
338 other gender identities. Finally, MEPS data is cross-sectional, and as such we cannot comment
339 on causality. The relationship between depression and QoL needs investigation using
340 longitudinal data to better understand if causal or recursive relationships exist.

341

342 **Implications for practice and/or policy**

343 Depression was associated with poor mental QoL in the general adult US population of
344 women and men. This is clinically important because of the opportunity to assess mental QoL in
345 women and men diagnosed with depression. Addressing the severity of depressive symptoms
346 may improve mental wellbeing and is likely to reduce the risk of medical comorbidities,
347 especially among patients diagnosed with depression (Barnes, Murphy, Fowler, & Rempfer,
348 2012).

349 Clinical assessment of women with depression for mental and physical health perceptions
350 may improve performance in their activities of daily living such as in the workplace or school
351 (Furegato, Santos, & Silva, 2008). Similarly, evaluating the functional status among men with
352 depression may provide an opportunity to integrate clinic- and workplace-based tailored
353 interventions that may improve physical wellbeing of men with depression in the general adult
354 population.

355 Although current United States Preventive Services Task Force (USPSTF) guidelines
356 recommend accurate diagnostic screening for depression as well as provision of effective
357 treatment and appropriate follow-up (USPSTF, 2016), screening for quality of life is not

358 addressed. Our findings indicate a clinically relevant rationale for mental QoL screening in
359 middle-aged populations of women and men with and without depression. In addition, our
360 findings suggest the importance of health perceptions screening among women with depression
361 and functional status screening among men with depression in order to improve their physical
362 wellbeing. Future research is needed that uses longitudinal study designs to investigate whether
363 any causal pathways exist in this gender- and age- differential relationship between depression
364 and physical QoL.

365 **Conclusions**

366 In conclusion, this study found that depression was associated with lower MCS and PCS
367 scores in both women and men, though women had lower MCS scores compared to men. In
368 addition, functional status explained the relationship between depression and PCS scores for
369 men, whereas health perceptions explained the relationship between depression and PCS
370 scores for women. Interventions to address depression should include additional components
371 that target functional status and perceptions of health among men and women, respectively, to
372 improve both depressive symptoms and the influence on QoL. Considerations for clinical
373 practice should include addressing the age- and gender related differences in the association
374 between depression and QoL.

375

376 **Availability of data and materials**

377 The datasets used and/or analyzed during the current study are available from the
378 corresponding author on reasonable request.

379 **Abbreviations**

380 CI: Confidence Interval; MCS: Mental Component Summary; MEPS-HC: Medical Expenditure
381 Panel Survey-Household Component; PCS: Physical Component Summary; PHQ-2: Patient
382 Health Questionnaire-2; QoL: Quality of Life

383

384 **References**

385 Addis, M. E. (2008). Gender and depression in men. *Clinical Psychology: Science and Practice, 15*(3), 153-
386 168.
387 AHRQ. (2013). *MEPS HC-036: 1996-2011 Pooled Linkage Variance Estimation File*. Retrieved from
388 https://meps.ahrq.gov/data_stats/download_data/pufs/h36/h36u11doc.shtml.
389 Barnes, A. L., Murphy, M. E., Fowler, C. A., & Rempfer, M. V. (2012). Health-related quality of life and
390 overall life satisfaction in people with serious mental illness. *Schizophrenia research and*
391 *treatment, 2012*.
392 Booker, L. A., Sletten, T. L., Alvaro, P. K., Barnes, M., Collins, A., Chai-Coetzer, C. L., . . . Rajaratnam, S. M.
393 (2020). Exploring the associations between shift work disorder, depression, anxiety and sick
394 leave taken amongst nurses. *Journal of Sleep Research, 29*(3), e12872.
395 Breslau, J., Gilman, S. E., Stein, B. D., Ruder, T., Gmelin, T., & Miller, E. (2017). Sex differences in recent
396 first-onset depression in an epidemiological sample of adolescents. *Translational psychiatry,*
397 *7*(5), e1139-e1139.
398 Brody, D. J., Pratt, L. A., & Hughes, J. P. (2018). Prevalence of depression among adults aged 20 and over:
399 United States, 2013-2016.
400 Campbell, J. A., Bishu, K. G., Walker, R. J., & Egede, L. E. (2017). Trends of medical expenditures and
401 quality of life in US adults with diabetes: the medical expenditure panel survey, 2002–2011.
402 *Health and quality of life outcomes, 15*(1), 70.
403 Cao, C., Hu, L., Xu, T., Liu, Q., Koyanagi, A., Yang, L., . . . Smith, L. (2020). Prevalence, Correlates and
404 Misperception of Depression Symptoms in the United States, NHANES 2015-2018. *Journal of*
405 *affective disorders*.
406 Cochran, S. V. (2001). Assessing and treating depression in men.
407 CRAN. (2019). The Comprehensive R Archive Network. Retrieved from https://cloud.r-project.org/
408 Crichton, S. L., Bray, B. D., McKevitt, C., Rudd, A. G., & Wolfe, C. D. (2016). Patient outcomes up to 15
409 years after stroke: survival, disability, quality of life, cognition and mental health. *Journal of*
410 *Neurology, Neurosurgery & Psychiatry, 87*(10), 1091-1098.
411 Dagher, R. K., McGovern, P. M., Dowd, B. E., & Gjerdingen, D. K. (2012). Postpartum depression and
412 health services expenditures among employed women. *Journal of occupational and*
413 *environmental medicine, 54*(2), 210-215.
414 Dewa, C. S., Hoch, J. S., Nieuwenhuijsen, K., Parikh, S. V., & Sluiter, J. K. (2019). Toward Effective Work
415 Accommodations for Depression: Examining the Relationship Between Different Combinations
416 of Depression Symptoms and Work Productivity Losses. *Journal of Occupational and*
417 *Environmental Medicine, 61*(1), 75-80.
418 Dismuke, C. E., Hernandez-Tejada, M. A., & Egede, L. E. (2014). Relationship of serious psychological
419 distress to quality of life in adults with diabetes. *The International Journal of Psychiatry in*
420 *Medicine, 48*(2), 135-146.
421 Egede, L. E., & Hernandez-Tejada, M. A. (2013). Effect of comorbid depression on quality of life in adults
422 with Type 2 diabetes. *Expert review of pharmacoeconomics & outcomes research, 13*(1), 83-91.
423 Ellis, C., Grubaugh, A. L., & Egede, L. E. (2013). Factors associated with SF-12 physical and mental health
424 quality of life scores in adults with stroke. *Journal of Stroke and Cerebrovascular Diseases, 22*(4),
425 309-317.
426 Farhat, T., Iannotti, R. J., & Summersett-Ringgold, F. (2015). Weight, weight perceptions and health-
427 related quality of life among a national sample of US girls. *Journal of developmental and*
428 *behavioral pediatrics: JDBP, 36*(5), 313.

429 Ferrari, A. J., Charlson, F. J., Norman, R. E., Patten, S. B., Freedman, G., Murray, C. J., . . . Whiteford, H. A.
430 (2013). Burden of depressive disorders by country, sex, age, and year: findings from the global
431 burden of disease study 2010. *PLoS medicine, 10*(11).
432 Fiske, A., Wetherell, J. L., & Gatz, M. (2009). Depression in older adults. *Annual review of clinical*
433 *psychology, 5*, 363-389.
434 Furegato, A. R. F., Santos, J. L. F., & Silva, E. C. d. (2008). Depression among nursing students associated
435 to their self-esteem, health perception and interest in mental health. *Revista latino-americana*
436 *de enfermagem, 16*(2), 198-204.
437 Good, G. E., & Brooks, G. R. (2005). *The new handbook of psychotherapy and counseling with men: A*
438 *comprehensive guide to settings, problems, and treatment approaches, Rev*: Jossey-Bass.
439 Greenberg, P. E., Fournier, A.-A., Sisitsky, T., Pike, C. T., & Kessler, R. C. (2015). The economic burden of
440 adults with major depressive disorder in the United States (2005 and 2010). *The Journal of*
441 *clinical psychiatry, 76*(2), 155-162.
442 Heesch, K. C., van Gellecum, Y. R., Burton, N. W., van Uffelen, J. G., & Brown, W. J. (2015). Physical
443 activity, walking, and quality of life in women with depressive symptoms. *American journal of*
444 *preventive medicine, 48*(3), 281-291.
445 Heesch, K. C., van Gellecum, Y. R., Burton, N. W., van Uffelen, J. G., & Brown, W. J. (2016). Physical
446 activity and quality of life in older women with a history of depressive symptoms. *Preventive*
447 *medicine, 91*, 299-305.
448 Hoertel, N., Blanco, C., Olfson, M., Oquendo, M. A., Wall, M. M., Franco, S., . . . Limosin, F. (2018). A
449 Comprehensive Model of Predictors of Suicide Attempt in Depressed Individuals and Effect of
450 Treatment-Seeking Behavior: Results From a National 3-Year Prospective Study. *The Journal of*
451 *clinical psychiatry, 79*(5).
452 Kessler, R. C., & Bromet, E. J. (2013). The epidemiology of depression across cultures. *Annual review of*
453 *public health, 34*, 119-138.
454 Kessler, R. C., Greenberg, P. E., Mickelson, K. D., Meneades, L. M., & Wang, P. S. (2001). The effects of
455 chronic medical conditions on work loss and work cutback. *Journal of Occupational and*
456 *Environmental Medicine, 43*(3), 218-225.
457 Kokras, N., & Dalla, C. (2017). Preclinical sex differences in depression and antidepressant response:
458 Implications for clinical research. *Journal of neuroscience research, 95*(1-2), 731-736.
459 Labaka, A., Goñi-Balentziaga, O., Lebeña, A., & Pérez-Tejada, J. (2018). Biological sex differences in
460 depression: a systematic review. *Biological research for nursing, 20*(4), 383-392.
461 Lewinsohn, P. M., Rohde, P., Seeley, J. R., Klein, D. N., & Gotlib, I. H. (2003). Psychosocial functioning of
462 young adults who have experienced and recovered from major depressive disorder during
463 adolescence. *Journal of abnormal psychology, 112*(3), 353.
464 Li, C., Ford, E. S., Zhao, G., Ahluwalia, I. B., Pearson, W. S., & Mokdad, A. H. (2009). Prevalence and
465 correlates of undiagnosed depression among US adults with diabetes: the Behavioral Risk Factor
466 Surveillance System, 2006. *Diabetes research and clinical practice, 83*(2), 268-279.
467 Löwe, B., Kroenke, K., & Gräfe, K. (2005). Detecting and monitoring depression with a two-item
468 questionnaire (PHQ-2). *Journal of psychosomatic research, 58*(2), 163-171.
469 Mackenzie, C. S., Visperas, A., Ogrodniczuk, J. S., Oliffe, J. L., & Nurmi, M. A. (2019). Age and sex
470 differences in self-stigma and public stigma concerning depression and suicide in men. *Stigma*
471 *and Health, 4*(2), 233.
472 Monteiro, F., Canavarro, M. C., & Pereira, M. (2016). Factors associated with quality of life in middle-
473 aged and older patients living with HIV. *AIDS Care, 28*(sup1), 92-98.
474 Negi, N. J., Swanberg, J. E., Clouser, J. M., & Harmon-Darrow, C. (2020). Working under conditions of
475 social vulnerability: Depression among Latina/o immigrant horse workers. *Cultural diversity and*
476 *ethnic minority psychology, 26*(1), 54.

477 Oh, Y.-K., & Hwang, S.-Y. (2017). A path analysis on the effect of anxiety and depression on health-
478 related quality of life of middle aged women. *Journal of Digital Convergence, 15*(10), 579-588.
479 Parker, G., & Brotchie, H. (2010). Gender differences in depression. *International review of psychiatry,*
480 *22*(5), 429-436.
481 Resnick, B., & Parker, R. (2001). Simplified scoring and psychometrics of the revised 12-item Short-Form
482 Health Survey. *Outcomes management for nursing practice, 5*(4), 161-166.
483 Rydberg Sterner, T., Gudmundsson, P., Falk, H., Seidu, N., Ahlner, F., Wetterberg, H., . . . Zettergren, A.
484 (2020). Depression in relation to sex and gender expression among Swedish septuagenarians—
485 Results from the H70 study. *PLoS One, 15*(9), e0238701.
486 Sareen, J., Cox, B. J., Stein, M. B., Afifi, T. O., Fleet, C., & Asmundson, G. J. (2007). Physical and mental
487 comorbidity, disability, and suicidal behavior associated with posttraumatic stress disorder in a
488 large community sample. *Psychosomatic medicine, 69*(3), 242-248.
489 Schultz, J., & Joish, V. (2009). Costs associated with changes in antidepressant treatment in a managed
490 care population with major depressive disorder. *Psychiatric services, 60*(12), 1604-1611.
491 Seib, C., Whiteside, E., Lee, K., Humphreys, J., Tran, T. H. D., Chopin, L., & Anderson, D. (2014). Stress,
492 lifestyle, and quality of life in midlife and older Australian women: results from the stress and
493 the health of women study. *Women's Health Issues, 24*(1), e43-e52.
494 Sherbourne, C. D., Meredith, L. S., Rogers, W., & Ware, J. E. (1992). Social support and stressful life
495 events: age differences in their effects on health-related quality of life among the chronically ill.
496 *Quality of Life Research, 1*(4), 235-246.
497 Sivertsen, H., Bjørkløf, G. H., Engedal, K., Selbæk, G., & Helvik, A.-S. (2015). Depression and quality of life
498 in older persons: a review. *Dementia and geriatric cognitive disorders, 40*(5-6), 311-339.
499 Skovlund, C. W., Kessing, L. V., Mørch, L. S., & Lidegaard, Ø. (2017). Increase in depression diagnoses and
500 prescribed antidepressants among young girls. A national cohort study 2000–2013. *Nordic*
501 *journal of psychiatry, 71*(5), 378-385.
502 Sohn, J. N. (2018). Factors influencing depression in Middle aged women: Focused on quality of life on
503 menopause. *Journal of Health Informatics and Statistics, 43*(2), 148-157.
504 Stewart, W. F., Ricci, J. A., Chee, E., Hahn, S. R., & Morganstein, D. (2003). Cost of lost productive work
505 time among US workers with depression. *Jama, 289*(23), 3135-3144.
506 Strine, T. W., Chapman, D. P., Kobau, R., Balluz, L., & Mokdad, A. H. (2004). Depression, anxiety, and
507 physical impairments and quality of life in the US noninstitutionalized population. *Psychiatric*
508 *services, 55*(12), 1408-1413.
509 Team, R. C. (2019). R: A Language and Environment for Statistical Computing. Version 4.0.0. R
510 Foundation for Statistical Computing. 2019.
511 USPSTF. (2016). *Final recommendation statement: Depression in adults: Screening*. Retrieved from
512 https://www.uspreventiveservicestaskforce.org/uspstf/recommendation/depression-in-adults-
513 screening.
514 Vetter, J. S., Spiller, T. R., Cathomas, F., Robinaugh, D., Brühl, A., Boeker, H., . . . Kleim, B. (2020). Sex
515 Differences in Depressive Symptoms and Their Networks in a Treatment-Seeking Population–a
516 Cross Sectional Study. *Journal of affective disorders*.
517 Ware, J., Kosinski, M., Turner-Bowker, D., & Gandek, B. (2002). How to score: version 2 of the SF-12v2
518 Health Survey. *Boston, MA: Health Assessment Lab, 22*(32.9), 32-35.
519 Ware Jr, J., Kosinski, M., & Keller, S. (2002). SF-12: how to score the SF-12 physical and mental health
520 summary scales. Boston: QualityMetric Inc. *Health Assessment Lab*.
521 Ware Jr, J. E., Kosinski, M., & Keller, S. D. (1996). A 12-Item Short-Form Health Survey: construction of
522 scales and preliminary tests of reliability and validity. *Medical care*, 220-233.
523 Williams, J. S., & Egede, L. E. (2016). The association between multimorbidity and quality of life, health
524 status and functional disability. *The American journal of the medical sciences, 352*(1), 45-52.

525 Wilson, I. B., & Cleary, P. D. (1995). Linking clinical variables with health-related quality of life: a
526 conceptual model of patient outcomes. *Jama, 273*(1), 59-65.
527 Wisniewski, S. R., Rush, A. J., Bryan, C., Shelton, R., Trivedi, M. H., Marcus, S., . . . Investigators, S. (2007).
528 Comparison of quality of life measures in a depressed population. *The Journal of nervous and*
529 *mental disease, 195*(3), 219-225.

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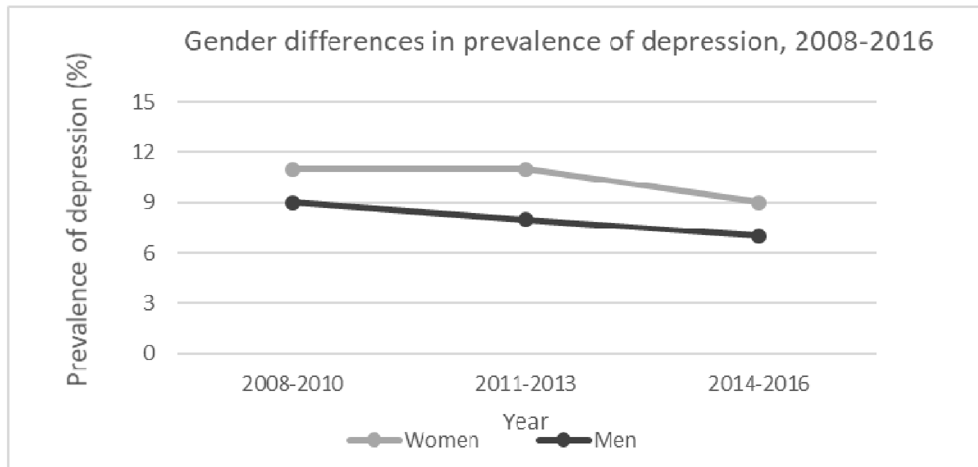
531

1 **Figure 1** Gender differences in prevalence of depression, 2008-2016



2

Year	Prevalence in men (%)	Prevalence in women (%)
2008-2010	9%	11%
2011-2013	8%	11%
2014-2016	7%	9%
Cochran-Armitage test for trend p-value =0.93 Linear trend in women with depression p-value=0.33 Linear trend men with depression p-value<0.001		

3

Table 1 Socio-demographic characteristics for time period, MEPS-HC 2008-2016

Characteristic	Overall n (%)	Depression n (%)	
		Yes	No
Individual characteristics			
Age (years)			
18-34	75,029 (33%)	4,409 (24%)	56,565 (32%)
35-44	40,841 (18%)	3,082 (17%)	32,459 (18%)
45-64	75,563 (33%)	7,224 (40%)	58,557 (33%)
≥ 65	36,230 (16%)	3,346 (19%)	28,659 (16%)
Gender			
Men	105,808 (46%)	7,053 (39%)	82,096 (47%)
Women	121,855 (54%)	11,008 (61%)	94,144 (53%)
Race and ethnicity			
Hispanic	62,471 (27%)	4,497 (25%)	48,145 (27%)
Non-Hispanic White	97,981 (43%)	7,618 (42%)	77,537 (44%)
Non-Hispanic Black	44,672 (20%)	4,500 (25%)	33,052 (19%)
Other	22,539 (10%)	1,446 (8%)	17,506 (10%)
Region			
Northeast	36,212 (16%)	2,763 (15%)	27,931 (16%)
Midwest	43,470 (19%)	3,396 (19%)	33,771 (19%)
South	86,081 (38%)	7,553 (42%)	66,414 (38%)
West	61,900 (27%)	4,349 (24%)	48,124 (27%)
Family Income to Poverty Ratio			
High income [>=400%]	66,206 (29%)	2,417 (13%)	54,475 (31%)
Middle Income [>=200% & <400%]	68,321 (30%)	4,368 (24%)	53,627 (30%)
Low Income [>=125% & <200%]	37,626 (17%)	3,557 (20%)	28,385 (16%)
Near Poor [>=100% & <125%]	13,566 (6%)	1,607 (9%)	10,034 (6%)
Poor [<100%]	41,944 (18%)	6,112 (34%)	29,719 (17%)
Insurance Coverage			
Any Private	129,900 (57%)	6,756 (37%)	105,758 (60%)
Public only	52,815 (23%)	7,942 (44%)	37,265 (21%)
Uninsured	44,948 (20%)	3,363 (19%)	33,217 (19%)
Education			
Less than Bachelors	143,906 (72%)	13,355 (84%)	109,402 (71%)
Bachelor's degree or more	54,868 (28%)	2,534 (16%)	45,560 (29%)
Year			
2008-2010	72,625 (32%)	6,313 (35%)	56,583 (32%)
2011-2013	79,362 (35%)	6,597 (37%)	62,575 (36%)
2014-2016	75,676 (33%)	5,151 (29%)	57,082 (32%)
Environmental characteristics			
Access to Care			
Have a usual care provider			
Yes	139,111 (72.5%)	13,869 (77.8%)	12,5242 (72.0%)
No	52,636 (27.5%)	3,966 (22.2%)	48,670 (28.0%)
Unable/delay to treatment			
Yes	10,354 (5.3%)	2,533 (14.1%)	7,821 (4.4%)
No	183,563 (94.7%)	15,474 (85.9%)	168,089 (95.6%)
Unable/delay to prescription			
Yes	8,192 (4.2%)	2228 (12.4%)	5,964 (3.4%)
No	185,685 (95.8%)	15,776 (87.6%)	169,909 (96.6%)
Symptom status, Mean (SD)			
Comorbidity Count (0-5)	0.95 (1.2)	1.467 (1.4)	0.897 (1.2)
Functional Status, Mean (SD)			
Missed work days	1.63 (7.5)	3.464 (11.7)	1.514 (7.1)

Missed school days	0.54 (2.5)	1.607 (5.9)	0.478 (2.1)
Health perceptions			
Perception of Health Status, Mean (SD)			
Physical health (1 excellent to 5 poor)	2.40 (1.1)	3.284 (1.2)	2.306 (1.0)
Mental health (1 excellent to 5 poor)	2.09 (1.0)	3.030 (1.2)	1.996 (0.9)
Quality of Life, Mean (SD)			
PCS	49.27 (10.6)	40.232 (13.6)	50.196 (9.8)
MCS	51.16 (10.0)	34.403 (10.7)	52.867 (8.2)

2

Table 2 Relationship between Depression and Mental Quality of Life as a linear outcome, MEPS-HC 2008-2016

Characteristic	β (95% CI)
Depressed	-0.39 (0.38,-1.16) ***
Gender	
Men	Ref
Women	-0.10 (0.10,-0.31) ***
Age	-0.04 (0.04,-0.11) *
Race	
Non-Hispanic White	Ref
Hispanic	0.04 (-0.04,0.12)
Non-Hispanic Black	0.08 (-0.08,0.24) ***
Other	0.01 (-0.01,0.04)
Poverty Category	
High income [>=400]	Ref
Middle Income [>=200 & <400]	-0.02 (0.02,-0.06)
Low Income [>=125 & <200]	-0.04 (0.04,-0.11)
Near Poor [>=100 & <125]	0.004 (-0.004,0.03)
Poor [<100]	-0.01 (0.01,-0.04)
Region	
Northeast	Ref
Midwest	0.03 (-0.03,0.08)
South	0.03 (-0.02,0.08)
West	-0.0003 (0.0003,-0.0008)
Insurance Coverage	
Any Private	Ref
Public only	0.0003 (-0.0003,0.0009)
Uninsured	-0.002 (0.002,-0.006)
Year	
2008-2010	Ref
2011-2013	0.01 (-0.01,0.02)
2014-2016	0.03 (-0.03,0.08)
Education	
Less than Bachelors	Ref
Bachelors degree or more	-0.03 (0.03,-0.09)
Access to care	
Have USC Provider	-0.04 (0.04,-0.12) *
Unable/ Delay to Treatment	-0.05 (0.05,-0.15) **
Unable/ Delay to Prescription	-0.03 (0.03,-0.1)
Comorbidities	
Comorbidity Count (0-5)	0.01 (-0.01,0.03)
Functional Status	
Missed work days	-0.01 (0.01,-0.02)
Missed school days	-0.04 (0.04,-0.13) *
Health Status	

Physical Health (1-excellent to 5-poor)	-0.02 (0.02,-0.07)
Mental Health (1-excellent to 5-poor)	-0.24 (0.24,-0.72)

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table 3 Relationship between Depression and Physical Health Related Quality of Life as a Linear Outcome stratified by gender, MEPS-HC 2008-2016

	OUTCOME: PCS									
	Model 1		Model 2		Model 3		Model 4		Model 5	
	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
Characteristic	β (95%CI)	β (95%CI)	β (95%CI)	β (95%CI)	β (95%CI)	β (95%CI)	β (95%CI)	β (95%CI)	β (95%CI)	β (95%CI)
Depression	-0.21 (0.21,-0.63) ***	-0.20 (0.19,-0.59) ***	-0.19 (0.19,-0.57) ***	-0.17 (0.17,-0.52) ***	-0.17 (0.17,-0.52) ***	-0.15 (0.15,-0.46) ***	0.01 (-0.01,0.03)	-0.09 (0.09,-0.28) *	0.01 (-0.01,0.04)	-0.08 (0.08,-0.24)
Age	-0.38 (0.37,-1.13) ***	-0.38 (0.37,-1.12) ***	-0.36 (0.35,-1.06) ***	-0.36 (0.35,-1.08) ***	-0.22 (0.21,-0.65) ***	-0.22 (0.21,-0.65) ***	0.03 (-0.02,0.07)	0.03 (-0.03,0.08)	0.04 (-0.03,0.10)	0.03 (-0.03,0.10)
Race										
Non-Hispanic White (Ref)	-	-	-	-	-	-	-	-	-	-
Hispanic	0.05 (-0.05,0.14) ***	0.03 (-0.03,0.10) ***	0.03 (-0.03,0.09) ***	0.02 (-0.02,0.06) ***	0.03 (-0.03,0.08) ***	0.02 (-0.02,0.05) **	-0.002 (0.001,-0.004)	-0.06 (0.06,-0.18) *	0.01 (-0.01,0.02)	-0.06 (0.06,-0.17) *
Non-Hispanic Black	0.01 (-0.01,0.02)	-0.01 (0.01,-0.03) *	-0.0003 (0.0003,-0.0001)	-0.02 (0.01,-0.05) **	0.03 (-0.03,0.08)	-0.01 (0.01,-0.03)	-0.07 (0.07,-0.22) **	-0.12 (0.12,-0.37) ***	-0.07 (0.07,-0.22) ***	-0.11 (0.11,-0.33) ***
Other	0.001 (-0.001,0.002)	-0.01 (0.01,-0.02)	-0.004 (0.004,-0.01)	-0.01 (0.01,-0.04) **	-0.01 (0.01,-0.02)	-0.02 (0.02,-0.05) ***	-0.006 (0.006,-0.018)	-0.02 (0.02,-0.06)	0.002 (-0.002,0.006)	-0.02 (0.02,-0.06)
Poverty category										
High income (>=400) (Ref)	-	-	-	-	-	-	-	-	-	-
Middle Income (>= 200 - <400)	-0.05 (0.05,-0.14) ***	-0.06 (0.06,-0.17) ***	-0.05 (0.05,-0.15) ***	-0.05 (0.05,-0.16) ***	-0.05 (0.05,-0.14) ***	-0.05 (0.04,-0.13) ***	-0.04 (0.04,-0.12)	0.002 (-0.002,0.005)	-0.02 (0.02,-0.06)	-0.004 (0.004,-0.013)
Low Income (>=125 - <200)	-0.07 (0.07,-0.21) ***	-0.08 (0.08,-0.23) ***	-0.07 (0.07,-0.21) ***	-0.08 (0.07,-0.23) ***	-0.07 (0.07,-0.20) ***	-0.07 (0.06,-0.20) ***	-0.02 (0.02,-0.07)	-0.01 (0.01,-0.02)	-0.002 (0.001,-0.004)	0.001 (-0.001,0.002)
Near Poor (>=100 - <125)	-0.06 (0.06,-0.19) ***	-0.07 (0.07,-0.21) ***	-0.06 (0.06,-0.19) ***	-0.07 (0.07,-0.20) ***	-0.06 (0.06,-0.18) ***	-0.06 (0.06,-0.17) ***	-0.01 (0.01,-0.04)	-0.04 (0.04,-0.13)	0.002 (-0.002,0.007)	-0.04 (0.04,-0.11)
Poor (<100)	-0.10 (0.10,-0.31) ***	-0.12 (0.12,-0.37) ***	-0.09 (0.09,-0.29) ***	-0.12 (0.12,-0.35) ***	-0.09 (0.09,-0.28) ***	-0.10 (0.10,-0.31) ***	-0.02 (0.02,-0.06)	-0.04 (0.04,-0.13)	0.02 (-0.02,0.07)	-0.03 (0.03,-0.10)
Region										
Northeast (Ref)	-	-	-	-	-	-	-	-	-	-
Midwest	-0.03 (0.03,-0.09) ***	-0.02 (0.02,-0.05) *	-0.03 (0.03,-0.10) ***	-0.02 (0.02,-0.05) **	-0.03 (0.03,-0.09) ***	-0.01 (0.01,-0.04)	-0.02 (0.02,-0.05)	0.05 (-0.05,0.16)	-0.02 (0.02,-0.07)	0.05 (-0.05,0.15)
South	-0.06 (0.06,-0.17) ***	-0.04 (0.04,-0.13) ***	-0.06 (0.06,-0.19) ***	-0.05 (0.05,-0.14) ***	-0.05 (0.05,-0.16) ***	-0.03 (0.03,-0.10) ***	-0.01 (0.01,-0.03)	0.07 (-0.07,0.2)	-0.01 (0.01,-0.04)	0.07 (-0.07,0.21)
West	-0.03 (0.03,-0.08) ***	-0.01 (0.01,-0.04) *	-0.03 (0.03,-0.08) ***	-0.02 (0.02,-0.05) *	-0.03 (0.03,-0.08) ***	-0.01 (0.01,-0.04) *	-0.03 (0.03,-0.09)	0.06 (-0.06,0.19)	-0.03 (0.03,-0.08)	0.07 (-0.07,0.22)
Insurance coverage										
Any Private (Ref)	-	-	-	-	-	-	-	-	-	-
Public only	-0.13 (0.13,-0.40) ***	-0.15 (0.14,-0.44) ***	-0.13 (0.13,-0.39) ***	-0.14 (0.14,-0.43) ***	-0.12 (0.12,-0.35) ***	-0.13 (0.13,-0.38) ***	-0.12 (0.12,-0.37) **	-0.10 (0.10,-0.31) **	-0.13 (0.13,-0.38)	-0.07 (0.07,-0.21)
Uninsured	0.02 (-0.02,0.05) **	0.003 (-0.003,0.009)	0.01 (-0.01,0.02)	0.003 (-0.003,0.008)	-0.01 (0.01,-0.02)	-0.01 (0.01,-0.02)	-0.05 (0.05,-0.16)	-0.03 (0.03,-0.10)	-0.05 (0.05,-0.15)	-0.01 (0.01,-0.04)
Year										
2008-2010 (Ref)										
2011-2013	0.004 (-0.004,0.012)	0.003 (-0.003,0.009)	0.01 (-0.01,0.02)	0.004 (-0.003,0.010)	0.01 (-0.01,0.02) **	0.001 (-0.001,0.003)	0.01 (-0.01,0.02)	-0.002 (0.002,-0.007)	0.001 (-0.001,0.002) ***	-0.01 (0.01,-0.02) *
2014-2016	0.01 (-0.01,0.04)	0.02 (-0.02,0.07) ***	0.01 (-0.01,0.04) *	0.02 (-0.02,0.07) ***	0.01 (-0.01,0.04)	0.02 (-0.02,0.07) ***	0.01 (-0.01,0.03)	0.05 (-0.05,0.14)	-0.01 (0.01,-0.02)	0.04 (-0.04,0.12)
Education										

Less than Bachelors (Ref)	-	-	-	-	-	-	-	-	-	-
Bachelors degree or more	0.09 (-0.09,0.29) ***	0.07 (-0.07,0.19) ***	0.09 (-0.09,0.29) ***	0.07 (-0.07,0.21) ***	0.09 (-0.08,0.26) ***	0.06 (-0.05,0.16) ***	-0.03 (0.03,-0.08)	-0.03 (0.03,-0.09)	-0.02 (0.02,-0.07)	-0.04 (0.04,-0.11)
Access to care										
Have USC Provider			-0.09 (0.08,-0.26) ***	-0.07 (0.07,-0.21) ***	-0.05 (0.05,-0.15) ***	-0.05 (0.05,-0.14) ***	-0.02 (0.02,-0.06)	-0.02 (0.02,-0.06)	-0.02 (0.02,-0.05)	-0.01 (0.01,-0.04)
Unable/ Delay to Treatment			-0.08 (0.08,-0.24) ***	-0.09 (0.09,-0.26) ***	-0.07 (0.07,-0.22) ***	-0.08 (0.08,-0.24) ***	-0.01 (0.01,-0.04)	-0.06 (0.06,-0.19) *	-0.02 (0.02,-0.05)	-0.05 (0.05,-0.14)
Unable/ Delay to Prescription			-0.07 (0.07,-0.21) ***	-0.07 (0.07,-0.21) ***	-0.05 (0.05,-0.16) ***	-0.06 (0.05,-0.17) ***	-0.07 (0.07,-0.2)	-0.06 (0.06,-0.18)	-0.06 (0.06,-0.19)	-0.06 (0.06,-0.18)
Comorbidities										
Comorbidity Count (0-5)					-0.25 (0.24,-0.74) ***	-0.26 (0.25,-0.78) ***	-0.08 (0.08,-0.24) ***	-0.02 (0.02,-0.05)	-0.06 (0.06,-0.18) **	0.01 (-0.01,0.03)
Functional Status										
Missed work days							-0.06 (0.06,-0.18)	-0.08 (0.08,-0.25)	-0.06 (0.06,-0.19)	-0.07 (0.07,-0.21)
Missed school days							-0.07 (0.07,-0.20)	-0.05 (0.05,-0.15)	-0.04 (0.04,-0.12)	-0.02 (0.02,-0.07)
Health Status										
Physical Health (1-excellent to 5-poor)									-0.31 (0.30,-0.93) ***	-0.31 (0.30,-0.92) ***
Mental Health (1-excellent to 5-poor)									0.17 (-0.16,0.5) ***	0.14 (-0.14,0.41) ***

Note: * p <0.05 ** p <0.01 *** p <0.001

B: Standardized beta coefficient

Model 1: Individual characteristics + depression

Model 2: Individual characteristics + depression + Access to Care

Model 3: Individual characteristics + depression + Access to Care + Comorbidity

Model 4: Individual characteristics + depression + Access to Care + Comorbidity + Functional status

Model 5: Individual characteristics + depression + Access to Care + Comorbidity + Functional status + Health status

Table 4 Relationship between depression and physical component summary (PCS) scores of quality of life as a linear outcome stratified by age-group, MEPS-HC 2008-2016

	OUTCOME: PCS					
	Women			Men		
Age group, years	Model I 18-39	Model II 40-64	Model III ≥65	Model IV 18-39	Model V 40-64	Model VI ≥65
	β (95%CI)	β (95%CI)	β (95%CI)	β (95%CI)	β (95%CI)	β (95%CI)
N	24,281	25,330	2,598	25,088	25,512	2,513
Characteristic						
Depression	-0.02 (0.02,-0.06)	-0.07 (0.07,-0.20) ***	-0.08 (0.08,-0.24) ***	-0.03 (0.03,-0.10) *	-0.09 (0.08,-0.26) ***	-0.05 (0.05,-0.15)
Race						
Non-Hispanic White (ref)						
Hispanic	-0.01 (0.01,-0.02)	0.04 (-0.04,0.12) ***	0.09 (-0.09,0.27) ***	0.004 (-0.004,0.013)	0.07 (-0.06,0.19) ***	0.08 (-0.08,0.23) ***
Non-Hispanic Black	-0.05 (0.04,-0.14) ***	0.02 (-0.02,0.05) *	0.10 (-0.10,0.31) ***	-0.03 (0.03,-0.09) ***	0.01 (-0.01,0.04)	0.04 (-0.03,0.11)
Other	-0.03 (0.03,-0.10) ***	-0.02 (0.02,-0.01)	0.04 (-0.03,0.11)	-0.05 (0.04,-0.13) ***	0.01 (-0.01,0.03)	0.05 (-0.05,0.14) *
Poverty Category						
High income (>=400) (ref)						
Middle Income (>=200 & <400)	-0.01 (0.01,-0.04) *	-0.01 (0.01,-0.03) *	-0.02 (0.02,-0.05) ***	-0.02 (0.02,-0.06) **	-0.03 (0.03,-0.08) ***	-0.02 (0.02,-0.05)
Low Income (>=125 & <200)	-0.02 (0.02,-0.06)	-0.02 (0.02,-0.07)	-0.05 (0.05,-0.14)	-0.04 (0.04,-0.13) *	-0.02 (0.02,-0.06)	-0.05 (0.05,-0.14)
Near Poor (>=100 & <125)	-0.01 (0.01,-0.04) *	-0.02 (0.01,-0.04) **	-0.05 (0.05,-0.16)	-0.02 (0.02,-0.06) ***	-0.01 (0.01,-0.04) *	-0.01 (0.01,-0.04)
Poor (<100)	-0.03 (0.03,-0.08)	-0.02 (0.02,-0.07)	-0.13 (0.13,-0.39)	-0.03 (0.03,-0.09) *	-0.04 (0.04,-0.12) **	-0.03 (0.03,-0.10)
Region						
Northeast (ref)						
Midwest	0.01 (-0.01,0.03)	-0.02 (0.01,-0.04)	-0.02 (0.02,-0.05)	-0.01 (0.01,-0.04)	-0.03 (0.03,-0.08) **	-0.05 (0.05,-0.14)
South	0.01 (-0.01,0.04)	-0.04 (0.04,-0.12) ***	-0.08 (0.07,-0.23) **	-0.04 (0.04,-0.12) ***	-0.05 (0.05,-0.16) ***	-0.06 (0.06,-0.17)
West	0.01 (-0.01,0.04)	-0.03 (0.03,-0.09) **	-0.06 (0.06,-0.17) *	-0.02 (0.02,-0.06)	-0.03 (0.02,-0.07) *	-0.06 (0.06,-0.18)
Insurance Coverage						
Any Private (ref)						
Public only	-0.06 (0.06,-0.18) ***	-0.06 (0.06,-0.19) ***	-0.02 (0.02,-0.07)	-0.05 (0.05,-0.15) ***	-0.06 (0.06,-0.18) ***	-0.02 (0.02,-0.06)
Uninsured	-0.01 (0.01,-0.04)	-0.01 (0.01,-0.03)	0.05 (-0.05,0.15) ***	-0.01 (0.01,-0.03)	-0.0001 (0.0001,-0.0002)	-0.01 (0.01,-0.04)
Year						
2008-2010 (ref)						
2011-2013	-0.02 (0.02,-0.05) *	0.003 (-0.003,0.008)	0.05 (-0.05,0.16) *	-0.01 (0.01,-0.02)	0.02 (-0.02,0.05)	-0.01 (0.01,-0.02)
2014-2016	0.03 (-0.03,0.10) ***	0.03 (-0.03,0.09) ***	0.08 (-0.08,0.23) **	0.01 (-0.01,0.04)	0.04 (-0.04,0.12) ***	0.01 (-0.01,0.04)
Education						
Less than Bachelors (ref)						
Bachelors degree or more	0.03 (-0.03,0.10) ***	0.04 (-0.04,0.11) ***	-0.01 (0.01,-0.02)	0.05 (-0.05,0.14) ***	0.06 (-0.06,0.18) ***	0.05 (-0.05,0.14)
Access to care						
Have USC Provider	-0.03 (0.02,-0.07) **	-0.05 (0.05,-0.14) ***	-0.01 (0.01,-0.04)	-0.04 (0.04,-0.12) ***	-0.04 (0.04,-0.13) ***	-0.02 (0.02,-0.07)
Unable/ Delay to Treatment	-0.06 (0.06,-0.19) ***	-0.08 (0.07,-0.23) ***	-0.04 (0.04,-0.11)	-0.06 (0.05,-0.17) ***	-0.08 (0.08,-0.25) ***	-0.08 (0.07,-0.22) ***
Unable/ Delay to Prescription	-0.04 (0.04,-0.12) ***	-0.04 (0.04,-0.12) ***	-0.03 (0.03,-0.09)	-0.02 (0.02,-0.07)	-0.04 (0.04,-0.13***)	-0.03 (0.03,-0.09)
Comorbidities						
Comorbidity Count (0-5)	-0.09 (0.08,-0.25) ***	-0.14 (0.14,-0.42) ***	-0.12 (0.12,-0.36) ***	-0.06 (0.06,-0.18) ***	-0.13 (0.12,-0.38) ***	-0.17 (0.17,-0.51) ***

Functional Status						
Missed work days	-0.10 (0.10,-0.31) ***	-0.11 (0.11,-0.34) ***	-0.03 (0.03,-0.10)	-0.11 (0.11,-0.32) ***	-0.13 (0.13,-0.40) ***	-0.10 (0.10,-0.31) ***
Health Status						
Physical Health (1-excellent to 5-poor)	-0.34 (0.33,-1.02) ***	-0.43 (0.41,-1.27) ***	-0.48 (0.47,-1.44) ***	-0.32 (0.31,-0.94) ***	-0.37 (0.36,-1.11) ***	-0.36 (0.35,-1.07) ***
Mental Health (1-excellent to 5-poor)	0.10 (-0.10,0.3) ***	0.08 (-0.08,0.25) ***	0.06 (-0.06,0.18) *	0.08 (-0.07,0.22) ***	0.06 (-0.06,0.18) ***	-0.05 (0.05,-0.14)

Note: ***p < .001; **p < .01; *p < .05

Table 5 Relationship between depression and mental component summary (MCS) scores of quality of life as a linear outcome stratified by age-group, MEPS-HC 2008-2016

	OUTCOME: MCS					
	Women			Men		
	Model I	Model II	Model III	Model IV	Model V	Model VI
Age group, years	18-39	40-64	≥65	18-39	40-64	≥65
	β (95%CI)	β (95%CI)	β (95%CI)	β (95%CI)	β (95%CI)	β (95%CI)
N	24,290	25,339	2,600	25,097	25,529	2,513
Depressed	-0.42 (0.41,-1.25) ***	-0.45 (0.43,-1.33) ***	-0.36 (0.36,-1.08) ***	-0.38 (0.37,-1.14) ***	-0.40 (0.39,-1.20) ***	-0.34 (0.33,-1.01) ***
Race						
Non-Hispanic White (ref)						
Hispanic	0.05 (-0.05,0.16) ***	0.04 (-0.04,0.11) ***	-0.01 (0.01,-0.02)	0.04 (-0.04,0.13) ***	0.02 (-0.02,0.05) *	-0.03 (0.03,-0.08)
Non-Hispanic Black	0.07 (-0.07,0.21) ***	0.05 (-0.05,0.16) ***	0.03 (-0.03,0.08)	0.06 (-0.06,0.17) ***	0.05 (-0.05,0.14) ***	0.04 (-0.04,0.13) *
Other	0.04 (-0.04,0.12) ***	0.03 (-0.03,0.08) ***	-0.03 (0.03,-0.1)	0.04 (-0.04,0.12) ***	0.02 (-0.02,0.05) *	0.03 (-0.03,0.08)
Poverty Category						
High income [>=400] (ref)						
Middle Income [>=200 & <400]	-0.01 (0.01,-0.04) ***	-0.02 (0.02,-0.06) **	0.002 (-0.002,0.007)	-0.004 (0.004,-0.012) **	-0.01 (0.01,-0.04) ***	-0.02 (0.02,-0.07) *
Low Income [>=125 & <200]	-0.01 (0.01,-0.03) *	-0.04 (0.04,-0.11) **	-0.01 (0.01,-0.04)	-0.03 (0.03,-0.08)	-0.02 (0.02,-0.06)	-0.02 (0.02,-0.07) **
Near Poor [>=100 & <125]	-0.02 (0.02,-0.06)	-0.02 (0.02,-0.07) ***	-0.02 (0.02,-0.06)	-0.01 (0.01,-0.03) **	-0.01 (0.01,-0.02) **	-0.06 (0.06,-0.17)
Poor [<100]	-0.04 (0.04,-0.11)	-0.03 (0.03,-0.08) **	-0.01 (0.01,-0.03)	-0.03 (0.03,-0.09)	-0.03 (0.03,-0.1)	-0.07 (0.07,-0.20)
Region						
Northeast (ref)						
Midwest	-0.01 (0.01,-0.03)	0.01 (-0.01,0.02)	0.02 (-0.02,0.07)	0.002 (-0.002,0.007)	-0.002 (0.002,-0.005)	0.03 (-0.03,0.08)
South	-0.03 (0.03,-0.09) *	0.003 (-0.003,0.010)	0.004 (-0.004,0.013)	0.03 (-0.03,0.1) *	-0.001 (0.001,-0.003)	0.003 (-0.003,0.009)
West	-0.04 (0.04,-0.12) **	-0.02 (0.02,-0.05)	-0.04 (0.04,-0.13)	-0.01 (0.01,-0.02)	-0.02 (0.02,-0.06)	-0.01 (0.01,-0.04)
Insurance Coverage						
Any Private (ref)						
Public only	0 (0,0.01)	-0.03 (0.02,-0.08) **	-0.03 (0.03,-0.08)	-0.001 (0.001,-0.003)	-0.01 (0.01,-0.01)	0.02 (-0.02,0.06)
Uninsured	0.01 (-0.01,0.04)	0.003 (-0.003,0.008)	0.02 (-0.02,0.05)	0.01 (-0.01,0.02)	-0.01 (0.01,-0.03)	-0.005 (0.005,-0.014)
Year						
2008-2010 (ref)						
2011-2013	0.03 (-0.03,0.09) ***	0.01 (-0.01,0.02)	-0.04 (0.04,-0.12)	0.03 (-0.03,0.08) ***	0.003 (-0.003,0.010)	-0.003 (0.003,-0.009)
2014-2016	0.05 (-0.05,0.15) ***	0.03 (-0.03,0.1) ***	-0.03 (0.03,-0.1)	0.05 (-0.05,0.16) ***	0.04 (-0.04,0.12) ***	0.02 (-0.02,0.07)

Education						
Less than Bachelors (ref)						
Bachelor's degree or more	-0.02 (0.02,-0.07) **	-0.02 (0.02,-0.07) ***	0.002 (-0.002,0.004)	-0.04 (0.04,-0.13) ***	-0.05 (0.05,-0.16) ***	-0.03 (0.03,-0.08)
Access to care						
Have USC Provider	-0.02 (0.02,-0.05) *	-0.003 (0.023,-0.009) ***	-0.01 (0.01,-0.03)	-0.02 (0.02,-0.05) **	0.01 (-0.01,0.03)	0.04 (-0.04,0.13)
Unable/ Delay to Treatment	-0.06 (0.06,-0.17) ***	-0.04 (0.04,-0.12) ***	-0.06 (0.06,-0.19)	-0.05 (0.05,-0.15) ***	-0.04 (0.04,-0.13) ***	-0.03 (0.03,-0.08)
Unable/ Delay to Prescription	-0.03 (0.03,-0.09) ***	-0.03 (0.03,-0.10)	0.02 (-0.02,0.05)	-0.04 (0.04,-0.13) ***	-0.02 (0.02,-0.06) **	-0.01 (0.01,-0.03)
Comorbidities						
Comorbidity Count (0-5)	-0.02 (0.02,-0.07) **	0.004 (-0.004,0.012)	-0.04 (0.04,-0.12)	-0.04 (0.04,-0.11) ***	-0.01 (0.01,-0.03)	-0.03 (0.03,-0.08)
Functional Status						
Missed work days	-0.01 (-0.02,0.01)	-0.01 (0.01,-0.02)	-0.01 (0.01,-0.04)	-0.02 (0.02,-0.06) *	-0.01 (0.01,-0.04)	-0.03 (0.03,-0.1)
Health Status						
Physical Health (1-excellent to 5-poor)	-0.02 (0.02,-0.06) *	-0.03 (0.03,-0.1) **	0.01 (-0.01,0.04)	-0.04 (0.04,-0.11) ***	-0.03 (0.03,-0.1) ***	-0.08 (0.08,-0.25) *
Mental Health (1-excellent to 5-poor)	-0.26 (0.26,-0.78) ***	-0.24 (0.23,-0.71) ***	-0.25 (0.24,-0.74)	-0.22 (0.21,-0.65) ***	-0.22 (0.22,-0.67) ***	-0.19 (0.19,-0.57) ***

Note: ***p < .001; **p < .01; *p < .05