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Garcia-Velázquez, Regina

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Socioeconomic inequalities in impairment associated with depressive symptoms: Evidence from the National Survey on Drug Use and Health

Regina García-Velázquez^{a,b*}, Kaisla Komulainen^a, Kia Gluschkoff^{a,b}, Jaakko Airaksinen^{a,c}, Ilmari Määttä^a, Tom Henrik Rosenström^a, Markus Jokela^a

^a Department of Psychology and Logopedics, University of Helsinki, Helsinki, Finland

^b Finnish National Institute for Health and Welfare, Helsinki, Finland

^c Institute of Criminology and Legal Policy, University of Helsinki, Helsinki, Finland

* Corresponding author. Mannerheimintie 166 PL30, 00271 Helsinki, Finland. E-mail address: regina.garcia.velazquez@thl.fi (R. García-Velázquez).

Abstract

Objective: Individuals with low socioeconomic status have higher rates of depression, but it is unknown whether the socioeconomically disadvantaged also have more disabling depressive symptoms. We examined (1) the associations of three indicators of socioeconomic status with depression-related severe role impairment, and (2) whether socioeconomic factors moderate the association between individual depression symptoms and depression-related severe role impairment.

Methods: We used data from the National Survey on Drug Use and Health (NSDUH). Depressive symptoms, role impairment and socioeconomic indicators (poverty, participation in workforce, educational attainment) were self-reported by participants. The analytic sample consisted of participants who screened positive for a depressive episode during past 12 months (n=32 661). We used survey-weighted logistic models to examine the associations of depressive symptoms with severe role impairment and the modifying effects of socioeconomic indicators.

Results: The association between depression symptom count and severe role impairment was stronger among those not in workforce (OR= 1.12[1.02-1.23]). The association between specific depression symptoms and severe role impairment was stronger for conditions of poverty (fatigue, OR= 2.97 [1.54-5.73]; and anhedonia, OR=1.93[1.13-3.30]), workforce non-participation (inability to concentrate/indecisiveness, OR=1.54[1.12-2.12]), and lower educational attainment (anhedonia, OR=0.77 [0.59-0.99]). Feelings of worthlessness was the only symptom with independent associations for all socioeconomic groups (adjusted OR=1.91[1.35-2.70]).

Conclusion: Depression was more frequent and also more disabling for socioeconomically disadvantaged groups, especially when assessed with workforce participation. Additionally, some specific symptoms showed socioeconomic differences. Our findings highlight the need to prioritize population groups with more severe impairment associated with depressive symptoms.

Introduction

Depression is one of the leading causes of disability (World Health Organization, 2018). This disability most often manifests as impaired role performance, meaning an interference in daily life and over multiple life spheres– for example social or occupational (McKnight and Kashdan, 2009). Almost all people diagnosed with major depression (MD) during past 12 months report some impaired role performance, and 60% describe this impairment as severe or very severe (Kessler et al., 2003). Furthermore, the incidence of depression is influenced by socioeconomic factors: disadvantaged people are at a higher risk of depression (Fryers et al., 2003; Patel et al., 2018; Weinberger et al., 2018). Socioeconomic disadvantage has also been associated with more adverse depression-related outcomes, such as lower health care service utilization (Packness et al., 2017), higher likelihood of relapse and chronicity (Lorant et al., 2003), and treatment discontinuation (Bocquier et al., 2014). It is possible that a similar socioeconomic gradient also exists in depression-related role impairment; people with high socioeconomic status (SES) may have better resources to protect them from the adverse psychosocial consequences of depression. However, it is not known whether the association of depression with role impairment has a socioeconomic gradient.

Symptom-level characterizations of depression seem essential to better understand the incidence and impact of depression (Fried, 2017). For instance, some studies have shown that specific depression symptoms can be differently associated with prognostic characteristics like duration, treatment response or help seeking (Bringmann et al., 2015; Komulainen et al., 2020; Komulainen et al., 2020; Olbert et al., 2016; van Eeden et al., 2019). In terms of role impairment, there is also evidence of symptom-level differences (Faravelli et al., 1996; Fried and Nesse, 2014; Tweed, 1993). One epidemiological study looking at the differential associations between age groups and role impairment found that mood, feelings of worthlessness and guilt, and concentration difficulties were more strongly related to role impairment for middle as compared to early and late adulthood. However, the same study found no role of sex (García-Velázquez et al., 2019). Another study using a clinical sample identified the same pattern of effects for age and sex, but did not look into the modifying effects of these variables (Fried and Nesse, 2014). Despite of knowing that sociodemographic factors are systematically associated with onset or worse prognosis of depression (Kessler et al., 2014, 2003; Kessler and Bromet, 2013), the corresponding symptom-level associations remain mostly unexplored.

Aims of the study

We used data from the National Survey on Drug Use and Health (NSDUH), a nationally representative survey of US civilian, noninstitutionalized population, to study the association of depressive symptoms with severe role impairment among participants screening positive for MD during past 12 months. We hypothesized that individuals experiencing a higher number of depressive symptoms would more often report severe role impairment, and that this association would be greater among those with low SES. We also explored such associations at the level of specific depression symptoms. SES was measured using three indicators: (1) income with respect to poverty threshold, (2) participation in workforce, and (3) educational attainment.

Materials and methods

Data collection and study sample

NSDUH is a cross-sectional nationwide survey focused on substance use, mental health, and other health-related issues in the U.S. The survey began in 1971 and it is carried out annually by interviewing approximately 70 000 people aged 12 and older. Participants answer most questions in private and enter their responses directly into the computer. Participating households are randomly selected, and participation is voluntary and economically rewarded. NSDUH has been described in detail elsewhere (Center for Behavioral Health Statistics and Quality, 2018). NSDUH has a multistage (stratified cluster) sample design for representative estimates of the U.S population. The survey weights are described in more detail in the *Statistical analyses* section.

Information about depression was self-reported and first available in the year 2004 survey (Center for Behavioral Health Statistics and Quality, 2016). Our analytic sample comprised survey years from 2008 to 2017 (meaning ten cross-sectional samples) because data on severe role impairment were only available from survey year 2008 onwards. The analytic sample consisted of participants screening positive for MDE in past 12 months (N=32 661). Note that NSDUH makes no exclusion for MDE caused by medical illness, bereavement, or substance use disorders.

The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008. NSDUH was reviewed and approved by one of RTI's Institutional Review Boards before any interviews were conducted. The IRB reviews the NSDUH protocol following guidelines from the U.S. Department of Health and Human Service's Office for Human Research Protections. All participants provided an informed consent.

Instruments

Role impairment: our outcome variable was derived from the maximum severity level of MDE role impairment. In NSDUH, the Adult Depression module contains measures of role impairment, which are self-reported with respect to the following life domains: home management, ability to work, close relationships, and social life. The wording of the four specific items covering these domains can be found in Appendix 1, together with information of all variables included in our study. We used the NSDUH binary variable which distinguishes “severe” and “very severe” interference from “no”, “mild”, and “moderate” interference of the MDE symptoms on the domains of role performance. We chose this distinction so that the two severity groups would maximally differ from each other, while being as similar as possible among them. In doing this, we aimed for clinical relevance of our outcome variable.

Depression: the depression module in the survey corresponds to the DSM-IV diagnostic criteria for Major Depressive Episode (MDE; American Psychiatric Association, 2000). The wording for the symptoms in self-reports were as follows: (1) depressed mood or discouragement (hereinafter referred to as *mood*), (2) loss of interest or pleasure (hereinafter referred to as *anhedonia*), (3) changes in appetite or weight, (4) sleep problems, (5) restlessness or lethargy, (6) tiredness/low energy (hereinafter referred to as *fatigue*), (7) feelings of worthlessness, (8) inability to concentrate or indecision, and (9) suicidal thoughts or plans. Symptoms were self-reported with respect to the worst depressive period within the last 12 months, and were rated dichotomously as “yes” or “no”. Depression sum score was calculated as the count of depressive symptoms the participant had experienced (range 5–9 in our sample, because 5 is the minimum amount required for MDE, addition to endorsement of either symptom (1) or (2)).

Socioeconomic status (SES): SES was assessed with three different indicators. (1) Family income below the poverty threshold (“no” as reference category in analyses, and “yes”). (2) Participation in the workforce (“yes” and “no” as reference category in analyses). Workforce non-participation includes all those participants not having a job, those on layoff and/or looking for work, retired persons, disabled persons, homemakers, students, or other persons not in the labor force according to NSDUH specifications. (3) Educational attainment (“college graduate”, “some college”, “high school”, and “less than high school”). Educational attainment was analysed in sensitivity analyses as categorical (in which case “less than high school” was the reference category) and interval variable. Results are presented here in interval scale for simplicity of the model, because results were the same.

Potential confounders: sex (“male” as reference category in analyses, and “female”), age in years (ranging from 12 to 95), ethnic background (“white” as reference category, “black”, “Hispanic”, and “other”), marital status (“never married” as reference, “married”, “widowed”, and “separated”), number of chronic diseases (count variable based on reporting the following: asthma, bronchitis, cirrhosis, diabetes, heart disease, hepatitis, hypertension, lung cancer, HIV, sleep apnea, stroke, and ulcers), having any health insurance (“covered” as reference and “not covered”), comorbid diagnosis of anxiety disorder in the past 12 months (“yes”, and “no” as reference), and alcohol dependence or abuse in the past 12 months (“yes”, and “no” as reference).

Statistical analyses

We used logistic regression analyses to assess the associations of depressive symptoms with severe role impairment. First, we examined the association of the total number of depression symptoms (depression sum score) with severe role impairment, adjusting for the three SES indicators and all other confounders. Sum score was a proxy of overall severity of depression. Numerous studies have found a monotonic trend (i.e. dose-response association) in validators of pathology as the number of depressive symptoms increases (early reports by Kendler & Gardner, 1998; Kessler, Zhao, Blazer, & Swartz, 1997). This is therefore the most proximal variable we had at hand to control for the severity of depression in the analyses. Second, to assess whether the associations of the depression sum score with severe role impairment differed across levels of SES, we included an interaction term between depression sum score and SES indicator in models that also included the main effects of all predictors (sum score, SES indicators, and confounders). Finally, to evaluate the symptom-specific associations with SES, we conducted the interaction analyses separately for each depressive symptom (a total of nine models). These fully adjusted models included the exposure symptom, the three SES indicators (main effects and interactions), the sum score of all other depression symptoms, and confounders. We adjusted for the sum score of all other symptoms for two main reasons. First, by adjusting for symptom count we accounted for the circumstance that some symptoms tend to co-occur with others (i.e. most of the participants reporting suicidal ideation do suffer from other symptoms too). If we had not adjusted for symptom count, we would not be able to differentiate whether the role impairment associated to symptom X is attributable to it (i.e. an independent association), or an artifact of multiple symptoms which cluster with such symptom X. Moreover, as reporting depressed mood or anhedonia was requisite for inclusion (core criteria of MD), this symptom count adjustment was practically unavoidable because of high overlap of these symptoms with others.

We examined collinearity, influential cases, and residuals of all models. None of these had practical influence on the model or on the interpretation of the results. We also examined the degree of overlap between the three SES indicators by calculating bivariate tetrachoric (for pairs of

dichotomous variables) and polychoric (polytomous variables) correlations. A p-value of 0.05 was considered significant in two-sided tests. We conducted all statistical analyses in R version 3.6. (R Core Team, 2019). The package *survey* (Lumley, 2019) was used to model the complex multistage sampling weights, in order to achieve representative estimates of prevalence and regression parameters. The NSDUH strategy on sampling and calibration is detailed elsewhere (National Survey on Drug Use and Health, 2019). We took into account the strata design and chose the sampling weights according to the survey years included in the analyses. Model diagnostics were conducted with the package *svydiags* (Valliant, 2018).

Results

Table 1 presents the characteristics of the 32 661 participants included in the study. Of them, 63.8% reported severe role impairment during past 12 months. Depressive symptom count varied between 5 (minimum symptom threshold for screening positive for MDE) and 9, with a mean of 7.55. The most common symptom in the sample was mood (95.7%), and the least common symptom was psychomotor disturbances (57.5%).

For a study including highly prevalent predictors, the issue of statistical power may be relevant. This is because those patterns of variation that are less frequent may be represented by smaller amounts of data, having implications over statistical power when testing. In this study, sample sizes of the different variation patterns were more than large enough to adequately estimate regression coefficients. We observed a total of 391 different symptom combinations. The variation patterns were plenty enough to adequately estimate our models, also for the two symptoms that conditioned inclusion in the sample (i.e. the two diagnostic core symptoms). Precisely, there were 65 symptom combinations in which depressed mood was *not* endorsed, meaning 1 452 participants' data. For anhedonia, we observed 81 different symptom combinations excluding it, comprising 1 823 participants. In terms of symptom counts, it is naturally so that the higher the symptom count, the fewer combinations can be observed (i.e. due to higher number of symptoms endorsed). The sum score value with least data available was symptom count of five, involving 2 444 participants and 159 different symptom combinations. The most frequent symptom count (i.e. mode) was eight, endorsed by 9 829 participants. We include this information thanks to one of the reviewers, who suggested that knowing more about the variation patterns of highly prevalent predictors would give the reader confidence in the regression models.

The tetrachoric correlation for living below the poverty level and workforce non-participation was .39. The polychoric correlation estimate for educational attainment and poverty was -.30, and for educational attainment and workforce non-participation -.32. The size of these correlations

supported the choice of including all three indicators simultaneously in subsequent regression analyses. Depression symptoms showed a trend of decreasing prevalence from low to high socioeconomic groups: the lower the SES indicator, the more frequent the symptoms were and the higher the average sum score (see Supplementary Materials, **Figure S1 and S2**).

Overall depression

The presence of one additional depressive symptom was associated with 60% increased odds of severe role impairment (odds ratio [OR]=1.59, 95% CI=1.53–1.66, $p<0.001$). Of the three SES indicators, family income below the poverty threshold and workforce non-participation were associated with severe role impairment (main effect OR=1.20, 95% CI=1.05–1.37, $p=.008$ for poverty; main effect OR= 1.60 (95% CI=1.43–1.79, $p<.001$ for workforce non-participation). Educational attainment was not associated with severe role impairment ($p=0.500$).

The model containing interactions (**Table 2**) showed that only workforce non-participation was associated with severe role impairment via interaction effect: per each additional depression symptom, participants outside workforce had 12% increased odds of experiencing severe role impairment when compared to those active in workforce (interaction OR= 1.12, 95% CI=1.02-1.23, $p=.019$, effect depicted in **Figure 1**).

Symptom-level associations

In the symptom-level models, four symptoms (anhedonia, feelings of worthlessness, fatigue, and inability to concentrate/indecision) were associated with severe impairment after adjusting for overall symptom count (see Supplementary Materials, **Table S1**). The association between three of these symptoms was stronger for participants from lower socioeconomic groups. Living below the poverty threshold increased the odds of severe role impairment for symptoms of anhedonia (interaction OR=1.93, 95% CI=1.13-3.30, $p=0.019$) and fatigue (interaction OR=2.97, 95% CI=1.54-5.73, $p=0.002$). Workforce non-participation intensified the odds of severe role impairment for participants reporting inability to concentrate/indecision (interaction OR=1.54, 95% CI= 1.12-2.12, $p=0.010$). Last, lower educational attainment intensified the odds of severe role impairment for participants suffering from anhedonia (interaction OR=0.77, 95% CI=0.59-0.99, $p=0.046$). Among all depression symptoms, feelings of worthlessness was the only symptom to predict severe role impairment among the depressed directly, and independently of socioeconomic groups (main effect OR=1.91, 95% CI=1.35-2.70, $p<0.001$).

Discussion

In a nationally representative U.S. sample of individuals screening positive for MDE in the past 12 months, the majority of participants reported severe role impairment as consequence of depressive symptoms. Each additional symptom was associated with a 40% increased odds of severe role impairment. This association was stronger among those outside the workforce, who showed an additional 12% increased odds of severe role impairment per symptom. The findings were independent from a variety of confounders, such as age and sex, comorbid chronic and mental conditions, and health insurance coverage among others.

Depression-related impairment and socioeconomic inequality

People suffering from depression are heterogeneous in terms of symptoms, antecedents, treatment response, and prognosis (Fried and Nesse, 2015; Lorenzo-Luaces, 2015; Olbert et al., 2014). This study found empirical evidence for socioeconomic gradient in depression-related role impairment as interaction effect.

Several mechanisms could intervene in explaining greater odds of severe role impairment for persons excluded from workforce, including subjective and objective factors. Studies have found that subjective experience of inequality (i.e. *subjective relative deprivation*) is a key factor explaining the link between social inequality and mental illness in general, and for depression too (Callan et al., 2015; Eibner et al., 2004; Fryers et al., 2003; Kraus et al., 2013; Mishra and Carleton, 2015). Relative deprivation is an affective reaction that can cause frustration, shame, stress, and result in maladaptive or ineffective coping responses (Smith and Huo, 2014). Similarly, perceptions of weakened productivity can undermine sense of agency, control and self-reliance, that in turn persons participating in workforce may experience in terms of finding or maintaining employment. In this sense, employment can be seen as a protective factor against mental illness (Drake and Wallach, 2020). Apart from these subjective aspects, it is well known that persons from lower SES are exposed to stress due to environmental adversity: scarcity of resources, uncertainty, and trade-offs in daily life may influence the capacity to cope against depression (Weich and Lewis, 1998). Stress can increase the risk of depression and related outcomes, such as role impairment, through physiological (Caspi et al., 2003; Seeman et al., 2010) and psychosocial pathways (McEwen, 2007; Pampel et al., 2010). Furthermore, the burden of depression may be heavier or remain untreated for persons from lower SES, because they use mental health services less often (Packness et al., 2017; Wang et al., 2007).

Symptom-level associations with impairment and socioeconomic inequality

Individual depression symptoms have shown variation with respect to role impairment (Faravelli et al., 1996; Fried and Nesse, 2014; García-Velázquez et al., 2019, 2017; Tweed, 1993). In our study, some associations between individual depression symptoms and severe role impairment remained beyond overall depression level. This is consistent with other research suggesting that the severity of depression is more complex than the aggregate of symptoms (Lux et al., 2010; Zimmerman, 2012; Zimmerman et al., 2018). We found that the symptom feelings of worthlessness was associated with 92% increased odds of severe role impairment for all participants, despite of their socioeconomic background. This distinct link with role impairment has been previously reported by other studies (Faravelli et al., 1996; García-Velázquez et al., 2019). A study examining depression symptoms in the context of subjective relative deprivation found that negative self-thoughts about played an important role in aggravating depression symptoms (Beshai et al., 2017). We observed a main effect (i.e. for all individuals), but did not observe a moderation effect of feelings of worthlessness with SES, as would be consistent with the study by Beshai and colleagues. However, three other symptoms (anhedonia, fatigue and inability to concentrate/indecisiveness) showed differences across SES levels: suffering from these symptoms and belonging to disadvantaged groups implied increased odds of severe role impairment. This is in line with empirical evidence pointing at specific psychological processes like decision-making and self-regulation, reward-seeking behavior, cognitive capacity and attentional span being involved in socioeconomic disparities (Dean et al., 2018; Mani et al., 2013; Shah et al., 2012; Vohs, 2013). Depression symptoms such as anhedonia, fatigue, or inability to concentrate/indecisiveness are linked to the aforementioned processes and may therefore be more taxing to persons with disadvantaged SES who are coping with depression.

Our study renders contribution at several levels of analysis. First, our results have implications at a clinical level by suggesting that the same depression sum score, or individual symptoms, may reflect more severe role impairment among those with adverse compared to affluent socioeconomic circumstances. This might be relevant when assessing natural recovery and treatment remission, as being free of functional impairment is a critical aspect of recovery from depression from the clinical viewpoint (Zimmerman et al., 2007, 2008). Second, from the perspective of basic research on depression, our study makes the contribution of connecting subjective and “objective” aspects of depression. For example, according to the bargaining model, depression involves an evolved mechanism for withholding productivity to deliver an honest social signal of need (Hagen and Rosenström, 2016). According to the theory, signaling via self-harm and withholding of productivity occurs especially when facing adversity (Hagen et al., 2008). Our findings align with

the theory and suggest role impairment may be more reliably assessed by self-reports in populations facing real adversity. Finally, our findings also provide empirical evidence on how the surrounding society may influence mental health. The knowledge that sociodemographic factors have a systematic link with mental health outcomes implies that political decisions can impact people's wellbeing. Programs aiming to promote equality have the potential of becoming mental health interventions in practice, among achieving other widely positive effects for the general population (Wills and Holmes-Rovner, 2006).

Our study has limitations. Our data were cross-sectional and do not allow for causal inference between SES and depression-related role impairment. On the one hand, longitudinal evidence suggests that people experiencing depressive symptoms are at risk for role impairment, and that low SES predisposes individuals to worse mental health (Lorant et al., 2003; Patel et al., 2018; Pickett and Wilkinson, 2010; Ritsher et al., 2001; Zimmerman and Katon, 2005) and general disability (Hosseinpoor et al., 2013). On the other, the associations of depressive symptoms, role impairment and SES may also run in the opposite direction. For instance, pre-morbid poor functioning has been found to increase vulnerability to onset of depression (Bos et al., 2018). Similarly, role impairment and disability are consistently associated with worse socioeconomic outcomes (Hosseinpoor et al., 2013). Thus, there may be multiple mechanisms of causality and selection underlying the associations between depression, SES and disability, which can contribute to the accumulation of socioeconomic disparities in mental health outcomes. Characterizing these associations is fundamental to improve the understanding of socioeconomic disparities, and it was the purpose of this study. Further studies may disentangle the causal mechanisms underlying these complex processes.

Second and relative to the use of secondary data, our sample consisted of participants screening positive for a depressive episode in the past year. This reduced variation in the model predictors (i.e. symptom endorsement), which may have led to larger standard errors of the regression coefficients. Also, the symptoms in NSDUH were measured as single dichotomous variables with no information on intensity, frequency or duration, although these characteristics could determine the severity of depression-related role impairment. Instead, our measure of depression severity was symptom count, which is a rather rough indicator. In addition, we were unable to control for previous history of major depression, which could explain accumulated role impairment. However, some prospective evidence suggests that the "scarring" effect of previous depression is not a substantial vulnerability factor for post-morbid poor role performance (Bos et al., 2018). Additional research is needed to test whether the present findings can be observed with different measures of

depression and of functional impairment, because the specific measures may naturally influence results. For instance, it would be insightful to collect information directly on the severity of participants' depression and how it interferes in daily life, together with other socioeconomic variables (Hanson & Young, 2017). Additionally, future research could include a wider choice of covariates that could influence results, such as history of depression or confounding causes of disability.

Finally, it is possible that the association between SES and depressive symptoms varies depending on the context. For example, the financial crisis starting in 2008 might have made contextual factors increasingly important to mental health (Human Rights Council, 2019). Future studies could examine whether the impact of depression on role performance varies by means of age-period-cohort analysis, and benefit from temporal patterns to better describe within- and between-subject variability.

As expected, higher depression sum scores were associated with greater odds of severe role impairment among depressed individuals. Furthermore, our results elucidate social disparities in mental health: not only were depressive symptoms more frequent among socioeconomically disadvantaged people, but they were also more strongly associated with severe role impairment. Our findings highlight the need to reach and support population groups at higher risk of social exclusion and mental illness.

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Declaration of interest: The authors declare that they have no conflict of interest.

Ethics approval: The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008. NSDUH was reviewed and approved by one of RTI's Institutional Review Boards (IRBs) before any interviews were conducted. The IRB reviews the NSDUH protocol following guidelines from the U.S. Department of Health and Human Service's Office for Human Research Protections.

Consent to participate: All participants provided an informed consent.

Code availability: R (R Core Team, 2019) code is available from the first author.

Author contributions: All authors contributed to the study conception and design. Regina García-Velázquez performed the statistical analysis and all authors contributed to the interpretation of the data. Regina García-Velázquez drafted the first version of the manuscript and all authors critically revised it for important intellectual content. All authors approved the version to be published and agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Data statement: We used the public-release datasets of the NSDUH survey years 2008-2017, available from the website of the Substance Abuse & Mental Health Data Archive (SAMHDA): <https://www.datafiles.samhsa.gov/study-series/national-survey-drug-use-and-health-nsduh-nid13517>.

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Fig. 1. Model-adjusted probabilities of severe role impairment as a function of number of depression symptoms and participation in the workforce.

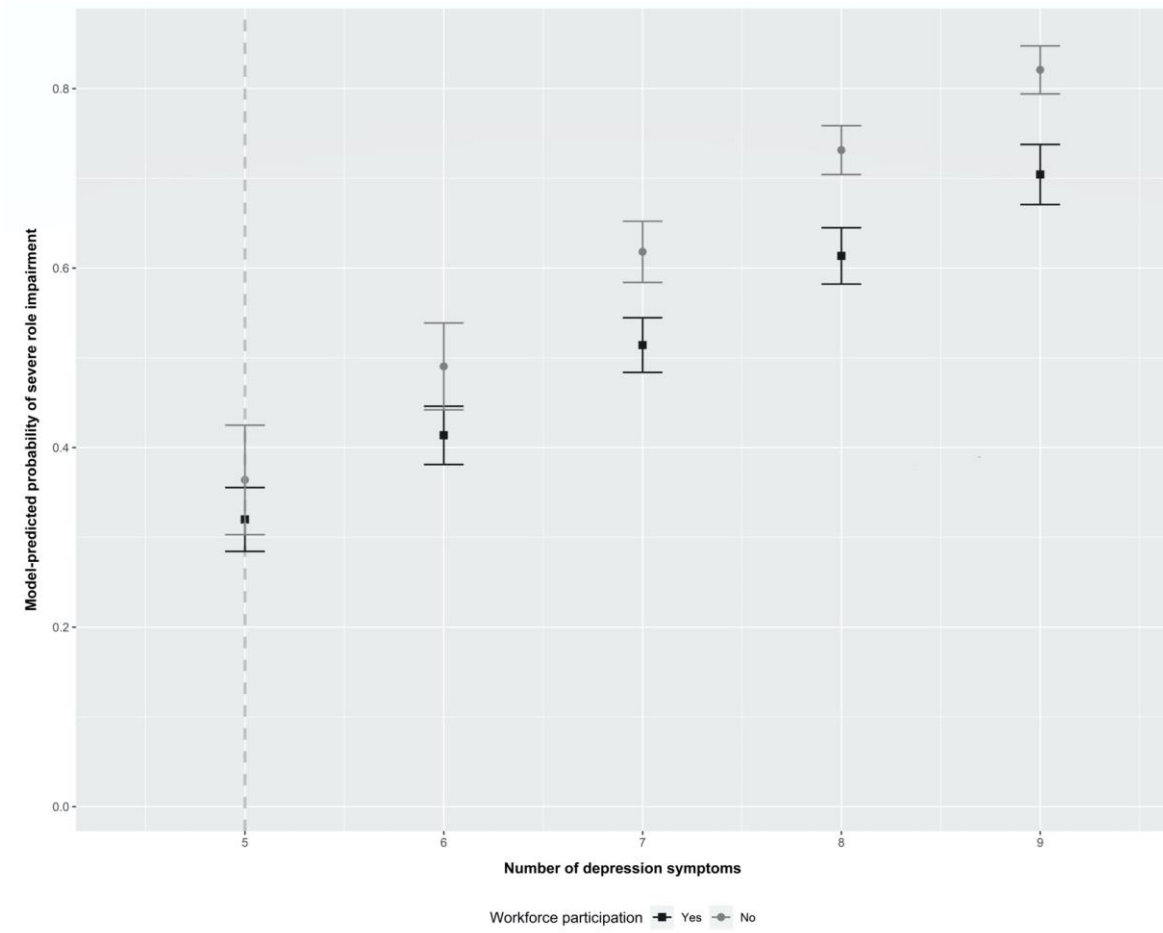


Table 1. Survey-weighted characteristics of the NSDUH participants screening positive for MDE in past 12 months.

	Mean (SD.)	%
Severe role impairment		64
Total number of depressive symptoms	7.55	
Depressed mood		96
Loss of interest/pleasure		95
Changes in appetite/weight		91
Sleep problems		97
Psychomotor disturbance		57
Tiredness/low energy		97
Feelings of worthlessness		60
Inability to concentrate/indecision		90
Suicidal thoughts/behavior		71
Educational attainment	2.69	
Less than high school		14
High school		30
Some college		31
College graduate		26
Family income below poverty level		21
Non-participation in the workforce		43
Severity levels of role impairment		
None		1
Mild		7
Moderate		29
Severe		44
Very severe		20
Sex (female)		65
Age	33.38	
Ethnicity		
White		73
Black		10
Hispanic		12
Other		5
Marital status		
Never married		35
Married		39
Widowed		4
Separated		22
Number of chronic diseases	0.63	
Covered by any health insurance		84
Comorbid anxiety disorder last 12 months		29
Comorbid alcohol dependence or abuse last 12 months		17

N=32 661 (NSDUH survey years 2008-2017)

Table 2. Adjusted odds ratios for associations of depression sum score and SES indicators with severe role impairment.

Estimate	OR	2.5 %	97.5 %	p-value
Depression sum score (below DSS)	1.40	1.20	1.63	<.001 *
Workforce participation (ref. "yes")	0.69	0.35	1.37	0.280
Household income (ref. "above poverty threshold"; below Poverty)	0.63	0.27	1.51	0.310
Educational attainment	1.20	0.83	1.72	0.340
DSS * Workforce non-participation	1.12	1.02	1.23	0.020 *
DSS * Poverty	1.09	0.97	1.22	0.150
DSS * Educational attainment	0.97	0.93	1.02	0.300

Abbreviations: OR=odds ratio

N=20 252; participants in NSDUH 2008 to 2017 screening positive for MDE in past 12 months, who had data available for the variables in the model
 Model adjusted for sex, age, ethnicity, marital status, number of chronic diseases, health insurance coverage, and comorbid positive screening for anxiety and alcohol abuse and/or dependence in past 12 months.

Appendix. Variable codes used in this study. Information available from the 2017 NSDUH codebook¹

Variables related to sample and sampling weights

amdeyr: filter variable for presence of MDE in past 12 months (*amdeyr*="yes")

vestr: sampling weights, strata

verep: analysis replicate

analwc10: sampling weights

Role impairment

Our outcome variable is found from the NSDUH data as *amdeimp*. It is a recode of two other variables. One covers the presence of MDE in the past 12 months (*AMDEYR*=1), and the other distinguishes "severe" and "very severe" role impairment from the other categories ("none", "mild", "moderate", variable *ASDSOVL2*). Next we explain how the variable *ASDSOVL2* was derived.

In the NSDUH interview, the wording of the role impairment questions is as follows (preceded by the interview item code)

(AD66a) Think about the time in the past 12 months when these problems with your mood were most severe. Using the 0 to 10 scale shown below, where 0 means no interference and 10 means very severe interference, select the number that describes how much these problems interfered with your ability to do each of the following activities during that period. You can use any number between 0 and 10 to answer. How much did your [depression symptoms] interfere with your ability to do home management tasks, like cleaning, shopping, and working around the house, apartment, or yard? (*ADPSHMGT* variable in codebook)

(AD66b) During the time in the past 12 months when your [depression symptoms] were most severe, how much did this interfere with your ability to work? (*ADPSWORK* variable in codebook)

(AD66c) How much did your [depression symptoms] interfere with your ability to form and maintain close relationships with other people during that period of time? (*ADPSRELS* variable in codebook)

(AD66d) How much did [depression symptoms] interfere with your ability to have a social life during that period of time? (*ADPSSOC* variable in codebook)

The four SDS role domain variables were recoded by NSDUH so that no interference=1, mild=2, moderate=3, severe=4, and very severe=5. A maximum impairment score (*ASDSOVL2* for adults) was then defined as the single highest severity level of role impairment across all four SDS role

¹ Retrieved from <https://www.datafiles.samhsa.gov/study-dataset/national-survey-drug-use-and-health-2017-nsduh-2017-ds0001-nid17939>

domains. Ratings greater than or equal to 7 on the original SDS scale (*ASDSOVL2* or *SDSOVRL=4, 5*) were considered severe impairment.

Depression

Original variables under the names *ad_mdea1* to *ad_mdea9*, all dichotomous.

Socioeconomic status

- Poverty: derived from the variable *poverty2*, that was dichotomized into values “living in poverty” against the other two categories indicating household income above poverty level.
- Workforce participation: was a recode of the variable *empstaty* merging categories “employed full time” and “employed part time”, against the categories “unemployed” and “other (inc. not in labor force).”
- Educational attainment: variable *educat2*, we used the original categories (“college graduate”, “some college”, “high school”, and “less than high school”).

Potential confounders

- Sex (*irsex*)
- Age (*adwrage*)
- Ethnic background (*newrace2*)
- Marital status (*irmarit*)
- Chronic diseases. A count variable that we computed based on the following dichotomous medical conditions during past year: asthma, bronchitis, cirrhosis, diabetes, heart disease, hepatitis, hypertension, lung cancer, HIV, sleep apnea, stroke, and ulcers (*yrama*, *yrbronc*, *ycirr*, *yrdiab*, *yrhartd*, *yrhepat*, *yrhbp*, *yrlunca*, *yrhiv*, *yrslpap*, *yrstrok*, *yrulcer*).
- Health insurance (*irinsur4*)
- Diagnosis of anxiety disorder in the past 12 months (*yraxd*)
- Diagnosis of alcohol dependence or abuse in the past 12 months (*abodalc*)

Table S1. Symptom-level models predicting severe or very severe role impairment associated to depressive symptoms and SES indicators.

Estimate	OR	2.5 %	97.5 %	p-value	
Depression sum score (excluding symptom)	1.57	1.50	1.64	<,001	*
Mood	2.11	0.88	5.06	0.098	
Workforce participation (ref. "yes")	1.68	1.11	2.54	0.016	*
Poverty	1.45	0.88	2.38	0.148	
Educational attainment	1.03	0.79	1.33	0.847	
Mood*Workforce participation	0.95	0.62	1.47	0.815	
Mood*Poverty	0.82	0.48	1.39	0.462	
Mood*Educational attainment	0.96	0.73	1.25	0.738	
Depression sum score (excluding symptom)	1.57	1.50	1.64	<,001	*
Anhedonia	0.87	0.37	2.03	0.744	
Workforce participation (ref. "yes")	1.67	1.08	2.58	0.022	*
Poverty	0.65	0.38	1.10	0.109	
Educational attainment	1.26	0.98	1.62	0.070	
Anhedonia*Workforce participation	0.95	0.60	1.51	0.839	
Anhedonia*Poverty	1.93	1.13	3.30	0.019	*
Anhedonia*Educational attainment	0.77	0.59	0.99	0.046	*
Depression sum score (excluding symptom)	1.63	1.56	1.70	<,001	*
Appetite	1.08	0.60	1.95	0.805	
Workforce participation (ref. "yes")	1.35	0.94	1.93	0.109	
Poverty	1.06	0.71	1.59	0.768	
Educational attainment	1.00	0.85	1.19	0.976	
Appetite*Workforce participation	1.21	0.82	1.78	0.347	
Appetite*Poverty	1.14	0.74	1.75	0.557	
Appetite*Educational attainment	0.98	0.82	1.16	0.790	
Depression sum score (excluding symptom)	1.61	1.54	1.68	<,001	*
Sleep	0.79	0.36	1.73	0.554	
Workforce participation (ref. "yes")	1.54	0.83	2.84	0.172	
Poverty	0.78	0.35	1.74	0.546	
Educational attainment	1.09	0.85	1.40	0.490	
Sleep*Workforce participation	1.04	0.55	1.97	0.911	
Sleep*Poverty	1.56	0.70	3.43	0.278	
Sleep*Educational attainment	0.90	0.69	1.16	0.401	
Depression sum score (excluding symptom)	1.64	1.56	1.72	<,001	*
Psychomotor	1.21	0.84	1.74	0.317	
Workforce participation (ref. "yes")	1.45	1.22	1.72	<,001	*
Poverty	1.22	1.00	1.49	0.057	
Educational attainment	1.01	0.93	1.09	0.885	
Psychomotor*Workforce participation	1.20	0.94	1.52	0.145	
Psychomotor*Poverty	0.98	0.76	1.25	0.854	
Psychomotor*Educational attainment	0.96	0.85	1.08	0.512	
Depression sum score (excluding symptom)	1.60	1.54	1.67	<,001	*
Fatigue	0.50	0.23	1.11	0.094	
Workforce participation (ref. "yes")	1.18	0.66	2.13	0.575	

Poverty	0.42	0.22	0.80	0.010	*
Educational attainment	1.22	0.95	1.57	0.125	
Fatigue*Workforce participation	1.36	0.76	2.43	0.300	
Fatigue*Poverty	2.97	1.54	5.73	0.002	*
Fatigue*Educational attainment	0.80	0.62	1.02	0.078	
<hr/>					
Depression sum score (excluding symptom)	1.52	1.45	1.61	<,001	*
Worthlessness	1.91	1.35	2.70	<,001	*
Workforce participation (ref. "yes")	1.44	1.23	1.70	<,001	*
Poverty	1.21	0.99	1.47	0.067	*
Educational attainment	0.96	0.89	1.04	0.299	
Worthlessness*Workforce participation	1.20	0.98	1.48	0.088	
Worthlessness*Poverty	0.99	0.78	1.25	0.925	
Worthlessness*Educational attainment	1.04	0.94	1.16	0.429	
<hr/>					
Depression sum score (excluding symptom)	1.57	1.51	1.64	<,001	*
Concent./Decisions	1.27	0.69	2.33	0.448	
Workforce participation (ref. "yes")	1.09	0.81	1.47	0.572	
Poverty	1.00	0.68	1.46	0.991	
Educational attainment	1.02	0.88	1.19	0.769	
Concent./Decisions*Workforce participation	1.54	1.12	2.12	0.010	*
Concent./Decisions*Poverty	1.23	0.82	1.85	0.328	
Concent./Decisions*Educational attainment	0.95	0.79	1.15	0.628	
<hr/>					
Depression sum score (excluding symptom)	1.61	1.53	1.69	<,001	*
Suicidality	1.31	0.95	1.80	0.104	
Workforce participation (ref. "yes")	1.51	1.27	1.79	<,001	*
Poverty	1.09	0.85	1.40	0.498	
Educational attainment	1.00	0.93	1.09	0.919	
Suicidality*Workforce participation	1.09	0.87	1.36	0.446	
Suicidality*Poverty	1.15	0.84	1.58	0.385	
Suicidality*Educational attainment	0.96	0.87	1.07	0.493	

Abbreviations: OR=odds ratio

N=20 252; participants in NSDUH 2008 to 2017 screening positive for MDE in past 12 months, who had data available for the variables in the model

Model adjusted for sex, age, ethnicity, marital status, number of chronic diseases, health insurance coverage, and comorbid positive screening for anxiety and alcohol abuse and/or dependence in past 12 months.

Figure S1. Survey-weighted sum scores for depressive symptoms in NSDUH participants screening positive for MDE in past 12 months, stratified by socioeconomic groups.

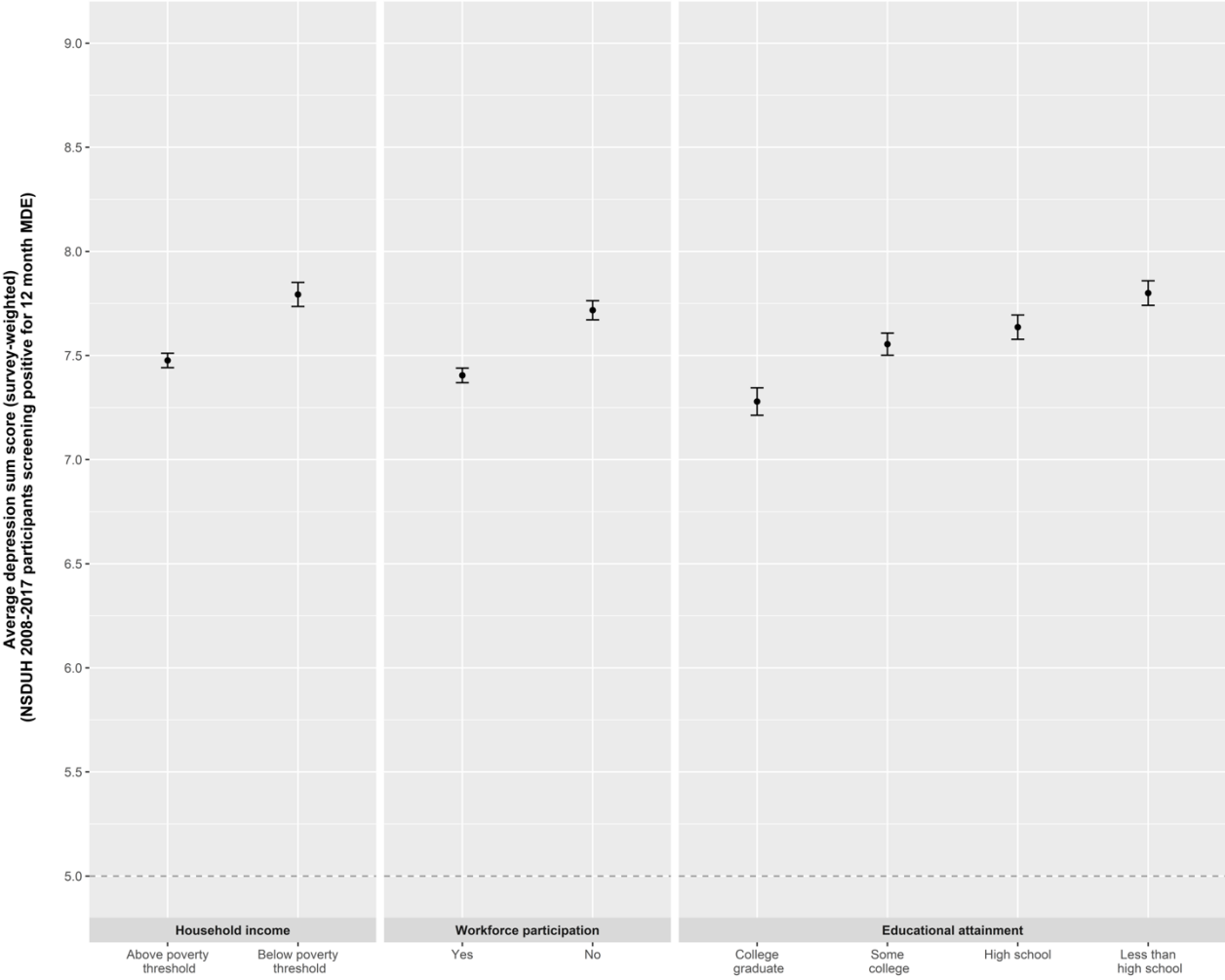


Figure S2. Survey-weighted frequency of symptoms of depression of the NSDUH participants screening positive for MDE in past 12 months, stratified by socioeconomic groups.

