Title Page

**Depression Symptoms on the Decline in Older Adults: Birth Cohort Analyses from the Rust Belt**

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Abstract

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Kevin J. Sullivan, MPH

University of Pittsburgh, 2019

**Abstract**

**Background/Objective.** Depression symptoms in older adults are associated with poor health outcomes. Long-term population trends in depression are well established for younger adults and prevalence is reportedly on the rise, but there is a paucity of data on trends specific to older adults. The present population-based study aimed to investigate birth cohort effects in depression symptoms in older adults from small-town communities in Southwestern Pennsylvania.

**Methods.** In an analysis sample of 3227 older adults, we identified four decade-long birth cohorts: 1902-1911, 1912-1921, 1922-1931, and 1932-1941.The outcome was symptoms of depression assessed at baseline and follow-up study visits using a modified Center for Epidemiologic Studies Depression Scale (mCES-D). The depression outcome was operationalized as: 1. A binary outcome of having ≥5 depression symptoms on the total mCES-D at any study visit, and 2. A continuous outcome of four factor-analyzed component scores of the mCES-D including Depressed Mood, Anergia/Hopelessness, Withdrawal, and Poor Self-Esteem. All analyses were jointly modeled with attrition and adjusted for age, sex, education, Mini Mental State Examination score, antidepressant medications, and total prescription medications.

**Results.** Participants from more recently born cohorts were significantly less likely to have a study visit in which they reported ≥5 depression symptoms, controlling for attrition. Specifically, in comparison to the 1902-1911 referent cohort, the 1912-1921 birth cohort was 43% less likely (OR=0.566, 95% CI: 0.341-0.939), the 1922-1931 birth cohort was 63% less likely (OR=.0369, 95% CI: 0.215-0.632), and the 1932-1941 cohort was 79% less likely (OR=.205, 95% CI: 0.106-0.399). The cohort effect was primarily driven by symptoms included in the Depressed Mood and Anergia/Hopelessness composites.

**Conclusions.** Given the rapidly aging population,it is of great public health importance to investigate epidemiologic trends in older adult mental health. Reduced rates of depression symptoms observed in successive birth cohorts of older adults may reflect compression of morbidity or other secular trends.

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# Introduction

##  Birth Cohort Trends in Older Adults

Understanding population trends in exposures and disease is a core objective of epidemiology. Observational studies examining changing patterns over time may provide insight into the relationship between risk factors and outcomes, potentially informing interventions aimed at modifiable exposures. Birth cohort analyses, in which, for example, birth year or decade is used as a predictor or moderating variable, have been particularly useful in examining trends in exposures and outcomes over long periods of time. Birth year is confounded by countless exposures over the life-span, many of which can be entirely circumstantial, outside the behavioral control of the individual: knowledge of the risk of smoking, availability of antihypertensive medications, bans on lead in gasoline and so on. This confounding is further complicated when considering time trends in disease in older adults, in which birth cohort differences may represent an entire life-span of variations of exposures. Despite these complications, there is great value in examining trends in mortality and morbidity in older adults, many of which have been positive, in informing future directions and interventions in late-life.

Birth cohort analyses have indicated several changing patterns in older adults born more recently, as compared to older adults born closer to the start of the 20th century. These analyses have reported a general observation of compression of medical and cognitive morbidity,1, 2 with older adults living longer into late life free from disability. General trends related to healthy aging have been positive in the past several decades in high-income countries. For example, more recently born cohorts have been observed to have a lower incidence of dementia and less cognitive impairment in older age than those born in earlier decades.1, 3-5 Additionally, these birth cohorts are more likely to be non-smokers and have higher educational attainment.6, 7 As the worldwide population age-distribution continues to shift higher, characterizing these population health trends accurately in older adults is an essential prerequisite for public health planning efforts. Examining positive trends in healthy aging may help to elucidate modifiable factors that can be used to design interventions around late-life disease prevention. While great attention has been paid to cohort effects in medical and cognitive morbidity, there has been few reported investigations into trends in other psychiatric conditions in older adults beyond dementia, including mood disorders.

## Depression in Older Adults

### Major Depressive Disorder

Major Depressive Disorder (MDD) is among the most common mental illnesses diagnosed in the United States, with prevalence reportedly lower in adults over the age of 65 compared to younger ages.8 MDD in older adults is often comorbid with chronic disease, cognitive impairment, and disability.9 Specifically, the fifth edition of the American Psychiatric Association’s Diagnostic and Statistical Manual (DSM-5) specifies the following criteria for MDD Diagnosis, with the A-C criteria representing a major depressive episode10:

**A. Presence of five or more of the following symptoms during the same two-week period that represent a change from previous function that must include at least one of symptom 1 and 2:**

*1. Depressed mood most of the day, nearly every day, as indicated by either subjective report or observation.*

*2. Markedly diminished interest or pleasure in all, or almost all, activities most of the day, nearly every day.*

*3. Significant weight loss when not dieting or weight gain (change of more than 5% of body weight in a month),-or decrease/increase in appetite nearly every day.*

*4. Insomnia or hypersomnia nearly every day.*

*5. Psychomotor agitation or retardation nearly every day (observable by others, not merely subjective feelings of restlessness or being slowed down).*

*6. Fatigue or loss of energy nearly every day.*

*7. Feelings of worthlessness or excessive or inappropriate guilt (which may be delusional) nearly every day (not merely self-reproach or guilt about being sick).*

*8. Diminished ability to think or concentrate, or indecisiveness, nearly every day (either by subjective account or as observed by others).*

*9. Recurrent thoughts of death (not just fear of dying), recurrent suicidal ideation without a specific plan, or a suicide attempt or specific plan for committing suicide.*

**B. The symptoms cause clinically significant distress or impairment in social occupational, or other important areas of functioning.**

**C. The episode is not attributable to the physiological effects of a substance ort to another medical condition**

In the case of older adults these criteria can be difficult to meet. The DSM-5 diagnostic criteria C requiring that symptoms not be “attributable to” another medical condition10 is a particularly challenging attribution to disprove in the frequent presence of chronic comorbidity among older adults. Some depression symptoms, including weight change11, sleep disturbances12, and increased fatigue13 are relatively common in older adults and often attributed to other chronic morbidities or aging processes, which may preclude a diagnosis of MDD. As a result of diagnostic and methodological challenges, considering cohort effects in symptoms of depression is likely a more comprehensive approach than considering only clinical diagnosis of MDD.

### Subsyndromal Depression

Many older adults with depression symptoms short of a full-blown depression syndrome, i.e. subsyndromal depression, who do not meet the clinical diagnostic criteria for MDD10, may still experience symptoms of depression that can negatively affect their quality of life, family well-being, health outcomes and psychiatric morbidity.14, 15 As a consequence of the strict MDD diagnostic criteria, which requires ruling out any attributable medical conditions, the prevalence of subsyndromal depression is estimated to be between 2-3 times higher than MDD in older adults.14 Prevalence of MDD in adults over age 65 is estimated between 1-5%,16 whereas prevalence of subsyndromal depression, or clinically significant symptoms of depression, is estimated around 15%.9, 14 Importantly, depressive symptoms in older adults increase risk of nonadherence to medical treatment,17 worse health outcomes of other medical illness,18 cognitive decline,19 Alzheimer’s disease,20 suicide,21 impaired physical function22 and overall mortality.9 Additionally, in older adults with subsyndromal depression, direct health care costs have been reported to be almost 50% higher than in older adults free from depressive symptoms, independent of medical comorbidities.23 From a public health and policy perspective, it would be valuable to characterize time trends in depression symptoms in older adults as the US population ages.24

Methodologically, self-report depression screeners are a useful tool for research in older adults because they isolate specific symptoms. Additionally, screeners provide a general measurement of burden of depression symptoms without a formal diagnosis, and have previously been used to represent subsyndromal depression.25-27 The Center for Epidemiologic Studies Depression Scale (CES-D), a longstanding screener that assesses 20 different symptoms of depression28 is a reliable and well validated tool for this purpose.29-32 CES-D score has been associated with negative outcomes in older adults including dementia and cognitive impairment 33, 34, and mortality, particularly when present in older adults with chronic cardiovascular diseases,35, 36. Beyond cognitive function and mortality, the CES-D score has also been associated with poor physical function outcomes. For example, higher CES-D scores were related to higher rate of negative post-surgical functional outcomes in women following hip fractures37 and have been related to lower physical activity.38 These studies relating the CES-D to negative outcomes further validate the scale as an accurate measurement of subsyndromal depression symptoms and support the assertion that depression symptoms, even if not significant enough to warrant an MDD diagnosis, deserve attention as a risk factor in older adults.

Regarding other age groups, changing trends in depressive disorders and symptoms are well established for younger individuals, with evidence suggesting that prevalence is increasing, or at least stable, in adolescent and mid-life individuals.39-41 We are aware of no previous studies that investigated cohort trends in depression symptoms specifically in older adults.

## Aims and Hypotheses

The present study had two aims related to investigating birth cohort effects in depression symptoms in older adults.

**Aim 1: Determine whether there is a birth cohort effect in total reported symptoms of depression across four decade-long birth cohorts comprising a population sample.**

*Hypothesis:* Based on cohort trends evidencing decreasing medical and cognitive morbidity,1, 2 we hypothesized that prevalence of depression symptoms would decrease in the more recently born cohorts.

**Aim 2: If a birth cohort effect is observed, is the effect driven by trends in specific clusters of symptoms?**

*Hypothesis:* We had no a priori hypotheses related to trends in specific symptom clusters because the factor analysis to determine these clusters was a component of this study.

# Methods

## Participants

 Data were pooled from two large prospective cohort studies conducted between 1987 and the present in the Monongahela Valley region of southwestern Pennsylvania. The Monongahela Valley Independent Elders Survey (MoVIES), focused on dementia, ran from 1987 until 2001 with biennial assessments of an initial sample of 1681. The Monongahela-Youghiogheny Healthy Aging Team (MYHAT) study, focused on mild cognitive impairment, has been ongoing since 2006 with annual assessments of an initial sample of 1982. Both samples were recruited using age-stratified random sampling from voter registration lists. Inclusion criteria was similar in both studies: age 65+, no significant vision or hearing impairment, not institutionalized at study entry, and having decisional capacity. Additionally, the MoVIES study required participants to have at least a 6th grade education and be fluent in English. While not explicitly required for study inclusion, all participants in the MYHAT study met these same education and fluency criteria. MYHAT also required participants to score at least 21 on an age-education corrected Mini Mental State Examination (MMSE).42, 43 Participants were reassessed biennially in MoVIES and annually in MYHAT and were followed for an average of 5.72 years. Further details regarding recruitment and assessment procedures have been reported previously for MoVIES44, 45 and MYHAT.46, 47

Across the two studies we identified four birth cohorts of sufficient size: 1902-1911 (n=305), 1912-1921 (n=1202), 1922-1931 (n=1051), and 1932-1941 (n=669). We excluded participants born before 1902 (n=14), born after 1941 (n=48), and participants with no depression data at any visit (n=338). Compared to the analysis sample, the 338 participants excluded from the analysis were more likely to be from earlier born cohorts, be less educated, and had a larger proportion of men (Table 1).

## Predictor Variables

The four birth cohorts were the main predictor variables. Other covariates included the following: Demographics, including baseline age, sex, race, and self-reported education level categorized as less than high school (<HS), graduated high school (HS), or some college education or higher (>HS); MMSE score from each study visit; total number of prescription drugs, as a measure of overall morbidity48, 49; and use of antidepressant drugs.

## Outcome Variables

At each study visit (excluding the baseline MoVIES visit), participants completed a modified Center for Epidemiologic Studies Depression scale (mCES-D).50 The modified scale includes all 20 depression symptoms in the original CES-D,28 but rather than recalling the number of days during the past week that they experienced each symptom, participants instead report whether or not they experienced that symptom over “most of the preceding week”, loosely operationalized as 3 or more days. Each symptom is scored as absent/present (0/1) with a possible maximum score of 20, so that the total mCES-D score represents number of symptoms. Having at least subsyndromal depression was operationalized for the present study as ≥5 endorsed items on the mCES-D, which we previously established as our threshold.50 We used two depression outcomes in the models; (1) an mCES-D score > 5 and (2) the four factors derived from the factor analysis described next (Table 2).

## Statistical Analyses

### Descriptive Statistics

Descriptive statistics were calculated in the overall sample and by each birth cohort. For categorical variables, we report frequencies and percentages. For continuous variables, we report mean and standard deviation for baseline age, and median, 25% percentile, and 75% percentile for baseline MMSE and total number of prescription medications (Table 3).

### mCES-D Factor Analysis

To find the latent subgroups of the individual symptoms of the mCES-D, we used principal components factor analysis and the varimax rotation. Applying the Kaiser criterion (eigenvalues > 1), we identified four subgroups of individual symptoms using baseline mCES-D data. The four factors explained 46% of the variance of the original matrix. All items included in the four subgroups achieved loading >0.4. The items in each factor are displayed in Table 2. Factor 1 (Depressed Mood) accounted for 28% of the variance of the original matrix. Factor 2 (Anergia/Hopelessness) accounted for 7% of the variance of the original matrix. Factor 3 (Withdrawal) accounted for 6% of the variance of the original matrix. Factor 4 (Poor Self-Esteem) accounted for 5% of the variance of the original matrix. Three items failed to load (“I felt fearful”, “my sleep was restless”, and “I felt that I was as good as other people”) and therefore omitted when factors were used as outcomes in the models. The identified factors, based on the current analysis sample comprised of both MYHAT and MoVIES, are similar to a previous factor analysis of the mCES-D performed in only the MoVIES participants,51 and are fairly consistent with reported meta-analyses factor analyzing the original CES-D.52, 53

### Models

In modelling the effect of birth cohort on the presence of >5 depression symptoms or one the four mCES-D factors, we recognized the need to account for higher attrition and mortality rates associated with depression.9, 54 Therefore, we used a joint modeling approach with shared random effects structure; the main events (depression symptoms ≥5 or the four mCES-D factors) were jointly modeled along with time to attrition to assess the association between the main event and birth cohort. In a joint model of ≥5 depression symptoms, the sub-model of the main event was a generalized linear mixed model with logit link adjusted for age, sex, education, antidepressant usage, MMSE, and total prescription medications, while the sub-model of time to attrition was a Weibull proportional hazards model adjusted for age, sex, education. A shared random effect term was used to link the two sub-models. In joint models of the four mCES-D profiles, the sub-model of the main even was a linear mixed model adjusted for age, sex, education, antidepressant usage, MMSE, and total prescription medications, and the sub-model of time to attrition was a Weibull proportional hazards model adjusted for age, sex, education. A shared random effect term was used to link the two sub-models. Sex and education were time invariant covariates. Age, antidepressant medication use, MMSE, and total number of prescription medications were time varying covariates. R version 3.5.1 and SAS 9.3 (SAS Institute) were used for data analysis, including the NLMIXED procedure for the joint models.

# Results

## Descriptive Statistics

Descriptive statistics for baseline information are provided by overall analysis sample (n=3227) and by birth cohort (Table 3). The proportion of each birth cohort that had at least one study visit with ≥5 mCES-D symptoms was lower in each subsequent birth cohort than in the preceding cohort (1902-1911: 23.0%, 1912-1921: 19.1%, 1922-1931: 16.0%, 1932-1941: 15.2%). Baseline characteristics were compared across each cohort using Chi-Square tests for categorical variables, ANOVA for normally distributed continuous variables, and Kruskal-Wallis rank sum test for non-normally distributed continuous variables (See Table 3.). Birth cohorts differed significantly by average baseline age (older age in 1902-1911 and 1922-1931 cohorts), education (lower in earlier born cohorts), antidepressant usage (lower in earlier born cohorts), baseline MMSE score (lower in earlier born cohorts), and total prescription medications (lower in earlier born cohorts). Additionally, earlier born cohorts were more likely to come from the MoVIES study, and participants in the 1902-1911 referent cohort had lower average years of follow-up compared to the more recently born cohorts.

## Aim 1: Overall mCES-D Outcome

 In the joint model of ≥5 depression symptoms, we observed a significant overall birth cohort effect (F=9.27, p<.0001). Participants from more recently born cohorts were less likely than the 1902-1911 referent birth cohort to have a study visit in which they endorsed ≥5 mCES-D symptoms (Table 4). With adjustment for sex, education, medications, and MMSE, we observed some attenuation in the estimated coefficients for the 1912-1921 birth cohort (15.1%) and the 1922-1931 birth cohort (24.5%) but very little for the 1932-1941 birth cohort (2.3%). However, the birth cohort effect remained significant with this adjustment. In follow-up pairwise comparisons, there was a large effect size suggesting that each subsequent birth cohort was less likely than each earlier born cohort to have a study visit with ≥5 depression symptoms (1922-1931 vs 1912-1921: t=-2.47, p=.014; 1932-1941 vs 1912-1921: t=-4.38, p<.001; 1932-1941 vs 1922-1931: t=-2.46, p=.014). However, correcting for multiple comparisons using a Bonferroni correction of α=.0083, only the 1932-1941 vs 1912-1921 comparison was statistically significant.

## Aim 2: mCES-D Factor Outcomes

 In joint models of the four mCES-D profiles, we observed a significant birth cohort effect in 3 of the 4 factors: Depressed Mood, Anergia/Hopelessness, and Withdrawal (Table 5). The birth cohort effect in each of these factors was consistent with the overall mCES-D analysis, with participants in more recently born cohorts endorsing fewer symptoms in comparison to the 1902-1911 birth cohort. The birth cohort effect was most evident for Depressed Mood and Anergia/Hopelessness, however only the 1932-1941 cohort reported fewer symptoms of Withdrawal compared to the 1902-1911 referent cohort. We observed no cohort effect for Poor Self-Esteem. Figure 1 displays trajectories in each mCES-D factor by birth cohort.

# Discussion

 The presented analysis investigated depression in two ways: a categorical cutoff of ≥5 symptoms of depression on the total mCES-D, and four factor analyzed components of the mCES-D. Across the four birth cohorts we examined, we report significantly lower endorsement of depression symptoms on the mCES-D in more recently born cohorts. Specifically, in comparison to the earliest born 1902-1911 cohort, we observed 79% lower odds of having ≥5 depression symptoms in the 1932-1941 birth cohort, 63% lower odds in the 1922-1931 birth cohort, and 43% lower odds in the 1912-1921 birth cohort. Additionally, each subsequent birth cohort had lower odds of having ≥5 depression symptoms when compared to each preceding birth cohort, suggesting a continually decreasing endorsement of depression symptoms across the examined cohorts, although this observation was not fully statistically significant with adjustment for multiple comparisons. When considering the factor analyzed components of the mCES-D, the declining trend was reflected most in items involving depressed mood and anergia.

 Our reported declining rate of symptoms of depression in older adults stands in contrast to the increasing or stable rates of MDD reported from younger age groups.39, 41 While no previous studies have examined cohort effects in depression symptoms among older adults, the Epidemiologic Catchment Area (ECA) in the early 1980s examined trends in MDD in cohorts born in the years 1905 to 1964, which overlaps partly with the birth years represented in the MoVIES/MYHAT cohort.39 However, the ECA study took place when the participants were considerably younger.55 To illustrate, the cumulative incidence of major depression in the ECA 1935-1944 birth cohort was calculated up to age 44. In the MoVIES/MYHAT birth cohort with the same birth decade (1932-1941), we prospectively measured symptoms of depression in participants who had an average age of 70 at baseline. The ECA investigators further indicated that the increasing depression trend appeared to be slowing in the most recently born cohorts.

In the present study, the cohort effect was unexplained by changing patterns in education and antidepressant medication usage, which were, as expected, higher in the more recently born cohorts. It is possible that lower reporting of depression symptoms is related to compression of morbidity, with more recently born older adults living longer into older age free from functional impairment than earlier born older adults.2 Symptoms of depression are more common in individuals with medical conditions.56 However, we observed a significant birth cohort effect even with adjustment for total number of prescription medications, which we have used previously to represent medical morbidity.48, 49

 Given the reported associations between cognitive impairment and depression,57 the observed cohort trend may be related to trends evidencing compression of cognitive morbidity.1, 3-5 However, while lower MMSE was related to higher overall mCES-D symptoms and more endorsed items on each of the four factors, the inclusion of MMSE in our model did not explain the observed birth cohort effect.

We have no obvious interpretation for the finding that birth cohort influenced the expression of some symptom groups but not others. Potentially, it may suggest that there is not only a quantitative change in depression symptoms but a qualitative time trend in how older adults experience or express depression. This may be of clinical relevance as different generations age into older adulthood and deserves further investigation.

The two cohorts pooled in the present study were recruited from communities in economically depressed post-industrial regions and represent an underserved population rarely targeted for health research. The stable population of the region facilitates longitudinal research. Both MoVIES and MYHAT were randomly selected community-based samples which enhance their external validity (generalizability) to the population at large. As the present results are reported from four birth cohorts that are predominantly white, our findings should be replicated in other cohorts with larger representations of ethnic minorities.

Further analyses should investigate other secular trends, such as smoking, which might help to explain declining trends in depression symptoms. Future population research focused on depression disorders should include diagnostic assessment to detect these disorders and determine whether there are also declining trends in major depression in older adults. It is also possible that period effects related to major historical events (e.g. World War II, The Great Depression) may have influenced the manifestation of depression in older adults who lived through different time periods. Such effects are difficult to study reliably, but there is recent evidence that civilians who lived in war-torn regions of Europe and Japan during World War II had higher lifetime odds of mood disorders including MDD and anxiety disorder.58 The relationship between cardiovascular disease (CVD) and depression also deserves emphasis for future research examining birth cohort trends, as declining CVD rates and mortality59 align with our reported declining depression rates. It is further possible that negative trends in CVD in younger adults related to obesity and diabetes may threaten to reverse positive trends in late-life psychiatric morbidity in the future.

# Conclusions

 As life expectancy increases in the population, reduced rates of depression symptoms in older adults might reflect compression of morbidity, or a declining trend in medical comorbidity. If confirmed in other cohorts, the trend is a positive development that may also influence other health outcomes.

* + - * 1. Tables

Table 1. Baseline characteristics of analysis sample and missing data samplea

|  |  |  |
| --- | --- | --- |
|   | Analysis Sample | MissingData Sample |
| Sample size, N  | 3227 | 338 |
| Born 1902-1911 | 305 (9.45) | 116 (34.32) |
| Born 1912-1921 | 1202 (37.25) | 197 (58.28) |
| Born 1922-1931 | 1051(32.57) | 24 (7.10) |
| Born 1932-1941 | 669 (20.73) | 1 (0.30) |
| Baseline age, Mean (SD) | 76.1 (7.10) | 74.44 (5.55) |
| Female Sex, N (%) | 1965 (60.90) | 159 (47.04) |
| <HS education, N (%) | 787 (24.40) | 186 (55.03) |
| HS education, N (%) | 1329 (41.20) | 84 (24.85) |
| >HS education, N (%) | 1111 (34.40) | 68 (20.12) |
| Baseline antidepressant use, N (%) | 283 (8.80) | 13 (3.86) |
| MYHAT study, N (%) | 1930 (59.80) | 4 (1.18) |
| Baseline MMSE, Median (Q1-Q3) | 28.0 (27.0 - 29.0) | 27 (26.5 – 27.5) |
| Baseline Number of Rx medications, Median (Q1-Q3) | 3 (1-5) | 2 (1-4) |

*Notes:* HS: high school; MYHAT: Monongahela Youghiogheny Healthy Aging Team; MMSE: Mini-Mental State Exam.

aParticipants that were missing all mCES-D measurements (baseline and follow-up visits) were excluded from the analysis sample

Table 2. Factor-Analyzed Composites of the mCES-D in MoVIES and MYHAT Sample (n=3227)

|  |  |
| --- | --- |
|  | Factors |
| mCES-D Item | DepressedMood | Anergia and Hopelessness | Withdrawal | Poor Self-Esteem | Did Not Load |
| I felt I could not shake off the blues even with help from family and friends | ✓ |  |  |  |  |
| I felt depressed | ✓ |  |  |  |  |
| I was happy | ✓ |  |  |  |  |
| I felt lonely | ✓ |  |  |  |  |
| I had crying spells | ✓ |  |  |  |  |
| I felt sad | ✓ |  |  |  |  |
| I felt that everything I did was an effort |  | ✓ |  |  |  |
| I felt hopeful about the future |  | ✓ |  |  |  |
| I enjoyed life |  | ✓ |  |  |  |
| I could not get going |  | ✓ |  |  |  |
| I was bothered by things that don't usually bother me |  |  | ✓ |  |  |
| I did not feel like eating; my appetite was poor |  |  | ✓ |  |  |
| I had trouble keeping my mind on what I was doing |  |  | ✓ |  |  |
| I talked less than usual |  |  | ✓ |  |  |
| I thought my life had been a failure |  |  |  | ✓ |  |
| People were unfriendly |  |  |  | ✓ |  |
| I felt that people dislike me |  |  |  | ✓ |  |
| I felt that I was as good as other people |  |  |  |  | ✓ |
| I felt fearful |  |  |  |  | ✓ |
| My sleep was restless |  |  |  |  | ✓ |

*Notes*: mCES-D: Modified Center for Epidemiologic Studies Depression Scale.

Table 3 Study Baseliine Characteristics by Birth Cohort and Total

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|   | 1902-1911 | 1912-1921 | 1922-1931 | 1932-1941 | Total | pa |
| Analysis sample, N | 305 | 1202 | 1051 | 669 | 3227 | n/a |
| At least one visit with mCES-D ≥5, N (%) | 70 (23.0) | 229 (19.1) | 168 (16.0) | 102 (15.2) | 569 (17.6) | 0.007 |
| Baseline age, Mean (SD) | 80.6 (4.2) | 75.7 (8.2) | 79.0 (5.5) | 70.2 (2.9) | 76.1 (7.1) | <.001 |
| Female, N (%) | 204 (66.9) | 727 (60.5) | 634 (60.3) | 400 (59.8) | 1965 (60.9) | 0.16 |
| <HS education, N (%) | 173 (56.7) | 420 (34.9) | 152 (14.5) | 42 (6.3) | 787 (24.4) | <.001 |
| HS education, N (%) | 52 (17.1) | 484 (40.3) | 497 (47.3) | 296 (44.3) | 1329 (41.2) | <.001 |
| >HS education, N (%) | 80 (26.2) | 298 (24.8) | 402 (38.3) | 331 (49.5) | 1111 (34.4) | <.001 |
| Baseline antidepressant use, N (%) | 7 (2.3) | 51 (4.2) | 113 (10.8) | 112 (16.8) | 283 (8.8) | <.001 |
| MYHAT study, N (%) | 12 (3.9) | 323 (26.9) | 926 (88.1) | 669 (100.0) | 1930 (59.8) | <.001 |
| Baseline MMSE, Median (Q1-Q3) | 23.5 (21.8-26.0) | 27.0 (26.0-28.0) | 28.0 (27.0-29.0) | 29.0 (28.0-30.0) | 28.0 (27.0-2.09) | <.001 |
| Baseline Number of Rx medications, Median (Q1-Q3) | 2 (1-3) | 2 (0-4) | 4 (2-6) | 4 (2-6) | 3 (1-5) | <.001 |
| Person-Years, Mean (SD) | 4.60 (3.64) | 6.13 (4.08) | 5.39 (3.62) | 6.03 (3.46) | 5.72 (3.80) | <.001 |

a Test for significant differences between cohort using Pearson’s Chi-Square (mCES-D, Sex, Education, Antidepressant use, Study), ANOVA (Age, Person-years) and Kruskal-Wallis rank sum test (MMSE, Rx Medications)

*Notes:* mCES-D: Modified Center for Epidemiologic Studies Depression Scale; HS: high school; MYHAT: Monongahela Youghiogheny Healthy Aging Team; MMSE: Mini-Mental State Exam.

Table 4 Joint Modelsa for Depression Symptoms (≥5 mCES-D)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|   | β | OR | 95% CI OR | p |
| *Unadjusted Model* |  |  |  |  |
| Born 1902-1911 (referent) | - | - | - | - |
| Born 1912-1921 | -0.671 | 0.511 | (0.307, 0.852) | .010 |
| Born 1922-1931 | -1.322 | 0.267 | (0.159, 0.446) | <.001 |
| Born 1932-1941 | -1.620 | 0.198 | (0.107, 0.365) | <.001 |
| Age | 0.184 | 1.202 | (0.914, 1.582) | .188 |
| *Adjusted Model* |  |  |  |  |
| Born 1902-1911 (referent) | - | - | - | - |
| Born 1912-1921 | -0.570 | 0.566 | (0.341, 0.939) | .028 |
| Born 1922-1931 | -0.998 | 0.369 | (0.215, 0.632) | <.001 |
| Born 1932-1941 | -1.583 | 0.205 | (0.106, 0.399) | <.001 |
| Age | -0.345 | 0.708 | (0.542, 0.926) | .012 |
| Female Sex | 0.978 | 2.658 | (1.963, 3.600) | <.001 |
| HS education | -0.832 | 0.435 | (0.307, 0.617) | <.001 |
| >HS education | -1.092 | 0.336 | (0.229, 0.491) | <.001 |
| Antidepressant use | 0.982 | 2.670 | (1.882, 3.787) | <.001 |
| MMSE | -0.155 | 0.856 | (0.824, 0.890) | <.001 |
| Number of Rx Medications | 0.142 | 1.152 | (1.104, 1.203) | <.001 |

*Notes:* Reference Groups are Born 1902-1911, Male Sex, <HS Education, and no antidepressant use. mCES-D: Modified Center for Epidemiologic Studies Depression Scale; HS: high school; MMSE: Mini-Mental State Exam; OR: odds ratio; CI: confidence interval.

aGeneralized linear mixed sub-model with logit link and Weibull proportional hazards time to attrition sub-model joint with shared random effect terms.

Table 5 Joint Modelsa for mCES-D Factor Scores by Birth Cohorts

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|   | Depressed Mood | Anergia/Hopelessness | Withdrawal | Poor Self-Esteem |
|   | β | SE | β | SE | β | SE | β | SE |
| Born 1902-1911 | - | - | - | - | - | - | - | - |
| Born 1912-1921 | -0.006 | 0.010 | -0.081b | 0.014 | -0.006 | 0.007 | -0.006 | 0.005 |
| Born 1922-1931 | -0.026b | 0.010 | -0.132b | 0.014 | -0.007 | 0.007 | -0.007 | 0.004 |
| Born 1932-1941 | -0.033b | 0.011 | -0.150b | 0.015 | -0.018b | 0.008 | -0.008 | 0.005 |
| Age | -0.003 | 0.003 | -0.010b | 0.003 | -0.007b | 0.002 | -0.003b | 0.001 |
| Female Sex | 0.032b | 0.004 | 0.020b | 0.005 | 0.021b | 0.003 | 0.003b | 0.001 |
| HS education | -0.029b | 0.007 | -0.030b | 0.008 | -0.012b | 0.004 | -0.005 | 0.002 |
| >HS education | -0.037b | 0.006 | -0.040b | 0.008 | -0.012b | 0.004 | -0.006b | 0.002 |
| Antidepressant use | 0.032b | 0.008 | 0.028b | 0.009 | 0.023b | 0.005 | 0.004 | 0.003 |
| MMSE | -0.005b | 0.001 | -0.008b | 0.001 | -0.004b | 0.001 | -0.001b | 0.001 |
| Number of Rx Medications | 0.003b | 0.001 | 0.008b | 0.001 | 0.002b | 0.001 | 0.001 | 0.001 |

*Notes:* Reference Groups are Born 1902-1911, Male Sex, <HS Education, and no antidepressant use. mCES-D: Modified Center for Epidemiologic Studies Depression Scale; HS: high school; MMSE: Mini-Mental State Exam; SE: standard error.

a Linear mixed sub-model and Weibull proportional hazards time to attrition sub-model joint with shared random effect terms.

b p<.05

* + - * 1. Figures



Figure 1. Predicted Average Number of Symptoms in Each mCES-D Factor by Birth Cohort and Age

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