Original Paper

Racial Variation in the Association between Childhood Depression and Frontal Pole Volume among American Children

Shervin Assari1,2*

1 Department of Family Medicine, Charles R. Drew University of Medicine and Science, Los Angeles, CA, USA
2 Department of Urban Public Health, Charles R. Drew University of Medicine and Science, Los Angeles, CA, USA

* Shervin Assari, E-mail: assari@umich.edu; Tel.: +(734)-232-0445; Fax: +734-615-873

Received: November 2, 2020  Accepted: November 17, 2020  Online Published: November 21, 2020
doi:10.22158/rhs.v5n2p121       URL: http://dx.doi.org/10.22158/rhs.v5n2p121

Abstract

Background: Major Depressive Disorder (MDD) is associated with an altered structure and function of the prefrontal cortex (PFC). There is more to find out about how this association differs among diverse racial groups. Aim: This study was performed to investigate racial differences in the association between MDD and frontal pole volume in 9/10-year-old children in the U.S. Materials and methods: This cross-sectional study used the Adolescent Brain Cognitive Development (ABCD) study. Then an analytical sample included 10185 American children between the ages of 9 and 10. The independent variable was current MDD, measured using K-SADS. The primary outcome was frontal pole volume, measured using the structural Magnetic Resonance Imaging (sMRI). Race was the moderator. Mixed-effects regression models were used for data analysis. Results: In the overall sample, MDD was associated with a smaller frontal pole volume among children. Race showed a statistically significant interaction with MDD on children’s frontal pole volume, indicating stronger effects on White children compared to Black children. Conclusion: The inverse association between MDD and frontal pole volume is steeper in Black than White American children. White American children with and without MDD show more similar frontal pole volume, while Black children with and without MDD differ more when it comes to the frontal pole volume. It is unknown whether or not the stronger association between frontal pole volume and MDD in Black children is due to a poor access to treatment or to a higher chronicity of MDD in Black communities.

Keywords
depression, frontal pole volume, population groups, prefrontal cortex, frontal pole, cerebral cortex
1. Introduction

Extensive animal (Nashed, Seidlitz, Frey, & Singh, 2015) and human (Grimm et al., 2008) research has shown that the prefrontal cortex (PFC) is a key brain region to affect regulation and emotion processing. A large body of research has also shown that an altered function (Masuda et al., 2017) and structure (Lu et al., 2019) of the PFC is linked to mood disorders such as major depressive disorder (MDD) and bipolar disorder (BD). A structural (Kozel et al., 2011) and functional (Grimm et al., 2008) alteration of PFC is consistently shown in children, youth, adults, and older adults with MDD. Similarly, an altered PFC function (Geller, Grisaru, Abarbanel, Lemberg, & Belmaker, 1997) and structure (Kozel et al., 2011) is linked to MDD severity and treatment response. In addition to that, children with MDD also show similar abnormalities in the function and structure of the PFC (Marrus et al., 2015; Zhang et al., 2020). These studies suggest that an altered PFC function and structure are among the main pathological features of MDD (Taki et al., 2005). Medial PFC (mPFC) is especially vulnerable to stress exposure (Treadway et al., 2015). In fact, stress-related morphometric changes in PFC are in line with the stress-sensitization theory of MDD (Treadway et al., 2015).

Morphological changes in PFC are well-known in MDD (Treadway et al., 2015). Multiple studies have shown volumetric reductions in mPFC among patients with MDD (Treadway et al., 2015). A structural Magnetic Resonance Imaging (sMRI) of regional gray matter volume of 34 subjects with subthreshold depression and 109 age-matched nondepressed controls showed that among males, individuals with subthreshold depression have smaller volumes of the medial part of bilateral frontal lobes and the right precentral gyrus when compared to normal controls. The same results, however, could not be found in females. The study suggested that even community-dwelling individuals with subthreshold depression show a bilateral volume reduction of PFC; a finding that is well established for patients with MDD (Taki et al., 2005). In a study of 103 medication-free patients with MDD and control subjects, sMRI was performed to examine the relationships between the number of prior MDD episodes, current stress, and cortical thickness. A greater number of prior depressive episodes but not current depressive diagnosis was associated with cortical thinning of the left mPFC. A higher number of prior episodes was also associated with a reduced volume in the dentate gyrus (Treadway et al., 2015). Although considerable research suggests that social, clinical, and behavioral correlates of MDD differ for White and Black individuals (Assari, 2016, 2017b, 2017c, 2018a, 2018b, 2019; Assari & Lankarani, 2016a, 2016b; Assari, Moazen-Zadeh, Lankarani, & Micol-Foster, 2016; Assari, Watkins, & Caldwell, 2015; Carter & Assari, 2016; Cobb & Assari, 2019; Evans, Cobb, Smith, Bazargan, & Assari, 2019), we are not aware of any previous studies that have explored racial differences in the association between PFC morphometry and MDD.

1.1 Aims

The current study was performed with two aims. The first aim was to test the association between current MDD and frontal pole volume in a national sample of 9/10-year-old American children (general population). The second aim was to compare racial groups of American children as for the association
between current MDD and frontal pole volume. While MDD is expected to be associated with smaller frontal pole volume (Hypothesis 1), this effect is expected to be more salient on Black than White children (Hypothesis 2). A stronger association between current MDD and PFC morphometry in Black than White children is based on our previous observation on higher severity of MDD in Black than White individuals (Assari, 2019; Assari & Moazen-Zadeh, 2016a, 2016b; Williams et al., 2007).

2. Materials and Methods

2.1 Design and Setting

With a cross-sectional design, this study applied a secondary analysis of data from the Adolescent Brain Cognitive Development (ABCD) study (Alcohol Research: Current Reviews Editorial, 2018; Casey et al., 2018; Karcher, O’Brien, Kandala, & Barch, 2019; Lisdahl et al., 2018; Luciana et al., 2018). The ABCD is a national brain development study of American children (Alcohol Research: Current Reviews Editorial, 2018; Auchter et al., 2018).

2.2 Sample and Sampling

The ABCD participants were sampled from 21 sites in multiple cities across different states in the U.S. The ABCD sample is mainly enrolled through the U.S. school system. The ABCD sampling strategy applied a careful design of pre-adolescents sampling across various sites (ABCD; Alcohol Research: Current Reviews Editorial, 2018; Asaad & Bjarkam, 2019; Auchter et al., 2018; Beauchaine, 2020; Buscemi et al., 2018; Casey et al., 2018; Dick et al., 2019a, 2019b, 2019c; Exuperio et al., 2019; Feldstein Ewing et al., 2018; Fine et al., 2019; Gray, Schvey, & Tanofsky-Kraff, 2019; Hoffman, Howlett, Breslin, & Dowling, 2018; Lisdahl et al., 2018; Lynch et al., 2019; Michelini et al., 2019; Werneck et al., 2018). To ensure that the ABCD sample is representative, the ABCD has used a weight (propensity score). Using weights, the final ABCD results are generalizable to the U.S., and the weighted participants are a close approximation of national sociodemographic, sex, and racial factors. A full description of the ABCD sample and sampling is published here (Garavan et al., 2018).

2.3 Analytical Sample

This study included 10185 9/10-year-old children who had data on our study variables, including negative urgency. Children from any race or ethnicity were included. No additional eligibility criteria were considered.

2.4 Measures and Measurements

Frontal pole volume. The frontal pole volume was measured using the sMRI. The ABCD imaging modalities are well described here (Hagler et al., 2019). All participating children in the ABCD study completed a high-resolution T1-weighted structural MRI scan (1-mm isotropic voxels) with any of the following scanners: Philips Healthcare (Andover, Massachusetts), GE Healthcare (Waukesha, Wisconsin), or Siemens Healthcare (Erlangen, Germany) (Casey et al., 2018). All the structural MRI data were processed using FreeSurfer version 5.3.0 (B. Fischl, Sereno, & Dale, 1999; Vargas, Damme, & Mittal, 2020), in line with the standard processing pipelines (Casey et al., 2018). The process included the
removal of nonbrain tissue, the segmentation of gray and white matter (Bruce Fischl et al., 2002) and the parcellation of the cerebral cortex (Bruce Fischl et al., 2004). Every scan session underwent a radiological review. An extended quality control protocol was implemented, which included a visual inspection of T1 images and FreeSurfer outputs for an acceptable quality (Hagler Jr et al., 2019). Any MRI imaging that did not pass the quality control was excluded. The cortical parcellation in this study was based on the Desikan-Killiany Atlas (Hagler Jr et al., 2019). Region of interest in this study was frontal pole. In this analysis, we used the volumetric data provided by the ABCD data. Figure 1 shows the distribution of the outcome in this study.

**Race.** Race, identified by parents, was a categorical variable with the following levels: Black, Asian, Other/Mixed race, and White (reference group). This variable was the effect modifier.

**Current depression.** Current MDD was measured using the depression module of the Kiddie Schedule for Affective Disorders and Schizophrenia (K-SADS) tool (Orvaschel, Puig-Antich, Chambers, Tabrizi, & Johnson, 1982; Puig-Antich & Chambers, 1978; Townsend et al., 2020). K-SADS, a structured and screening interview tool, is one the most widely used diagnostic tools of psychiatric disorders in children (Chambers et al., 1985; Orvaschel et al., 1982). K-SADS generates DSM-5 5 (KSADS-5) diagnosis of MDD and other psychiatric disorders (Kim et al., 2004). The child was interviewed for the past and present history of MDD in child’s depression as well as depression-related symptoms. Our outcome, current MDD, was treated as a categorical/dichotomous outcome with 0 for absence and 1 for presence of current MDD.

**Parental educational attainment.** Parental educational attainment was a five-level categorical variable. Responses included 1 = less than high school diploma; 2 = high school diploma or GED; 3 = some college; 4 = college degree; and 5 = some graduate education.

**Parental marital status.** The household’s marital status was a dichotomous variable: married = 1 and non-married = 0. Family structure and marital status of the parents are shown to predict children’s negative urgency (Rhoades, Greenberg, Lanza, & Blair, 2011).

**Family income.** Family income was a three-level categorical variable. The item used to measure parental educational attainment was: “What is your total combined parental educational attainment for the past 12 months? This should include income (before taxes and deductions) from all sources, wages, rent from properties, social security, disability and veteran’s benefits, unemployment benefits, workman”. Levels were 1= less than $50,000; 2 = $50,000 to $99,000; 3 = $100,000 or more.

**Ethnicity.** Ethnicity, self-identified by the parents, was 1 for Hispanics and 0 for non-Hispanics (reference category).

**Age.** Age was measured in months and was a continuous measure.

**Sex.** Sex, 1 for males and 0 for females, was a dichotomous variable.

### 2.5 Data Analysis

This analysis was performed in the Data Analysis and Exploration Portal (DEAP), National Data Archive (NDA), National Institutes of Health (NIH). DEAP is specifically designed for analysis of the ABCD...
data and uses R software for performing data analysis. Participants were nested within families who were nested within 21 sites. As such, our models should correct for non-independence of our observations. We applied mixed (random) effect models that allowed adjusting for the data’s nested nature.

To describe our sample, we reported mean (SD) for continuous variables, frequencies and percentages for categorical variables in the pooled sample and by race. We used Chi-square or ANOVA for bivariate analysis. Two mixed-effects multivariable models were performed. In both of these models, frontal pole cortical volume was the outcome, race was the moderator, current MDD was the predictor, and covariates (sex, ethnicity, age, household income, parental education, and family structure), as well as site and family ID were the control variables. Model 1 (no interaction) was estimated in the absence of any interaction terms. Model 2 (the interaction model) added interaction terms between race and current MDD. Appendix 1 shows the formula used for Model 1 and Model 2 in the DEAP system. Regression coefficient (b), SE, and p-values were reported for each model. Appendix 2 also shows the results of testing assumptions.

2.6 Ethical Aspect

For this study, we used a fully de-identified data set. As such, the study was exempted from a full review Institutional Review Board (IRB). However, the main study protocol, the ABCD, was approved by the IRB at the University of California, San Diego (UCSD), and several other institutions. Participants signed consent or assent depending on their age (Auchter et al., 2018).

3. Results

Table 1 depicts the summary statistics of the pooled sample and by race. The current analysis was performed on 10185, 9/10-year-old children from which 6784 were White (unweighted 66.6%; weighted 69.4), 1472 were Black (unweighted 14.5%; weighted 13.3%), 219 were Asian (unweighted 2.2%; weighted 3.6%), and 1710 were other/mixed race (unweighted 16.8%; weighted 13.7%).

| Table 1. Descriptive Data Overall and by Race |
|-----------------------------------------------|
| Level | All | White | Black | Asian | Other/Mixed | p |
|-------|-----|-------|-------|-------|-------------|---|
| N     | 10185 | 6784 | 1472 | 219 | 1710 | |
| Mean (SD) | Mean (SD) | Mean (SD) | Mean (SD) | Mean (SD) | Mean (SD) | Mean (SD) | Mean (SD) | Mean (SD) | Mean (SD) | Mean (SD) | Mean (SD) |
| Age (Months) | 118.97 (7.47) | 119.23 (7.48) | 119.03 (7.49) | 119.29 (7.49) | 118.98 (7.23) | 119.26 (7.23) | 119.35 (7.82) | 119.73 (7.83) | 118.68 (7.52) | 118.75 (7.59) | 0.302 | 0.130 |
| Left Frontal Pole Volume (mm³) | 970.41 (189.71) | 966.77 (191.29) | 989.81 (184.43) | 985.90 (190.30) | 916.70 (184.03) | 914.06 (185.51) | 936.09 (169.29) | 938.00 (167.90) | 944.09 (185.51) | 938.69 (194.12) | < 0.001 | < 0.001 |
| MDD | 0.02 (0.15) | 0.03 (0.16) | 0.02 (0.14) | 0.02 (0.15) | 0.03 (0.18) | 0.03 (0.18) | 0.02 (0.13) | 0.01 (0.11) | 0.02 (0.15) | 0.03 (0.16) | 0.020 | 0.069 |
| n(%) | % | n(%) | % | n(%) | % | n(%) | % | n(%) | % | n(%) | % |
MDD: Major Depressive Disorder

Table 2 and Table 3 summarizes our mixed-method regression model that adjusted for the nested nature of the data. These models were in the overall (pooled) sample. Model 1 (Main Effect Model) did show a significant inverse association between current MDD and frontal pole volume in the pooled sample. Model 2 (Interaction Effect Model) also showed a significant interaction between race and current MDD on frontal pole volume in the pooled sample.

Table 2. Percentage of the Variance of the Outcome Explained by Models

| Effect Size | Effect Size |
|-------------|-------------|
| N           | 10185       |
| R-squared   | 0.06702     |
| ΔR-squared  | 0.00061 (0.06%) | 0.01171 (1.17%) |
Table 3. Summary of the Results of Our Models

|                          | Model 1 |           |           | Model 2 |           |           |
|--------------------------|---------|-----------|-----------|---------|-----------|-----------|
|                          | df      | F         | p-value   | df      | F         | p-value   |
| MDD                      | 1*      | 6.24      | 0.012     | 1       | 2.02      | 0.155     |
| Age                      | 1***    | 31.32     | < 0.001   | 1***    | 31.36     | < 0.001   |
| Sex                      | 1***    | 318.19    | < 0.001   | 1***    | 319.59    | < 0.001   |
| Parental Education       | 4**     | 3.71      | 0.005     | 4**     | 3.77      | 0.004     |
| Household income         | 2*      | 3.29      | 0.037     | 2*      | 3.31      | 0.036     |
| Race                     | 3***    | 34.98     | < 0.001   | 3***    | 32.83     | < 0.001   |
| Married Family           | 1       | 0.65      | 0.421     | 1       | 0.56      | 0.4195    |
| Hispanic                 | 1***    | 73.54     | < 0.001   | 1***    | 74.03     | < 0.001   |
| MDD x Race               |         | 3*        | 3.04      | 0.028   |           |           |

MDD: Major Depressive Disorder

*P < 0.05  **P < 0.01  ***P < 0.001

Table 4 summarizes regression coefficients in our two mixed-method regression models that adjusted for the nested nature of the data. These models were in the overall (pooled) sample. Model 1 showed an inverse association between current MDD and frontal pole volume in the pooled sample. Model 2 (Interaction Model) showed a significant interaction term between race and current MDD on frontal pole volume in the pooled sample, suggesting a stronger inverse association between the two for Black than White children.

Table 4. Regression Coefficients in Our Models

|                          | Model 1 |           |           | Model 2 |           |           |
|--------------------------|---------|-----------|-----------|---------|-----------|-----------|
|                          | b       | SE        | p         | B       | SE        | p         |
| MDD                      | -29.13* | 11.66     | 0.013     | -20.62  | 14.50     | 0.155     |
| Age (Month)              | -1.35***| 0.24      | < 0.001   | -1.35***| 0.24      | < 0.001   |
| Sex (Male)               | 66.46***| 3.73      | < 0.001   | 66.59***| 3.73      | < 0.001   |
| Parental Education (HS Diploma/GED) | 3.16  | 11.51     | 0.784     | 4.40     | 11.52     | 0.702     |
| Parental Education (Some College) | 4.78  | 10.48     | 0.648     | 5.56     | 10.49     | 0.596     |
| Parental Education (Bachelor) | 15.54 | 11.19     | 0.165     | 16.70    | 11.20     | 0.136     |
| Parental Education (Post Graduate Degree) | 26.60*| 11.38     | 0.019     | 27.56*   | 11.39     | 0.016     |
| Household income (> =50K & < 100K) | 11.35*| 5.74      | 0.048     | 16.81*   | 6.61      | 0.011     |
| Household income (> =100K) | 16.73*| 6.61      | 0.011     | 11.26*   | 5.73      | 0.050     |
Race (Black)   -58.71  6.48  < 0.001  -56.31***  6.55  < 0.001
Race (Asian)   -58.51  11.62  < 0.001  -60.33***  11.71  < 0.001
Race (Other/Mixed)  -21.36  5.91  < 0.001  -21.90***  5.97  < 0.001
Race (Black) x MDD  -  -  -  -70.04*  29.71  0.018
Race (Asian) x MDD  -  -  -  114.00  91.52  0.213
Race (Other/Mixed) x MDD  -  -  -  27.37  34.27  0.425

MDD: Major Depressive Disorder
*P < 0.05   **P < 0.01   ***P < 0.001

Figure 1 shows an inverse association between current MDD and frontal pole volume in the pooled sample. Figure 2 shows that the inverse association between current MDD and frontal pole volume is steeper in Black than White sample.
4. Discussion

Our findings showed that current MDD is associated with a reduced frontal pole volume; however, the link between current MDD and frontal pole volume in American children depends on race. That is, the link between depression and frontal pole volume is more salient in Black than White children.

Past research has shown racial differences in correlates of depression in children, adults, and older adults (Assari, 2014, 2017b, 2017c, 2018b; S. Assari, Nikahd, Malekahmadi, Lankarani, & Zamanian, 2016; Carter & Assari, 2016; Lankarani & Assari, 2017; Watkins, Assari, & Johnson-Lawrence, 2015). For example, depression shows weaker SES correlates in Black than White families (Assari, 2017c, 2018b; Assari, Gibbons, & Simons, 2018; Assari, Nikahd, et al., 2016). There are also some studies showing a positive association between SES and depression in Black communities (Assari, 2017a, 2017c, 2020; Hudson, Bullard, et al., 2012; Hudson, Neighbors, Geronimus, & Jackson, 2012, 2016; Hudson, Puterman, Bibbins-Domingo, Matthews, & Adler, 2013).

Some research has shown that depression is associated with more depressive symptoms in Blacks than Whites (Assari, 2019; Assari & Moazen-Zadeh, 2016a, 2016b; Evans et al., 2019; Moazen-Zadeh &
Assari, 2016). Williams and colleagues have shown that depression is associated with a lower chance of treatment and more recent experience of depression in Black than White people (Williams et al., 2007). That means depression tends to be more chronic in Black than White people (Williams et al., 2007). This is in line with a worse treatment access and acceptability of Blacks than Whites (Ayalon, Arean, Linkins, Lynch, & Estes, 2007; Bailey, Blackmon, & Stevens, 2009; Nestor, Cheek, & Liu, 2016; Ward & Mengesha, 2013). Finally, the stigma is very high against depression in Black communities (Watkins, Abelson, & Jefferson, 2013).

Even more severe depression, which is associated with suicidality, shows differential correlates by race. In multiple studies, SES and race interact, with SES showing weaker effects on depression and associated suicide in Blacks than Whites. This means a diminished protective effect of SES indicators on depression and associated suicide in Black than White people, including adults and adolescents. As a result, Black middle class children remain at a high risk while middle-class White families show a lower risk (Assari, Boyce, Bazargan, & Caldwell, 2020). Many studies show racial variation in correlates of depression and associated suicide (Assari, 2015, 2018c, 2018d; Assari, Lankarani, & Lankarani, 2013; Assari, Moghani Lankarani, & Caldwell, 2017; Assari et al., 2019). Discrimination is a significant predictor of depression and associated suicide in Black (Assari et al., 2017) children and adults; however, the role of discrimination as a risk factor of psychopathology is smaller in Whites.

This study is not without methodological limitations. The first limitation is a cross sectional. We only measured current depression and did not include data on the history of depression, anxiety, and other psychiatric disorders. We also did not include data on the history of depression treatment, number of depressive episodes, severity of symptoms, or chronic stress. We also did not measure other factors such as supportive parenting and family context. The sample was not random as a result; we cannot generalize the results to all US children. However, we used the ABCD propensity score to maximize the comparability of racial groups and also the generalizability of results. Our sample size was also imbalanced, with the largest sample in White, and the smallest in Asian children. Despite the limitations listed above, our study is among the first to explore racial variation of the link between MDD and cortical morphometry. Another strength of this study was using a large national diverse sample of children.

Our result has implications for clinical practice as well as research regarding children’s MDD. Researchers who study brain morphometric aspects of depression may not reduce race to a control variable. Race may have a direct effect, but also alters the correlates of PFC morphometry and depression. The results may help the tailor depression treatment or the diagnosis among racially diverse groups of children. PFC volume may differently reflect emotion regulation, affect, trauma, and depression in Black and White children. Similarly, MDD treatment response may be differently measured in terms of PFC volume change.

More research is needed on the heterogeneity of psychiatric diagnoses such as MDD and brain morphometry. It is still unknown why the MDD – PFC volume link is more prominent in Black than White children. This may be because depression tends to remain untreated and stress is more common in
Black than White communities, and Black children are not an exception to this rule. Thus, research should investigate whether severity and chronicity of MDD and access to treatment explains the observed difference in the MDD – PFC connections.

5. Conclusions
Racial groups of children differ in the magnitude of the link between current depression (MDD) and frontal pole volume. This means, considering that MDD shows a strong association with reduced frontal pole volume in Black children, depression is showing a weakened association with frontal pole volume in White children. The result is of interest as PFC morphometry in general and frontal pole volume in particular are believed to be linked to the outcomes of childhood depression.

Conflicts of Interest: The author declares no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

ABCD Funding: Data used in the preparation of this article were obtained from the Adolescent Brain Cognitive Development (ABCD) Study (https://abcdstudy.org), held in the NIMH Data Archive (NDA). The ABCD Study is supported by the National Institutes of Health (NIH) and additional federal partners under award numbers U01DA041022, U01DA041025, U01DA041028, U01DA041048, U01DA041089, U01DA041093, U01DA041106, U01DA041117, U01DA041120, U01DA041134, U01DA041148, U01DA041156, U01DA041174, U24DA041123, and U24DA041147. A full list of federal partners is available at https://abcdstudy.org/federal-partners.html. A listing of participating sites and a complete listing of the study investigators can be found at https://abcdstudy.org/principal-investigators.html. This manuscript reflects the views of the authors and may not reflect the opinions or views of the NIH or ABCD consortium investigators. ABCD consortium investigators designed and implemented the study and/or provided data but did not necessarily participate in analysis or writing of this report.

Author Funding: Shervin Assari is supported by the grants with the numbers CA201415 02, DA035811-05, U54MD007598, U54MD008149, D084526-03, and U54CA229974 by the National Institutes of Health (NIH).

DEAP Acknowledgment: DEAP is a software provided by the Data Analysis and Informatics Center of ABCD located at the UC San Diego with generous support from the National Institutes of Health and the Centers for Disease Control and Prevention under award number U24DA041123. The DEAP project information and links to its source code are available under the resource identifier RRID: SCR_016158.

Author Acknowledgment: Author wishes to thank Gaella Attieh for her exceptional contribution to this paper.
References

ABCD. ABCD Protocl Brocure - Baseline. Retrieved from https://abcdstudy.org/images/Protocol-Brochure-Baseline.pdf

Alcohol Research: Current Reviews Editorial, S. (2018). NIH’s Adolescent Brain Cognitive Development (ABCD) Study. Alcohol Res, 39(1), 97. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/30557152

Asaad, S. K., & Bjarkam, C. R. (2019). The Aalborg Bolt-Connected Drain (ABCD) study: a prospective comparison of tunnelled and bolt-connected external ventricular drains. Acta Neurochir (Wien), 161(1), 33-39. http://doi.org/10.1007/s00701-018-3737-z

Assari, S. (2014). Separate and Combined Effects of Anxiety, Depression and Problem Drinking on Subjective Health among Black, Hispanic and Non-Hispanic White Men. Int J Prev Med, 5(3), 269-279. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/24829710

Assari, S. (2015). Ethnic and Gender Differences in Additive Effects of Socio-economics, Psychiatric Disorders, and Subjective Religiosity on Suicidal Ideation among Blacks. Int J Prev Med, 6, 53. http://doi.org/10.4103/2008-7802.158913

Assari, S. (2016). Gender differences in the predictive role of self-rated health on short-term risk of mortality among older adults. SAGE Open Med, 4, 2050312116666975. http://doi.org/10.1177/2050312116666975

Assari, S. (2017a). Combined Racial and Gender Differences in the Long-Term Predictive Role of Education on Depressive Symptoms and Chronic Medical Conditions. J Racial Ethn Health Disparities, 4(3), 385-396. http://doi.org/10.1007/s40615-016-0239-7

Assari, S. (2017b). Neuroticism Predicts Subsequent Risk of Major Depression for Whites but Not Blacks. Behav Sci (Basel), 7(4). http://doi.org/10.3390/bs7040064

Assari, S. (2017c). Social Determinants of Depression: The Intersections of Race, Gender, and Socioeconomic Status. Brain Sci, 7(12). http://doi.org/10.3390/brainsci7120156

Assari, S. (2018a). Educational Attainment Better Protects African American Women than African American Men Against Depressive Symptoms and Psychological Distress. Brain Sci, 8(10). http://doi.org/10.3390/brainsci8100182

Assari, S. (2018b). High Income Protects Whites but Not African Americans against Risk of Depression. Healthcare (Basel), 6(2). http://doi.org/10.3390/healthcare6020037

Assari, S. (2018c). Multiplicative Effects of Social and Psychological Risk Factors on College Students’ Suicidal Behaviors. Brain Sci, 8(5). http://doi.org/10.3390/brainsci8050091

Assari, S. (2018d). Suicide Attempts in Michigan HealthCare System; Racial Differences. Brain Sci, 8(7). http://doi.org/10.3390/brainsci8070124

Assari, S. (2019). Race, Depression, and Financial Distress in a Nationally Representative Sample of American Adults. Brain Sci, 9(2). http://doi.org/10.3390/brainsci9020029
Assari, S. (2020). Combined Effects of Race and Educational Attainment on Physician Visits Over 24 Years in a National Sample of Middle-Aged and Older Americans. *Hosp Pract Res, 5*(1), 17-23. http://doi.org/10.34172/hpr.2020.04

Assari, S., Boyce, S., Bazargan, M., & Caldwell, C. H. (2020). African Americans’ Diminished Returns of Parental Education on Adolescents’ Depression and Suicide in the Adolescent Brain Cognitive Development (ABCD) Study. *European Journal of Investigation in Health, Psychology and Education, 10*(2), 656-668. Retrieved from https://www.mdpi.com/2254-9625/10/2/48

Assari, S., Gibbons, F. X., & Simons, R. L. (2018). Perceived Discrimination among Black Youth: An 18-Year Longitudinal Study. *Behav Sci (Basel), 8*(5). http://doi.org/10.3390/bs8050044

Assari, S., & Lankarani, M. M. (2016a). Depressive Symptoms Are Associated with More Hopelessness among White than Black Older Adults. *Front Public Health, 4*, 82. http://doi.org/10.3389/fpubh.2016.00082

Assari, S., & Lankarani, M. M. (2016b). Stressful Life Events and Risk of Depression 25 Years Later: Race and Gender Differences. *Front Public Health, 4*, 49. http://doi.org/10.3389/fpubh.2016.00049

Assari, S., Lankarani, M. M., & Lankarani, R. M. (2013). Ethnicity Modifies the Additive Effects of Anxiety and Drug Use Disorders on Suicidal Ideation among Black Adults in the United States. *Int J Prev Med, 4*(11), 1251-1257. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/24404358

Assari, S., & Moazen-Zadeh, E. (2016a). Confirmatory Factor Analysis of the 12-Item Center for Epidemiologic Studies Depression Scale among Blacks and Whites. *Front Psychiatry, 7*, 178. http://doi.org/10.3389/fpsyt.2016.00178

Assari, S., & Moazen-Zadeh, E. (2016b). Ethnic Variation in the Cross-sectional Association between Domains of Depressive Symptoms and Clinical Depression. *Front Psychiatry, 7*, 53. http://doi.org/10.3389/fpsyt.2016.00053

Assari, S., Moazen-Zadeh, E., Lankarani, M. M., & Micol-Foster, V. (2016). Race, Depressive Symptoms, and All-Cause Mortality in the United States. *Front Public Health, 4*, 40. http://doi.org/10.3389/fpubh.2016.00040

Assari, S., Moghani Lankarani, M., & Caldwell, C. H. (2017). Discrimination Increases Suicidal Ideation in Black Adolescents Regardless of Ethnicity and Gender. *Behav Sci (Basel), 7*(4). http://doi.org/10.3390/bs7040075

Assari, S., Nikahd, A., Malekahmadi, M. R., Lankarani, M. M., & Zamanian, H. (2016). Race by Gender Group Differences in the Protective Effects of Socioeconomic Factors Against Sustained Health Problems Across Five Domains. *J Racial Ethn Health Disparities*. http://doi.org/10.1007/s40615-016-0291-3
Assari, S., Schatten, H. T., Arias, S. A., Miller, I. W., Camargo, C. A., & Boudreaux, E. D. (2019). Higher Educational Attainment is Associated with Lower Risk of a Future Suicide Attempt Among Non-Hispanic Whites but not Non-Hispanic Blacks. *J Racial Ethn Health Disparities*. http://doi.org/10.1007/s40615-019-00601-z

Assari, S., Watkins, D. C., & Caldwell, C. H. (2015). Race Attribution Modifies the Association Between Daily Discrimination and Major Depressive Disorder Among Blacks: the Role of Gender and Ethnicity. *J Racial Ethn Health Disparities*, 2(2), 200-210. http://doi.org/10.1007/s40615-014-0064-9

Auchter, A. M., Hernandez Mejia, M., Heyser, C. J., Shilling, P. D., Jernigan, T. L., Brown, S. A., . . . Dowling, G. J. (2018). A description of the ABCD organizational structure and communication framework. *Dev Cogn Neurosci*, 32, 8-15. http://doi.org/10.1016/j.dcn.2018.04.003

Ayalon, L., Arean, P. A., Linkins, K., Lynch, M., & Estes, C. L. (2007). Integration of mental health services into primary care overcomes ethnic disparities in access to mental health services between black and white elderly. *Am J Geriatr Psychiatry*, 15(10), 906-912. http://doi.org/10.1097/JGP.0b013e318135113e

Bailey, R. K., Blackmon, H. L., & Stevens, F. L. (2009). Major depressive disorder in the African American population: Meeting the challenges of stigma, misdiagnosis, and treatment disparities. *J Natl Med Assoc*, 101(11), 1084-1089. http://doi.org/10.1016/s0027-9684(15)31102-0

Beauchaine, T. P. (2020). Editorial: Family History of Depression and Child Striatal Volumes in the ABCD Study: Promise and Perils of Neuroimaging Research With Large Samples. *J Am Acad Child Adolesc Psychiatry*. http://doi.org/10.1016/j.jaac.2020.01.002

Buscemi, S., Corleo, D., Vasto, S., Buscemi, C., Massenti, M. F., Nuzzo, D., . . . Giordano, C. (2018). Factors associated with circulating concentrations of irisin in the general population cohort of the ABCD study. *Int J Obes (Lond)*, 42(3), 398-404. http://doi.org/10.1038/ijo.2017.255

Carter, J. D., & Assari, S. (2016). Sustained Obesity and Depressive Symptoms over 6 Years: Race by Gender Differences in the Health and Retirement Study. *Front Aging Neurosci*, 8, 312. http://doi.org/10.3389/fnagi.2016.00312

Casey, B. J., Cannonier, T., Conley, M. I., Cohen, A. O., Barch, D. M., Heitzeg, M. M., . . . Workgroup, A. I. A. (2018). The Adolescent Brain Cognitive Development (ABCD) study: Imaging acquisition across 21 sites. *Dev Cogn Neurosci*, 32, 43-54. http://doi.org/10.1016/j.dcn.2018.03.001

Chambers, W. J., Puig-Antich, J., Hirsch, M., Paez, P., Ambrosini, P. J., Tabrizi, M. A., & Davies, M. (1985). The assessment of affective disorders in children and adolescents by semistructured interview: test-retest reliability of the Schedule for Affective Disorders and Schizophrenia for School-Age Children, Present Episode Version. *Archives of general psychiatry*, 42(7), 696-702.
Cobb, S., & Assari, S. (2019). Psychiatric Disorders and Alcohol Consumption Among Low-Income African Americans: Gender Differences. *Brain Sci.*, 9(4). http://doi.org/10.3390/brainsci9040086

Dick, A. S., Garcia, N. L., Pruden, S. M., Thompson, W. K., Hawes, S. W., Sutherland, M. T., . . . Gonzalez, R. (2019a). Author Correction: No evidence for a bilingual executive function advantage in the ABCD study. *Nat Hum Behav.*, 3(10), 1124. http://doi.org/10.1038/s41562-019-0756-6

Dick, A. S., Garcia, N. L., Pruden, S. M., Thompson, W. K., Hawes, S. W., Sutherland, M. T., . . . Gonzalez, R. (2019b). Author Correction: No evidence for a bilingual executive function advantage in the nationally representative ABCD study. *Nat Hum Behav.*, 3(9), 999. http://doi.org/10.1038/s41562-019-0709-0

Dick, A. S., Garcia, N. L., Pruden, S. M., Thompson, W. K., Hawes, S. W., Sutherland, M. T., . . . Gonzalez, R. (2019c). No evidence for a bilingual executive function advantage in the nationally representative ABCD study. *Nat Hum Behav.*, 3(7), 692-701. http://doi.org/10.1038/s41562-019-0609-3

Evans, M. C., Cobb, S., Smith, J., Bazargan, M., & Assari, S. (2019). Depressive Symptoms among Economically Disadvantaged African American Older Adults in South Los Angeles. *Brain Sci.*, 9(10). http://doi.org/10.3390/brainsci9100246

Exuperio, I. N., Agostinete, R. R., Werneck, A. O., Maillane-Vanegas, S., Luiz-de-Marco, R., Mesquita, E. D. L., . . . Fernandes, R. A. (2019). Impact of Artistic Gymnastics on Bone Formation Marker, Density and Geometry in Female Adolescents: ABCD-Growth Study. *J Bone Metab.*, 26(2), 75-82. http://doi.org/10.11005/jbm.2019.26.2.75

Feldstein Ewing, S. W., Chang, L., Cottler, L. B., Tapert, S. F., Dowling, G. J., & Brown, S. A. (2018). Approaching Retention within the ABCD Study. *Dev Cogn Neurosci.*, 32, 130-137. http://doi.org/10.1016/j.dcn.2017.11.004

Fine, J. D., Moreau, A. L., Karcher, N. R., Agrawal, A., Rogers, C. E., Barch, D. M., & Bogdan, R. (2019). Association of Prenatal Cannabis Exposure With Psychosis Proneness Among Children in the Adolescent Brain Cognitive Development (ABCD) Study. *JAMA Psychiatry*, 76(7), 762-764. http://doi.org/10.1001/jamapsychiatry.2019.0076

Fischl, B., Salat, D. H., Busa, E., Albert, M., Dieterich, M., Haselgrove, C., . . . Klaveness, S. (2002). Whole brain segmentation: Automated labeling of neuroanatomical structures in the human brain. *Neuron*, 33(3), 341-355.

Fischl, B., Sereno, M. I., & Dale, A. M. (1999). Cortical surface-based analysis. II: Inflation, flattening, and a surface-based coordinate system. *Neuroimage*, 9(2), 195-207. http://doi.org/10.1006/nimg.1998.0396

Fischl, B., Van Der Kouwe, A., Destrieux, C., Halgren, E., Ségonne, F., Salat, D. H., . . . Kennedy, D. (2004). Automatically parcellating the human cerebral cortex. *Cerebral cortex*, 14(1), 11-22.
Garavan, H., Bartsch, H., Conway, K., Decastro, A., Goldstein, R. Z., Heeringa, S., . . . Zahs, D. (2018). Recruiting the ABCD sample: Design considerations and procedures. *Dev Cogn Neurosci, 32*, 16-22. http://doi.org/10.1016/j.dcn.2018.04.004

Geller, V., Grisaru, N., Abarbanel, J. M., Lemberg, T., & Belmaker, R. H. (1997). Slow magnetic stimulation of prefrontal cortex in depression and schizophrenia. *Prog Neuropsychopharmacol Biol Psychiatry, 21*(1), 105-110. http://doi.org/10.1016/s0278-5846(96)00161-3

Gray, J. C., Schvey, N. A., & Tanofsky-Kraff, M. (2019). Demographic, psychological, behavioral, and cognitive correlates of BMI in youth: Findings from the Adolescent Brain Cognitive Development (ABCD) study. *Psychol Med, 1-9*. http://doi.org/10.1017/S0033291719001545

Grimm, S., Beck, J., Schuepbach, D., Hell, D., Boesiger, P., Bermahl, F., . . . Northoff, G. (2008). Imbalance between left and right dorsolateral prefrontal cortex in major depression is linked to negative emotional judgment: an fMRI study in severe major depressive disorder. *Biol Psychiatry, 63*(4), 369-376. http://doi.org/10.1016/j.biopsych.2007.05.033

Hagler, D. J., Jr., Hatton, S., Cornejo, M. D., Makowski, C., Fair, D. A., Dick, A. S., . . . Dale, A. M. (2019). Image processing and analysis methods for the Adolescent Brain Cognitive Development Study. *Neuroimage, 202*, 116091. http://doi.org/10.1016/j.neuroimage.2019.116091

Hagler Jr, D. J., Hatton, S., Cornejo, M. D., Makowski, C., Fair, D. A., Dick, A. S., . . . Harms, M. P. (2019). Image processing and analysis methods for the Adolescent Brain Cognitive Development Study. *Neuroimage, 202*, 116091.

Hoffman, E. A., Howlett, K. D., Breslin, F., & Dowling, G. J. (2018). Outreach and innovation: Communication strategies for the ABCD Study. *Dev Cogn Neurosci, 32*, 138-142. http://doi.org/10.1016/j.dcn.2018.04.001

Hudson, D. L., Bullard, K. M., Neighbors, H. W., Geronimus, A. T., Yang, J., & Jackson, J. S. (2012). Are benefits conferred with greater socioeconomic position undermined by racial discrimination among African American men? *J Mens Health, 9*(2), 127-136. http://doi.org/10.1016/j.jomh.2012.03.006

Hudson, D. L., Neighbors, H. W., Geronimus, A. T., & Jackson, J. S. (2012). The relationship between socioeconomic position and depression among a US nationally representative sample of African Americans. *Soc Psychiatry Psychiatr Epidemiol, 47*(3), 373-381. http://doi.org/10.1007/s00127-011-0348-x

Hudson, D. L., Neighbors, H. W., Geronimus, A. T., & Jackson, J. S. (2016). Racial Discrimination, John Henryism, and Depression Among African Americans. *J Black Psychol, 42*(3), 221-243. http://doi.org/10.1177/0095798414567757

Hudson, D. L., Puterman, E., Bibbins-Domingo, K., Matthews, K. A., & Adler, N. E. (2013). Race, life course socioeconomic position, racial discrimination, depressive symptoms and self-rated health. *Soc Sci Med, 97*, 7-14. http://doi.org/10.1016/j.socscimed.2013.07.031
Karcher, N. R., O’Brien, K. J., Kandala, S., & Barch, D. M. (2019). Resting-State Functional Connectivity and Psychotic-like Experiences in Childhood: Results From the Adolescent Brain Cognitive Development Study. *Biol Psychiatry, 86*(1), 7-15. http://doi.org/10.1016/j.biopsych.2019.01.013

Kim, Y. S., Cheon, K. A., Kim, B. N., Chang, S. A., Yoo, H. J., Kim, J. W., . . . So, Y. K. (2004). The reliability and validity of kiddie-schedule for affective disorders and schizophrenia-present and lifetime version-Korean version (K-SADS-PL-K). *Yonsei Medical Journal, 45*(1), 81-89.

Kozel, F. A., Johnson, K. A., Nahas, Z., Nakonezny, P. A., Morgan, P. S., Anderson, B. S., . . . George, M. S. (2011). Fractional anisotropy changes after several weeks of daily left high-frequency repetitive transcranial magnetic stimulation of the prefrontal cortex to treat major depression. *J ECT, 27*(1), 5-10. http://doi.org/10.1097/YCT.0b013e3181e6317d

Lankarani, M. M., & Assari, S. (2017). Positive and Negative Affect More Concurrent among Blacks than Whites. *Behav Sci (Basel), 7*(3). http://doi.org/10.3390/bs7030048

Lisdahl, K. M., Sher, K. J., Conway, K. P., Gonzalez, R., Feldstein Ewing, S. W., Nixon, S. J., . . . Heitzeg, M. (2018). Adolescent brain cognitive development (ABCD) study: Overview of substance use assessment methods. *Dev Cogn Neurosci, 32*, 80-96. http://doi.org/10.1016/j.dcn.2018.02.007

Lu, S., Xu, R., Cao, J., Yin, Y., Gao, W., Wang, D., . . . Xu, Y. (2019). The left dorsolateral prefrontal cortex volume is reduced in adults reporting childhood trauma independent of depression diagnosis. *J Psychiatr Res, 112*, 12-17. http://doi.org/10.1016/j.jpsychires.2019.02.014

Luciana, M., Bjork, J. M., Nagel, B. J., Barch, D. M., Gonzalez, R., Nixon, S. J., & Banich, M. T. (2018). Adolescent neurocognitive development and impacts of substance use: Overview of the adolescent brain cognitive development (ABCD) baseline neurocognition battery. *Dev Cogn Neurosci, 32*, 67-79. http://doi.org/10.1016/j.dcn.2018.02.006

Lynch, K. R., Anokye, N. K., Vlachopoulos, D., Barbieri, F. A., Turi-Lynch, B. C., Codogno, J. S., . . . Fernandes, R. A. (2019). Impact of sports participation on incidence of bone traumatic fractures and health-care costs among adolescents: ABCD - Growth Study. *Phys Sportsmed, 1-6*. http://doi.org/10.1080/00913847.2019.1685859

Marrus, N., Belden, A., Nishino, T., Handler, T., Ratnanather, J. T., Miller, M., . . . Botteron, K. (2015). Ventromedial prefrontal cortex thinning in preschool-onset depression. *J Affect Disord, 180*, 79-86. http://doi.org/10.1016/j.jad.2015.03.033

Masuda, K., Nakanishi, M., Okamoto, K., Kawashima, C., Oshita, H., Inoue, A., . . . Akiyoshi, J. (2017). Different functioning of prefrontal cortex predicts treatment response after a selective serotonin reuptake inhibitor treatment in patients with major depression. *J Affect Disord, 214*, 44-52. http://doi.org/10.1016/j.jad.2017.02.034
Michelini, G., Barch, D. M., Tian, Y., Watson, D., Klein, D. N., & Kotov, R. (2019). Delineating and validating higher-order dimensions of psychopathology in the Adolescent Brain Cognitive Development (ABCD) study. *Transl Psychiatry*, 9(1), 261. http://doi.org/10.1038/s41398-019-0593-4

Moazen-Zadeh, E., & Assari, S. (2016). Depressive Symptoms Predict Major Depressive Disorder after 15 Years among Whites but Not Blacks. *Front Public Health*, 4, 13. http://doi.org/10.3389/fpubh.2016.00013

Nashed, M. G., Seidlitz, E. P., Frey, B. N., & Singh, G. (2015). Depressive-like behaviours and decreased dendritic branching in the medial prefrontal cortex of mice with tumors: A novel validated model of cancer-induced depression. *Behav Brain Res*, 294, 25-35. http://doi.org/10.1016/j.bbr.2015.07.040

Nestor, B. A., Cheek, S. M., & Liu, R. T. (2016). Ethnic and racial differences in mental health service utilization for suicidal ideation and behavior in a nationally representative sample of adolescents. *J Affect Disord*, 202, 197-202. http://doi.org/10.1016/j.jad.2016.05.021

Orvaschel, H., Puig-Antich, J., Chambers, W., Tabrizi, M. A., & Johnson, R. (1982). Retrospective assessment of prepubertal major depression with the Kiddie-SADS-E. *Journal of the American Academy of Child Psychiatry*, 21(4), 392-397.

Puig-Antich, J., & Chambers, W. (1978). *The schedule for affective disorders and schizophrenia for school-age children (Kiddie-SADS)*. New York: New York State Psychiatric Institute.

Rhoades, B. L., Greenberg, M. T., Lanza, S. T., & Blair, C. (2011). Demographic and familial predictors of early executive function development: Contribution of a person-centered perspective. *Journal of experimental child psychology*, 108(3), 638-662.

Taki, Y., Kinomura, S., Awata, S., Inoue, K., Sato, K., Ito, H., . . . Fukuda, H. (2005). Male elderly subthreshold depression patients have smaller volume of medial part of prefrontal cortex and precentral gyrus compared with age-matched normal subjects: a voxel-based morphometry. *J Affect Disord*, 88(3), 313-320. http://doi.org/10.1016/j.jad.2005.08.003

Townsend, L., Kobak, K., Kearney, C., Milham, M., Andreotti, C., Escalera, J., . . . Kaufman, J. (2020). Development of Three Web-Based Computerized Versions of the Kiddie Schedule for Affective Disorders and Schizophrenia Child Psychiatric Diagnostic Interview: Preliminary Validity Data. *J Am Acad Child Adolesc Psychiatry*, 59(2), 309-325. http://doi.org/10.1016/j.jaac.2019.05.009

Treadway, M. T., Waskom, M. L., Dillon, D. G., Holmes, A. J., Park, M. T. M., Chakravarty, M. M., . . . Pizzagalli, D. A. (2015). Illness progression, recent stress, and morphometry of hippocampal subfields and medial prefrontal cortex in major depression. *Biol Psychiatry*, 77(3), 285-294. http://doi.org/10.1016/j.biopsych.2014.06.018

Vargas, T., Damme, K. S. F., & Mittal, V. A. (2020). Neighborhood deprivation, prefrontal morphology and neurocognition in late childhood to early adolescence. *Neuroimage*, 220, 117086. http://doi.org/10.1016/j.neuroimage.2020.117086
Ward, E., & Mengesha, M. (2013). Depression in African American men: A review of what we know and where we need to go from here. *Am J Orthopsychiatry, 83*(2 Pt 3), 386-397. http://doi.org/10.1111/ajop.12015

Watkins, D. C., Abelson, J. M., & Jefferson, S. O. (2013). “Their depression is something different . . . it would have to be”: Findings from a qualitative study of black women’s perceptions of depression in black men. *Am J Mens Health, 7*(4 Suppl), 45S-57S. http://doi.org/10.1177/1557988313493697

Watkins, D. C., Assari, S., & Johnson-Lawrence, V. (2015). Race and Ethnic Group Differences in Comorbid Major Depressive Disorder, Generalized Anxiety Disorder, and Chronic Medical Conditions. *J Racial Ethn Health Disparities, 2*(3), 385-394. http://doi.org/10.1007/s40615-015-0085-z

Werneck, A. O., Agostinete, R. R., Cayres, S. U., Urban, J. B., Wigna, A., Chagas, L. G. M., . . . Fernandes, R. A. (2018). Association between Cluster of Lifestyle Behaviors and HOMA-IR among Adolescents: ABCD Growth Study. *Medicina (Kaunas), 54*(6). http://doi.org/10.3390/medicina54060096

Williams, D. R., Gonzalez, H. M., Neighbors, H., Nesse, R., Abelson, J. M., Sweetman, J., & Jackson, J. S. (2007). Prevalence and distribution of major depressive disorder in African Americans, Caribbean blacks, and non-Hispanic whites: Results from the National Survey of American Life. *Arch Gen Psychiatry, 64*(3), 305-315. http://doi.org/10.1001/archpsyc.64.3.305

Zhang, A., Yang, C., Li, G., Wang, Y., Liu, P., Liu, Z., . . . Zhang, K. (2020). Functional connectivity of the prefrontal cortex and amygdala is related to depression status in major depressive disorder. *J Affect Disord, 274*, 897-902. http://doi.org/10.1016/j.jad.2020.05.053

**Appendix 1. Model Formula**

**Model 1**

\[
\text{smri\_vol\_cort.desikan\_frontalpole.lh} \sim \text{ksads\_1\_1\_t} + \text{age} + \text{sex} + \text{high.educ.bl} + \text{household.income.bl} + \text{race.4level} + \text{married.bl} + \text{hisp} \\
\text{Random: } \sim (1|\text{rel\_family\_id})
\]

**Model 2**

\[
\text{smri\_vol\_cort.desikan\_frontalpole.lh} \sim \text{ksads\_1\_1\_t} + \text{age} + \text{sex} + \text{high.educ.bl} + \text{household.income.bl} + \text{race.4level} + \text{married.bl} + \text{hisp} + \text{ksads\_1\_1\_t} * \text{race.4level} \\
\text{Random: } \sim (1|\text{rel\_family\_id})
\]
Appendix 2. Distribution of the Predictor (a), Outcome (b), Residuals (c) and Quantiles (d)