# Remote digital measurement of visual and auditory markers of Major Depressive Disorder severity and treatment response

## SUBMISSION DETAILS

**What is the Methodological Question Being Addressed?** Can remotely collected digital markers of central nervous system functioning measure disease severity and treatment response in patients with Major Depressive Disorder receiving antidepressant therapy?

**Introduction** Individuals with Major Depressive Disorder (MDD) exhibit distinct observable characteristics indicative of MDD symptom severity. These observable characteristics have traditionally been quantified using paper-based clinical assessments such as the Montgomery-Åsberg Depression Rating Scale (MADRS). Traditional clinical scales pose several key problems in clinical research: They can be (a) burdensome for both patients and clinicians, (b) subjective to clinician observation, and (c) insensitive to change, particularly when specific symptoms are affected in response to treatment rather than the heterogeneous symptomatology of a disease. Digital measurement of MDD symptomatology poses potential solutions to each of these challenges. Here, we evaluate the ability of remotely collected visual and auditory markers of MDD to measure symptom severity and treatment response in patients on approved antidepressants.

**Methods** Individuals with MDD (n = 18) being placed on an SSRI/SNRI treatment were enrolled as study participants. All participants were assessed by a trained clinician for MDD symptom severity using the MADRS during the first, third, and fifth weeks of treatment. Concurrently, all participants used the smartphone-based remote measurement of visual and auditory digital markers of MDD symptom severity including facial expressivity, characteristics of speech, and patterns of movement. Digital markers were averaged for the first, third, and fifth weeks of treatment to align with MADRS timepoints. Both the MADRS and digital markers were used to independently assess treatment response using a repeated measures analysis of variance (ANOVA). The ability of each measure to quantify treatment response was compared.

**Results** Participants demonstrated a significant reduction in MDD severity as measured by the MADRS from week 1 to week 5 [$F(2,34) = 50.52$, $p < .0001$], indicating a positive response to treatment based on a traditionally used primary clinical endpoint. Improvement in MDD symptomatology was also observed using digital markers of MDD as would be hypothesized based on previously reported findings. This included a significant increase in overall facial expressivity [$F(2,34) = 32.6$, $p < .0001$], decrease in the length of pauses between words during speech [$F(2,34) = 4.66$, $p < 0.05$], increase in the amount of overall head movement [$F(2,34) = 0.27$, $p < 0.01$], and improved upward-facing head posture [$F(2,34) = 0.47$, $p < 0.05$] from week 1 to week 5.

**Conclusion** Here, we demonstrate that remotely collected digital markers of central nervous system functioning are able to quantify disease severity and treatment response in the context of Major Depressive Disorder and that such measurements can be at least as robust as traditional clinical endpoints. Use of such measures alongside traditional endpoints in clinical research would allow for scalable, objective, and sensitive measurement of disease severity in response to

treatment.

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## Keywords

| Keywords |
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| Digital Biomarkers |
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**Disclosures if applicable** AA, IGL, and VY are employees of AiCure
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