# Technology and the Future of Digital Tools in Mental Health


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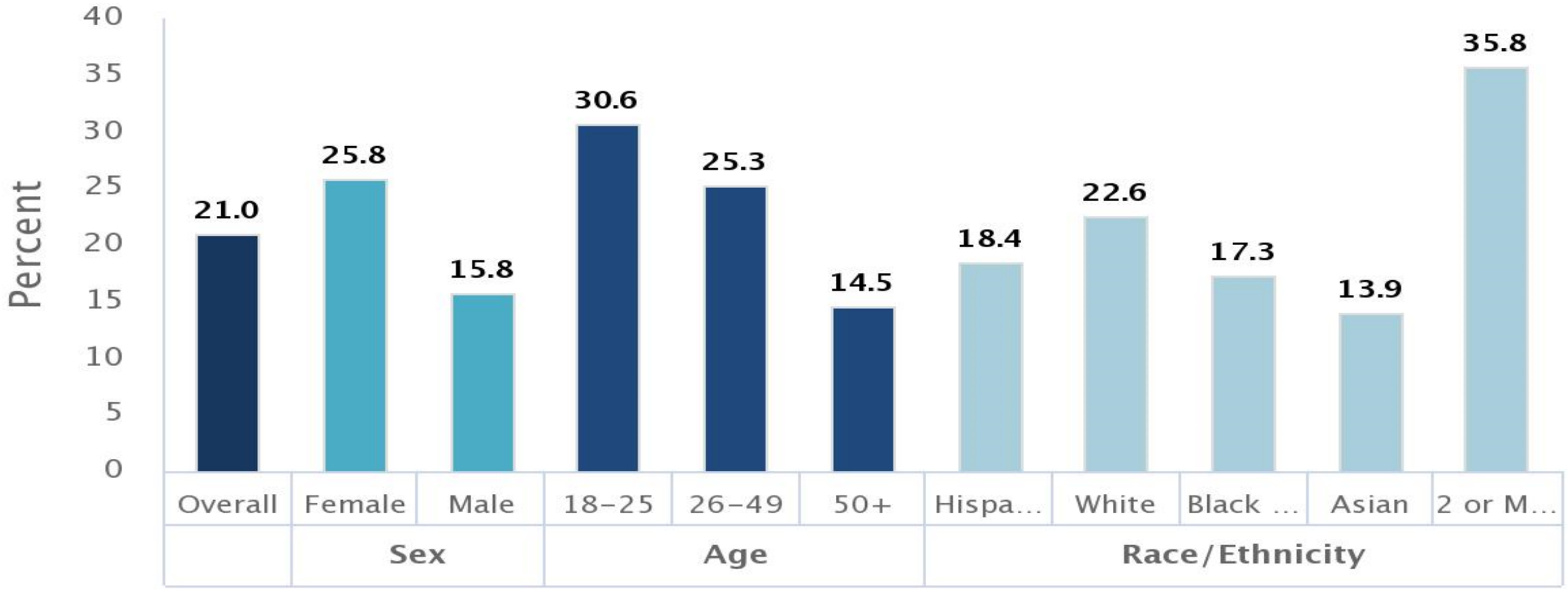
# Past Year Prevalence of Any Mental Illness Among U.S. Adults (2020)

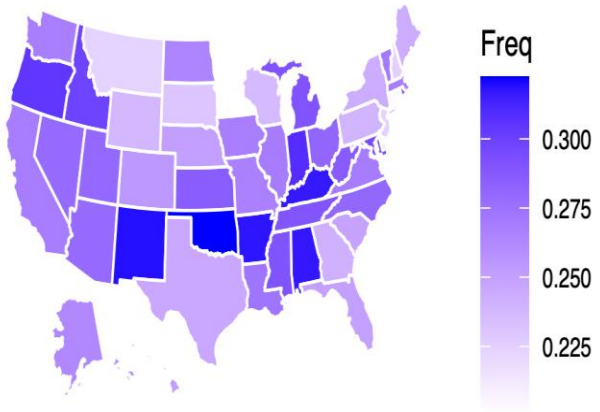
Data Courtesy of SAMHSA



# COVID-19 IMPACT ON MENTAL HEALTH: A Tripling of the Rates of Depression Perlis et al, Depression and Anxiety, 2021

https://www.covidstates.org/reports/mental-health-in-the-united-states

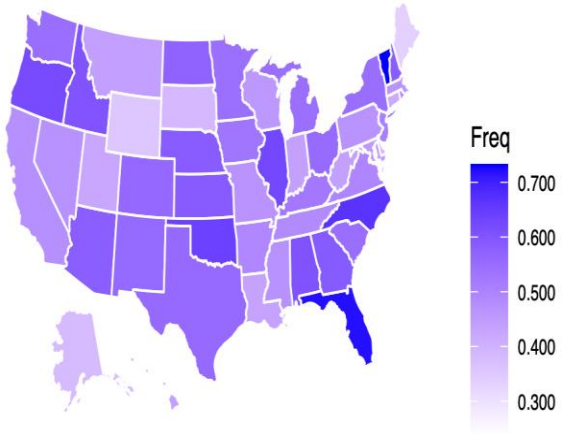
## Proportion of US adults with moderate or greater depressive symptoms, March 2022




N=22,234 US adults, surveyed March 2022 – covidstates.org

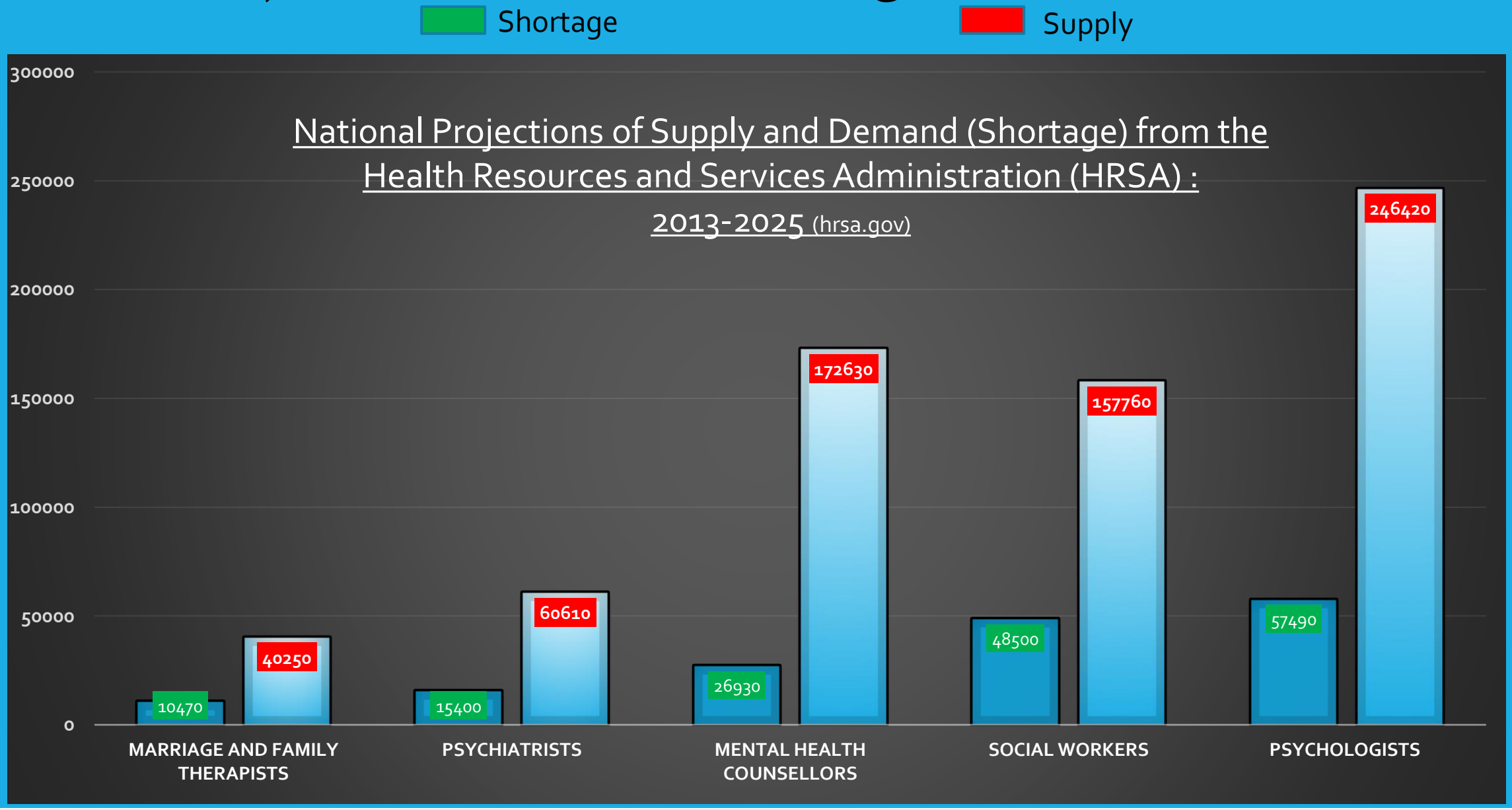


## Proportion of US adults age 18-24 with moderate or greater depressive symptoms, March 2022

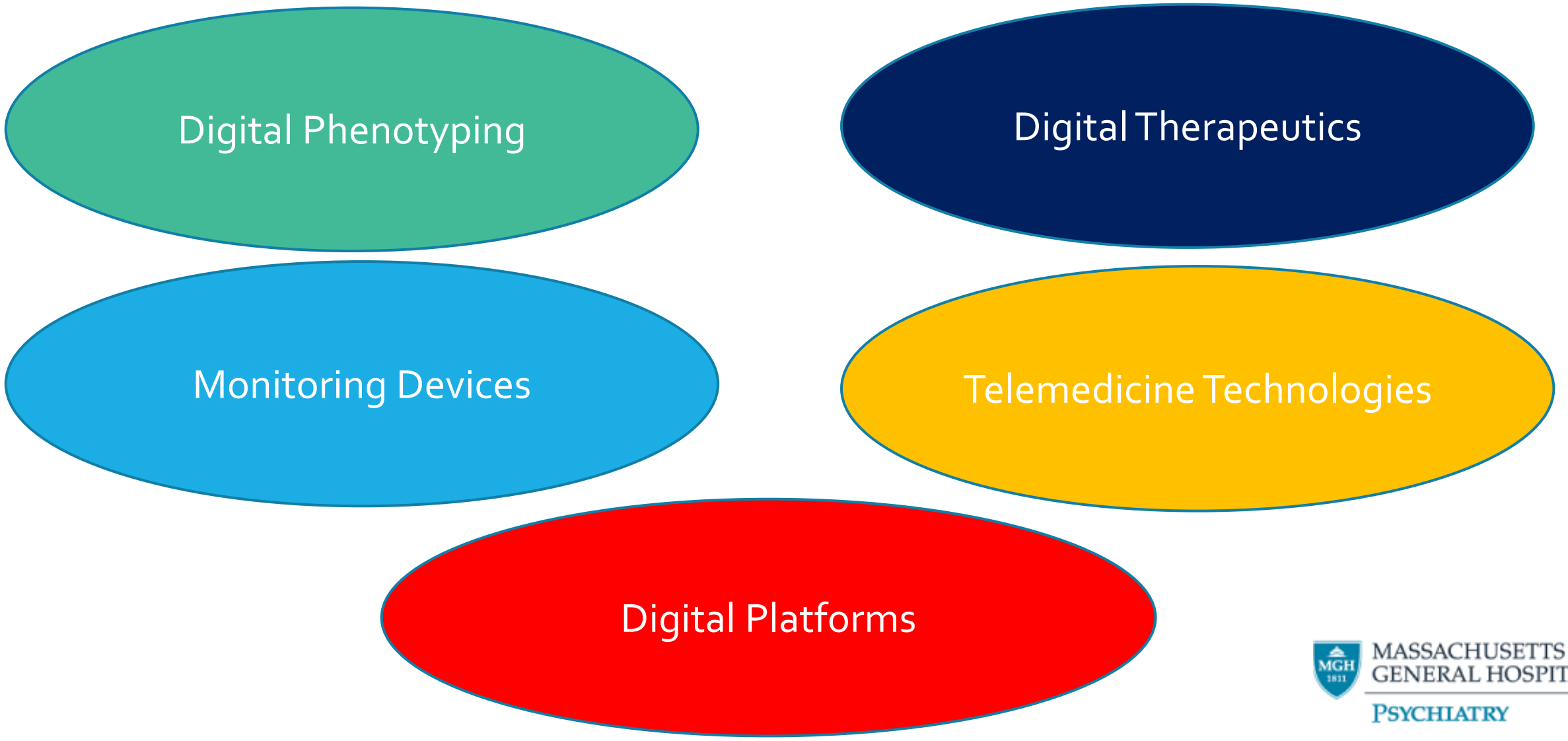



N=2,771 US adults age 18-24, surveyed March 2022 – covidstates.org

# Projected Provider Shortage in the US



# The Use of Digital Tools in Psychiatry

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# Why Digital Phenotyping is Important?

- Current nosology has limitations
- Heterogeneity of psychiatric illnesses
- Relative imprecision of our current diagnostic measures
- Leveraging advances in the neuroscience of psychiatric illnesses
- Digital technologies have dramatically evolved in the past few years

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# Digital Phenotyping of Depression

**Phone interactions**
Open apps
Phone on/off
Calls
Texting
Microphone

**Motion Sensing**
Accelerometer
Gyroscope
Actigraphy
GPS
Wi-Fi
Ambient sensor

**Physiology**
EDA
HRV
Temperature

frontiers in Psychiatry

ORIGINAL RESEARCH
published: 18 December 2020
doi: 10.3389/fpsyt.2020.584711

## Monitoring Changes in Depression Severity Using Wearable and Mobile Sensors

*Paola Pedrelli[1*†], Szymon Fedor[2†], Asma Ghandeharioun[2], Esther Howe[3], Dawn F. Ionescu[4], Darian Bhathena[2], Lauren B. Fisher[1], Cristina Cusin[1], Maren Nyer[1], Albert Yeung[1], Lisa Sangermano[1], David Mischoulon[1], Johnathan E. Alpert[5] and Rosalind W. Picard[2]*

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REVIEW ARTICLE | WEARABLE DIGITAL HEALTH TECHNOLOGIES IN MEDICINE

## Wearable Technology in Clinical Practice for Depressive Disorder

**Authors**: Szymon Fedor, Ph.D., Robert Lewis, M.Sc., Paola Pedrelli, Ph.D., David Mischoulon, M.D., Ph.D., Joshua Curtiss, Ph.D., and Rosalind W. Picard, Sc.D. Author Info & Affiliations

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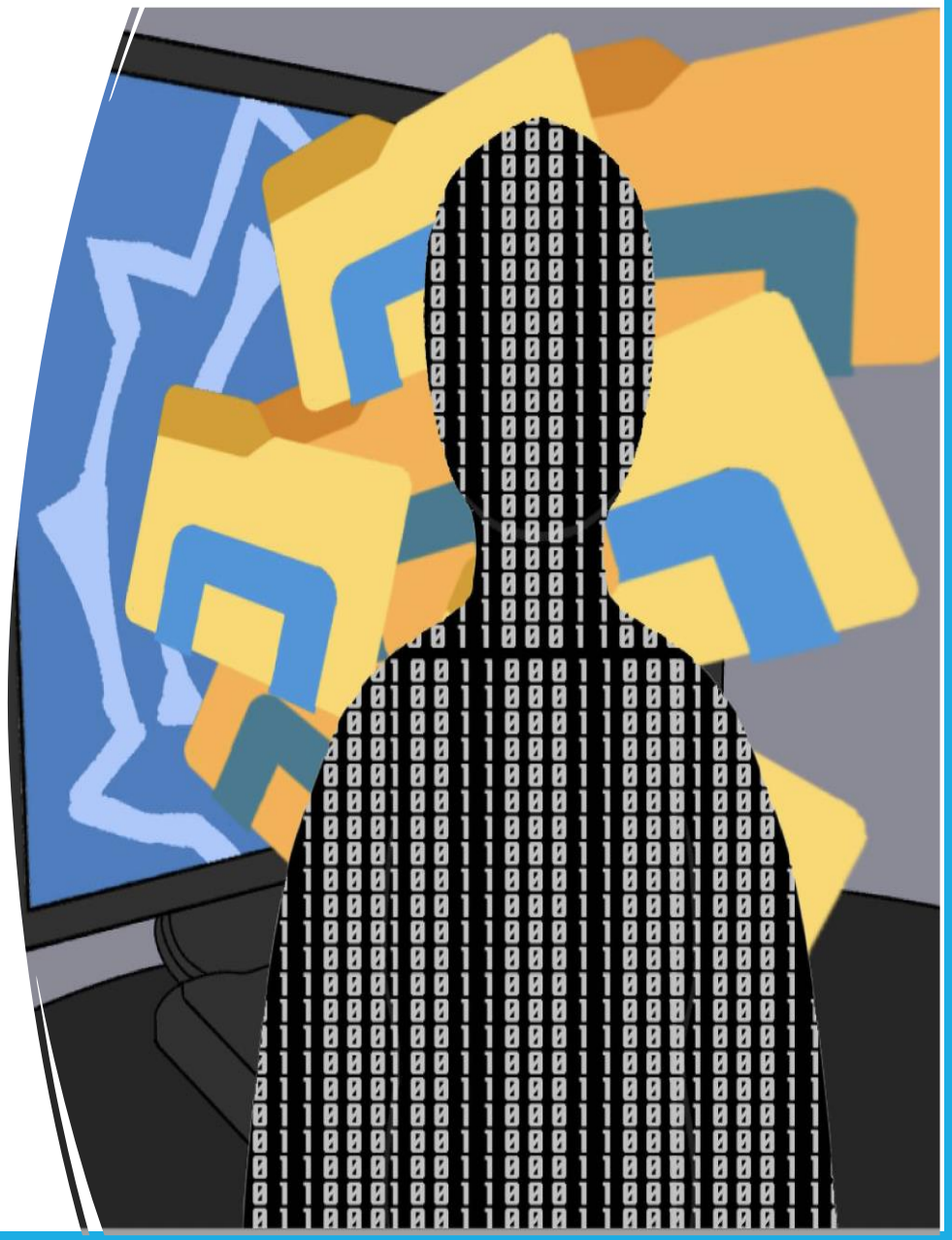
# Grand Challenge study

- 31 adults with MDD monitored for 8 weeks yielding 1643 days of data.
- The best AI model had an NMAE=.06 for predicting HDRS-17
- The mixed effects models outperform the baseline models
- Correlation with the Hamilton Depression Rating Scale r=0.83

# Sensors-Based Characterization Of Depression (SENSCODE)

- ~5000 days of well-characterized data on speech, physiology, activity aligned with PHQ9 data, in the context of well-characterized patients with 950 weekly clinician-provided assessments
- Used more advanced models mixed-effects machine learning methods (MELM and MERF)
- The mixed effects models outperform the traditional LM and RF in the personalized scenarios that included their own patients' data.
- They did not see a significant improvement in performance with the mixed effects machine learning (ML) models over the personalized patient baselines in the model that examined training data from one set of patients generalizing to a different set of patients,



# Designing the standard for AI research: What are the better/most parsimonious models?

## Features Ranking

- AI models identified 73 features as the most important for the estimation of depression severity
- Features processed from EDA, HR/HRV, motion, and location signals were identified as the most important for the estimation of the depression
- Found a significant association between the circadian rhythm of EDA and the severity of depression.  A similar association was found for the circadian rhythm of HR.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# Why Digital Monitoring is Important?

- Source of feedback to patients
- Provides critical information to clinicians
- Measurement-based care enhances outcome
- Digital technologies have dramatically evolved in the past few years

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# A Randomized Evaluation of MoodFX, a Patient-Centered e-Health Tool to Support Outcome Measurement for Depression

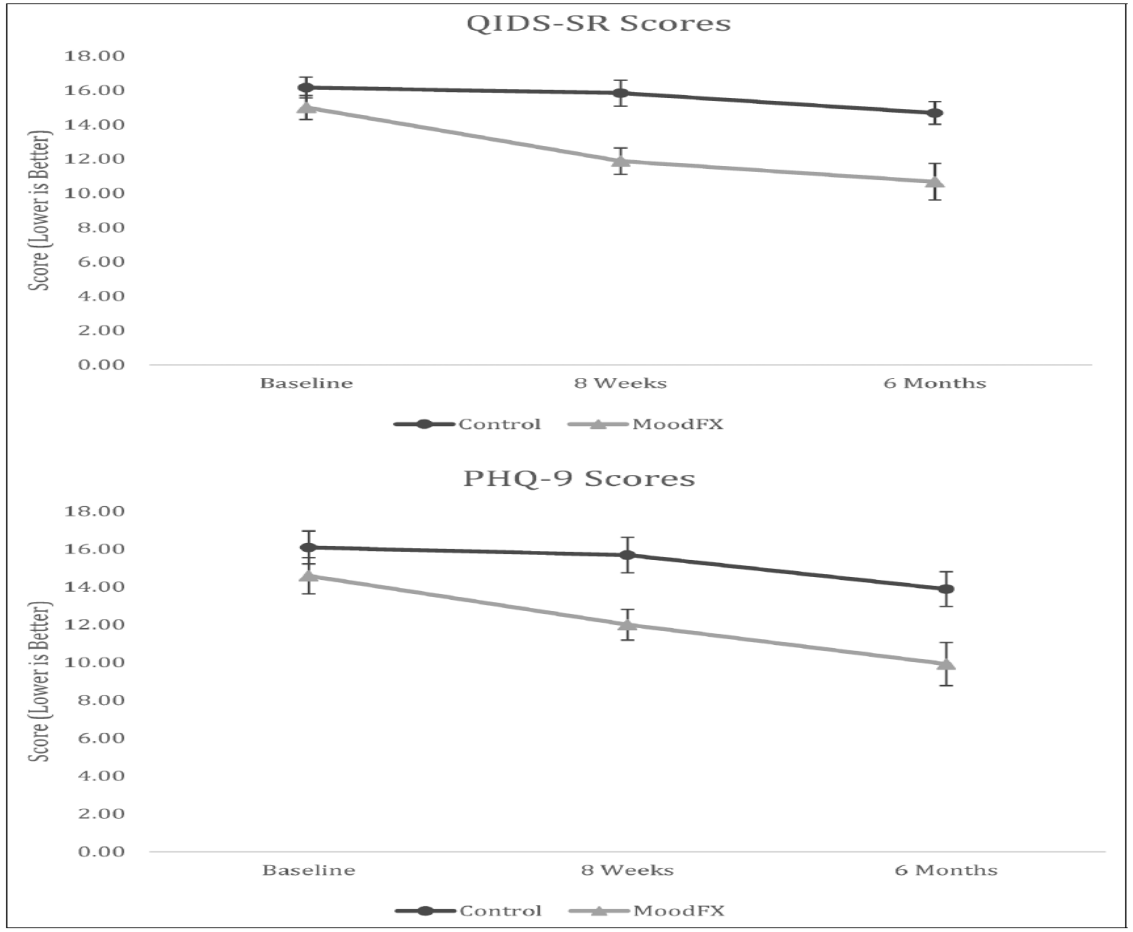


**Figure 2.** Mean QIDS-SR and PHQ-9 scores over time between control and MoodFX conditions. Error bars = SEM. Control n = 25. MoodFX n = 24. PHQ-9=Perceived Deficits Questionnaire, 9-item; QIDS-SR, Quick Inventory of Depressive Symptomatology, Self-Rated; SEM=standard error of the mean.

Li et al, Canadian J Psychiatry 2024, Vol. 69(7) 493-502

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# Why Using Digital Platforms in Practice?

- Addressing burn-out among clinicians
- Need to increase the efficiency of clinical encounters
- Not enough time to carefully assess patients
- Need for educating patients in a user-friendly way
- Providing access to useful apps

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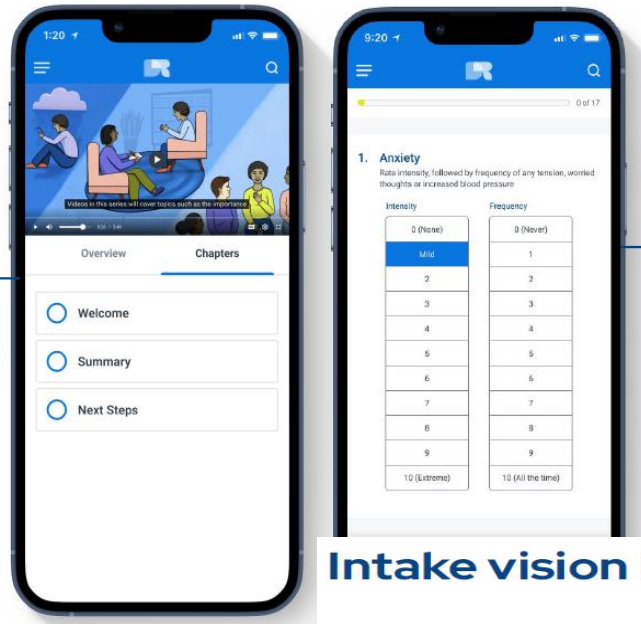
# The app motivates patients to stay engaged with care.

Assign informational videos and exercises to patients and review feedback.

System uses AI to personalize the patient experience.




Measure symptoms of mental health conditions with increased efficiency.

System uses AI to improve diagnosis precision and treatment plan.

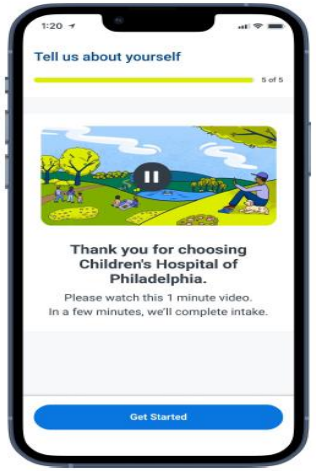
## Personalized Support

- Self-report symptoms and better understand diagnosis
- Get more help from therapy skills videos and worksheets
- Receive appointment reminders

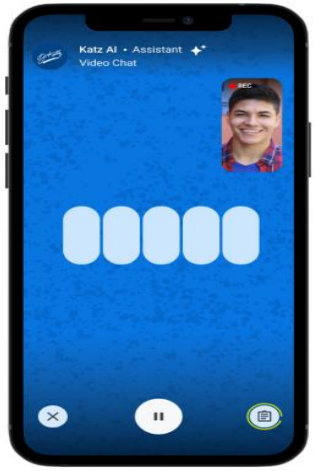
## Measurable Impact

- Monitor patient-reported outcomes with precision
- Increase Collaborative Care (CoCM)
- Tailor patient and family communications

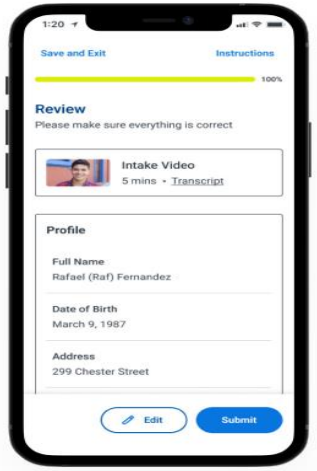
## Intake vision harnesses the power of video and AI.




Intake is a **conversation** – a more welcoming step in the patient journey




An **intelligent** experience using your camera and voice to better understand how you're doing




**Accessible** to all, it makes organizing information a breeze

# Why Using Digital Therapeutics in Practice?

- Addressing the access problem in mental health
  - Shortage of therapists
  - Shortage of psychiatrists
- Improving efficiency in therapy encounters
- Highly scalable interventions
- Leveraging advances in the neuroscience of psychiatric illnesses
- Digital technologies have dramatically evolved in the past few years

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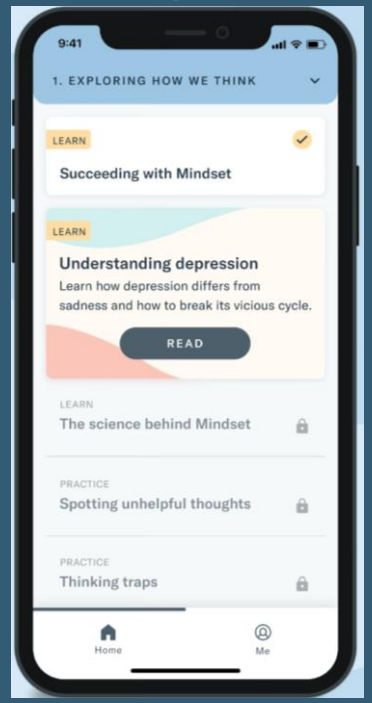
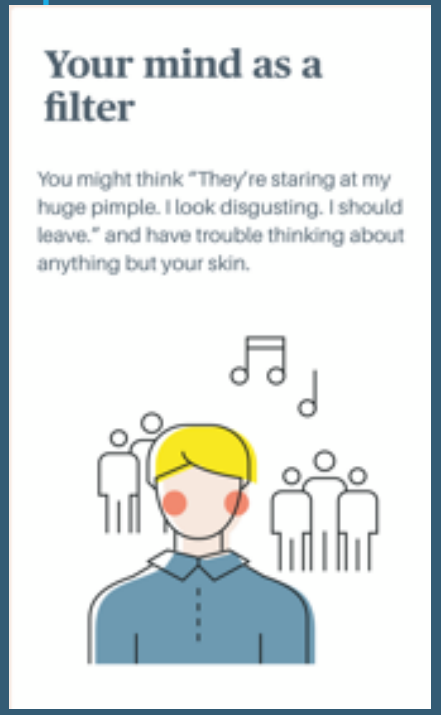
# Evidence-Based Smartphone Apps

## Cognitive Behavioral Therapy (CBT) apps co-developed by MGH, industry partners, and patients

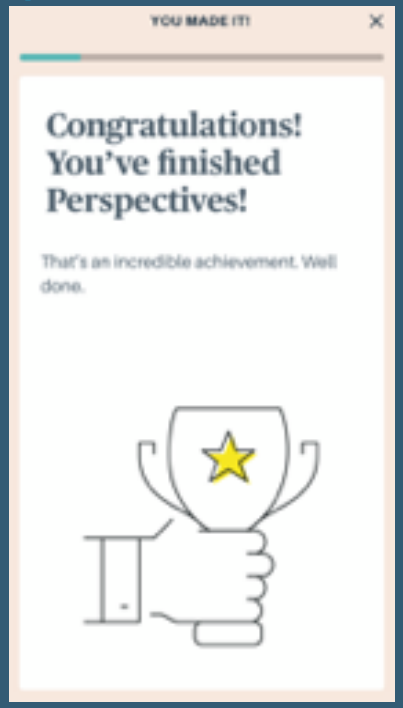
- Mindset Depression




- Perspectives BDD




- Perspectives OCD

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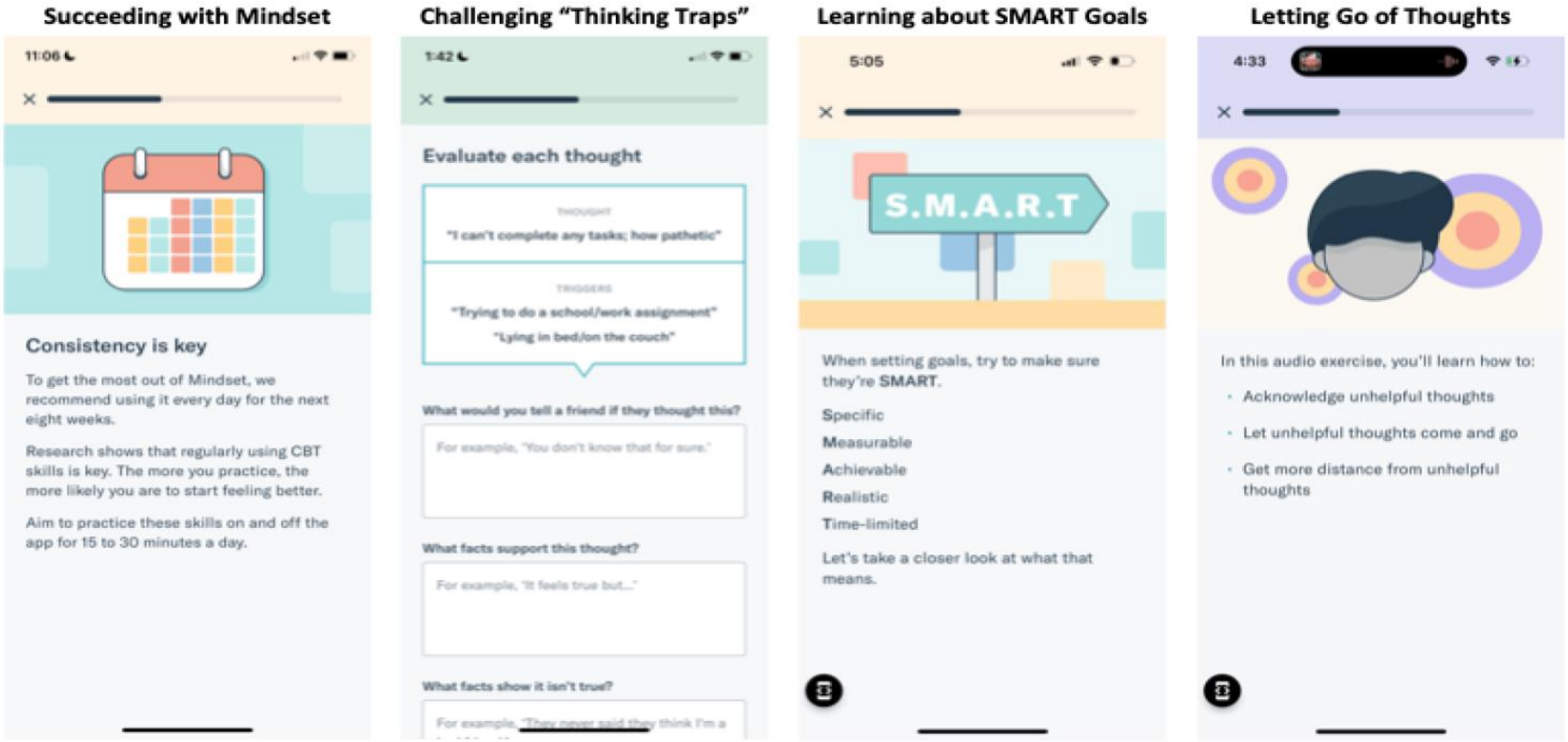
# MINDSET

**Figure 1.** Screenshots from the Mindset for Depression smartphone app. CBT: cognitive behavioral therapy; SMART: specific, measurable, achievable, relevant, and time-bound.



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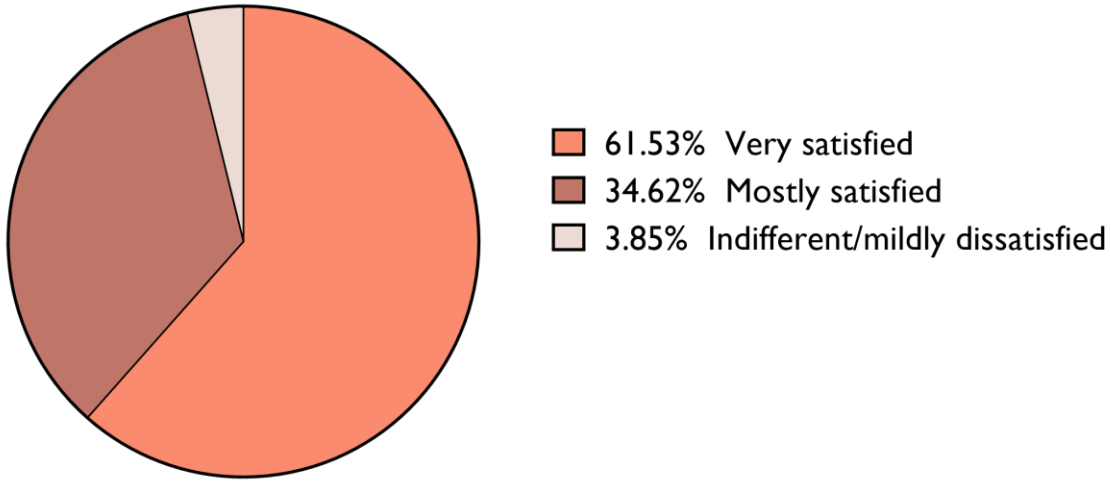
# Mindset Treatment for Depression

- **Clinical Trial**
- 8 weeks of app-based treatment plus brief weekly **virtual sessions** with a **therapist**
- 28 adults with depression, recruited in MA

- **Feasibility and Adherence**
- Low dropout (7%)
- High adherence (completed median of 7 out of 8 modules [IQR 6, 8])

- **Therapist Time**
- 24.5 (1.1) min per session

- **Acceptability**




**100%** would recommend our program to a friend with similar problems

Source: Wilhelm S et al., in press

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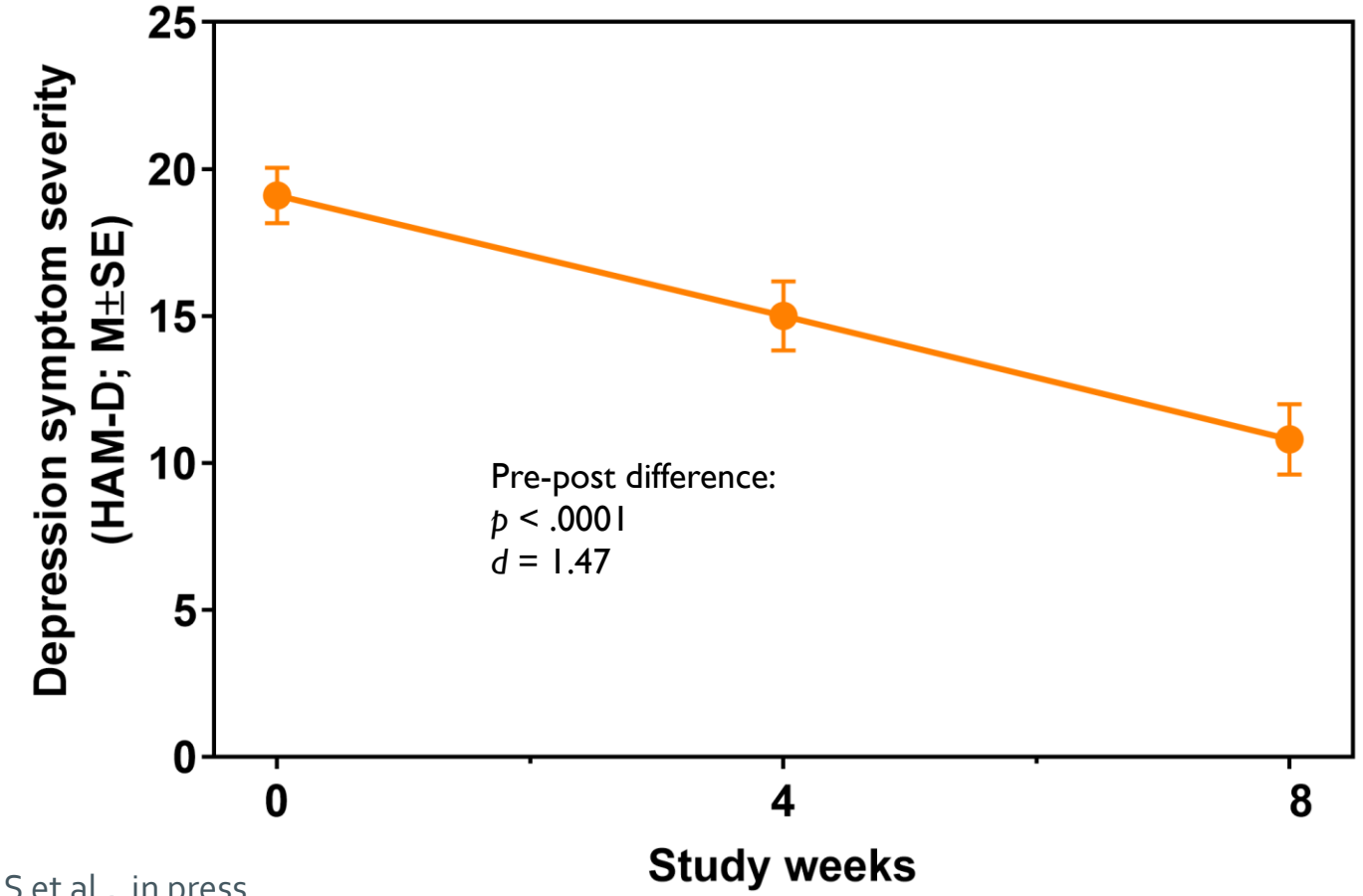
# Depression Severity Changes with the App

## Clinician-Rated




Source: Wilhelm S et al., in press

# Perspectives Treatment for BDD

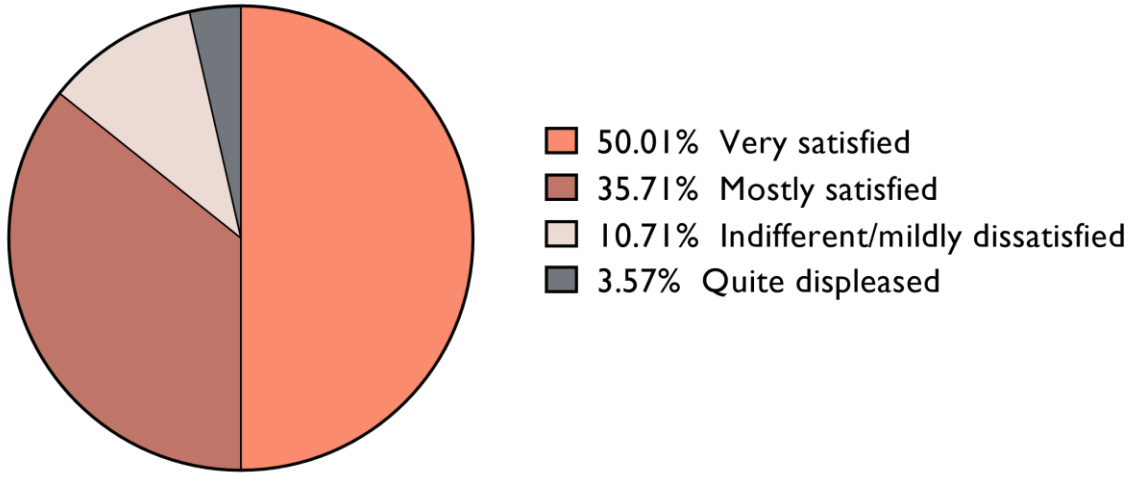
- **Efficacy Trial**
- 12-week randomized controlled trial, app vs. waitlist condition
- **BA-level coaches, asynchronous chat**
- 80 adults with primary BDD, recruited nationally

**Study Dropout**

- 23% (9/40) app and coach, 8% (3/40) waitlist

- **Coaching Time**
- 26.9 min (SD=10.9) on phone per participant across 2.1 (SD=0.8) calls
- 1.5 minutes (SD=1.3) per participant per week via chat

- **Acceptability**




- **89%** would recommend our program
  - to a friend with similar problems.

Wilhelm et al, Psychother Psychosom 2022;91:277–285

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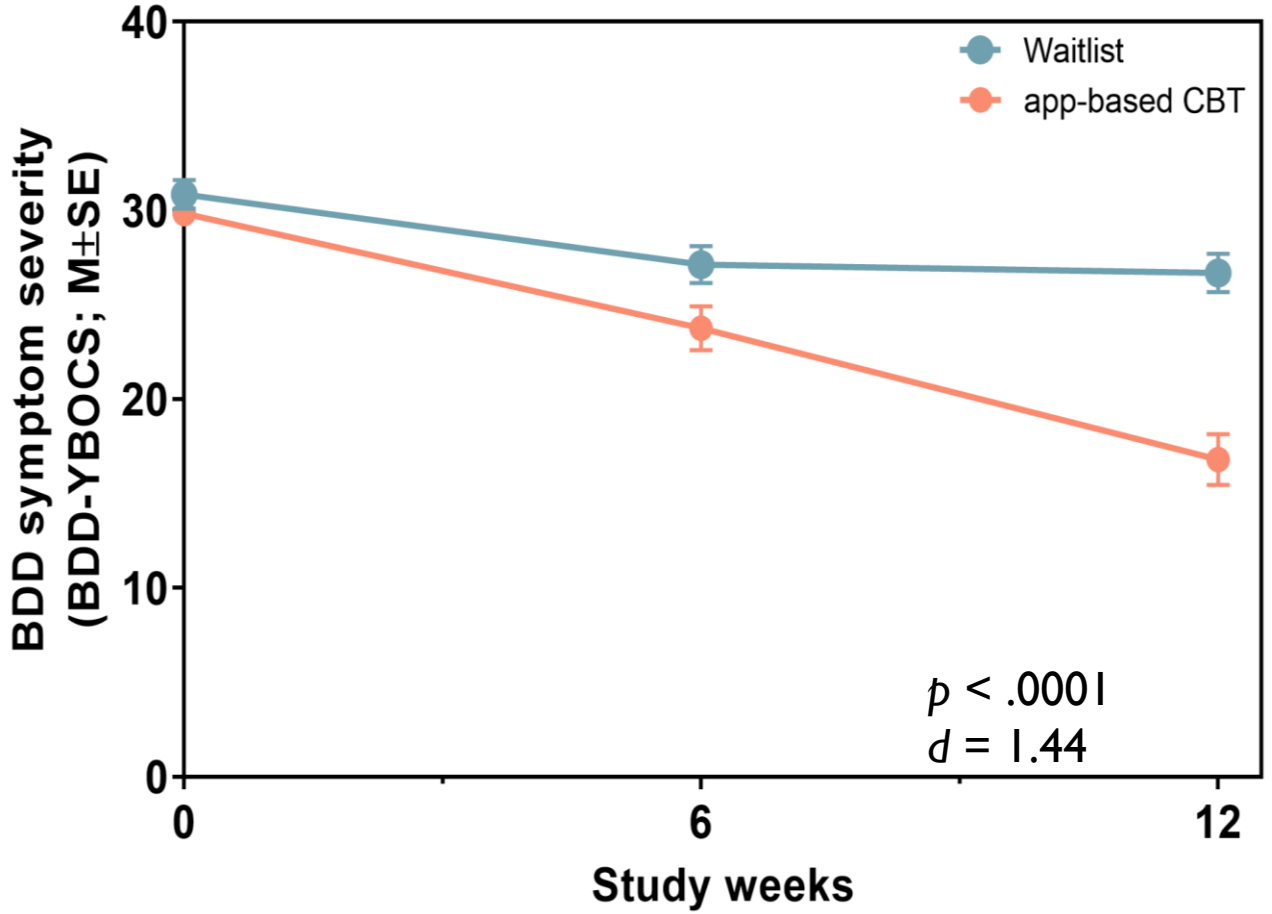
# BDD Symptom Severity




Wilhelm et al, Psychother Psychosom 2022;91:277–285

# SURVEY OF THE USE OF INTHEROOMS.COM (ITR), A LARGE, WELL-KNOWN RECOVERY SOCIAL NETWORK SITE (SNS) AVAILABLE FOR FREE 24 HR/DAY VIA WEBSITE AND MOBILE SMARTPHONE APPLICATIONS



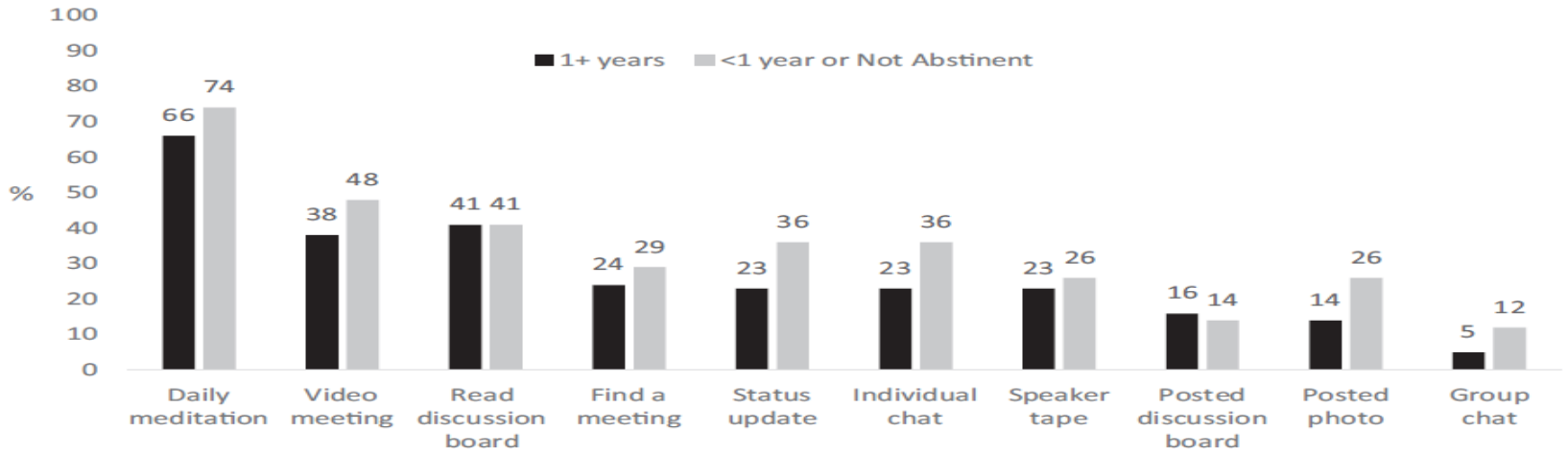



*Figure 1.* Proportion of individuals engaging in each InTheRooms.com (ITR) activity during the past 90 days for those abstinent for 1 or more years (black; 1+; $n = 80$) and abstinent for less than 1 year or not abstinent (gray; <1; $n = 42$). *Find a meeting* refers to utilization of ITR's dynamic database of face-to-face 12-step mutual help organization meetings. There were no significant differences between 1+ and <1 participants on past-90-day ITR activity engagement.

Bergman et al, Psychology of Addictive Behaviors 2017, Vol. 31, No. 4, 506–512

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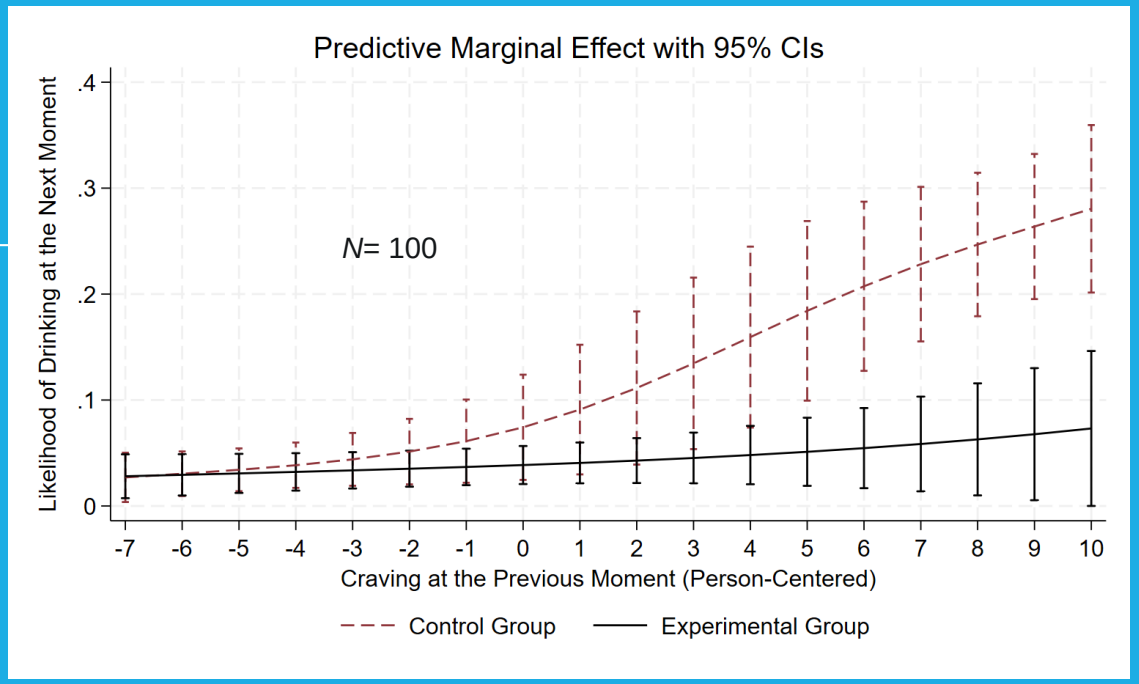
Lief Therapeutics

# Phase II RCT of Heart Rate Variability Biofeedback for substance use disorder

R21DA056468; PI: David Eddie

- Heart Rate Variability Biofeedback with 2nd gen., wearable Lief device disaggregates relationship between craving and subsequent alcohol use in individuals in early addiction recovery

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Founding Member, Mass General Brigham
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NIH National Institute on Drug Abuse

# Why Adapting Telemedicine Technologies?

- Convenience (for patients) of televisits
- Addressing access problem in mental health
- 80% of outpatient visits at MGH are virtual
- Opportunities for anonymity by leveraging virtual reality technologies

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# Multi-User Virtual Reality (VR) Resilience Training

The Resilience and Prevention Program
Mass General Hospital

- Consists of six 1-hour sessions in immersive, multi-user VR

  1) Delivers Resilience Training in a group setting

  2) Exposes participants to being “near” others in a safe, virtual environment

- Participants experience “social presence” - the feeling of being present (“in the room”) with others
- Provides **anonymity** (avoids mental health stigma)
- Increases **engagement**
- Increases **access**

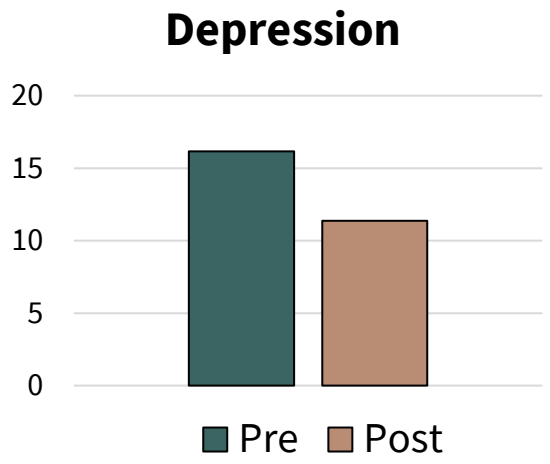
Holt, DeTore et al., under review
https://www.researchsquare.com/article/rs-4707220/v1

# Initial Results with VR-based Resilience Training

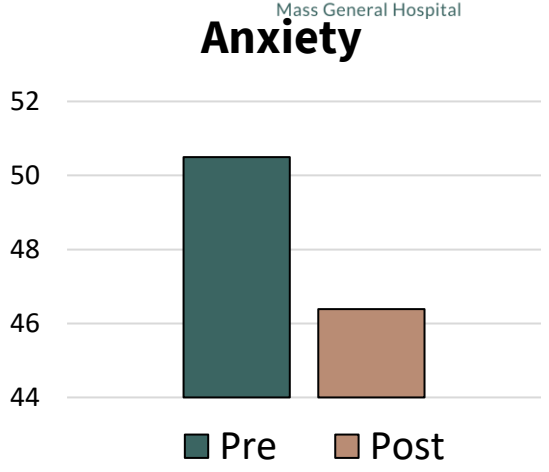
The Resilience and Prevention Program
Mass General Hospital

- Piloted Resilience Training in VR in 44 participants thus far
- Majority of participants reported that the **anonymity was important** to them, helped them participate more
- Found significant **decreases in depression and anxiety**
- And significant **improvements in resilience and self-efficacy**

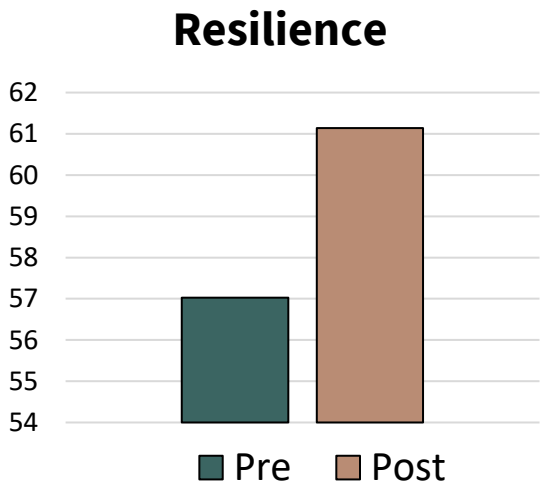
RAPP team, in preparation



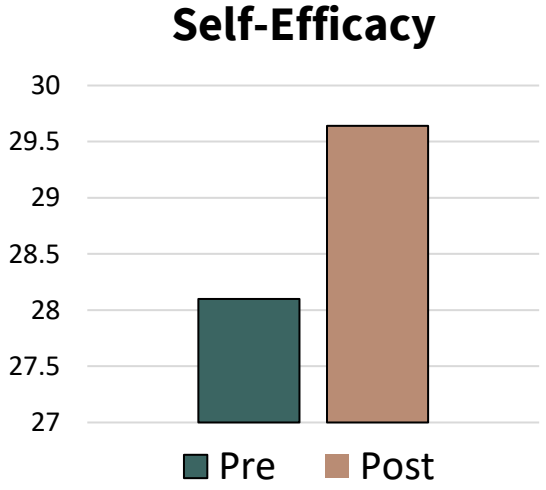

t = 4.81, p < .001




t = 2.48, p = .027




t = -1.77, p = .027




t = -2.00, p = .028

# CONCLUSION

MASSACHUSETTS GENERAL HOSPITAL
PSYCHIATRY