Leveraging Digital Health Technologies for Advancing Behavioral and Lifestyle Medicine

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Lifestyle interventions work

Lifestyle interventions are effective for preventing chronic disease and extending life

Diet + physical activity can reduce incidence of diabetes by nearly 60%

However, lifestyle programs are typically resource intensive

Require multiple visits to multiple providers (dieticians, psychologists, exercise physiologists)

Difficult to implement large scale approaches to lifestyle interventions

Digital health technologies can be part of the solution

Personal technologies (i.e., smartphones) are now ubiquitous

91% of American own a smartphone
96% use the internet
59% own a wearable

Technology use is high among all population subgroups

African American and Hispanic American have a higher rates of smartphone and smartwatch adoption than White Americans

Older adults, low income and low education adults are adopting technology at the fastest rates

Digital health technologies offer the potential to facilitate provision of complex intensive lifestyle interventions

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Roybal Center

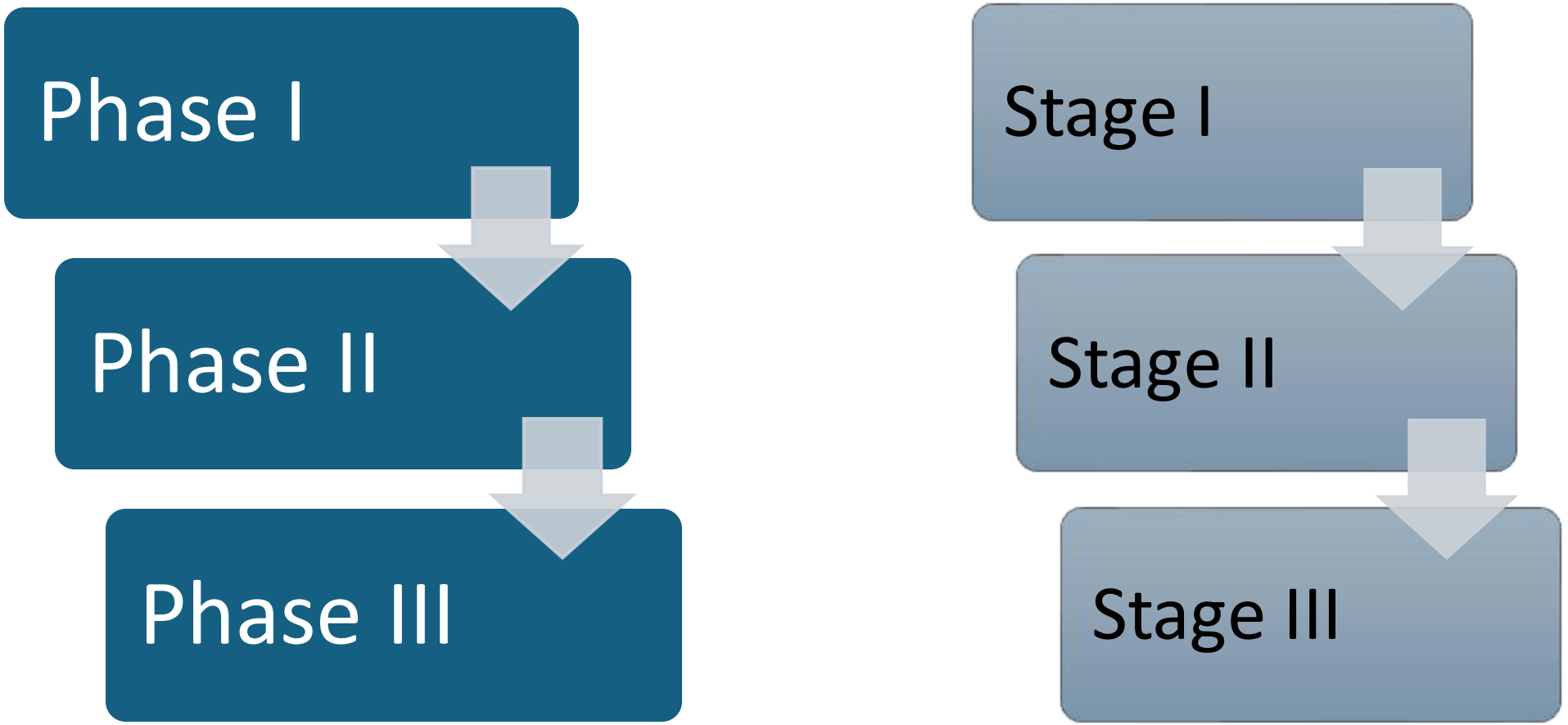
The NIH Stage Model for Advancing Digital Behavioral Intervention Research

Application in ASU Roybal Center's Conceptual Framework

The NIH Stage Model

> … a conceptual framework that supports the development of **maximally potent, maximally implementable behavioral interventions** to achieve meaningful improvements in health and well-being

Historical Context: NIDA Stage Model



Implementation Cliff

The NIH Stage Model

BASIC RESEARCH

STAGE 0

INTERVENTION GENERATION/
REFINEMENT

STAGE I

EFFICACY TESTING
RESEARCH SETTING & PROVIDER

STAGE II

EFFICACY TESTING
COMMUNITY SETTING & PROVIDER

STAGE III

EFECTIVENESS

STAGE IV

IMPLEMENTATION & DISSEMINATION

STAGE V

Principle-Driven Interventions

STAGE 0

Use-inspired

STAGE 0

Mechanisms

Intervention

Aerobic Exercise

<u>Molecular</u>
Brain-derived Neurotrophic Factors

<u>Pathologic</u>
β-amyloid plagues
Tau tangles

<u>Physiologic</u>
Brain Structure & Function

Proximal Outcomes

Cognition

STAGE I

Stage IA

- Develop
- Modify
- Adapt
- Refine

Stage IB

- Feasibility testing
- Pilot testing

FIT-AD Trial

An exercise study for people with Alzheimer's Disease

STAGE I

STAGE I

FIT-AD Trial

An exercise study for people with Alzheimer's Disease

Pilot	N	Sample	Min a session	Months	Funding
1	2	75 y.o. men: MMSE 17; 86 y.o. woman: MMSE 26	10–30	2	American Nurses Foundation
2	4	61–82 y.o.; MMSE 2-12; 100% male	10–30	2	NIH K12 Award
3	11	81.5±3.5 y.o.; MMSE 21.0±4.5; 72.8% female	10–45	6	NIH K12 Award
4	28	78.1±8.4 y.o.; MMSE 19.9±4.0; 64.3% female	15–45	6	BrightFocus Foundation®

Prescribe Moderate Intensity

Pilot 1

Age-Predicted Maximal Heart Rate

Pilot 3

Pilot 2

Heart Rate Reserve

Pilot 4

Efficacy

RESEARCH SETTING

RESEARCH THERAPISTS/PROVIDERS

STAGE II

COMMUNITY SETTING

COMMUNITY THERAPISTS/PROVIDERS

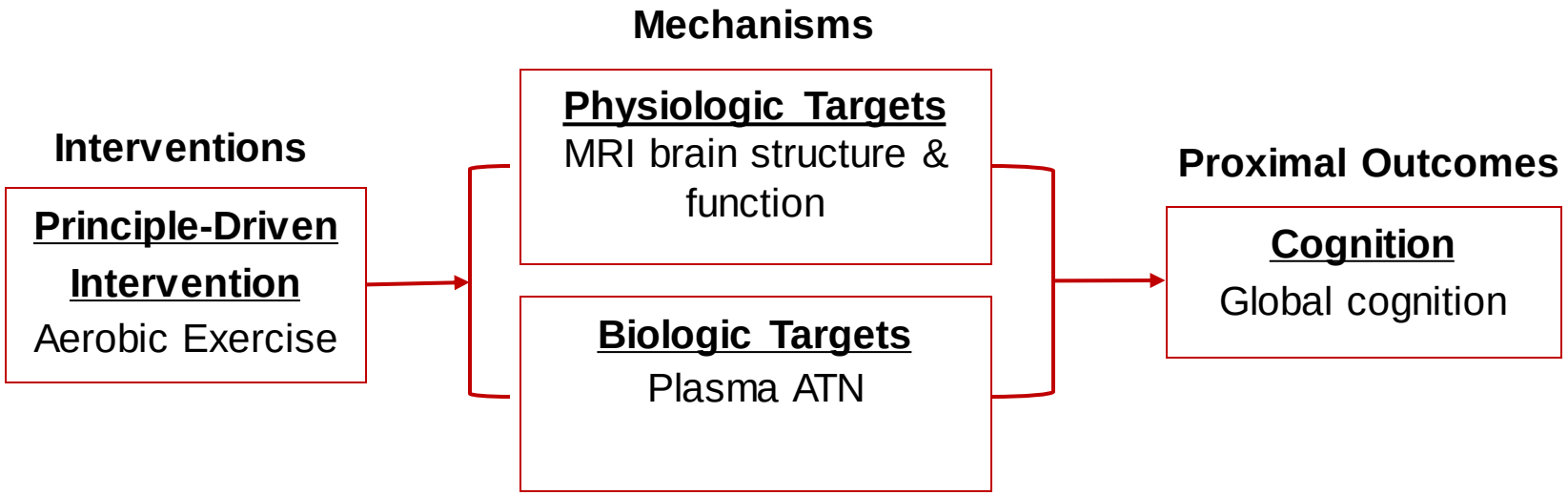
STAGE III

FIT-AD Trial

An exercise study for people with Alzheimer's Disease

EFFICACY TESTING
COMMUNITY SETTING/RESEARCH PROVIDER

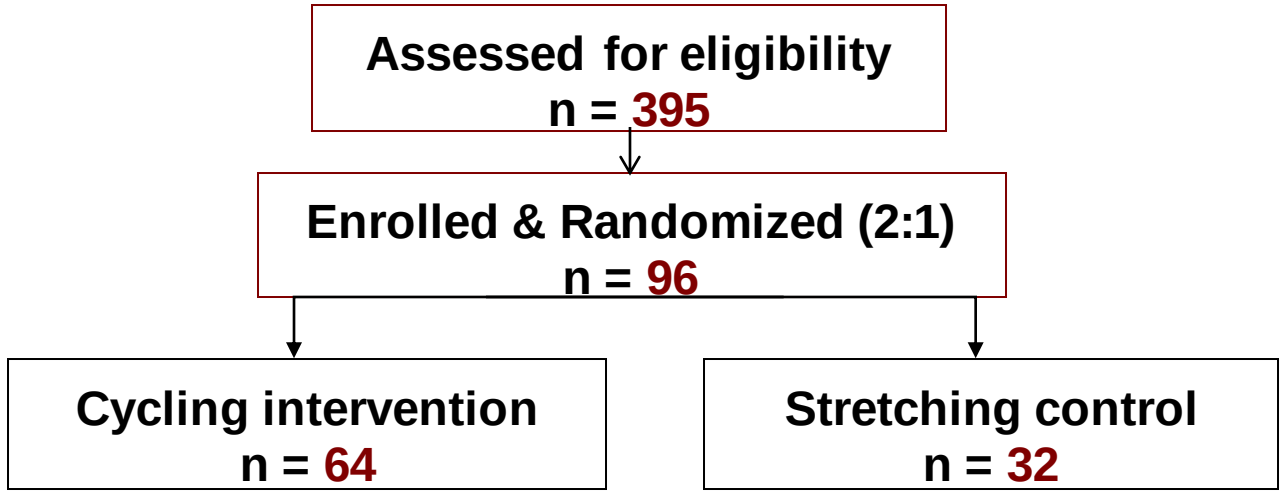
STAGE II/III



FIT-AD Trial

An exercise study for people with Alzheimer's Disease

STAGE II/III



Stages III-V

BASIC RESEARCH

STAGE 0

INTERVENTION GENERATION/
REFINEMENT

STAGE I

EFFICACY TESTING
RESEARCH SETTING & PROVIDER

STAGE II

EFFICACY TESTING
COMMUNITY SETTING & PROVIDER

STAGE III

EFECTIVENESS

STAGE IV

IMPLEMENTATION & DISSEMINATION

STAGE V

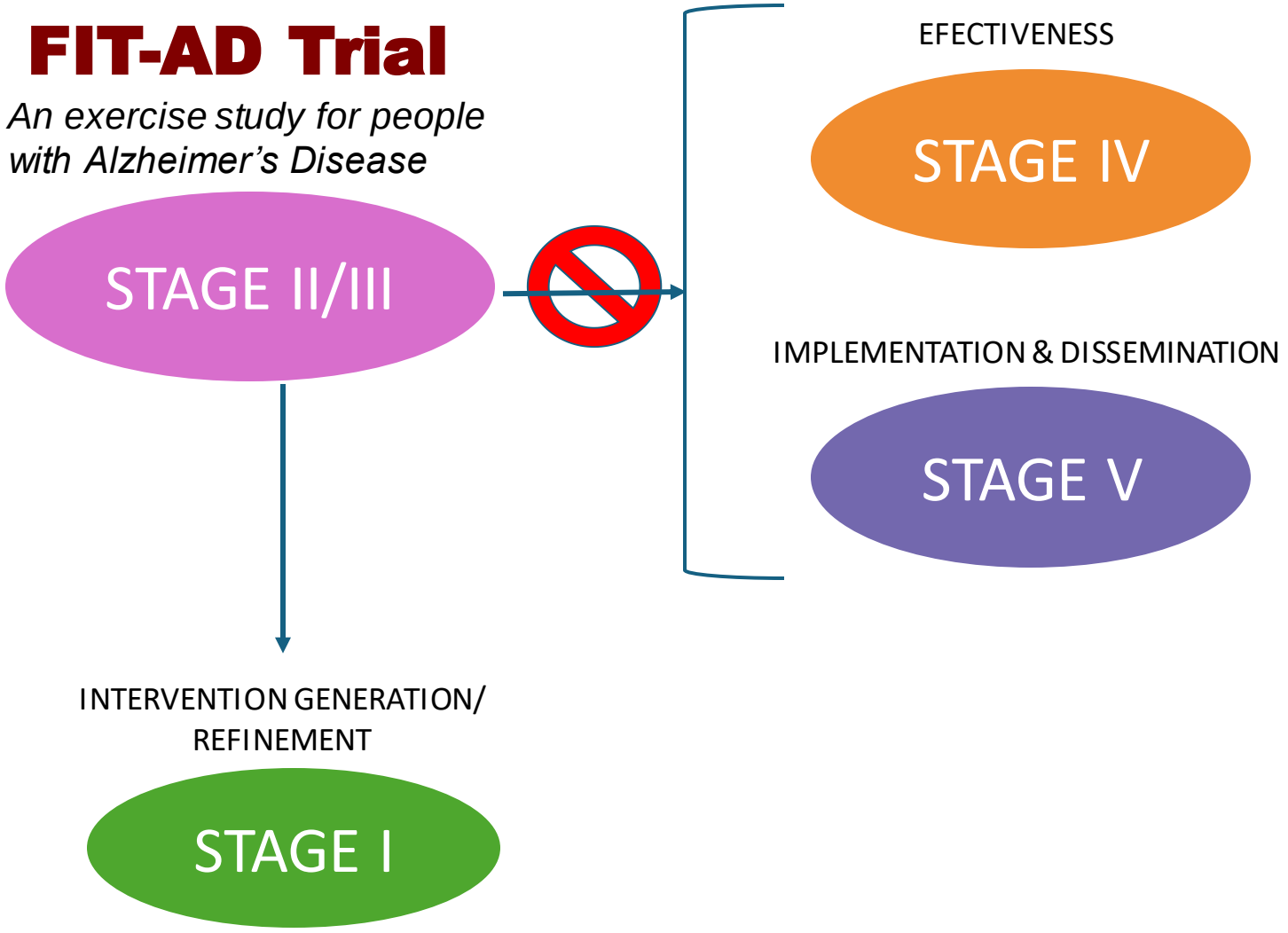
FIT-AD Trial

An exercise study for people with Alzheimer's Disease

Building a cadre of Memory Loss Exercise Specialists to provide exercise to people with Alzheimer's disease (AD)

FIT-AD Trial

An exercise study for people with Alzheimer's Disease



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Roybal Center

Arizona State University Roybal Center for Older Adults Living Alone with Cognitive Decline: Technology-Enabled Behavioral and Lifestyle Change to Delay Alzheimer's Disease and Improve Quality of Life

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Arizona State University
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Stage 0 → Stage IV

Interventions

MoBC-driven Technology-enabled Interventions
e.g., wearable devices, app, virtual reality

Mechanistic Outcomes

MoBC Targets
e.g., stress resilience & reactivity, interpersonal & social processes, self-regulation

Behavior and Lifestyle Change
e.g., physical activity

Biological Targets
e.g., ATN, GFAP

Proximal Outcomes

Cognition
e.g., episodic memory

Functional Status
e.g., ADLs

Psychological Wellbeing
e.g., depression, anxiety

Other QoL Indicators
e.g., QoL, PROMs, life satisfaction

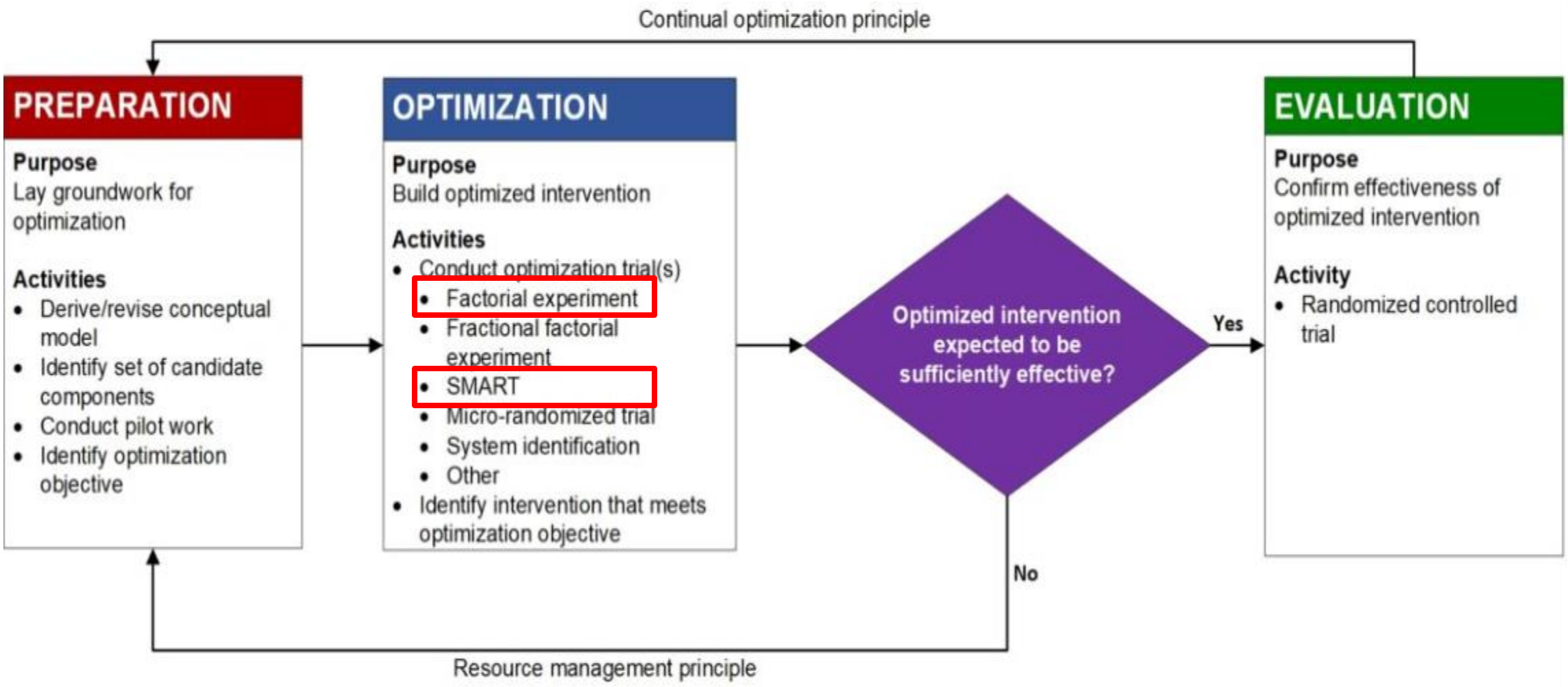
Long-Term Outcomes

e.g., ADRD onset, AD/ADRD progression, long-term care placement, maintenance of proximal outcomes

Health Disparity Factors

Fundamental, sociocultural, environment factors

Multiphase Optimization Strategy (MOST)



Collins, L.M. and Kugler, K.C., 2018. Optimization of behavioral, biobehavioral, and biomedical interventions. *Cham: Springer International Publishing*, *10*(1007), pp.978-3. https://link.springer.com/book/10.1007/978-3-319-91776-4

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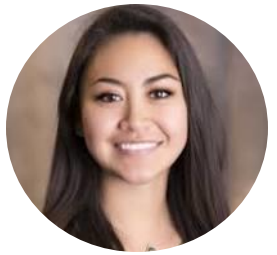
StandUPTV

A full-factorial optimization trial to reduce sedentary screen time among adults

Sarah Keadle, PhD
Assoc Prof
Cal Poly San Luis Obispo

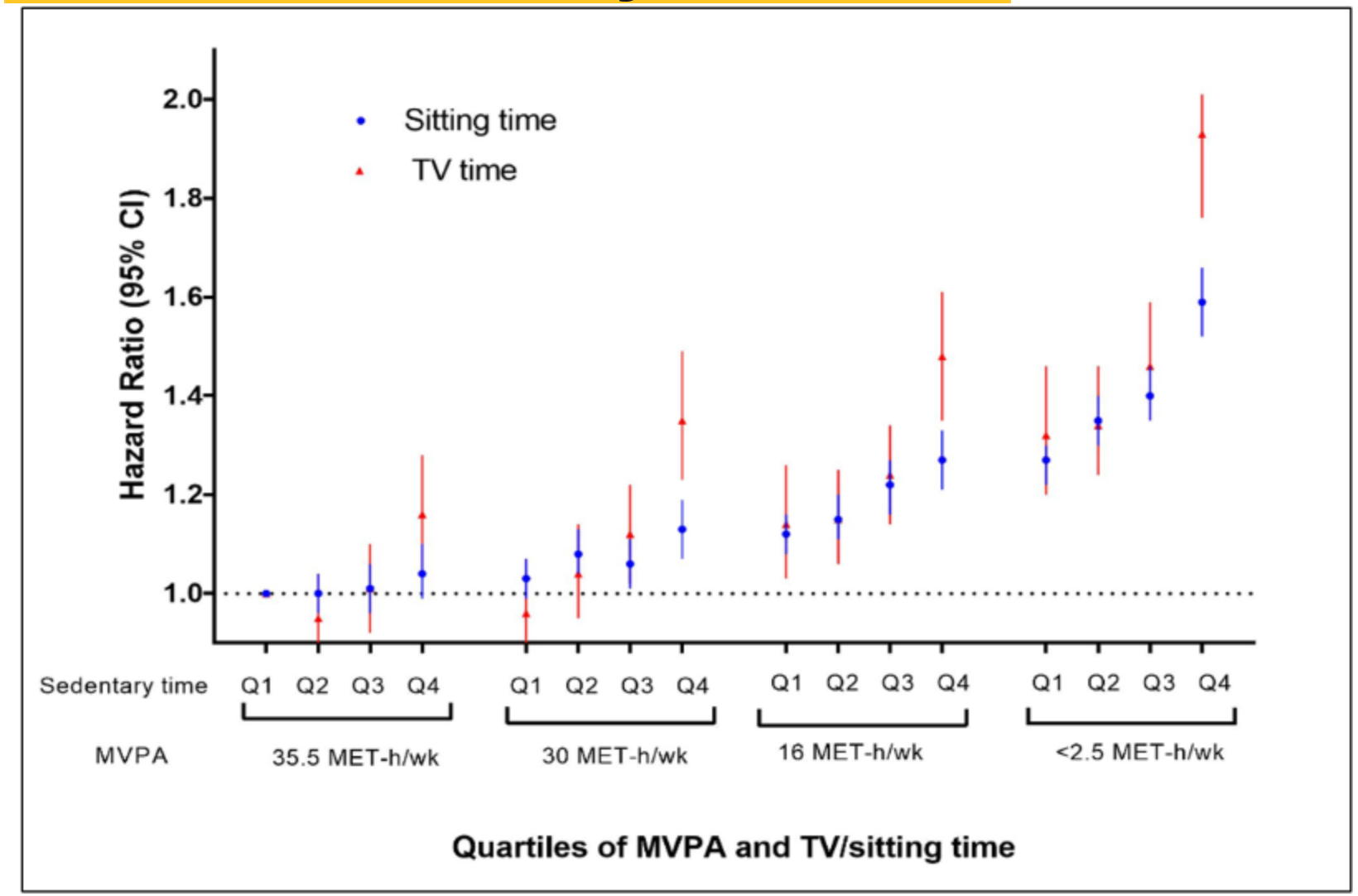


Arlene Fernandez, MA
Program Mgr Research

Clinical Trial Registry: NCT04464993

NIH: R01CA239612
(PI: Keadle & Buman)

Mortality risks are stronger for TV vs overall sedentary behavior

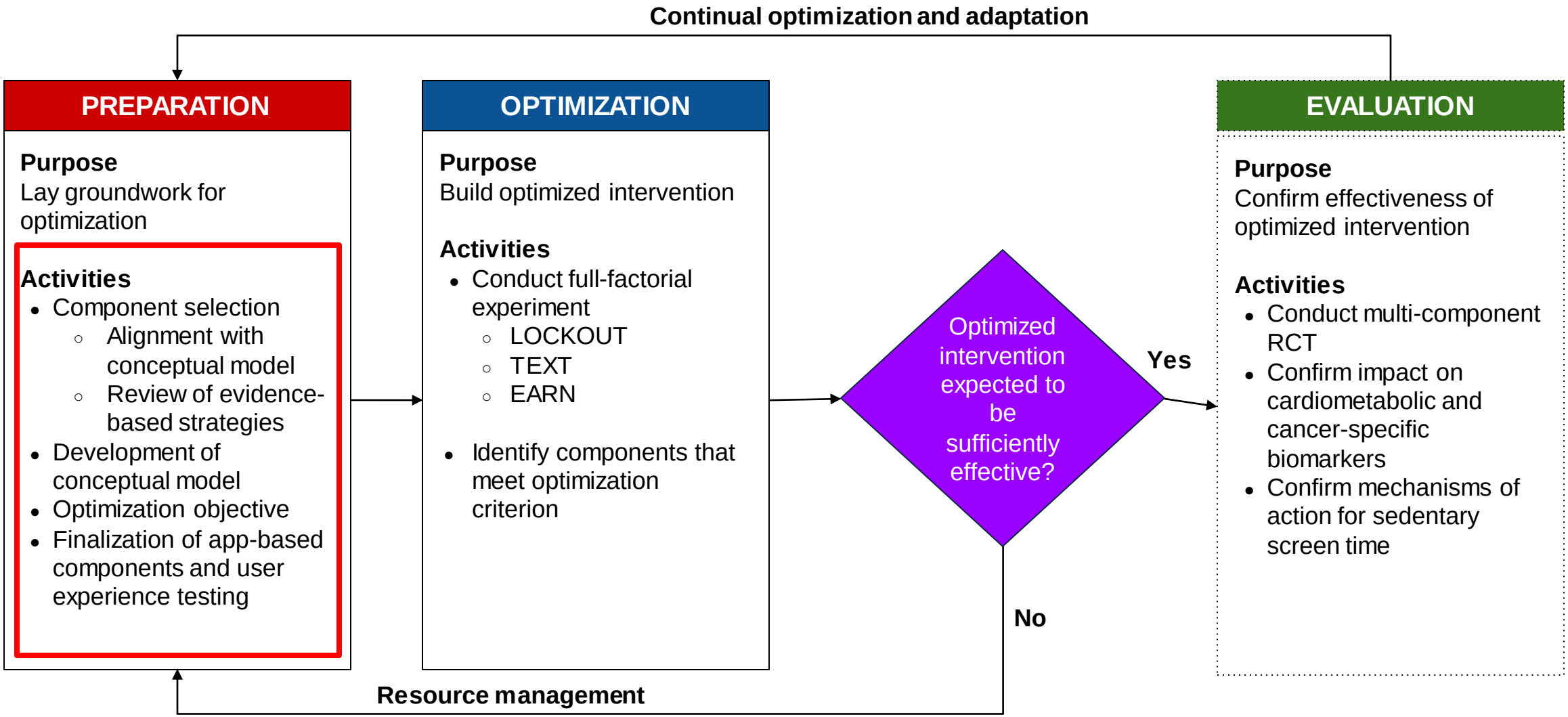


High amounts of exercise (60-75 min/day) were needed to eliminate risk of sitting time

Excess risk for TV viewing remains.

Ekelund U, Steene-Johannessen J, Brown WJ, et al. *Lancet*. 2016;388(10051):1302-1310.

Preparation Phase



StandUPTV optimization strategy. *Adapted from Collins et al. 2018.*

StandUPTV

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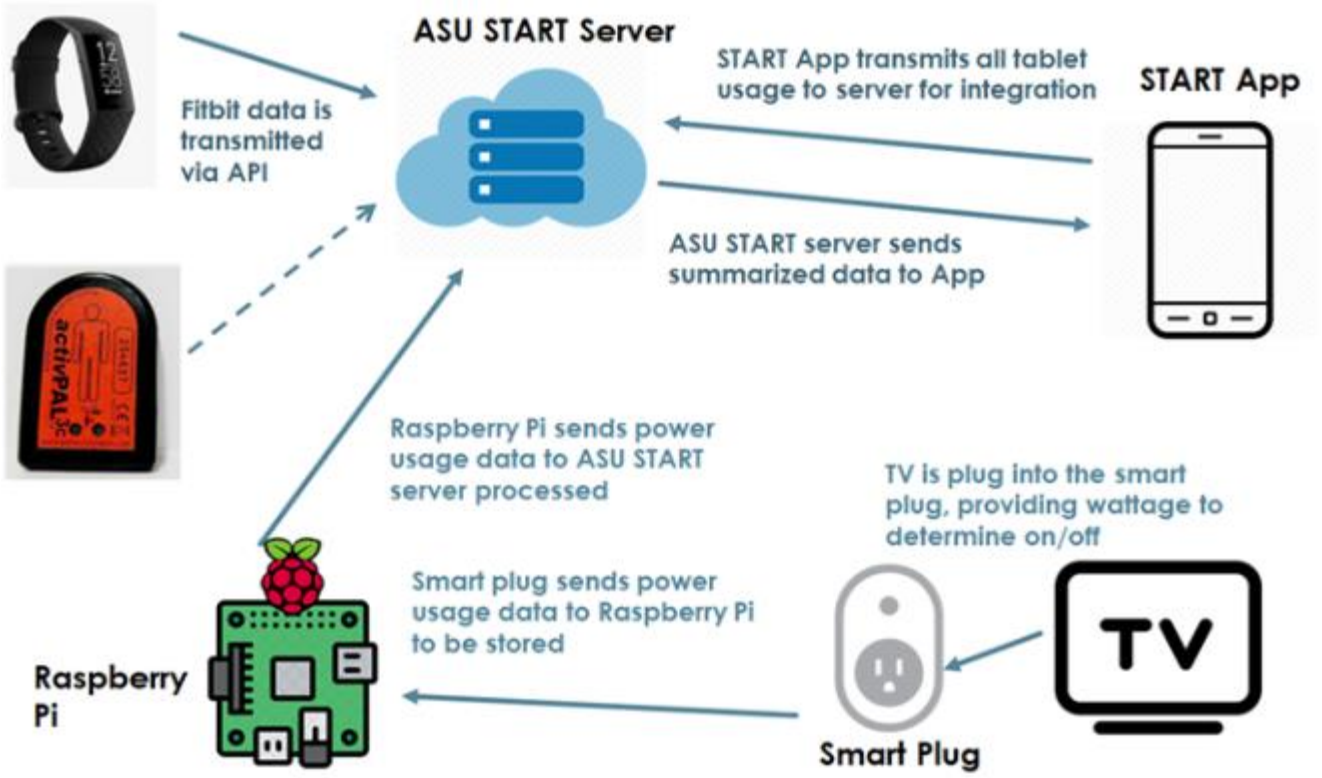
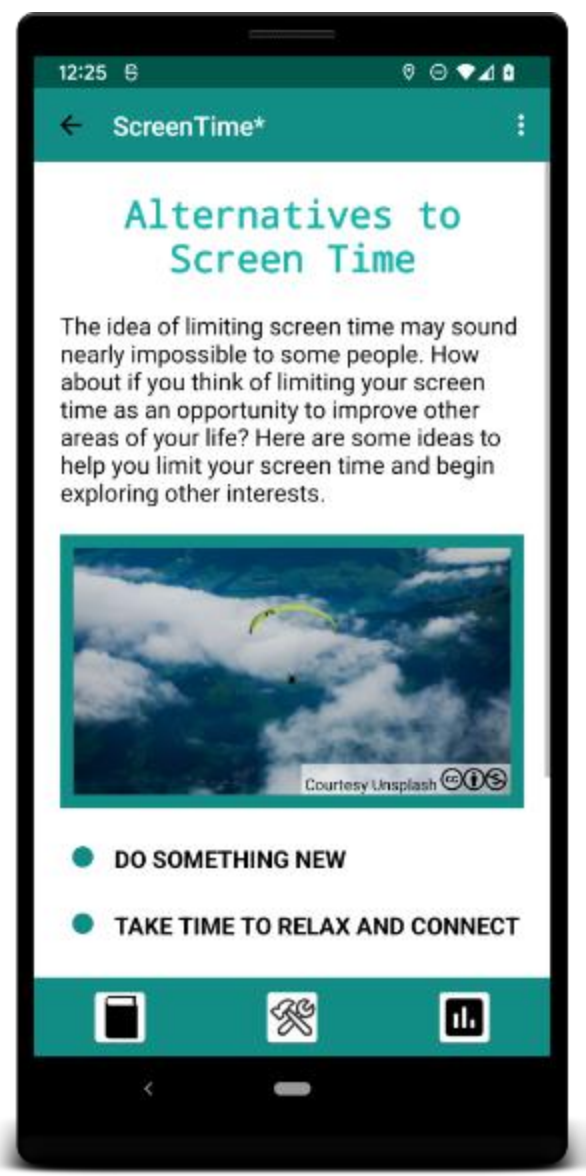
Full factorial design

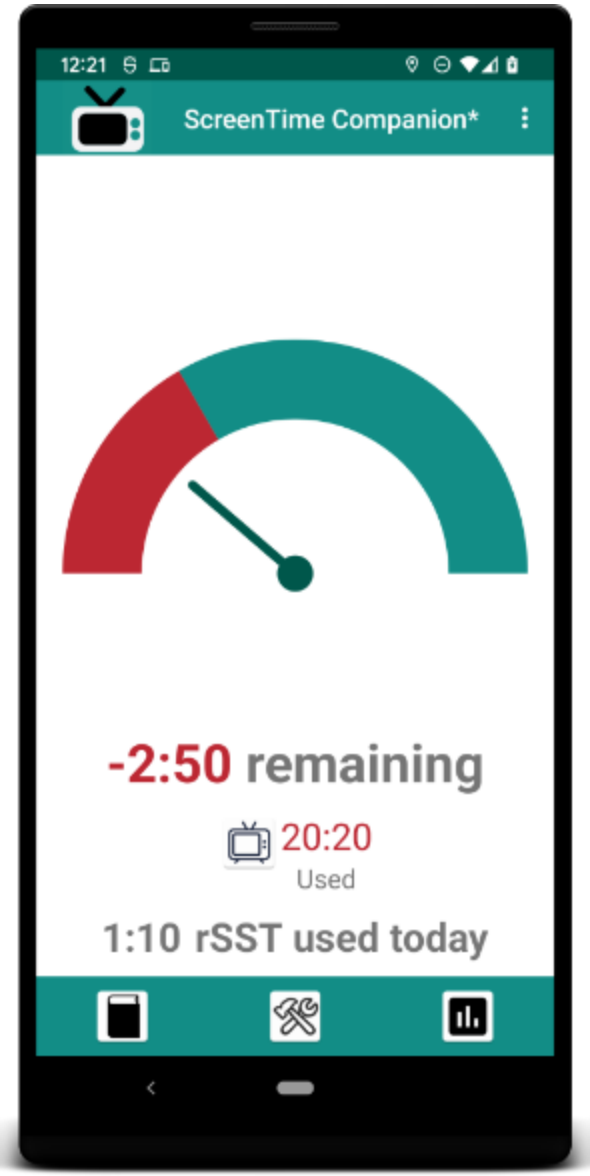
Target: 50% reduction in sedentary screen time

- **LOCKOUT** screen locks out once screen time target has been reached
- **TEXT** adaptive prompts and reminders
- **EARN** earn screen time through physical activity

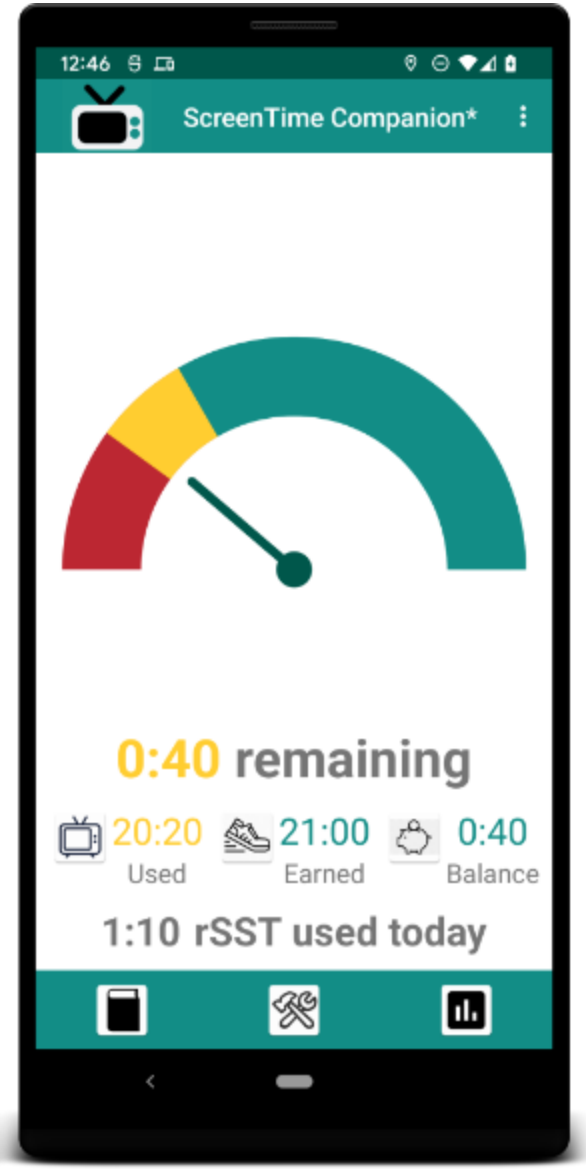




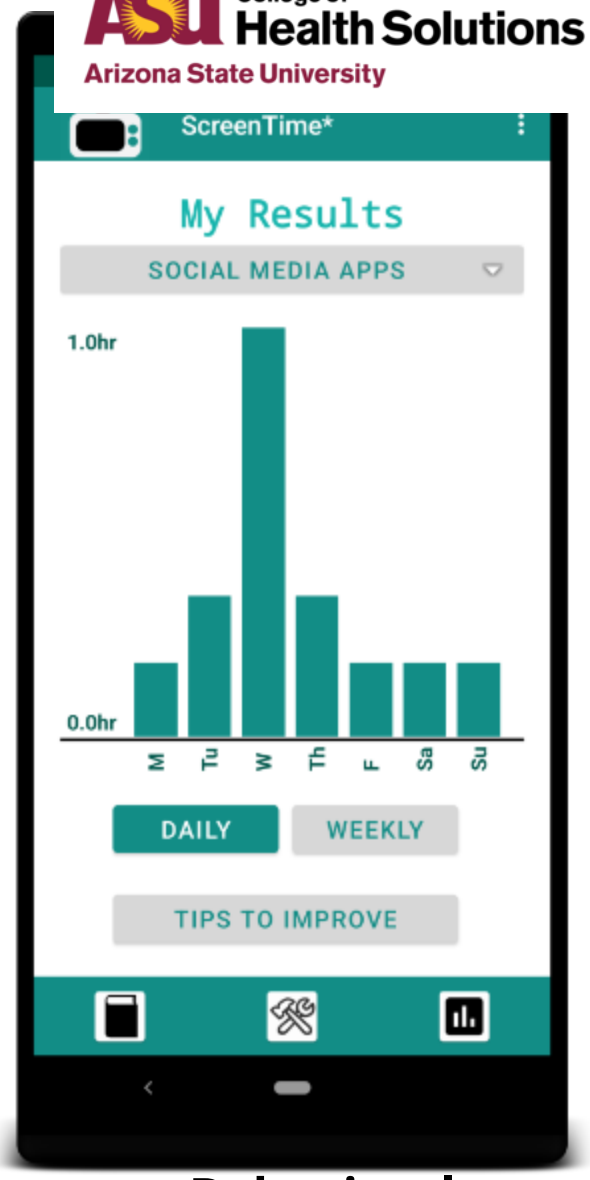
SST Education



Daily self-monitoring



Daily self-monitoring with EARN



Behavioral feedback

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Optimization Phase

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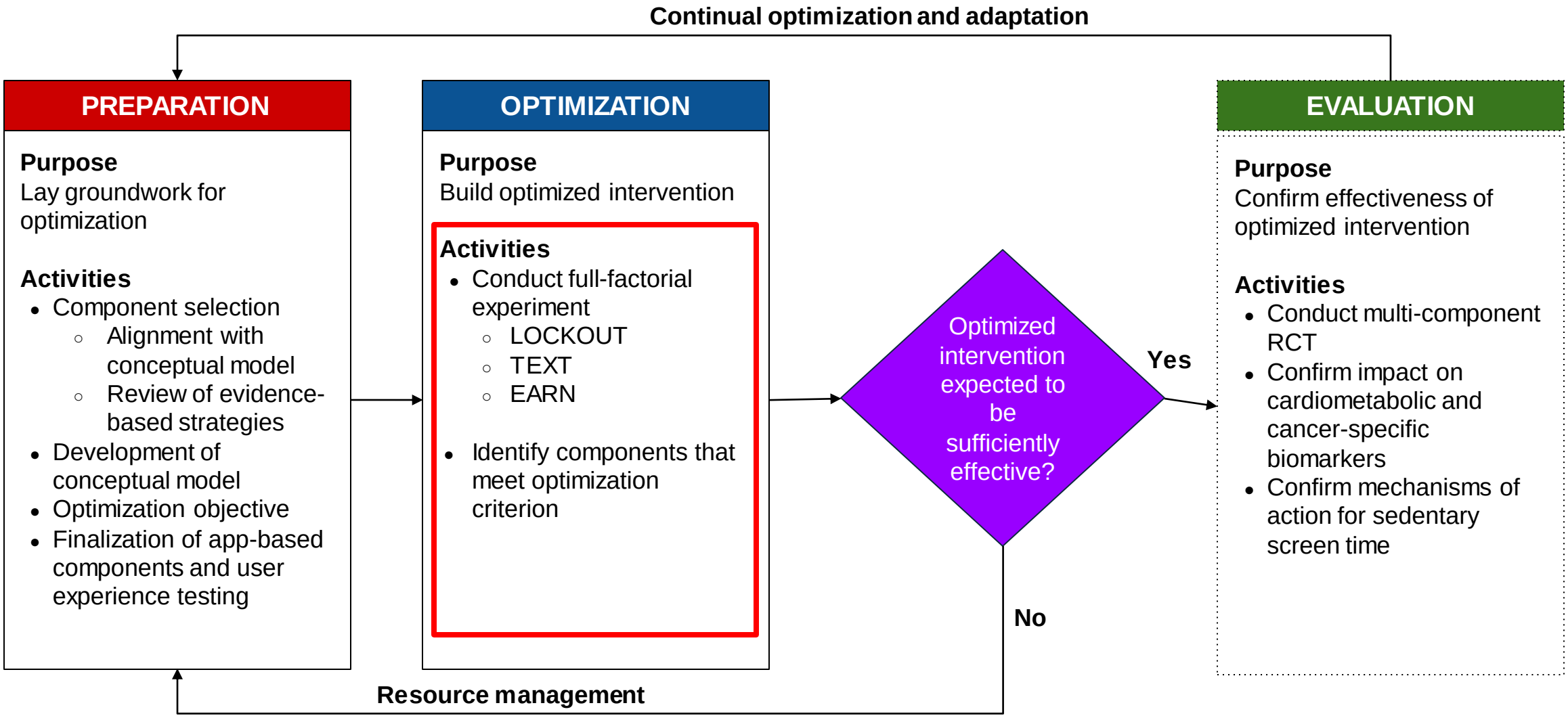

StandUPTV optimization strategy. *Adapted from Collins et al. 2018.*

Full-Factorial Trial Design

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Condition	LOCKOUT	EARN	TEXT
1	ON	ON	ON
2	ON	OFF	ON
3	ON	ON	OFF
4	ON	OFF	OFF
5	OFF	ON	ON
6	OFF	OFF	ON
7	OFF	ON	OFF
8	OFF	OFF	OFF

Primary Aim

To develop an optimized intervention for reducing SST by identifying which component(s) from three components under consideration for inclusion in *StandUPTV* reduce SST **by >60 min/day at 16 weeks.**

Baseline participant characteristics

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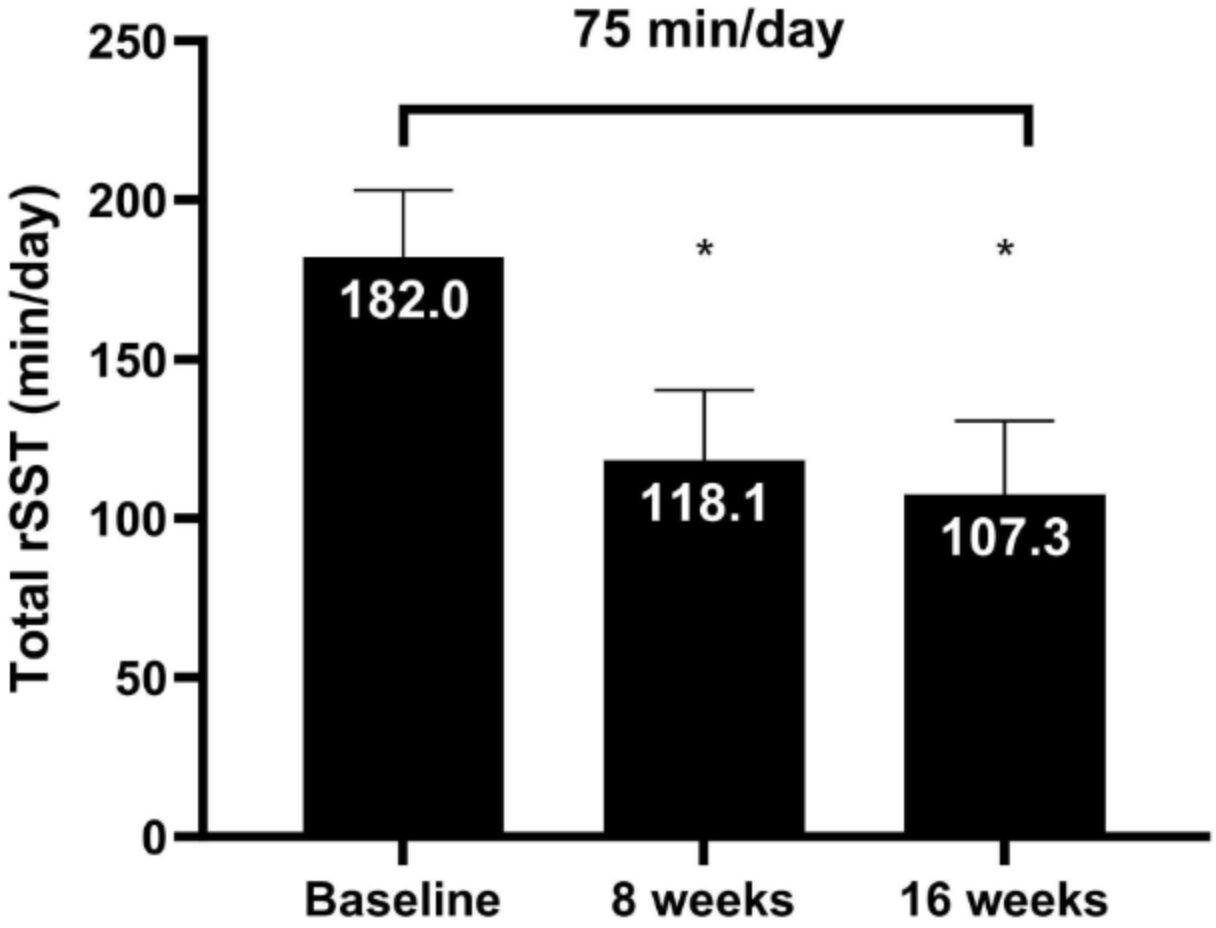
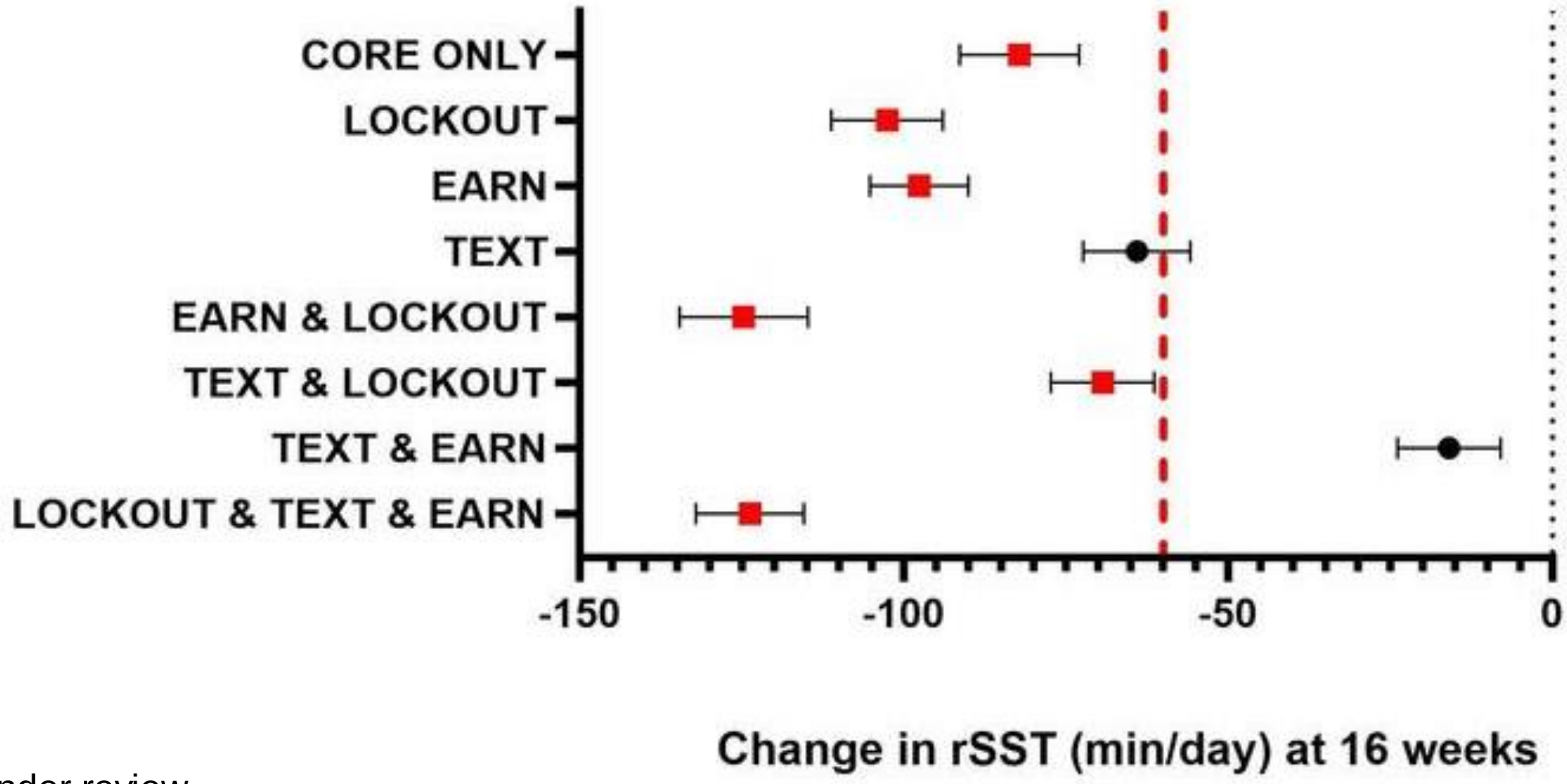
Experimental component	Sample Size	Female (%)	Age years	BMI kg/m2	Race, (%)				Ethnicity, (%)		rSST	Total sedentary time	MVPA	Steps
					White	AA	Asian	Other	Not Hispanic	Hispanic	min/day	min/day	min/day	steps/day
Overall	n=110	82%	42.0 (11.7)	29.7 (7.8)	75%	5%	13%	11%	79%	21%	184.1 (125.8)	641.4 (98.8)	20.6 (14.8)	6736 (2815)

Results: Significant reduction in rSST over time



Under review

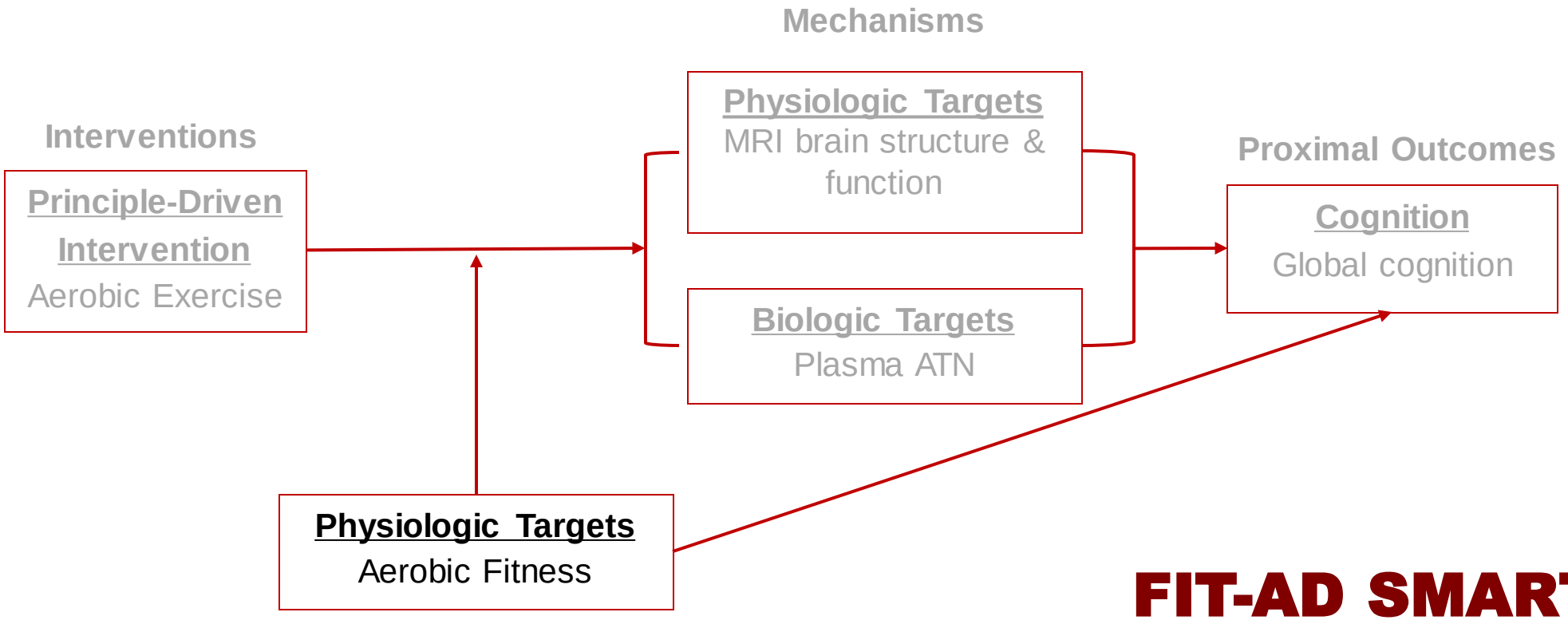
Results: Intervention version differences



Under review

FIT-AD Trial

An exercise study for people with Alzheimer's Disease



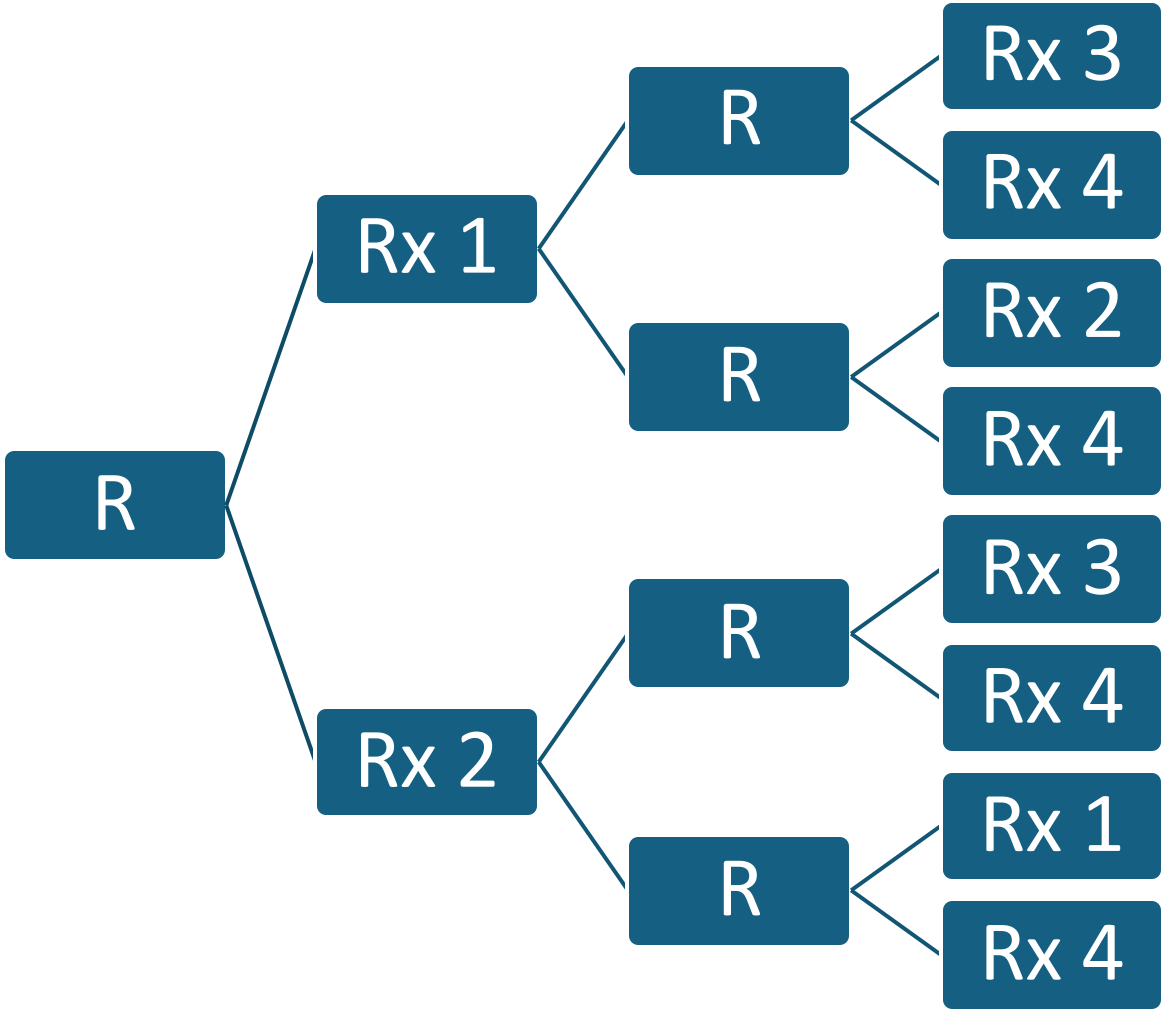
FIT-AD SMART

An exercise study for people with early Alzheimer's Disease

FIT-AD SMART

An exercise study for people with early Alzheimer's Disease

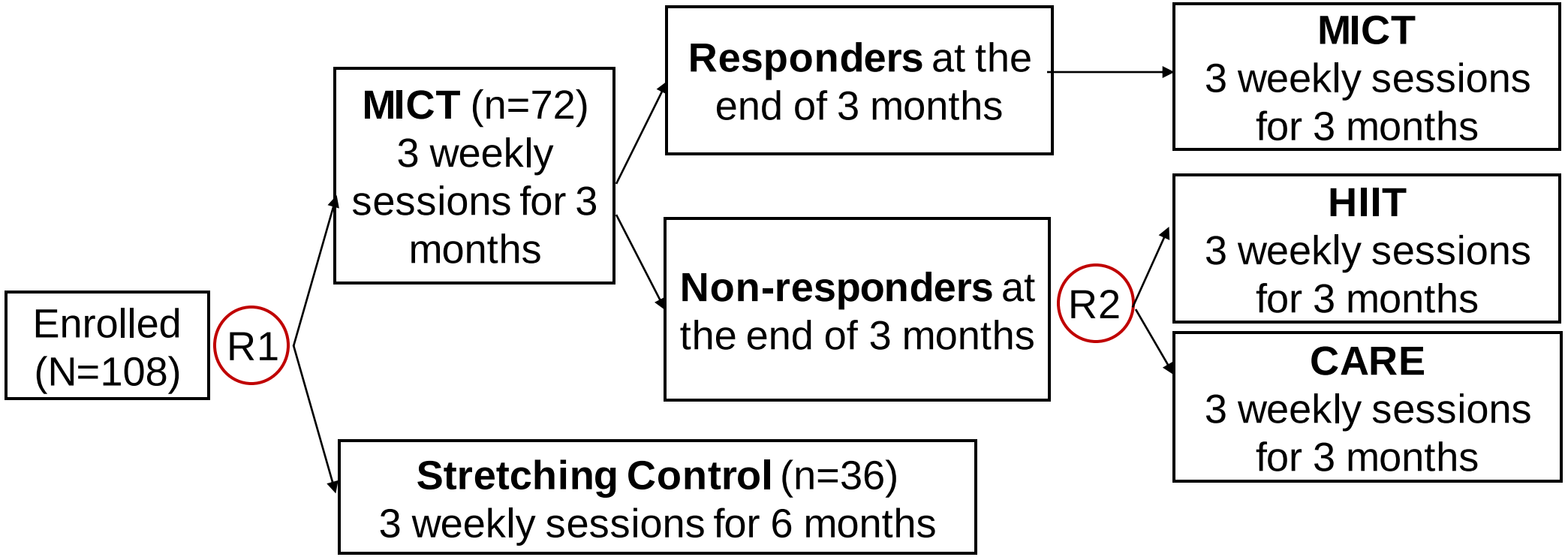
Sequential Multiple Assignment Randomized Trial



FIT-AD SMART

An exercise study for people with early Alzheimer's Disease

STAGE IB



SMART: Sequential Multiple Assignment Randomized Trial

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More actionable information

for patients, providers, and health systems

Wearable device integration with EHR system

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LOCAL TITLE: BEWELL24 (LIFESTLYE SMARTPHONE APP) UPDATE
STANDARD TITLE: BEWELL24 UPDATE
DATE OF NOTE: MAY 25, 2017 ENTRY DATE: MAY 25, 2017
AUTHOR: REAVEN, PETER EXP COSIGNER:
URGENCY: STATUS: COMPLETED

SLEEP

Patient sleep duration: 8 HOURS/NIGHT over the last two weeks; this is up from 7 hours/night
ADVISE: Praise patient for getting adequate sleep.

Patient sleep quality: POOR over the last two weeks; this was GOOD previously
ADVISE: Encourage regular bed and wake times. Avoid alcohol and caffeine before bed.

PHYSICAL ACTIVITY

Exercise: 32 MINUTES/DAY over the last two weeks; this is up 20%
Lifestyle movement: 120 MINUTES/DAY over the last two weeks; this is up 20%
ADVISE: Praise patient for regular exercise and incorporating movement into their daily routine.

PHOENIX VA HEALTH CARE SYSTEM

BeWell24

Peter Reaven, MD

Testing data integration with clinical team

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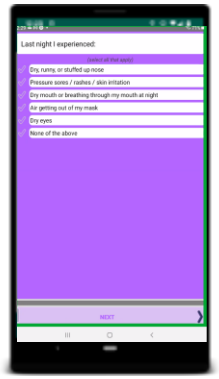
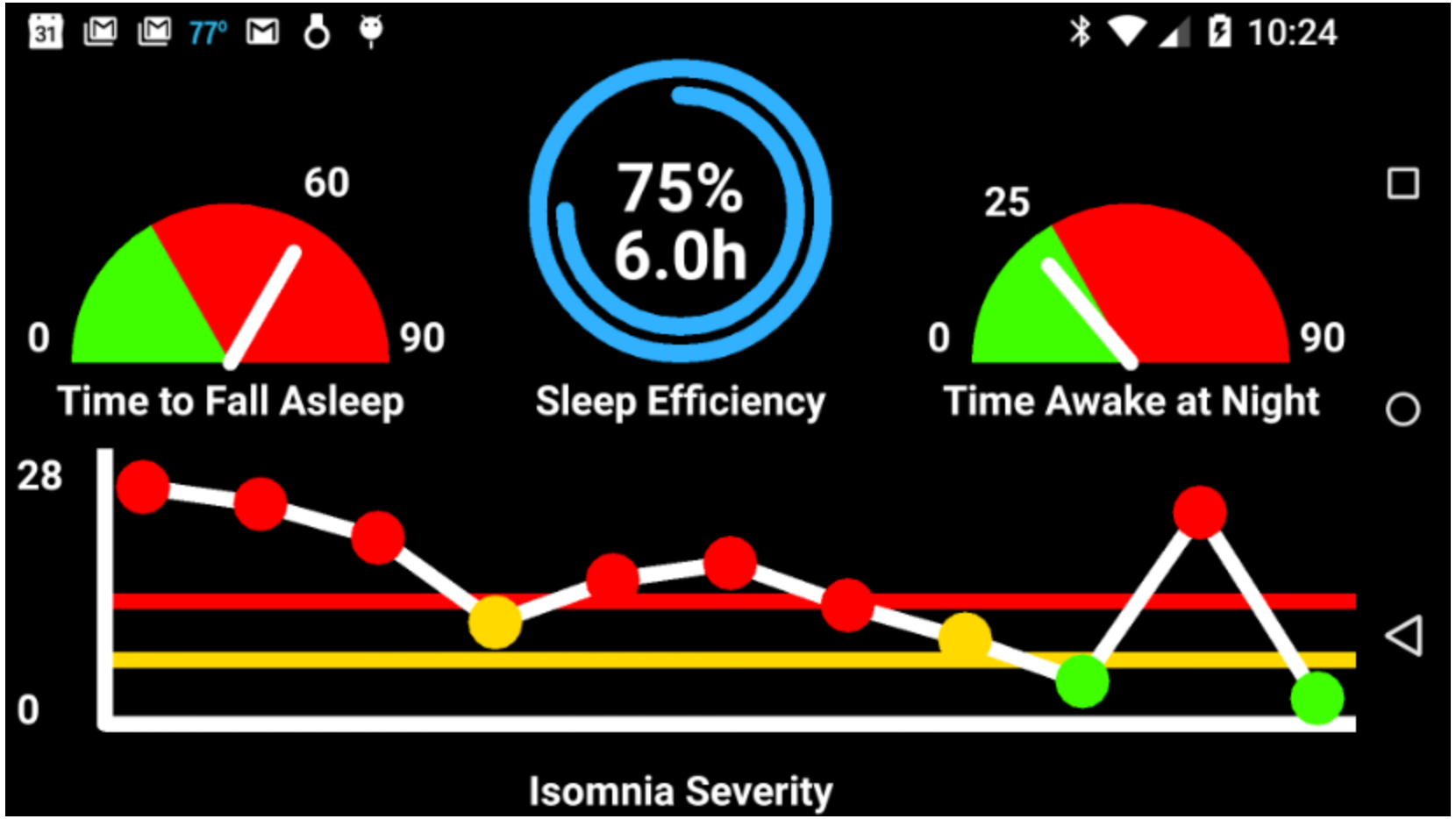
CPAP



Ecological Momentary Assessment

"Show my provider" screen



SleepWell24

MAYO CLINIC

Megan Petrov, PhD

Patient/Participant facing dashboards

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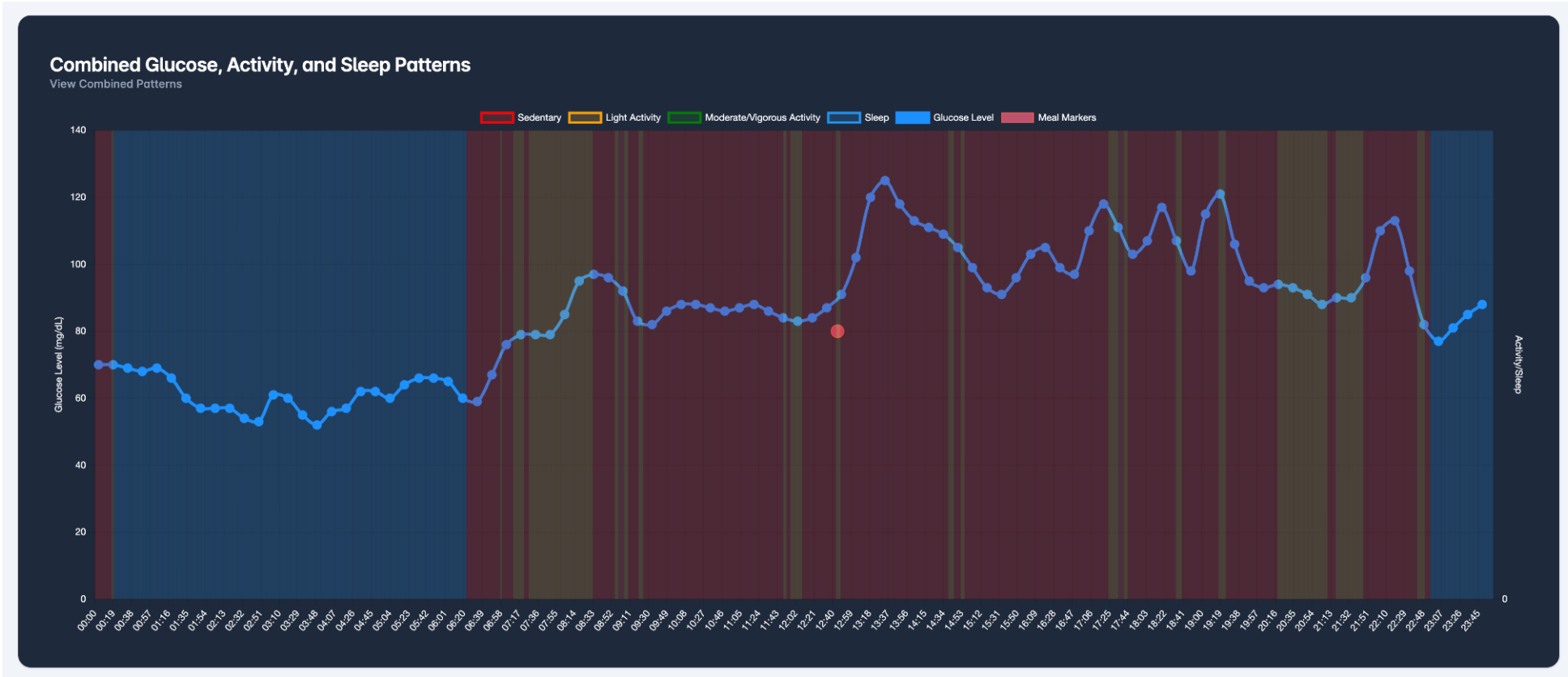

Jean-Pierre Kocher

Dorothy Sears

Harsh Anand

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Daniel Rivera, PhD

Control Systems Engineering

Digital Twin for Behavior Change

Hassan Ghasemzadeh, PhD

Behavioral intervention optimization

through advanced algorithms

Stephanie Carpenter, PhD

Micro-randomized trials

Precision Health Research Initiative

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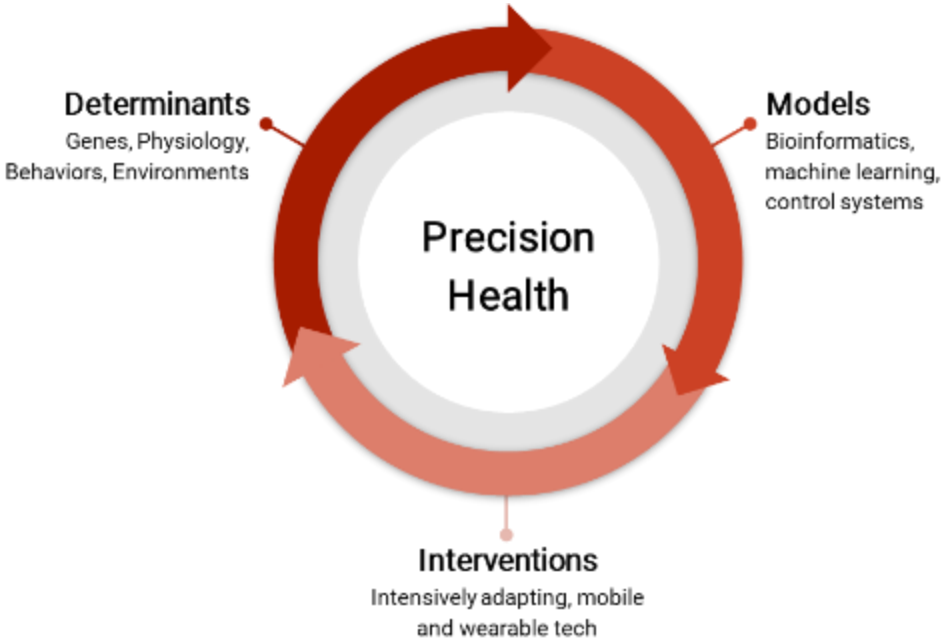
- Precision health research considers differences in people's genes, lifestyles, and environments to develop treatment strategies unique to the individual.

- Genomic sequencing and epigenetics, bioinformatics, mobile and wearable technologies, social and behavioral determinants, and environment sensing to enable more personalized and tailored approaches to health.



Deliver the right intervention, to the right person, at the right time

Thank you!

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