

Toward Wearable-Driven Individualized and Context-Specific Behavior Activation Using Major Depression with Sub-threshold Symptoms as a Test Case

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What is the Methodological Issue Being Addressed? Statistical/machine learning methods that utilize smartwatch data from matched (non-depressed control vs. lifetime history of depression) participants to characterize precise differences in physical activity in matched groups, which may inform future individualized guidance for behavioral activation.

Introduction In adults, meeting physical activity recommendations (e.g., 150 minutes/week) is consistently associated with higher mental health benefits. Depressed patients are often left in a state of diminished functioning (e.g., lower energy, reduced activity, etc.), especially when actively symptomatic. However, subtle deficits in energy, activity, and sleep may remain despite improvement in self-reported symptoms. Increased physical activity may enable more optimized recovery in such patients, and smartwatches and AI-assisted gamified fitness apps may be effective behavior activation tools. However, guidance for physical activity from existing tools is often not individualized around a given patient's clinical or work/life context, which may limit their effectiveness.

Methods A 12-month decentralized digital health wellbeing study of registered nurses (RNs) with smartwatches was conducted at Mayo Clinic's Rochester, Minnesota and Jacksonville, Florida sites (NCT05481138). Participants (a) were issued a Garmin smartwatch along with needed accessories with the expectation of adhering to a wear-time of 70% during the 12-month observation period, and (b) received quarterly individualized summaries of smartwatch measures via email. Two participant groups were defined based on lifetime history of MDD (Yes: LH-MDD; No: NH-MDD). All had depressive symptoms below the threshold for clinical concern, i.e., Center for Epidemiologic Studies Depression Scale (CES-D) score <16 , at baseline. A $>30\%$ reduction in CES-D total score from baseline to 12-months was deemed as being clinically meaningful improvement in depressive symptom severity. The two participant groups were matched on age, sex, marital status, number of children in household, total adverse childhood events, shift-type, site, and nursing specialty using propensity scores. Linear mixed effects regression (LMER) models were developed to establish differences in daily and 12-month differences in smartwatch measures between the two participant groups. Daily smartwatch measures comprised step count, sleep (total duration, duration of sleep stages, sleep debt, sleep regularity index), and heartrate (heartrate variability, resting heartrate).

Results A total of 531 participants were recruited in the study, 397 of whom met adherence criteria, and 215 of whom had CES-D scores <16 at baseline. Of these, 142 patched participants

were derived for the LH-MDD (n=71) and NH-MDD (n=71) groups. Smartwatch wear time adherence was 91% across groups over 12-months, with no significant between-group differences observed. LMER models showed that the LH-MDD group had significantly fewer daily steps (delta = -1,561 steps/day), fewer minutes of daily exercise (delta = -13 minutes/day), and lower sleep regularity than the NH-MDD group. Group x time interaction effects showed significantly greater improvements over time in sleep regularity, sleep interruptions, and time spent exercising for the LH-MDD group compared with the NH-MDD group. In participants who saw clinically meaningful improvement in CES-D total score from baseline, LH-MDD participants walked 1,378 steps fewer per day and had lower sleep regularity in comparison to matched NH-MDD participants.

Conclusion The study demonstrates the ability of statistical/machine learning methods to utilize longitudinal smartwatch data to derive precise differences in functioning between matched individuals with diagnosed depression with subthreshold symptoms and non-depressed controls. This methodological formulation, combined with patient-centered engagement, may provide a foundation for future studies of digital health technologies for the promotion of behavior activation in subthreshold depressed individuals.

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Keywords

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Guidelines I have read and understand the Poster Guidelines

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