

Activity Tracker-Based Behavioral Data Is Correlated with Validated Quality-of-Life Metrics

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Background

- Health-related quality of life (HRQOL), defined as an individual's perceived mental and physical health over time, can be a strong predictor of mortality and morbidity.¹
 - However, HRQOL measures currently rely on self-reported questionnaires that are often times quite lengthy.
 - As such, measuring HRQOL to assess change in health status may not always be feasible during standard office visits and is also limited by visit frequency.
- Identifying behavioral patterns that are associated with HRQOL measures could lead to the development of digital biomarkers that enable healthcare providers to objectively monitor changes in quality of life (QoL) over time based on passively collected data, rather than relying on self-report.

Objectives

- We explored whether passively-collected activity tracker data from consumer wearables could serve as a potential digital biomarker for QoL status based on the PROMIS-10 Global Health Score, a validated mental and physical health QoL metric.

References

- Centers for Disease Control and Prevention (CDC). HRQOL Concepts. www.cdc.gov/hrqol/concept.htm

Methods

STUDY POPULATION

- Members of the Achievement health app (a product of Evidation Health) were invited to participate in a 1-year observational study on mental health.
- Participants were 18 years or older, lived in the U.S., and had a self-reported diagnosis of anxiety or depression.

BEHAVIORAL AND HEALTH OUTCOMES DATA

- Participants tracked their daily activity and sleep using consumer wearable activity trackers, and completed quarterly questionnaires assessing their health status, quality of life (PROMIS-10), depression and anxiety symptom severity, and healthcare utilization.
- Activity tracker data from 3 months pre-enrollment were used to calculate baseline per-participant statistics for over 500 behavioral data features (i.e., activity, step, and sleep metrics).
- Baseline PROMIS-10 Global Health scores were used to characterize individuals into two cohorts:

Cohort 1: High QoL	Cohort 2: Low QoL
<ul style="list-style-type: none"> N = 413 Individuals who had scores <u>above</u> or equal to the median* for both the mental and physical health components of PROMIS-10 	<ul style="list-style-type: none"> N = 212 Individuals who had scores <u>below</u> the median* for both the mental and physical health components of PROMIS-10

*PROMIS-10: median physical health score = 13, median mental health score = 12

STATISTICAL ANALYSIS

- A logistic regression model was utilized to identify associations between cohort assignment and univariate behavioral data features, controlling for PHQ-9 and GAD-7 scores, age, sex, race, and socioeconomic status.
- P-values were adjusted for multiple testing using a false discovery rate (FDR) correction with a significance level of 0.05 for reporting.

Results

STUDY POPULATION

Baseline Characteristics	Cohort 1: High QoL (N = 413)	Cohort 2: Low QoL (N = 212)
Age, mean years (SD)	33.3 (8.3)	30.8 (8.1)
Female, n (%)	345 (83.5)	179 (84.4)
PHQ-9 score, mean (SD)	6.3 (3.9)	13.1 (5.8)
GAD-7 score, mean (SD)	6.4 (4.1)	11.7 (5.3)

PHQ-9 = Patient Health Questionnaire 9-item Scale (depression)
GAD-7 = Generalized Anxiety Disorder 7-item Scale

LOGISTIC REGRESSION ANALYSIS

- On average, individuals in Cohort 1 (high QoL) were more active than Cohort 2 (low QoL) as measured by mean and total daily steps and daily calories burned.
- Individuals in Cohort 1 (high QoL) also were more consistent in tracking their sleep compared to those in Cohort 2 (low QoL).
- There was no clinically or statistically significant difference between the two cohorts for other behavioral metrics evaluated.

Behavioral Data Feature (3 months pre-enrollment)	Cohort 1: High QoL	Cohort 2: Low QoL	Difference	P-value ¹
Mean calories burned per day	1,059	944	115	< 0.01
Minimum calories burned per day	264	159	105	< 0.01
Total calories burned	75,541	64,810	10,731	< 0.01
Mean # steps taken per day	8,168	6,485	1,683	< 0.05
Median # steps taken per day	7,919	6,242	1,677	< 0.05
Maximum # steps taken in a day	18,153	15,378	2,775	< 0.05
% days with more than 10,000 steps	32%	21%	11%	< 0.05
Total # steps taken	617,653	488,779	128,874	< 0.05
% days of consecutive sleep tracking	86%	82%	4%	< 0.05
% days with a break in sleep tracking (in previous 1-4 days)	4%	7%	-3%	< 0.05
% days tracking sleep	82%	77%	5%	0.055

¹ P-values were corrected for FDR to minimize the Type 1 error rate from multiple comparisons.

Conclusions

- Passive monitoring of daily behaviors via consumer wearable activity trackers indicate that higher daily activity levels and greater engagement with sleep tracking is associated with better quality of life (based on PROMIS-10 global mental and physical health scores) in individuals with depression and/or anxiety.
- Longitudinal analyses assessing how behavioral patterns and PROMIS-10 scores change over time will be conducted in the 1-year analysis to further understand how digital biomarkers can characterize HRQOL.
 - In the near future, rather than requiring active user input, this could enable unobtrusive HRQOL monitoring by healthcare providers and caretakers.
- As activity tracker use continues to grow, so do the opportunities to use behavioral data and digital biomarkers to assess changes in health status and health-related quality of life.

Limitations

- This study was conducted in a largely female population with depression and/or anxiety, which limits the generalizability of the results.

The authors are all employees of Evidation Health. There are no conflicts of interest to disclose.