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ARTICLE OPEN

Real-time health monitoring through urine metabolomics

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Current healthcare practices are reactive and based on limited physiological information collected months or years apart. By enabling patients and healthy consumers access to continuous measurements of health, wearable devices and digital medicine stand to realize highly personalized and preventative care. However, most current digital technologies provide information on a limited set of physiological traits, such as heart rate and step count, which alone offer little insight into the etiology of most diseases. Here we propose to integrate data from biohealth smartphone applications with continuous metabolic phenotypes derived from urine metabolites. This combination of molecular phenotypes with quantitative measurements of lifestyle reflect the biological consequences of human behavior in real time. We present data from an observational study involving two healthy subjects and discuss the challenges, opportunities, and implications of integrating this new layer of physiological information into digital medicine. Though our dataset is limited to two subjects, our analysis (also available through an interactive web-based visualization tool) provides an initial framework to monitor lifestyle factors, such as nutrition, drug metabolism, exercise, and sleep using urine metabolites.

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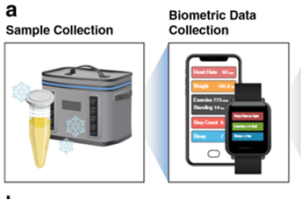
Introduction

Background:

- Medicine currently focuses on managing disease states, rather than being preventative
- There is a wide variety of consumer products that can track user health data.
- Current devices cannot give mechanistic data
- Urine is a rich source of metabolites and ~4500 have been discovered
- Many metabolites in urine can be linked to diseases: obesity, cancer, inflammation….

Purpose:

- Determine if a mixture data from smartphones and metabolomics can be used to look at real time effects on humans



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Methods

Sample preparation

- Urine was collected midstream decanted in BD Vacutainer Urine Complete Cup Kit and immediately stored at -80 C or dry ice overnight and then stored at -80 C
- Samples were derivatized for gas chromatography analysis using a 50 L solution of 1:1 pyridine: N-Methyl-N-(trimethylsilyl)trifluoroacetamide with 1% trimethylchlorosilane and incubated at 60 C for 30 min

Gas Chromatography

- Samples analyzed in Thermo Scientific Gas Chromatography-Fourier Transform Mass Spectrometry (GC-FTMS) Orbitrap using a temperature gradient starting at 100°C (hold time of one minute), and increasing at a rate of 8.5°C per minute until reaching 260°C then increased to 50°C per minute until reaching a final temperature of 320°C
- Data was analyzed using Y3K GC Quantitation Pipeline
- Ethyl glucuronide standard was used and processed in the same manner

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Methods

Biometric data

- Recorded using Lose It! App
- Subject 1 calorie activity was monitored using an Apple Watch Series 2
- Sleep was calculated using the Sleep Cycle App

Statistical analysis:

- All samples were normalized to total ion current (TIC)
- Most of the statistical analysis was done on log2 transformed (TIC) data

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Figure 1

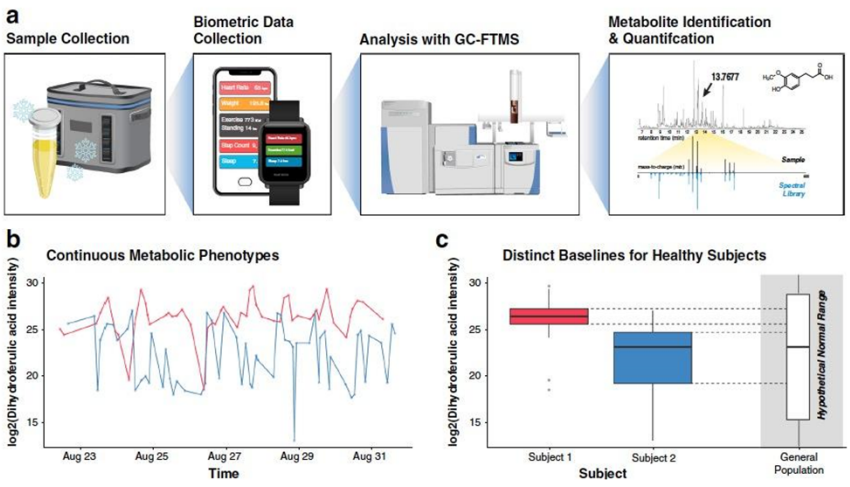

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Figure 1

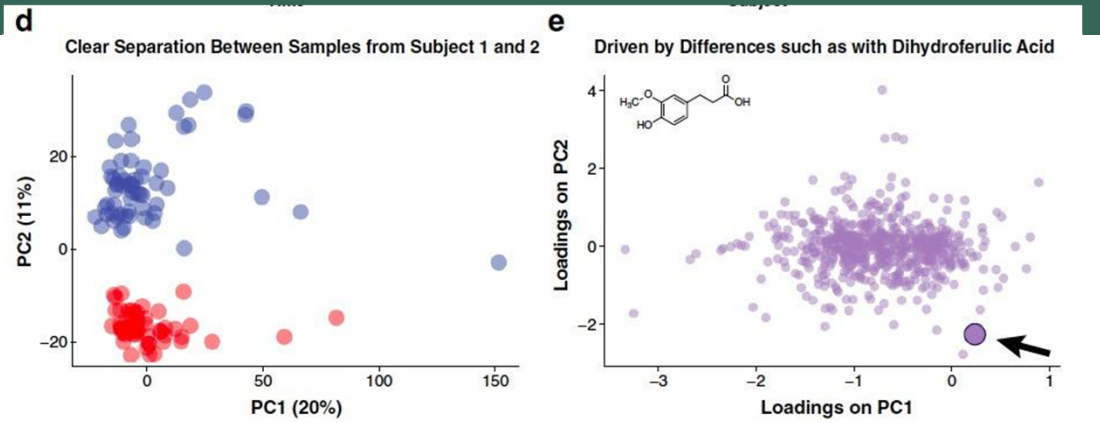

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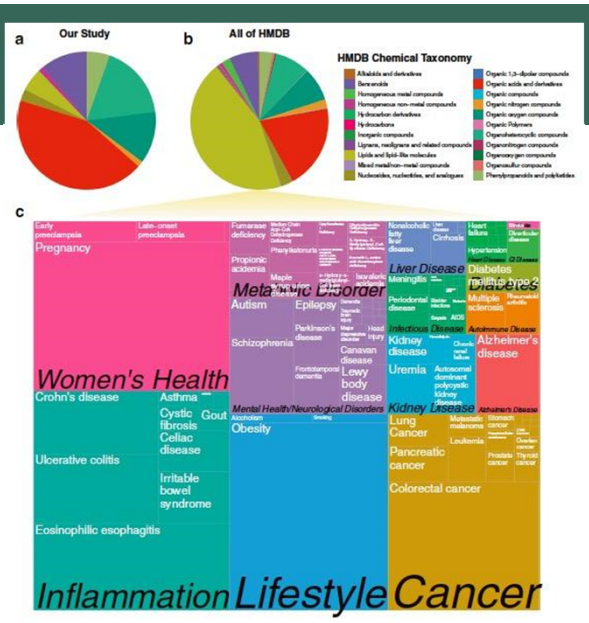
Figure 2



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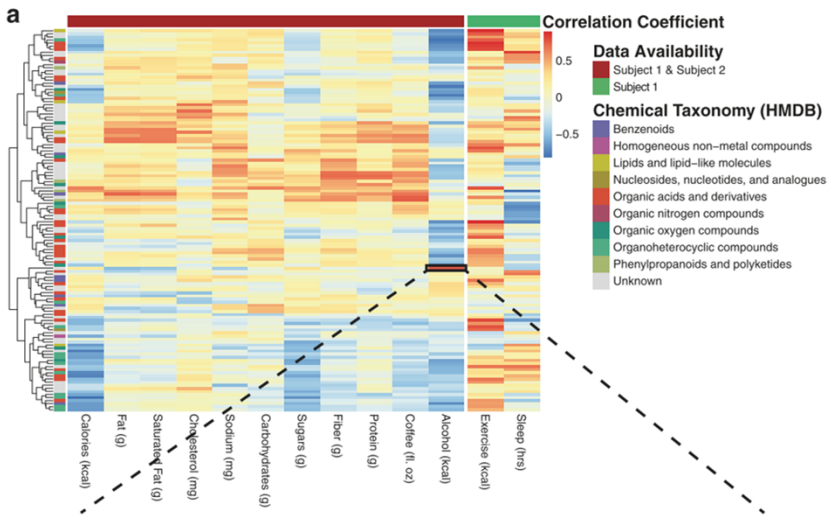
Figures 3



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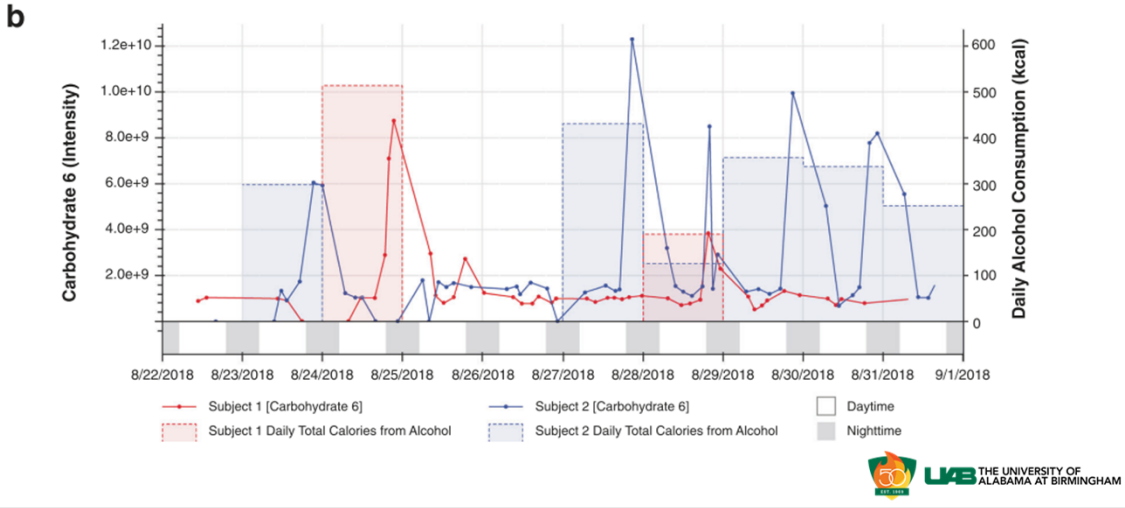
Figures 3



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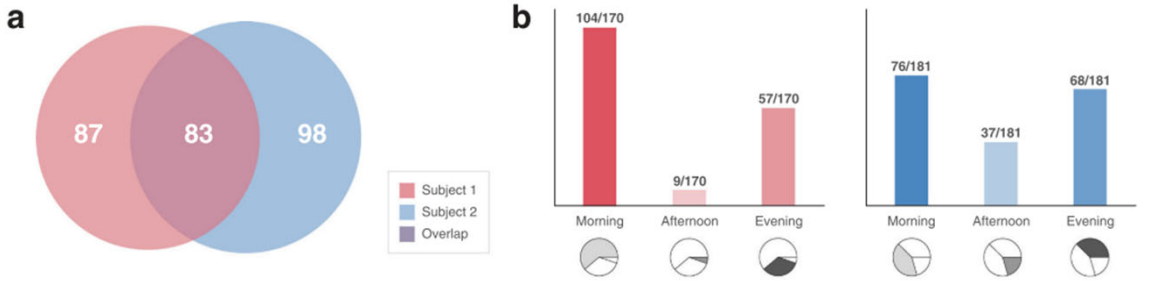
Figures 4



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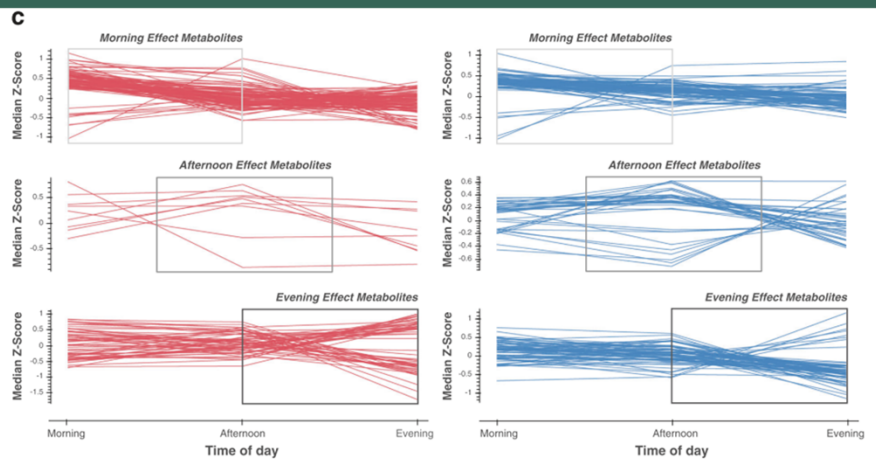
Figures 4



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Conclusions

General

- Proof of principal for using nutritional and lifestyle tracking apps in concert with urine metabolomics for better health predictions and medical personalization

Critiques

- Lack of sleep and exercise data for both subjects

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