

How Sleep and Physical Activity Affect Metabolic Health in Firefighters : A Proposed Study

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INTRODUCTION

- Firefighters experience occupational challenges, including 24-hour shifts, unpredictable emergency calls, and frequent sleep disruptions.
- Research indicates that 73% of firefighters experience sleep loss during work shifts,¹ averaging only 5.45 hours of sleep per shift.²
- Despite the physically demanding nature of firefighting, approximately 70% of work shifts involve light-intensity physical activity.³
- Limited research has examined how emergency call frequency, sleep disruption, and physical activity relate to occupational exposure and metabolic health biomarkers in firefighters.

STUDY AIMS

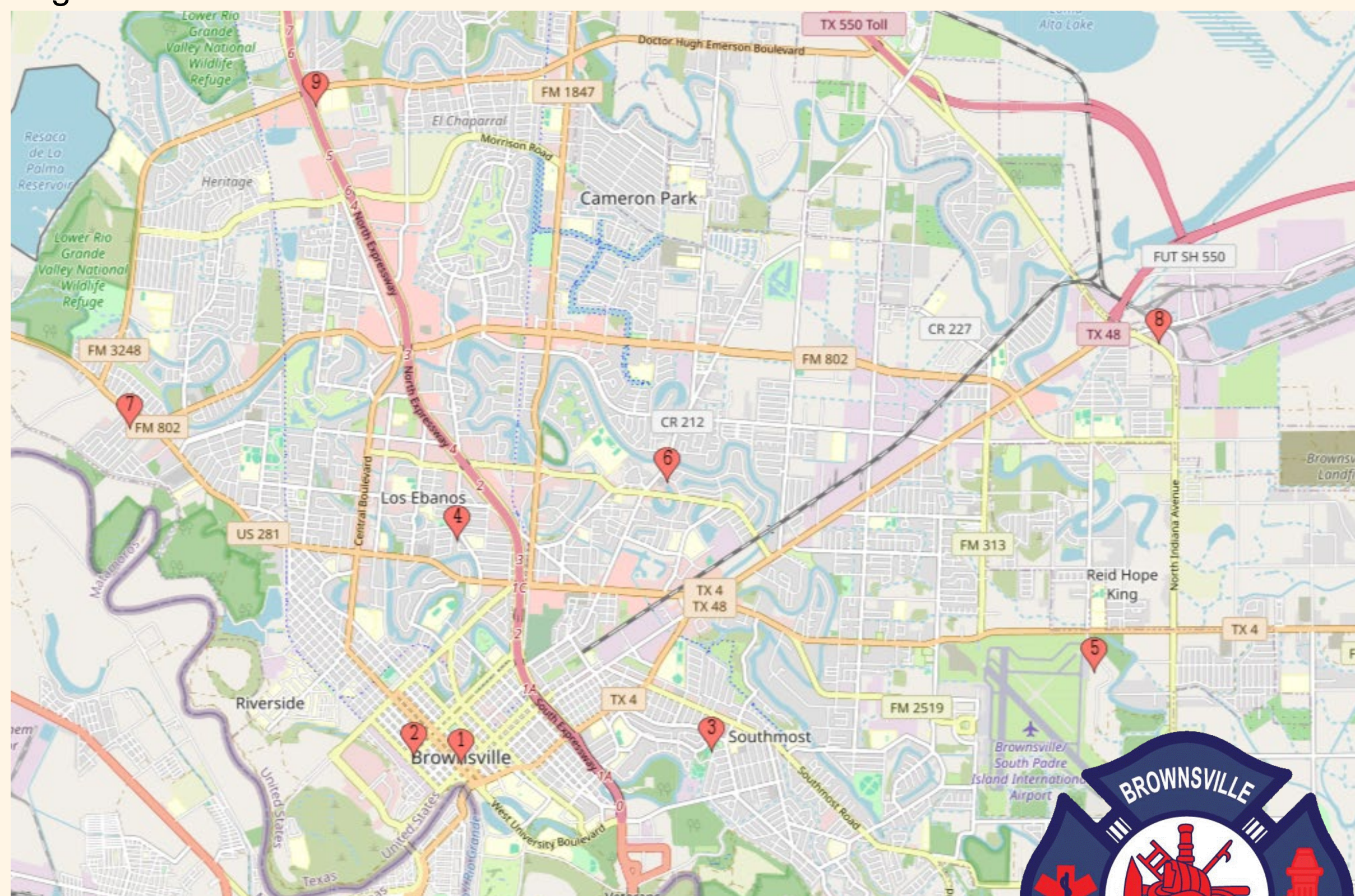
- Primary:** Assess the association of emergency call frequency with sleep patterns and physical activity among firefighters.
- Secondary:** Examine the relationships of sleep quality and physical activity with occupational exposure biomarkers (urinary hydroxylated polycyclic aromatic hydrocarbons [OH-PAHs]) and metabolic health.
- Tertiary/Exploratory:** Compare accelerometer-measured sleep patterns with self-reported sleep assessments from the sleep diary.

PROPOSED STUDY METHODS

Main Geographic Catchment Area

- City of Brownsville, TX

Figure 1: Nine Fire Stations Locations



Data source: Brownsville Fire Stations, Google Map, Mapcustomizer.com

Study Design

- Prospective cohort study

Target Study Sample

- Recruit and enroll 50 career firefighters (ages 18-65) from fire stations in Brownsville, Texas.
- Participants will be recruited from stations with high (n=25) and low (n=25) emergency call volumes.

PROPOSED STUDY METHOD –contd.

Study Procedures

- Recruitment and Enrollment:** Eligible firefighters (aged 18-65) will be recruited from two of the nine participating fire stations in Brownsville, TX, and they will provide informed consent. The study protocol will be reviewed by UTHealth Houston.
- Initial Assessment (Baseline):** Participants will complete questionnaires assessing demographics, occupational characteristics, health history, and sleep quality using the QuestionPro (<https://uthealth.questionpro.com/FFsleepBrownsville>, unpublished) and will be provided an Emergency Service Sleep Diary (ESSD) for 14 days (Fig 2.)
- 14-Day Monitoring:** Participants will be asked to wear a wrist-mounted ActiGraph GT3X accelerometer (Fig. 3) continuously for a minimum 7 consecutive days to 14 days.

ActiGraph GT3X measures sleep duration (total sleep time, TST), sleep onset latency (SOL), wake after sleep onset (WASO), sleep efficiency (SE), nocturnal average wake bout length (WBL), step counts, and physical activity and intensity (Fig. 4).

- Emergency Call Records:** Fire department logs will be used to determine emergency call frequency.
- Biospecimens Collection:** At the end of the 14-day monitoring period, first-morning urine samples will be collected to assess OHPAHs and metabolic biomarkers
- Incentives:** Participants will receive \$50 upon completing the study, as compensation for their time.

Statistical Analysis

- Descriptive statistics
- Multivariable Linear Regression Models
- Linear mixed-effects models

Figure 2: ESSD questionnaire (partial)¹



Figure 3: ActiGraph GT3X model

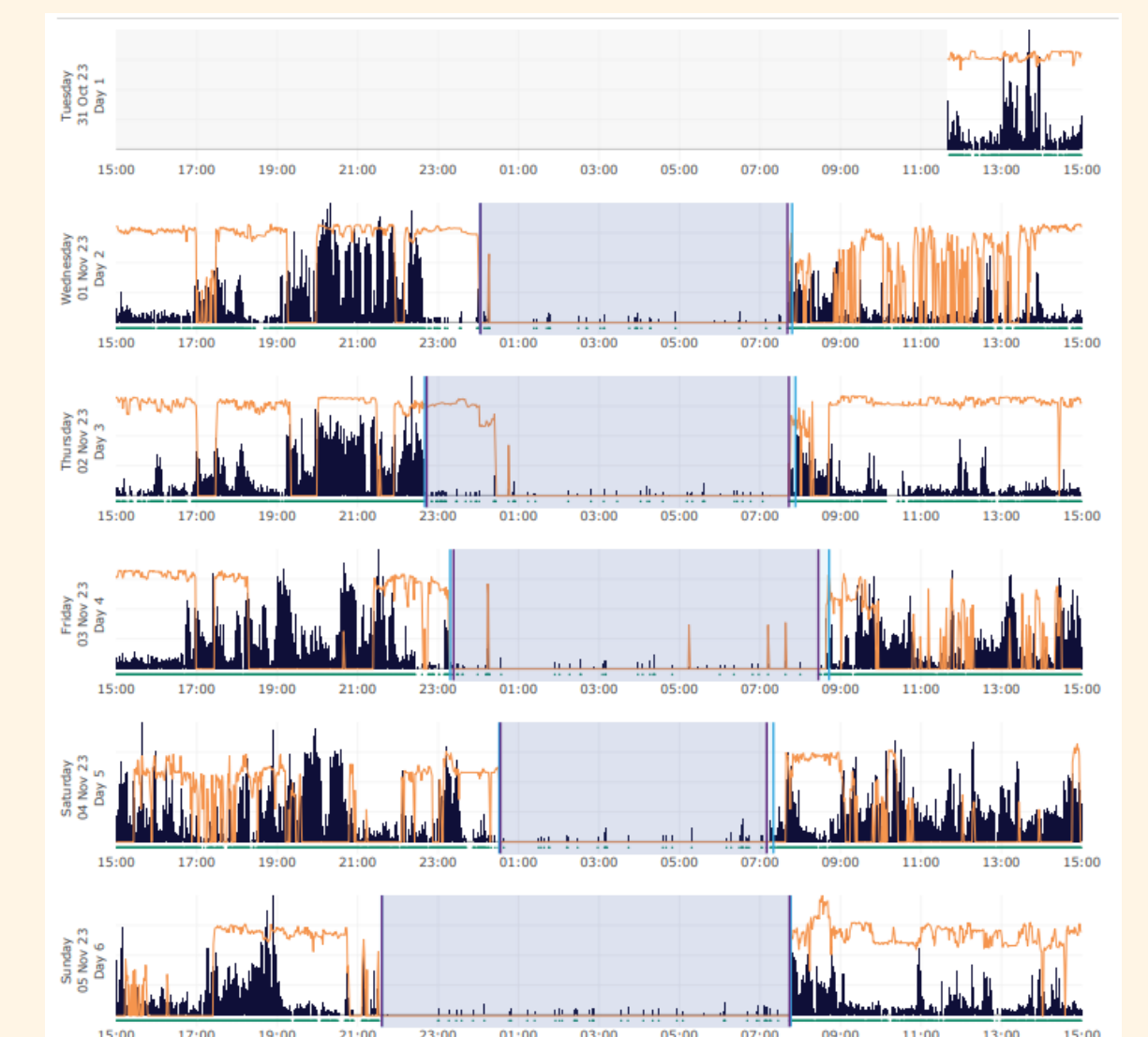
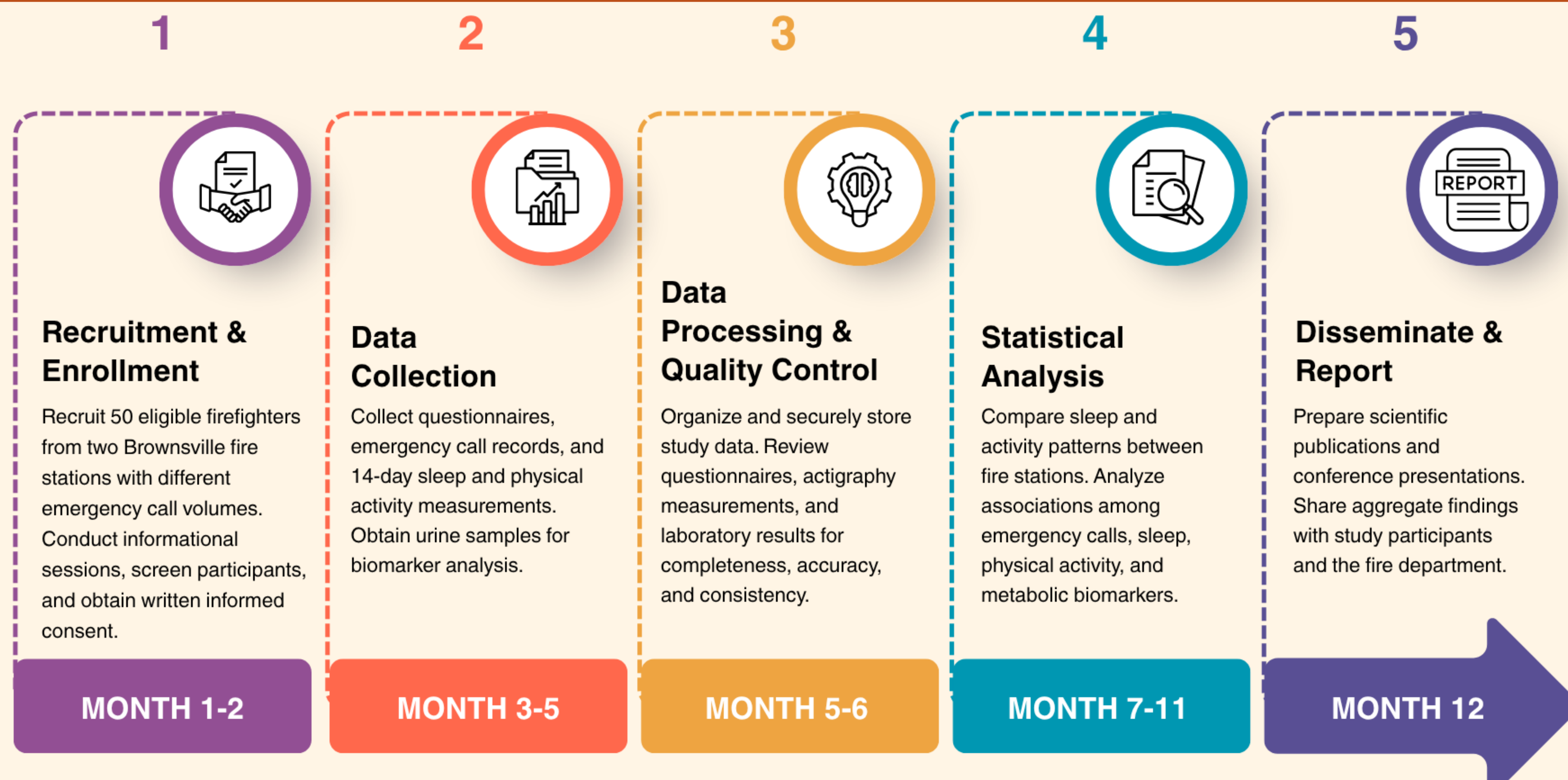


Figure 4: Example data from ActiGraph Report (image source: Activinsights.com)

PROPOSED STUDY TIMELINE



REFERENCES

- Billings, J. & Focht, W. Firefighter shift schedules affect sleep quality. *J. Occup. Environ. Med.* **58**, 294–298 (2016).
- Jelmini, J. D., Gribble, P. A., Abel, M. G., Whitehurst, L. N. & Heebner, N. R. The Influence of Emergency Call Volume on Occupational Workload and Sleep Quality in Urban Firefighters. *J. Occup. Environ. Med.* **66**, 580–589 (2024).
- Barry, A. M. et al. Firefighters Are More Physically Active On-Duty Compared to Off-Duty. *Int. J. Environ. Res. Public Health* **17**, (2020).