Characterizing the Impact of ActiGraph's Idle Sleep Mode on Free-Living Nocturnal Sleep Parameters

Samuel R. LaMunion, Robert J. Brychta, Lindsey A. Smith, Asuka Ishihara, Antoinette Rabel, Ranganath Muniyappa, Kong Y. Chen

Diabetes, Endocrinology, and Obesity Branch, National Institute of Diabetes, Digestive, and Kidney Diseases, National Institutes of Health Intramural Research Program, Bethesda, MD, USA

Background

- Wearable accelerometers are increasingly used to objectively measure physical behaviors in clinical and epidemiological studies. ActiGraph accelerometers are among the most commonly used research-grade wearable devices.

- Idle sleep mode (ISM) is an optional battery-conserving feature unique to some models of ActiGraph accelerometers. Enabling ISM may have implications for post-processing of data.

- According to the manufacturer, when ISM is enabled, the device enters a low-power state and halts recording when acceleration changes < ± 40 milli-g for ≥10 second (ISM engagement). A breach of this acceleration threshold causes recording to resume, and missing data to be imputed with the last acceleration value recorded before ISM engagement.

- To our knowledge, there is limited documentation on the effects of ISM on device-based sleep outcomes.
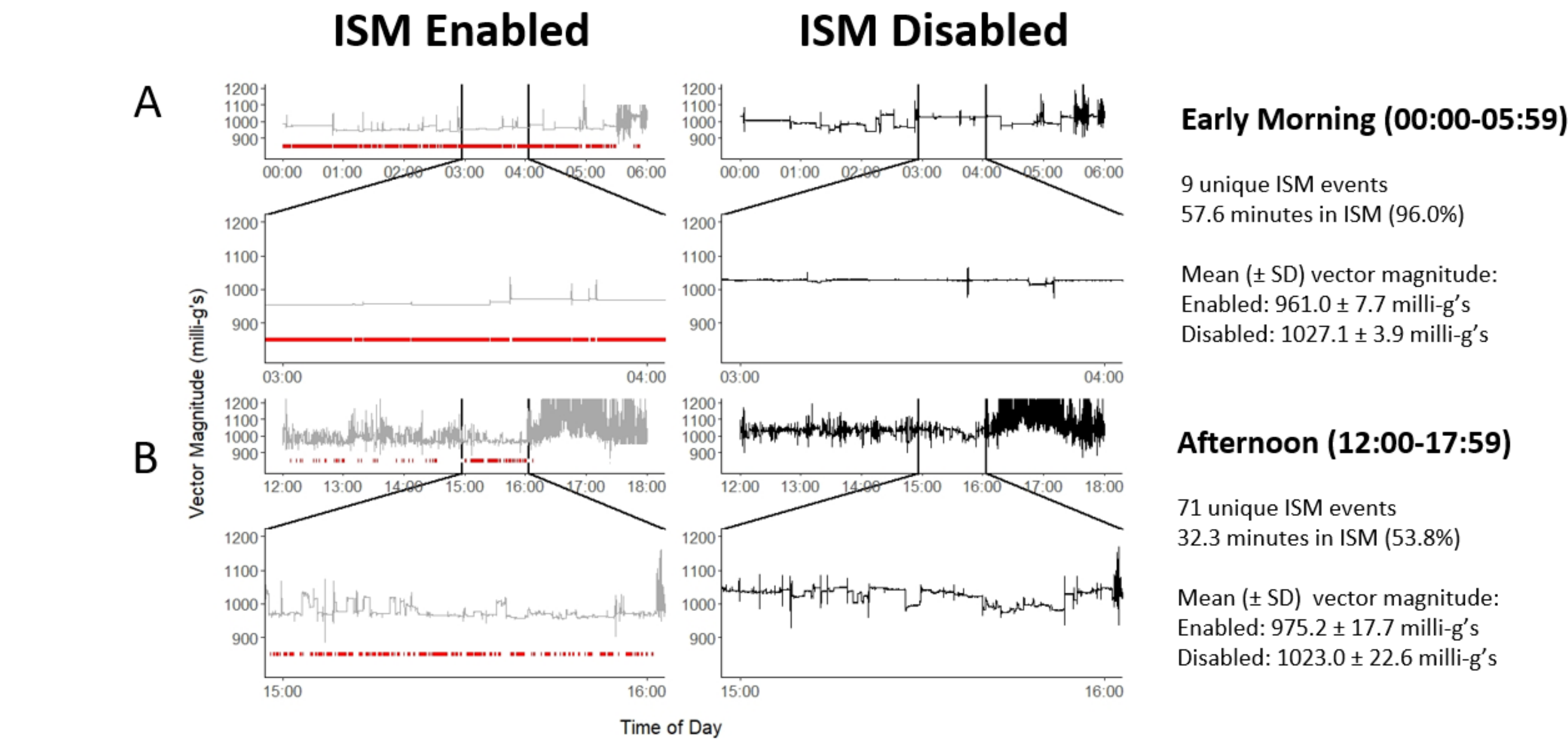

Figure 1. Idle sleep mode (ISM) engagement (red ticks) in raw acceleration vector magnitude (milli-g's) from devices with ISM enabled (left column) and ISM disabled (right column) during a randomly selected early morning (A, 00:00-05:59) and afternoon (B, 12:00-17:59) quadrant of a seven-day continuous free-living assessment. Single-hour zoomed insets within each quadrant are used to highlight ISM events.

Purpose

Aim: To compare the effects of ISM on three frequently used sleep outcomes calculated using two different data formats and scoring methods to better understand the potential for error for ISM-enabled data compared ISM-disabled data.

Methods

We characterized the impact of ISM on free-living sleep behaviors using:

- A 7-day, 24-hr, free-living wear protocol.
  - Two ActiGraph wGT3X-BT devices (80 Hz) worn in a randomized, counterbalanced order on the non-dominant wrist (Figure 2).
  - Data were scored using in two formats:
    - Raw 80 Hz data (.gt3x) were scored in R (version 4.1.2) using *GGIR* (version 2.9.0).
    - 60-second epoch vector magnitude counts were scored using a combination of the Cole-Kripke sleep algorithm (default settings) followed by the Tudor-Locke sleep period detection algorithm in ActiLife (version 6.13.0).
    - Three primary outcomes from both methods:
      - *1) Total Sleep Time (TST), 2) Sleep Efficiency (%), and 3) Wake After Sleep Onset (WASO)*
  - Mixed effects models were used to compare each sleep outcome between the ISM settings (enabled/disabled) for the two scoring methods used (counts/raw).

- Sample Characteristics:
  - N = 35, 26 (74.3%) F, Age: 40.0 ± 14.6 y, Body Mass Index: 29.1 ± 6.5 kg/m^2
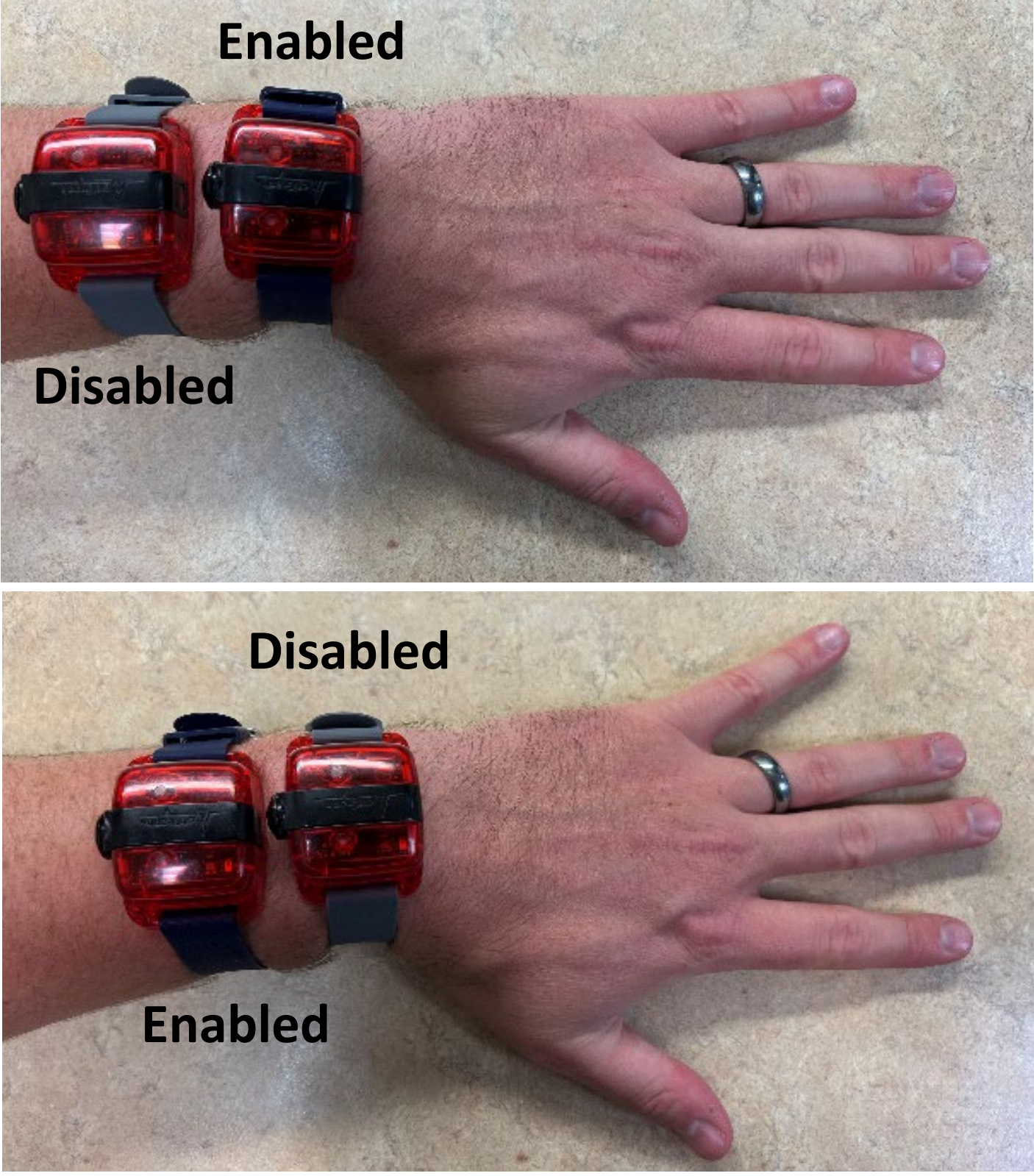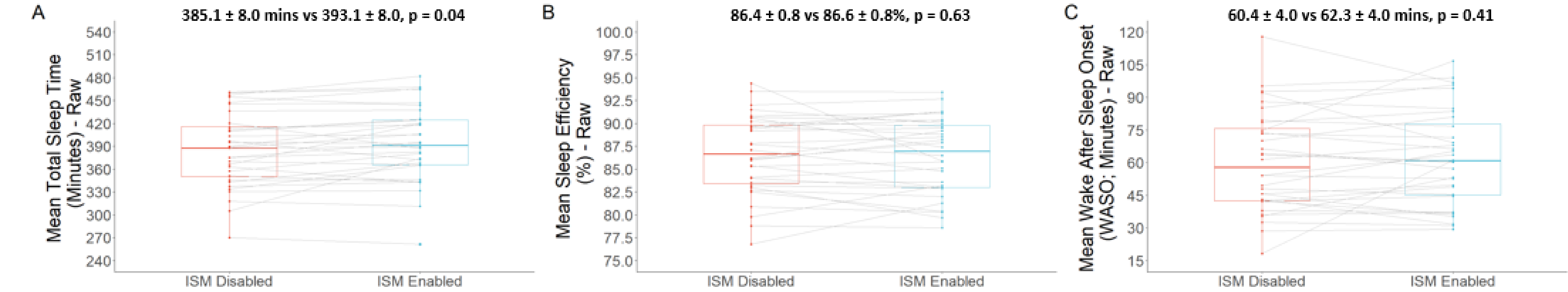

Figure 2. Simultaneous wear of two ActiGraph wGT3X-BT devices, one with ISM enabled and one with ISM disabled, worn in a randomized, counterbalanced proximal/distal order.

Results

Comparison of ISM-Enabled and Disabled Sleep Outcomes From GGIR Applied to Raw 80 Hz Data

Comparison of ISM-Enabled and Disabled Sleep Outcomes From Cole-Kripke and Tudor-Locke Applied to 60-Second Epoch Activity Counts
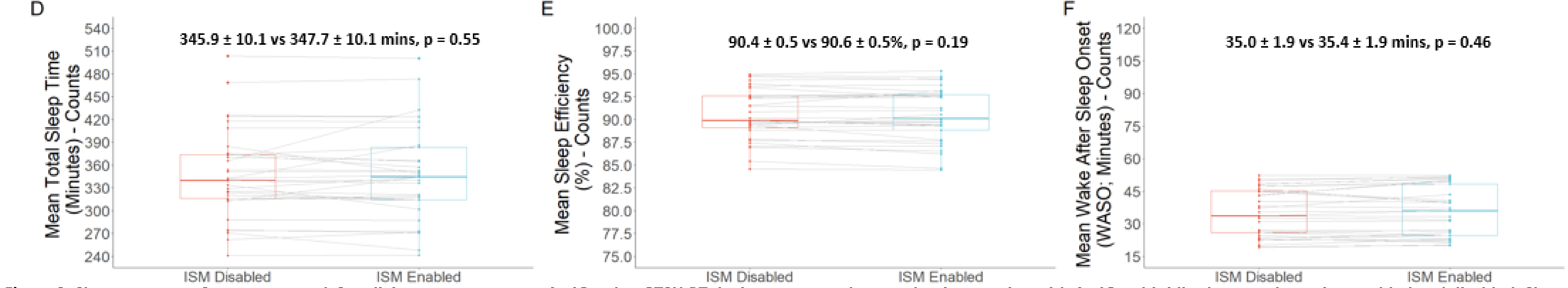
Figure 3. Sleep outcomes from a one-week free-living assessment two ActiGraph wGT3X-BT devices worn on the non-dominant wrist, with ActiGraph's idle sleep mode setting enabled and disabled. Sleep outcomes [total sleep time (TST; A, D), sleep efficiency (B, E), and wake after sleep onset (WASO, C, F)] were scored using GGIR for raw data (A-C) and Cole-Kripke and Tudor-Locke for activity counts data (D-F)

Conclusions

- **In summary, we did not detect clinically significant differences in any of the sleep outcomes between the ISM enabled and disabled devices using two different data formats and sleep scoring methods applied to the simultaneously collected data.**

- **Further investigation is needed to understand the potential impact of ISM on possible differences waking physical behaviour parameters, particularly sedentary behaviour.**

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