

Wearable Sleep Trackers in Occupational Health Psychology

A critical review and illustrative case studies (Part 1)

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16th Conference

European Academy of Occupational Health Psychology

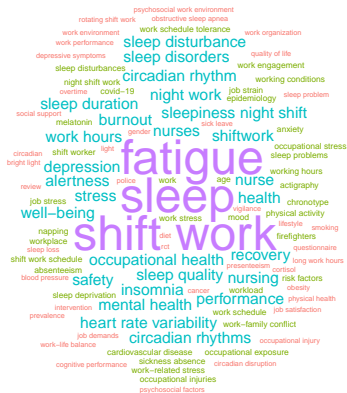
Granada, June 5-7 2024

Symposium: Sleep research trends in occupational health psychology

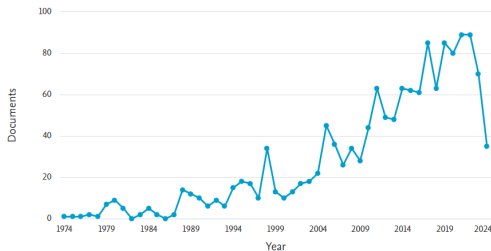


The importance of sleep in OHP research

Increasing use of sleep measures to investigate how psychosocial conditions such as job demands and shift work impact on **sleep/wake patterns & circadian rhythms** and how sleep, in turn, impact on work-related health, safety, and performance.



Documents by year



Scopus search of "work" AND "sleep" in WOP
journals between 1970 and 2024 ($N = 1447$)

Sleep measurement in OHP

🕒 Primarily based on
retrospective self-reports

*How is your sleep quality,
in general?*

📅 Recent increase in the use of
sleep diaries

How was your sleep last night?

❤️ Rarely measured through
objective techniques →

Evolution of ambulatory sleep assessment (ASA) techniques



Portable PSG



Actigraphy



Multi-sensor



Consumer tech

Is it time to include wearable sleep trackers in the applied psychologists' toolbox?



The Spanish Journal of Psychology (2024), 27, e8, 1–5
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Review Article

Is it Time to Include Wearable Sleep Trackers in the Applied Psychologists' Toolbox?

Luca Menghini^{1,2} , Cristian Balducci³  and Massimiliano de Zambotti^{4,5} 

Critical review of state-of-the-art wearable ASA in ~~applied psychology~~ occupational health psychology research and professional practice.

Portable PSG & holters



Polysomnography (PSG)

= multichannel recording of cortical, muscular, and eye-movement activity into 30-sec epochs

Portable PSG

= home-based PSG recording

Holters

= portable electrocardiograph (ECG) monitoring devices

Challenges

- Equipment costs
- Unsuitable for long-term recording (obtrusiveness)
- Technical expertise required
- Poorly used in OHP

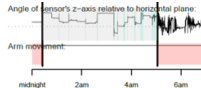
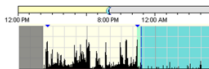


Actigraphy



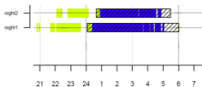
Standard actigraphy

= piezoelectric sensors
quantifying body movements
(‘activities’) and defining
sleep as the absence of motion



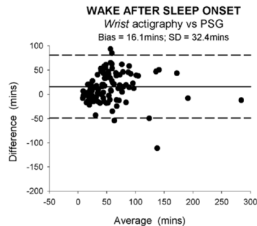
Accepted alternative to PSG
in clinical & research
non-laboratory settings

Validated against PSG
e.g., Cole–Kripke and
Sadeh algorithms



Challenges

- Equipment costs
- Proprietary algorithms (black box)
- Technical expertise required
- Low specificity (unable to detect motionless wake)



Slater et al (2015)

Consumer-grade wearables



Smartwatches and other wearable sensors with sleep tracking features

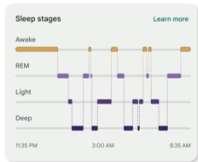
More acceptable & accessible (lower costs, better design, less expertise needed)

Consumer-oriented features (e.g., battery and memory capacity) → large scale

Multi-sensor features integrating acceleration and cardiac activity (PPG)

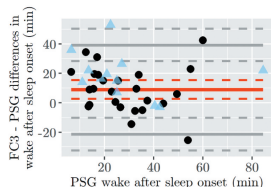
→ sleep staging

→ better accuracy?



Challenges

- Mostly not validated
- Proprietary algorithms (black box)
- Limited access to raw data (low reproducibility)
- Consumer-oriented updates (e.g., firmware version)



Menghini et al (2021)

Towards rigorous evaluation of ASA performance




A standardized framework for testing the performance of sleep-tracking technology: step-by-step guidelines and open-source code

Luca Menghini^{1,2,*,}, Nicola Cellini^{2,3,4,5,6,}, Aimee Goldstone^{1,}, Fiona C. Baker^{1,6,}, Massimiliano de Zambotti^{1,6,}

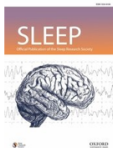


Rigorous performance evaluation (previously, “validation”) for informed use of new technologies for sleep health measurement

Massimiliano de Zambotti, PhD • Luca Menghini, PhD • Michael A. Grandner, PhD • ... Ying Zhang, PhD





Meredith L. Wallace, PhD • Orfeu M. Buxton, PhD •  • [Show all authors](#)

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Review

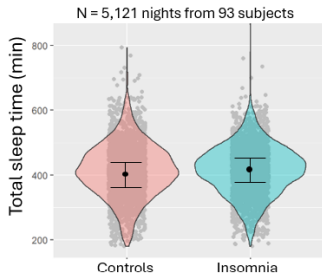
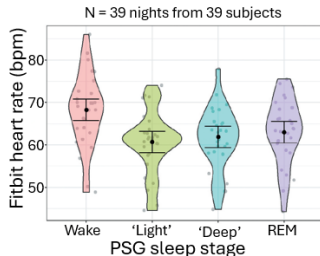
State of the science and recommendations for using wearable technology in sleep and circadian research

Massimiliano de Zambotti^{1,2,3,*,} , Cathy Goldstein^{1,†} , Jesse Cook^{1,}, Luca Menghini^{5,}, Marco Altini^{6,}, Philip Cheng^{2,†} , Rebecca Robillard^{1,5,†} 

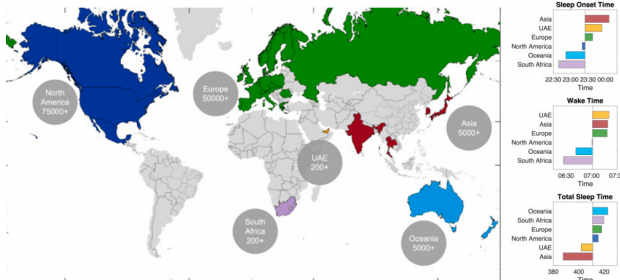
Beyond sleep tracking

2nd generation research-grade & consumer devices

- Optimized wake detection + sleep staging
- Optical detection of night-time cardiac activity and heart rate variability (HRV) analysis
- Cloud-based research services
- Integrated with experience sampling methods (ESM)
 - Needed for accurate analysis (lights-off/on)
 - **Sleep discrepancies** (e.g., paradoxical insomnia objective vs. subjective)



Opportunities for OHP research & practice



Willoughby et al (2023)

50+ million night's sleep from
~220,000 Oura ring users in 35
countries (~242 nights/person)

- Towards **longer-term & larger-scale studies**
- Towards more **reproducible multi-source research** on work-related sleep antecedents & consequences
- Towards **ecological momentary interventions** improving employee health and well-being (e.g., EWP) and reducing work-related injuries (e.g., drivers)

Challenges for OHP research & practice

- Work-in-progress validity varies across devices, populations, and applications
- Getting familiar with device features
e.g., memory & battery capacity (at least 1-2 weeks), cost, sensors, connectivity, device performance
- Black box & data format
Use raw data when available, otherwise use the maximum available resolution (e.g., 1-min)
- Participant burden, compliance, & missing data
- Acceptability & privacy

The Nation.

ACTIVISM / MARCH 12, 2018

The West Virginia Teachers Strike Shows That Winning Big Requires Creating a Crisis

The strikers won all five of their demands by shutting down every public school in the state.

board. Later that year, the board proposed the implementation of Go365, an app that requires workers to wear devices like FitBit that submit tracking data. Workers that refused would face increased health-care costs. Peters notes, "It was a complete, total invasion of our privacy."

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Portable PSG

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Actigraphy

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Consumer sleep trackers

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Thank you!

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R code available from <https://luca-menghini.github.io/pResentations>