SLEEP AND PERFORMANCE TRACKERS AND THE NOCEBO/PLACEBO EFFECT

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OUR CASE

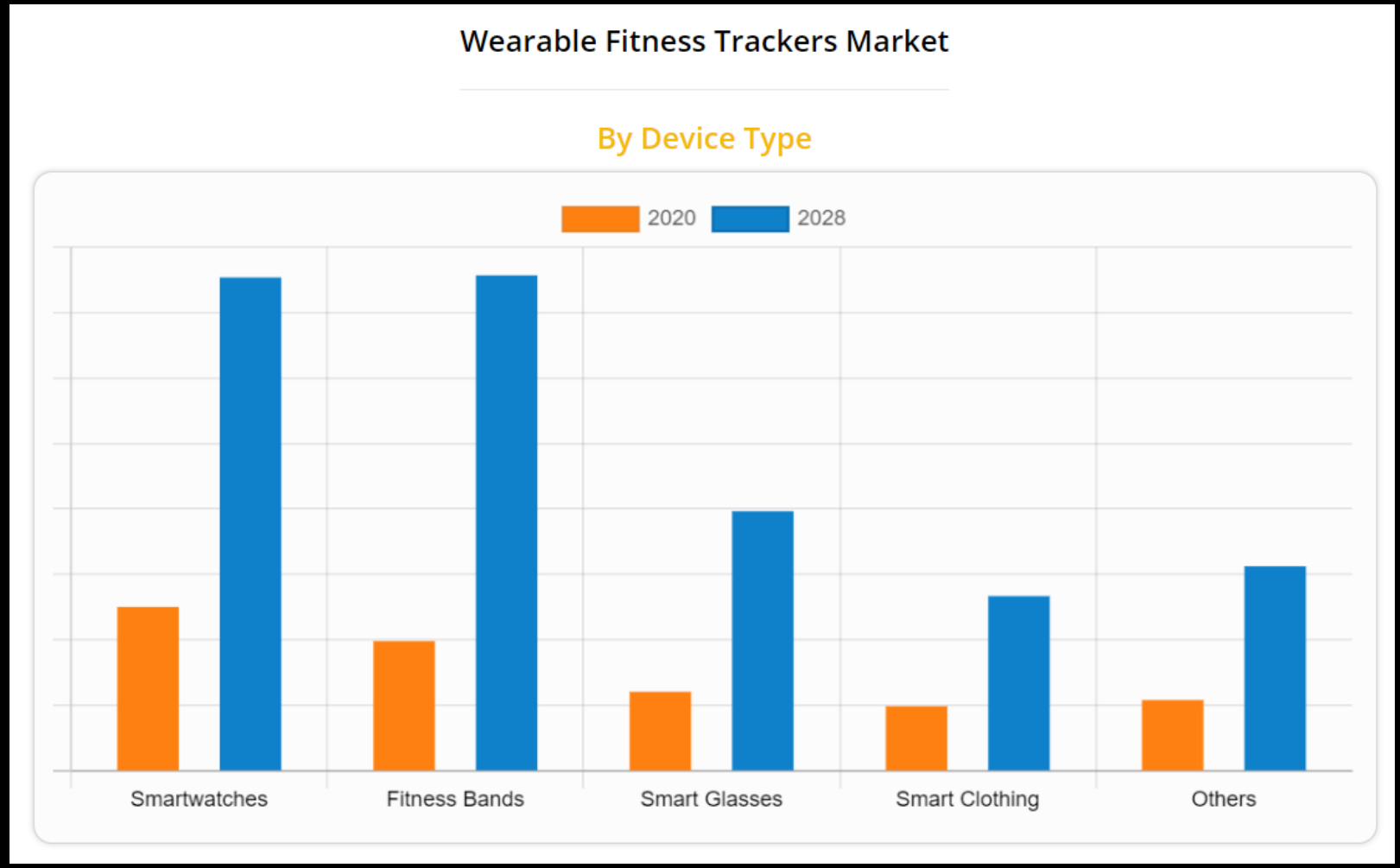
- Michael is a 41 year old private investigator who has concerns over the data his activity-tracking watch is giving him. He says although he feels he is very active, his watch tells him he is not meeting his fitness goals. It has also been telling him his sleep is very broken. Today he is asking for a sleep apnea test and a stress test to assess his cardiovascular fitness even though he says he regularly "runs down bad guys" for his job without any trouble.

OBJECTIVES

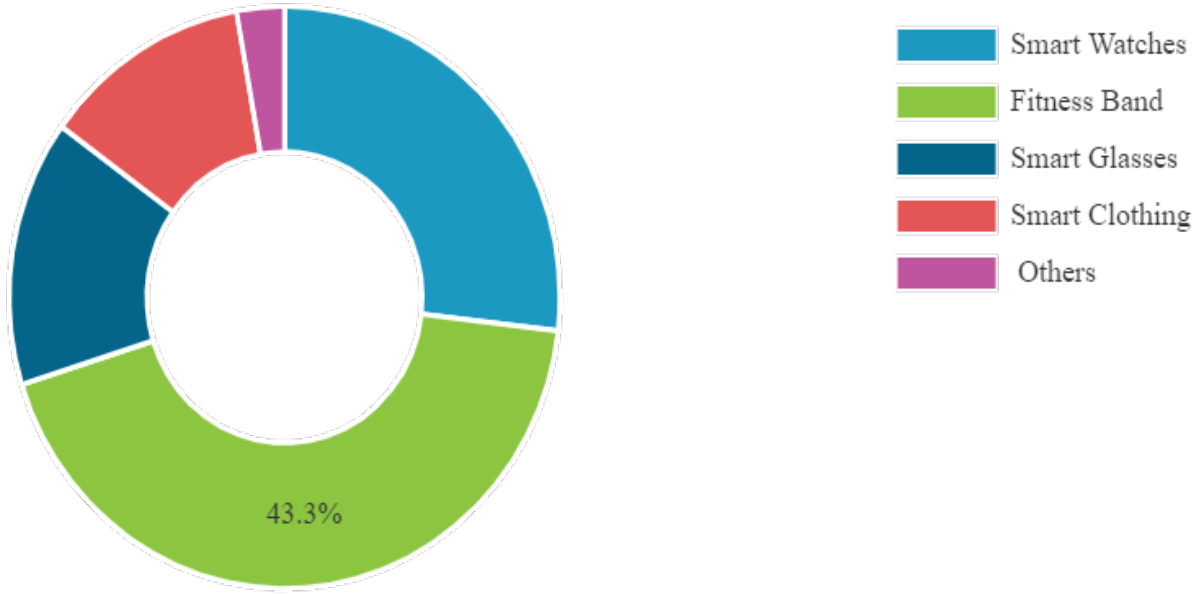
- Review current and popular activity tracking devices currently on the market
- Review concept of nocebo and placebo effect of these devices and activity adequacy mindset, overall health
- Learn about how to interpret and discuss activity tracking information with patients
- This talk will not address the utility of trackers to diagnose or surveil disease

WEARABLES IN THE MARKET

- Introduced to the market in 2013
- Use expected to climb exponentially in the next decade; in 2020: $36B, by 2028 $114B
- More than 10 major manufacturers of wearable activity trackers



U.S Fitness Tracker Market Share, By Device Type, 2020



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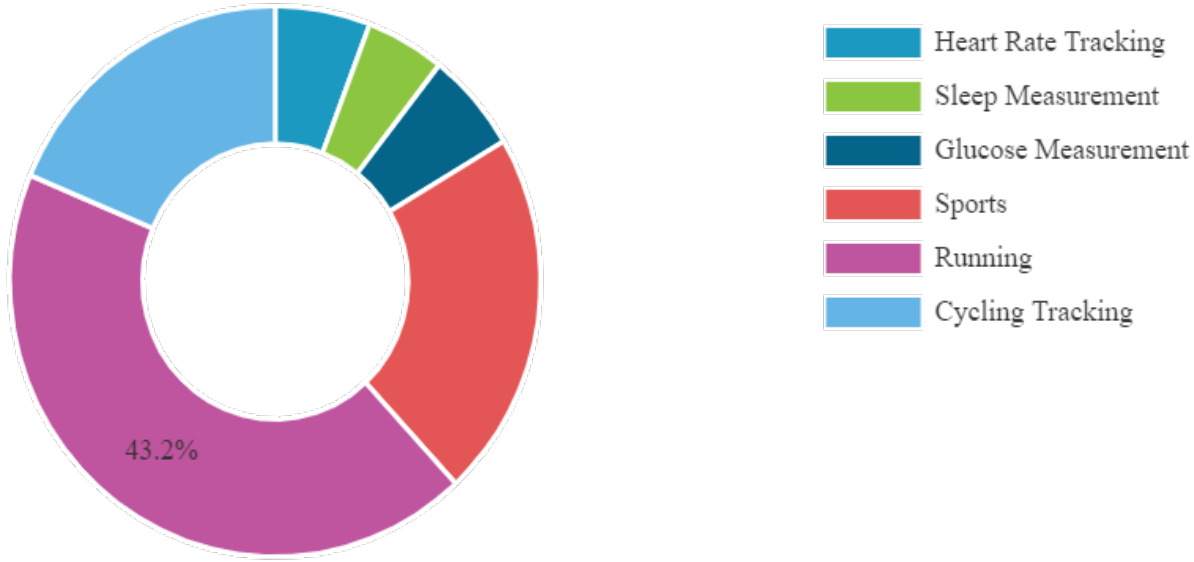
Global Fitness Tracker Market Share, By Application, 2020



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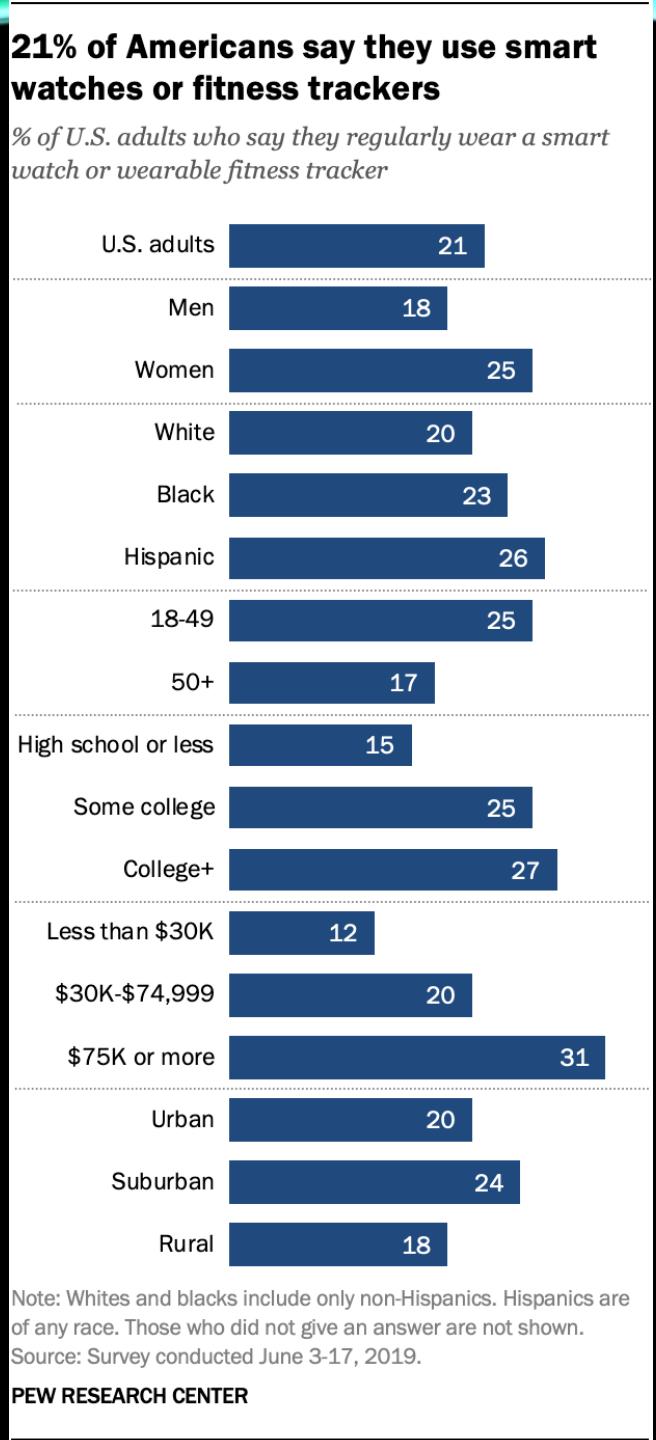
PREVALENCE OF WAT USE BY AMERICANS

By 2020, 1 in 4 Americans reported using a smart watch or tracker

Most approve of use of this information in research

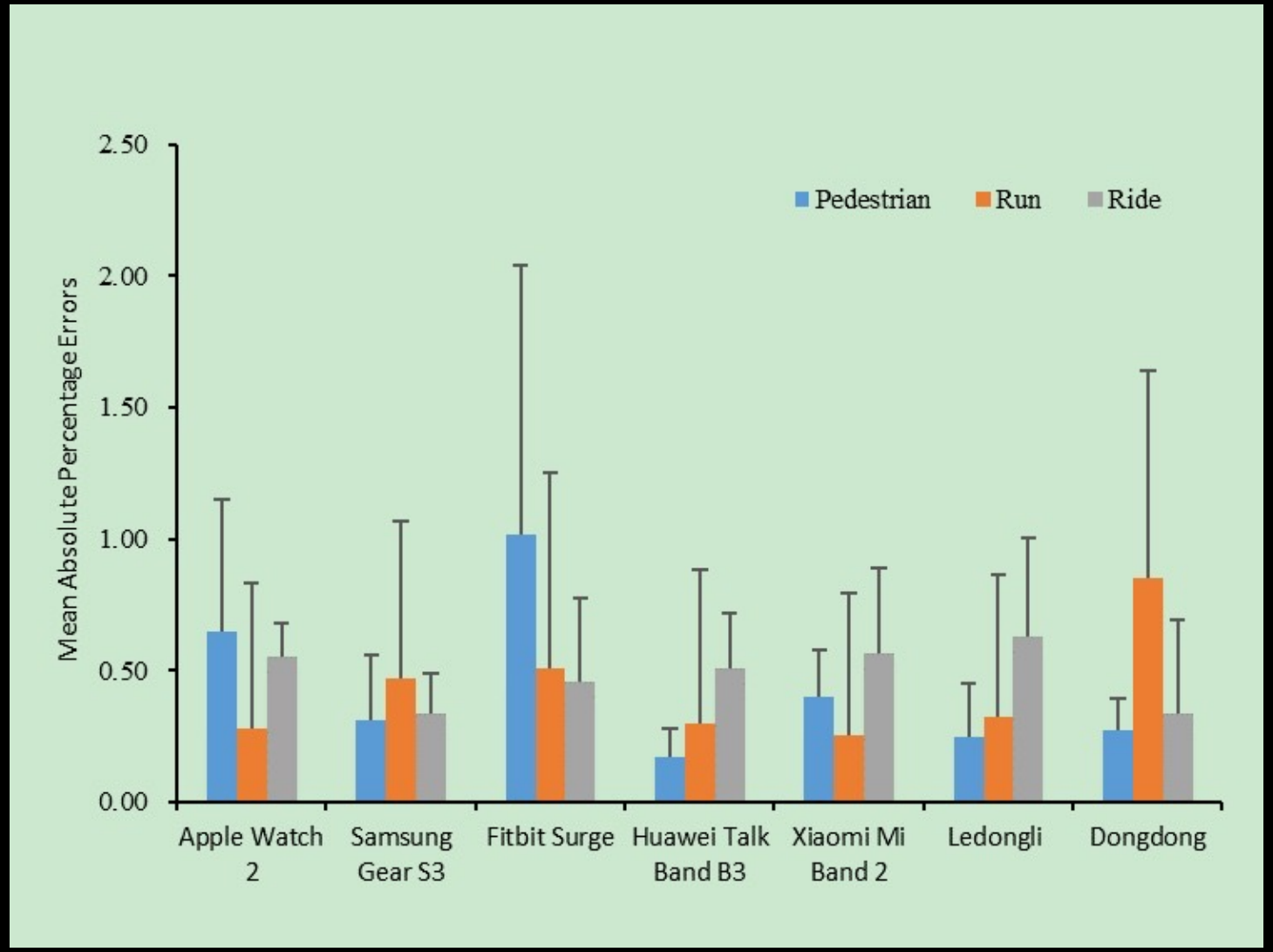
Women, Hispanics and those with higher education and incomes are more likely to use WATs

One meta-analysis of all WAT studies thru 2020 suggested that there is no ideal device model due to the highly variable goals, tech savvy, demographics and health behaviors among users



WATS: IS THE DATA RELIABLE?

- About 44% of research is focused on WAT technologics/reliability and behavior change
- Current data shows that WATs are able to accurately track total steps, distance, and sleep duration but accuracy is *highly variable across brands and activity*
- Literature consistently shows WATs do not accurately track energy expenditure



WATS: IS THE DATA RELIABLE?

- One study that WAS blinded compared a waist-worn Acti-graph accelerometer to a wrist-worn FitBit and showed the FitBit significantly overestimated daily steps
- Most current studies have failed to truly "blind" the participants, allowing them to have access to the tracker info, which impacts their mindset and in turn, their actual activity and habits!
- The same studies have proven this data impacts patients' actual behaviors
- Remember that our behavior changes when we are being measured or observed!

THE PLACEBO AND NOCEBO EFFECT AND THE CONCEPT OF ACTIVITY MINDSET

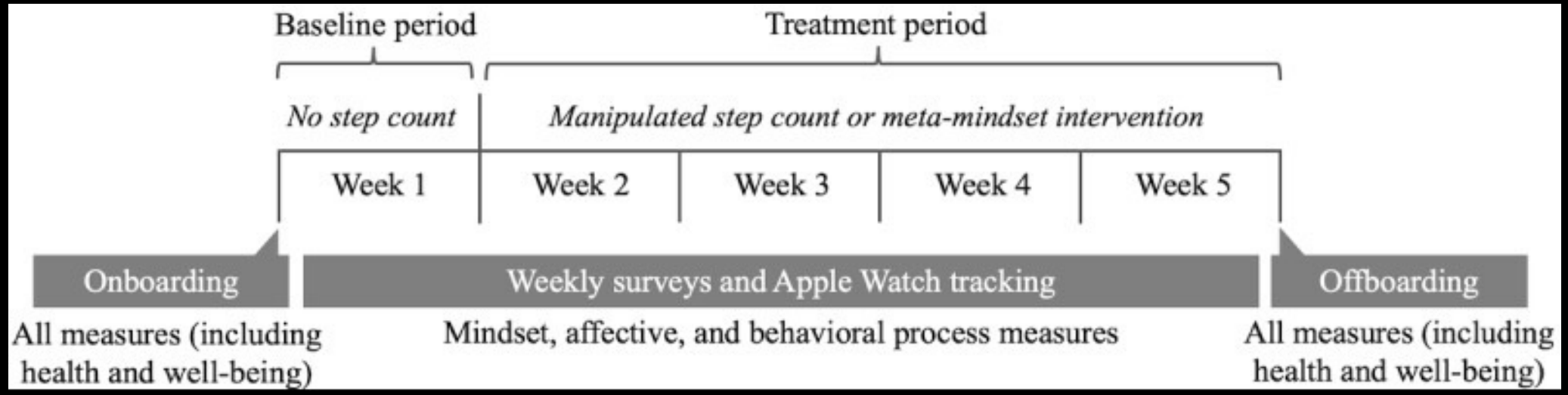
- Think of activity mindset as a person's baseline opinion on their health behaviors
- Data shows a patient's mindset can be:
  - Poorly reflective of a person's actual behavior
  - Can actually impact their overall health
  - Patients (and doctors) may assume their WAT info will make this mindset well-reflective of their true behavior AND incentivize better health behaviors when in fact the opposite could be true
- People who have an **inadequate** activity mindset have a 72% higher mortality than those who have an adequate activity mindset and have poorer cognitive function and higher stress

ACTIVITY MINDSET

- Wearable activity trackers give patients feedback on their health that may or may not accurrately reflect real behaviors or activity
- How patients interpret this information can shape behavior and habits moving forward, either for the positive (placebo effect) or negative (nobebo effect), or have no impact at all
- Patients' fixation on this data can also lead to anchoring or confirmation bias on the part of the patient that can be challenging to undo

THE APPLE WATCH EXPERIMENT

- Participants steps measured at baseline and during a 4 week treatment period to determine if the nocebo effect of the tracker or education on activity mindset would impact activity and health behaviors
- Interventions:
  - Manipulated (increased or decreased 40% from actual) step count
  - Mindset intervention where videos asked participants to notice, count and celebrate healthy activity events



RESULTS

- No manipulated step count
  - Improved mental health, self-esteem and adequate activity mindset
  - →true placebo effect
- Elevated step count
  - Decreased actual step count
  - Increased reported level of activity
  - Worse adequate activity mindset (not statistically significant)
- Depressed step count
  - Decrease in mental health, self-esteem, activity mindset and physiological health (none statistically significant)
  - Worse dietary intake (less produce, more fat)
  - →true nocebo effect

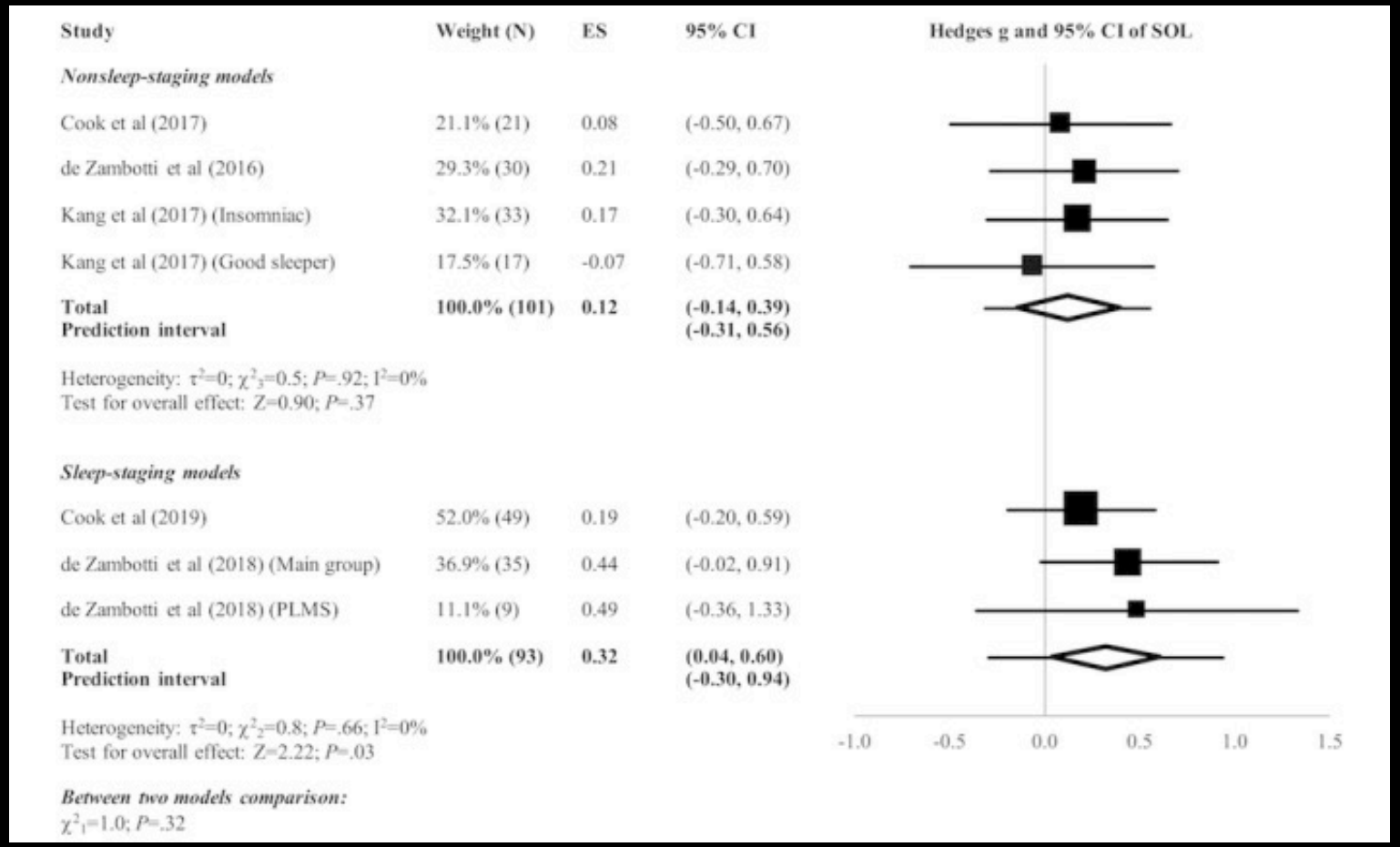
- Mindset intervention with accurate step count improved perception of functional health (ie: ability to engage in ADLs, pain levels) and improved self-esteem, but no change in actual physical activity
- Takeaway:
  - education on adequate activity mindset may be a great first step for patients who need motivation but do not wear trackers
  - Inaccurate data is likely ***worse*** than no data

ACCURACY OF SLEEP TRACKERS

- Sleep trackers tend to use simply accelerometers (some also measure HRV) and proprietary software algorithms to determine sleep duration and sleep staging
- These algorithms are not made available to the public
- Most studies find devices accurate for sleep duration alone, and not for sleep efficacy or staging, and on the whole ***over-estimate*** sleep duration (PMID: 35622397, PMID: 27043070, PMID: 31626361)

THE FITIBIT EXPERIMENT

- Overall both the nonsleep-staging and sleep-staging models ***overestimated*** total sleep time and sleep efficiency and ***underestimated*** wake after sleep onset compared to polysomnography



WATS USE IN ATHLETES—FANTASTIC REVIEW ARTICLE

- "The organization of this review is structured around discussing the value wearable sensors provide in sports to monitor player activity levels and mitigate injury"
- Discusses the use of tri-axial accelerometers that can measure speed over time and GPS that can measure athlete position within 1m
- Discusses the Catapult device which also has gyroscope and magnetometer to allow measurement of impact forces as well
- This is useful in predicting and preventing injury

nature › npj digital medicine › review articles › article

Review Article | Open Access | Published: 29 July 2019

Wearable sensors for monitoring the internal and external workload of the athlete

Dhruv R. Seshadri, Ryan T. Li, James E. Voos, James R. Rowbottom, Celeste M. Alfes, Christian A. Zorman & Colin K. Drummond

npj Digital Medicine **2**, Article number: 71 (2019) | Cite this article

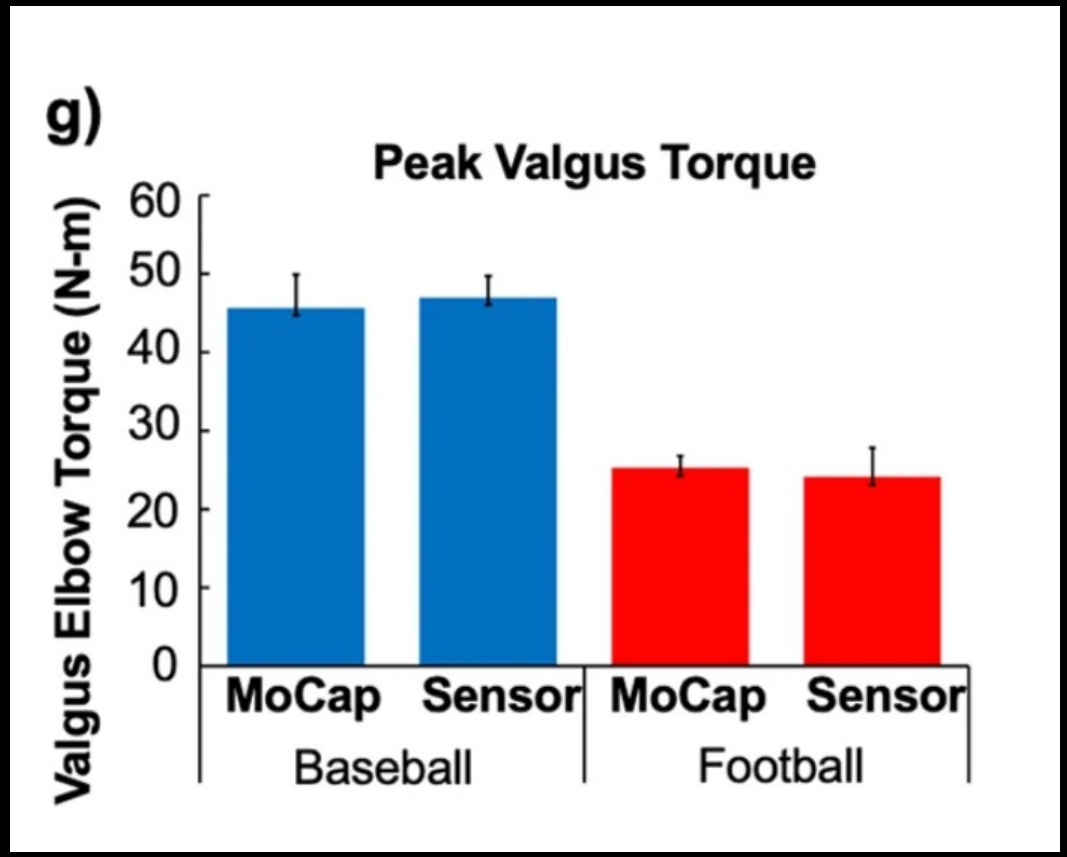
33k Accesses | **99** Citations | **32** Altmetric | Metrics

Abstract

The convergence of semiconductor technology, physiology, and predictive health analytics from wearable devices has advanced its clinical and translational utility for sports. The detection and subsequent application of metrics pertinent to and indicative of the physical performance, physiological status, biochemical composition, and mental alertness of the athlete has been shown to reduce the risk of injuries and improve performance and has enabled the development of athlete-centered protocols and treatment plans by team

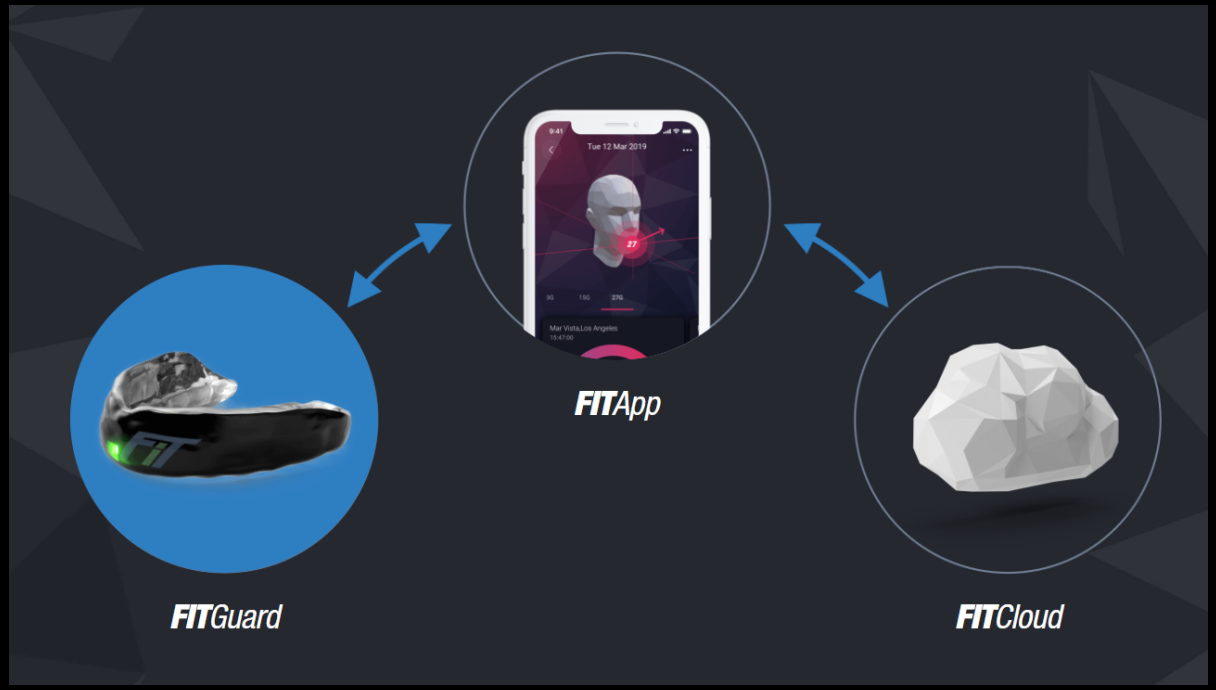
WATS USE IN ATHLETES

- Impact detection: being used in helmets, mouthguards, equipment in contact sports
- Biomechanics detection: being used in pitchers to lessen UCL strain, and in pivot sports to lessen ACL strain
- Heart rate: chest worn monitors were the most accurate across broadest range of activity; in development: wearable textiles for HR
- Sleep measurement: again showed variability among devices, accuracy only in total sleep time and that PSG remains the gold standard for sleep assessment



WATS ALREADY USED IN COLLEGE AND PROFESSIONAL SPORTS

https://fitguard.me/how-it-works/fitguard/



https://www.catapultsports.com/solutions/optimeye-s5

WHAT DO WE TELL MICHAEL?

- WATs are rarely accurate at estimating energy expended so we recommend he simply keep a journal of his exercise to help him notice and credit himself with these active periods; he explains his "car secretary" will be able to do that for him
- WATs are poor at detecting sleep quality, but his tracker is detecting broken sleep which could indicate movement at night; we refer him for a sleep apnea test and assure him that if this test in normal, he sleep is also sufficicent as long as he gets at least 8 hours of sleep opportunity and we suggest he journal this as well

Everett Collection/ Wikipedia

MAIN TIPS FOR PATIENTS

- Devices are variable in their accuracy from activity to activity
- Patients should not assume that their data is an accurate reflection of their true activities and should not become attached to the data
- Patients should not assume that there is accuracy from brand to brand
- Step count is over-estimated for wrist-worn devices
- Energy output is not a reliable metric on these devices, nor is sleep quality
- Consider ignoring sleep duration on devices unless bed and wakeup times are manually entered in devices
- Patients should not assume their data remains private

MAIN TIPS FOR PATIENTS

- The body part on which the WAT is worn impacts accuracy
- Use of a WAT and its information will likely change your health behaviors (at least short-term), probably for the better
- A WAT may be better used as an accountability device instead of a health tracker for a recreational athlete
- Ex: a patient with chronic fatigue and apoor sleep routine may benefit from seeing consistently late-night time of sleep onset and realize he is not giving himself sufficient sleep opportunity to feel rested each day
- Emerging data suggests high-tech wearables are able to predict injury, inform return to play and enhance training in elite and professional athletes

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