# Biomarker, Sleep, and Activity Patterns Data: Insights for Personalized Recommendations

Svetlana Vinogradova, PhD

InsideTracker

# OUR MISSION

## Our goal is to improve the quality of life

- by giving nutrition and lifestyle advice
- based on scientific research and data

This is our version of making the world a better place

# RECOMMENDATIONS INPUTS QUALITY AND VALIDITY

| Data source | Dynamic / Static | Data Frequency | # of Users | Actionability |
|---|---|---|---|---|
| Blood biomarkers | Dynamic | Every 3-12 months | Everyone | Very High |
| Genetics | Static | Once in a life time | 30 million | Currently Mid |
| Activity tracker | Dynamic | Every second | 100’s of millions | Low |
| Microbiome | Unclear | Not clear | Few | Currently Low |

Microbiome

Genetics

Activity Tracker

Blood biomarkers

# RECOMMENDATIONS INPUTS: ACTIVITY TRACKERS

Microbiome

Genetics

Activity Tracker


Blood biomarkers


https://www.theguardian.com/lifeandstyle/2018/sep/03/watch-your-step-why-the-10000-daily-goal-is-built-on-bad-science

In 1960s, Japanese company Yamasa designed the world's first wearable step-counter, a device called a manpo-kei, which translates as "10,000-step meter"

**Why 10,000? Does it fit everyone?**

# RECOMMENDATIONS ARE BASED ON YOUR DATA

Blood test + DNA + activity

Analysis of 1000's of recommendations based on scientific research

Personalized recommendations

# FOLLOWING YOUR PROGRESS

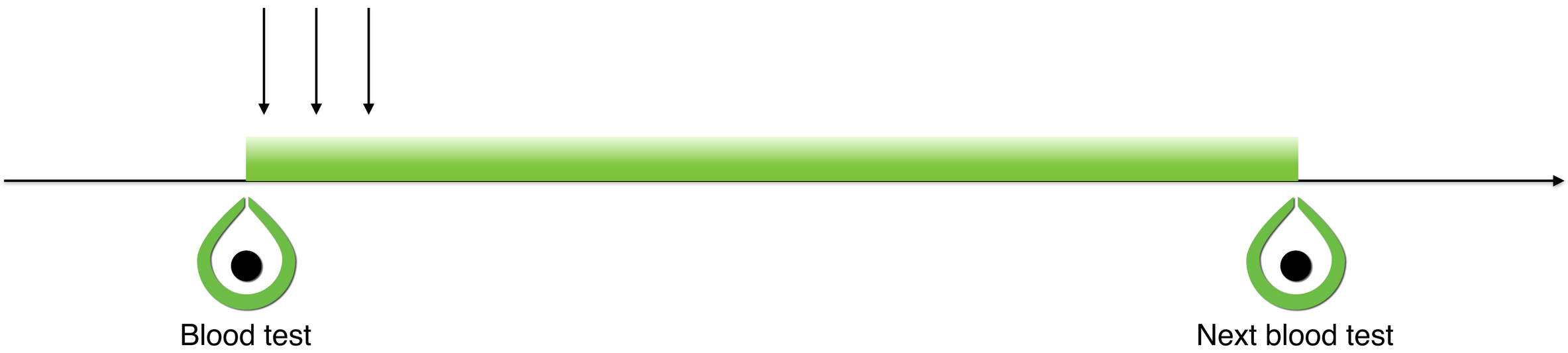
- How do we track your progress over time?


-Questionnaire (check-ins)

-Next blood test

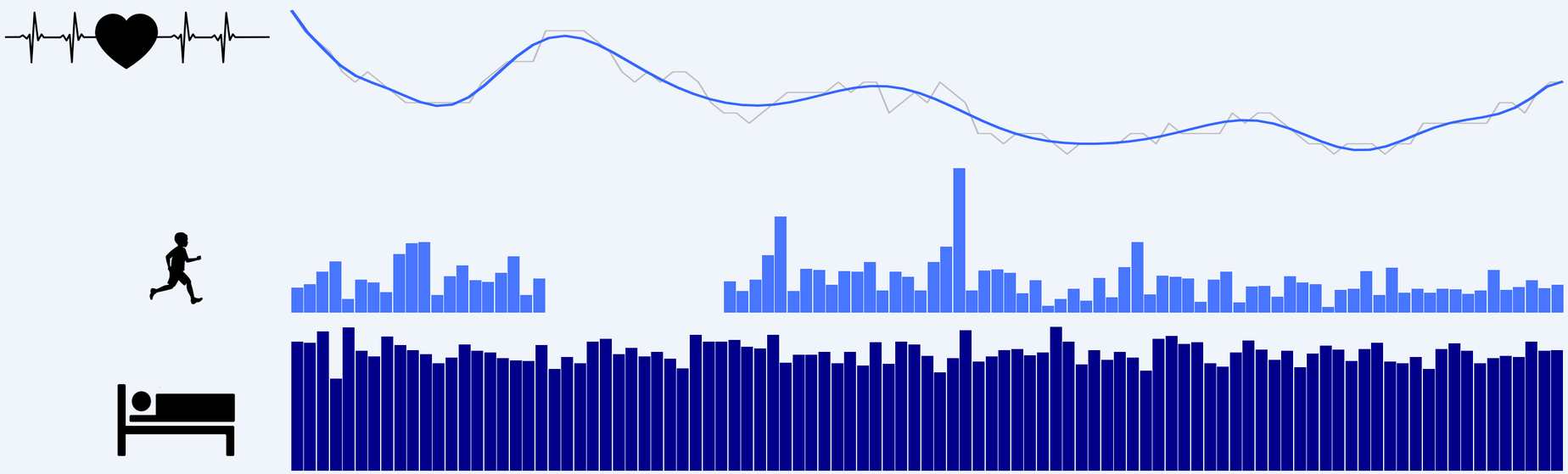
-Objective data from wearables

# FOLLOWING YOUR PROGRESS

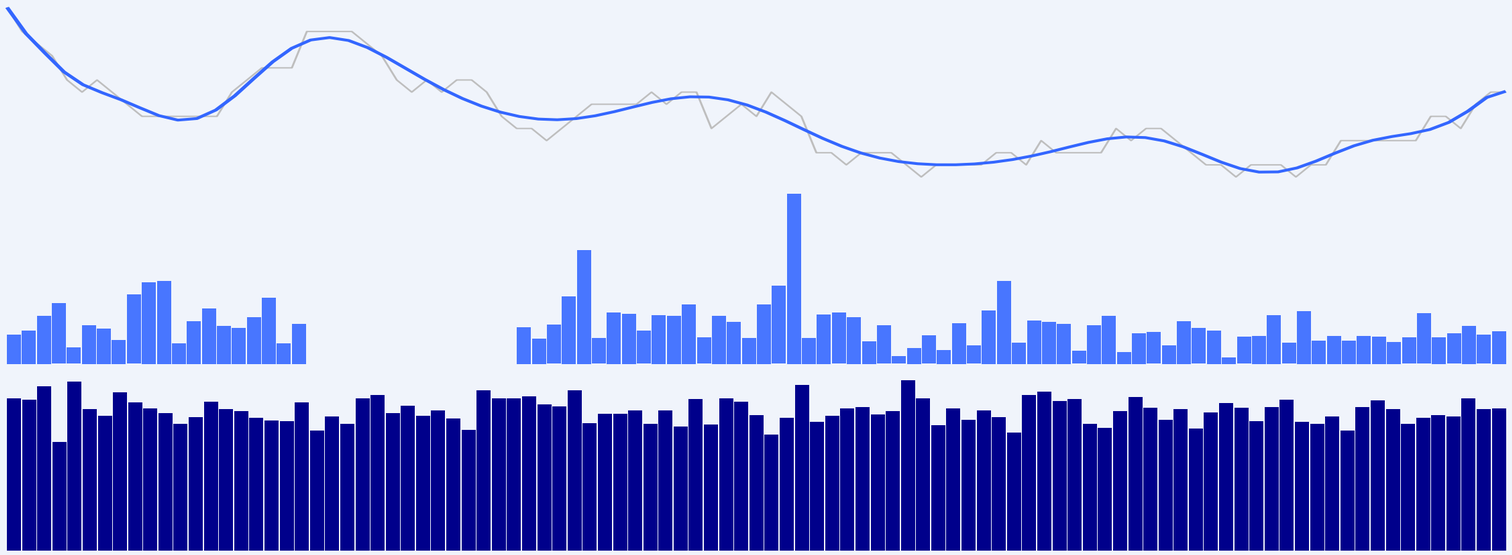


Blood test

Next blood test

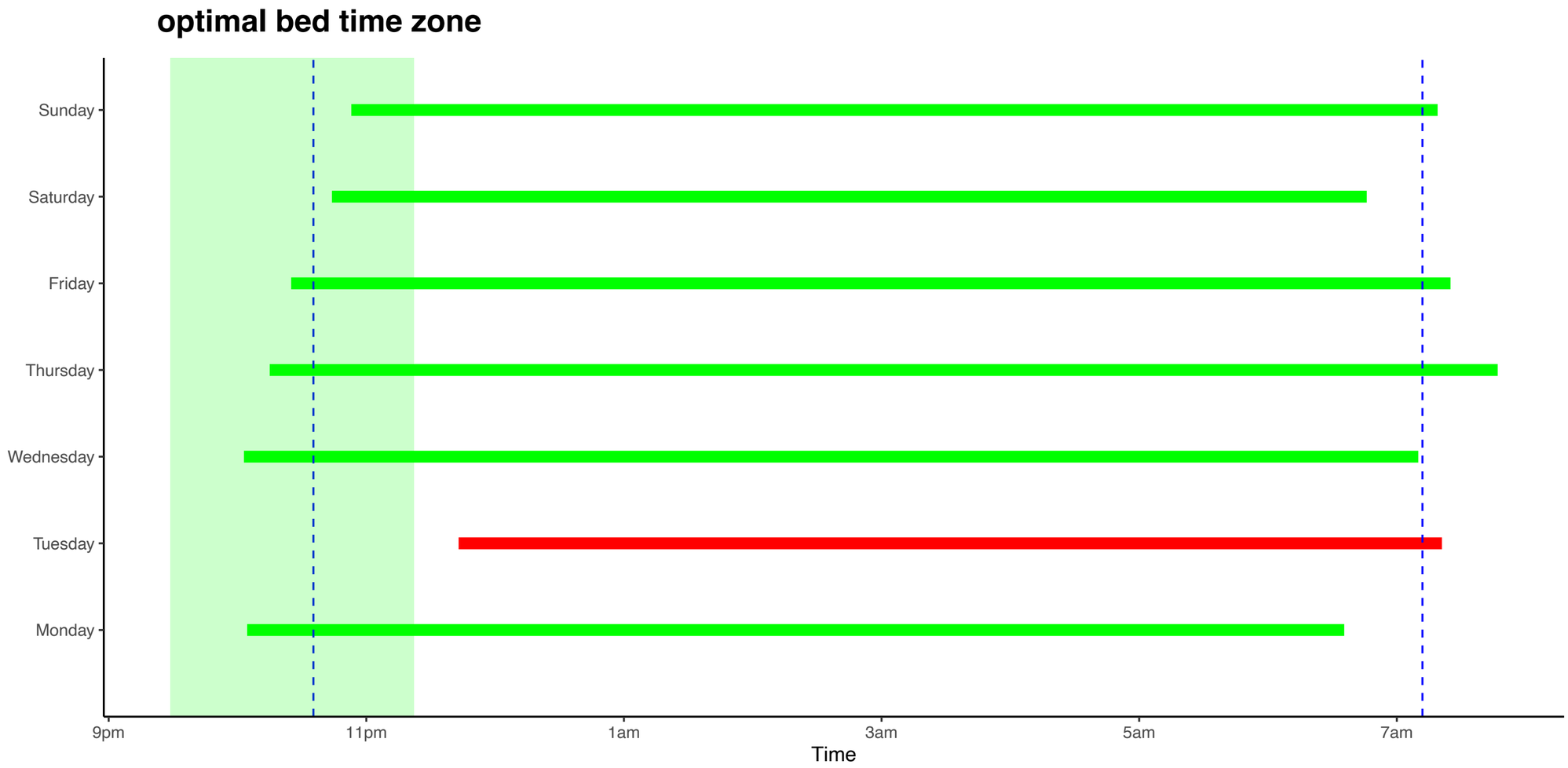


# ACTIONABLE DATA FROM WEARABLES



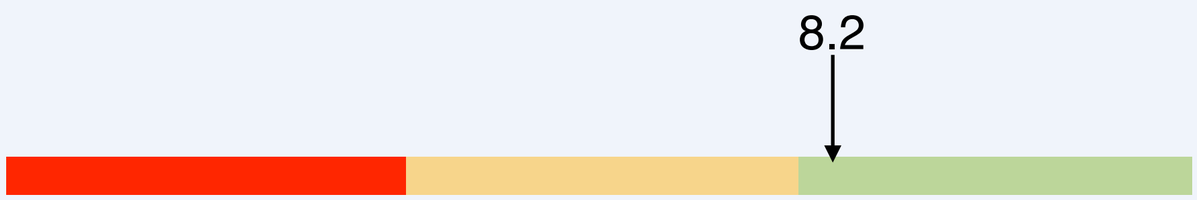
- Sleep recommendations: improve sleep quality and sleep hygiene
- Activity recommendations: optimize your training schedule and volume
- Resting heart rate: get you in your optimal heart rate zone

# SLEEP DATA: BED TIME




We develop sleep scores based on

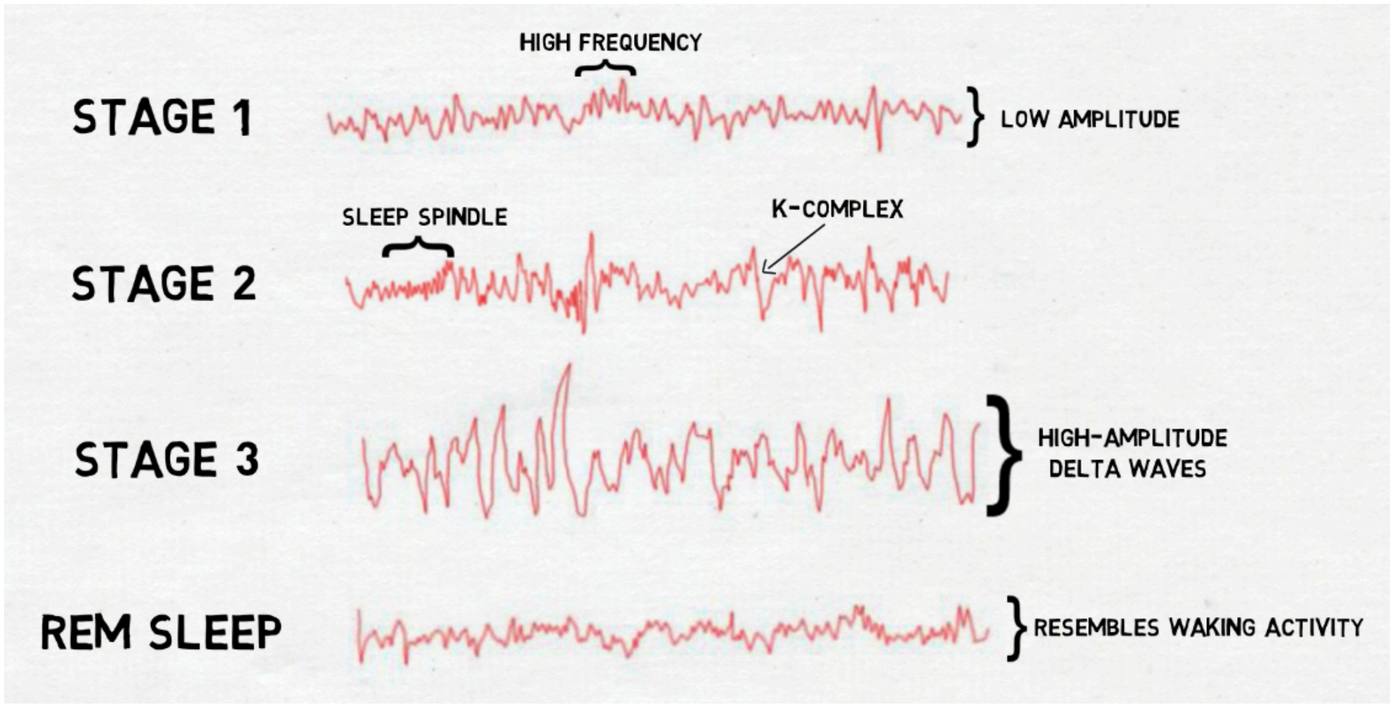
- Bed time consistency
- Sleep duration
- Overall sleep quality



# SLEEP DATA: STAGES

- Sleep stages are defined based primarily on the measurement of electrical activity in the brain using an electroencephalogram, or EEG

- EEG represents fluctuations in brain electrical activity in voltage as a wave with variable frequency and amplitude




- Wearables: based on **night-time heart rate** and **movement patterns**, wearables are able to provide estimates on how much time you spend in light, deep, and rapid eye movement (REM) sleep

https://www.neuroscientificallychallenged.com/blog/2-minute-neuroscience-stages-of-sleep

# SLEEP STAGES

## REM sleep

- Your heart rate tends to increase during REM sleep and breathing may become irregular
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- Deep sleep is crucial for physical renewal, hormonal regulation, and growth
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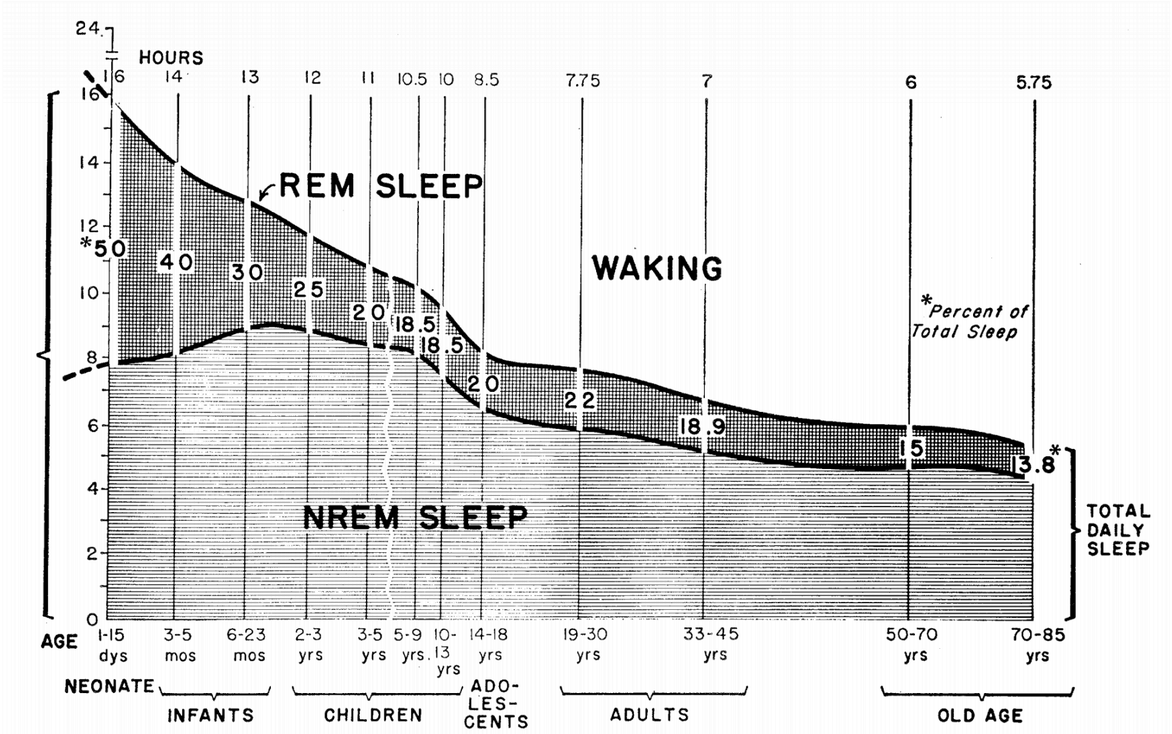
## Light sleep

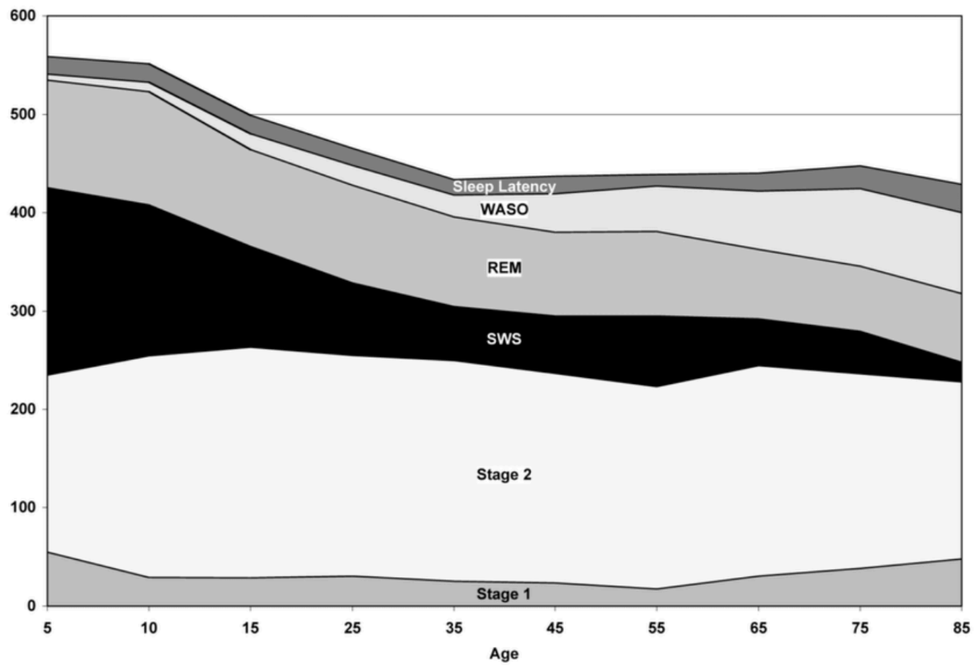
## Awake time

# SLEEP STAGES VERSUS AGE

- How much time do you need to spend in each sleep zone?
- Does it change with age?
- Does it depend on gender or ethnicity or anything else?

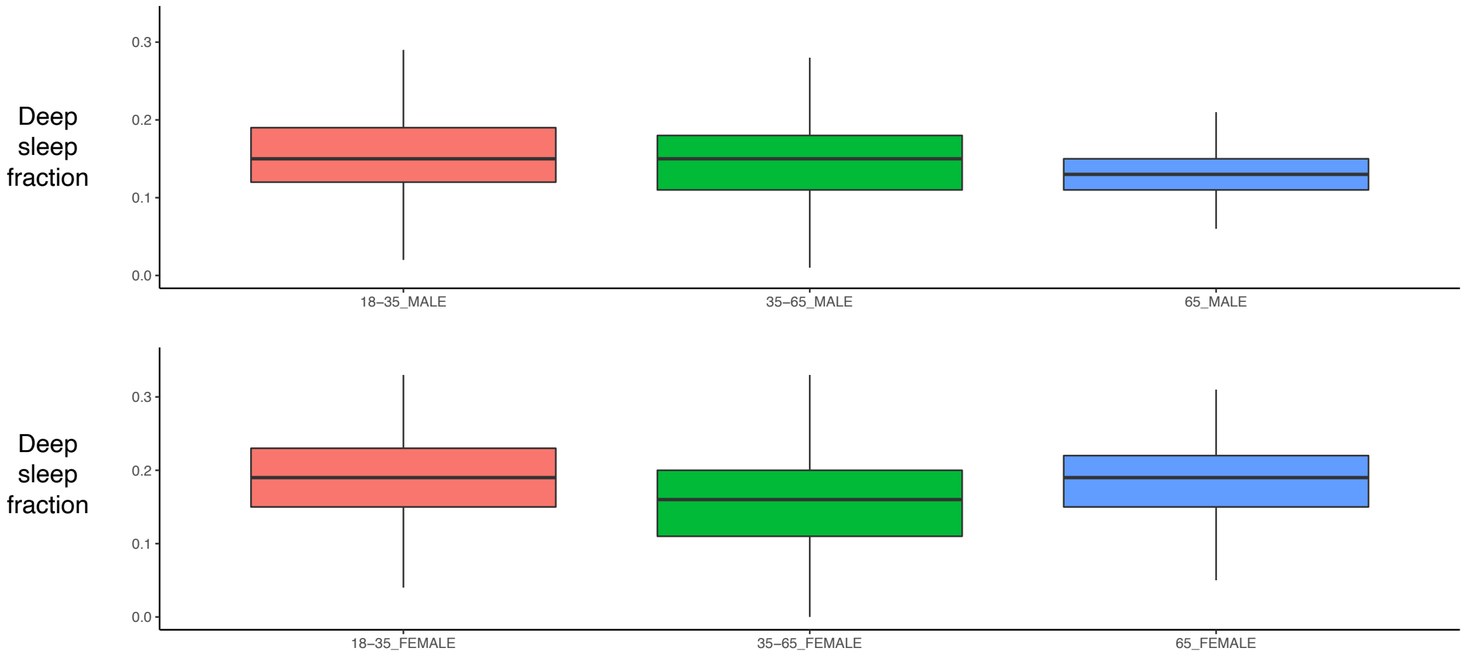


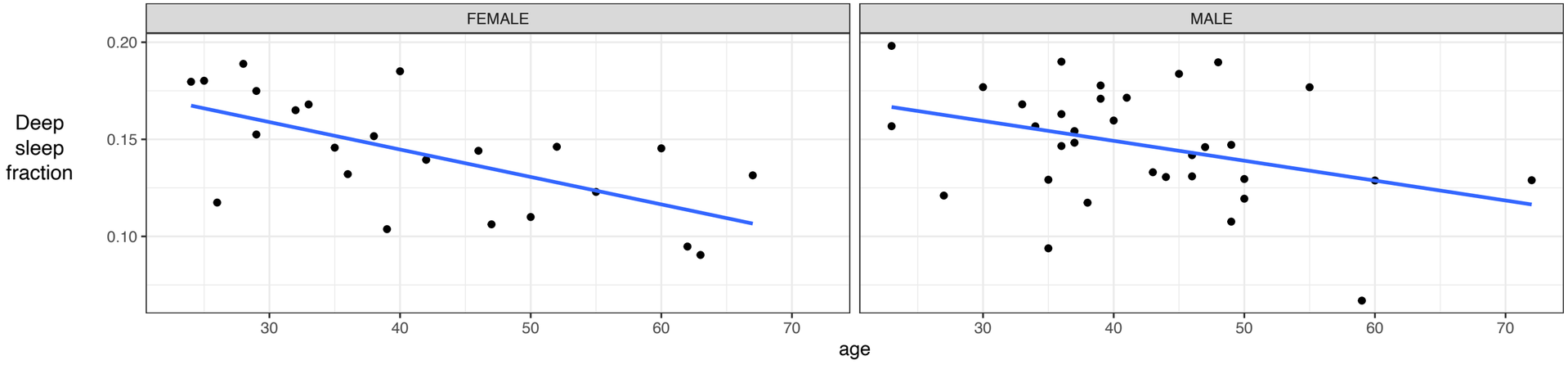

*Roffwarg, H. P., Muzio, J. N., & Dement, W. C. Ontogenetic Development of the Human Sleep-Dream Cycle.*




*Roenneberg T, Kuehnle T, Juda M, Kantermann T, Allebrandt K, Gordijn M, Merrow. M. Epidemiology of the human circadian clock.*

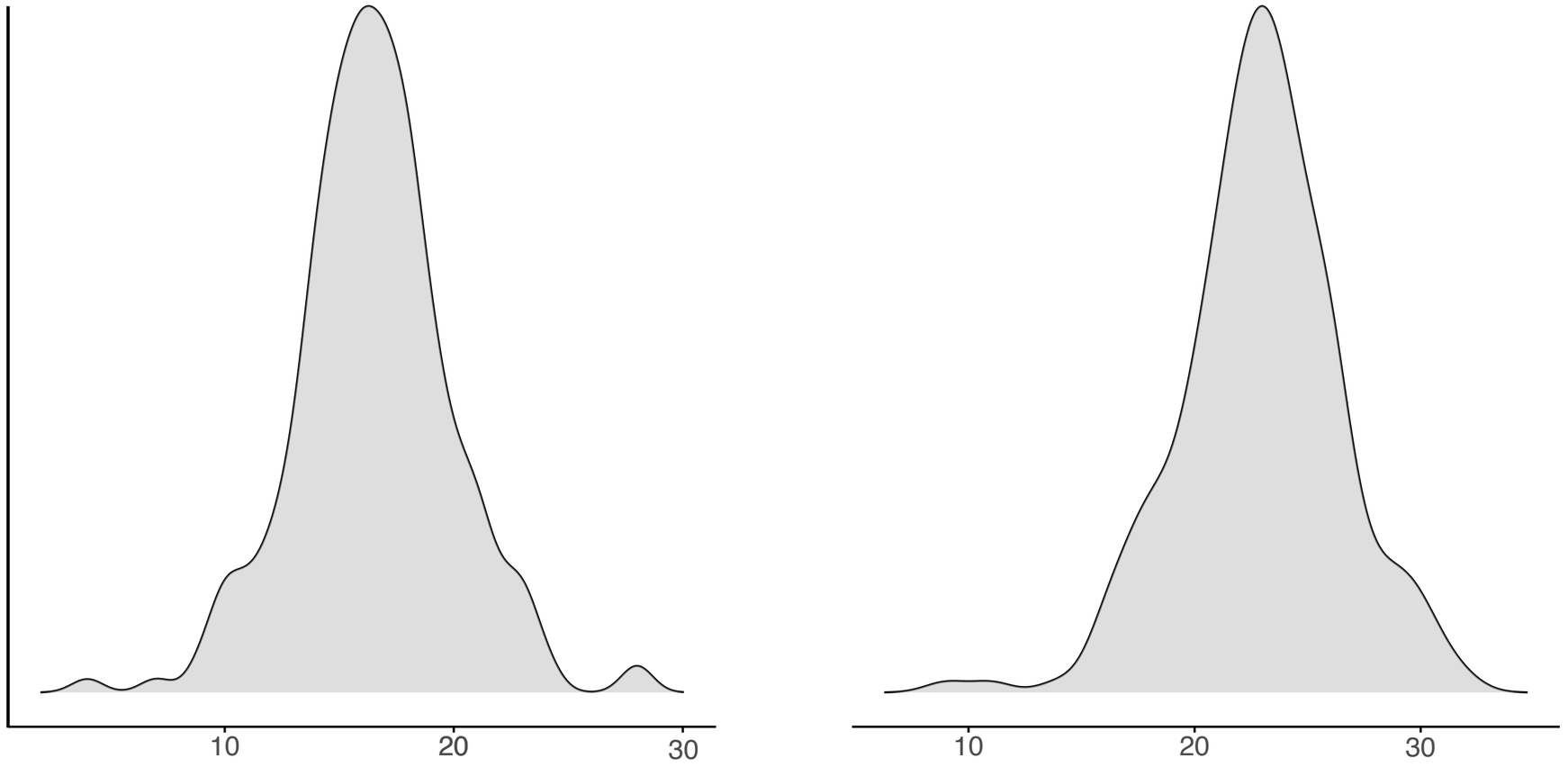
# DEEP SLEEP DECREASING WITH AGE



# SLEEP STAGES: OPTIMAL ZONES

Each night → { Deep sleep %<br>REM sleep % } → Statistics on Deep and REM over 30 days or lifetime

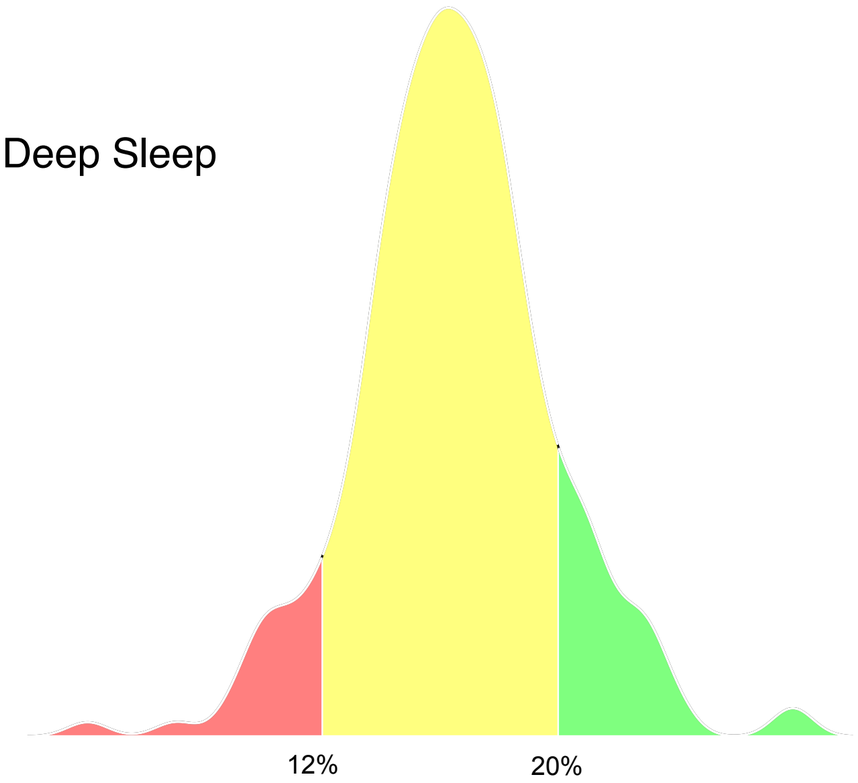



**Am I getting enough deep and REM sleep?**

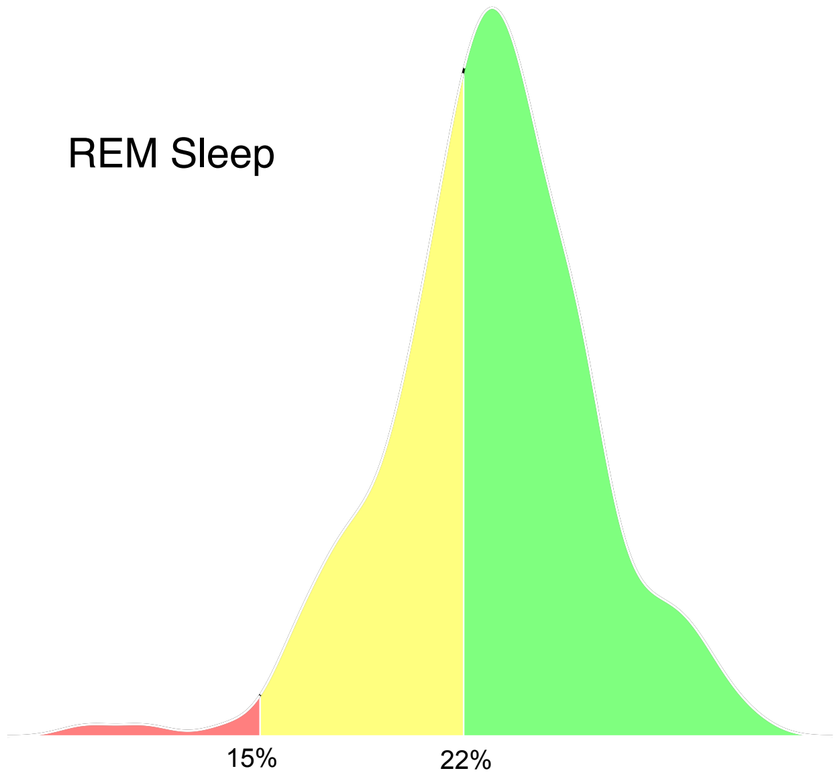
# SLEEP STAGES: OPTIMAL ZONES

Each night → { Deep sleep % / REM sleep % } → Statistics on Deep and REM over 30 days or lifetime → **Optimal zones**

Deep Sleep




REM Sleep



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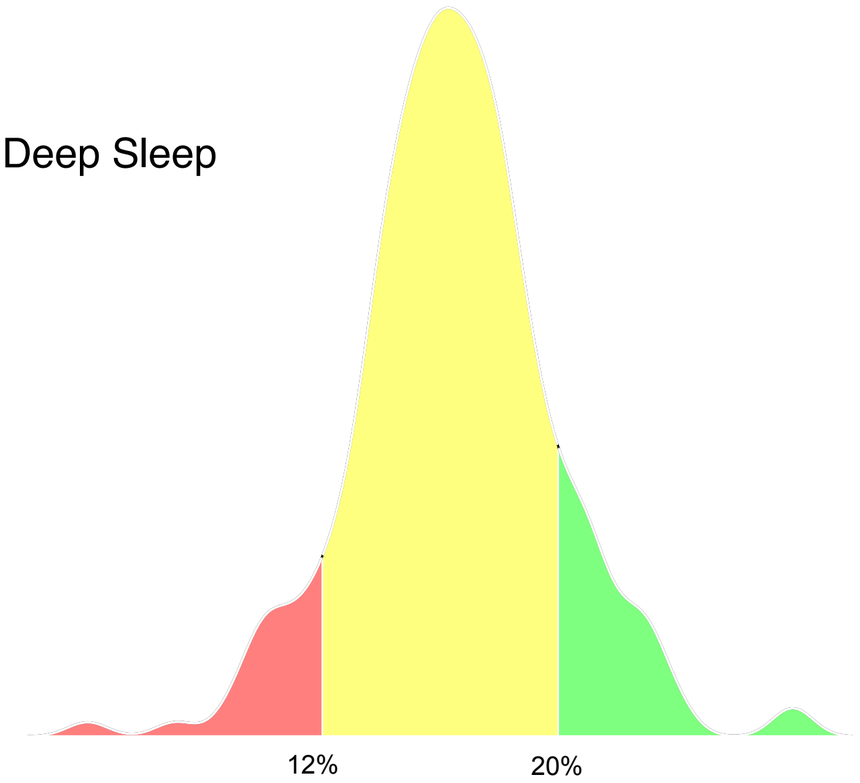
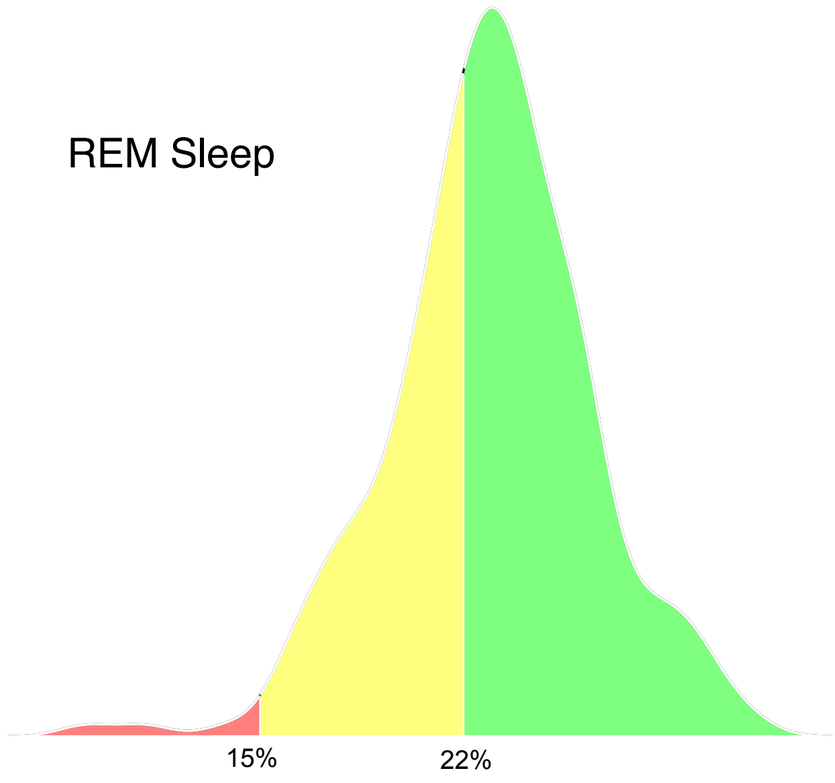



REM Sleep

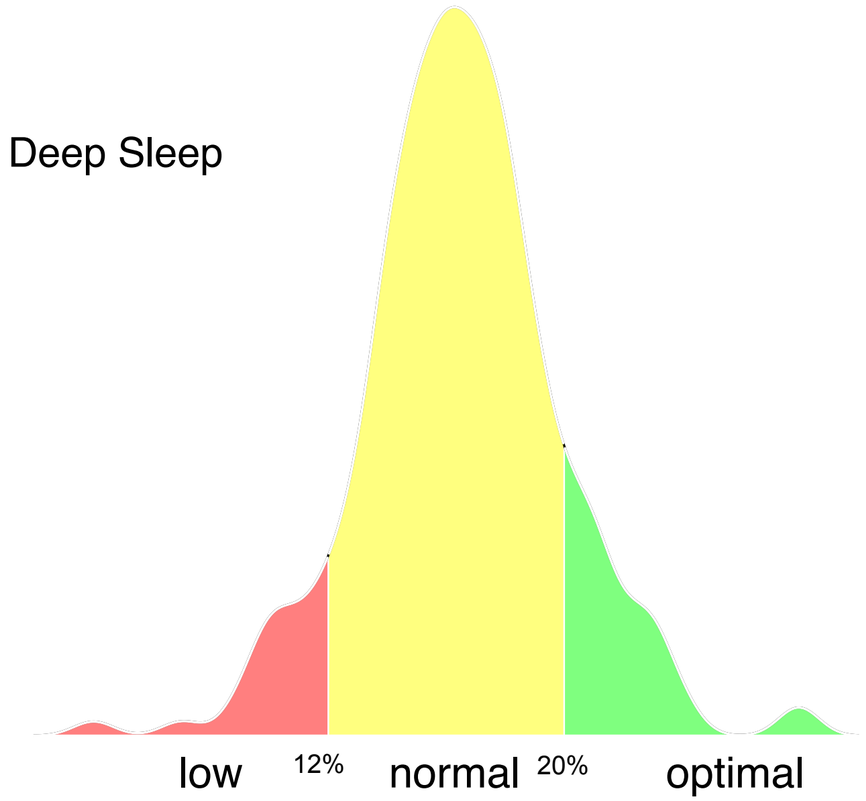


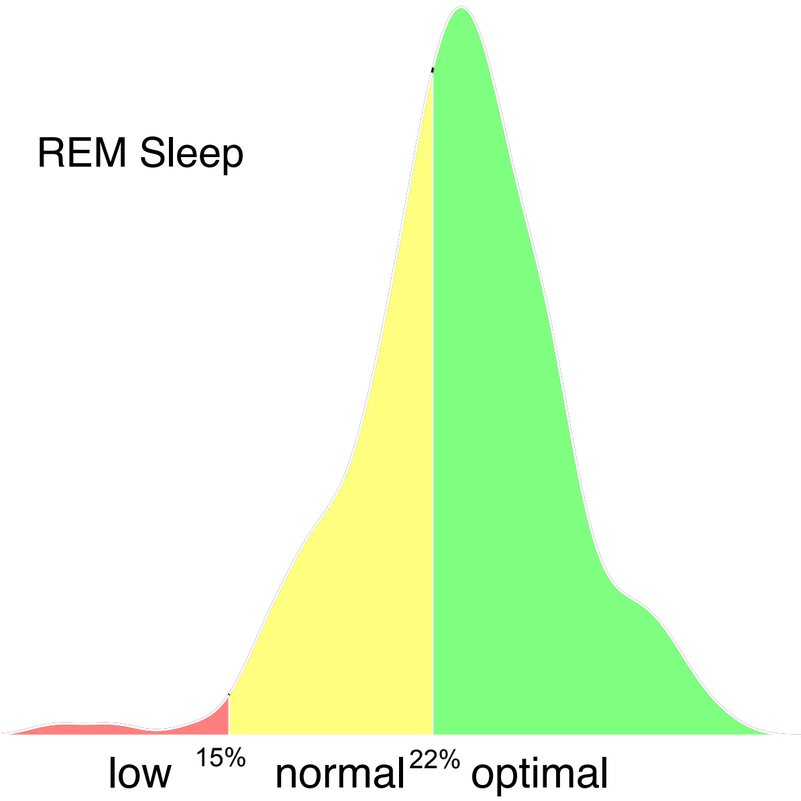

Optimal zones are based on data from **research papers** and our own data

↓

Sleep stages are measured with a different method/device

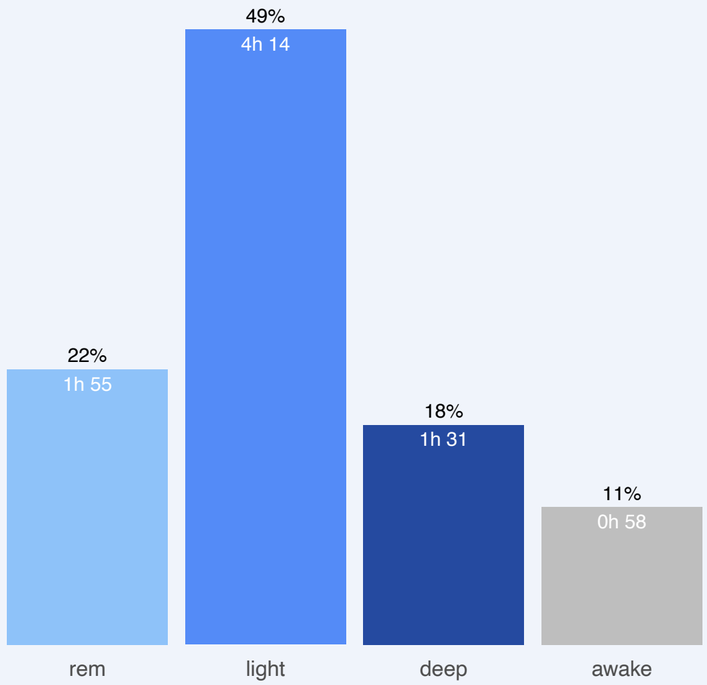
# SLEEP STAGES: OPTIMAL ZONES




Deep and REM sleep % → Check-ins (sleep quality, freshness, cognitive performance, changes in mood) + Blood Biomarkers → Optimizing recommendations over time

# SLEEP STAGES: OPTIMAL ZONES




REM % is **optimal**

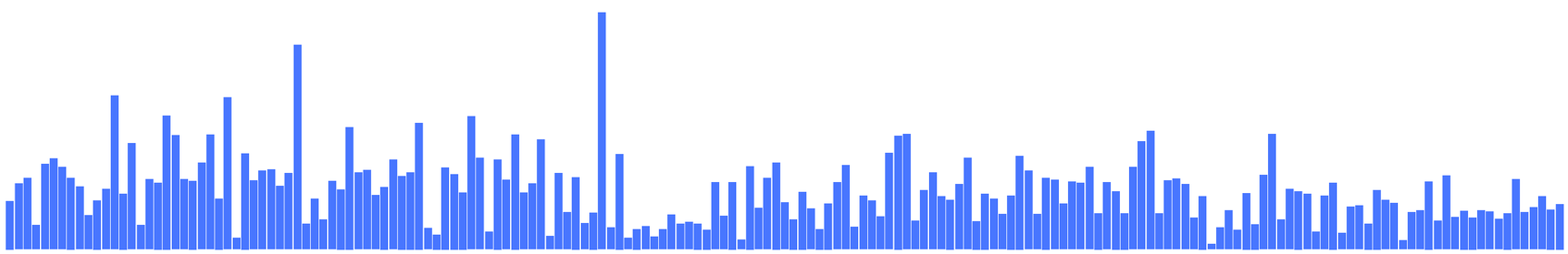
Deep % is **normal**

recommendations

Detecting personalized
**Optimal** zones

# ACTIVITY DATA

Steps



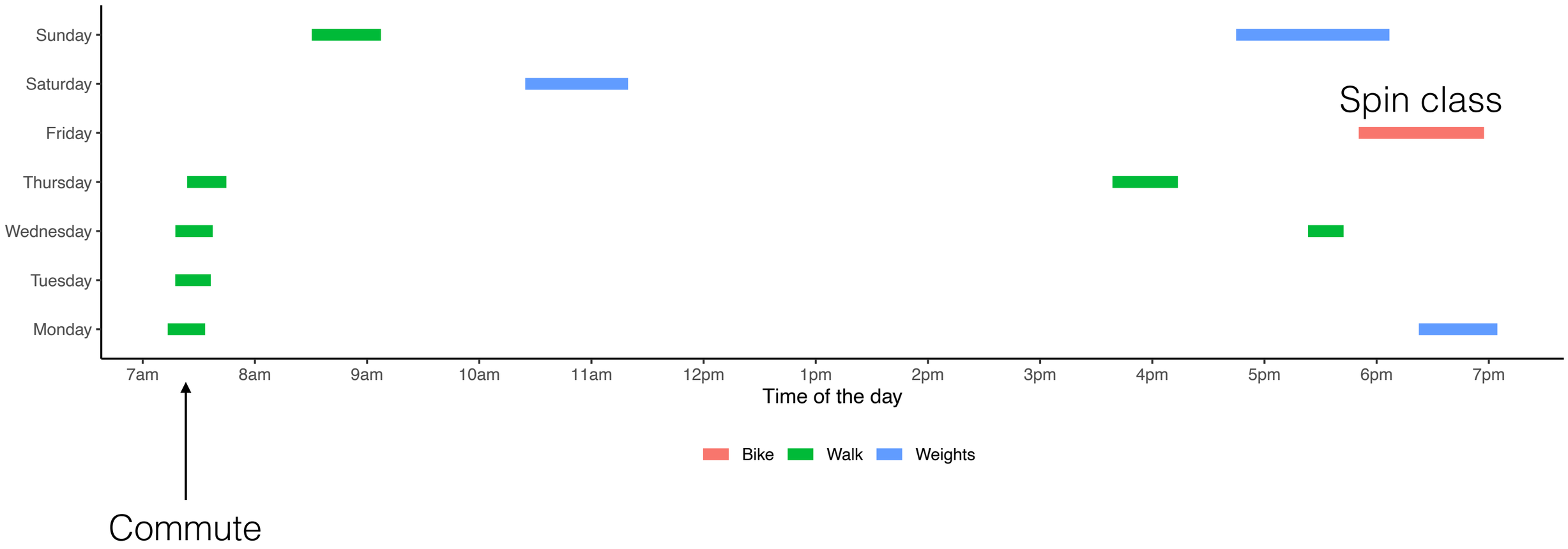
Metrics directly reported by Fitbit:

- Average number of steps per day
- Time of activity
- Calories burnt per activity
- Sedentary versus active minutes

What metrics are **actionable**?

- Time of activity relative to sleep
- MET (hrs / day)
- Heart rate during activity (maximum / average)
- Sedentary minutes
- Activity patterns during the day (commute, etc.)

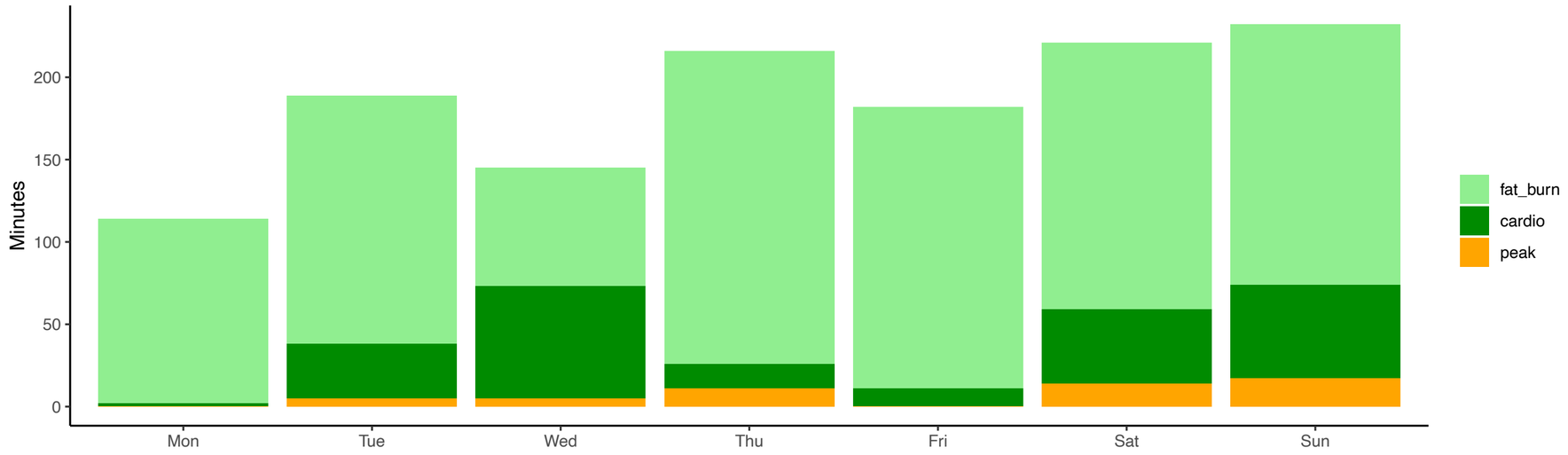
# ACTIVITY DATA: DETECT PATTERNS




We can detect weekly activity patterns and give more **personalized** recommendations based on:

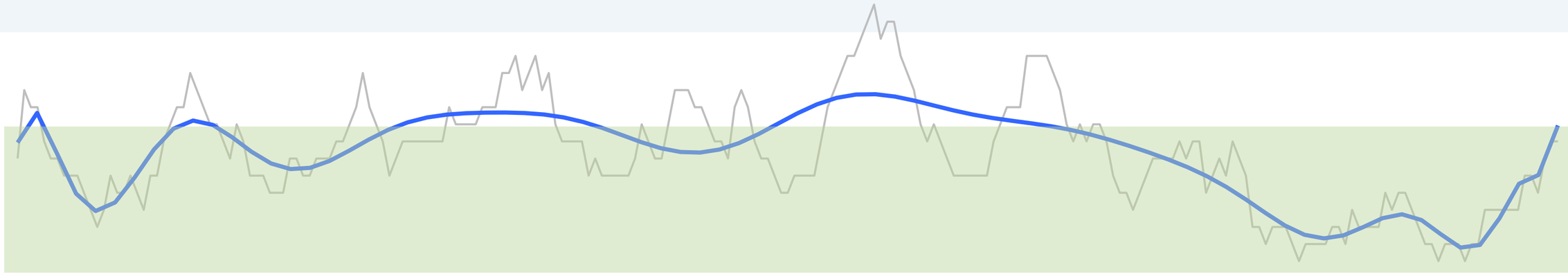
- commute patterns
- heart rate during activities
- typical time of activity relative to sleep

# ACTIVITY DATA: MINUTES IN PULSE ZONES

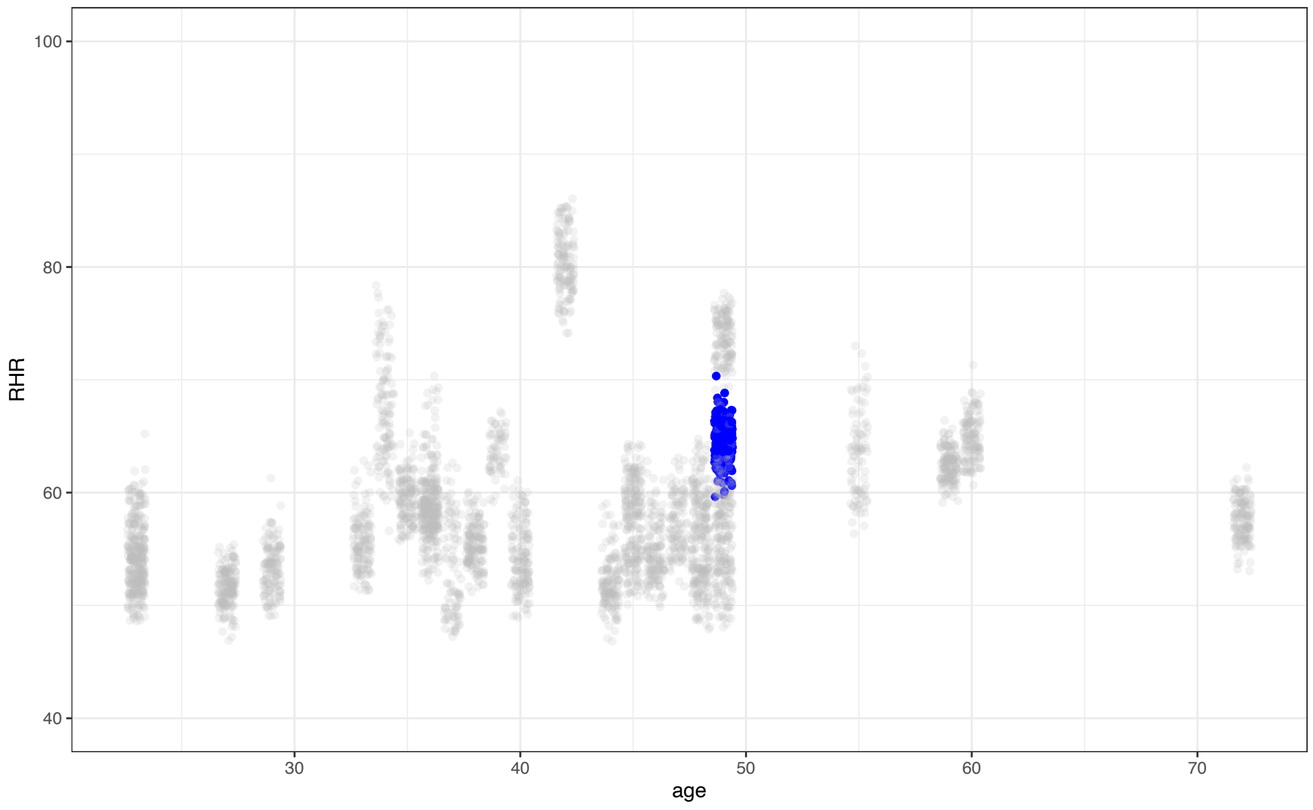



| Zone | Pulse zone | Minutes this week | Minutes last week |
|---|---|---|---|
| Fat Burn | 94 - 132 | 1016 | 1088 |
| Cardio | 132 - 160 | 231 | 266 |
| Peak | 160 - 220 | 52 | 46 |

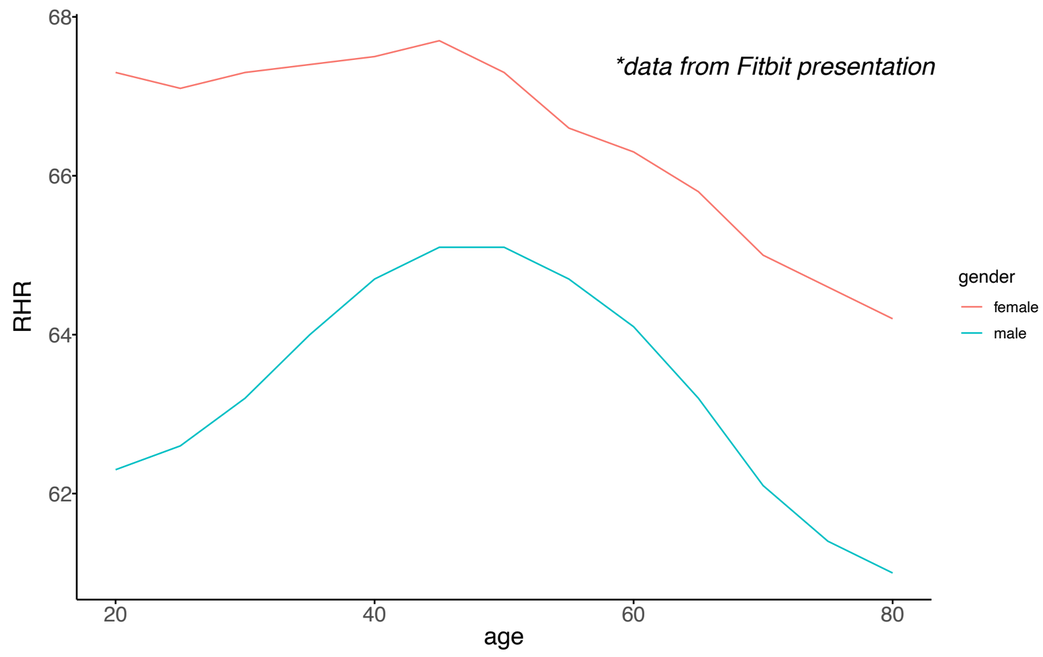
# RESTING HEART RATE DATA: OPTIMAL ZONE



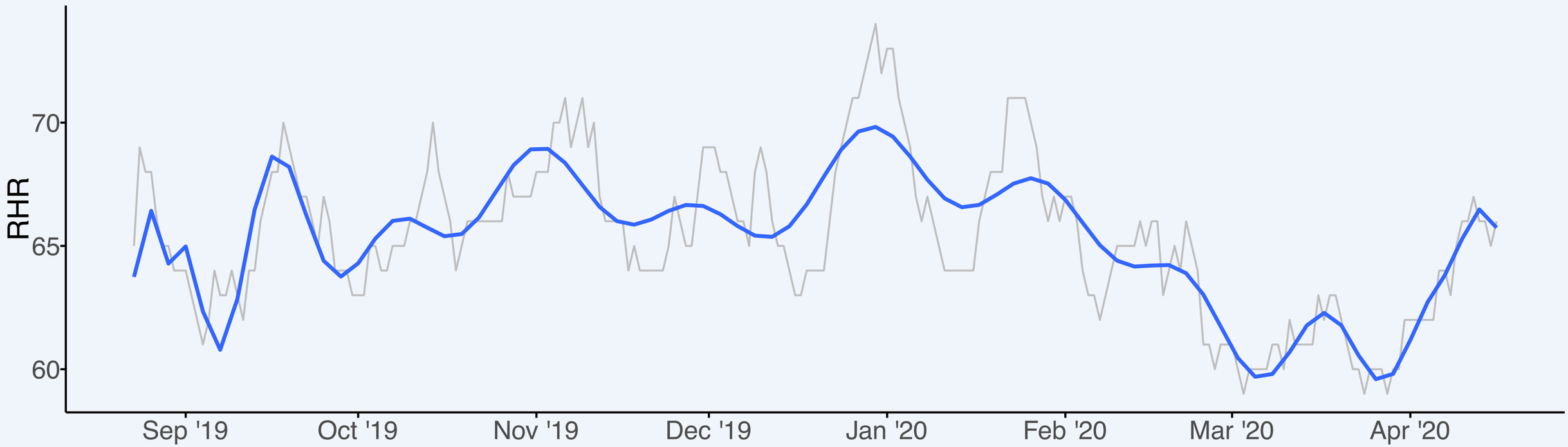
Compare with other users of your gender, how variable is your RHR




Compare with group averages



# RESTING HEART RATE DATA: PATTERNS



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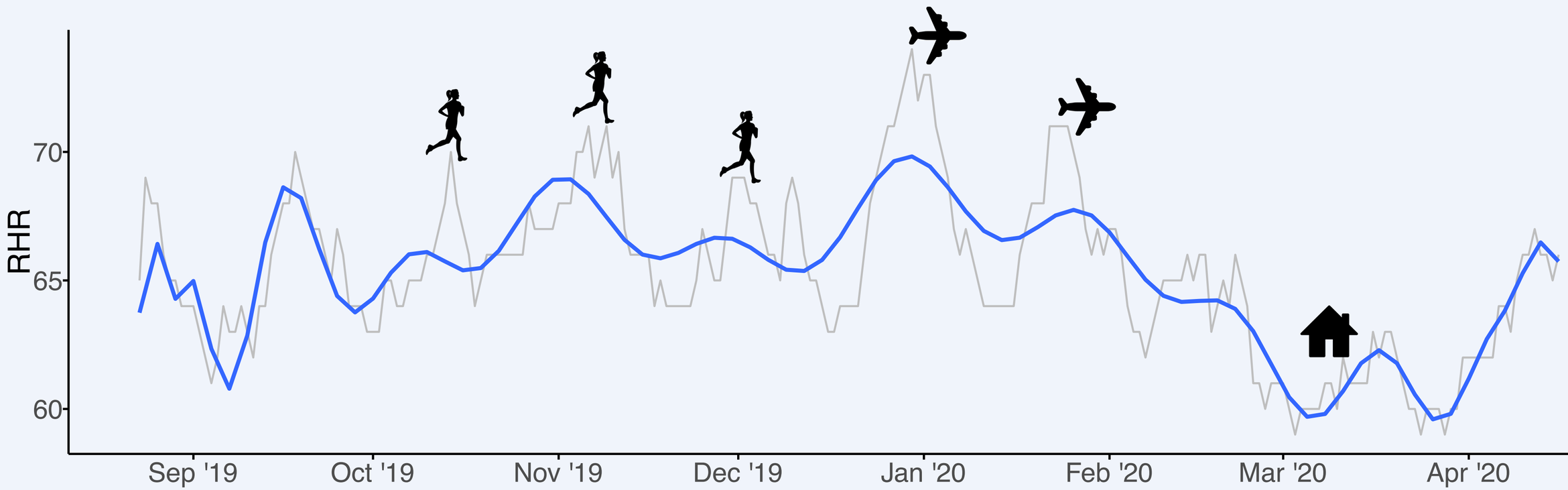
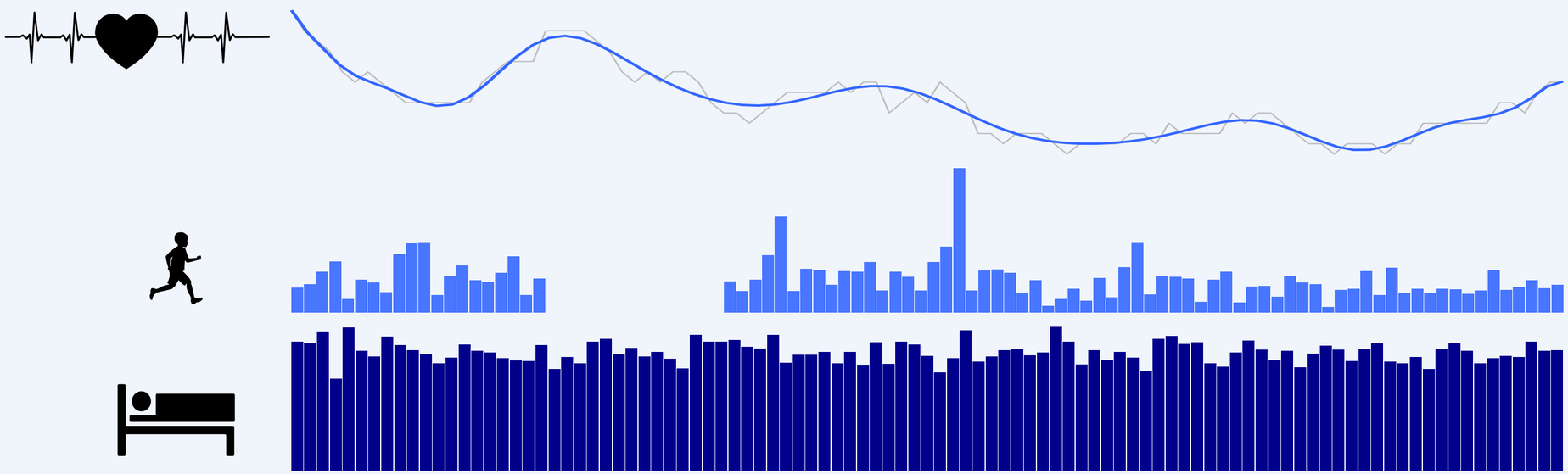



Insights
for one person → Overall patterns
and causation

- We need much more data to understand patterns and causations between different activities, sleep, and resting heart rate
- Open anonymized data from wearables would facilitate sleep and resting heart rate research

# SUMMARY

- Data from wearable is **actionable:** we can improve recommendations based on sleep, activity, and resting heart rate
- Open anonymized data from wearables would facilitate sleep and resting heart rate research, and help us determine optimal zones for many **physiological biomarkers**
- Machine learning methods can be applied to sleep and heart rate data and will help with our understanding of the underlying biological processes



# TEAM AND CONTACT INFORMATION

Gil Blander
Founder & CSO

Milena Jorge
VP of Science

Bartek Nogal
Scientist

Joe Wellwood
Exercise Physiologist

Svetlana Vinogradova
Lead Data Scientist

Michelle Cawley
Scientist

Jimmy Kennedy
Senior Scientist

@kintany

linkedin.com/in/svetlana-phd/

insidetracker.com/