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Fractal cycles of sleep: a new aperiodic activity-based definition of sleep cycles

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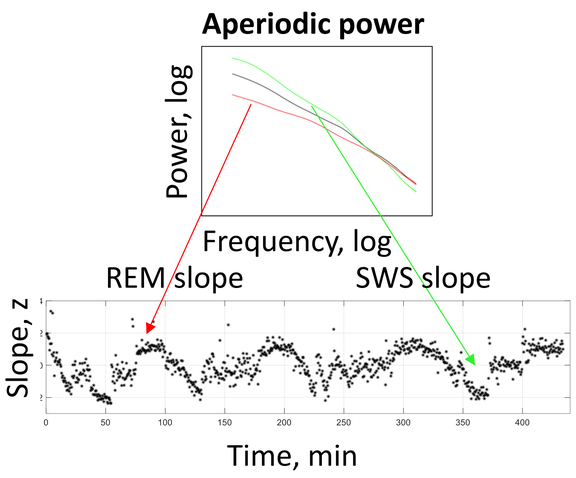
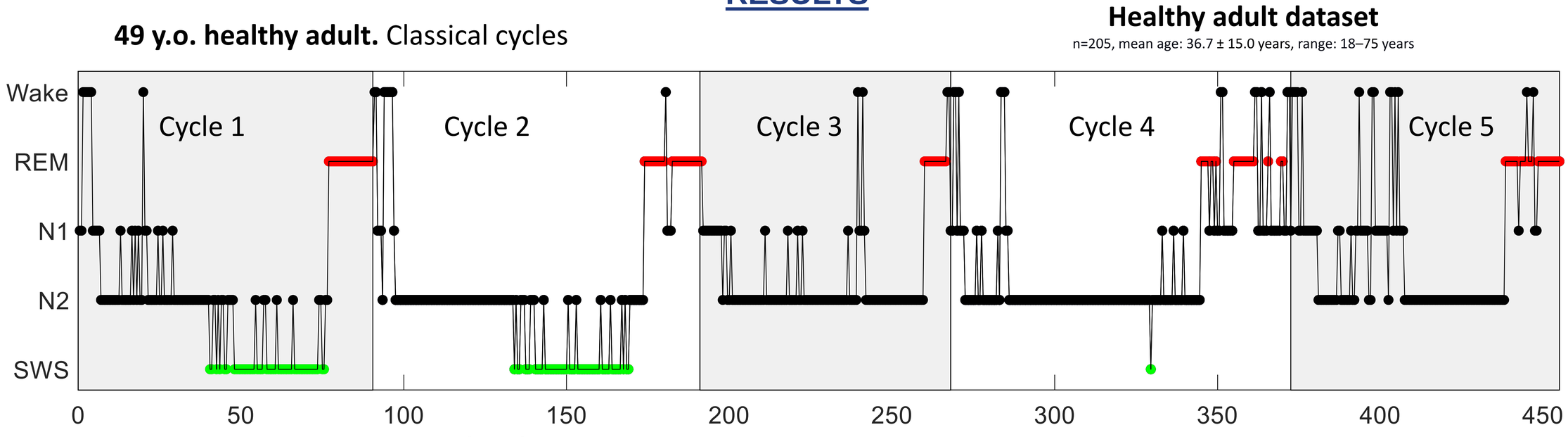
INTRODUCTION

- ✓ Classical sleep cycle is an episode of NREM sleep followed by an episode of REM sleep [1].
- ✓ While sleep cycles are considered fundamental components of sleep, their functional significance remains to a large extent unclear [1].
- ✓ Absence of a "data-driven" definition of sleep cycles.
- ✓ To reconceptualize the definition of sleep cycles based on fractal (aperiodic) neural activity[2] as a well-established marker of arousal and sleep stages [3,4].
- ✓ We anticipate that this data-driven and continuous approach to defining sleep cycles will foster considerable advancements in the field of sleep science.

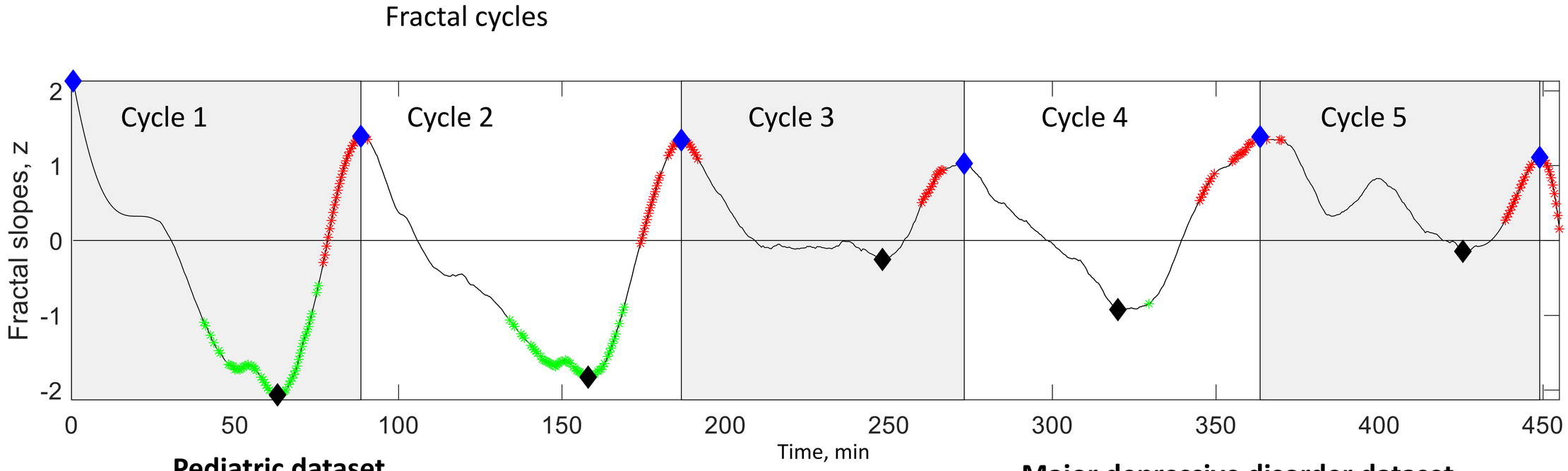
METHOD



RESULTS

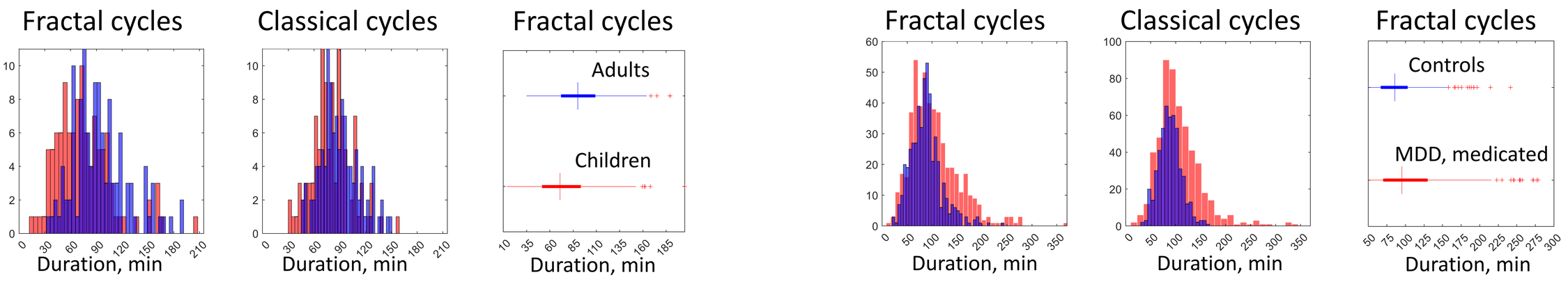


Healthy adult dataset
n=205, mean age: 36.7 ± 15.0 years, range: 18–75 years



Pediatric dataset
n=21, mean age: 12.4 ± 3.1 years, range: 8–17 years

Major depressive disorder dataset
n=111, mean age: 42.5 ± 14.4 years, range: 19–75 years



CONCLUSIONS

- Fractal cycles are an objective, quantifiable and biologically plausible way to display sleep neural activity and its cycles.
- Timings of 81% of fractal cycles could be matched to those of classical sleep cycles.
- Cycle-to-cycle dynamics showed a gradual decrease in absolute amplitudes of the fractal descents and ascents.
- In major depressive disorder, antidepressant medication is associated with longer fractal cycles.
- Fractal cycle duration is shorter in children and adolescents compared to young adults.
- In adults, fractal cycle duration decreases with age.

REFERENCE

[1]Feinberg & Floyd, 1979. Systematic trends across the night in human sleep cycles.

[2]He, 2014. Scale-free brain activity: past, present, and future.

[3]Gao et al., 2017. Inferring synaptic excitation/inhibition balance from field potentials.

[4]Lendner et al., 2020. An electrophysiological marker of arousal level in humans.

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