

# Age Related Changes in Objectively Measured Sleep Observed in a Large Population in the Home

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## Background and Aims:

A Wireless System (Zeo, Inc., Newton, MA,) has been developed that utilizes a no-prep dry fabric sensor incorporated in a headband that transmits data to a base station. The data is processed by a neural network, which determines and records sleep stages in real time. The Wireless System has been previously validated<sup>1,2</sup>.

A summary objective measure of a night's sleep, ZQ, has been created. It is intended as an educational tool for consumers, providing a window into deeper insights about their sleep.

The DOZER sleep registry is an IRB approved research database of sleep in the US population in the home. Its participants purchase and use the Wireless System as they see fit. Data that has been uploaded are de-identified and coded before inclusion in the registry. To date, this registry contains data from over 7,000 subjects, and over 200,000 nights.

The aim of this study was to describe age-related changes in sleep quantity and quality in a large sample using objective data collected in the home.

## Methods:

### Subjects:

- 5099 subjects, 24.4% Female Aged 17-90+ years 141,019 nights of data

### Procedure:

- All subjects in the DOZER sleep registry who included at least one night of sleep data as of March 30, 2010, were included. Only nocturnal sleep recordings lasting at least 3 hours were included.
- All subjects 90 years of age or older were categorized as "90+" in conformance with de-identification standards.

### Analysis:

- Sleep measures were averaged for all nights contributed by each subject. Sleep measures included:

- Total Sleep Time (TST)
- Latency to Persistent Sleep (of 10 continuous minutes of sleep, after using begins recording) (LPS)
- Wake Time During Sleep (between LPS and last epoch of sleep) (WTDS)
- Time in REM (TR), Percent in REM (%TR)
- Time in Light (R&K Stages 1 and 2) (TL), Percent in Light (%TL)
- Time in Deep (R&K Stages 3 and 4) (TD), Percent in Deep (%TD)
- ZQ, a single number that summarizes TST, TR, TD, WTDS and the number of awakenings.

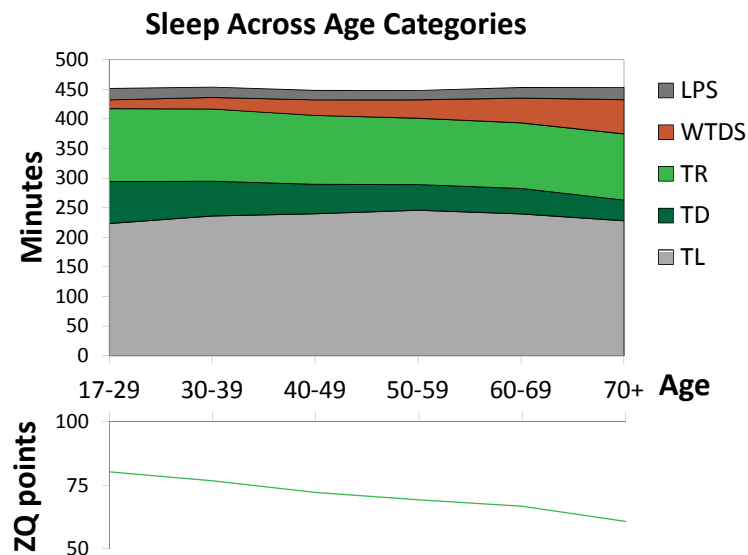
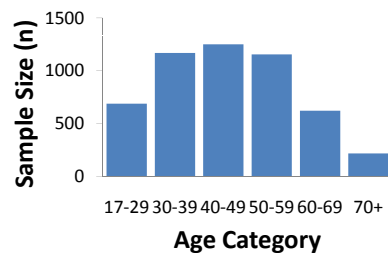
- Subjects were grouped into 6 age categories (17-29, 30-39, 40-49, 50-59, 60-69, 70+)

- Two-way ANOVAs compared sleep measures across age groups. The models included gender due to a significant difference in gender across age groups ( $\chi^2=11.3486$ ,  $p<0.05$ ).

- Linear regression analysis on ungrouped subjects (controlling for gender) excluded 6 subjects aged 90+ due to the uncertainty of their actual age.

## Results:

Age category had a significant effect on all sleep measures ( $F(5,5092)>10.9$ ,  $p<0.0001$ ).



## Linear Regressions (min/decade):

	Coefficient	95% CI	
ZQ	-3.76*	-4.03	-3.50
TST	-7.75*	-8.89	-6.61
LPS	-0.25†	-0.53	0.02
WTDS	7.41*	6.84	7.98
TR	-3.30*	-4.08	-2.53
TL	2.82*	1.86	3.78
TD	-7.27*	-7.75	-6.79

\* $p<0.001$  † $p=0.073$

## Percent in Stage [mean(SD)]:

Age	%TR	%TD	%TL
17-29	28.9(6.5)	17.4(6.5)	53.7(8.8)
30-39	28.8(7.0)	14.4(6.1)	56.8(8.5)
40-49	28.3(7.8)	12.4(5.5)	59.3(8.7)
50-59	27.6(8.8)	10.9(5.5)	61.5(9.6)
60-69	27.8(9.9)	11.0(6.4)	61.1(10.7)
70+	29.6(13.7)	9.5(6.2)	60.9(14.1)

## Discussion and Conclusion:

The findings that TST, TR, and TD decreased, while TL increased with age, are consistent with the findings previously reported by Ohayon et al.<sup>4</sup> However, the rate of change in our data is somewhat less than previously reported<sup>4</sup> and Carrier et al. did not observe an increase in TL.<sup>5</sup> Several differences in study design may account for these discrepancies. First, these data were collected using the Wireless System in the home. Second, most participants contributed data from multiple nights, an average of 28 nights each. Finally, there is potential that sample bias affected the result, as the population in the present study consisted of subjects who are of a socio-economic status capable of affording a personal sleep system and who have sufficient access to and ability with internet technologies.

## References:

1. Shambroom, J.R. et al (2009). Evaluation of a portable monitor... *Sleep*, 32(Suppl.), A386. Abstract 1182.
2. Blake, S.K. et al (2009). Assessment of a wireless system... *Sleep*, 32(Suppl.), A370. Abstract 1132.
4. Ohayon, M. M. et al (2004). Meta-analysis of quantitative sleep parameters... *Sleep*, 27(7), 1255-73.
5. Carrier, J. et al (2001). The effects of age and gender on sleep... *Psychophysiology*, 38(2), 232-42.

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