# Sleep-length differences are associated with altered body composition and longevity in the fruit fly D. melanogaster.

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## Abstract

Sleep deprivation has been shown to negatively impact health outcomes, leading to decreased immune responses, memory loss, increased activity of stress and inflammatory pathways, weight gain, and even behavioral changes. These observations suggest that sleep deprivation substantially interferes with important physiological functions, including metabolic pathways of energy utilization.

Many of those phenotypes are correlated with age, suggesting that disrupted sleep may also interfere with the aging process. However, little is known about how sleep disruption affects aging and longevity. Here, we investigate this relationship using eight representative fruit fly lines from the Sleep Inbred Panel (SIP). The SIP consists of 39 inbred lines that display extreme short- and long-sleep patterns, and constitutes a crucial Drosophila community resource for investigating the mechanisms of sleep regulation.

We obtained four long-sleep and four short-sleep lines from the SIP, and verified their activity patterns. We then analyzed the longevity of these short- and long-sleep lines. Interestingly, our data show that male flies with short-sleep periods have ~16% longer life span, as well as reduced aging rate, compared to flies with long-sleep. This increased longevity is accompanied by a ~10% reduction in body weight for short sleep animals, compared to the long sleepers. In addition, short-sleep males also have small reductions in fat and glucose levels. In contrast, when the circadian rhythm of flies with normal sleep patterns is disrupted by continuous exposure to light, fly longevity is decreased.

## Acknowledgments

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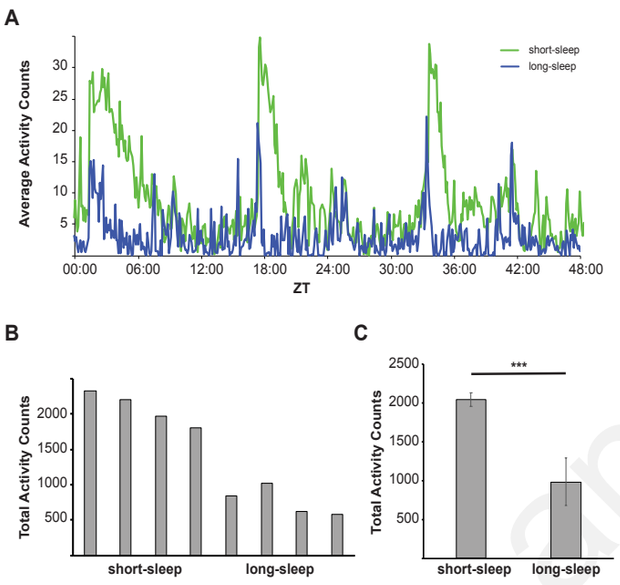


**Figure 1: Male Activity pattern differences between short- and long-sleep fly lines**. A) Activity patterns of a representative short-sleep line (green) and a representative long-sleep line (blue) were observed over a 48hr recording interval. Shown is the average activity of at least eight separate recordings of a single male fly. B) Total activity was integrated over a 48hr time period for four different short-sleep lines and four different long-sleep lines, using at least eight replicate recordings per line. C) Total activity counts over a 48hr period for each of the four short-sleep and four long-sleep, respectively, lines were combined. Shown are the average activity counts observed in three independent experiments (error bars represent the standard deviation, p=0.0026).

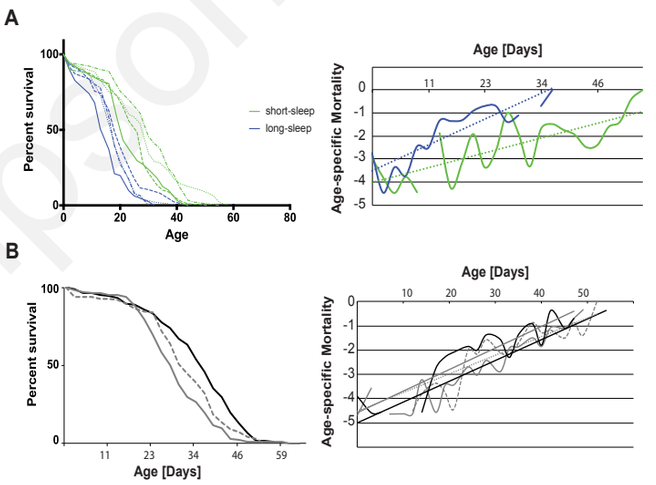


**Figure 2: Sleep length changes longevity and age-specific mortality rates.** A) Survivorship curves of four long-sleep (blue lines) and four short-sleep (green lines) Drosophila strains show increased longevity in the short sleep lines. Shown is a representative of three independent experiments. Survivorship curves were converted into Gompertz mortality curves. Shown are one representative line each of the short-sleep (green) and the long-sleep (blue) flies. The dotted lines represent the linear regression of the age-specific mortality rates. Short-sleep flies have a dramatic decrease in the slope of the mortality rate curve. B) Disruption of circadian rhythm alters longevity, but not mortality rates. Flies raised under the standard 12hr light/dark cycle show longest life span (black), while disruption of the circadian pattern reduces longevity. Flies raised under constant light conditions show a ~20% reduction in longevity (grey), while flies raised in constant darkness (grey dotted) have ~12% reduced longevity. However, the slope of the mortality rate curve does not change between treatments. Shown is a representative of three independent experiments.

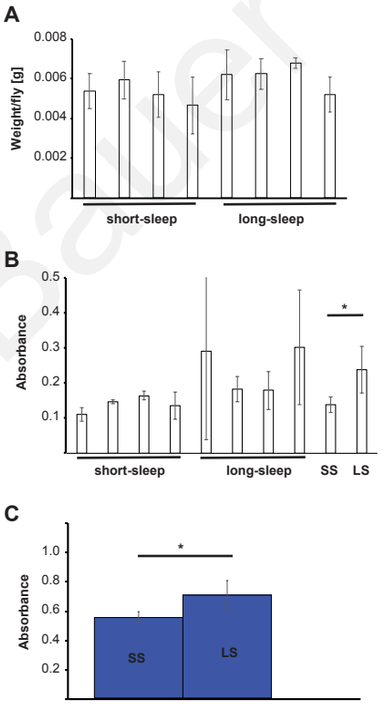


**Figure 3: Metabolic status of sleep-disrupted flies.** Flies were raised until 10d of age, weighed and assayed for fat and glucose content. A) Weight per fly of the four individual lines each with short- and long-sleep. B) Measuring fat content with the Infinity TAG Determination kit. Average absorbances at 405nm of three independent experiments each are shown for the four short- and four long-sleep lines, along with the averages of all lines. C) Measuring glucose content with the Infinity Glucose Determination kit.Average absorbances of all short- and long-sleep lines at 340nm is shown for three independent experiments.
Error bars represent the standard deviation of at least three independent experiments (SS: short-sleep; LS: long-sleep; *: p<0.05)

## Conclusion

Our study shows that altering sleep length via selective breeding leads to different physiological responses compared to disrupting sleep patterns by circadian disruption. Our data suggest that the circadian clock system and the sleep system modulate longevity by distinct mechanisms. Interestingly, the SIP short-sleep lines show metabolic signs of Calorie Restriction (CR), a well-established longevity-increasing intervention. This data is consistent with previous reports that show that starvation increases fly activity levels and suppresses sleep. Together, these data suggest that, at least in these flies, mechanisms of CR may overlap with those of sleep modulation.