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## PRESS RELEASE

Leibniz Research Centre for Working Environment  
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# The internal clock of immune cells: Is the immune system younger in the morning?

Our immune system ages: it reacts more slowly to pathogens, vaccines become less effective, and the risk of cancer increases. At the same time, the immune system follows a 24-hour rhythm, as the number and activity of many immune cells fluctuate throughout the day. Researchers at the Leibniz Research Centre for Working Environment and Human Factors (IfADo) in Dortmund have now investigated whether this daily rhythm influences the aging of the immune system and whether the immune system reacts “younger” or “older” at certain times of the day.

## “IMMAX” as a marker for immune age

For the study, researchers took blood samples from participants in the morning, at noon, and in the evening. Using the so-called “IMMune Age indeX (IMMAX)”, they determined each individual's immune age and analyzed how it changed throughout the day. The IMMAX is a biomarker determined by the ratio of certain immune cells in the blood. As part of biological age, it correlates with actual chronological age. “Individual immune cells that are relevant for calculating the IMMAX fluctuate throughout the day,” explains Dr. Sina Trebing, research assistant in the “Immunomodulation” group at IfADo. “For example, in the morning we observed an increased frequency of natural killer cells (NK cells) - key protective cells that defend the body against infections and cancer. In contrast, other immune cell types showed the opposite pattern.”

The circadian rhythm regulates immune system activity. Hormones, body temperature, nerve signals, and messenger molecules tell immune cells when to move or become active. This leads to daily fluctuations in the number of immune cells in the blood. However, these fluctuations do not appear to influence immune age over the course of the day, as the researchers discovered. Despite measurable daily differences, the IMMAX remained largely stable, as individual immune cell types apparently balance each other out.

## For early risers, the IMMAX shows slightly greater daily fluctuations

The IMMAX is a biomarker for immune age that is largely independent of the time of day. Nevertheless, slight differences were observed depending on a person's chronotype - that is, whether they are more active early in the day (“larks”) or late in the day (“owls”). For early risers (“larks”), the IMMAX value decreased slightly from morning to noon. This suggests that the time of blood sampling in relation to waking up is important. “When we wake up in the morning and become active, this apparently influences the movement of our immune cells and thus has a slight effect on the



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IMMAX value,” explains Trebing. “In large cohort studies, the timing of sampling is less critical, as fluctuations are balanced out. In upcoming projects involving IMMAX measurements, we now make sure to use a consistent time window after waking to further improve precision.”

### **Original publication:**

Trebing S., Bröde P., Claus M., Watzl C. 2025. *Influence of circadian rhythm on the determination of the IMMune Age indeX (IMMAX)*. Frontiers in Aging 6. [10.3389/fragi.2025.1716985](https://doi.org/10.3389/fragi.2025.1716985).

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