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## The dynamics of stress in female chimpanzees: interactions of social and ecological factors

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### Abstract:

Cortisol, as a biomarker of the generalized adaptive stress response, can provide critical information on the physiological effects of behavior. However, group-living animals face multiple interacting stressors from their social and ecological environments. While recent research has revealed the impact of particular social stressors in isolation, few studies have examined how diverse factors contribute to long-term stress hormone variation.

We applied multivariate analyses to a 10-year dataset to investigate urinary cortisol variation in wild female chimpanzees (*Pan troglodytes schweinfurthii*) in Kibale National Park, Uganda. In interindividual contrasts, older females had higher cortisol levels, as did females that were low-ranking for their age. Over time, cortisol was significantly predicted by rates of aggression, particularly female-targeted aggression. The effect of male-female aggression was most pronounced for cycling, swollen females, who are the most frequent targets of sexual coercion. On the other hand, lactating females were strongly affected by group size, such that cortisol levels were elevated when parties contained more females and fewer males. Fruit consumption was an important covariate for lactating females, who experienced higher cortisol when the diet was poor. Our data indicate that both social and energetic factors contribute to stress variation in female chimpanzees, but that energetic stress increases in significance for females facing high reproductive costs. Our study also contributes to growing evidence that direct and indirect competition, while subtle in their expression, can have substantial impacts on female chimpanzees.