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# HPA axis responses to laboratory psychosocial stress in healthy elderly adults, younger adults, and children: impact of age and gender

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## Abstract

Data from five independent studies were reanalyzed in order to investigate the impact of age and gender on HPA axis responses to an acute psychosocial laboratory stress task. The total sample consisted of 102 healthy subjects with 30 older adults (mean age: 67.3 y), 41 young adults (mean age: 23.5 y), and 31 children (mean age: 12.1 y). All participants were exposed to the Trier Social Stress Test (TSST).

The stress protocol caused highly significant ACTH and total plasma cortisol responses in older and younger male and female adults (all  $p < 0.0001$ ) as well as salivary free cortisol responses in all six age and gender groups (all  $p < 0.0001$ ). Three-way ANOVAs for repeated measurement were applied to investigate the impact of age and gender on ACTH and cortisol responses. Results showed that the ACTH response to stress was higher in younger adults compared to older adults (main effect:  $p = 0.009$ , interaction:  $p = 0.06$ ). Post hoc analyses revealed that there was no age effect in the subgroup of women ( $p = \text{n.s.}$ ), while younger men had higher ACTH responses compared to older men ( $p = 0.01$ ). For total plasma cortisol, ANOVA results showed that the pattern of reactivity did not differ between age and gender groups (all interactional effects  $p = \text{n.s.}$ ), although older females had heightened overall cortisol levels compared to the other groups, as proofed in post hoc analyses (all  $p < 0.05$ ). For free

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salivary cortisol, a significant main effect of gender ( $p=0.05$ ) and an almost significant three-way-interaction ( $p=0.09$ ) emerged. Post hoc analyses showed an elevated overall free salivary cortisol response in elderly men compared to elderly women ( $p=0.006$ ), while no gender differences emerged in neither young adults nor children (both  $p=n.s.$ ).

In sum, the stressor induced significant HPA axis responses in all age and gender groups. The observed ACTH response patterns in young and elderly adults may suggest that a heightened hypothalamic drive in young men decreases with age, resulting in similar ACTH responses in elderly men and women. Alternative interpretations are also discussed. The data also supports the idea of a greater adrenal cortex sensitivity to ACTH signals in young females. Free salivary cortisol responses were elevated in elderly men compared to elderly women, an effect which cannot be explained by gender differences in perceived stress responses to the TSST. It can be speculated if corticosteroid binding globulin (CBG) and/or sex steroids are important modulators of these effects.

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*Keywords:* HPA axis; Salivary cortisol; Age; Gender; Stress; TSST; ACTH

## 1. Introduction

Although it is known from animal as well as human studies that there exist age-related alterations in hypothalamic–pituitary–adrenal (HPA) axis regulation, it still remains an open question whether stress-related HPA axis functioning alters significantly with age.

While in humans there are only little differences in daytime basal ACTH and cortisol levels (Seeman and Robbins, 1994; Gotthardt et al., 1995; Kudielka et al., 1999, 2000), the circadian rhythm seems to advance with age and diurnal amplitudes appear to flatten (Sherman et al., 1985; Van Coevorden et al., 1991; Deuschle et al., 1997). Primarily, cortisol concentrations show age-related changes during night-time at the circadian trough of HPA activity (Van Cauter et al., 1996).

Human studies which apply psychological stress protocols in young and elderly

### Nomenclature

#### *Abbreviations*

ACTH	adrenocorticotropin
CBG	corticosteroid binding globulin
HPA axis	hypothalamic–pituitary–adrenal axis
sem	standard error of mean
TSST	Trier Social Stress Test
VAS	visual analog scale
y	years

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