Hypothalamic pituitary adrenal axis

The hypothalamic–pituitary–adrenal axis (HPA axis or HTPA axis) is a complex set of direct influences and feedback interactions among three components: the hypothalamus, the pituitary gland (a pea-shaped structure located below the thalamus), and the adrenal (also called suprarenal glands (small, conical organs on top of the kidneys).

These organs and their interactions constitute the HPA axis, a major neuroendocrine system that controls reactions to stress and regulates many body processes, including digestion, the immune system, mood and emotions, sexuality, and energy storage and expenditure. It is the common mechanism for interactions among glands, hormones, and parts of the midbrain that mediate the general adaptation syndrome (GAS).

While steroid hormones are produced mainly in vertebrates, the physiological role of the HPA axis and corticosteroids in stress response is so fundamental that analogous systems can be found in invertebrates and monocellular organisms as well.

The HPA axis, HPG axis, HPT axis, and the hypothalamic–neurohypophyseal system are the four major neuroendocrine systems through which the hypothalamus and pituitary direct neuroendocrine function.

Hypothalamic-pituitary-adrenal (HPA) axis dynamics are disrupted by opioids and may be involved in substance abuse; this persists during withdrawal and abstinence and is associated with co-morbid sleep disruption leading to vulnerability to relapse. We hypothesized that chronic sleep restriction (SR) alters the HPA axis diurnal rhythm and the sexually dimorphic response to acute stressor during opioid abstinence. We developed a rat model to evaluate the effect of persistent sleep loss during opioid abstinence on HPA axis dynamics in male and female rats. Plasma ACTH and corticosterone were measured diurnally and in response to acute restraint stress in rats Before (control) compared to During subsequent opioid abstinence without or with SR. Abstinence, regardless of sleep state, led to an increase in plasma ACTH and corticosterone in the morning in males. There was a tendency for higher PM plasma ACTH during abstinence in SR males ($P = 0.076$). ACTH and corticosterone responses to restraint were reduced in male SR rats whereas there was a failure to achieve the post-restraint nadir in female SR rats. There was no effect of the treatments or interventions on adrenal weight normalized to body weight. SR resulted in a dramatic increase in hypothalamic PVN AVP mRNA and plasma copeptin in male but not female rats. This corresponded to the attenuation of the HPA axis stress response in SR males during opioid abstinence. We have identified a potentially unique, sexually dimorphic role for magnocellular vasopressin in the control of the HPA axis during opioid abstinence and sleep restriction [1)].

1)

Raff H, Glaeser BL, Szabo A, Olsen CM, Everson CA. Sleep Restriction during Opioid Abstinence Affects the Hypothalamic-Pituitary-Adrenal (HPA) Axis in Male and Female Rats. Stress. 2023 Mar 1:1-21. doi: 10.1080/10253890.2023.2185864. Epub ahead of print. PMID: 36856367.