Stress Response in Young Male Rats Following Brief Systemic Exposure to 5G Millimeter Waves

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With the rapid expansion of 5th generation (5G) wireless systems, there is growing concern about the health effects of the millimeter waves (MMW) used in these systems. However, biological evidence for the adverse effects of MMW exposure is still limited [1]. In this study, we focused on the stress response to whole-body exposure to 5G-MMW.

Male SD rats were exposed to 28 GHz-MMW at the whole-body averaged specific absorption rates (SAR) of 0, 3.7, and 7.2 W/kg for 40 minutes. During exposure these rats were awake and restrained in an acrylic holder. The indoor environment was either a temperature of ≈ 22.5°C and humidity of 45–55% (regular) or a temperature of ≈ 32°C and humidity of ≈ 70% (heat). Urine and blood samples were collected at several intervals before and after exposure.

Regardless of the degree of MMW exposure, urinary free catecholamines (noradrenaline, adrenaline, and dopamine) and free corticosterone in the serum were at elevated levels, whereas serum BAP, an index for antioxidative capacity, had decreased at the end of the exposure experiment. This suggests that restraint stress was the cause of the changes. However, this increase in urinary free noradrenaline was suppressed by MMW and was further suppressed by heat (additive effects of MMW and heat). No such association was found with serum corticosterone. Urine samples were not collected on the day after the experiment, but serum samples were collected at day 1 or day 3. Serum corticosterone levels were elevated in these samples, presenting a positive relationship with MMW. This association was notable in those animals whose rectal temperature increased by more than 1°C. Serum d-ROMs, an oxidative stress marker, did not fluctuate on the day of exposure, but increased on day 1 or day 3, and this increase tended to be suppressed by heat. In particular, the d-ROMs elevation was suppressed in the animals that showed higher body temperatures at the end of the exposure period.

Thus, each marker demonstrated different dynamics; urinary free noradrenaline and serum free corticosterone were directly associated with the MMW, and for noradrenaline, an additive effect of MMW and heat was detected. It is suggested that the thermal effect of MMW/heat affected the biomarkers, based on the association between the markers and body temperatures.

This is the first instance showing that systemic exposure to 5G-MMW affects stress response markers, under such conditions of the experiment, and that the heat can have an additive effect on this response. These results may provide biological evidence to support whole-body exposure guidelines for MMW, but scientific credibility needs to be strengthened through reproducibility and mechanistic elucidation.

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References

[1] "Guidelines for Limiting Exposure to Electromagnetic Fields (100 kHz to 300 GHz)," Health Phys., vol. 118, no. 5, pp. 483–524, May 2020.