STRESS HORMONES AND NOCTURNAL AIRCRAFT NOISE

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Introduction It is believed that nocturnal aircraft noise is a strong stressor to humans, and thus results in a pronounced stress reaction according to the generally accepted stress model. Therefore a close relation between nocturnal aircraft noise and excretion of stress hormones to be detected in urinary samples collected all night is hypothesized. However, during the past decade findings from different studies are quite inconsistent with respect to excretion rates of epinephrine, norepinephrine and cortisol. While several authors report increased concentrations of stress hormones in all night urine due to aircraft noise, others do not detect any significant alteration. Often lack of control groups and rather small sample surveys reduce the power of evidence. Therefore, during these extensive DLR-studies on nocturnal aircraft noise effects, the concentrations of those relevant stress hormones mentioned were measured according to the literature to shed more light on this controversial field.

Methods As explained elsewhere in detail, 3 laboratory studies on 32 subjects each sleeping for 13 nights each in the lab facilities, were performed that added up to 1248 investigated nights with various aircraft noise patterns, and included 16 subjects who never received any noise and served as control. Urine was completely collected and recorded from all 96 subjects between 19:00 and 23:00, and at night from 23:00 till 07:00. Aliquots were immediately deep frozen for their respective determination of the concentrations of epinephrine, norepinephrine and cortisol. Catecholamines were analyzed by standard high performance liquid chromatography (HPLC) and electrochemical detector. Free cortisol analysis was done by a radio immuno assay (RIA) for laboratory studies I and III, whereas a linked enzyme immuno assay (LEIA) cortisol kit was used in study II. From concentrations and collection periods mean flux rates (absolute and relative) for the appropriate stress hormones resulted. Statistical analysis was done by SPSS version 10.0.7 using tests for non-parametric pairs, and independent samples. We compared flux rates and respectively, equivalent sound pressure levels, maximum sound pressure levels and frequencies of passing aircraft noise events. Moderators like age, sex, and degree of annoyance by nocturnal aircraft noise prior to the studies were considered.

Results All results obtained during nights 1, 12, and 13 were not considered. The remaining 960 nights held 240 nights without any noise, including the 2 control groups with 160 nights. Findings of second nights, always noiseless ones with background noise of LAS,eq(3) < 30 dB, served as baseline for relative flux rates of stress hormones. *Epinephrine*: concentrations were below detection in 189 samples of noiseless nights (78%), and in 554 samples out of 720 noisy nights (77%). Maximum values were not exceeding 4 ng/min, and merely 1% (7 from 720 nights) scored 3 to 4 ng/min. In comparison while awake, more than 85% of the subjects had detectable epinephrine concentrations from urine collected 19:00 till 23:00, with maximum values of 14 ng/min. For statistical analysis the all night collections of urine were insufficient, and no correlation available with respect to ephinephrine and noise effects. *Norepinephrine*: No statistically significant correlation between the relative flux mean of nocturnal norepinephrine excretion and the noise levels ranging from 31,2 to 54,5 dB LAS,eq(3), nor the

frequencies of noise events (4 to 128 events per night, applying levels of LAS,max 50 to 80 dB) could be demonstrated. *Cortisol*: The appropriate relative mean excretion rates for cortisol showed low correlations with the equivalent noise level LAS,eq(3), the maximum noise pressure LAS,max, (though not with the frequency of noise events) and the day of the study, i.e., cortisol excretion increased slightly during the study period. For catecholamines, the most prominent moderators (age, sex, degree of annoyance prior to the studies) did not prove of any statistical significance. For cortisol there were low correlations. Higher flux rates were observed with female subjects, elder persons and people who had declared being highly annoyed by air traffic noise prior to the studies.

Discussion The findings obtained in these laboratory studies suggest that catecholamine excretion from all night urine collections are no indicator for stress relevant correlations. The nocturnal epinephrine concentration is too low. This may be due to either the chosen method, namely collecting all night urine, or to the low excretion rate itself. Nocturnal norepinephrine flux rates in all night collections do not change with nor without aircraft noise. Thus, catecholamines from all night urine sampling seem to lack quality for the identification of stress induced changes. We cannot verify results reported in the literature that were derived by the same method. Using this identical method cortisol shows alterations, though weak. Its clinical relevance is to be discussed.

Keywords aircraft, noise, nocturnal, urine, stress, hormones, epinephrine, norepinephrine, cortisol