CORTISOL RESPONSE AND SUBJECTIVE SLEEP DISTURBANCE AFTER LOW FREQUENCY NOISE EXPOSURE

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Introduction Little is known of how low frequency noise (<200 Hz) affects sleep. One previous study found increased levels of cortisol in urine among children chronically exposed to heavy vehicle traffic noise [1]. Another experimental study showed that the cortisol response upon awakening was reduced following low frequency noise exposure during the night [2]. This study was an extension of the experimental study, comprising a larger number of subjects and an extended period of acclimatisation.

Materials and methods Twenty-six male, normal hearing students with an average age of 26 years (sd=4.3) slept in a sleep laboratory for five consecutive nights. Half of the subjects were exposed to low frequency noise (LFN) on the 4th and had their reference night (ref) on the 5th while the reverse conditions were present for the other half of the group (Table 1).

Table 1 Design of the study (accl = acclimatisation nights, ref=reference night, LFN=low frequency noise exposure)

Group	Night 1	Night 2	Night 3	Night 4	Night5
I	accl 1	accl 2	accl 3	LFN	ref
II	accl 1	accl 2	accl 3	ref	LFN

Saliva samples for cortisol determination were taken immediately after wake up, and after 15, 30 and 45 minutes. Subjective evaluations of sleep and mood were given on questionnaires in the morning and in the evening. During the accl nights and ref nights, the background sound level from the ventilation was 24 dBA. The LFN was a recorded wide band ventilation noise to which was added a dominant 50 Hz tone, sinusoidally amplitude modulated (100%) with a modulation frequency of 2 Hz. The LFN noise had a level of 40 dBA. The LFN was played continuously with two interruptions at 00.30h to 01.00h and 04.30h to 05.00h, during which time it was reduced to background sound level.

Results The median values of sleep quality (ranges 0=good to 10= bad) over the week for all subjects were 5.4, 3.7, 3.6 during the three accl nights, 3.8 after ref and 4.7 after LFN. After the initial accl night the sleep quality was thus rather stable and no significant difference between nights and hence noise conditions was found (Chi-sq=3.481, df=4, p=0.48). No difference was found between groups. Tiredness in the morning was reported significantly higher and social orientation significantly lower after nights with LFN compared to ref (Table 2).

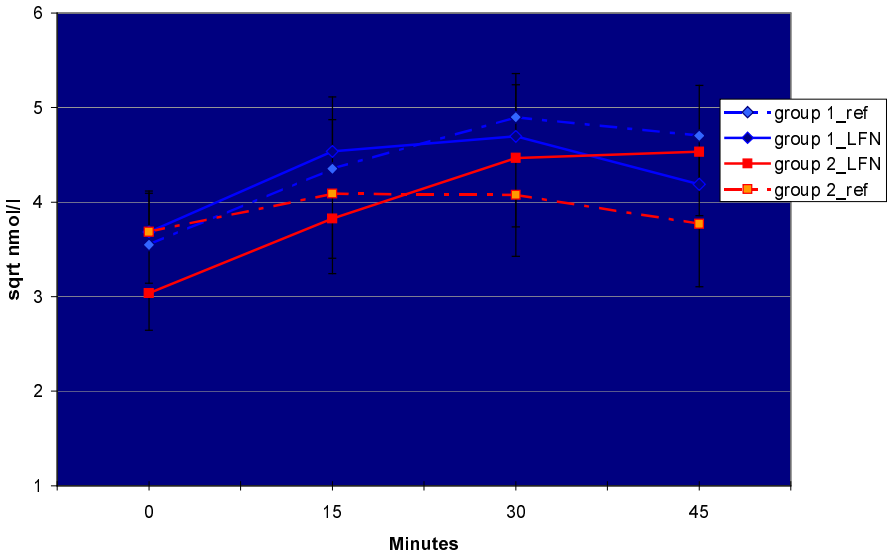
Table 2 Median values of reported tiredness and social orientation

	Ref	LFN	Significance value
Tiredness morning (0-10)	4.8	6.5	Z=-2.185, 0.029
Tiredness evening (0-10)	5.7	6.8	N.S.
Social orientation morning (1-4)	3.0	2.9	Z=-1,959, 0.051
Social orientation evening (1-4)	3.1	2.9	Z=-2.263, 0.024

Social orientation, hedonic tone, extroversion and relaxation were rated significantly lower in the evenings following nights with LFN as compared to evenings after ref (z=-2.263, p=0.024;

z =-2.208, p=0.027; z=-2.243, p=0.015; z=-1.959, p=0.05). No significant differences were found between noise conditions for time to fall asleep, number of times waking up during the night, and reported tension in the morning.
For the total group the expected cortisol response to awakening with levels reaching a peak at 30 minutes was found, and the main effect of sampling time after wake up was significant ($F(3)=24.8$), $p<0.001$). No significant main effect for noise condition or significant interaction between noise condition and sampling time was found. The response pattern did however vary between the two groups, and a significant interaction between noise, time and group was found ($F(1.492)=9.3$, $p=0.001$)(Figure 1). The data indicated that the cortisol response pattern for group 1 after LFN was similar to group 2 after ref and that the response pattern for group 2 after LFN was similar to group 1 after ref. As the responses after LFN were obtained at different weekdays (Thursday vs Friday) for the two groups, the influence of weekday was added to the analysis. A significant interaction between the day of the week and response of cortisol ($F(1.492)=9.3$, $p=0.001$), was found while no significant effect was found for group.

Figure 1. Cortisol response for the two groups in the morning after the reference night and the night with low frequency noise exposure



Discussion This study found largely in accordance with the previous study [1] that some subjective sleep parameters were affected by LFN. In contrast, however, this study did not find an effect of LFN exposure on the cortisol response upon wake up. Data indicate that either group or weekday was related to response. We could not identify any group differences that could explain the result, however a recent study measuring cortisol in urine over a period of 40 nights [3] found a weekday rhythm in cortisol excretion, which supports the hypothesis of a weekday variation. The interference with different response pattern for weekdays may thus be one explanation for the inconsistent results between this and the previous study.

Keywords: sleep, low frequency noise, cortisol awakening response, subjective sleep

References

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