Association between residents' attitude towards air traffic and their objective sleep quality at Frankfurt Airport.

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ABSTRACT

Sleep disturbances and impaired quality of life are among frequent complaints from residents around airports. This paper aims at investigating whether the subjective attitude towards air traffic is related to the objective sleep quality of an individual.

In 2012 as part of the NORAH sleep study, 74 residents around Frankfurt Airport rated their attitude towards air traffic and assessed its necessity. In the STRAIN study 2001/2002, these parameters were assessed in 61 residents living in the vicinity of Cologne / Bonn Airport. Polysomnography was recorded in residents' home environment.

In the NORAH study, a negative attitude towards air traffic was associated with a significantly impaired sleep quality (i.e. prolonged sleep onset latency: Δ 5.3 min, increased wake after sleep onset: Δ 12.8 min, reduced sleep efficiency: Δ 3 %, and less deep sleep: Δ 14.1 min). The assessment of air traffic as less necessary was related to a significant reduction in deep sleep duration (Δ 14.5 min). In the STRAIN study, no association was found.

These results suggest that residents' objective sleep quality and subjective assessment of air traffic can be related, even though the causality of the effect remains to be identified. In contrast to the long established Cologne/Bonn Airport, the high media attention and the changes in air traffic density at Frankfurt Airport might explain the observed differences between airports.

INTRODUCTION

Aircraft noise leads to adverse psychological and physiological reactions among affected residents. Frequent complaints concern annoyance and disturbed sleep times as well as the fear of negative long-term effects such as cardiovascular diseases [1, 2]. Inter-individual differences in the severity of sleep disturbances like arousals or awakenings due to aircraft noise exist that cannot exclusively be explained by age or gender [3].

Frankfurt airport in Germany has a high traffic density. In October 2011 a highly debated new runway was set into operation. As part of a mediation process among the different stakeholders at Frankfurt Airport the NORAH (Noise-Related Annoyance, Cognition, and Health) study examined from 2011-2015 the impact of aircraft noise on health, sleep disturbances, quality of life, and the mental development of children [4, 5]. A newly established flight ban restricted flight movements at night between 23.00 - 5.00 starting in 2011.

The airport in Cologne/ Bonn is a freight hub with cargo aircraft mainly landing and starting during night hours.

One of the questions the NORAH sleep study tried to answer was whether there is a relation between residents' attitude towards air traffic and their objective sleep quality.

METHODS

In 2012 as part of the NORAH sleep study, we examined 81 residents living in the vicinity of Frankfurt Airport. In the years 2001/2002 we investigated 64 residents near Cologne/ Bonn Airport in the so-called STRAIN study.

Participants' nightly sleep duration and quality were measured with polysomnography, while they slept in their homes being exposed to their usual aircraft noise environment. According to standard criteria [6], sleep EEG (F4/A1, C4/A1, O2/A1), electrooculogram (EOG), the electromyogram (EMG), a 2-lead electrocardiogram (ECG), respiratory movements of thorax and abdomen, and finger pulse amplitude were recorded und evaluated continuously.

Questionnaires were used to assess residents' attitudes (on five-point scales) towards air traffic (from 1 = negative to 5 = positive) and how they evaluated the necessity of air traffic (from 1 = not necessary to 5 = highly necessary).

From the NORAH study, 74 complete datasets were available for analyses, from the STRAIN study 61 complete datasets were available.

Attitude

Scores ≤ 2 were defined as negative attitude, scores > 2 formed the moderate to positive attitude group.

In the NORAH sample, 28 participants (18 female, mean age 44 ± 16 (SD) years) had a negative attitude towards air traffic. Sixty-six polysomnographically recorded nights were obtained in this group. A moderate to positive attitude was found in 46 participants (29 females, mean age 44 ± 15 years) who contributed 108 nights.

In the STRAIN sample, 21 participants (13 female, mean age 35 ± 11 years) had a negative attitude towards air traffic. They contributed 161 nights. The moderate to positive attitude group included 40 participants (19 female, mean age 38 ± 14 years) with 316 nights.

Necessity

Participants who scored ≤ 3 built the moderate necessity group, and scores > 3 were defined as high necessity group.

In the NORAH sample, 22 participants (15 female, mean age 45 ± 10 years) rated in the moderate necessity range and contributed 54 nights. Fifty-two residents (32 female, mean age 43 ± 17 years) scored in the high necessity range. From these residents 120 nights were available for analyses.

In the STRAIN sample, 16 participants (8 female, mean age 33 ± 12 years) examined in 123 nights evaluated air traffic to be of moderate necessity. The high necessity group had 45 participants (26 female, mean age 38 ± 13 years) and 354 nights.

Parameters of sleep duration and quality (total sleep time (TST), sleep onset latency (SOL), wake duration after sleep onset (WASO) and percentage of wake in the sleep period time (SPT), sleep efficiency (SE), deep sleep and REM sleep duration as well as percentage of deep sleep and REM sleep in SPT) were primary outcome parameters. Generalized estimating equations (GEE) were used for analyses and if significant adjusted for age and gender.

RESULTS

NORAH

The group that had a negative attitude towards air traffic showed significantly impaired sleep quality criteria in comparison to the group of residents with a moderate to positive attitude. They had an increased sleep onset duration (Δ 5.3 ± 2.2 (SE) min, p=0.01), longer wake times during the night (Δ WASO 12.8 ± 5.6 min, p=0.03; Δ wake 2.4 ± 1.1%, p=0.02), a decreased sleep efficiency (Δ 3 ± 1%, p=0.02), and a shorter deep sleep duration (Δ 14.1 ± 5.4 min, p=0.01; Δ 3.1 ± 1.1%, p=0.01). No differences were found for TST and REM sleep.

The evaluations of the necessity of air traffic did not show differences concerning TST, SOL, SE, WASO, percentage wake in SPT, REM sleep duration, and percentage REM in SPT. However, participants who scored in the moderate necessity group had a significantly shorter deep sleep duration (96 min) than the high necessity group (111 min, Δ 14.5 ± 5.6 min, p=0.01; Δ 3.0 ± 1.2%, p=0.01).

STRAIN

The negative in comparison to the positive attitude group as well as the moderate in comparison to the high necessity group did not differ significantly regarding the investigated sleep parameters (all p>0.10).

DISCUSSION

The results of the NORAH study hint at an association between residents' objective sleep quality and their attitude towards air traffic which could not be explained by age and gender differences. Differences in the inter-individual reaction probability to noise during sleep have been attributed to sleep spindle frequencies [7]. It remains to be explored if high sleep spindle rates can explain the observed group differences. Moreover, the causality of the relationship is unclear, i.e. whether a poor sleep quality induced a negative attitude towards air traffic or, conversely, whether a negative attitude caused more severe sleep impairments. In order to value the magnitude of the observed effect on sleep, we can state that sleep parameters of both groups were within the normal range seen for this age group [8]. Interestingly, we did not find any association between residents' attitude towards air traffic and objective sleep quality in the STRAIN sample. An explanation could be the change in air traffic pattern at Frankfurt Airport. In 2012 residents' at Frankfurt Airport lived through profound changes in air traffic movements with high traffic densities at shoulder hours around the night ban. Furthermore, the reorganization of air traffic at Frankfurt was highly debated with intense Media coverage. Both factors might have added to an increased psychological and/or physiological sensitivity of residents at Frankfurt in contrast to residents at Cologne/Bonn Airport.

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