

Aircraft Noise and Health Effects – a six monthly update

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Chapter 1

Introduction

- 1.1 This report is an update on recent work and findings in the field of aircraft noise and health effects. It covers published research from September 2021 – March 2022. The report will provide an overview of the most relevant findings that were published during this period.
- 1.2 The aim of the report is to provide a succinct overview of new work relating to aviation noise and health, and such updates are published on a six-monthly basis. This report has been published to provide the public and the aviation industry with a concise and accessible update on recent noise and health developments. It should be noted that the CAA has not validated any of the analysis reported at the conferences, nor takes any view on their applicability to UK policy making. The authors would like to thank Bernard Berry (Bel acoustics) for his valued contribution to the source material.
- 1.3 The findings in the following chapters are grouped by subject area.

Chapter 2

Aircraft Noise and Annoyance

- 2.1 This chapter summarises the main findings on aircraft noise and annoyance that have been published during the past six months.
- 2.2 Preisendörfer et al published a paper on annoyance responses to residential and aircraft noise in the two European cities Mainz in Germany and Zurich in Switzerland. The study examined both acoustic and non-acoustic factors that may affect indoor annoyance. The study examined the environmental concern in participants, and the link between income and annoyance to road and aircraft noise.
- 2.3 The paper discusses the most important acoustic factor, the objective exposure to noise, predominantly measured as the day-evening-night level (L_{den}). The most prominent non-acoustic factor is noise sensitivity, usually seen as a personality trait. Besides sociodemographic variables (gender, age, etc.), attitudes toward the noise source have been shown to be relevant for annoyance responses. Fear of harm connected with the noise source, individual coping capacity, and expectations of the future noise development are other non-acoustic factors that have been studied as part of the annoyance relationship.
- 2.4 The study focussed on three main factors:
- (1) The role of windows as a feature of the building where people live.
 - (2) The role of individual environmental concern as a general attitude; and
 - (3) The role of household income as an indicator of socioeconomic resources.
- 2.5 The first looks at an acoustic factor, the second two are related to non-acoustic factors. The study explores the role of windows in reducing noise annoyance in general, and the role of high-quality windows in particular. The baseline hypothesis is that windows are an important barrier against outdoor residential noise and serve simultaneously as a subjective coping tool with noise. Closing windows can reduce indoor noise, and it may additionally be important for the subjective evaluation of the capacity to cope with noise (with windows as a tool to control the noise situation).
- 2.6 The authors explain that the growing environmental awareness of the public, and the increasing political attention to environmental protection have contributed to categorising noise issues under the broader umbrella of environmental problems. They liken the reaction to the effects of passive smoking to the way the public may take information on the negative health effects of noise more seriously now than in the past.

- 2.7 Environmental concern is a general attitude relating to affective worries about environmental protection, to cognitive insights into the endangerment of the environment, and to support for environmental action. The authors explain that the general mindset of a high environmental concern can stimulate negative emotions toward noise as an environmental problem and thus result in stronger noise annoyance given the same level of noise exposure.
- 2.8 The relationship between income and noise annoyance can depend on local features, and the “environmental shielding hypothesis” focuses on how high-income households cope with noise and suggests several possibilities of noise protection. Sufficient income resources enable households to shield themselves against noise by using soundproofed high-quality windows. Apartments of resourceful households are usually larger than those of low-income households, with apartment size being important for locating living spaces and bedrooms away from road traffic noise. There might be a positive association between income and noise sensitivity, partly compensating the supposed negative income effect on noise annoyance.
- 2.9 Both cities are located near international airports. Mainz (with 210,000 inhabitants) is affected by Frankfurt Airport, which is about 25 km east of the city. Zurich (the largest city in Switzerland, with 430,000 inhabitants) is affected by Zurich Kloten Airport, which is about 10 km north of the city. Aircraft noise has been a controversial public issue in both cities for many years. Data were gathered as part of a project supported by the German Research Foundation (DFG) and the Swiss National Science Foundation (SNSF). The road traffic noise exposure L_{den} of the survey respondents is close to the WHO recommended limit of 53 dB L_{den} , both in Mainz (52.8 dB) and in Zurich (53.1 dB). The aircraft noise exposure is above the WHO recommended limit of 45 dB L_{den} in Mainz (46.5 dB) and slightly below the WHO limit in Zurich (44.3 dB).
- 2.10 Multivariate regression analysis was used to analyse the results, with the 11-point annoyance scale as the dependent variable. The results indicated that closed windows in general and closed high-quality windows in particular are an important barrier against outdoor road traffic and aircraft noise, as well as a helpful subjective coping tool against corresponding annoyances. Environmental concern, too, proves to be a significant predictor of noise annoyance.
- 2.11 Environmentally highly concerned people articulated feelings of annoyance more often than environmentally less concerned ones. As expected, income was negatively related to road traffic noise annoyance. However, a positive association of income with annoyance from aircraft noise was found. Although objective exposure to aircraft noise was lower for high-income households, they felt more strongly annoyed by noise from aircraft. Income shows various indirect effects on noise annoyance.

- 2.12 Marquis-Favre et al published a paper on combined road, rail and aircraft noise sources and a total annoyance model from field data. The study examined the annoyance in relation to combined noise sources using mixed models. The background to the study is that previously, studies looking at annoyance due to combined noise sources proposed different total annoyance models. These were very rarely assessed using field annoyance data. The authors explain that the aim of this study was to assess them using annoyance data from urban settings exposed to two or three combined transportation noise sources.
- 2.13 Ten classical total annoyance models were assessed and highlighted relevant existing models to account for combined transportation noise annoyance in cities. The results suggested that perceptual total annoyance models, based on annoyance due to each transportation noise source better performed the total annoyance calculation than psychophysical total annoyance models, which were based on the L_{den} index.
- 2.14 The results indicated that the dominant source effect mainly explained total annoyance responses from the residents, and the strongest component model led to a good calculation of mean total annoyance ratings. However, perceptual models with an interaction term, such as mixed models, better explained total annoyance judgements from respondents as they accounted for the contribution of each combined noise source and their interaction. The perceptual linear regression model was also interesting as it accounted for the contribution of each combined noise source and might be used for more than two combined noise sources. Those perceptual models accounted well for the resident feeling towards the different combined noise sources. The authors suggested that the results may provide a useful insight into studying the effects of combined noise sources and annoyance responses in the future.
- 2.15 Di et al looked at the role of noise sensitivity on perceived annoyance. This was not an aircraft noise-focussed study but given the importance of noise sensitivity as a non-acoustic factor in aircraft noise and annoyance studies, its findings may be relevant.
- 2.16 The study proposed a method to identify noise-sensitive individuals based on the experimental results of noise perceived annoyance, and the influence of noise sensitivity on perceived annoyance was also examined. 337 participants (undergraduate students) were recruited randomly. The noise sensitivity score (NSS) of each subject was obtained through the Weinstein's noise sensitivity scale. Using the ICBEN 11-point numerical annoyance scale, perceived annoyance in relation to noise (14 pink noise¹ samples) was examined in a

¹ Pink noise consists of all frequencies heard by humans, but the energy is not distributed equally across them. It is more intense at lower frequencies, which creates a deeper sound than e.g. white noise.

soundproof room. The subjects were divided into several groups according to the NSS of each subject.

- 2.17 The subjects were divided into several groups according to the NSS of each subject. According to the difference of perceived annoyance between different groups, a certain NSS was chosen as the threshold to identify high and low noise sensitive individuals. Results showed that the threshold was 110, i.e., the NSS of each high noise-sensitive individual was larger than or equal to 110 and the NSS of each low noise-sensitive individual was smaller than 110. Regression analysis revealed the effect of noise-sensitivity as a factor on perceived annoyance was up to 26%. The authors suggest that these results assist in determining the influence of noise sensitivity on perceived annoyance and highlight the importance of noise sensitivity as a non-acoustic factor.