



Department
for Transport

Aviation Night Noise Effects (ANNE) study

Subjective Study

Tim May

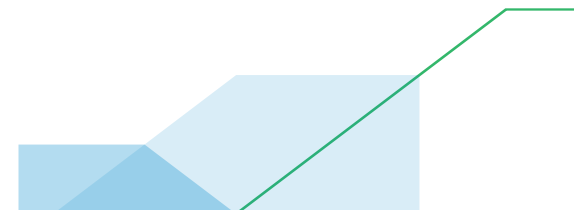
Wednesday 10th June 2026

OFFICIAL-SENSITIVE

Aim of session

To present the following:

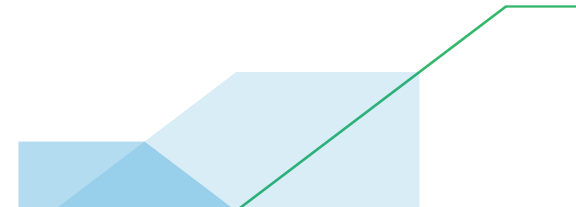
1. Background
2. Main findings
3. Caveats
4. IGCB(N) and TAG
5. Update on ANNE Objective Study



Background

Aim and Research design

- **Aim:** examine the relationship between aviation noise and sleep disturbance and annoyance, using a range of time-average metrics (LAeq,8h, Lnight, N60, overflights) and for different hourly periods between 21.00-08.00 using the LAeq,1h metric.
- **Research design** - two study approach
- **Social survey**
 - 4000 people living near 8 UK airports
 - Assess associations of aviation noise exposure and subjective sleep disturbance and annoyance
 - Examines if the effects of night aviation noise on annoyance differ by age, ethnicity, noise sensitivity, and pre-existing illness.
- **Objective sleep disturbance study**
 - Physiological measurements
 - Recording sleep for a one-week period
 - Assess associations of aviation noise exposure and objective sleep disturbance



Innovations and strengths of the study

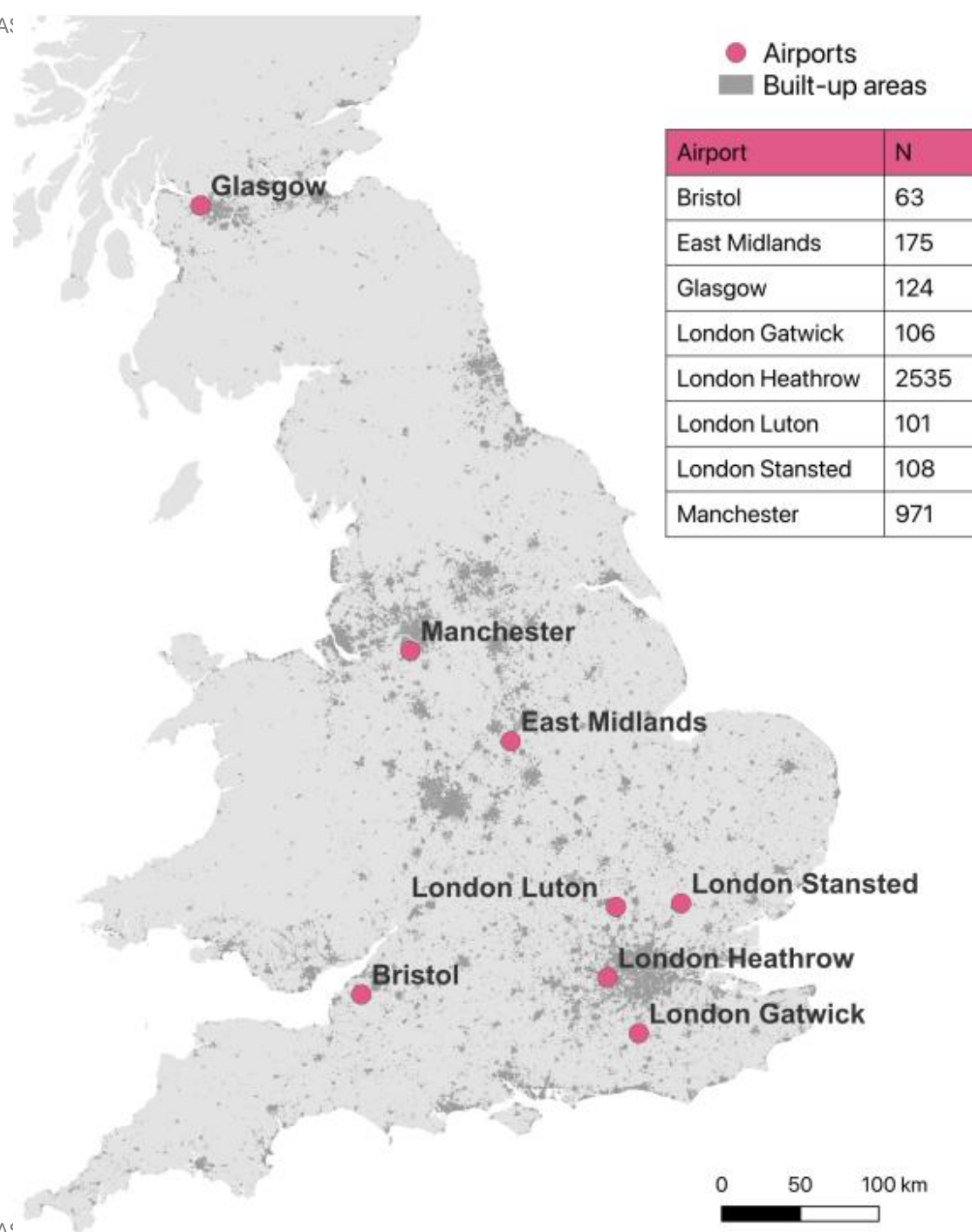
- First study designed to assess aviation night noise and sleep in the UK for 30 years.
- First study to look at how annoyance and sleep disturbance vary by LAeq,1h during the night-time.
- Examines lower levels of exposure to identify 'where effects begin' (thresholds) - down to 35dB Lnight
- Assesses two key policy relevant health effects using standardised approaches
 - Highly Annoyed (HA) (ISO/TS 15666)
 - Highly Sleep disturbed (HSD)
- More sophisticated statistical analyses (testing shape of relationships) to ensure analyses reflects the shape of the relationships between aviation night noise and health

Data collection

- Purposive sampling of airports and push to web survey
- Data collected end October 22 to early Jan 23 (9 weeks)- 3 attempts at contact (including paper questionnaire)
- 2 people per household could complete
- Achieved 20% household response rate, 4,183 individuals
- 74% online / 26% paper response

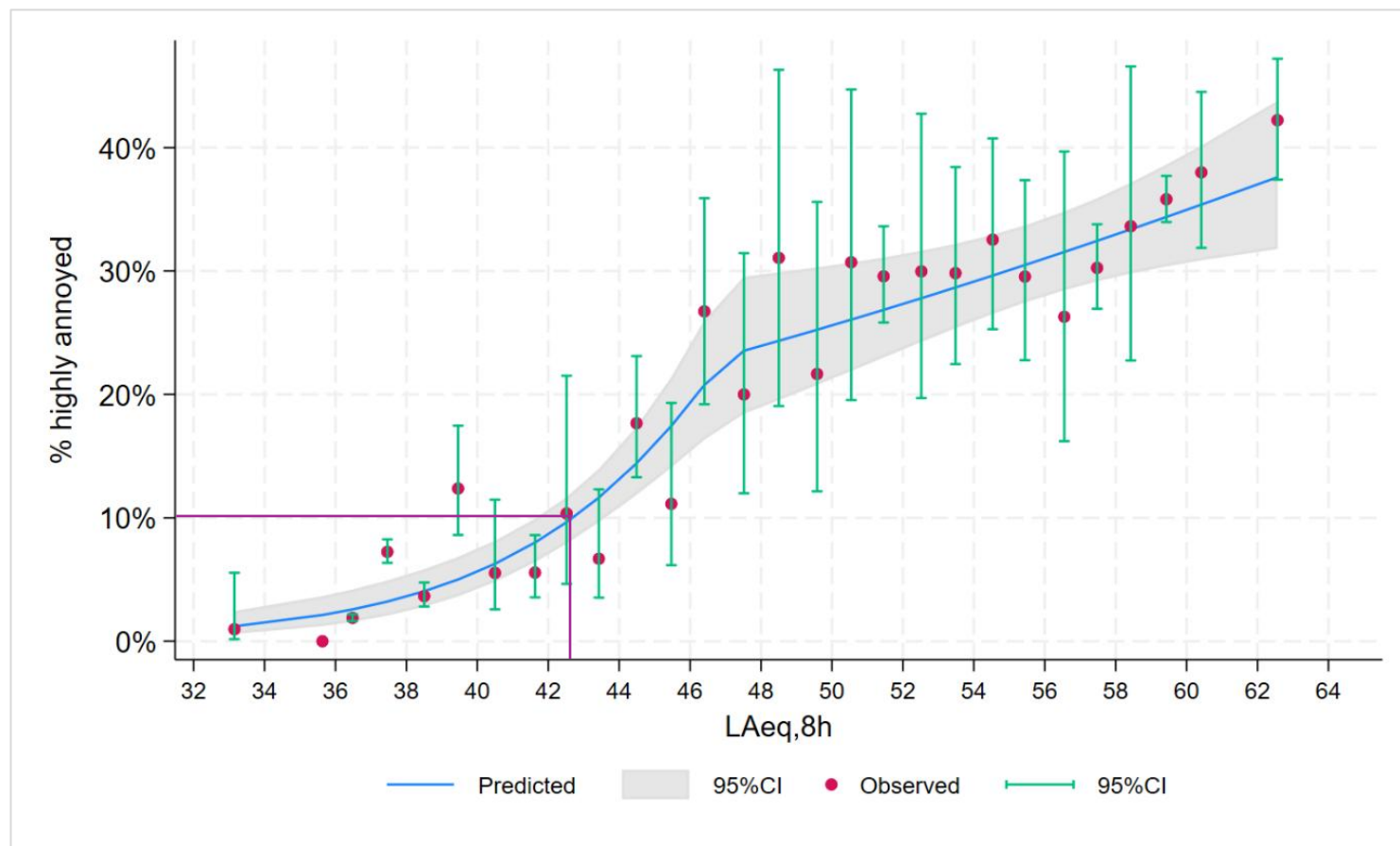
Participating individuals	
	Participating individuals
Noise exposure band (decibels, dB - L_{night})	n
35 - 47.9	1,458
48 - 49.9	286
50 - 51.9	325
52 - 53.9	322
54 - 55.9	329
56 - 57.9	426
58 - 59.9	532
≥ 60	505
<i>Base</i>	<i>4,183</i>

*Sensitivity analyses showed that the study findings were not dominated by the larger samples in the ANNE study from London Heathrow and Manchester airports



Main Findings

Annoyance thresholds - 8-hour night-time period (23.00-07.00) ($LA_{eq,8h}$, summer)



Very few participants reported being 'highly annoyed' at the lowest exposures

10% of the sample were 'highly annoyed' at 43dB $L_{Aeq,8h}$ (Purple line)

Annoyance increases with exposure, until levelling out at around 30% 'highly annoyed' for exposures in the 55-60dB $L_{Aeq,8h}$ range.

Relationship very similar for L_{night}

Figure 7: Plot of highly annoyed (5-point scale) (HA_v) as a function of $L_{Aeq,8h}$ (92-day average summer night) noise exposure

Annoyance varies across, and is seen outside, the 23.00-07.00 night-time period

Noise metric	Level at which 10% HA (HA_v) (based on regression line)
$L_{Aeq,1h}$ 21.00-22.00	49dB
$L_{Aeq,1h}$ 22.00-23.00	49dB
$L_{Aeq,1h}$ 23.00-00.00	43dB
$L_{Aeq,1h}$ 00.00-01.00	43dB
$L_{Aeq,1h}$ 01.00-02.00	43dB
$L_{Aeq,1h}$ 02.00-03.00	48dB
$L_{Aeq,1h}$ 03.00-04.00	40dB
$L_{Aeq,1h}$ 04.00-05.00	36dB
$L_{Aeq,1h}$ 05.00-06.00	40dB
$L_{Aeq,1h}$ 06.00-07.00	50dB
$L_{Aeq,1h}$ 07.00-08.00	51dB

Table 34: Summary for each noise metric for the exposure level at which it was predicted that 10% were highly annoyed (HA_v) (based on the regression line).

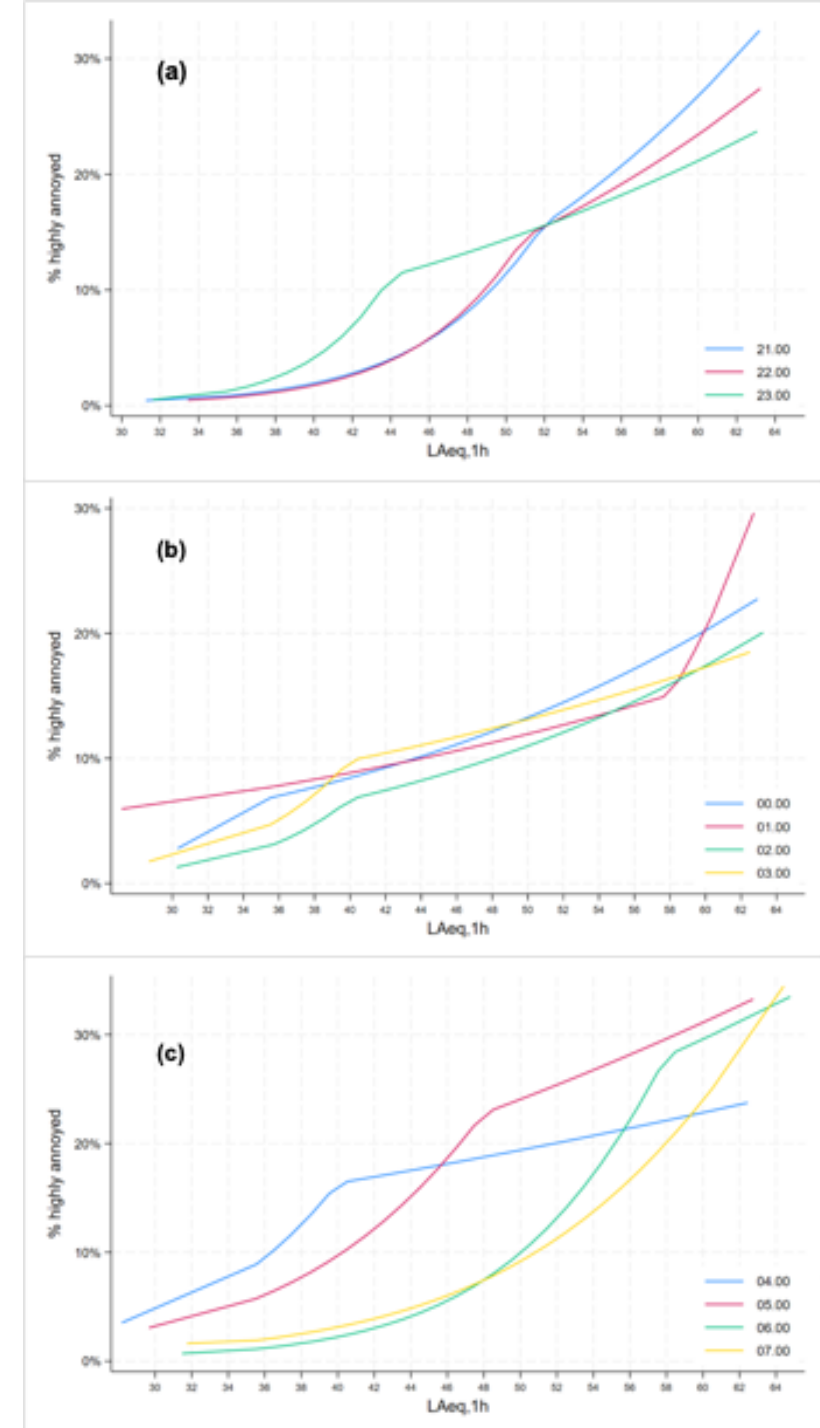
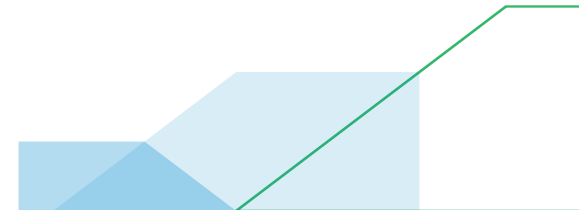


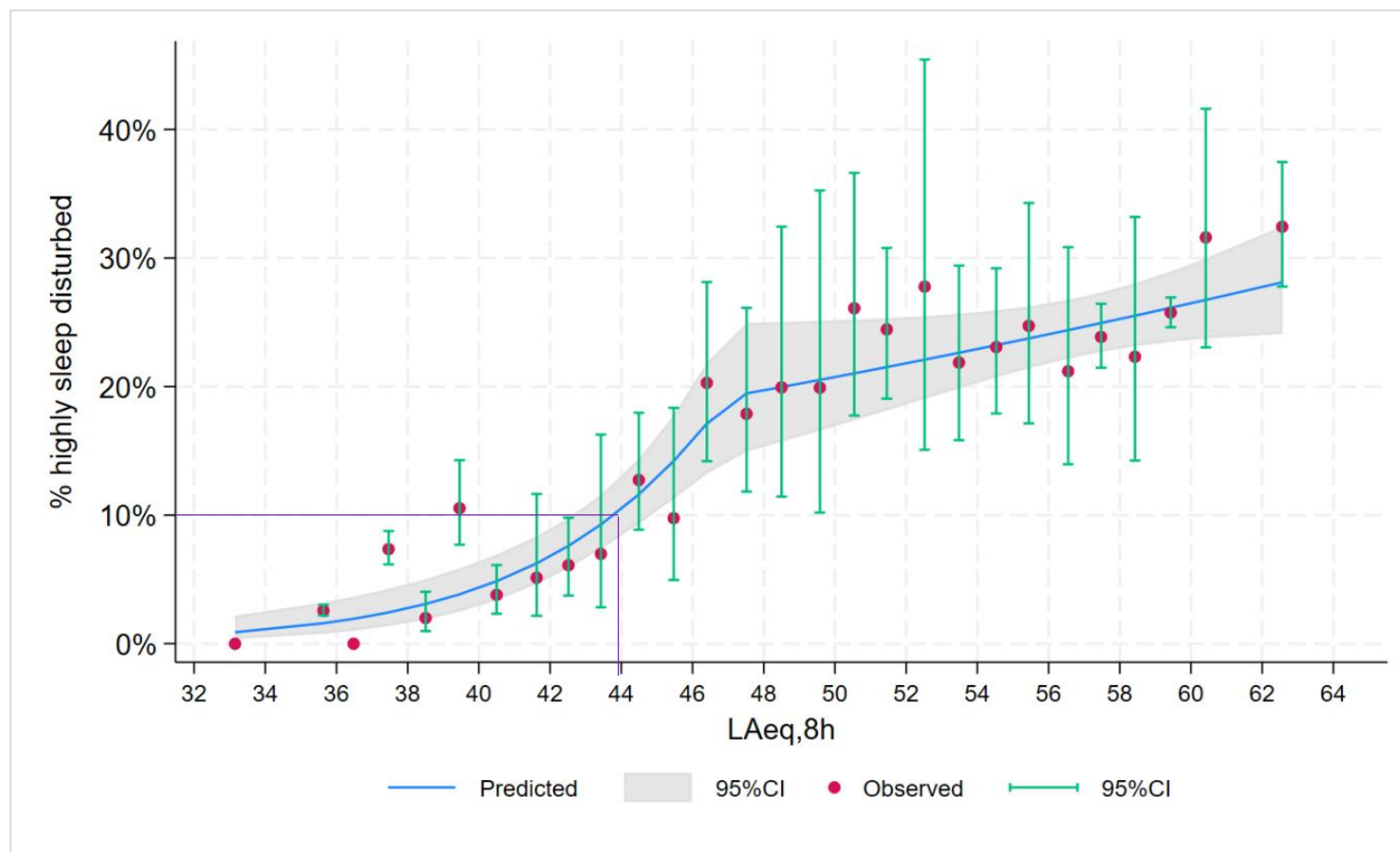
Figure 10: Plot of highly annoyed (hourly 5-point scale) as a function of $L_{Aeq,1h}$ from periods from (a) 21.00-00.00, (b) 00.00-04.00, (c) 04.00-08.00.

Annoyance responses are influenced by non-acoustic and demographic factors

- **Higher Annoyance was reported by:** Noise sensitive individuals; those with home insulation; 'higher managerial, administrative, & professional occupations'; those with negative attitudes about aviation; participants with 'white' ethnic background.
- **No difference in annoyance by:** self-reported health status; number of years someone lived in the house (no habituation)
- **Lower annoyance reported by:** younger participants (18-34y); those with aviation related employment in the household.



Sleep disturbance thresholds - 8-hour night-time period (23.00-07.00) ($LA_{eq,8h}$, summer)



Very similar relationship as for annoyance

Few participants reported being 'highly sleep disturbed' at low exposures

10% of the sample were 'HSD' at 44dB $L_{Aeq,8h}$ (Purple line)

HSD increased to 20% at 49dB, where the regression line flattened out but still increased with increasing exposure, remaining at around 20-28% $L_{Aeq,8h}$.

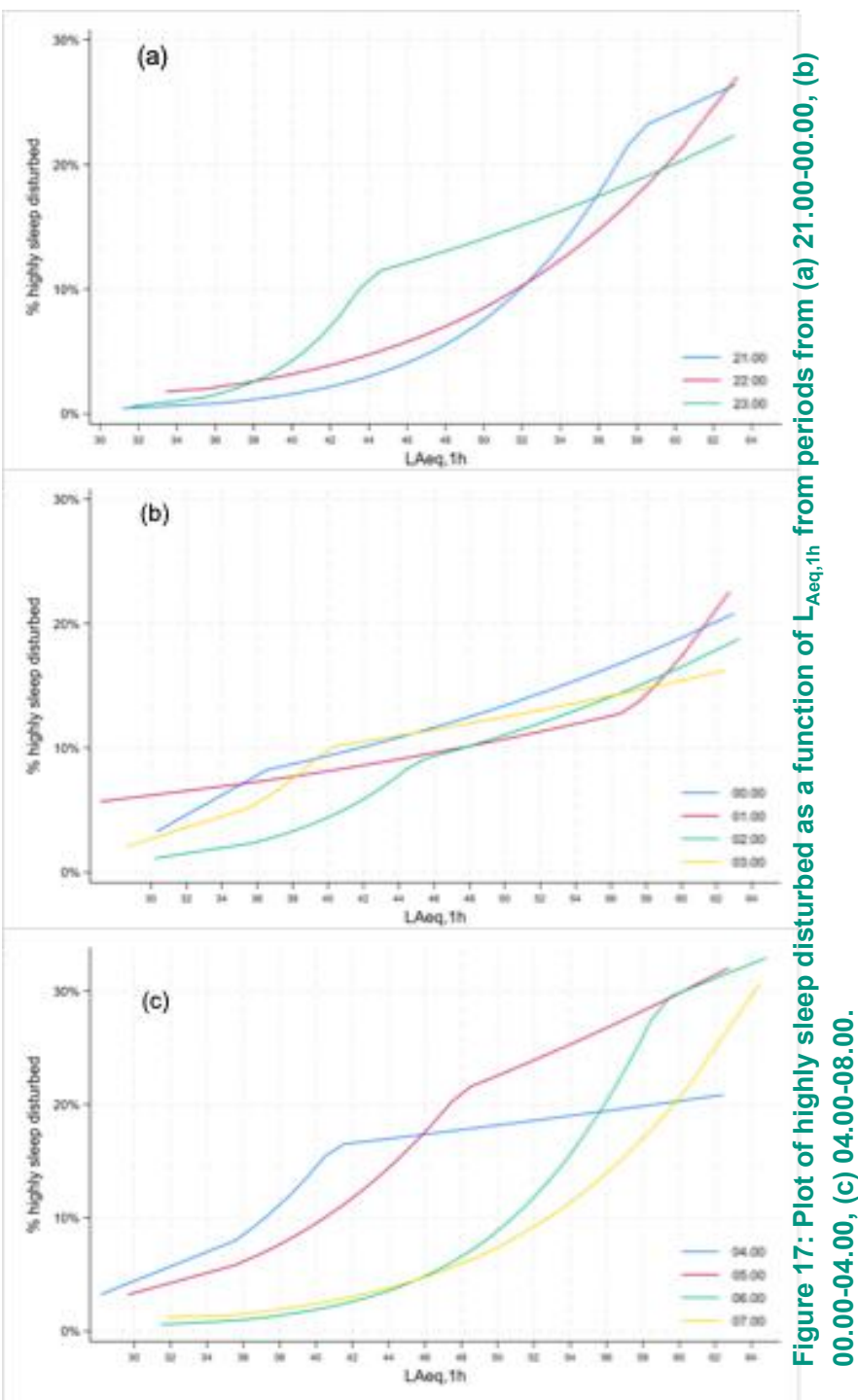
Relationship very similar for L_{night}

Figure 14: Plot of highly sleep disturbed as a function of $L_{Aeq,8h}$ (92-day average summer night) noise exposure.

Sleep disturbance varies across, and is seen outside, the 23.00-07.00 night-time period

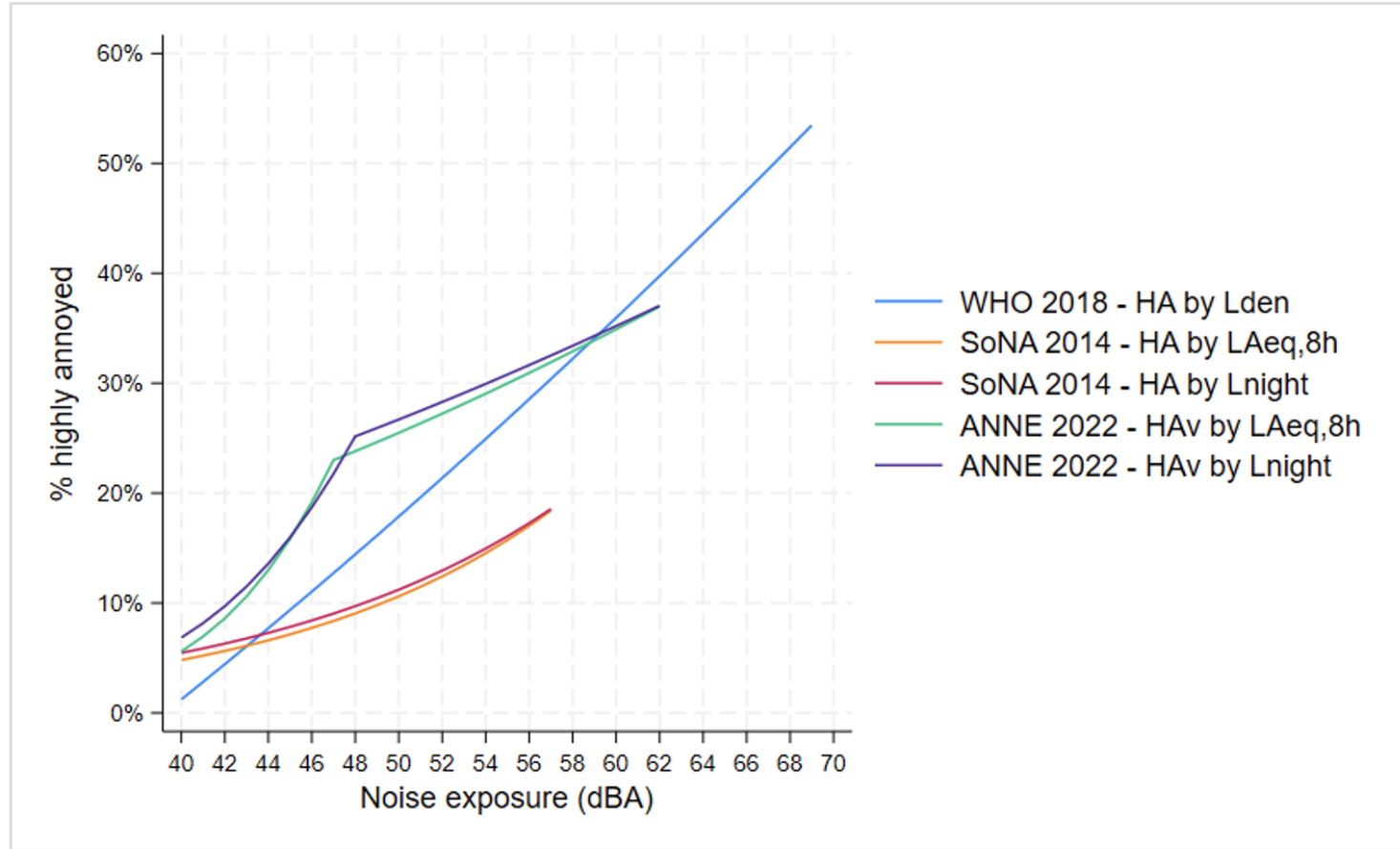
Noise metric	Level at which 10% HSD (based on regression line)
$L_{Aeq,1h}$ 21.00-22.00	52dB
$L_{Aeq,1h}$ 22.00-23.00	52dB
$L_{Aeq,1h}$ 23.00-00.00	43dB
$L_{Aeq,1h}$ 00.00-01.00	42dB
$L_{Aeq,1h}$ 01.00-02.00	47dB
$L_{Aeq,1h}$ 02.00-03.00	47dB
$L_{Aeq,1h}$ 03.00-04.00	40dB
$L_{Aeq,1h}$ 04.00-05.00	37dB
$L_{Aeq,1h}$ 05.00-06.00	40dB
$L_{Aeq,1h}$ 06.00-07.00	51dB
$L_{Aeq,1h}$ 07.00-08.00	53dB

Table 47: Summary for each noise metric for the exposure level at which it was predicted that 10% were highly sleep disturbed (based on the regression line).



The ANNE study suggests higher rates of annoyance than SoNA 2014

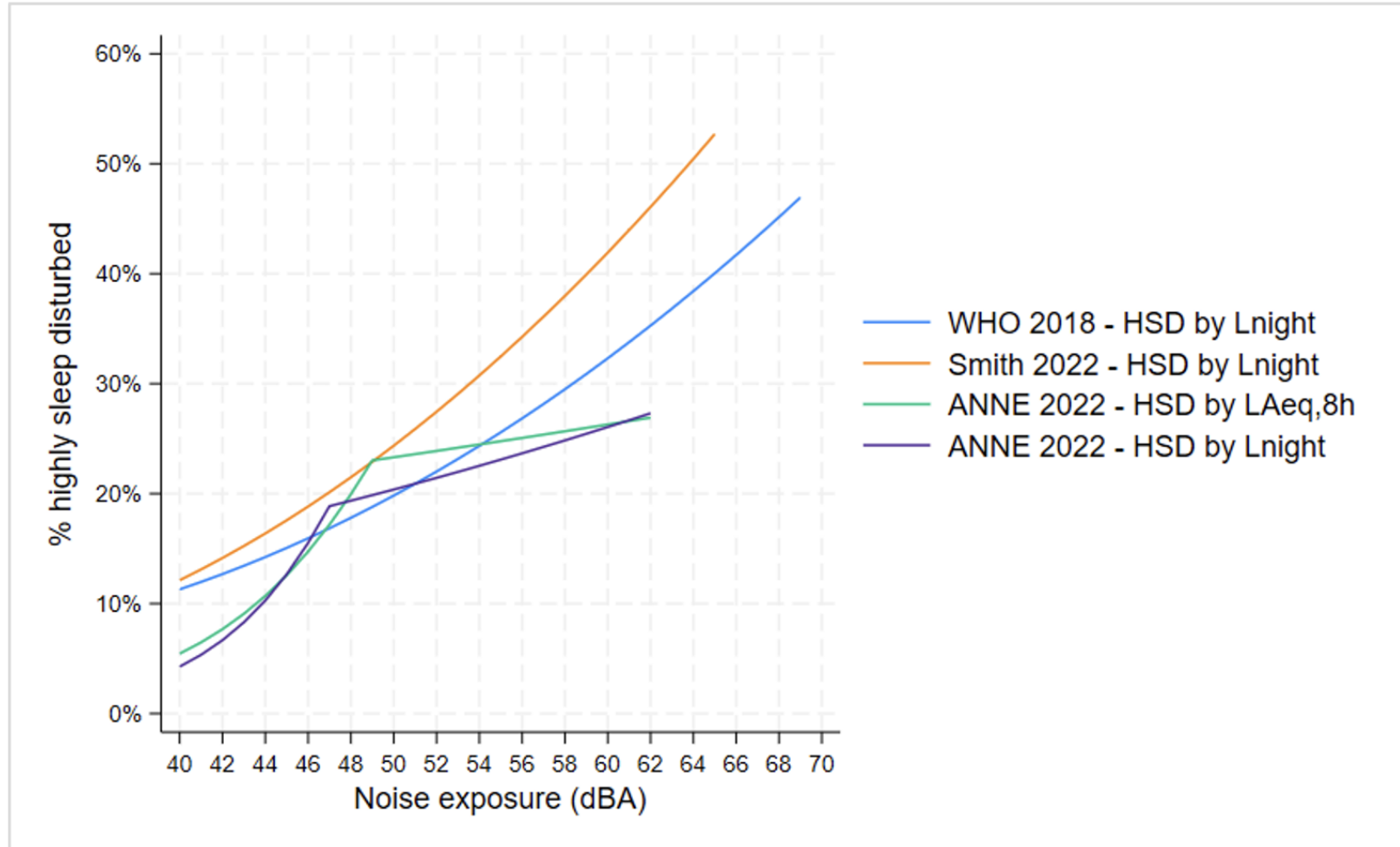
Figure 18: Plot comparing the ANNE study findings with other recent estimates of the relationship between aircraft noise at night and HA



NB: in considering the data in Figure 18 it should be remembered that the WHO 2018 and SoNA 2014 use the 28% cut-off for HA, whilst ANNE 2022 uses the 40% cut-off for HA.

The ANNE study suggests slightly lower rates of sleep disturbance than the WHO

Figure 19: Plot comparing the ANNE study findings with other recent estimates of the relationship between aircraft noise at night and HSD



Comparing the ANNE study findings to other exposure-response functions

Key differences to bear in mind:

- ANNE sampled on night-time exposure; other studies sample on daytime or day/evening/night (Lden).
- Analytical techniques differ:
- Single studies (ANNE, SoNA) versus meta-analysis of several studies (WHO).
- Statistical techniques – shape of the regression line.
- Studies use different thresholds for highly annoyed (28% WHO, SoNA versus 40% (ANNE)).

Caveats

Caveats of the study

- Whilst the study shows people are more annoyed by aviation noise than they were, we cannot say how much more annoyed they are.
- ANNE findings can only be applied between 21:00 and 08:00 and not extended to time periods outside this. ANAS may be more relevant here.
- The findings should be considered in the light of:
 - Small number of sample exposed to higher levels of aviation noise at night
 - Small numbers for some sub-group analyses examining non-acoustic factors
 - Higher proportion of participants from certain sub-groups
- We cannot speculate on relationships for exposure levels higher than ~60dB, as these levels were not examined and are rarely seen in the UK context at night.
- Indoor noise is attenuated to an unknown degree in the study (we do not know building characteristics or behaviours including window opening).

IGCB(N) and TAG

IGCB(N) and TAG

IGCB(N)

- Both studies will be taken to the Interdepartmental Group on Costs and Benefits (Noise Subgroup) (IGCB(N)).
- The IGCB(N) is a cross-governmental expert group, chaired by Defra, that is responsible for issuing guidance for valuing impacts associated with environmental noise.
- This process is used to incorporate new evidence from across a range of sources of environmental noise (including aviation, road and rail) into guidance on valuing environmental noise impacts.
- Defra are currently drafting the latest IGCB(N) report (which will supersede the 2014 report) and this will take account of any relevant changes in the evidence.

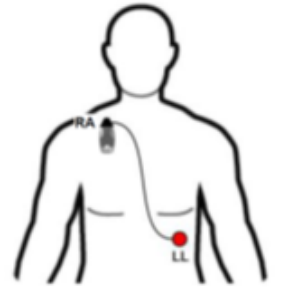
TAG

- Transport Appraisal Guidance (TAG) provides guidance on how environmental impacts, including noise impacts from aviation, can be monetised. There is a specific Aviation Noise workbook, which includes an appraisal value (£ per dB / per person) that can be used to estimate health impacts.
- ANNE provides new evidence that could change these appraisal values.
- The DfT is committed to exploring potential changes to TAG following the publication of ANNE and ANAS (see DfT's Appraisal, Modelling and Evaluation Strategy (May 2026))

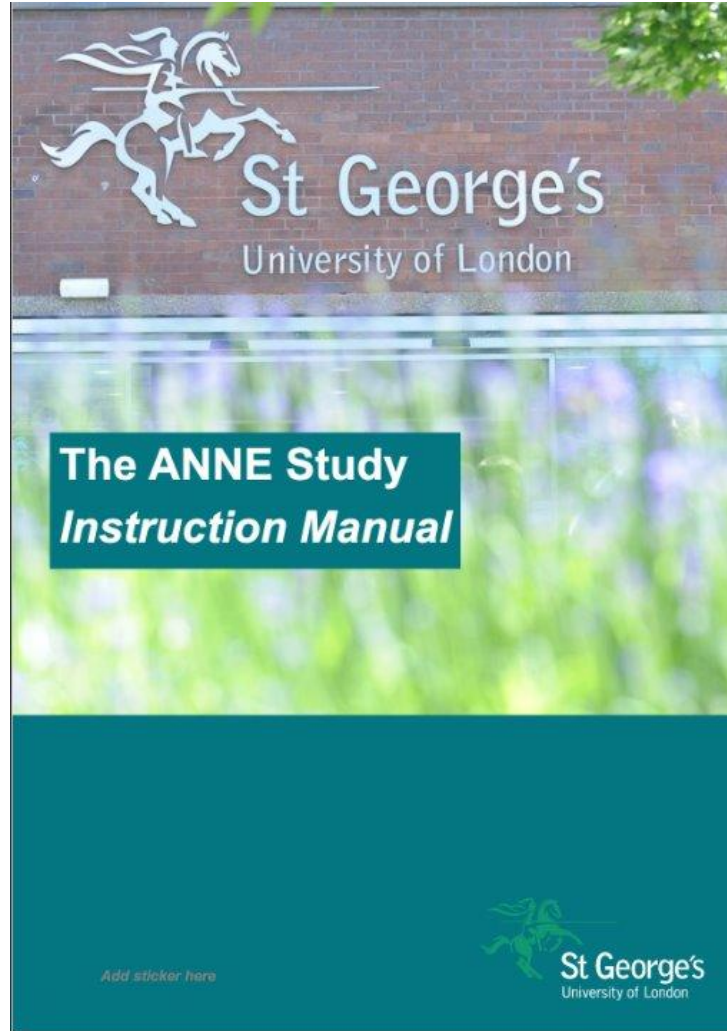
Update on ANNE Objective Study

Objective study

- **Aim:** To estimate the association of night aviation noise on objective sleep disturbance (awakenings) for a sample of residents living near UK airports. Will consider a range of time-average metrics (LAeq,8h, LAeq,T, N60, overflights) and event-based metrics (LAmax, SEL) for different time-periods between 22.00-08.00 hours.
- **Approach:**
 - Participants were recruited from the subjective study
 - Participants were mailed equipment and asked to record sleep for a one-week period using the Faros device (ECG and actigraphy data for the scoring of noise-induced awakenings). Morning surveys were also completed, which collected data about subjective sleep disturbance.
 - Both indoor and outdoor noise levels were recorded (aircraft noise data modelled outdoors via flight-track data, indoor aircraft noise levels using sound level meters)
 - Incentive £200
- **Primary outcomes:**
 - Awakenings
 - Sleep Fragmentation Index – the number of awakenings per hour of sleep



Objective study



Objective study

- 2,553 consented to being contacted about the objective sleep study
- 1,450 (57%) met the eligibility criteria (based on their survey data)
- Target sample size 200 – approximately 17 per month
- Selected randomly by noise strata
- In field April 2024-March 2025 – achieved the 200 target sample size
- Timeline
 - Data collection ended March 2025
 - Analysis throughout rest of 2025-2026
 - Expecting report by the end of 2026
 - Peer review via journal paper submission