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## **The effects of annoyance due to aircraft noise on psychological distress**

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### **ABSTRACT**

**The effects of annoyance due to aircraft noise on psychological distress have not been largely investigated, and remain discussed. The present study aimed at investigating the association between aircraft noise annoyance and psychological distress among people living near French airports. The DEBATS study included 1,244 residents around three major French airports. Information about psychological distress was provided by a face-to-face questionnaire including the 12-version of the General Health**

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**Questionnaire (GHQ-12). Annoyance due to aircraft noise was assessed through the verbal 5-point ICBEN scale. The association with psychological distress was investigated using logistic regressions. About 22% of the participants were considered to have psychological distress according to the GHQ-12. A significant association was found between aircraft noise annoyance and psychological distress. The ORs ranged from 1.49 (95%CI=0.94-2.39) to 3.64 (95%CI=1.70-7.78), with gradual ORs across the different categories of annoyance. This relationship remained unchanged when noise sensitivity was included in the model. This study highlighted a significant association between aircraft noise annoyance and psychological distress confirming the results found in the literature. However the direction of the association can be questioned: annoyed people might be more prone to have psychological distress, but it is also possible that people with psychological distress might be more prone to be annoyed.**

## **1 INTRODUCTION**

Many studies have evidenced adverse effects of aircraft noise exposure on health, such as annoyance, cardiovascular diseases, sleep disorders or altered cognitive performance<sup>1-6</sup>. Some studies have investigated low birth weight, obesity or diabetes<sup>7,8</sup>, but these effects remain discussed in the literature because of divergent results.

It's also the case for psychological distress: some studies showed a significant association between aircraft noise exposure and psychological disorders<sup>9-11</sup>, and some other did not<sup>12-14</sup>. However, the hypothesis that noise annoyance could be considered as a mediator in the causal chain between aircraft noise exposure and health disorders has been proposed<sup>15</sup>.

The association between annoyance due to noise and psychological distress has not been largely investigated<sup>11,13,16,17</sup>, and no study has been carried out in France.

DEBATS (Discussion on the health effects of aircraft noise) is the first research program in France to investigate the health effects of aircraft noise exposure. One of the specific objectives of the study was to evaluate the effects of annoyance due to aircraft noise on psychological distress in people living near airports in France.

## **2 METHODS**

### **2.1 Study population**

DEBATS randomly included 1,244 individuals older than 18 and living near three major French airports (Paris-Charles de Gaulle, Lyon-Saint-Exupéry and Toulouse-Blagnac) in 2013. The study population was stratified on aircraft noise contours produced with the "Integrated Noise Model" (INM) by the DGAC (French Civil Aviation Authority). These contours are based on the day-evening-night equivalent noise level ( $L_{den}$ ) and define four categories: <50, 50-54, 55-59 and  $\geq 60$  dB(A). All the participants responded to a questionnaire administered by an interviewer at their place of residence. The questionnaire collected in particular demographic and socio-economic information, lifestyle factors such as smoking and alcohol consumption, and personal medical history.

## **2.2 Annoyance due to aircraft noise**

Annoyance due to aircraft noise was assessed with the following question: “Thinking about the last 12 months, when you are at home, how much does aircraft noise annoy you?” The 5-point verbal scale proposed by the International Commission on the Biological Effects of Noise (Icben) was used: extremely, very, moderately, slightly or not at all.

## **2.3 Psychological distress**

Psychological distress was evaluated during the face-to-face interview with the 12-item version of General Health Questionnaire (GHQ-12)<sup>18</sup>. The GHQ-12 is a self-report instrument for the detection of mental disorders within community. A GHQ-score was then calculated and treated as a dichotomous variable, with a 2/3 threshold: participants with a GHQ-score  $\geq 3$  were considered to have psychological distress.

## **2.4 Confounders**

Several factors known in the literature to affect psychological distress were obtained from the questionnaire: age (six categories: 18-34; 35-44; 45-54; 55-64; 65-75; >75 years old), country of birth (France-born; foreign-born), gender, occupational activity (yes; no), marital status (single; married; widowed; divorced), alcohol consumption (no; light; moderate; heavy), smoking (non-smoker; ex-smoker; occasional smoker; daily smoker), sleep duration ( $\leq 5$ h; 6h; 7h; 8h;  $\geq 9$ h), number of stressful life events (0; 1;  $\geq 2$ ), education (< French high-school certificate; French high-school certificate; >French high-school certificate), household monthly income (<2,600\$/month ; 2,600 to 4,500\$/month ;  $\geq 4,500$ \$/month), and antidepressant use (yes; no).

## **2.5 Statistical analysis**

A logistic regression model (M1 model) with the dichotomized GHQ-score as the outcome variable and annoyance due to aircraft noise and confounders as covariates was used to assess the associations between annoyance due to aircraft noise and psychological distress.

As it has been suggested that noise sensitivity could influence the effects of noise on physical and psychological distress, noise sensitivity was also included in two categories (less sensitive than or as sensitive as/more sensitive than people around you) in a second logistic regression model (M2 model).

## **3 RESULTS**

About 22% of the participants were considered to have psychological distress according to the GHQ-12.

Table 1 shows the odds-ratios (OR) and their 95% confidence intervals (CI) for the dichotomized GHQ-score in relation to annoyance due to aircraft noise and confounders included simultaneously in the logistic regression model. A significant association was found between annoyance due to aircraft noise and psychological distress: ORs ranged from 1.49 (95% CI 0.94-2.39) to 3.64 (95% CI 1.70-7.78), with gradual ORs across the different categories of annoyance. OR reached the maximum estimate for people reporting to be extremely annoyed compared to those who were not at all annoyed.

The results remained similar when noise sensitivity was included in the model. People reporting to be more sensitive than people around them had a higher risk of psychological distress (OR=1.70, 95% CI 1.25-2.31).

Table 1: Odds-ratio for the relationship between annoyance due to aircraft noise and psychological distress evaluated with the GHQ-12

	N	M1 model		M2 model	
		OR	(95% CI)	OR	(95% CI)
<b>Annoyance due to aircraft noise</b>					
Not at all	246	1.00	Ref	1.00	Ref
Slightly	312	1.49	(0.94-2.39)	1.51	(0.94-2.44)
Moderately	460	1.49	(0.95-2.32)	1.46	(0.93-2.30)
Very	186	<b>2.07</b>	<b>(1.25-3.44)</b>	<b>1.99</b>	<b>(1.19-3.35)</b>
Extremely	40	<b>3.64</b>	<b>(1.70-7.78)</b>	<b>3.56</b>	<b>(1.65-7.69)</b>
<b>Noise sensitivity</b>					
Less sensitive than or as sensitive as people around you	866	-	-	1.00	Ref
More sensitive than people around you	369	-	-	<b>1.70</b>	<b>(1.25-2.31)</b>
<b>Gender</b>					
Male	549	1.00	Ref	1.00	Ref
Female	695	<b>1.58</b>	<b>(1.15-2.16)</b>	<b>1.58</b>	<b>(1.15-2.17)</b>
<b>Age</b>					
18-34	226	1.00	Ref	1.00	Ref
35-44	236	1.56	(0.94-2.57)	1.56	(0.94-2.59)
45-54	266	<b>1.82</b>	<b>(1.10-3.01)</b>	<b>1.81</b>	<b>(1.08-3.01)</b>
55-64	260	1.24	(0.73-2.10)	1.18	(0.69-2.01)
65-74	185	0.72	(0.37-1.40)	0.73	(0.38-1.43)
≥75	71	1.17	(0.49-2.79)	1.19	(0.50-2.86)
<b>Country of birth</b>					
France-born	1054	1.00	Ref	1.00	Ref
Foreign-born	190	1.29	(0.88-1.90)	1.30	(0.88-1.93)
<b>Occupational activity</b>					
No	499	1.00	Ref	1.00	Ref
Yes	745	0.81	(0.55-1.19)	0.77	(0.52-1.14)
<b>Education</b>					
< French high-school certificate	452	1.00	Ref	1.00	Ref
French high-school certificate	215	1.18	(0.78-1.79)	1.09	(0.71-1.67)
> French high-school certificate	577	1.05	(0.74-1.49)	0.99	(0.69-1.42)
<b>Marital status</b>					
Single	253	1.00	Ref	1.00	Ref
Married	782	1.04	(0.69-1.58)	1.01	(0.66-1.54)
Widowed	76	1.23	(0.58-2.60)	1.21	(0.57-2.57)
Divorced	133	0.97	(0.56-1.69)	0.98	(0.56-1.72)
<b>Smoking habits</b>					
Non smoker	625	1.00	Ref	1.00	Ref
Ex-smoker	330	1.30	(0.91-1.85)	1.34	(0.94-1.92)
Occasional smoker	19	0.24	(0.03-1.86)	0.23	(0.03-1.83)
Daily smoker	269	<b>1.58</b>	<b>(1.09-2.29)</b>	<b>1.57</b>	<b>(1.08-2.29)</b>
<b>Alcohol consumption</b>					
No	348	1.00	Ref	1.00	Ref
Light	637	0.89	(0.64-1.24)	0.91	(0.64-1.27)
Moderate	193	0.56	(0.34-0.92)	0.62	(0.38-1.02)
Heavy	54	0.77	(0.35-1.66)	0.89	(0.41-1.96)

	<i>N</i>	<i>M1 model</i>		<i>M2 model</i>	
		<i>OR</i>	<i>(95% CI)</i>	<i>OR</i>	<i>(95% CI)</i>
<b>Number of work-related stress and major stressful life events</b>					
0	287	1.00	Ref	1.00	Ref
1	330	1.03	(0.65-1.62)	1.02	(0.64-1.62)
≥ 2	627	1.83	(1.23-2.73)	<b>1.84</b>	<b>(1.23-2.75)</b>
<b>Household monthly income</b>					
≥ 4,000 euros (4,500 US\$)	319	1.00	Ref	1.00	Ref
2,300 - 4,000 euros (2,600 – 4,500 US\$)	474	1.07	(0.72-1.59)	1.02	(0.68-1.52)
< 2,300 euros (2,600 US\$)	451	1.69	(1.08-2.64)	<b>1.62</b>	<b>(1.03-2.54)</b>
<b>Sleep duration</b>					
≤5h	52	0.52	(0.23-1.16)	0.51	(0.23-1.16)
6h	156	0.69	(0.42-1.12)	0.70	(0.42-1.15)
7h	363	1.00	Ref	1.00	Ref
8h	424	0.92	(0.65-1.32)	0.92	(0.64-1.32)
≥9h	249	0.74	(0.47-1.16)	0.72	(0.46-1.14)
<b>Antidepressant use</b>					
No	1203	1.00	Ref	1.00	Ref
Yes	41	1.92	(0.91-4.03)	1.84	(0.86-3.92)

All possible confounding factors were simultaneously included in the model.  
 Bold values are statistically significant  $p \leq 0.05$ .

## 4 DISCUSSION

The DEBATS study is the first to investigate in France the relationship between annoyance due to aircraft noise and psychological distress in the population living near airports.

The results of the present study highlighted a significant association between annoyance due to aircraft noise and psychological distress. A dose-effect relationship was evidenced, showing an increased risk of psychological distress related to an increased severity of annoyance due to aircraft noise. These findings confirm those obtained in a previous study by *van Kamp et al.*<sup>13</sup> The authors also found a significant association between aircraft noise annoyance and psychological distress assessed by the GHQ-12.

The association between annoyance due to aircraft noise and psychological distress remained unchanged when noise sensitivity was included in the model. Moreover, people reporting to be more sensitive than people around them had a higher risk of psychological distress. This result confirms the one found in another study by *Stansfeld et al.*<sup>19</sup> The authors observed that high sensitivity was associated with psychological distress: noise sensitivity has been identified as a predictor of mental ill-health.

In the present study, both associations, between annoyance and psychological distress on one hand, and between noise sensitivity and psychological distress on the other hand were still significant, underlining the independent effects of both factors.

The GHQ-12 is a reliable screening questionnaire, particularly recommended for identifying minor psychological disorders within community settings. Since the GHQ-12 is brief, simple, and easy to complete, and since its application in research settings as a screening tool is well documented, the GHQ-12 is widely used in large-scale studies as a general indicator of psychological distress. However, it is not a tool for indicating a clinical diagnosis.

Noise annoyance was assessed with the 5-point verbal scale recommended by ICBEN. This scale has been largely used within studies dealing with annoyance due to aircraft noise. This assessment method was part of the recommendations stated during the ICBEN conference in 2001 for standardized general-purpose noise reaction questions for community noise surveys<sup>20</sup>. Moreover, this scale has been introduced in the ISO standard ISO/TS 15666:2003 adopted in 2003<sup>21</sup>.

Selection and confounding biases were minimized in the present study, thus leading to reliable results. However, the direction of the association observed between annoyance due to aircraft noise and psychological distress could be questioned. Extremely annoyed people might be more at risk to have psychological disorders, but it is also possible that people with psychological disorders might be more at risk to be annoyed. The present study did not allow addressing this issue.

## 5 CONCLUSIONS

The present study found a significant association between annoyance due to aircraft noise and psychological distress assessed by the GHQ-12, showing gradual ORs across the different categories of noise annoyance. This result is consistent with the findings of the few studies performed to address that issue. However the direction of the association could be questioned. Therefore, further research is necessary to better understand this relationship.

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