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COMPARISON OF REACTION (DISSATISFACTION, ANNOYANCE ETC.) TO AIRCRAFT NOISE AMONG SHIFT WORKERS AND NON-SHIFT WORKERS

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ABSTRACT
Curfews at Sydney airport result in shift workers being exposed to more aircraft noise when they are trying to sleep than are non-shift workers. The present community survey of 1,015 residents of high and low noise areas in the vicinity of Sydney Airport assessed whether shift workers report greater noise-induced sleep disturbance than non-shift workers, and whether this translates into more negative reactions to noise. The role of noise sensitivity in the effects of shift work was also considered. Shift workers report more difficulty sleeping, and more frequent use of sleeping pills than non-shift workers in high but not low noise areas. Reaction was also worse amongst shift-workers compared to non-shift workers in high noise areas. Self-reported sleep disturbance correlated significantly and positively with reaction. The findings are consistent with the claim that greater sleep disturbance contributes to the more negative reactions of shift workers compared to non-shift workers.

1 - INTRODUCTION
Shift-workers may be more at risk of aircraft-noise-induced sleep disturbances than non-shift-workers, because they sleep during the day. This may simply owe to shift-workers' greater noise exposure during their (daytime) sleeping hours. Specifically, shift workers are often exposed to more frequent noise events because their sleeping hours are not subject to nighttime curfews on aircraft operations. Alternatively (or additionally), shift-workers may be more susceptible to sleep disturbance than non-shift workers at equivalent noise exposures, because their normal circadian rhythms are disrupted. This latter effect may result in shift-workers suffering greater sleep disturbance (compared to non-shift-workers) even when they have the opportunity to sleep at night.

Data addressing these issues are extremely limited. In a community survey, shift-workers have been found to demonstrate more noise-induced disturbance of activities, assessed by an index including sleep disturbance, than non-shift workers [1]. Data are inconsistent regarding whether shift-workers' increased risk is simply due to sleeping during non-curfew hours or whether their sleep is generally more easily disturbed. Ehrenstein and Muller-Limmroth [2] reported that shift-workers sleeping in the laboratory during the night following day shift achieved 30% less slow wave sleep when exposed to noise than when not exposed to noise. The difference was more marked for sleep during the day following night shift, when there was a 45% 'reduction' in stage 4 sleep However, other researchers could not replicate this finding [3].

If shift-workers suffer more noise-induced sleep disturbance than non-shift-workers, they may also experience more negative reactions to noise, and more related health problems. Indeed, shift-workers may have more negative reactions, even if they have equivalent sleep disturbance, because they may perceive sleep as being more important. Self-reported sleep quality has demonstrated a relationship with road traffic noise annoyance [4,5]. Further, in a community survey 26.7% of seriously affected respondents (in terms of general reaction) identified sleep disturbance as the aircraft-noise-induced activity disturbance that they would most like to eliminate (as compared to 19.1% of all respondents) Hede and Bullen [6]. Ising et al. [7] report greater risk of myocardial infarction amongst shift-workers than non-shift-workers. Given relationships of noise-sensitivity with noise-induced sleep disturbance [see 8] and with reaction to noise [see 9,10], the role of noise-sensitivity in shift-workers' susceptibility to sleep disturbance and reaction should be considered.

The present community survey around Sydney Airport (where curfews apply on noisy aircraft) assessed whether shift workers report greater noise-induced sleep disturbance than non-shift workers, and whether this translates into more negative reactions to noise (dissatisfaction, annoyance etc.). The role of noise sensitivity in the effects of shift work was also considered.

2 - METHODS

2.1 - Subjects and sample selection

Subjects were 523 female and 482 male residents of areas selected on the basis of location relative to Sydney (Kingsford Smith) Airport to produce a 2 ×2 design; noise exposure prior to runway reconfiguration (when the present data were collected) was "high" or "low", and noise exposure was projected to change (decrease or increase, respectively) or to remain unchanged, due to reconfiguration. The four areas thus produced- "high to high" (H-H), "high to low" (H-L), "low to low" (L-L), "low to high" (L-H)- were approximately equally represented in the main sample (N=1012). Each area comprised several census districts.

From a random starting point within each census district, every 7th residence along a predetermined path was approached, and one respondent selected within each household using the "last birthday" technique, without replacement.

2.2 - Materials

A structured interview (based on previous socioacoustic surveys [11,12] and pilot results) assessed a range of variables including sleep disturbance, reactions to noise, and noise-sensitivity. Participants also filled out several self-completion questionnaires.

Subjects were asked whether they do regular daytime work, shift-work, or night shift only, or do not work. Subjects who reported doing any kind of shift work were grouped together, and all remaining subjects were grouped together.

Subjects were asked to indicate whether local aircraft noise "disturbs or interferes with sleeping". They were also asked about noise-induced changes to their use of sleeping pills, from which it was determined whether sleeping pills were used.

Two questions assessed general reaction to aircraft noise: (i) "Would you please... estimate how much you personally, are affected overall by aircraft noise?"; (ii) "How dissatisfied are you with aircraft noise in this neighbourhood? Please... estimate how much dissatisfaction you feel overall." Three questions assessed annoyance with aircraft noise specifically: (i) "How much annoyance do you feel when you hear a jet plane passing overhead?" (ANN1); (ii) "How much annoyance do you feel about aircraft noise?" (ANN2); (iii) "How would you describe your general feelings about the aircraft noise in this neighbourhood?" (ANN3). Response choices for this final question were "highly", "considerably", "moderately", "slightly", or "not at all" annoyed. For the remaining questions, subjects responded using a card depicting a thermometer marked with numbers from 1 to 10 with an associated 5-point verbal scale (2="a little", 5="moderate", 7="a lot", 10="much").

Noise sensitivity was assessed by having subjects rate their annoyance with 12 noise situations (e.g. a pneumatic drill or jackhammer is operating nearby, someone rustles paper at the movies, you hear the sound of a door slamming) using a card depicting a thermometer marked with numbers from 0 to 10 and an associated verbal scale ("none", "a little", "moderate", "a lot", "very much"). Factor analysis revealed a factor relating to loud noises, and another relating to quiet noises. Thus, the corresponding two sensitivity indices were computed.

2.3 - Procedure

Before the changes to the configuration of Sydney Airport, a letter was sent to every selected residence announcing the investigation. Second, trained interviewers door-knocked at selected residences and asked to speak to the person over 18 living at the residence who had last had a birthday. When a suitable individual agreed to participate, the structured interview was conducted in the home and questionnaires were completed by the subject while the interviewer waited.

3 - RESULTS

3.1 - Differences in sleep disturbance, reaction & noise sensitivity between shift-workers versus non-shift-workers

For each noise area, Chi-square analysis was employed to examine the predictions that shift-workers would have higher self-reported sleep disturbance, and self-reported sleeping pill use, that non-shift workers [see Table 1]. Independent samples t-tests were employed to compare shift-workers and non-shift-workers in terms of their reaction to aircraft noise (annoyance and general reaction) and their sensitivity to loud and quiet noises [see Table 1].

In all areas, sleep disturbance and sleeping pill use was nonsignificantly greater amongst shift-workers, than among non-shift-workers. Similarly, both annoyance and general reaction were nonsignificantly greater among shift-workers in the H-H and L-L areas. In addition, annoyance was nonsignificantly greater among shift-workers in the H-L area. Generally, sensitivity to loud and quiet noises was greater for non-shift-workers compared to shift-workers, although the difference only reached significance for sensitivity to quiet noises in the H-H area.

3.2 - Relationships between reaction & sleep disturbance

The relationship of reaction with sleep disturbance, and with sleeping pill use, was also examined employing independent samples t-tests with reaction as the dependent variable. In each noise area, self-reported noise-induced sleep disturbance was significantly associated with general reaction (H-H: t_{244}=6.01, p<.001; H-L: t_{240}=6.40, p<.001; L-L: t_{167}=6.36, p<.001; L-H: t_{237}=8.42, p<.001) and annoyance (H-H: t_{243}=7.14, p<.001; H-L: t_{241}=8.21, p<.001; L-L: t_{168}=7.39, p<.001; L-H: t_{237}=9.40, p<.001). Generally, general reaction was also greater amongst respondents who used sleeping pills, compared to those who did not, although the difference was only significant in two areas (H-L: t_{240}=1.65, p=.05; L-H: t_{237}=1.95, p=.026; L-L: t_{167}=0.47, p=.319; H-H: t_{244}=1.54, p=.062). Sleeping pill use was significantly associated with annoyance in only one area (H-L: t_{241}=2.10, p=.019; H-H: t_{243}=1.33, p=.093; L-L: t_{168}=0.01, p=.495; L-H: t_{237} =-0.56, mean in a direction inconsistent with prediction).

3.3 - Relationships between sleep disturbance & noise sensitivity

The relationship of noise sensitivity with sleep disturbance, and with sleeping pill use, was also examined employing independent samples t-tests with sensitivity as the dependent variable [see Table 2].

Only in L-L was self-reported noise-induced sleep disturbance significantly associated with sensitivity to loud noises (t_{159}=2.70, p=.008; next highest t_{228}=1.31, p=.191 in H-H) and with sensitivity to quiet noises (t_{164}=3.35, p=.001; next highest t_{233}=0.92, p=.357 in H-L). Sensitivity to loud or quiet noise demonstrated no significant association with use of sleeping pills (highest nonsignificant t_{228}=1.17, p=.244 in H-H).

Sensitivity to loud and quiet noises was significantly and positively related to general reaction and annoyance in H-H. H-L, and L-L. In L-H, only sensitivity to loud noises was significantly and positively correlated with general reaction and annoyance.

4 - DISCUSSION

Shift workers report more difficulty sleeping, more frequent use of sleeping pills, and more negative reaction to noise, than non-shift workers, although these differences did not reach statistical significance. Thus, these data support the often made, but infrequently testes, claim that shift-workers are more likely to suffer noise-induced sleep disturbance than are non-shift-workers. However, these and earlier data are insufficient to identify whether shift workers are at increased risk of noise-induced sleep disturbance over and above their exposure to noise when they are trying to sleep during the day. Clearly, more research is required to resolve this issue.

Self-reported sleep disturbance was significantly and positively related to reaction. The findings are consistent with the claim that sleep disturbance contributes to negative reactions to noise among shift workers.

		H-H	H-L	L-L	L-H
	% who are shift-workers	18.3	14.0	12.4	20.9
Sleep disturbance	% of shift-workers	64.4	58.8	19.0	40
	% of non-shift-workers	53.7	45.5	12.8	35.4
	Chi-squared$_1$	$\chi_1^2 = 1.71$ *p=.10*	$\chi_1^2 = 2.10$ *p=.07*	$\chi_1^2 = 0.62$ *p=.21*	$\chi_1^2 = 0.35$ *p=.28*
Sleeping pill use	% of shift-workers	28.9	23.5	19.0	30
	% of non-shift-workers	21.9	25.8	16.1	28
	Chi-squared$_1$	$\chi_1^2 = 1.01$ *p=.16*	$\chi_1^2 = 0.08$ *wd*	$\chi_1^2 = .116$ *p=.37*	$\chi_1^2 = 0.07$ *p=.39*
General reaction	mean for shift-workers	7.16	6.37	3.09	5.03
	mean for non-shift-workers	6.89	6.51	2.29	5.43
	t	t_{252}=*0.59* *p=.28*	t_{250}=*-0.25* *wd*	t_{248}=*1.58* *p=.058*	t_{255}=*-0.90* *wd*
Annoyance	mean for shift-workers	7.33	6.73	3.00	5.02
	mean for non-shift-workers	6.86	6.63	2.64	5.73
	t	t_{251}=*1.17* *p=.12*	t_{251}=*0.19* *p=.42*	t_{229}=*0.77* *p=.22*	t_{255}=*-1.56* *wd*
Sensitivity:	mean for shift-workers	5.14	4.81	4.82	5.17
Loud noises	mean for non-shift-workers	5.52	4.98	5.04	5.67
	t	t_{233}=*1.10* *p=.27*	t_{238}=*0.40* *p=.69*	t_{235}=*0.47* *p=.64*	t_{247}=*1.65* *p=.10*
Sensitivity:	mean for shift-workers	4.54	4.62	4.45	4.67
Quiet noises	mean for non-shift-workers	5.13	4.95	4.68	4.96
	t	t_{240}=*2.04* *p=.04**	t_{243}=*0.81* *p=.42*	t_{239}=*0.45* *p=.66*	t_{248}=*0.92* *p=.36*

Table 1: Percentage of subjects who are shift workers, percentage of shift-workers versus percentage of non-shift workers who are sleep disturbed (Chi-squared) and who use sleeping pills (Chi-squared), mean general reaction to, and annoyance with, noise for shift-workers versus non-shift workers (t-tests), and mean sensitivity, to loud and quiet noises, for shift-workers versus non-shift-workers (t-tests), in the H-H, H-L, L-L, and L-H noise areas (wd= means in a direction opposite to prediction).

	H-H	H-L	L-L	L-H
GR with SQUI	.295** (242)	.151* (245)	.310** (240)	.099 (250)
GR with SLOU	.306** (235)	.274** (240)	.314** (236)	.214* (249)
ANN with SQUI	.269** (242)	.143* (245)	.296** (241)	.064 (250)
ANN with SLOU	.270** (235)	.249** (240)	.315** (237)	.162* (249)

Table 2: Correlation of sensitivity to quiet and loud noises (SQUI & SLOU) with general reaction (GR) and annoyance (ANN), for high noise areas expecting noise to remain the same (H-H) or to decrease (H-L), & low noise areas expecting noise to remain the same (L-L) or to increase (L-H).

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