Health Impact Assessment of airport noise on people living nearby six Italian airports

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Summary
Auditory effects of noise on humans have been established but aircraft noise has been associated with several health effects on non auditory system, as well. During the last decade the rise of low-cost airlines has increased air traffic thus exposing the population to increased noise levels and potential disturbances and health disorders. To estimate the exposure levels and evaluate the health impact of aircraft noise on residents nearby six airports in Italy (Rome: Ciampino; Milan: Linate and Malpensa; Pisa; Turin; Venice) focusing on hypertension, acute myocardial infarction (AMI) , annoyance and sleep disturbances. Registry offices of the municipalities involved have provided residential addresses and personal data of all residents updated to 31/12/2010. Acoustic fingerprint of each airport to 2011 was estimated using the Integrated Noise Model. All residence addresses were geocoded and Lden (<55, 55-60, 60-65, 65-70 dB), Lnight, Leq (day and night) were assigned to each participant. Available exposure-response relationships were used to estimate the number of additional cases of hypertension, AMI, annoyance and sleep disturbances. 73,272 persons exposed to aircraft noise levels >55dB were considered: 55,915 (76.3%) were exposed to 55-60 dB; 16,562 (22.6%) to 60-65 dB; 795 (1.2%) to 65-70 dB. Exposure to aircraft noise levels above 55 dB was estimated to be responsible each year of 4,607 (95%CI 0-9,923) additional cases of hypertension; 3.4 (95%CI 0-10.7) cases of AMI; 9,789 (95%CI 6,895-11,962) cases of annoyance; 5,084 (95%CI 1,894-10,509) cases of sleep disturbances. A significant impact of airport noise on the health of residents nearby six Italian airports was estimated.

Epidemiological evaluation and noise mitigation measures to protect the health of residents should be introduced by policy makers in noise abatement programs.

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1. Introduction

World Health Organization (WHO) recommendations on noise exposure establish that, to protect the health of residents, Lday values should not exceed 55 dB(A) while Lnight values should not be greater than 40 dB(A) in residential areas [1] It has been estimated that at least one million Disability-Adjusted Life years (DALYs) due to environmental noise are lost every year in Western Europe (about 340 million people). A recent review on the health effects of noise exposure shows that acute and chronic exposure to environmental noise (from traffic road and aircraft) is associated with adverse effects on health and well-being of the exposed population [2].

In the last decade in Europe, especially for the advent of low-cost airlines, air traffic has rapidly increased and small airports have been turned into international airports thus exposing the population to increased noise levels and environmental pollution.

We conducted an Health Impact Assessment (HIA) of aircraft noise on residents nearby Ciampino (Rome), Linate and Malpensa (Milan), San Giusto (Pisa) Caselle (Turin) and Tessera (Venice) Italian airports. This HIA of aircraft noise was conducted within the project SERA (Studio sugli Effetti del Rumore Aeroportuale - Study on the effects of airport noise) funded by the Italian Ministry of Health.

2. Methods

The study area was defined as a 5 km radius from the boundary of each airport under study. Acoustic fingerprints were estimated at 2011 by using the Integrated Noise Model 7.0b (INM) which took into account information relating aircraft movements and local meteorology data. Municipal Registers of all residents at December 2010, who have lived at the same address from at least two years, were collected and all the addresses were geocoded. The study population was classified according to the estimated aircraft noise in four groups: Lden 55-60, 60-65, 65-70, and 70-75 dB.

The health points under study were the number of hypertension, acute myocardial infarction (AMI), annoyance and sleep disorders cases attributable to aircraft noise. Table I shows the methods used to estimate the impact of airport noise on the population residing nearby the six airports.

3. Results

The estimated aircraft noise levels are function of the number of tracks, their length, the prevailing traffic, the trajectories of landings and takeoffs and the weather conditions during the study period, while the distribution of the residents near each airport depends on the urbanization level, the presence of rural areas and parks or, as for the Venice airport, the sea (see Figure 1). 896,322 persons were recruited, 73,272 (8.2%%) of whom exposed to aircraft noise levels >55dB. There were 55,915 (76.3%) subjects exposed to 55-60 dB, 16,562 (22.6%) to 60-65 dB, and 795 (1.1) to 65-70 dB. The 795 people most affected by aircraft noise (65-70 dB) were mainly residents nearby the Rome-Ciampino (62.5%) and Torino-Caselle (27.9%) airports.

Table II shows, for each outcome, the exposed population, the number of cases not attributable to aircraft noise, the estimated number of cases attributable to noise and the attributable fraction.

We estimated that exposure to aircraft noise levels above 55 dB were responsible each year of 4,607 (95%CI: 0-9,923) additional cases of hypertension, and of 9,789 (95%CI: 6,895-11,962) cases of annoyance.

Among the 12,891 residents in areas where aircraft noise exceeds 60 dB, 3.4 (95%CI: 0-10.7) additional cases of AMI were estimated. In areas with noise levels of 47.5 dB of more at night (62,385 exposed residents) 5,084 (95%CI: 1,894-10,509) cases of sleep disorders attributable to aircraft noise were estimated. 21% of cases of hypertension and 14% of myocardial infarctions were attributable to aircraft noise.

Table I. Summary of methods used to estimate the impact of airport noise on the population residing nearby six Italian airports: age range, noise range, background rate and concentration response functions, type of evidence and related references.

OUTCOME	AGE RANGE	NOISE RANGE	REFERENCE RATE	CONCENTRATION-RESPONSE FUNCTION	TYPE OF EVIDENCE	REFERENCES
Hypertension	35-74 yy	45-70 dB Lden	51% (Men) 37,2% (Women)	RR~1,13 (IC95% 1,00-1,28) for increments of 10 dB	Meta-analysis	Babisch W, Kamp Iv. Exposure-response relationship of the association between aircraft noise and the risk of hypertension. Noise Health 2009;11:161-8
Acute myocardial infarction	25-84 yy	≥60 dB Lden	0,2273% (Men) 0,0979% (Women)	RR~1,08 (IC95% 0,93-1,25) for increments of 5 dB	Meta-analysis	Babisch W. Road traffic noise and cardiovascular risk. Noise Health 2008; 10(38):27-33
Annoyance	≥15 yy	≥42 dB Lden	-	pop [-9,199 10^{-5}(Lden-42)^3 + 3,932 10^{-2} (Lden-42)^2+ 0,2939 (Lden-42)] 10^{-2} for increments of 5 dB	Single study	Miedema HM, Oudshoorn CG. Annoyance from transportation noise: relationships with exposure metrics DNL and DENL and their confidence intervals. Environ Health Perspect 2001; 109(4): 409–16
Sleep disorders	≥15 yy	45-70 dB Lnight	-	pop [18,147 – 0,956 Lnight + 0,01482 (Lnight)^2] 10^{-2} for increments of 5 dB	Meta-analysis	Miedema HM, Vos H. Associations between self-reported sleep disturbance and transport noise based on reanalyses of pooled data from 24 studies. Behav Sleep Med 2007; 5(1):1-20

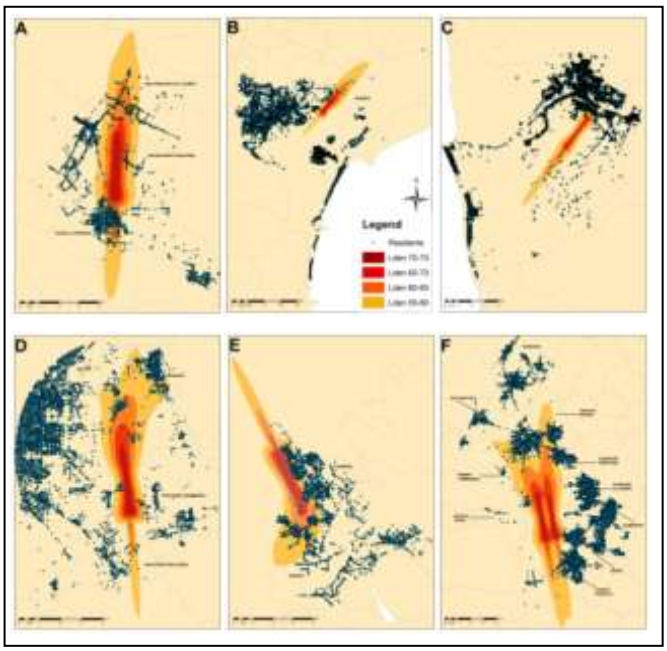

Figure 1. Aircraft noise levels and residents: Turin-Caselle (A); Venice-Tessera (B); Pisa-San Giusto (C); Milan-Linate (D); Rome-Ciampino (E); Milan-Malpensa (F).

4. Discussion

Around the airports of Ciampino (Rome), Linate and Malpensa (Milan), San Giusto (Pisa), Caselle (Turin) and Tessera (Venice) 73,272 residents lived in areas where aircraft noise is over 55 dB, thus overcoming the noise levels recommended by WHO for residential areas [1]. Because of this exposure, in the target population an annual health impact equal to 4,607 additional cases of hypertension, 3.4 cases of acute myocardial infarction, 9,789 cases of annoyance and 5,084 cases of sleep disorders has been estimated. The estimated health impact is lower for the airports of Pisa and Venice, where the acoustic footprint falls outside the urban area, and greater in Milan, Linate and Malpensa, airports where the footprint falls on urbanized areas.

Each step of the HIA procedure - the exposure assessment, the health status at baseline, the

Table II. Impact assessment of aircraft noise on the population residing nearby six Italian airports.

Outcome	Exposed population	Number of cases not attributable to noise	Number of cases attributable to noise	95% CI		Attributable fraction (%)
	(a)	(b)	(c)			(d)
Hypertension (35-74 years)	40,131	17,631	4,607	0	9,923	21
Acute myocardial infarction (25-84 years)	12,891	20,8	3.4	0.0	10.7	14
Annoyance (≥15 years)	62,385	0	9,789	6,895	11,962	100
Sleep disorders (≥15 years)	62,385	0	5,084	1,894	10,509	100

a. Population exposed to aircraft noise
b. Number of cases not attributable to noise = a * reference rate
c. Number of cases attributable to noise were calculated using the CRFs
d. Percentage of noise attributable cases = c/(b+c) * 100

appropriate concentration-response function - presents uncertainties that should be taken into account. We assumed that the association between aircraft noise exposure and outcomes was not affected by confounding or distortions, as supported by several epidemiological studies. We applied CRFs derived from epidemiological studies conducted in other settings assuming that the Italian local situations were similar to the reference conditions. However, studies on the occurrence of hypertension and annoyance in people residing close to airports were also conducted in Italy confirming the existence of the association and the order of magnitude of the estimates [3]. Meta-analysis of epidemiological studies on acute myocardial infarction (AMI) and aircraft noise are not currently available. Therefore we decided to use CRFs available for road traffic noise. However, a cohort study conducted in Switzerland supported the existence of an association between aircraft noise and the incidence of AMI [4], and two cross-sectional studies conducted in England [5] and USA [6] found an association between aircraft noise and the risk of hospitalization for cardiovascular diseases.

5. Conclusions

The Italian SERA project has provided a quantitative estimate of the overall health impact of aircraft noise on the health of populations living nearby six Italian airports. The impact is important, especially for the airports of Ciampino (Rome) and Caselle (Turin), and justifies intervention programs to reduce the exposure of the population. A monitoring system should be developed to study the health status of the residents populations , especially in cases where structural changes of the airports are planned.

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