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PARTICIPATION THROUGH KNOWLEDGE SHARING AND TRANSFER: NOISE MONITORING & NOISE RISK PERCEPTION

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The LIFE GIOCONDA project aims to provide Local Authorities in Europe with an innovative methodology that supports policies on Environment and Health involving young people. The role of GIOCONDA is to involve young people as the protagonists in a continuous and concrete participative democracy regarding the environment and health. In fact, young people are the most vulnerable subjects of environmental pressure, they are the key-actors in future actions to improve the quality of the environment, and their perception of environmental risk is an important indicator of the attitudes, concerns, and desires of the entire community. In the overall sample, only 5% of students had a very high-risk perception index. The mean RPI was significantly higher in Taranto and Naples samples, compared to the other two areas. No differences of RPI according age class and gender were observed in Taranto and Ravenna samples.
The higher perception of females < 14 years and of males > 14 years need to be further investigated.

1. Introduction

The effects of noise on health, well-being, and learning are of growing concern among both the general public and policy-makers in Europe [1]. Noise is one of the modifiable environmental factors (or impacts) recognized by the WHO [2]. Studies conducted on the general population have demonstrated that noise perception can affect general well-being and more specifically, the health-related quality of life [3-4]. Environmental noise from road or air traffic has been shown to increase stress levels, heart rate, blood pressure and ischemic heart diseases [5-6]. High residential traffic exposure as well as road traffic noise have also been associated with hypertension [7-8].

Noise is one of the risk factors influencing mental, behavioural and neurological disorders, which account for only 3.0% of deaths worldwide, but represent 10% of the global disease burden, which is projected to rise to 15% by the year 2020 [2]. Among a broad range of types of harm associated with environmental noise, cognitive impairment in school-age children represents a serious health issue [9], with language skills, reading comprehension, memory and attention being particularly affected.

Recognizing the special need to protect children from the harmful effects of noise, the WHO Parma Declaration [10] called on all stakeholders to work together to reduce the exposure of children to noise. In fact, it is estimated that the disability-adjusted life years (DALYs) attributable to the environmental noise in western European is 45,000 years due to the cognitive impairment of children aged 7-19 years [1]. The extent to which noise impairs cognition has been studied both by epidemiological and experimental studies. Reliable evidence highlights the adverse effects of chronic noise exposure on children’s cognition, despite limitations arising in some studies mainly from the methodological quality criteria, specific noise sources, and related adequate noise metrics [1].

In the last few decades risk perception has received increasing attention in environmental research. In general, risk perception results from a complex set of stimuli, combining subjective evaluations with socially and culturally constructed dimensions. Social, behavioural, and decision science have explored risk perception, identifying behavioural principles that interact in complex ways [11-12]. The classical analysis proposed by Slovic and developed in the following years with the psychometric paradigm is the most commonly-used approach, showing consistent results in experimental surveys The psychometric paradigm is particularly useful in planning researches using questionnaires, and it was applied for the study here presented [13].

In terms of noise-related risk perception, in a recent work by Okokon et al. [14], a considerable proportion of Finnish adults perceived road-traffic noise as a significant health risk, almost comparable to traffic exhaust. The individual's ability to perceive environmental risks depends on a number of psychological factors, together with the knowledge and sensitivity towards environmental problems.

Environmental education at school, when the child's personality starts to be shaped and awareness increases, plays a crucial role in the future risk perception. Notwithstanding the importance of this issue, little is known about risk perception in children, including noise-related risk perception. The "Noise and Children Workshop" at the United Nations Environment Programme's Millennium International Children's Conference on the Environment (Eastbourne, UK, 2000) highlighted that children perceive the risk of noise pollution as low even though it affects their everyday activities [15]. In a Turkish study on the environmental risk perceptions of high school students, noise pollution was perceived as a medium-level risk factor [16].

Within the framework of the GIOCONDA project - *Young voices count in decisions on environment & health* (EU LIFE+ Environment Policy and Governance 2013 Project) - environmental noise exposure and risk perception were addressed.

The aim of the GIOCONDA project was to involve adolescents in the construction of effective evidence-informed policies on the environment and health. The mean was a process of learning and dialogue with adolescents based on a scientific approach: examining and discussing data, facts and options, and then elaborate concrete proposals for action. One of the priorities was to understand young people's perception of risk associated with environmental pollution. The project was thus carried out in four Italian areas characterized by different environmental conditions: Naples (in the region of Campania), Ravenna (Emilia-Romagna), Taranto (Apulia) and Lower Valdarno Valley (Tuscany).

The project combined two monitoring systems in school environments: one was based on environmental data collection (indoor and outdoor measurements of air and noise pollution), the other was based on a self-administered questionnaires exploring students' risk perception and "willingness-to-pay" in relation to local environmental health issues.

This paper reports the results of an exploratory quantification of risk perception related to environmental noise at school in a sample of children aged 11-17 years.

2. Methods

2.1 Project location and participants

The GIOCONDA project involved a total of four schools with students aged between 11 and 13 (secondary school), and four with 14-18 year old (high school). In each location, one of each type of school was selected. The four regions were selected due to their different demographic, social and environmental characteristics, such as population distribution and employment, socio-economic conditions and environmental pressures.

Naples (Campania) is defined as a metropolitan area: 959,000 inhabitants, densely concentrated in the city centre which is highly polluted and highly socially deprived. In the city there are former industrial areas, which have been abandoned without reclamation, and a large port area, with commercial and touristic activities.

Ravenna (Emilia-Romagna) is a medium size former industrial city: 154,000 inhabitants, characterized by a limited industrial area, a port, and commercial and touristic activities in the city and surrounding areas.

Taranto (Apulia) is a medium size industrial city: 198,000 inhabitants. The biggest steel plant in Europe, ILVA, is located very close to the city, together with a refinery, a power plant, and a cement plant.

The Lower Valdarno Valley (Tuscany), has four municipalities, and is characterized by small leather production plants and agriculture: 65,000 inhabitants live in the area. The town of San Miniato (SM) was selected as the GIOCONDA project area.

In each city, the two schools were selected in areas with different environmental pressures.

The culture and knowledge of the populations in terms of environment and health were not homogenous due to the differing physical and economic backgrounds. A description of the areas in terms of “exposure to information” is on-going, and will be used to fine-tune the analysis presented here.

Naples has serious waste management problems, and the year before the beginning of the GIOCONDA project, it was “the most polluted city of the year”, according to the Legambiente (Environment Citizen Association) Air Pollution Annual Report. The Ravenna administration is very active in environmental education, with public initiatives on sustainability and innovation, however the level of air and noise pollution sometimes raises public concern. Taranto has been burdened in the last four years with a judicial inquiry concerning the pollution from the steel plant, and public debate and awareness have been polarized in the city. The Lower Valdarno Valley was very polluted in the past, due to a poor strategy used to limit the release of many chemical products used in leather production. In the 1980s, when the first European legislation regarding water pollution was approved, local leather factories set up an association, built the first water depurator, and worked to clean the polluted soil and to filter air emissions. Today, the general feeling of the population is that they are protected from pollution, since when problems emerge the public authorities make a quick response.

In the eight schools involved in the GIOCONDA project, 28 classes took part including a total of 603 students. 521 of them completed the questionnaire on risk perception.

Due to known gender differences in risk perception [17-18], data were analysed taking gender into account.

2.2 Measurements

Data collection was performed using a self-administered questionnaire (with the teachers' support, when necessary) completed in the classroom setting. The questions, arranged in different sections, were designed to investigate the level of awareness on environmental issues, the perception of risks related to environment and health, and the “willingness-to-pay” (the willingness to pay (WTP) measures what individuals are willing to pay to reduce the likelihood of an adverse event. WTP is not examined in this paper).

Noise-related questions

Respondents were asked to express their degree of concern regarding a series of issues.

The following noise-related questions were used:

a) “Do you think your school is noisy?”
b) “What is the main source of annoying noise you hear in the area around your school?”
c) “How annoying is the noise you usually hear when you're at school?”
d) “Are you worried about the noise in the area where the school is located?”
e) “Is the annoying noise in the area around your school causing you any problems?”
f) “How afraid are you of the harm to health caused by noise?”
g) “How often are you aware of noise around you?”
h) “In your opinion, how serious is the harm to health caused by noise?”
i) “In your opinion, how much harm to health is caused by noise in the short-term?”
j) “In your opinion, how much long-term harm to health is caused by noise?”

Most of the questions were on a Likert-type format (1-5) with the following options:

Questions a-c-d-f-h, “not at all, a little, somewhat, a lot, very much”;

Question g, “never, seldom, sometimes, often, always”;

Questions i-j, “none, a few, some, many, a lot”.

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Two questions were structured as multiple choice:

Question b, 1) cars, 2) trucks/buses, 3) factories, 4) mopeds/motorcycles, 5) trains, 6) people, 7) aircrafts, 7) shops, 8) other (specify);

Question e, dichotomous answer (yes/no) on multiple choice: 1) not at all, 2) makes me feel nervous, 3) stops me from being able to hear the people talking in the room, 4) gives me a headache, 5) distracts me, 6) I'm worried about my health.

2.2.1 Individual risk perception index

Questions a, c-j reported above were used to estimate the individual risk perception index (RPI) according to Signorino [19].

The RPI is calculated as a weighted average of absolute frequencies of each choice:

$$RPI = \frac{\sum_i^k n_i \pi_i}{N \cdot (k)}$$

where: n_i represents the absolute frequency of the ith mode (e.g. not at all, a little, somewhat, a lot, very much); π_i represents the weight assigned to the ith mode (e.g. 1=not at all, 2=a little, 3=somewhat, 4=a lot, 5=very much); N represents the total number of observations (i.e. the total number of respondents); k represents the number of points (in this case =5) in the Likert scale. The values of the dichotomous variables were treated as two points on the Likert scale, so the value 0 ("no") was turned into 1 ("not at all") and the value 1 ("yes") into 3 ("somewhat"). The RPI value ranges between zero and one: the closer the value is to one, the greater the risk perception. RPI values lower than 0.33 suggest a low risk perception, RPI values greater than 0.66 suggest a high risk perception.

In order to validate the RPI, a similar index was also calculated by the Structural Equation Model (SEM-RPI) using the same set of variables. The goodness of fit of SEM-RPI was very good (standardized root mean squared residual, SRMSR<0.10). The correlation between RPI and SEM-RPI was very high (rho=0.96), confirming the reliability of the RPI.

2.2.2 Co-factors

The main variables potentially influencing the RPI were gender, age (students aged <14 years and 14+ years) and study areas (Naples, Ravenna, Taranto and Valdarno).

2.3 Statistical methods

As a first step, a descriptive analysis of RPI distribution was conducted both on the total number of respondents and on the sample stratified by area, age group and gender. The Shapiro-Wilk normality test was applied to check the normality distribution of the RPI.

The differences in the RPI distribution between areas, age groups and gender were tested by non-parametric tests (Kruskal-Wallis test), in order to evaluate which of these factors influenced the RPI. A non-parametric multiple regression model [20] was used to estimated the median value of the RPI on the linear combination between the three factors. Interactions between factors were also evaluated in order to highlight any RPI differences by area, age group and gender. The goodness of fit of the model on the RPI data was tested by the R square index.

Statistical significance was set at p<0.05 (two-tailed). All the analyses were performed using STATA software, version 13.0.

3. Results

Of the 521 students included in the study, 503 completed the questionnaires and were analysed (297 males; age 14.1 ± 2.2 years [mean ± SD]).

No significant differences were found for noise perception between areas. Overall, 67% of students aged 14+ years, compared to students aged <14 years, thought that their school was not / a little noisy (p<0.001) with significant differences also found within gender (younger vs older male group: 51.8% vs 48.2% respectively, p<0.01; younger vs older female group: 31.9% vs 68.1% respectively, p<0.001). The majority of students (73.4%) in the Naples sample considered mopeds/motorcycles as the main source of annoying noise, differing significantly (p=0.001) from students from other areas.

As regards RPI, since the normality test indicated that the distribution was not normal, non-parametric statistical tests were used. Descriptive statistics of RPI are reported in Table 1. In the overall sample, the median of RPI (0.46) indicates the perception of the total sample is modest. With respect to the different geographical areas, the mean RPI was significantly ($p<0.001$) higher in Taranto and Naples, compared to the other two areas.

Table 1: Mean (±SD) and percentile values of risk perception index in the overall sample and in the study areas.

	n.	mean±SD	25th	50th	75th	95th	min	max.
Total	503	0.41±0.08	0.35	0.40	0.46	0.56	0.22	0.80

Naples	128	0.43±0.08	0.37	0.41	0.49	0.58	0.26	0.69
Ravenna	153	0.39±0.06	0.34	0.39	0.43	0.50	0.29	0.66
Taranto	102	0.44±0.08	0.37	0.43	0.50	0.59	0.27	0.70
Valdarno	120	0.40±0.10	0.34	0.39	0.46	0.59	0.23	0.80

Descriptive statistics of RPI in the various subgroups by area, gender and age group (Table 2) showed a significant ($p<0.01$) heterogeneity, suggesting an interaction effect of these factors on RPI. Thus, a non-parametric multiple regression model was used, taking into account all the interaction variables.

Table 2: Estimate risk perception index by area, age and gender.

Area	Age	Gender	N.	Median	95% CI	
Naples	<14 years	F	28	0.46	0.42	0.49
		M	29	0.44	0.41	0.48
	14+ years	F	38	0.39	0.36	0.42
		M	33	0.41	0.38	0.45
Ravenna	<14 years	F	47	0.40	0.37	0.43
		M	46	0.37	0.34	0.40
	14+ years	F	24	0.36	0.32	0.39
		M	36	0.37	0.34	0.40
Taranto	<14 years	F	25	0.43	0.39	0.47
		M	45	0.43	0.40	0.46
	14+ years	F	9	0.41	0.36	0.47
		M	23	0.46	0.42	0.50
Valdarno	<14 years	F	33	0.40	0.37	0.43
		M	34	0.44	0.41	0.48
	14+ years	F§	2	0.27	0.21	0.33
		M	51	0.36	0.33	0.38

CI= Confidence interval; F= females, M= males; § low number of subjects.

In the Naples sample, significant differences in median RPI were detected between <14 year and 14+ year-old females (0.46 and 0.39 respectively, $p=0.001$), <14 year-old males and 14+ year-old females (0.44 and 0.39 respectively, $p=0.023$), <14 year-old females and 14+ year-old males (0.46 and 0.41 respectively, $p=0.100$), suggesting a higher concern in the younger students. In the Valdarno area, all the comparisons between subgroups showed significant differences, but comparisons involving the 14+ year-old female group cannot be considered as informative due to the smaller number of subjects. The significant differences in median RPI observed between <14 year-old males and <14 year-old females (0.44 and 0.40 respectively, $p=0.07$), <14 year-old males and 14+ year-old males

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(0.44 and 0.36 respectively, p<0.001), <14 year-old females and 14+ year-old males (0.40 and 0.36 respectively, p=0.06), showed younger students, especially males, with a higher risk perception than older students. No significant differences were detected in the comparisons in the Taranto and Ravenna samples.

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4. Discussion

The aim of this study was to investigate student experiences with noise at school and their perceptions of environmental noise as a health risk. A risk perception index was thus used which summarises part of the information collected through a questionnaire. In fact, it combines the answers to a set of questions related both to the perceived noise exposure and to the perceived potentially risk effect on health. Overall, the median of RPI (0.46) indicates the perception of the total sample is modest. This finding is consistent with those reported in a qualitative study in which the perceived risk of noise pollution as a hazard was minimal [21].

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The subsequent step was to assess how RPI was associated with other variables, such as geographical area, age and gender. A significant heterogeneity emerged, suggesting the interaction effects of these factors on RPI and allowing only tentative conclusions. In general, higher perception values were reported in Naples and Taranto than in Ravenna and SM (except for the young males who showed a medium-high perception). Young female students reported a higher perception than young males in all samples, except for SM. In contrast, among the >14 year-old students, males showed a higher perception in all the areas studied.

Despite being aware of the limit represented by the small sample size, we believe that the perception profiles, which emerged as different by sex, age and geographical areas, represent a useful starting point.

The reliability of the RPI can be further improved by extending the research to a larger sample of schools (in differently characterized areas) and evaluating the role of other variables that could influence the noise–related risk perception, such as socio-economic and ecological determinants. Another important piece of information concerning the association with the levels of measured noise is treated by the work presented by Chetoni and collaborators. The association of RPI with quantitative information regarding indoor and outdoor noise measurements at school is in progress.

In addition, it should also be highlighted that the noise-related risk perception is part of a wider assessment of young people's perception of risk associated with environmental pollution.

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