

Air pollution: a study of citizen's attitudes and behaviors using different information sources

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ABSTRACT

Background: From November 2015 to January 2016, the routine air monitoring showed a peak of air pollution (in particular of PM10) that caused alarm in many Italian cities and was widely reported by mass media. After some weeks from this alarm, we tried to evaluate the citizen awareness and interest towards air pollution together with their positive behaviors, using different information sources.

Methods: From September 2015 to March 2016, in parallel with the number of exceedances of the PM10 in Italy we evaluated the press coverage, the average monthly searches on Google and the interest on Twitter. Moreover, a qualitative content analysis on daily newspapers was conducted and a self-compiled questionnaire on the attitudes and behaviors about environmental issues and their determinants was administered to 598 parents involved in the project MAPEC_LIFE (LIFE12 ENV/IT/00614).

Results: The media coverage of the theme of air pollution was very high from the end of 2015 to the beginning of 2016, as well as internet searches and twitter messages. Our qualitative analysis highlighted that only a small portion of articles included information about positive behaviors and environmental awareness. Despite the high media coverage and the satisfactory self-perceived knowledge, the majority of respondents judged negatively the received information (as untrue and incomplete) and declared a limited adoption of pro-environmental behaviors.

Conclusion: The parallel study of mass media information and people's attitudes and behaviors seem to indicate that the high media coverage was not followed by a very high motivation towards pro-environmental behaviors.

Key words: Air pollution, Health, Information sources, Mass media, Pro-environmental behaviors.

INTRODUCTION

Air pollution represents the largest single environmental health risk in Europe. Over 90% of the European citizens are exposed to annual levels of outdoor fine particulate matter that are above what is specified in the World Health Organization's air quality guidelines. This exposition accounted for 482,000 premature deaths in 2012 from heart and respiratory diseases, blood vessels conditions and strokes, and lung cancer. Moreover, indoor air pollution resulted in an additional 117,200 premature deaths, five times more in low-income and middle-income countries than in high-income countries [1]. In 2012, among the EU states, the highest value of premature deaths (84,400) caused by air pollution was found in Italy [2]. The main sources of air pollution include the sectors of transport, energy, industry, heating systems (in commercial, institutional and household sectors), agriculture and wastes treatment. Each of them concurs differently to the emission of different pollutants (such as SOX, NOX, NH₃, PM₁₀, PM_{2.5}, NMVOCs, CO, CH₄, O₃, BC, As, Cd, Ni, Pb, Hg, and BaP or C₂₀H₁₂). A good indicator of emissions with significant relations with health effects is the PM10 level [3], generally used for a synthetic description of the air quality. The PM₁₀ primary source is represented by commercial, institutional and household fuel combustion sectors (contributing to 43% and to 58% of the total primary PM₁₀ and PM_{2.5} emissions) followed by industry, agriculture and transport [2]. The greatest part of post-industrial human activities contributes to the emission of air pollutants and the sources of pollution have shifted from production to consumption processes. Citizens' activities like house's heating systems and private transports play an important and increasing role to impact on local air quality. For this reason, environmental awareness is necessary as a new policy tool, in addition to legal and economic instruments, so to promote the process of behavioral change [4]. Despite the citizens have increased their environmental knowledge base, it has been documented [5] a decrease in their beliefs about their capability to influence positively the environment.

In this context, the information campaigns are expected to change the individuals' attitudes and beliefs about environmental issues, to induce citizens to take appropriate actions and collective lifestyles [6-8]. Unfortunately, the level of citizens' information and awareness is still quite low, as it is reported in the Flash Eurobarometer 360 [9]: six out ten of the Europeans say they do not feel informed about air quality issues in their country and three quarters of the Europeans have not heard of EU air quality standards of the National Emission Ceilings Directive [10]. Furthermore, the adoption of positive behaviors is not related only with knowledge, but also with social and psychological determinants [11]. An individual's perception of inability to effect positive changes regarding

the environment (self-efficacy) can influence the adoption of pro-environmental behaviors [12].

The media can play an important role in the construction of environmental awareness. In recent years, social media have become a major communication channel in our society. The 13th Censis/Ucsi report [13] has shown how Internet use has increased of 2.8% over the last year with 73.7% of Italians going online – a percentage that grows to 95.9% for those under 30 showing a significant generational gap. Overall, social networks/groups, Internet search engines and online newspapers are increasingly being used as information sources, while fewer Italians are still reading printed newspapers. Subsequently, the analysis of web search queries, social networks/groups and online newspapers can facilitate the understanding of the public perception and the awareness level on different environmental issues. Social media users can be considered as "social sensors" so that a rich information about popular perceptions and awareness within the fields of biological and environmental sciences can be extracted from their messages and their searches [14]. For example, some recent articles [15, 16] have shown the presence of a correlation between air pollutant levels and online social network posts and has proposed to integrate these data with other pollution sensing network data.

The aim of this article was to study the mass media resonance and public awareness related to the peak of air pollution (in particular of PM₁₀) occurred in Italy from November 2015 to January 2016. To this end, a quantitative analysis on mass media (Twitter, Google and online daily newspapers) and a qualitative analysis on daily newspapers was carried out. Although Facebook is the most popular social network we have decided to exclude it because the majority of its content are private and therefore cannot be extracted and analyzed. Finally, a questionnaire on knowledge, beliefs and behaviors on environmental pollution was collected from parents who had children involved in the MAPEC_LIFE "Monitoring Air Pollution Effects on Children for supporting public health policy" project – LIFE12 ENV/IT/000614 [17, 18].

METHODS

Collection and analysis of data on air pollution (PM₁₀) and mass media

Air pollution (PM₁₀) data:

The data on monthly exceedances for PM₁₀ at national level were taken using the database MoniQA (Monitoring Index Quality Air) [19]. This database is a collection of the data provided on daily basis by the environmental protection agencies, and is the only system of its kind in Italy.

Internet search query data:

Internet search query data was collected from Google AdWords (GA), a public web facility of Google Inc. We used GA to get the Average Monthly Searches (AMS), that indicate the average number of times that people have searched for an exact keyword based on the location and Search Network targeting selected [20]. In order to get the AMS we used the Keyword Planner (free GA tool) applying the following search criteria: i) keyword "smog", ii) data range "from September 2015 to March 2016" and iii) geographic location "Italy".

Temporal analysis of press coverage and tweets on Twitter:

From September 2015 to March 2016, we performed a systematic search using the keyword "smog" into two national daily newspapers ("Corriere della Sera" and "La Repubblica") and two local daily Tuscan newspapers ("La Nazione" and "Il Tirreno") in order to evaluate the press coverage of the topic of air pollution. For the same period, we performed a temporal analysis of post messages (known as tweets) on Twitter (<https://twitter.com/>) using the following search criteria: i) keyword "smog", ii) data range "from September 2015 to March 2016", and iii) geographic location "Italy". We decided to use Twitter instead of Facebook, because all the contents exposed by Twitter are public. These analyses have been performed using the websites' internal search engines.

Correlation statistical analysis:

On the data collected from the media and from the database MonQA we have performed a Bivariate Pearson's correlation analysis using the Statistical Package for Social Science (SPSS) software version 20 [21].

Qualitative content analysis

A qualitative content analysis was carried out on a

sample of local and national online daily newspapers in order to put in evidence the frequency of faced topics (Table 1). In the peak period, from December 2015 to February 2016, we performed a systematic search using the keyword "smog" into two national daily newspapers ("Corriere della Sera" and "La Repubblica") and two local daily Tuscan newspapers ("La Nazione" and "Il Tirreno"). The online articles were gathered using NCapture [22], in order to perform a qualitative content analysis using an inductive approach [23, 24]. The articles obtained were imported in QSR NVivo 11 Plus qualitative software [25] and were subjected to a selection process in order to choose only articles focused on the keyword "smog". Afterwards, in the process of analysis, the articles were re-read multiple times separately by two of the authors before being coded in NVivo in order to create the nodes and a categorical framework.

Survey on Environmental Attitudes and Behavior

Survey Design:

A 14 questions self-compiled anonymous questionnaire was used to investigate environmental related attitudes and behaviors. It was structured in four parts for the collection of:

1. socio-demographic data: gender, age and education level (Table 2);
2. main information channels, confidence in various information sources, perceived quality of information, perception of one's own knowledge and knowledge of environmental disease burden (Table 3);
3. order of importance of different pro-environmental behaviors and of different actors on pollution control, perceived role of the citizens and of children role for pollution prevention (Table 4);
4. adoption of pro-environmental behaviors and the perceived obstacles to the process of behavioral change (Figure 2).

TABLE 1. Categories identified by qualitative analysis.

Name of category	n° of articles (%) ¹		n° of selection (%) ²	
1. Ordinances on air pollution control	146	(53.7)	217	(26.2)
2. PM10 exceedances	140	(51.5)	180	(21.8)
3. Negative comments on ordinances	73	(26.8)	97	(11.7)
4. Main causes of air pollution	54	(19.9)	60	(7.3)
5. Air quality planning	46	(16.9)	60	(7.3)
6. Health effects	43	(15.8)	59	(7.1)
7. Need for structural interventions	42	(15.4)	55	(6.7)
8. Citizens Associations	38	(14.0)	47	(5.7)
9. Positive behaviors	23	(8.5)	28	(3.4)
10. Environmental awareness	20	(7.4)	24	(2.9)

¹Percentages are referred to the total number of articles analyzed (272); ²Percentages are referred to the total number of selection (827). A selection is a portion of text (few words, a whole passage or all text) of an article focused on a topic.

TABLE 2. Socio-demographic characteristics of the sample.

Characteristics	n	%
Gender		
male	175	29.3
female	418	69.9
no response	5	0.8
Age (years)		
young people (18-44)	373	62.4
old people (over 45)	221	36.9
no response	4	0.7
Education level		
low level of education (college or below)	205	34.3
high level of education (university degree or higher)	386	64.5
no response	7	1.2

TABLE 3. Source of information, perception and knowledge.

Question	Answer	n	%
Main information channel used to search information no response: 6 (1.0%)	internet	475	79.4
	TV	321	53.7
	daily newspaper	191	31.9
	radio	122	20.4
	social	56	9.4
	weekly magazines	9	1.5
More trusted sources of information no response: 20 (3.3%)	research institutes	351	58.7
	local health authorities	177	29.6
	citizens' associations	155	25.9
	environmental protection agencies	134	22.4
	municipalities	127	21.2
Perceived quality of information no response: 11 (1.8%)	truthful and complete	73	12.2
	truthful but incomplete	293	49.0
	untruthful and incomplete	179	29.9
	do not know	42	7.0
Perception of one's knowledge no response: 11 (1.8%)	satisfactory	304	50.8
	incomplete	267	44.6
	poor	16	2.7
Estimate of the environmental burden of disease (%) no response: 77 (12.9%) *correct answer	0-20%	96	16.1
	21-40%*	165	27.6
	41-60%	133	22.2
	61-80%	106	17.7
	81-100%	21	3.5

A total of 1274 questionnaires were administered between February and March 2016 to the parents of children involved in the project MAPEC_LIFE project [17, 18].

Statistical analysis of questionnaire data:

The data from the survey questionnaires were analyzed using the SPSS version 20. We used a generalized linear model (GLM) fitted with a binary logistic regression or

TABLE 4. The importance of the pro-environmental behaviors and of the different actors, the perceived role of the citizens and the children.

Question	Answer	weight ¹	
Order of importance attributed of some pro-environmental behaviors no response: 88 (14.7%)	to reduce energy use	5.2	
	to use less-polluting fuels	5.1	
	to collect waste separately	4.8	
	to use public transport	4.3	
	to use low impact products	4.0	
	to use low emission vehicles	3.6	
	to use air particles sensors	1.3	
Order of importance attributed to different actors for the fight against pollution no response: 95 (15.9%)	political institutions	4.8	
	environmental protection agencies	4.4	
	health institutions	3.7	
	industrial associations	3.1	
	citizens' associations	3.0	
	single citizens	2.6	
Question	Answer	n	%
Perception of their own role to reduce environmental pollution no response: 12 (2.0%)	a lot	365	59.5
	a little	217	36.3
	nothing	13	2.2
Children's role to promote pro-environmental behaviors in family no response: 12 (2.0%)	a lot	368	61.5
	a little	191	31.9
	nothing	17	2.8

Note: ¹ For the analysis of results we assigned a weight to each answer choice so that average rating was calculated [https://help.surveymonkey.com/articles/en_US/kb/Matrix-Question].

with a Poisson log linear [21] in order to determine the effect of different factors (*gender, age, education level and channels of information*) on attitudes, perceptions and adoption of pro-environmental behaviors. P values less than or equal to the alpha level (0.05) were considered statistically significant for all the analyses.

RESULTS

Data on air pollution (PM₁₀) and mass media data

The data collected from the database MonIQA [19], from September 2015 to March 2016, show the presence of one peak period of PM₁₀ exceedances (Figure 1) from November 2015 to February 2016. The number of PM₁₀ exceedances indicates the number of times for each month that the PM₁₀ daily limit mean value, fixed to 50 micrograms per cubic meter (EU Directive 2008/EC/50), was exceeded. A peak period is a period during which it occurs a number of monthly PM₁₀ exceedances significantly higher compared to previous months. This peak was associated with an increase of public's interest:

in fact, in December 2015 in comparison with the previous month, the AMS increase of 524.1%, the articles published in newspapers of 629.9% and the number of tweets of 1233.6%.

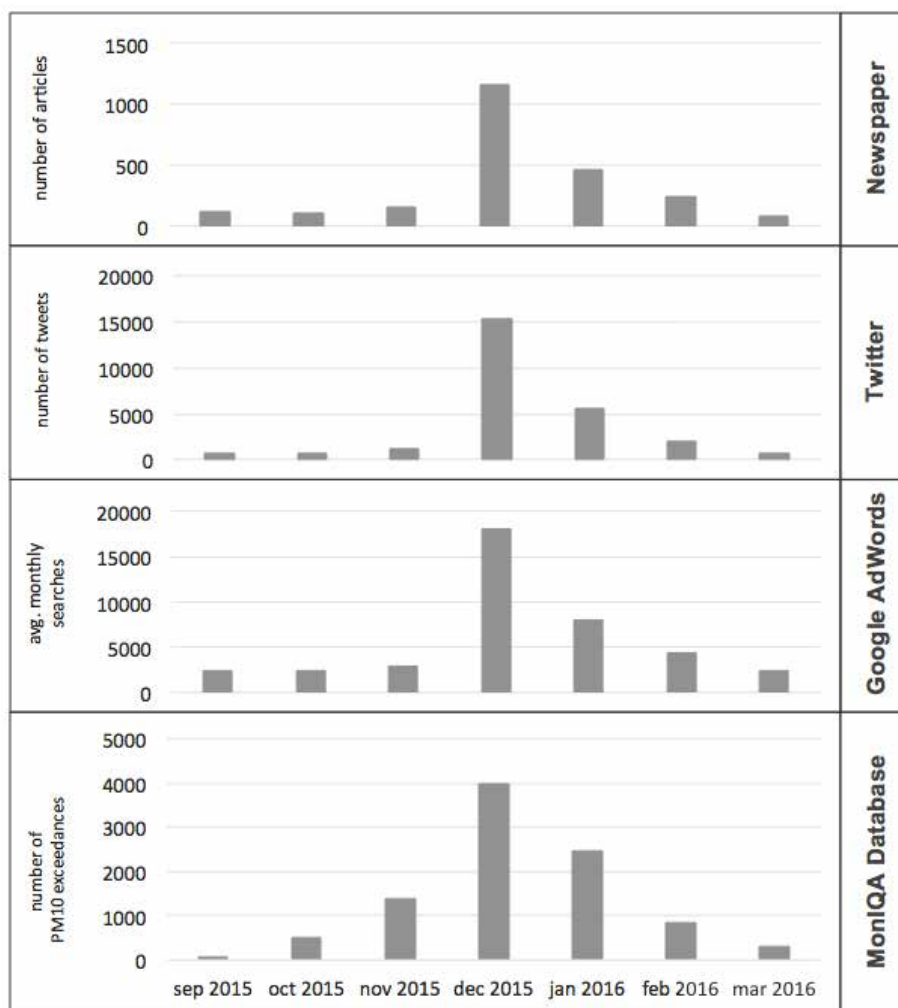
The results of the bivariate Pearson's correlation coefficient showed a positive correlation between the numbers of PM₁₀ exceedances and the number of article in newspapers, of tweet on Twitter and of searches on Google.

Qualitative content analysis

Through the selection process, 272 articles were included in the qualitative content analysis that allowed us to summarize the following 10 content categories (see Table 1).

1. Ordinances on air pollution control: includes information about the measures against air pollution as the total or partial traffic block, the reduction of the temperature of private and public heating systems and the measures to increase the use of public transport.
2. PM₁₀ exceedances: includes information about

FIGURE 1. Illustration of the trends of the data from the newspapers, Twitter, Google AdWords and PM₁₀ exceedances [16].



- the number of PM₁₀ exceedances occurred in different Italian cities.
- 3. Negative comments on ordinances: contains considerations on the limited usefulness of the ordinances to improve air quality.
- 4. Main causes of air pollution: provides information about main sources of air pollution in urban areas and on the impact of weather conditions (e.g. precipitations) on air quality.
- 5. Air quality planning: highlights the role of planning to improve air quality.
- 6. Health effects: provides information about acute and chronic effects on human health.
- 7. Need for structural interventions: provides the message that structural interventions are needed to significantly reduce air pollution.
- 8. Citizens Associations: the citizen associations ask to institutions to solve the air pollution problem.
- 9. Positive behaviors: contains recommendations for citizens to improve air quality and to reduce personal health risks.

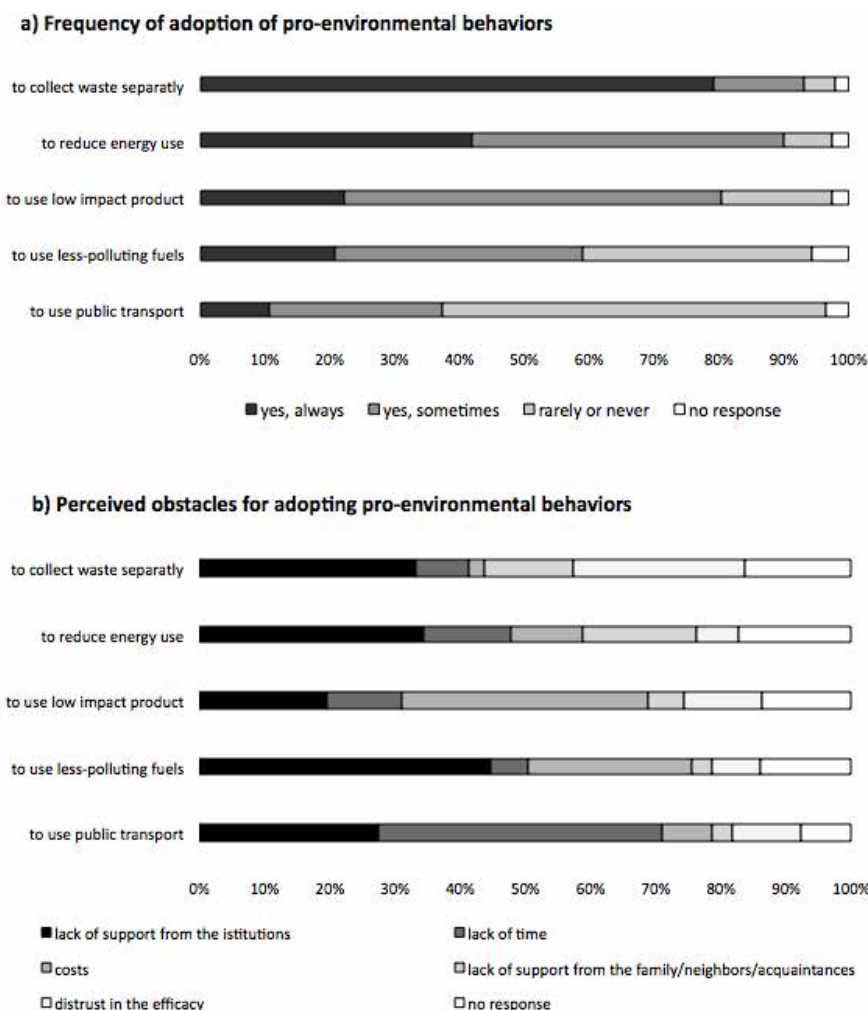
- 10. Environmental awareness: encourages citizens to change their lifestyles and to improve their environmental knowledge and attitudes.

Survey on Environmental Attitudes and Behaviors

On the whole, 598 questionnaires (with a response rate of 46.9 %) were collected. The socio-demographic characteristics of the respondents are shown in Table 2.

As shown in table 3, among the channel of *information*, the most frequently cited was Internet, followed by TV, daily newspapers, radio, social and weekly magazines . In some cases, the socio-demographic factors have determined a significant effect on the choice of an information channel rather than another. In particular, i) males (p=0.017) and young people (p=0.009) more frequently indicate Internet, ii) respondents with a low level of education (p=0.000) more frequently indicate TV and iii) old people (p=0.000) and respondents with a low level of education (p=0.010) more frequently indicated

FIGURE 2. Frequency and perceived obstacles in the adoption of pro-environmental behaviors.



daily newspapers. The majority of the respondents (50.8%) perceived their own knowledge as satisfactory, mainly the males ($p=0.011$). On the other hand, the correct answer about environmental burden disease was provided only by 29.6% of the respondents.

In figure 2, we show the frequency of adoption of each pro-environmental behavior and the perceived obstacles to the process of behavioral change. Overall, only the 1.3% (8) always adopts all the five pro-environmental behaviors reported in the questionnaires: females ($p=0.012$) and old people ($p=0.010$) more frequently adopted them. The lack of support from institutions represents the main obstacle to the process of behavioral change except for the use of public transports and products with a low impact on the environment, for which the main obstacles are represented respectively by the lack of time and by the costs.

As we show in table 4, the respondents have attributed the greatest importance to the reduction of energy consumption and have considered the political institutions as the most important actor for the fight against pollution. The majority of respondents believes that citizens

can play an important role to reduce pollution and has attributed to children an important role to encourage put the word "pro-environmental" on the same line behaviors into the families.

DISCUSSION

In this paper, we focused our attention on a peak of air pollution, in particular of PM_{10} , that occurred in the urban areas of Italy from November 2015 to January 2016. It was particularly intense, also because of the unfavorable weather conditions, although each year in the same period, air pollution emergency episodes occur [26].

This event was widely reported by the mass media and seemed to stimulate active research in internet and discussion in the social media. Indeed, some recent studies [14-16] have investigated the relationship between air pollution and the use of social media, suggesting to use them to monitor the air quality.

Nevertheless, the qualitative analysis of the press during the peak period showed that newspapers focused their attention mainly on short term and alarmist issues whereas they devote very little attention to more general issues concerning behaviors and lifestyles that should be adopted so to improve air quality. We note, indeed, that issues concerning positive (or pro-environmental) behaviors and environmental awareness are much less frequently dealt with than the ones related to pollution data and municipalities interventions.

In accordance with to the low attention devoted by the newspapers to the individual behaviors, the questionnaire's respondents attributed more importance to institutions for the fight of pollution, and, among the obstacles indicated for the adoption of pro-environmental behaviors, the *lack of support from the institutions* is more frequently ranked first. In contradiction with this information, the majority of people considered their own role as determinant against pollution. The documented importance of the self-efficacy perception in inducing positive behaviors [27] suggests the need to further investigate this point in relation to the mass and social media information.

Moreover, the citizens perceived their own knowledge as generally satisfactory, although only a minority of them has given the correct answer to the evaluation of environmental burden on diseases.

Last but not least the parents perceive the role of their children as very important to promote pro-environmental behaviors in the families. These results are confirmed by other studies [28] that suggest that environmental education can be transferred between generations and indirectly induce targeted behavioral changes.

CONCLUSIONS

In conclusion, the parallel study of mass media information and people's attitudes and behaviors seem to indicate that the high media coverage was not followed by a very high motivation to action and behaviors against pollution. Nevertheless, it is not possible to link questionnaire data and mass media data without more specific studies that put into evidence this association. These studies will be useful for a better understanding of the citizen's attitudes and behaviors, as already done for other topics (for instance on AIDS and political elections [29,30]), and for the design of education interventions to induce pro-environmental lifestyles.

However, it is essential to remember that the dimensions that significantly predict environmental behaviors include both cognitive and affective components [31]. Indeed, at least in some contexts, pro-environmental behaviors can be driven by 'egoistic' concerns rather than by altruistic views and motivations: considering that for individuals the health is of primary interest linking the environment to health programs could be of help in motivating pro-environmental actions.

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