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Environment and health: Risk perception and its determinants among Italian university students

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ENVIRONMENT AND HEALTH: RISK PERCEPTION AND ITS DETERMINANTS AMONG ITALIAN UNIVERSITY STUDENTS

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ABSTRACT (DA RIVEDERE)

Among the determinants of environmental health risk perception, health literacy and social media messages have been generally neglected. This study details the environmental health risk perception and its determinants in Italian university students, including a measure of functional health literacy and an analysis of newspapers and social media. A cross sectional survey was carried out among students from 15 Italian universities and different disciplines (grouped into Scientific-Health and Humanistic-Legal-Social sectors) using a self-administered anonymous questionnaire, divided into six sections: socio-demographic characteristics, information on health and environment, environmental health risk perception, trust, attitudes and behaviors and functional health literacy. Local newspapers and tweets in the same areas and period were analyzed in relation to quantity, topics and tone. The study population included 4778 students (65.1% female) aged 21 ± 4.3 years. functional health literacy was low (below the cutoff value) for 44.4% of students and high for 55.6%.

A new outcome of the survey is that the detected association between high functional health literacy a higher global health risk perception and trust in institutions both as sources of information and as actors for protection against environmental risks.

The internet and social networks were the most frequently consulted sources of information (77.7%), which was predictive of a higher risk perception. The possible relation between environmental health risk perception and tweet communication was highlighted by a comparison between the two cities (Pisa and Modena) with more tweet registered. INCLUDERE COSA MIGLIORARE

To the best of our knowledge, this is the first study with such a wide sample and sampling area, taking into account functional health literacy and social media as determinants of environmental health risk perception and trust. The data obtained can thus be considered of high value, suggesting the inclusion of functional health literacy and social media in future surveys to improve environmental health risk perception evaluation.

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Introduction

Risk communication is defined by WHO as an essential component of the risk analysis, strictly linked to the other two components of risk assessment and management, at the basis of public health prevention strategies (WHO, 2013; Covello and Allen, 1988). The environmental risk communications from public health institutions should be carefully programmed based on an accurate study of the context (Covello, 2003; Smillie and Blissett, 2010), including the assessment of public risk perception and trust as well as their determinants.

According to the studies on environmental health risk perception (Sandman, 2003), it includes a combination of "hazard" (the risk evaluated by experts: probability times severity of harm) and "outrage" (a global emotional experience of fear, anger and concern, causing a feeling of injustice).

Various determinants of the outrage have been identified, including: voluntariness, control, fairness, process, morality, familiarity, memorability, dread, diffusion in time and space (Sandman, 1987, 2003). They mainly pertain to the nature of risk and the ways it is managed by institutions; however, an important role could also be attributed to people's attitudes, trust and awareness and the media influence.

Health literacy and mass media/social media information are rarely considered in studies and guidelines (Kuroda et al., 2018), despite their proven representativeness of risk perception, awareness and behaviours in many contexts (Institute of Medicine, 2004; Bennet and Calman, 2010; Berkman et al., 2011; Kickbusch et al., 2013).

Health literacy was initially defined as "the capacity to obtain, process and understand basic health information and services needed to make appropriate health decisions" (Ratzan and Parker, 2000; Institute of Medicine, 2004). It has subsequently been given a more complex definition, differentiating between functional, communicative and critical health literacy (Nutbeam, 2000, 2008), where functional health literacy represents the baseline individual literacy skills needed to read and understand health information.

The growing complexity of health-related information scenarios has led to further distinctions, defining e-health literacy (Kayser et al., 2018) and health literacy related to specific topics such as vaccine health literacy (Lorini et al., 2018) or environmental health literacy (Finn and O'Fallon, 2017). In studies where measurements of health literacy have been included in surveys on attitudes and perceptions, they were found to be strongly related

to knowledge, health behaviors, health outcomes and medical costs (Institute of Medicine, 2004; Berkman et al., 2011; Kickbusch et al 2013). On the other hand, few studies have investigated the relationships between ~~HL~~ health literacy and risk perception of environmental issues (Kuroda et al., 2018).

Mass media have a significant influence both on the knowledge and attitudes of people (Nelkin, 1987), as well as risk perception (Bennet and Calman, 2010). Studying mass media information is a useful mean~~s~~ to understand social "sentiments" and tendencies in political debates (Scheufele, 2014). In addition, it has also been used to estimate the public risk perceptions regarding health-related topics, such as epidemics (Dettori et al., 2018), vaccines (Aquino et al, 2017) or environmental risks (Carducci et al., 2017; Dettori et al., 2019).

The aim of the present study was to give a broad picture of the environmental health risk perception and its determinants in university students in Italy, by analyzing 15 universities and students from different disciplines.

In response to the lack of information on the relations of health literacy and mass media/social media messages with environmental health risk perceptions as well as the lack of tools to investigate them, our study included factors such as functional health literacy, mass media and social media coverage.

Another specific objective was to propose a functional health literacy measure that would be easily applicable in environmental risks perception surveys. This is represented by a very simple test, which it is already used in previous studies for other topics and target population (Calamusa et al., 2012) and it is easily translatable in other languages without any cultural adaptation problems.

Methods

Study population and data collection

From November 2017 to January 2018 we conducted a survey among students attending courses in 15 Italian Universities: Bari, Camerino, Catania, Chieti, Florence, Genoa, Lecce, Messina, Milan, Modena, Naples, Padua, Pisa, Sassari, and Turin (Figure 1). Students were distributed in the sectors of Scientific-Health (biological and environmental sciences, biotechnology, medicine, pharmacy, physics, mathematics, civil and industrial engineering) and Humanistic-Legal-Social (sociology, political sciences, communication sciences, literature, philosophy, cultural heritage, business economics, economics and finance, law).

The survey instrument was a questionnaire, distributed by researchers in classrooms or study rooms, autonomously compiled by the students in the same places and collected immediately after compilation in boxes to guarantee the anonymity (self-administered anonymous questionnaire). This modality configures the study as cross-sectional, and the measurements of risk perception as prevalence in a population which represents future adult leaders in scientific as well as humanistic sectors. Before the distribution, researchers explained to the participants that by filling out the self-administered questionnaire, informed consent was being given for the use of data for research purposes, according to the Law for Protection of Personal Data and the European Code of Conduct for Research Integrity (at www.allea.org), established by the ALLEA (All European Academics). The questionnaire and the study protocol were approved by the Ethical Committee of the University of Milan.

The questionnaire was tested, adjusted and validated through a pilot study, carried out on a convenience sample of 362 students in seven universities (Bari, Catania, Chieti, Messina, Modena, Pisa, Sassari).

The internal consistency of the Risk Perception Index sections was assessed with Cronbach's alpha test.

The final questionnaire (available in the Supplemental Material A) consisted of 21 close-ended questions and was divided into six sections:

1) Socio-demographic characteristics: gender, age, ~~place~~ area of residence and the sector of university degree course attended (Scientific-Health or Humanistic-Legal-Social);

2) Information: 1. Sources. 2. Trust in these sources. 3. Perceived quality of information. 4. Self-evaluation of knowledge on environmental health risks. The trust was measured by a Likert 4-point-scale (1=none, 2=little, 3=limited, 4=a lot);

3) Environmental health risk perception was explored through five questions: 1. Estimation of burden of environmental diseases. 2. Opinion on the association between environmental factors and some diseases (6 items). 3. Risk perception regarding environmental risks (25 items). They were chosen to provide a list as wide as possible of the issues of concern for the population. 4. Risk perception of behavioral risks (5 items). 5. General environmental health risk perception and self-perception of their own health status (6 items). 6. Smoking habits, to find relations with environmental risk perception. Except for questions 1 and 6, the answers were coded according to a Likert 5-point-scale (1=not important, 2=not very important, 3=quite

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Commentato [AC1]: Per rispondere al commento sui rischi considerati

Commentato [AC2]: "global risk perception" index spiegare

Commentato [AC3]: general risk perception" index spiegare

important, 4=very important, 5=extremely important). For question 3 a "global risk perception index" was calculated summing the scores given to the single items (maximum=125). For question 5 scores to the items ….. were summed to calculate a "general risk perception index";

Commentato [AC4]: Per Maria Fiore: scusa, puoi recuperare questo dato?

4) Trust in different subjects: 1. Evaluation of the importance for pollution reduction and control (11 items: 6 institutional and 5 ~~non~~ non-institutional subjects). 2. Evaluation of the extent to which these subjects fulfill pollution reduction and control. The answers were coded according to a Likert 5-point-scale (1=scarce, 2=sufficient, 3=medium, 4=high, 5=very high). Global indexes of trust (for institutional and non-institutional subjects) were calculated by the sum of scores for the corresponding items;

5) Attitudes and behaviors in reducing and controlling environmental pollution (five questions): the answers to this section were not considered in the present paper and will be the ~~subject~~ topic of a further publication;

6) Functional health literacy: to measure the ability to read and understand information related to health, a tool previously designed was used (Calamusa et al., 2012) in order to include this factor in KPAB (Knowledge Perceptions Attitudes and Behaviors) questionnaires on different themes. Briefly, the understanding of 12 terms (chosen from a list of the most common words obtained through a computational linguistic analysis of a sample of information leaflets of the 38 bestselling over-the-counter medicines) was tested by asking participants to place them in the correct section of a stylized body divided into four sections.

Newspapers and social media analysis

A search of articles published by local newspapers of the participating cities in the days immediately preceding and during the survey period (specific for each city) was carried out with three keywords (pollution, air pollution and smog). The articles were then examined by two independent reviewers in relation to the pertinence, topic and tone of the message. The tones of the messages were classified either as alarming or not alarming.

For the same periods, tweets with the same keywords were downloaded with NCapture (QSR© International Pty Ltd. NCapture Help.) and reviewed in terms of pertinence and topic and tone.

Data analysis

The answers to the questionnaire were coded as qualitative data or scores, according to the question, and analyzed with SPSS 21.0 software (SPSS Inc., Chicago, IL, USA).

The frequency of answers was compared with the chi-squared test and Cramers' V. For the Likert scales, the medians were calculated. For some questions (i.e. trust in sources of information, risk perception and trust in subjects for pollution control) a global score was calculated summing the single items. Global trust indexes were calculated separately for the institutional subjects (Ministries of Health and Environment, Public Health and Regional Environmental Agencies, Municipalities, Regions and Physicians) and for the non-institutional subjects ("ecolabel" industries, environmentalist associations, non-governmental organizations, local community stakeholders, and individual citizens).

For the functional health literacy, each answer was coded as 1 (correct) or 0 (missing or incorrect), and a total functional health literacy score was calculated (minimum 0, maximum 12). The total score was divided into two levels: ≤ 9 (low functional health literacy) and > 9 (high functional health literacy) based on its median value (Calamusa et al., 2012).

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A bivariate analysis was performed using Student's t-test or Mann-Whitney U test, as appropriate, whereas the multiple group comparisons were carried out with analysis of variance (ANOVA) or Kruskall-Wallis test.

A multiple logistic analysis was performed to find the determinants of risk perception and trust. The following variables were thus dichotomized (taking the median as the cutoff value): risk perception index (low = ≤75, high = > 75) and trust in institutional subjects (low = ≤21, high = >21) and in non-institutional subjects (low = ≤15 high = > 15) as dependent variables, the internet and social media as sources of information (yes or no), functional health literacy (low = ≤ 9, high = > 9), gender, area of residence (centre-north and south-islands) and smoking habits as independent variables.

In order to evaluate the impact of newspapers and twitter information on risk perception, the correlation between the number of alarming articles and risk perception index for cities was investigated and the same was done for tweets. In the case of cites showing a peak of Twitter or newspapers articles, a more extensive analysis was planned to compare risk perception, globally and for a single risk factor.

The results obtained revealed a ~~particular~~ peak in Modena: the data from this city were compared with those from Pisa, which in turn shows a high number of tweets and is similar to Modena with regard to demographic characteristics (ISTAT, 2018).

All the statistical tests were two-sided and p-values were calculated to show the level of differences/associations. The most recent epidemiological tendencies suggest not to use p statistics to define significance because there is an intrinsic risk of misinterpreting the data, i.e. to give importance to information that have not and, vice versa, to neglect important data (Rothman et al., 2008; Wasserstein and Lazar, 2016). Nevertheless, we decided to highlight (with asterisks in the tables) the most relevant differences/associations in order to facilitate data interpretation.

Results

Internal consistency of the questionnaire and response rate

Cronbach's alpha reliability test showed a global value of 0.905, which highlights the very good internal consistency of the global risk perception index (25 items, values from 25 to 125).

Because the questionnaire was distributed and completed during lessons or study hours, the response rate was very high (over 99%). The main explanation reported for the non-respondents was a lack of time due to exam preparations.

Study population: Socio-demographic characteristics and health literacy

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The study population included 4778 students (65.1% female) aged 21 ± 4.3 years. A total of 2505 participants (53.2%) belonged to the scientific-health sector. Overall, 65.1% of students were following three-year degree courses (bachelor's degree). The mean functional health literacy level was 10 ± 3: functional health literacy was ≤ 9 for 44.4% of students and > 9 for 55.6%. The most represented area of residence was southern Italy, including Sicily and Sardinia which accounted for 57.1% of respondents, followed by the centre (25.0%) and the north (17.9%). Among the socio-demographic variables, functional health literacy was lower for people following three-year degree courses, and for the scientific health-sectors (Table 1).

A minor difference was found among areas of residence, with the highest percentage of functional health literacy > 9 in the centre, followed by the south-islands, and finally by the north. No difference in ~~Functional~~ functional ~~Health~~ health ~~Literacy~~ literacy was observed between genders.

Information

The ~~Internet~~ internet and social networks were the most frequently consulted sources of information (77.7%), followed by Newspapers and Weeklies (14.6%), TV and Radio (7.7%). A weak association was found between the sources of information and gender (e.g. ~~Internet~~ internet and social networks: Female vs Male, 78.8% vs 75.7%; Newspapers and Weeklies: Female vs Male, 13.6% vs 16.5%) and the sector (e.g. ~~Internet~~ internet and social networks: Scientific-health sector vs Humanities sector, 73.7% vs 83.5%).

Information was considered "truthful, but incomplete" by 64% of the sample; the proportion was higher among functional health literacy > 9 students (62.5% vs 65.2%), ~~in particular~~mainly in Milan (61.7 vs 67) and Turin (67.1 vs 79.3).

Regarding the self-evaluation of their own knowledge about environmental health risks, 29.1% of students considered it "satisfying", with the main differences due to functional health literacy (≤9=25.8% vs >9=31.7%), above all in Catania, Chieti, Lecce, Messina and Milan, and to gender (Male 62.2% vs Female 58.4%).

Although most students consulted the ~~Internet~~ internet and social media as the main source of information (78%), they placed "moderate" and "low" trust, respectively on these sources (internet vs social media, 48.6% vs 45.5%) regardless of the level of functional health literacy, gender and sector; whereas students with functional health literacy > 9 were more trusting than functional health literacy ≤ 9 in the Ministry of Environment (40.3% vs 37.1%), Ministry of Health (44.2% vs 40.8%), Regional Environmental Protection Agency (34.3% vs 30.9%) and University and Research Institutions (53.9%). On the other hand, students with functional health literacy ≤ 9 were more trusting in social networks (9.1% vs 7.5%) and experts in alternative medicines (23.9% vs 20.5%).

The global trust index for institutional subjects– as sources of information was higher for functional health literacy > 9 (18 vs 17).

No important differences in global trust in sources of information were found according to the area of residence.

During the time period of the questionnaire distribution, the number of newspaper articles varied among the different cities (Figure ~~3~~2), with a maximum in Turin (21), followed by Lecce (11), Padua and Milan (10), Sassari (8), Modena (6), Naples (5), Bari (4), Messina and Catania (3), and Pisa (2). In the remaining cities no pertinent articles were published. The most reported topics regarded air pollution (41.0% of articles), followed by traffic bans (14.5%), pollution in schools (6.0%) and other (38.6%), and the tone was mainly negative (78.3%).

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A positive trend was detected between the number of newspapers articles and the global risk perception index, although a statistical significance was not reached, which could be attributable to the small size of the dataset (number of cities concerned).

The quantitative analysis of tweets for the same cities and periods (Figure 43) showed a huge peak in Modena. In the figure, only cities with more than zero tweets are reported, according to social media analysis based on the defined keywords. The qualitative analysis indicated outdoor air quality as the most tweeted topic (70.56%), followed by car traffic (18.45%), exhaust and industrial emissions (2.82%), climate change (2.25), chemicals in food or drinking water (2.11%), pollution of coasts, rivers and lakes (1.41%), indoor air quality (1.13%), high-voltage lines, radio and TV repeaters, cellphones and pollution of groundwater (0.42%), heating systems and thermoelectric power plants and germs in food or drinking water (0.14%).

Risk perception

Only 17% of students estimated the global burden of diseases caused by environmental factors according to WHO (between 21 and 40%), with differences between functional health literacy levels (14.4 for functional health literacy ≤ 9 vs 16.5 for functional health literacy > 9). Most students overestimated this burden (82.1%). Respiratory diseases were considered to be mostly associated with environmental factors (89.2% of students answered "very" or "extremely important") followed by tumors (87.3%), infectious diseases (77.7%), congenital malformation (61.9%), heart diseases (58.4%) and neurological disorders (38.9%). No differences were found in relation to socio-demographic variables, however some differences were detected for functional health literacy in some cities: for functional health literacy > 9 a higher proportion of students answered "very" or "extremely important" in Bari and Padua regarding tumors, in Bari and Sassari regarding infectious diseases, in Firenze, Messina, Modena and Sassari regarding congenital malformation, in Bari regarding heart diseases, and in Genoa and Sassari regarding neurological disorders.

The risk perception in relation to specific environmental risks (Figure 24) was highest for the chemical pollution of water and food (median score 5) and the lowest for urban noise (median score 3). No differences were found for functional health literacy.

The perception of single risks was different among cities, above all for road accidents (perceived higher in Bari, Catania, Genoa, Lecce, Modena, Padua, Pisa, and Sassari), genetically modified food (perceived higher in

Commentato [MV7]: Ln271-273. This is most likely an expected conclusion, but could have been verified with a testable hypothesis with targeted hypothetical articles

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Catania, Florence, Genoa, Modena, Padua, and Sassari), pollution of coasts, rivers and lakes (perceived worse in Chieti, Milan, Modena, Padua, and Turin). The highest number of perceived high risks was in Padua (7) and Genoa (9). In Naples, the perception was lower for five risks (nuclear facilities, exhausts and emissions from industries, chemicals in food or drinking water, germs in food or drinking water and traffic noise).

The global index of risk perception (calculated by summing the scores for the single risks), generally high (median …. with a maximum of 125) was higher for students with functional health literacy > 9 (functional health literacy ≤ 9 vs functional health literacy > 9, median: 95 vs 96), and those resident in Genoa, Turin, Sassari and Florence.

A general environmental health risk perception index was evaluated from the opinions on the pollution of water, air, soil and surrounding environments. This index was also positively associated with functional health literacy (functional health literacy ≤ 9 vs functional health literacy > 9, 95 vs 96).

The majority (43.8%) of students reported that they were able to control the risks to their own health and considered their health to be quite good (83.1%). These data were not influenced by functional health literacy, area of residence or gender.

Of the entire sample, 29.4% were smokers, with differences according to functional health literacy (functional health literacy ≤ 9 vs functional health literacy > 9, 33.1% vs 26.4%) and (slightly) area of residence (25.2% in the north, 30.4% in the centre, and 30.3% in the south and the islands).

Although the global risk perception index (high vs low) was not influenced by the smoking habits, differences were found between smokers and non-smokers in several questions of this section.

Regarding the importance of the environment as the cause of diseases, smokers considered it to be significantly stronger for tumors (88.4% vs 86.9%) and heart diseases (52.3% vs 51.5%), non-smokers for congenital malformation (59.7 % vs 62.9%), and neurological disorders (38.1% vs 39.3%).

Among personal behaviors, students considered smoking as the most dangerous (89.9% answered “very” or “extremely important”), followed by inadequate food preservation (65.0%), misuse of chemicals for domestic purposes (house and garden) (63.1%), exposure to solar radiation without any protection (63.0%), and use of pellet stoves (27.4%). Smoking seems to be related to a different risk perception of these behaviors: smokers only attributed more importance to pellet use for global warming (27.6% of smokers answered “very” or

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"extremely important" vs 27.0% of non-smokers). On the other hand, non-smokers attributed more importance to smoke (non-smokers vs smokers: 90.9% vs 87.6%), solar UV exposure (65.0% vs 58.2%), food preservation (66.0% vs 62.4%) and misuse of chemicals (64.7% vs 59.1%).

The global risk perception index was also lower for smokers (median 95 vs 96).

The multiple logistic regression showed that the risk perception can be predicted by the use of ~~Internet~~ internet and social media as sources of information (Table 2).

The number of tweets for all cities was not associated with the ~~global~~ general risk perception index. However, there was a clear difference in this index between Pisa and Modena (median 93.5 vs 95.5), possibly related to the number of tweets. The specific risk perception was lower in Pisa than in Modena regarding nuclear plants, emissions from heating systems, discharges and emissions from industries, electromagnetic fields (high voltage lines, radio, TV and cell phone repeaters) and genetically modified food. Only for the industry emissions and discharges, the number of tweets was different between the two cities (20 in Modena and 0 in Pisa).

Commentato [I9]: c'era scritto global, ma credo sia un refuso, dovrebbe riferirsi al "general risk perception"

Trust

In general students considered "*institutional subjects*" (Ministries of Health and Environment, Public Health and Regional Environmental Agencies, Municipalities, Regions and Physicians) to be more important than "*non institutional*" ones ("ecolabel" industries, Environmentalist Associations, Non-Governmental Organizations, local community stakeholders and individual citizens) in terms of the protection against environmental risks (mean: 3.7 vs 2.9).

Institutional subjects were considered more important for students with functional health literacy > 9, for those who did not report the internet and social media as sources of information and for people from Genoa, Chieti, Pisa and Florence). On the other hand, students with functional health literacy ≤ 9 and those resident in Florence, Padua and Sassari considered ~~non~~ non-institutional subjects to be more important.

The real fulfillment of actions against environmental risks was in general considered more effective for institutional subjects~~IS~~ (mean: 2.6 vs 2.4). Students with functional health literacy > 9 were more trusting in the Ministry of Health and Public Health Agencies in terms of fulfillment, while students with functional health literacy ≤ 9 were more trusting in Regional Environmental Agencies, Municipalities, "ecolabel" industries,

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environmental associations, non-governmental organizations, local community stakeholders, and individual citizens. Finally, females were more trusting in physicians than males.

The multiple logistic regression showed that trust in institutional subjects can be predicted by functional health literacy and area of residence (Table 3), while no predictive variables were found for trust in non-institutional subjects.

The responses to the trust in information on health risks from different sources, the importance of different subjects in protecting the general population from environmental health hazards, and the evaluation of their fulfilment are reported for single source/subject in Figures B.1, B.2, B.3, respectively, of Supplemental Material B.

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Discussion and conclusion

Environmental risk perception data have been studied for over 30 years, due to their importance in understanding people's attitudes and in planning information interventions (Covello, 2003). Nevertheless, our study shows various features that make it original and innovative: which mainly concern the broad population considered, the functional health literacy analysis and the study of mass media and social media coverage.

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The survey design (in a short period of time in every city), and the instrument (with a high internal consistency) made the answers comparable among the different geographical areas and the administration method (in study classrooms, with the immediate collection after completing) guaranteed a very high response rate (99%) avoiding the selection bias based on the willingness to participate.

Study population: Socio-demographic characteristics and health literacy

Studies on environmental health risk perception have often focused on specific groups of populations such as people living in polluted areas (Signorino and Beck, 2014; Coi et al, 2016; Kuroda, 2018), and high school or university students have also frequently been involved (Yapici et al., 2017; Durmuş-Özdemir and Şener, 2016; Weber et al, 2000; Bilgin et al., 2016; Young et al., 2015) . This is due to educational reasons and given that young people studying at a high level will likely be the future educators and decision makers. A detailed description of the surveys carried out among student populations is beyond the scope of the present study,

however a literature review was performed in order to compare our study design and results with other studies, which is reported in Supplemental Material C. Briefly, in previous surveys among high school or university students, the questionnaires used have generally been based on multiple dimensions (i.e. demographic and social characteristics, awareness, attitudes and risk perception), and many risk factors have been considered. However, the aims, target populations and individual questions were different, so that our comparisons had to be limited to general aspects.

Studies considering such large populations and areas are very uncommon due to their complex organization. The majority of studies on students considered small numbers of people and limited geographical areas (see Table C.1), except for Weber et al. (2000), Altunoğlu and Atav (2016), and Young at al. (2015) who performed a nationwide survey enrolling numerous cities across the USA, Turkey and Taiwan, respectively.

Also, the survey carried out by Zhang and Fang (2013), Zhang et al. (2013) and Altunoğlu et al. (2017) included a large sample size, with more than 1000 students, but each study was limited to one city, thus lacking a broader vision of the whole country. Moreover, no one of these studies reached the dimension of our sample (4778 students).

Our study analyzed a very broad population, distributed over an entire country. This revealed spatial differences, but also increased the variability of the studied population, thus highlighting the most important associations or differences that go beyond the geographical distribution and can thus be generalized.

In addition, we carried out the study during the same time period (about a month) in all cities, so that differences among universities could be attributed mainly to local situations and characteristics of the sample (gender, area of residence, degree course).

Considering the functional health literacy, although in the case of environmental risks, some authors (Kuroda et al., 2018) measured health literacy in its critical and communicative dimensions, in this work we decided to use a simple measure of functional health literacy. The current Italian validated functional health literacy measurement tools (Lorini et al., 2017; Biasio et al., 2018) seem too long and time-consuming to be used as items in more complex questionnaires on risk awareness and perception. Moreover, our test is also easy to translate and does not need a cultural adaption, in the hypothesis of use in multicultural populations.

In the studied population no differences were found in functional health literacy according to gender and geographical areas, while it was positively associated with the level of university degree (it was higher for master's degrees). These results are partially in accordance with scientific literature, in which the level of health literacy increased with the grade of school education (Zhang et al., 2016; Dolezel et al., 2018). Moreover, further positive associations where found according to female gender and high family income (Vozikis et al., 2014; Zhang et al., 2016; Sukys et al., 2017).

Sources of information and mass media and social media coverage

As expected, the ~~Internet~~ internet and social networks were the most used sources of information, in agreement with other surveys on similar populations (Bilgin et al., 2016; Durmuş-Özdemir and Sener, 2016; Zhang et al., 2013). This predominance was even more evident for the humanistic sector students and for females, as reported in many studies (Escoffery et al., 2005; Fox, 2011; Rice, 2006; Horgan and Sweeney, 2012), although in the whole population and about health in general (EU, 2014) no difference were found by gender. Nevertheless, the quality of information was not completely satisfying for the 64% of students: this percentage was quite similar to the one resulting from Eurobarometer (EU, 2014), where 73% of general population was "fairly satisfied" of the health information on internet.

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The risk perception of environmental problems is often socially mediated by the mass media, especially when it is not directly experienced (Weber et al., 2000). Mass media, including digital and social media have been proven to have a significant influence both on the knowledge and attitudes of people (Nelkin, 1987). Considering environmental risks, the information in the press, on TV, websites and social media have been strongly associated with risk perception and sometimes considered as a determinant of conflict (Bennet and Calman, 2010).

In the era of social networks, health-related information can be rapidly available, representing officially reported data with a good sensitivity. The social media information has recently been used for epidemiological surveillance, digital epidemiology (Khan et al., 2010; Salathe et al., 2012) and for environmental pollution research (geosocial search) (Carducci et al., 2017; Jang et al, 2015; Sammarco et al., 2016). Concerning geosocial search, it finds user activities advertised on Online Social Networks (OSNs), in a specific geographical area (Beckerman et al., 2008) and can be used to reveal alarming events and to follow how they are perceived

over time. Despite the recognized high potential of infodemiology, meaning the study of occurrence, distribution and content of electronic health information (Zeraatkar and Ahmadi, 2018), there are some limitation in its use to obtain epidemiological data: it tracks only the segment of population that uses the Web, that is often non uniformly distributed, it allows only a surface picture of a situation without any other individual health information and it does not allow to quantify the study population.

Our study had not an epidemiological aim, so it was planned without specific focus on a particular environmental risk nor disease. It was a tentative approach to investigate if the level of risk perception directly evaluated by a questionnaire, was related to measurable peaks of information, both on traditional mass media (newspapers) and social media (twitter). A further analysis of articles content in relations with health problems could be the aim of future development of this study.

Environmental risk perception

Globally, the impact of environmental risk on health was over-estimated by the majority of students in comparison with the global burden of diseases attributed to the environment by the WHO (2016). The reasons of this discrepancy can be attributed to the lack of knowledge: in fact, a high functional health literacy was associated with a better estimation of the global burden of diseases attributed to the environment. Considering the importance of environment on specific health problems, the respiratory diseases were considered at the first place, followed by tumors, infectious diseases, congenital malformation, heart diseases and neurological disorders: the relative importance given to these diseases does not represent the one deriving from epidemiological studies at a global level (WHO, 2016).

To study the perception of health risk deriving from the environment, a wide list of specific issues of possible concern for people was included in the questionnaire: these were chosen on the basis of previous studies (Carducci et al., 2017; Zhang and Fang, 2013) and with the aim of representing a view of environmental health risks as much complete as possible, without any specific focus. So it was quite predictable that the top three environmental risks were “chemicals in food or drinking waters”, “pollution of groundwaters” and “outdoor air quality” that represent environmental matrices with the highest exposure by breathing or ingesting like ground waters that are frequently used for potable purposes and in the agri-food sector. Other environmental factors of growing concern such as climatic changes or contamination of sea, lakes and river water could have appeared

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399 less strictly related to health, even if they represent major environmental problems. Moreover, at least in the
400 period of the survey, the information from mass media and social was focused on the problems of air or water
401 pollution rather than the climate change.

402 In general, the environmental risk perception is strongly related to the contingent situation and some surveys
403 have been designed to explore the main risks ~~of utmost interest~~ based on the geographical area and the period~~for~~
404 ~~an area and period of time~~. This is the case of surveys carried out in Turkey (Yapici at al., 2017) and Poland
405 (Bilgin et al., 2016) where nuclear risks were mostly considered by several authors, and were ranked first among
406 other risks, in coincidence with a public concern on this issue.

407 In our work, a wider list of environmental risk was investigated, also in order to evidence differences among
408 cities. In fact, even if the risks mostly indicated as "very important" or "important" were related to chemical
409 pollution of water and food everywhere, geographical differences were found for the perception of road
410 accidents, genetically modified food, pollution of coasts, rivers and lakes. In Naples, the perception was lower
411 for five risks (nuclear facilities, exhausts and emissions from industries, chemicals in food or drinking water,
412 germs in food or drinking water and traffic noise). The different pattern of environmental health risks can be
413 attributed to the environmental conditions of Naples, a city with significant waste management, air and noise
414 pollution problems (Mazza et al., 2018), thus citizens tend to underestimate every-day-life risks as traffic noise
415 or polluted air or waters.

416 The global risk perception index was generally quite high and higher in Genoa, Turin, Sassari and Florence.
417 These differences may be attributed to the different environmental conditions, political debates, or media
418 attention that change over time and space.

419 Our study investigated the role of functional health literacy as a determinant of environmental health risk
420 perception as already demonstrated for other topics: i.e. it was found to be positively associated for over-the-
421 counter drugs (Calamusa et al., 2012), and diabetes (Darlow et al., 2012), and negatively for teratogenic agents
422 during pregnancy (Lupattelli et al., 2017) and for vaccines (Brewer et al., 2007). In fact, the risk perception can
423 be also affected by psychological and social factors and can show a reciprocal influence with trust (Siegrist et
424 al., 2005). Both the "global risk perception" and the "general environmental health risk perception" indexes
425 were higher for the high functional health literacy students, thus confirming the influence of this determinant.

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On the contrary, the self-perception of their own health was not influenced either by functional health literacy, or area of residence, or gender: it was generally good (83,1%) even higher than the one found in a nationwide survey on university students (77%) (de Waure et al., 2015).

Lifestyles are often synergistic with environmental pollution as risk factors for many diseases: among them smoking habit is the most representative. In our sample about 30% declared smoking, with a lower frequency for subjects with high health literacy and living in the North.

The obtained results are in accordance with Italian data on smoking habits (PASSI surveillance system, 2015-2018), with 28% and 31% of smokers in the 18-24 and 25-34 age groups, respectively, and the highest frequency in the regions of Centre and South. In similar populations the smoking habit was slightly higher among males (Teleman at al., 2016) while in our study no difference was found between genders.

The smoking habit influences the environmental health risk perception: ~~in fact more~~ many smokers consider the environment as cause of tumors and hearth diseases, that are, also, the most important diseases linked to smoke as reported in a recent report on smoking prevalence and attributable disease burden through the world (Reitsma et al., 2017). Accordingly, among personal behaviors, smokers tend to underestimate the importance of smoke as health hazard (EU, 2007). The majority of researches investigated the association between smoking ~~and this result is confirmed also for Ita~~ status and risk perception of smoking (Ferrante et al., 2010; Wagener et al., 2014), but there is still a lack of studies addressing smoking and risk perception of environmental health issues.

In our study, we observed a global risk perception index lower for smokers, suggesting that smokers are generally less afraid for factors that can affect their health: accordingly, several surveys on risky behaviors in young people demonstrated that dangerous lifestyles (smoke, drug addiction, gambling, etc.) are frequently associated (Rondina et al., 2007; Zuckerman and Kuhlman, 2000).

In our study, the ~~Internet~~ internet and social media as sources of information were predictive for a higher risk perception. However, an analysis of the information from newspapers and tweets~~, there~~ appeared to be no direct influence on risk perceptions, probably due to the scarcity of collected data during the period of survey.

The peak of tweets for Modena was difficult to explain in terms of their topics and the simultaneous newspapers articles. However, a further comparison between two cities (Modena and Pisa) showed a significant difference between the global risk perception index. Among the single risks, a higher risk perception corresponding to a

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higher number of tweets was found only for industry emissions and discharges.

Trust

Trust in institutions is considered an important factor against the "outrage". Some studies have demonstrated that in situations where an environmental problem occurs, it is very important a rapid response from institutions and the involvement of population (Sandman, 2003). Our study explored trust towards different subjects in informing correctly, in protecting general population from environmental health hazards and in really fulfilling their duties. On the whole, physicians were the most trusted for every of these aspects, confirming that they are still a reference about health, as demonstrated by numerous studies (Blendon et al., 2014). On the contrary, the second position was different according to the question: as information source, universities and research institution were more trusted than other public institutions. This result can derive from the study population represented by university students. Concerning the importance for the health protection from environmental risks, the second and third places were attributed to the involved Ministries (Health and Environment), but it is noteworthy the role assigned to individual citizens considered, "extremely important" or "very important" by the 57% of students. This indicates that the respondents give a high value to the action of general population, including themselves: some other surveys ~~indagated~~ investigated this aspect, referring to the "locus of control" that indicates the degree to which people believe that they have control over their lives and events (Rotter, 1954). There are some evidences that a higher internal locus of control is associated to a greater predisposition to pro-environmental attitudes and behaviours (Pavalache-Ilie and Unianu, 2012; McCarty and Shrum, 2001). The frequency of people recognizing their own importance in protecting the environment was explored in other surveys: it was 37 % in 1990 in USA (Roper Organization, 1990), 28 % in a similar population (GfK, 2011) and 60% in an adult Italian population in ~~2018~~ 2016 (Carducci et al., ~~2018~~2017~~, MAPEC~~). On this question notable influences of sources of information, health literacy and area of residence were also detected. The lower use of ~~Internet~~ internet and social as well as the higher health literacy seems to increase the importance attributed to ~~Institutional~~ institutional subjects.

The real fulfillment of actions against environmental risks was in general considered more effective for ~~Institutional~~ institutional subjects, mainly by students with functional health literacy > 9.

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The multiple logistic regression showed that trust in institutional subjects can be predicted by functional health literacy and area of residence. The functional health literacy was the only predictive factor for all the three aspects of trust in institutions: as sources of information, as important subjects and as effective actors against environmental health risks.

The main influence of the area of residence was on the trust in the real action of institutions, which was significantly higher in the centre-north, in agreement with the well-known Italian social-economical differences ~~geographical divide in Italy~~ based on geographical pattern (Musolino, 2018).

Conclusions

The few studies that have evaluated the relationships between ~~HL~~ health literacy and risk perception in terms of environmental issues or trust (Kuroda et al., 2018)~~,~~ suggest that to plan effective risk communication strategies, the health literacy levels of target publics should be taken into account.

Our simple functional health literacy test may thus be useful in surveys on environmental health risk perception, attitudes and behaviors. It could be included in a more complex framework describing Environmental Health Literacy through related perspectives such as health literacy, risk communication, environmental health sciences, public health, and social sciences (Finn et al., 2017).

In our study, the functional health literacy~~,~~ measured with our simple test resulted associated with many of the investigated aspects: preferred sources of information and relative quality, risk perception for singular risks and on the whole, trust in institutions.

In conclusion, we believe that our study is useful to better plan information and education programs: in particular, the level of functional health literacy should be increased at the general level including health information and education in school programs as soon as possible, to make the basis for further specific information. Moreover, the importance of mass and social media suggests ~~to include~~including them in planning communication intervention and in verifying their results.

To the best of our knowledge this is the first study on environmental health risk perception and trust to show an association with functional health literacy, mass media and ~~OSNs~~online social network. This highlights the need

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504 to include these factors in such surveys, together with the importance of analyzing social networks in order to
505 provide a timely measurement of public sentiment (Wu and Li, 2016).

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Table 1. Descriptive statistics of socio-demographic variables according to Functional Health Literacy (N=4778). The sum of the numbers for some characteristic variables is less than the total due to missing values

Variables	Total N=4778 n (% on total)	Functional Health Literacy	
		Poor ≤ 9 N=2122 n (row %)	Good > 9 N=2656 n (row %)
Gender			
Female	3107 (65.1%)	1372 (44.2%)	1735 (55.8%)
Male	1668 (34.9%)	749 (44.9%)	919 (55.1%)
Age (year) median (IQR)*	21 (20-24)	21 (20-24)	21 (20-24)
Age year			
≤20	1587 (33.2%)	704 (44.4%)	883 (55.6%)
≥21	3191 (66.8%)	1418 (44.4%)	1773 (55.6%)
Area of residence			
North	855 (17.9%)	393 (46.0%)	462 (54.0%)
Centre	1194 (25.0%)	518 (43.4%)	676 (56.6%)
South and Islands	2729 (57.1%)	1211 (44.4%)	1518 (55.6%)
Degree course **			
Three-year	3083 (65.1%)	1327 (43.0%)	1756 (57.0%)
Six/five-year	1652 (34.9%)	776 (47.0%)	876 (53.0%)
Sector **			
Science-Health	2505 (53.2%)	1151 (45.9%)	1354 (54.1%)
Humanistic-Legal-Social	2200 (46.8%)	938 (42.6%)	1262 (57.4%)

*IQR: Interquartile range

** Indicates important differences according to the bivariate analysis (Chi-square test and U Mann-Whitney test).

Table 2. ORs and 95% CI of risk perception determinants

Variables	Low risk perception n (row %)	High risk perception n (row %)	Crude OR (95% CI)	Adjusted OR[1] (95% CI)
Internet and social as sources of information **				
No	149 (14%)	915 (86%)	*	*
Yes	429 (11.6%)	3281 (88.4%)	0.803 (0.657-0.981)	0.801 (0.653-0.982)
Functional Health Literacy				
High (>9)	296 (11.1%)	2360 (88.9%)	*	*
Low (≤9)	285 (13.4%)	1837 (86.6%)	1.237 (1.040-1.472)	1.153 (0.965-1.378)
Gender				
Female	381 (12.3%)	2726 (87.7%)	*	*
Male	200 (12%)	1468 (88%)	0.975 (0.812-1.70)	0.988 (0.820-1.190)
Area of residence				
North-centre	240 (11.7%)	1809 (88.3%)	*	*
South-islands	341 (12.5%)	2388 (87.5%)	1.076 (0.903-1.284)	1.113 (0.929-1.333)
Smoking				
Never smoked	380 (11.5%)	2912 (88.5%)	*	*
Current smoker	176 (12.8%)	1194 (87.2%)	1.130 (0.933-1.377)	1.117 (0.922-1.354)

[1]Each odds ratio is adjusted for all other variables in the table.
* Reference category.
** Indicates important differences

Table 3. ORs and 95% CI of trust in institutional subject determinants

Variables	Low trust in institutional subjects n (row %)	High trust in institutional subjects n (row %)	Crude OR (95% CI)	Adjusted OR[1] (95% CI)
Internet and social as sources of information				
No	270 (25.4%)	794 (74.6%)	*	*
Yes	928 (25%)	2782 (75%)	1.019 (0.871-1.192)	1.013 (0.863-1.190)
Functional Health Literacy **				
High (>9)	606 (22.8%)	2050 (77.2%)	*	*
Low (≤9)	595 (28%)	1527 (72%)	0.759 (0.665-0.865)	0.780 (0.682-0.892)
Gender				
Female	800 (25.7%)	2307 (74.3%)	*	*
Male	401 (24%)	1267 (76%)	1.096 (0.954-1.258)	1.102 (0.956-1.269)
Area of residence **				
North-centre	490 (23.9%)	1559 (76.1%)	*	*
South-islands	711 (26.1%)	2018 (73.9%)	0.892 (0.781-1.019)	0.870 (0.759-0.996)
Smoking				
Never smoked	800 (24.3%)	2492 (75.7%)	*	*
Current smoker	345 (25.2%)	1025 (74.8%)	0.954 (0.824-1.103)	0.976 (0.843-1.129)

[1]Each odds ratio is adjusted for all other variables in the table.
*Reference category.
** Indicates important differences.

Figure 1. Location of the universities involved

Figure 2. Number of newspaper articles for each city in the time period of the questionnaire distribution

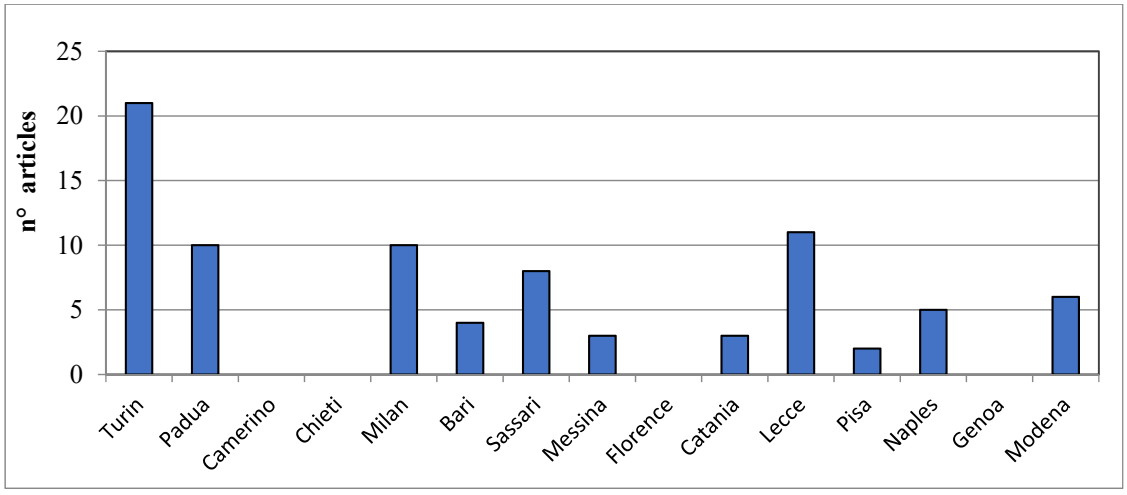


Figure 3. Quantitative analysis of tweets for each city

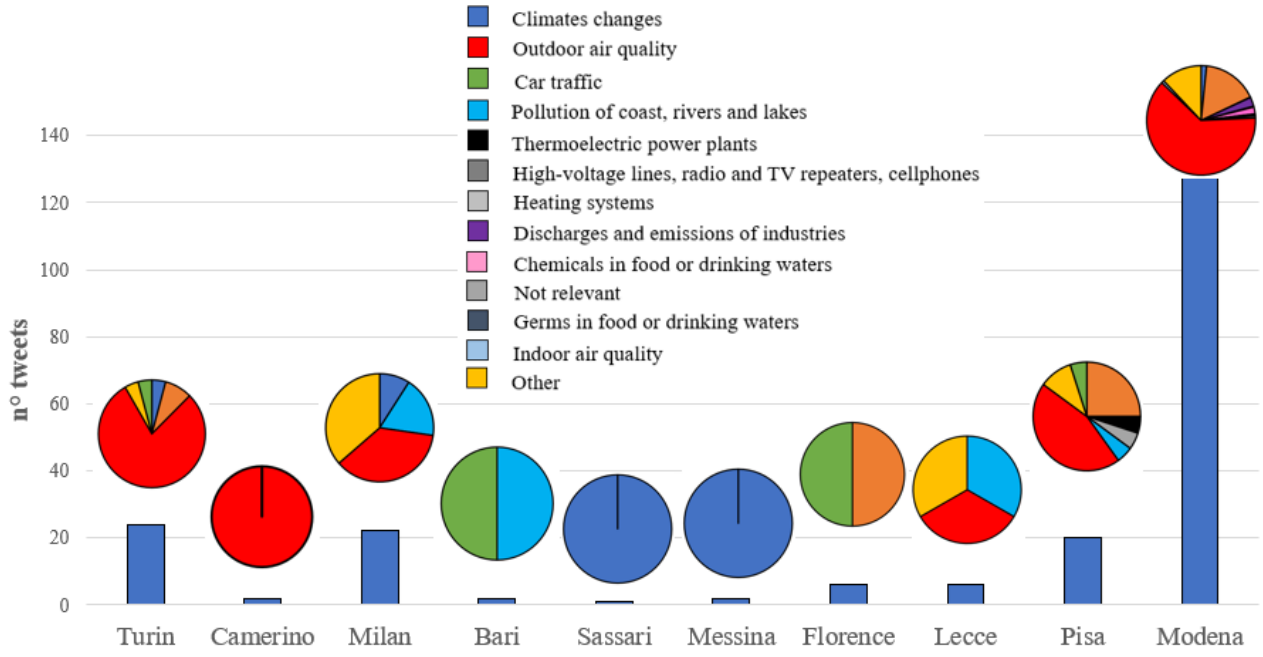
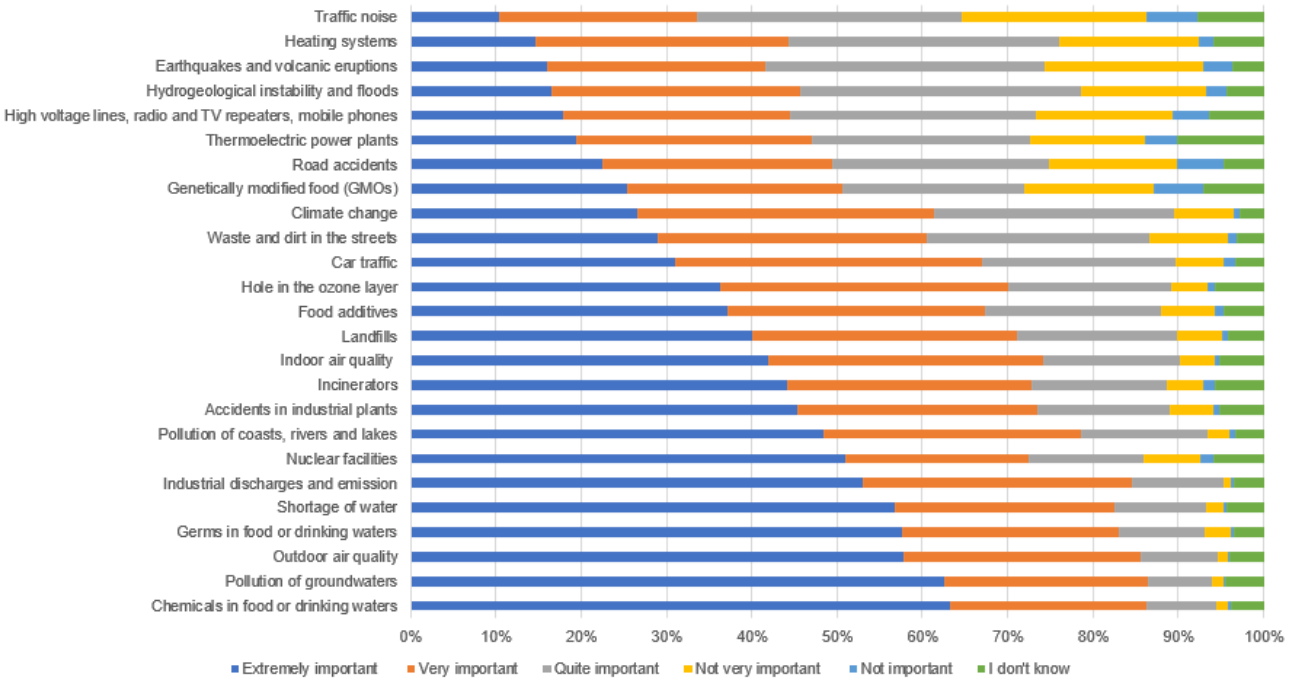


Figure 2. Risk perception regarding environmental factors



Supplemental material for:

ENVIRONMENT AND HEALTH: RISK PERCEPTION AND ITS DETERMINANTS AMONG ITALIAN UNIVERSITY STUDENTS

A. Carducci, M. Fiore, A. Azara, G. Bonaccorsi, M. Bortoletto, G. Caggiano, A. Calamusa, A. De Donno, O. De Giglio, M. Dettori, P. Di Giovanni, A. Di Pietro, Facciolà A., I. Federigi, I. Grappasonni, A. Izzotti, G. Libralato, C. Lorini, M.T. Montagna, L.K. Nicolosi, G. Paladino, G. Palomba, F. Petrelli, T. Schilirò, S. Scuri, F. Serio, M. Tesauro, M. Verani, M. Vinceti, F. Violi, M. Ferrante

List of contents:

A. Questionnaire administrated to Italian participants (translated in English)

AmbSal

Questionnaire on environmental and health awareness and behaviour

Dear Students,
Citizens and politicians are interested in environmental pollution due to its multiple effects on the climate, economy, quality of life, and more specifically on health. The public debate on this issue is broad and widespread through many media and information sources.
Citizens have a very important role both in the production of pollution and in its reduction, by their behaviour and through the political pressures they can exert.
This study investigates the sources of information, risk perception, attitudes and behaviour towards environmental pollution, in order to promote information and educational interventions.
To help us, we would therefore like to ask you to answer these questions.

It should take you about 15 minutes to complete the questionnaire.

Thanks for your collaboration!

1. SOCIO-DEMOGRAPHIC CHARACTERISTICS

Gender ☐ **M** ☐ **F**

Age (years) ☐☐ **Place of residence** _____**Prov.**_____

Degree course ☐ **Bechelor's degree** ☐ **Master's degree**

Sector ☐ **Scientific-Health** ☐ **Humanistic-Legal-Social**

..... In **which city do you live? (may be different from the place of residence)**

How long have you lived there? ☐☐ **Years** ☐☐ **Months**

2. INFORMATION

2.1 Where do you receive most of your information on the relationship between health and environment? (maximum two answers)

☐ Newspapers ☐ Internet ☐ Weekly ☐ Social networks ☐ TV ☐ Radio ☐ Other

2.2 How would you judge this information?

☐ Truthful and complete ☐ Not truthful or complete ☐ Truthful, but incomplete ☐ Don't know

2.3 How do you evaluate your knowledge about the relationship between health and the environment?

☐ Satisfying ☐ Incomplete ☐ Scarce

2.4 How much trust do you have in the information on health risks from the following sources?

1. None **2.** Little **3.** Limited **4.** A lot **5.** I don't use this source of information

	1	2	3	4	5		1	2	3	4	5
1. TV and radio						**9. Local community stakeholders**					
2. Newspapers and magazines						**10. Municipalities**					
3. Internet						**11. Ministry of Environment**					
4. Social network						**12. Ministry of Health**					
5. Friends and relatives						**13. Regional Environmental Protection Agency**					
6. Physicians						**14. Public Health Agencies**					
7. Alternative medicine experts						**15. University and Research Institutions**					
8. Environmentalist Associations						**16. Industry**					

3. RISK PERCEPTION

3.1 How important is the environment for the development of the following diseases?

1. Not important **2.** Not very important **3.** Quite important **4.** Very important **5.** Extremely important **6**. Don't know

	1	2	3	4	5	6
1. Tumours						
2. Heart diseases						
3. Dementia and neurological diseases						
5. Congenital malformations						
6. Infectious diseases						
7. Respiratory diseases						

3.2 In your opinion, what is the percentage of diseases due to environmental pollution in the world?

☐ 0-20% ☐ 21-40% ☐ 41-60% ☐ 61-80% ☐ > 80% ☐ Don't know

3.3 How important is the health risk to the population resulting from the following?

1.Not important **2.** Not very important **3.** Quite important **4.** Very important **5.** Extremely important **6**. Don't know

	1	2	3	4	5	6		1	2	3	4	5	6
1. Earthquakes and volcanic eruptions							**14. Chemicals in food or drinking waters**						
2. Hydrogeological instability and floods							**15. Germs in food or drinking waters**						
3. Climate change							**16. Food additives**						

4. Hole in the ozone layer							**17. Shortage of water**							
5. Road accidents							**18. Pollution of groundwater**							
6. Nuclear facilities							**19. Pollution of coasts, rivers and lakes**							
7. Car traffic							**20. Outdoor air quality**							
8. Heating systems							**21. Indoor air quality**							
9. Industrial discharges and emissions							**22. Traffic noise**							
10. Thermoelectric power plants							**23. Waste and dirt in the streets**							
11. Accidents in industrial plants							**24. Landfills**							
12. High voltage lines, radio and TV repeaters, mobile phones							**25. Incinerators**							
13. Genetically modified food (GMOs)														

3.4 Can you quantify the importance of the health risk arising from the following behaviours?

1. Not important **2.** Not very important **3.** Quite important **4.** Very important **5.** Extremely important **6**. Don't know

	1	**2**	**3**	**4**	**5**	**6**
1. Exposure to sunlight without protection						
2. Smoking						
3. Use of wood or pellet stoves						
4. Improper use of chemicals in the home and in the garden						
5. Poor food storage						

3.5 For each statement, please indicate whether your level of agreement with the following statements

1. Strongly disagree **2.** Disagree **3.** Agree **4.** Strongly agree **5.** Don't know

	1	**2**	**3**	**4**	**5**
1. In the place where I live, the environment is a source of health problems					
2. I believe my local area is becoming a healthier place to live					
3. Soil, air and water are now more polluted than ever					
4. I can control my health risks					
5. Experts are able to make accurate estimates of health risks from chemicals in the environment					
6. I believe I am in good health					

4. ATTITUDES

4.1 How important are the following subjects in protecting the general population from environmental health hazards?

1. Not important **2.** Not very important **3.** Quite important **4.** Very important **5.** Extremely important **6**. Don't know

	1	2	3	4	5	6		1	2	3	4	5	6
1. Ministry of Health							**7. Physicians**						
2. Public Health Agencies							**8. "Ecolabel" industries**						
3. Ministry of Environment							**9. Environmentalist Associations**						
4. Regional Environmental Protection Agencies							**10. Local community stakeholders**						
5. Municipalities							**11. Individual citizens**						
6. Regional governments							**12. Non-Governmental Organizations**						

4.2 To what extent do the following subjects fulfil in protecting the population from environmental health risks?

1. Scarce **2.** Sufficient **3.** Medium **4.** High **5.** Very high **6.** Don't know

	1	2	3	4	5	6		1	2	3	4	5	6
1. Ministry of Health							**7. Physicians**						
2. Public Health Agencies							**8. "Ecolabel" industries**						
3. Ministry of Environment							**9. Environmentalist Associations**						
4. Regional Environmental Protection Agencies							**10. Local community stakeholders**						
5. Municipalities							**11. Individual citizens**						
6. Regional governments							**12. Non-Governmental Organizations**						

4.3 To what extent do you support the following measures to limit air pollution?

1. Strongly disagree **2.** Disagree **3.** Agree **4.** Strongly agree **5.** Don't know

	1	2	3	4	5
1. Limitation of vehicular traffic in the city					
2. Closure of the center to vehicular traffic					
3. Toll parking					
4. Alternative transport (cycle paths, public transport development)					
5. Temperature limit for domestic heating					
6. Decentralization of industries					

4.4 In your opinion, how important are the following behaviours of citizens in the fight against pollution?

1.Not important **2.** Not very important **3.** Quite important **4.** Very important **5.** Extremely important **6**. Don't know

	1	2	3	4	5	6
1. Separate collection of waste						
2. Use less polluting fuels						
3. Buy products with low impact on the environment						
5. Reduce energy consumption						
6. Buy cars with low emissions						
7. Use public transport						

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4.5 Indicate your level of potential support for the following initiatives

1.Very low **2.** Low **3.** Neither high nor low **4.** High **5.** Very high **6.** Don't know

	1	2	3	4	5	6
1. A new incinerator in your municipality						
2. A new landfill in your municipality						
3. A new high voltage line within 500 m of your home						
5. An underground oil / gas pipeline within 1 km of your home						
6. A new highway within 1 km of your home						
7. Establishing a natural park around your home						

5. BEHAVIOURS

5.1 Do you smoke? ☐ Yes ☐ No

If YES: For how many years? |___|___|, how many cigarettes do you smoke per day? |___|___|

(If occasional smoke indicate <1)

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If NO: ☐ **How long ago did you stop? |___|___| Years |___|___| Months**

☐ **I have never smoked**

5.2 How often have you adopted the following behaviours?

1. Never **2.** Rarely **3.** Yes, sometimes **4.** Yes, always

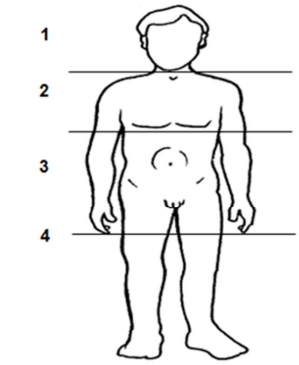
	1	2	3	4
1. Separate collection of waste				
2. Use public transport				
3. Reduce energy consumption				
4. Use less polluting fuels (e.g. methane, electricity)				
5. Buy products with low impact on the environment (e.g. zero km, biodegradable)				

5.3 What obstacles do you find in implementing them? (report obstacles, even more than one, for each behaviour)

OBSTACLES / BEHAVIOUR	Lack of support from institutions	Lack of support from family / neighbours / acquaintances	Lack of time	Mistrust in effectiveness	Costs
Separate collection of waste					
Use public transport					
Reduce energy consumption					
Use less polluting fuels (e.g. methane, electricity)					
Buy products with low impact on the environment					

TEST FOR FUNCTIONAL HEALTH LITERACY

Lastly, associate the words listed below with the corresponding body part.



1 Cold

- ☐ Headache
- ☐ Laxative
- ☐ Emphysema
- ☐ Oral route
- ☐ Nephritis
- ☐ Constipation
- ☐ Meniscus
- ☐ Rhinitis
- ☐ Hepatic damage
- ☐ Alveoli
- ☐ Peptic Ulcer
- ☐ Hematuria

B. Trust in different sources of information and in different subjects

Figure B.1. Trust in information sources, obtained from the answers to the question "How much trust do you have in information on health risks from the following sources?". The results were ordered from the answer "Much"

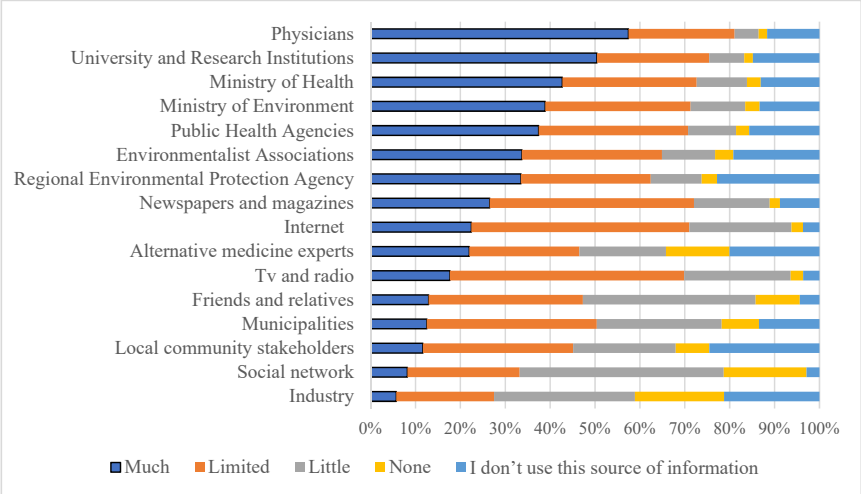


Figure B.2. Evaluation of the importance of different subjects in protecting the general population from environmental health hazards. The results were ordered from the answer "Extremely important"

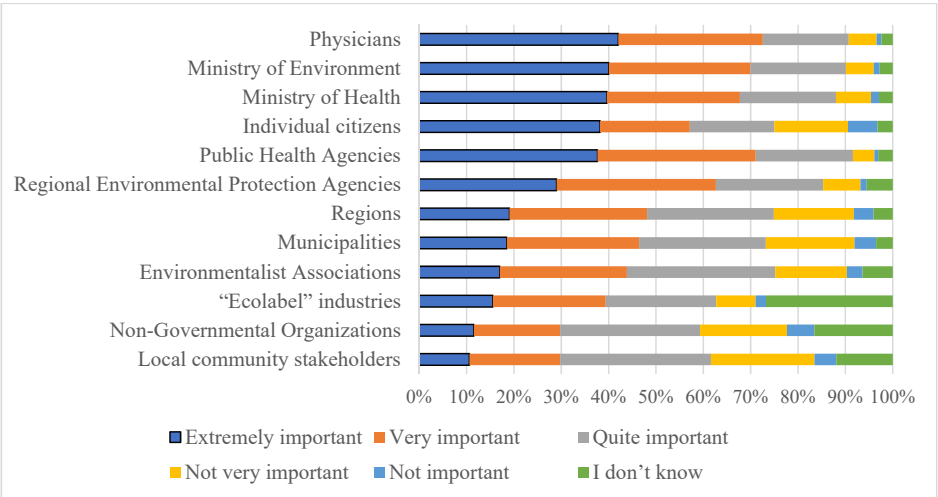
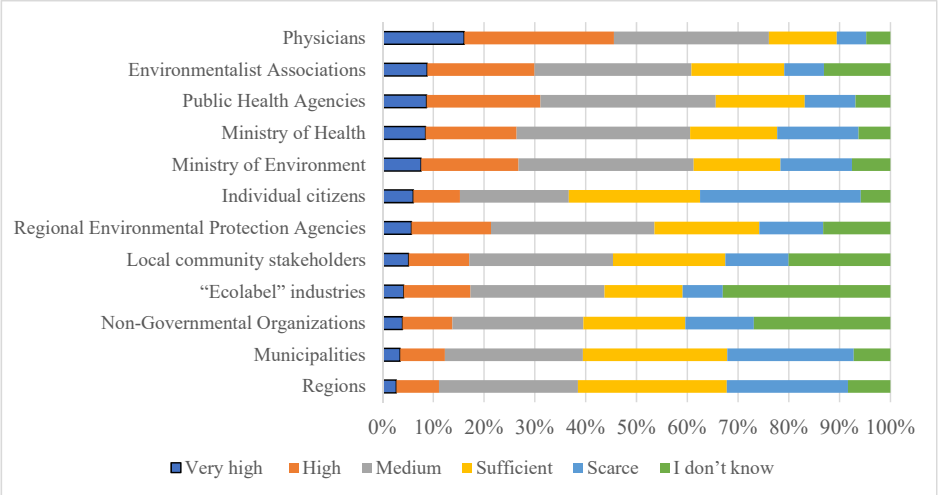


Figure B.3. Evaluation of fulfilment of different subjects in protecting the population from environmental health risks. The results were ordered from the answer "Very High"



C. Literature review on surveys carried out in student population to investigate environmental risk perception (ERP)

C.1 Methodology of literature search

The literature search was conducted on April 3, 2019, using four databases that are considered a good combination to ensure an adequate literature coverage (Bramer et al., 2017): Scopus, Web of science, PubMed, Google Scholar. The searches were performed using the defined search terms listed below: "Perceived Environmental Risk" OR "environmental risk perception" AND students.

From the above database searches, 1147 hits were identified: 13 from Scopus, 25 from Web of Science, 444 from PubMed, and 665 from Google Scholar. Titles and abstracts of papers were initially screened for relevance, according to the following inclusion criteria: (1) primary focus on analysing environmental risk perception in student population through questionnaires, (2) original research articles or conference papers, (3) in English. Publications identified by the online search engine were first screened by two reviewers for the inclusion criteria based on title and abstract, and any doubt regarding the inclusion was resolved by one other reviewer. The screening process yielded a total of 16 studies.

C.2 Extraction of information

The 16 selected studies were analysed in order to extract information on the study design: (1) location of the study area; (2) type of sampled population; (3) whether or not a pilot study had been carried out before the main survey; (4) sample size; (5) main goal of the study; (6) method for data collection survey on environmental risk perception; (6) sources of information on environment and health; (7) trust in Authorities; (8) main associations of ERP. The extracted information is summarized in Table S1, in comparison with our study.

Table C.1. Research design of the selected papers (ERP stands for Environmental Risk Perception)

	Study area	**Sampled population and study courses**	**Pilot study**	**Sample size of the final survey**	**Aim**	**Data collection survey on ERP**	**Main sources of information on environment and health**	**Trust in the Institutions**	**Risks mainly perceived**	**Main associations**
Current study	Italy (nation-wide study enrolling 15 cities across the country, in order to cover the 3 geographical regions of Italy)	University students (53% attending Scientific-Health sector, 47% attending Humanistic-Legal-Social one)	Yes, on a sample of 362 students from 7 Universities	4778 students	Investigate ERP, trust and attitudes, related to socio-demographic factors, Functional Health Literacy (FHL), mass-media and social-media coverage	25-items ERP scale developed by researchers	Internet e social	Directly correlated with FHL (Higher with FHL > 9)	- Pollution of groundwaters, - chemicals in food - chemicals in drinking waters	ERP with - FHL (higher for FHL > 9), - mass media (higher using internet and social). Trust with - FHL (higher for FHL > 9), - area of residence (higher in North-Centre)
Altunoğlu and Atav, 2016	Turkey (nation-wide study enrolling 16 cities across the country, in order to cover the 7 geographical regions of Turkey)	High school students (sector not specified)	Yes, on a sample of 320 secondary school students	682 students	Investigate the effects of socio-demographic factors on perceptions regarding environmental risk.	23-items ERP scale developed by Slimak and Dietz (2006) divided into four domains (ecological, chemical, resource depletion, global risks)	NA	NA	Risk belonging to global risk domain: - greenhouse effect - radiation - hazardous waste areas	ERP with - geographical region (higher in Black sea) - gender (higher in female)
Altunoğlu et al., 2017	Turkey (one city)	Secondary School Students from Technical high school, and public high	No	1003 students	Investigate environmental risk perceptions and attitudes towards the environment	26-items ERP scale developed by Walsh-Daneshmandi and MacLachlan	NA	NA	- Impure drinking water, - Large fires, - Water shortage (e.g. drought, water depletion)	ERP with - gender (higher in female) - school type (lower in

		school				(2000), divided into three domains (industrial risk, natural disasters, everyday life risk)				technical high school)
Anilan, 2014	Turkey (two cities)	High school students from: Anatolian high schools, science high schools, general high schools	No	413 students from three different high school	Investigate ERP and awareness	20-items ERP scale developed by researcher	NA	NA	- active and passive smoking, - global warming, - HIV.	ERP with - gender (higher in males) - school type (greater in Anatolian and science high schools)
Bilgin et al., 2016	Poland (one city)	University students in environmental and technological matters (sector not specified)	No	788 students	Investigate environmental, social and technological risk perceptions. In addition, also awareness was analysed	11-items social and environmental risk perception scale; 20-items ERP scale; 12-items technological risk scale developed by researchers	Internet (92%), followed by TV and radio	**Low trust** in authorities in case of environmental incidents	- Terrorism - Water, air, lakes and marine pollution, - nuclear power plants (51%)	NA
Cici et al., 2008	Turkey (one city)	School population divided in: - Two groups of teachers (academicians and high school); - Two group of students (undergraduate	No	521 students and educators	Evaluate ERP in students and educators	8-items ERP scale developed by researchers	NA	NA	Environmental pollution is the highest risk factor for all four groups	ERP with profession (higher in high-school teachers)

		and postgraduate)								
Der-Karabetian et al., 1996	USA (one city) and Britain (one city)	University students in science courses	No	215 students: 119 from USA and 96 from Britain	Evaluate ERP in different geographical areas, according to emotional and and cognitive aspects	10-items emotional ERP scale developed by Maloney et al. (1975); 15-items cognitive ERP scale developed by researchers	NA	NA	NA	Lower ERP in British sample. ERP is associated with pro-environmental behaviours
Der-Karabetian et al., 2014	USA (one city), China (one city), Taiwan (one city)	University students in science courses	No	1122 students: 442 in USA, 516 in China, 164 in Taiwan	Evaluate ERP according to national or global belonging and world-mindedness	ERP scale based on Der-Karabetian et al. (1996) study	NA	NA	NA	Personal ERP and global belonging were significant predictors of sustainable behaviour
Duan and Fortener, 2010	USA (one city), China (one city)	University students with the majority from economics-related subjects	No	520 students: 240 in USA, 280 in China	Cross-cultural comparison to evaluate ERP in the western (USA) and eastern (China) cultures, and according to risk communication	34-items ERP scale developed by researchers and divided into five domains (traditional pollution-based environmental issues, natural disaster, human activities, resource shortage risks, global environmental issues)	NA	NA	Different between Chinese (i.e. human population growth, fresh water shortage) and American (i.e. hazardous chemical waste; species extinction) students	Chinese respondents have a higher ERP
Durmuş-Özdemir and Sener, 2016	Turkey (one city)	University students in Technical-Scientific sector (environmental	Yes, on a sample of 250 students	570 students	Evaluate the ERP according to environmental education	21-itmes ERP scale developed by researchers, based on Slimak and Dietz (2006)	Internet, TV, newspapers	NA	- Acid rain, - Ozone layer depletion - Increase in UV sunlight	ERP with environmental education (higher in students in environmental

		/ agricultural sciences, computer science, engineering)				study, with the scale divided into four domains (ecological, chemical, biological, global risks)				/ agricultural sciences)
Hayran et al., 2015	Turkey (one city)	University students attending faculty of Agriculture	No	73 students	Evaluate ERP in University students in faculty of Agriculture	24-items ERP scale developed by Slimak and Dietz (2006)	NA	NA	Risk belonging to global risk domain: - Hazardous waste sites, - global warming, - Radiation	ERP with age (higher in younger students)
Sayan and Kaya, 2016	Turkey (one city)	University students attending nursing course	No	778 nursing students	Evaluate ERP and environmental attitudes	23-items ERP scale developed by Slimak and Dietz (2006)	NA	NA	Risk belonging to chemical risk domain: - Radiation - Hazardous waste sites - Genetically modified agricultural products	ERP and attitudes with - gender (higher in female) - interest in environmental issues, - endorsement of the college course on environment as necessary, - participation in an environmental activity - awareness of non-government environmental organizations
Weber et al., 2000	USA (state-wide study)	School population (students and	Yes, on a sample of 288 people (67%	3400 students and	Evaluate ERP and awareness in different	32-items ERP scale developed by researchers	NA	NA	- Eating oysters caught in polluted waters	ERP with - age (higher in high school

		educators) from different degree of education (high-, middle-, elementary school) and from science and non-science matters	students, 33% teachers)	educators (79% students, 21% teachers)	group of school population				- Storage of chemicals in tanks or barrels that could leak. - Wastewater discharge into lakes and rivers	students) - profession (higher in teachers)
Yapici et al., 2017	Turkey (one city)	University students from Health Sciences, Science Engineering and Technology, Social Sciences, Educational Sciences	No	774 students	Evaluate ERP and environmental attitudes	22-items ERP scale developed by Slimak and Dietz (2006)	NA	NA	- Radioactive materials - Nuclear power generation	ERP with - course (greater in Health Sciences) - gender (greater in female)
Young et al., 2015	Taiwan (nation-wide study enrolling 13 cities across the country, in order to cover the 4 geographical regions of Taiwan)	University students attending Engineering and Health Sciences	No	1218 students (+ 35 college professor)	Evaluate ERP with respect to a wide variety of hazards	26-itmes ERP developed by researchers	NA	NA	- Hazardous waste - Virus infectious disease - Chemical contaminated food	ERP with - students' course (greater in technological college) - gender (higher in female)
Zhang and Fan, 2013	China (one city)	University students attending science and technology courses	Yes, three subsequent pilot studies in order to revise the questionnaire, each study with about 20	3079 students	Investigate perception of health risks	15-items ERP adapted from Dake et al. (1991) and divided into three domains (environmental, technological	NA	NA	- Motor vehicle accidents - Chemical pollution - Cigarette smoking	ERP with - geographical region (higher in students living in rural areas) - gender (higher in

			participants from the University			and social risks)				female)
Zhang et al., 2013	China (one city)	University students from social science science, and engineering courses	No	1735 students	Investigate ERP and attitudes towards environmental risk management system	25-items ERP developed by researchers	Internet, followed by television, and newspapers	Environmental agencies and research institutes or universities considered the most reliable organizations for providing information in cases of environmental accidents	- Water pollution - Air pollution - Noise pollution	ERP with - personal experience with environmental accidents, - membership of environmental organizations, - education level (higher in master and PhD students)

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