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

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(Article begins on next page)

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

Formattato: Allineato al centro

Formattato: Tipo di carattere: 14 pt, Grassetto

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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.

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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.

30 **Introduction**

31 Risk communication is defined by WHO as an essential component of the risk analysis, strictly linked to the
32 other two components of risk assessment and management, at the basis of public health prevention strategies
33 (WHO, 2013; Covello and Allen, 1988). The environmental risk communications from public health institutions
34 should be carefully programmed based on an accurate study of the context (Covello, 2003; Smillie and Blissett,
35 2010), including the assessment of public risk perception and trust as well as their determinants.

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

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

43 Health literacy and mass media/social media information are rarely considered in studies and guidelines
44 (Kuroda et al., 2018), despite their proven representativeness of risk perception, awareness and behaviours in
45 many contexts (Institute of Medicine, 2004; Bennet and Calman, 2010; Berkman et al., 2011; Kickbusch et al.,
46 2013).

47 Health literacy was initially defined as “the capacity to obtain, process and understand basic health information
48 and services needed to make appropriate health decisions” (Ratzan and Parker, 2000; Institute of Medicine,
49 2004). It has subsequently been given a more complex definition, differentiating between functional,
50 communicative and critical health literacy (Nutbeam, 2000, 2008), where functional health literacy represents
51 the baseline individual literacy skills needed to read and understand health information.

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

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

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

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

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

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

73

74 **Methods**

75 *Study population and data collection*

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

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

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

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

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

- 96 1) Socio-demographic characteristics: gender, age, [place-area](#) of residence and the sector of university degree
97 course attended (Scientific-Health or Humanistic-Legal-Social);
- 98 2) Information: 1. Sources. 2. Trust in these sources. 3. Perceived quality of information. 4. Self-evaluation of
99 knowledge on environmental health risks. The trust was measured by a Likert 4-point-scale (1=none,
100 2=little, 3=limited, 4=a lot);
- 101 3) Environmental health risk perception was explored through five questions: 1. Estimation of burden of
102 environmental diseases. 2. [Opinion on the association between environmental factors and some diseases \(6](#)
103 [items\)](#). 3. Risk perception regarding environmental risks (25 items). [They were chosen to provide a list as](#)
104 [wide as possible of the issues of concern for the population](#). 4. Risk perception of behavioral risks (5 items).
105 5. [General environmental health risk perception and self-perception of their own health status \(6 items\)](#). 6.
106 Smoking habits, to find relations with environmental risk perception. Except for questions 1 and 6, the
107 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

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

111 4) Trust in different subjects: 1. Evaluation of the importance for pollution reduction and control (11 items: 6
112 institutional and 5 ~~non~~-non-institutional subjects). 2. Evaluation of the extent to which these subjects fulfill
113 pollution reduction and control. The answers were coded according to a Likert 5-point-scale (1=scarce,
114 2=sufficient, 3=medium, 4=high, 5=very high). Global indexes of trust (for institutional and non-
115 institutional subjects) were calculated by the sum of scores for the corresponding items;

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

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

124 *Newspapers and social media analysis*

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

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

131 *Data analysis*

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

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

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

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

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

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

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

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

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

166

167 **Results**

168 *Internal consistency of the questionnaire and response rate*

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

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

174 *Study population: Socio-demographic characteristics and health literacy*

175 The study population included 4778 students (65.1% female) aged 21 ± 4.3 years. A total of 2505 participants
176 (53.2%) belonged to the scientific-health sector. Overall, 65.1% of students were following three-year degree
177 courses (bachelor's degree). The mean functional health literacy level was 10 ± 3 : functional health literacy was
178 ≤ 9 for 44.4% of students and > 9 for 55.6%. The most represented area of residence was southern Italy, including
179 Sicily and Sardinia which accounted for 57.1% of respondents, followed by the centre (25.0%) and the north
180 (17.9%). Among the socio-demographic variables, functional health literacy was lower for people following
181 three-year degree courses, and for the scientific health-sectors (Table 1).

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

185 *Information*

Commentato [AC5]: TITOLO CAMBIATO PER
RIORGANIZZARE LA DISCUSSIONE

186 The Internet-internet and social networks were the most frequently consulted sources of information (77.7%),
187 followed by Newspapers and Weeklies (14.6%), TV and Radio (7.7%). A weak association was found between
188 the sources of information and gender (e.g. Internet-internet and social networks: Female vs Male, 78.8% vs
189 75.7%; Newspapers and Weeklies: Female vs Male, 13.6% vs 16.5%) and the sector (e.g. Internet-internet and
190 social networks: Scientific-health sector vs Humanities sector, 73.7% vs 83.5%).

191 Information was considered “truthful, but incomplete” by 64% of the sample; the proportion was higher among
192 functional health literacy > 9 students (62.5% vs 65.2%), in particular mainly in Milan (61.7 vs 67) and Turin
193 (67.1 vs 79.3).

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

197 Although most students consulted the Internet-internet and social media as the main source of information (78%),
198 they placed “moderate” and “low” trust, respectively on these sources (internet vs social media, 48.6% vs 45.5%)
199 regardless of the level of functional health literacy, gender and sector; whereas students with functional health
200 literacy > 9 were more trusting than functional health literacy <= 9 in the Ministry of Environment (40.3% vs
201 37.1%), Ministry of Health (44.2% vs 40.8%), Regional Environmental Protection Agency (34.3% vs 30.9%)

202 and University and Research Institutions (53.9%). On the other hand, students with functional health literacy <=
203 9 were more trusting in social networks (9.1% vs 7.5%) and experts in alternative medicines (23.9% vs 20.5%).

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

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

207 During the time period of the questionnaire distribution, the number of newspaper articles varied among the
208 different cities (Figure 32), with a maximum in Turin (21), followed by Lecce (11), Padua and Milan (10),
209 Sassari (8), Modena (6), Naples (5), Bari (4), Messina and Catania (3), and Pisa (2). In the remaining cities no
210 pertinent articles were published. The most reported topics regarded air pollution (41.0% of articles), followed
211 by traffic bans (14.5%), pollution in schools (6.0%) and other (38.6%), and the tone was mainly negative
212 (78.3%).

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Commentato [16]: le figure sono state spostate, le ho rinumerate

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

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

223 Risk perception

224 Only 17% of students estimated the global burden of diseases caused by environmental factors according to
225 WHO (between 21 and 40%), with differences between functional health literacy levels (14.4 for functional
226 health literacy ≤ 9 vs 16.5 for functional health literacy > 9). Most students overestimated this burden (82.1%).

227 Respiratory diseases were considered to be mostly associated with environmental factors (89.2% of students
228 answered “very” or “extremely important”) followed by tumors (87.3%), infectious diseases (77.7%), congenital
229 malformation (61.9%), heart diseases (58.4%) and neurological disorders (38.9%). No differences were found
230 in relation to socio-demographic variables, however some differences were detected for functional health
231 literacy in some cities: for functional health literacy > 9 a higher proportion of students answered “very” or
232 “extremely important” in Bari and Padua regarding tumors, in Bari and Sassari regarding infectious diseases, in
233 Firenze, Messina, Modena and Sassari regarding congenital malformation, in Bari regarding heart diseases, and
234 in Genoa and Sassari regarding neurological disorders.

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

238 The perception of single risks was different among cities, above all for road accidents (perceived higher in Bari,
239 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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240 Catania, Florence, Genoa, Modena, Padua, and Sassari), pollution of coasts, rivers and lakes (perceived worse
241 in Chieti, Milan, Modena, Padua, and Turin). The highest number of perceived high risks was in Padua (7) and
242 Genoa (9). In Naples, the perception was lower for five risks (nuclear facilities, exhausts and emissions from
243 industries, chemicals in food or drinking water, germs in food or drinking water and traffic noise).

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

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

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

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

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

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

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

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267 “extremely important” vs 27.0% of non-smokers). On the other hand, non-smokers attributed more importance
268 to smoke (non-smokers vs smokers: 90.9% vs 87.6%), solar UV exposure (65.0% vs 58.2%), food preservation
269 (66.0% vs 62.4%) and misuse of chemicals (64.7% vs 59.1%).

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

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

273 The number of tweets for all cities was not associated with the ~~global-general~~ risk perception index.

274 However, there was a clear difference in this index between Pisa and Modena (median 93.5 vs 95.5), possibly
275 related to the number of tweets. The specific risk perception was lower in Pisa than in Modena regarding nuclear
276 plants, emissions from heating systems, discharges and emissions from industries, electromagnetic fields (high
277 voltage lines, radio, TV and cell phone repeaters) and genetically modified food. Only for the industry emissions
278 and discharges, the number of tweets was different between the two cities (20 in Modena and 0 in Pisa).

279 *Trust*

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

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

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

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

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

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

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

302

303 **Discussion and conclusion**

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

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

312 *Study population: Socio-demographic characteristics and health literacy*

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

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

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

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

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

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

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

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

351 *Sources of information and mass media and social media coverage*

352 As expected, the ~~Internet~~ internet and social networks were the most used sources of information, in agreement
353 with other surveys on similar populations (Bilgin et al., 2016; Durmuş-Özdemir and Sener, 2016; Zhang et al.,
354 2013). This predominance was even more evident for the humanistic sector students and for females, as reported
355 in many studies (Escriffery et al., 2005; Fox, 2011; Rice, 2006; Horgan and Sweeney, 2012), although in the
356 whole population and about health in general (EU, 2014) no difference were found by gender.

357 Nevertheless, the quality of information was not completely satisfying for the 64% of students: this percentage
358 was quite similar to the one resulting from Eurobarometer (EU, 2014), where 73% of general population was
359 “fairly satisfied” of the health information on internet.

360 The risk perception of environmental problems is often socially mediated by the mass media, especially when
361 it is not directly experienced (Weber et al., 2000). Mass media, including digital and social media have been
362 proven to have a significant influence both on the knowledge and attitudes of people (Nelkin, 1987). Considering
363 environmental risks, the information in the press, on TV, websites and social media have been strongly
364 associated with risk perception and sometimes considered as a determinant of conflict (Bennet and Calman,
365 2010).

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

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

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

382 *Environmental risk perception*

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

391 To study the perception of health risk deriving from the environment, a wide list of specific issues of possible
392 concern for people was included in the questionnaire: these were chosen on the basis of previous studies
393 (Carducci et al., 2017; Zhang and Fang, 2013) and with the aim of representing a view of environmental health
394 risks as much complete as possible, without any specific focus. So it was quite predictable that the top three
395 environmental risks were “chemicals in food or drinking waters”, “pollution of groundwaters” and “outdoor air
396 quality” that represent environmental matrices with the highest exposure by breathing or ingesting like ground
397 waters that are frequently used for potable purposes and in the agri-food sector. Other environmental factors of
398 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 et 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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426 On the contrary, the self-perception of their own health was not influenced either by functional health literacy,
427 or area of residence, or gender: it was generally good (83,1%) even higher than the one found in a nationwide
428 survey on university students (77%) (de Waure et al., 2015).

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

432 The obtained results are in accordance with Italian data on smoking habits (PASSI surveillance system, 2015-
433 2018), with 28% and 31% of smokers in the 18-24 and 25-34 age groups, respectively, and the highest frequency
434 in the regions of Centre and South. In similar populations the smoking habit was slightly higher among males
435 (Teleman et al., 2016) while in our study no difference was found between genders.

436 The smoking habit influences the environmental health risk perception: ~~in fact more many~~ smokers consider the
437 environment as cause of tumors and hearth diseases, that are, also, the most important diseases linked to smoke
438 as reported in a recent report on smoking prevalence and attributable disease burden through the world (Reitsma
439 et al., 2017). Accordingly, among personal behaviors, smokers tend to underestimate the importance of smoke
440 as health hazard (EU, 2007). ~~The majority of researches investigated the association between smoking and this~~
441 ~~result is confirmed also for Ita-~~ status and risk perception of smoking (Ferrante et al., 2010; Wagener et al.,
442 2014), but there is still a lack of studies addressing smoking and risk perception of environmental health issues.

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

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

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

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

454 *Trust*

455 Trust in institutions is considered an important factor against the “outrage”. Some studies have demonstrated
456 that in situations where an environmental problem occurs, it is very important a rapid response from institutions
457 and the involvement of population (Sandman, 2003). Our study explored trust towards different subjects in
458 informing correctly, in protecting general population from environmental health hazards and in really fulfilling
459 their duties. On the whole, physicians were the most trusted for every of these aspects, confirming that they are
460 still a reference about health, as demonstrated by numerous studies (Blendon et al., 2014). On the contrary, the
461 second position was different according to the question: as information source, universities and research
462 institution were more trusted than other public institutions. This result can derive from the study population
463 represented by university students. Concerning the importance for the health protection from environmental
464 risks, the second and third places were attributed to the involved Ministries (Health and Environment), but it is
465 noteworthy the role assigned to individual citizens considered, “extremely important” or “very important” by
466 the 57% of students. This indicates that the respondents give a high value to the action of general population,
467 including themselves: some other surveys ~~indagated~~ investigated this aspect, referring to the “locus of control”
468 that indicates the degree to which people believe that they have control over their lives and events (Rotter, 1954).
469 There are some evidences that a higher internal locus of control is associated to a greater predisposition to pro-
470 environmental attitudes and behaviours (Pavalache-Ilie and Unianu, 2012; McCarty and Shrum, 2001). The
471 frequency of people recognizing their own importance in protecting the environment was explored in other
472 surveys: it was 37 % in 1990 in USA (Roper Organization, 1990), 28 % in a similar population (GfK, 2011) and
473 60% in an adult Italian population in ~~2018~~ 2016 (Carducci et al., ~~2018~~ 2017, MAPEC). On this question notable
474 influences of sources of information, health literacy and area of residence were also detected. The lower use of
475 ~~Internet~~ internet and social as well as the ~~higher~~ health literacy seems to increase the importance attributed to
476 ~~Institutional~~ institutional subjects.
477 The real fulfillment of actions against environmental risks was in general considered more effective for
478 ~~Institutional~~ institutional subjects, mainly by students with functional health literacy > 9.

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

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

486 *Conclusions*

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

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

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

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

502 To the best of our knowledge this is the first study on environmental health risk perception and trust to show an
503 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).

506

507

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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)

¹Each 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)

¹Each 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

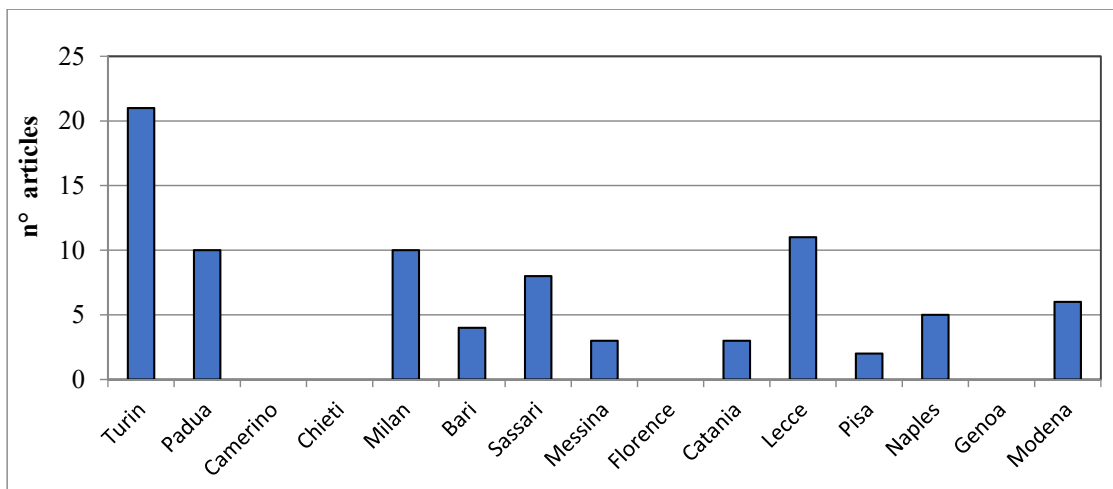


Figure 3. Quantitative analysis of tweets for each city

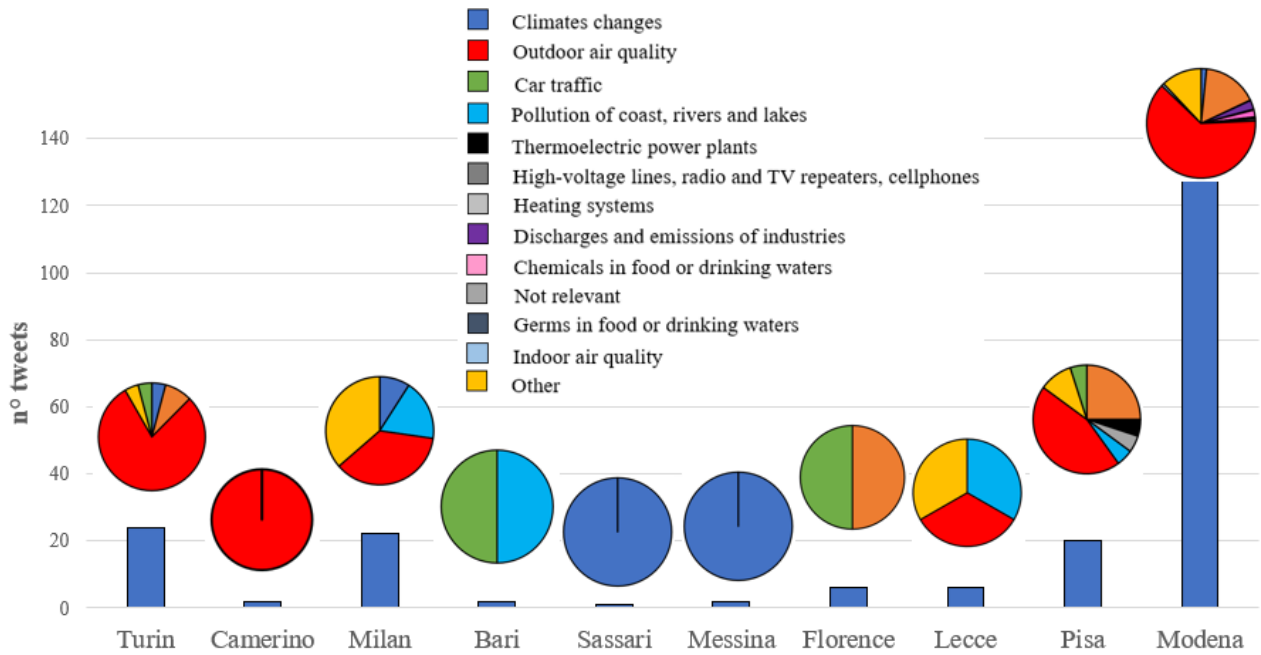
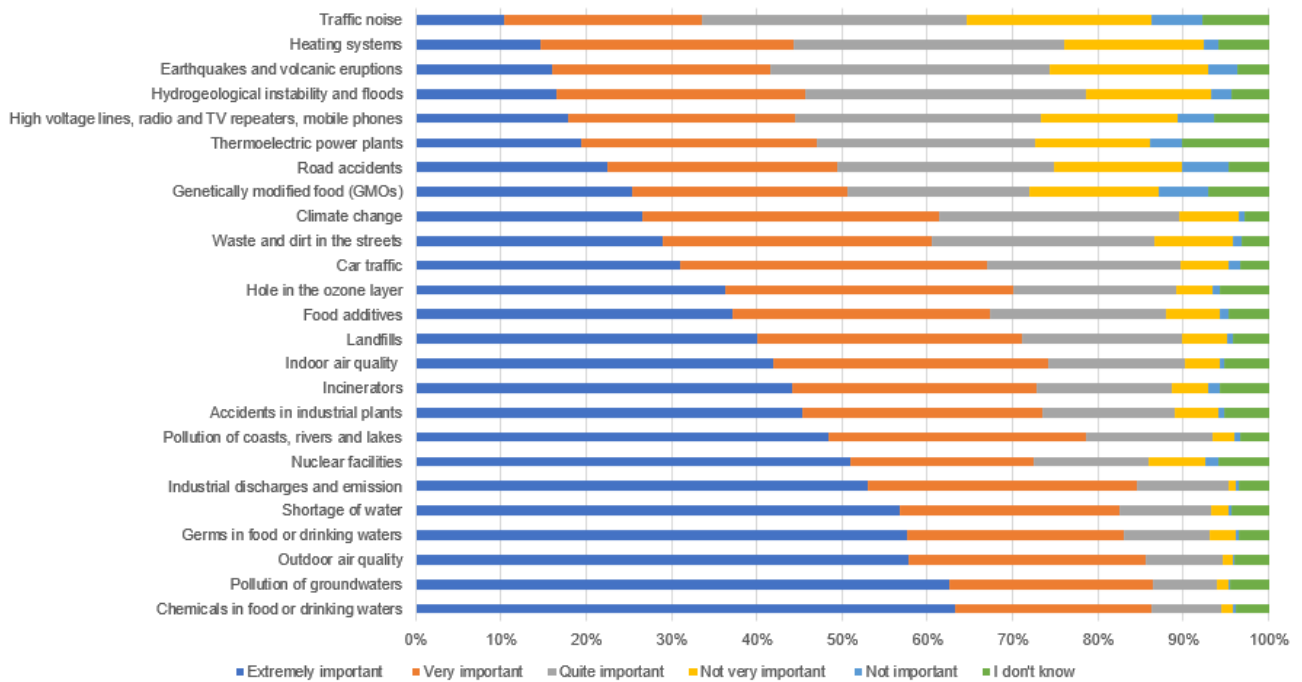


Figure 2. Risk perception regarding environmental factors



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, Facciola 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).
- B. Trust in different sources of information and in different subjects
- C. Literature review on surveys carried out in student populations to investigate environmental risk perception

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 Bachelor'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						

Formattato: Nessuna, SpazioPrima: 0 pt, Interlinea: singola, Non mantenere con successivo, Non mantenere assieme le righe

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)

If NO: How long ago did you stop? [][] Years [][] Months

have never smoked

Formattato: Nessuna, SpazioPrima: 0 pt, Interlinea: singola, Non mantenere con successivo, Non mantenere assieme le righe

5.2 How often have you adopted the following behaviours?

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

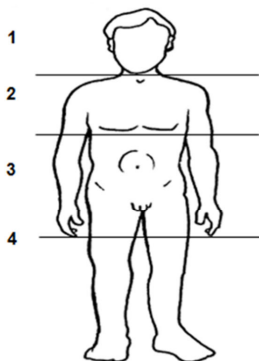
	1	2	3	4
1. Separate collection of waste				
2. Use public transport				
3. Reduce energy consumption				
4. Use less polluting fuels (e.g. methane, electricity)				
5. Buy products with low impact on the environment (e.g. zero km, biodegradable)				

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 Meniscus
- Laxative Rhinitis
- Emphysema Hepatic damage
- Oral route Alveoli
- Nephritis Peptic Ulcer
- Constipation 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”

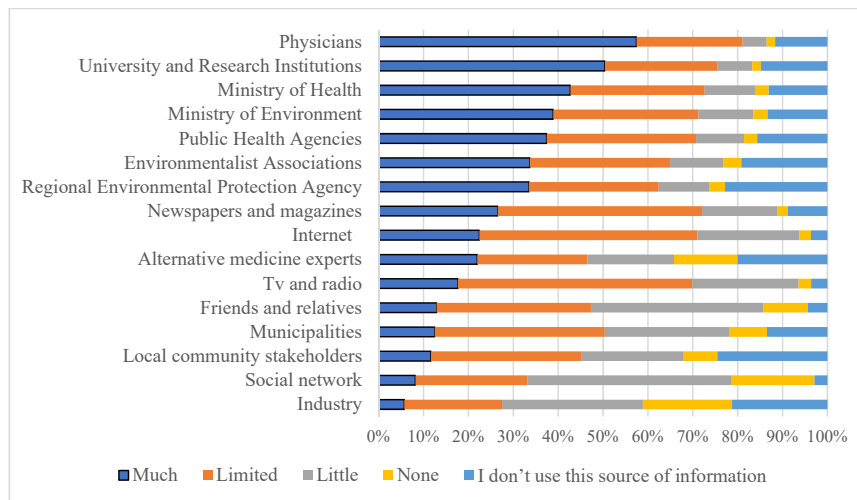


Figure B.2. Evaluation of the importance of different subjects in protecting the general population from environmental health hazards. The results were ordered from the answer “Extremely important”

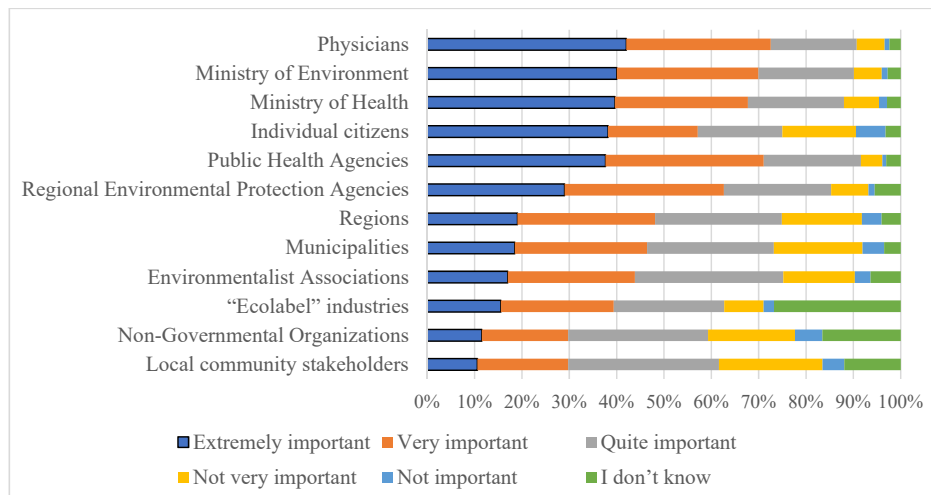
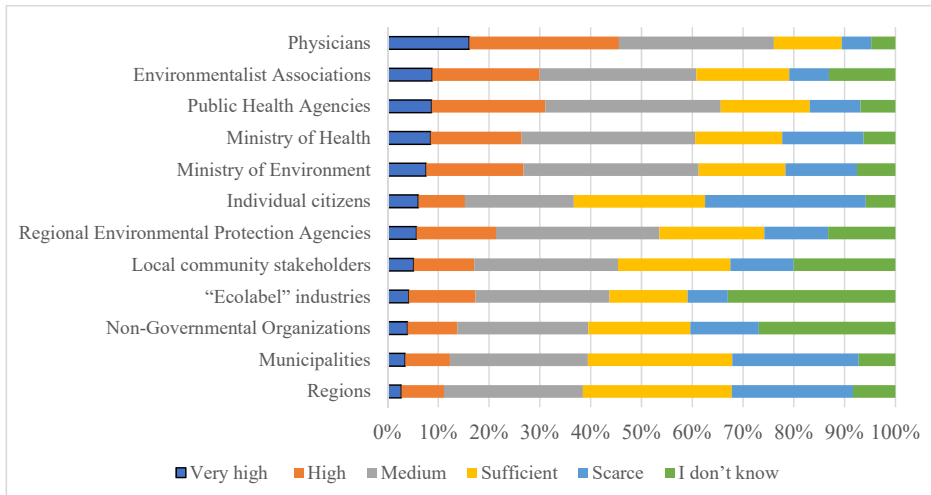


Figure B.3. Evaluation of fulfilment of different subjects in protecting the population from environmental health risks. The results were ordered from the answer “Very High”



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 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-items 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-items 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, 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)

C.3 References

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