

Knowledge on causes and consequences of Climate Change in a cohort of Italian students

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Abstract

Background. Climate change (CC) is the greatest threat to the health of the planet. The scientific community has established its connection to human activities and its role in emerging and premature diseases. Our study helps to understand how students of various backgrounds and academic fields retrieve information on CC and highlights the knowledge on the main causes and consequences of global warming and on the role of healthcare workers in the fight towards this threat.

Methods. A cross-sectional study was performed through an online questionnaire administered to university students between January and December 2020. Univariable analyses were performed, Chi-square was calculated and multivariable analysis was used to investigate the relationship between the answers and socio-demographic variables. Statistical significance was set at a p-value of less than 5%.

Results. More than 80% of the sample correctly identifies as major consequences of CCs the increase in Earth's temperature (95.0%), melting of ice caps (89.4%), rising sea levels (81.8%), and the more frequent occurrence of climate-related natural disasters. Across courses of study, the frequency on how CC is addressed differs ($p < 0.001$): 31.5% of the students from the medical field reported the topic to be taught in class, compared to 49.0% from humanities and 63.4% from science and technology.

Conclusion. The study shows that medical students are less prepared and less aware of the consequences and causes of CC than students in other faculties. Since CC will play a role in every aspect of patients' lives, barriers to health care will have to be overcome through the knowledge and skills acquired during undergraduate courses. *Clin Ter* 2022; 173 (5):443-452 doi: 10.7417/CT.2022.2461

Key words: Climate change, education, knowledge, university students, healthcare workers

Introduction

Climate change (CC) is the main threat for planetary health (1) and the scientific community established its connection with human activities. This phenomenon, also

known as global warming, is linked to the increase in emissions of greenhouse gases, such as carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O). The increase in the concentration of these gases in the atmosphere have occurred since the beginning of the industrial era (2) and will continuously rise in the upcoming years, even with the uptake of direct actions to tackle greenhouse gas emissions (3). During this century, the Earth's temperature has warmed by about 0.5 degrees Celsius, and mid-range estimates on the rise of temperature and sea level are of 2.0 degrees Celsius and 49 centimetres by the year 2100, respectively. The higher variability of the weather associated with CC is causing major new stress on developing countries, already vulnerable due to environmental degradation, scarcity of resources, overpopulation, or their geographical location (4). However, most of the Countries are not yet providing proportionate solutions to the growing risks their populations are facing (5).

CC plays also a role in emerging diseases and premature deaths worldwide, with increasing negative health effects caused by heat waves, extreme weather events and reduced air quality (3,6,7). Because of the multiple simultaneous and interacting health risks, CC jeopardises years of progress in medicine and public health. Since the present and forecast impact of global warming on health and the role played by healthcare systems in contributing to CC (5), the responsibilities and the impact of healthcare workers are becoming more and more discussed and prominent, with scientific societies taking position on the issue (8–10). Healthcare workers play a role in promoting individual and collective changes, such as eating less meat and avoiding car transfers, for people to change their behaviours with a co-benefit for the population' and environment's health (11,12). Higher education plays an essential role in training students on the challenges posed by CC. Adequate knowledge and information built into university curricula is therefore essential to act on the consequences of global warming. Considering that CC is identified as one of the greatest threats to health, a thorough knowledge assessment is important to understand whether the curriculum of medical students is capable of providing adequate training on this topic (13).

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However, the need for appropriate solutions against CC requires an increase in the awareness of the population on this topic, as well as a greater understanding of the causes and consequences of CC(14) and therefore should be included in each education curriculum. Currently there are few studies on university students' knowledge and attitudes on this issue (15).

The aim of this study is to evaluate knowledge of students from different academic fields in their training on the main causes and repercussions of CC and the perception of the role of healthcare professionals in addressing this phenomenon.

Methods

Study design: A cross-sectional study, according to the STROBE checklist (ref), was performed between January and December 2020.

Setting Participants: a total number of 480 individuals enrolled were contacted via email to take part in the survey. The link to the questionnaire was shared and three reminders were sent.

Data sources/ measurement: The tool of the study is a questionnaire developed and validated by De Paula Baer et al. (16) and contains two sections. The first one was a socio-demographic section collecting information on gender, age, civil status, academic field of pertinence and geographical area of origin. The subsequent section investigated knowledge on CC covering, with a total number of 20 questions on the following themes: definition of CC and greenhouse gases; knowledge about the effects of global warming; respondents' awareness about the argument and options to fight CC and pollution. Questions could include more than one correct answer. The answer to each question was mandatory, therefore no missing data were reported.

Statistical methods: Some variables were modified in order to perform statistical analyses. Academic field of pertinence was grouped as follows: under medical field we included students in medicine, nursing, and healthcare professions, under scientific and tech students attending engineering, architecture, statistical and biological sciences and under economic and humanities students from economic, marketing and communication, law, linguistics, psychology, Italian and foreign languages and literatures. Regions of provenience were grouped into three macro-areas: North (Friuli-Venezia Giulia, Liguria, Lombardy, Piedmont, Trentino-South Tyrol and Veneto), Centre (Emilia-Romagna, Lazio, Marche, Tuscany and Umbria) and South and Islands (Abruzzo, Apulia, Basilicata, Molise, Calabria, Campania, Sardinia and Sicily).

Regarding the way students collected the information on CC, we considered books as scientific literature and demonstrations under NGOs.

The statistical analyses were performed using Statistical Package for Social Sciences (SPSS) version 25. Descriptive analyses were performed using frequencies, mean and SD. Bivariate analysis was computed using Chi-square test in order to assess the possible associations between the answers to the questionnaire and above listed socio-demographic variables. Multivariate analysis with stepwise using the backward

wald selection was used to confirm the relationship between the answers and socio-demographic variables. The statistical significance was set at a p-value of less than 5%.

Results

The total number of respondents was 461 (response rate 96%), of which 314 were females (68.1%) and 147 males (31.9%).

The mean age was 21.7 years old (SD ± 2.5). 90.5 % of the sample reported to be single, while 5.9% were either cohabitants or married.

The students were from different academic fields: 123 from the scientific and technological area (26.6%), 238 from the medical one (51.6%) and 100 from the economic and humanities field (21.7%).

The Region of residence of the respondents was located in the North of Italy in 4.6% of the cases, in the Centre in 76.4% and in the South or Islands in 19.1%.

The main sources of information on CC used by the respondents are television (79.8%), internet (48.8%) and the university or school context (46.2%), while 39.5% of the students retrieve the information on the newspapers and 19.5% on the radio. A minority of the respondents discuss these topics at home (10.0%), during conventions (6.5%) or get information through associations or NGOs (6.9%). Data on knowledge and sources of information are shown in Table 1.

From our results, schools and universities appear to be a privileged font of knowledge for singles ($p = 0.020$). Males consult more often the scientific literature ($p = 0.002$), take information at home ($p = 0.035$) or through participation at associations or NGOs ($p = 0.023$).

Students older than 22 years get information more often than the younger colleagues on the internet ($p = 0.006$), on the radio ($p = 0.002$), through scientific literature ($p = 0.037$), at conventions ($p = 0.002$) and through the participation at associations and NGOs ($P = 0.015$).

Regarding the academic field of pertinence, there is a difference in the habit of taking information on the internet ($p < 0.001$), from the newspapers ($p = 0.004$), through scientific literature ($p = 0.004$) and on the radio ($p = 0.021$). For each item, students with medical background are those registering the lowest utilisation rate for each of the sources above mentioned.

The resort to internet to find information on this issue is significantly different according to the geographical area of origin ($p = 0.023$), with the North of Italy registering the lowest percentages (23.8%) and the South the highest (56.8%).

During the studies, the frequency on which CC is addressed differs ($p < 0.001$): students from the medical field stated that topic related to global warming were taught in 31.5% of the cases, rising to 49.0% among the students of economic and humanities and reaching 63.4% among scientific and technology students.

Results regarding knowledge on the consequences of CC are displayed in Table 2.

Almost all of the students (95%) acknowledged the scientist's explanations on the causes of the greenhouse effect.

Table 1. Participants' knowledge and main sources of information

Question	Yes/True	Gender N(%)		Age N (%)		Civil Status N(%)		Academic field N (%)				Macro Area N (%)		
	N(%)	Female	Male	≤22	>22	Cohabitant &Married	Single	Medical	Scientific &Tech	Economic& Humanities	North	Centre	South &Islands	
Have you ever heard about climate change before?	461 (100)	314 (100)	147 (100)	319 (100)	142 (100)	40 (100)	417 (100)	238 (100)	123 (100)	100 (100)	21 (100)	352 (100)	88 (100)	
On TV?	368 (79.8)	249 (79.3)	119 (81.0)	258 (80.9)	110 (77.5)	33 (75.0)	335 (80.3)	192 (80.7)	97 (78.9)	79 (79.0)	16 (76.2)	282 (80.1)	70 (79.5)	
p		0.680		0.399		0.402		0.896				0.907		
At School/University?	213 (46.2)	141 (44.9)	72 (49.0)	139 (43.6)	74 (52.1)	13 (29.5)	200 (48.0)	107 (45.0)	64 (52.0)	42 (42.0)	10 (47.6)	170 (48.3)	33 (37.5)	
p		0.413		0.090		0.020		0.281				0.190		
On the Internet?	225 (48.8)	158 (50.3)	67 (45.6)	142 (44.5)	83 (58.5)	27 (61.4)	198 (47.5)	84 (35.3)	65 (52.8)	76 (76.0)	5 (23.8)	170 (48.3)	50 (56.8)	
p		0.343		0.006		0.080		0.000				0.023		
In the newspaper?	182 (39.5)	119 (37.9)	63 (42.9)	121 (37.9)	61 (43.0)	18 (40.9)	164 (39.3)	77 (32.4)	55 (44.7)	50 (50.0)	9 (42.9)	138 (39.2)	35 (39.8)	
p		0.310		0.308		0.838		0.004				0.944		
On scientific literature?	56 (12.1)	28 (8.9)	28 (19.0)	32 (10.0)	24 (16.9)	3 (6.8)	53 (12.7)	18 (7.6)	24 (19.5)	14 (14.0)	4 (19.0)	40 (11.4)	12 (13.6)	
p		0.002		0.037		0.255		0.004				0.516		
At home?	46 (10.0)	25 (8.0)	21 (14.3)	27 (8.5)	19 (13.4)	4 (9.1)	42 (10.1)	21 (8.8)	12 (9.8)	13 (13.0)	3 (14.3)	38 (10.8)	5 (5.7)	
p		0.035		0.104		0.836		0.502				0.286		
In Conventions?	30 (6.5)	16 (5.1)	14 (9.5)	13 (4.1)	17 (12.0)	2 (4.5)	28 (6.7)	12 (5.0)	10 (8.1)	8 (8.0)	1 (4.8)	26 (7.4)	3 (3.4)	
p		0.072		0.002		0.579		0.419				0.379		
On the radio?	90 (19.5)	57 (18.2)	33 (22.4)	52 (16.3)	38 (26.8)	11 (25.0)	79 (18.9)	36 (15.1)	26 (21.1)	28 (28.0)	2 (9.5)	72 (20.5)	16 (18.2)	
p		0.278		0.009		0.335		0.021				0.442		
Through associations/ NGOs?	32 (6.9)	16 (5.1)	16 (10.9)	16 (5.0)	16 (11.3)	3 (6.8)	29 (7.0)	14 (5.0)	9 (7.3)	9 (9.0)	1 (4.8)	25 (7.1)	6 (6.8)	
p		0.023		0.015		0.973		0.578				0.918		
During the course of your university studies was the subject of global warming addressed?	202 (43.8)	129 (41.1)	73 (49.7)	132 (41.4)	70 (49.3)	16 (36.4)	186 (44.6)	75 (31.5)	78 (63.4)	49 (49.0)	5 (23.8)	158 (44.9)	39 (44.3)	
p		0.084		0.114		0.295		0.000				0.166		

Table 2. Knowledge on the consequence of CC

Question	Yes/True N(%)	Gender N(%)		Age N (%)		Civil Status N(%)		Academic field N (%)			Macro Area N (%)		
		Female	Male	≤22	>22	Cohabitant &Married	Single	Medical	Scientific &Tech	Economic & Humanities	North	Centre	South & Islands
Most scientists agree that the warming is due to the increasing concentrations of greenhouse gases, which imprison the heat in the atmosphere, a process determined by human activities and not just by natural causes	438 (95.0)	295 (93.9)	143 (97.3)	304 (95.3)	134 (94.4)	41 (93.2)	397 (95.2)	222 (93.3)	119 (96.7)	97 (97.0)	19 (90.5)	337 (95.7)	82 (93.2)
p		0.303		0.339		0.313		0.333			0.451		
Do you think global warming can have an impact	461 (100)	314 (100)	147 (100)	319 (100)	142 (100)	44 (100)	417 (100)	238 (100)	123 (100)	100 (100)	21 (100)	352 (100)	88 (100)
		314 (100)	146 (99.3)	319 (100)	141 (99.3)	44 (100)	416 (99.8)	237 (99.6)	123 (100)	100 (100)	21 (100)	351 (99.7)	88 (100)
		0.143		0.133		0.745		0.625			0.856		
Do you think a health professional can contribute to reducing the impact of climate change?	449 (97.4)	309 (98.4)	140 (95.2)	309 (96.9)	140 (98.6)	43 (97.7)	406 (97.4)	230 (96.6)	120 (97.6)	99 (99.0)	21 (100)	344 (97.7)	84 (95.5)
		295 (93.9)	133 (90.5)	299 (93.7)	129 (90.8)	42 (95.5)	386 (92.6)	320 (96.6)	109 (88.6)	89 (89.0)	20 (95.2)	325 (92.3)	83 (94.3)
		0.046		0.282		0.885		0.457			0.364		
p		0.178		0.267		0.480		0.005			0.737		

It is recognized by the whole sample that global warming has an impact on the health of the environment, and the majority is aware of the impact also on animals' and human's health (99.8% and 97.4%). However, there is a significant difference among males and females regarding this latter knowledge ($p=0.046$), with males showing less awareness of the impact of CC on the health of human beings.

Regarding the possible contribution of a health professional in reducing the impact of CC, different answers are reported depending on the academic field of pertinence ($p=0.005$), with 96.6% of students form medical area answering affirmatively versus 88.6% of scientific and technological field and 89.0% of economic and humanities. 72.7% of the sample affirmed that health professionals can help diminishing the impact of CC through transportation, with a significant difference for age ($p=0.026$). 87.4% thought that these professionals can help also through energy use and 85.5% through waste disposal (Table 3).

46.4% can properly identify all the factors playing a role in changing the climate on earth, with a statistically significant difference for age ($p=0.015$), while 55.1% can recognize all the gases that rise into the atmosphere.

More than 80% of the sample correctly identifies as the main consequences of CC the rising of earth's temperature (95.0%), the melting of ice caps (89.4%), the rising of sea level (81.8%) and the more frequent occur of weather-related natural disasters, such as storms, droughts, floods and heat waves (86.8%). Less than half of the respondents marked correctly as consequences of global warming the fact that the economy will suffer (40.1%) and the diseases will spread (45.1%).

There were some differences in the answers: single people and the ones coming from the Central Regions of Italy identified more often the melting of ice caps ($p=0.001$ and $p=0.011$, respectively). Single people correctly marked the answers "Weather-related natural disasters will occur more frequently: storms, droughts, floods and heat waves" ($p=0.015$) and "The food production will be at risk" ($p=0.036$). There were significant differences in the answers given to the options regarding food production ($p<0.001$), the rising of sea level ($p=0.033$), the increasing in water shortage ($p=0.034$), the challenges that the population will face ($p=0.0012$) and the catastrophic transformations that can occur ($p=0.031$) according to the academic field of belonging. In addition, males identified more often the rising of sea level ($p=0.005$) and suffering of the economy ($p=0.014$) as consequences.

In table 4 questions emerging from the backward wald elimination are reported.

Being Married or Cohabitant is associated with not answering correctly to the question "In what way can a health professional contribute to diminish the impacts of climate change by transport?" (OR= 0.48; 95% CI: 0.25-0.94), while being older than 22 years is associated with a correct answer to the previous question (OR: 1.86, CI 95% 1.14-3.01) and to the one asking "What are the main factors able to modify the climate on the Earth?" (OR: 1.64, CI 95% 1.10-2.44).

Regarding the main repercussions of CC, who marked "Melting of Ice caps" was from the Central Regions of Italy (OR: 2.69, CI 95% 1.37-5.28) but not Married nor Cohabitant (OR: 0.28, 95% CI 0.13-0.61). The latter group

Table 3. Results of the bivariate analysis concerning Causes, Consequences and Actions towards Climate Change

Question	N(%)	Gender N(%)		Age N (%)		Civil Status N(%)		Academic field N (%)			Macro Area N (%)		
		Female	Male	≤22	>22	Cohabitant&Married	Single	Medical	Scientific & Tech	Economic& Humanities	North	Centre	South& Islands
In what way can a health professional contribute to diminish the impacts of climate change	by transport?	All are correct	335 (72.7)	232 (69.3)	103 (30.7)	222 (66.3)	113 (33.7)	27 (8.1)	308 (91.9)	74 (22.1)	13 (3.9)	259 (77.3)	63 (18.8)
	Error	126 (27.3)	82 (65.1)	44 (34.9)	97 (77.0)	29 (23.0)	109 (86.5)	73 (57.9)	27 (21.4)	26 (20.6)	8 (6.3)	93 (73.8)	25 (19.8)
	p		0.391		0.026		0.077		0.200			0.491	
	by energy use?	All are correct	403 (87.4)	277 (68.7)	126 (31.3)	277 (68.7)	126 (31.3)	39 (9.7)	364 (90.3)	87 (21.6)	19 (4.7)	307 (76.2)	77 (19.1)
What are the main factors able to modify the climate on Earth?	Error	58 (12.6)	37 (63.8)	21 (36.2)	42 (72.4)	16 (27.6)	53 (91.4)	26 (44.8)	19 (32.8)	13 (22.4)	2 (3.4)	45 (77.6)	11 (19.0)
	p		0.450		0.570		0.798		0.466			0.908	
	by waste disposal?	All are correct	394 (85.5)	274 (69.5)	120 (30.5)	268 (68.0)	126 (32.0)	41 (10.4)	353 (89.6)	88 (22.3)	17 (4.3)	305 (77.4)	72 (18.3)
	Error	67 (14.5)	40 (59.7)	27 (40.3)	51 (76.1)	16 (23.9)	64 (95.5)	36 (53.7)	19 (28.4)	12 (17.9)	4 (6.0)	47 (70.1)	16 (23.9)
Which gases that are rising in the atmosphere as a consequence of human activities cause an increase in Earth's temperature?	p		0.110		0.184		0.127		0.717			0.431	
	What are the main factors able to modify the climate on Earth?	All are correct	214 (46.4)	142 (66.4)	72 (33.6)	136 (63.6)	78 (36.4)	20 (9.3)	194 (90.7)	47 (22.0)	10 (4.7)	156 (72.9)	48 (22.4)
	Error	247 (53.6)	172 (69.6)	75 (30.4)	183 (74.1)	64 (25.9)	223 (90.3)	133 (53.8)	61 (24.7)	53 (21.5)	11 (4.5)	196 (79.4)	40 (16.2)
	p		0.451		0.015		0.893		0.520			0.226	
p	Which gases that are rising in the atmosphere as a consequence of human activities cause an increase in Earth's temperature?	All are correct	254 (55.1)	174 (68.5)	80 (31.5)	169 (66.5)	85 (33.5)	28 (11.0)	226 (89.0)	50 (19.7)	12 (4.7)	191 (75.2)	51 (20.1)
	Error	207 (44.9)	140 (67.6)	67 (32.4)	150 (72.5)	57 (27.5)	191 (92.3)	105 (50.7)	52 (25.1)	50 (24.2)	9 (4.3)	161 (77.8)	37 (17.9)
	p		0.842		0.170		0.231		0.484			0.808	

follows

Which are the main repercussions of climate change? (More than one answer was possible to this question)	Rising of Earth's temperature	Yes/true	438 (95.0)	295 (93.9)	143 (97.3)	304 (95.3)	134 (94.4)	43 (97.7)	395 (94.7)	227 (95.4)	116 (94.3)	95 (95.0)	20 (95.2)	336 (95.5)	82 (93.2)
	p			0.126		0.671		0.384			0.907			0.681	
	Melting of ice caps	Yes/true	412 (89.4)	279 (88.9)	133 (90.5)	291 (91.2)	121 (85.2)	33 (75.0)	379 (90.9)	213 (89.5)	108 (87.8)	91 (91.0)	17 (81.0)	323 (91.8)	72 (81.8)
	p			0.598		0.053		0.001			0.741			0.011	
	Ice retraction	Yes/true	353 (76.6)	235 (74.8)	118 (80.3)	243 (76.2)	110 (77.5)	30 (68.2)	323 (77.5)	180 (75.6)	92 (74.8)	81 (81.0)	17 (81.0)	273 (77.6)	63 (71.6)
	P			0.199		0.763		0.167			0.490			0.442	
	Rising of sea level	Yes/true	377 (81.8)	246 (78.3)	131 (89.1)	261 (81.8)	116 (81.7)	35 (79.5)	342 (82.0)	184 (77.3)	105 (85.4)	88 (88.0)	16 (76.2)	294 (83.5)	67 (76.1)
	p			0.005		0.974		0.687			0.033			0.219	
	Biodiversity will be reduced	Yes/true	356 (77.2)	244 (77.7)	112 (76.2)	240 (75.2)	116 (81.7)	31 (70.5)	325 (77.9)	165 (69.3)	98 (79.7)	93 (93.0)	12 (57.1)	275 (78.1)	69 (78.4)
	p			0.717		0.127		0.260			0.080			0.623	
	The food production will be at risk	Yes/true	267 (57.9)	181 (57.6)	86 (58.5)	181 (56.7)	86 (60.6)	31 (72.7)	235 (56.4)	114 (47.9)	81 (65.9)	72 (72.0)	12 (57.1)	208 (59.1)	47 (53.4)
	Increased water shortage	Yes/true	233 (50.5)	149 (47.5)	84 (57.1)	165 (51.7)	68 (47.9)	26 (59.1)	207 (49.6)	114 (47.9)	57 (46.2)	62 (62.0)	11 (52.4)	182 (51.7)	40 (45.5)
	P			0.862		0.443		0.036			0.000			0.626	
	Weather-related natural disasters will occur more frequently: storms, droughts, floods and heat waves	Yes/true	400 (86.8)	277 (88.2)	123 (83.7)	281 (88.1)	119 (83.8)	33 (75.0)	367 (88.0)	202 (84.9)	109 (88.6)	89 (89.0)	18 (85.7)	308 (87.5)	74 (84.1)
	P			0.180		0.210		0.015			0.462			0.693	
	The economy will suffer	Yes/true	185 (40.1)	114 (36.3)	71 (48.3)	117 (36.7)	68 (47.9)	19 (43.2)	166 (39.8)	90 (37.8)	47 (38.2)	48 (48.0)	7 (33.3)	142 (40.3)	36 (40.9)
	p			0.014		0.023		0.664			0.192			0.806	
	Diseases will spread	Yes/true	208 (45.1)	135 (43.0)	73 (49.7)	145 (45.5)	63 (44.4)	21 (47.7)	187 (44.8)	101 (42.4)	57 (46.3)	50 (50.0)	7 (33.3)	162 (46.0)	39 (44.3)
	p			0.180		0.828		0.715			0.422			0.518	
	Population will face food and water shortages, leading to conflicts and migration	Yes/true	311 (67.5)	209 (66.6)	102 (69.4)	215 (67.4)	96 (67.6)	31 (70.5)	280 (67.1)	147 (61.8)	86 (69.9)	78 (78.0)	13 (61.9)	238 (67.6)	60 (68.2)
	p			0.546		0.965		0.656			0.012			0.852	
	Catastrophic transformations can occur	Yes/true	282 (61.2)	190 (60.5)	92 (62.6)	204 (63.9)	78 (54.9)	25 (56.8)	257 (61.6)	142 (59.7)	68 (55.3)	72 (72.0)	12 (57.1)	217 (61.6)	53 (60.2)
	p			0.670		0.067		0.533			0.031			0.900	

Table 4. Multivariate analysis: Logistic Regression with "backward wald" elimination procedure*

Question	Gender		Age		Civil Status		Academic field			Macro Area		
	OR (95% CI)		OR (95% CI)		OR (95% CI)		Medical	Scientific & Tech	Economic & Humanities	North	Centre	South & Islands
	F	M	≤22	>22	Single	Married & Cohabitant						
In what way can a health professional contribute to diminish the impacts of climate change by transport? All are correct				1.86 (1.14-3.01)		0.48 (0.25-0.94)						
What are the main factors able to modify the climate on the Earth? All are correct				1.64 (1.10-2.44)								
Melting of ice caps						0.28 (0.13-0.61)				1.07 (0.31-3.72)	2.69 (1.37-5.28)	1
Rising of sea level		2.62 (1.45-4.76)					0.38 (0.19-0.76)	0.70 (0.32-1.54)	1			
Biodiversity will be reduced							0.17 (0.08-0.39)	0.30 (0.12-0.72)	1			
The food production will be at risk						2.22 (1.10-4.50)	0.35 (0.21-0.58)	0.73 (0.41-1.30)	1			
Increased water shortage		1.66 (1.10-2.49)					0.50 (0.31-0.82)	0.48 (0.28-0.84)	1			
Weather-related natural disasters will occur more frequently: storms, droughts, floods and heat waves						0.41 (0.19-0.86)						
The economy will suffer		1.64 (1.1-2.43)		1.58 (1.06-2.37)								
Population will face food and water shortages leading to conflicts and migration							0.46 (0.27-0.78)	0.66 (0.36-1.21)	1			
Catastrophic transformations can occur				0.64 (0.42-0.97)			0.52 (0.31-0.87)	0.47 (0.27-0.83)	1			

*only answers giving ? as result have been reported

also does not identify the answer “Weather-related natural disasters will occur more frequently: storms, droughts, floods and heat waves” (OR: 0.41, 95% CI 0.19-0.86).

Male students indicate properly the answer “Rising of sea level” (OR: 2.62, 95% CI 1.45-4.76), unlike students from medical area (OR: 0.38, 95% CI 0.19-0.76), which also do not recognize the fact that “Population will face food and water shortages leading to conflicts and migration” (OR: 0.46, 95% CI 0.27-0.78). Students from the medical and scientific field do not recognize the reduction of biodiversity as an effect of CC (OR: 0.17, 95% CI 0.08-0.39 and OR: 0.30, 95% CI 0.12-0.72, respectively) and that there will be water shortage (OR: 0.50, 95% CI: 0.31-0.82 and OR: 0.48, 95% CI: 0.28-0.84). Male students identified correctly to this latter consequence (OR=1.66; 95% CI: 1.10-2.49). Along with students older than 22 years, males also identified more often the sufferance of the economy as a repercussion of CC (OR: 1.58, 95% CI 1.06-2.37 for males, OR= 1.64; 95% CI: 1.1-2.43 for students ages >22 years). Married or Cohabitant students properly stated that food production will be at risk (OR: 2.22, 95% CI 1.10-4.50), unlike students from the medical area (OR: 0.35, 95% CI 0.21-0.58). Who does not say that “Catastrophic transformations can occur” is older than 22 years (OR: 0.64, 95% CI 0.42-0.97), from the medical or scientific and technological academic field (OR: 0.52, 95% CI 0.31-0.87 and OR: 0.47, 95% CI 0.27-0.83, respectively).

Discussion

Information

Our study helps to understand how students of various backgrounds and academic fields retrieve information on CC and highlights the knowledge on the main causes of global warming, its most important consequences and on the role of healthcare workers in the fight towards this threat. In line with a previous study (16), along with schools and universities, television remains the major source of knowledge, even though a widespread mistrust in this media has been reported across the generation considered (17). On the other hand, compared to a previous 22% of only a couple of years ago (16), about half of the sample resorts to the internet for this purpose and the web has been increasingly seen as a more efficient tool to spread concepts related to CC (17). Remarkably, just a risible minority discuss these topics at home or within associative contexts. Indeed, young people seem not to talk and communicate much about climate change, even though they seem to actually care about the planet's future (18–21). Indeed, in the last years our societies witnessed the rise of several associations and organisations fighting against CC, which saw the participation of teenagers and university students in Italy and worldwide (22–24). According to our results, students aged more than 22 years are more inclined to inform themselves within the associative contexts and males also discuss more often these topics at home.

Knowledge

95% of the sample recognised the role of human activities in the process behind global warming, which is higher in respect of Italian adults (25) and confirmed by the literature (26). Nevertheless, the share of respondents that correctly identified all the causes and the factors implied in the phenomenon is lower than those observed in other countries (27). Students seem to be well aware of the consequences of CC on environmental, human and animal's health, but this knowledge is incomplete: some information are well acknowledged, such as the rising of temperatures and sea levels and the melting of ice caps, while the repercussions on the economy and the spread of the diseases are underestimated. This difference could be explained by the fact that the media representation of CC almost always assumes a few predictable shapes (28) with a lack of coverage in general and of relevant messages in particular (17). Also schools and university classes can spread misconceptions on the causes (29) or give wrong ideas on the possible consequences of CC, paying less attention to the economic repercussions (30). Indeed, it has been shown that CC is viewed by many U.S. Americans as impacting other species or people who are distant both geographically and temporally (26), with a misleading idea on the consequences on people's everyday lives.

Almost all of the respondents recognize the role of healthcare professionals in diminishing the impact of CC.

Being older than 22 is positively associated with knowledge of the causes of CC with a broader utilisation of different types of media for retrieving information, even though these students do not show higher awareness of the consequences. A study from Yale found that teenagers report lower understanding of CC compared to American adults, although showing a higher awareness of the human's responsibilities (26). According to our interpretation, this age difference could be related to an increase in awareness of the topic once inside the university context, which is usually culturally stimulating and helpful for the building of an environmental consciousness. Therefore, older students could have had more time to learn how to find diverse and more reliable sources of information and to develop critical cognition on the subject.

Throughout the whole questionnaire, a clear difference among students of diverse backgrounds emerges. Notably, students from the medical field are those reporting the lowest rates of resort to almost all sources of information except for television. They also show less knowledge on the main repercussions of CC, aside from some items (melting of ice caps, weather-related natural disasters). Misconceptions of university students on this topic had been already pointed out in previous research (15), although without a specific focus on students of the medical field. According with our data, only 31% of the future healthcare workers attended classes dealing with the topic of global warming, compared to 49% and 63.4% of students from humanities and scientific fields, respectively.

These data are discouraging in the light of the importance of healthcare professionals in addressing CC, but it is not surprising considering that a call to an implementation of CC courses has been sent by students and institutions from different Countries (13,31–35). However, Italy is imple-

menting education on sustainability and climate change in its schools' core curriculum (36).

Strengths and limitations

Our study is among the few conducted in Italy on the topic of CC and provides a multifaceted picture on the knowledge of university students aged less than 30 years, clearly showing how important the enhancing of academic education on the topic is.

We also recognize some limitations: the questionnaire is not clear on how healthcare professionals can contribute in addressing the issues displayed, and this could have influenced the answers of non-medical students, which could have had difficulties in identifying the potential role of healthcare workers. In addition, it lacks in investigating some of the main causes of climate change on which healthcare professionals can have an impact, such as dietary habits and sustainable lifestyle behaviours.

Some of our findings, such as the higher knowledge of male students and singles, are of difficult interpretation, also due to a lack of literature on the topic.

Lastly, even if beyond the purpose of this work, it would have been interesting to understand if greater knowledge on the topic are related to greater chances of behavioural changes in the fight towards CC.

Conclusion

From our study emerges how students from a medical field are less educated and less aware of the consequences and causes of CC compared to same age students of other faculties.

Climate change is the context in which today's medical students will practice their profession. This threat will play a role in every aspect of patients' lives and will impose barriers to healthcare that will have to be overcome using the knowledge and skills acquired during the studies (37). It is now time to introduce proper teachings on CC in every university course.

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Conflict of interest

The authors declare no conflict of interest.

Key points

Students retrieve information on climate change mainly through television, internet and at school/university.

Students from the medical field reveal lower knowledge on climate change compared to their peers from different faculties.

The majority of the students is aware of the key role healthcare workers can play fighting climate change.

Students' knowledge on the consequences of global warming are mainly focused on the environmental repercussions, while economic and health consequences are underestimated.

Given the consequences of climate change on health and the poor knowledge proved by students from medical field on the topic, it would be desirable to implement these themes within the curricula of future healthcare workers.

References

1. McMichael A. Climate Change and Human Health (World Health Organization, World Meteorological Organization, United Nations Environmental Program, Geneva.). 1996
2. Stocker T, Qin D, editors. Climate change 2013: the physical science basis: summary for policymakers, a report of working group I of the IPCC: technical summary, a report accepted by working group I of the IPCC but not approved in detail: and frequently asked questions: part of the working group I contribution to the fifth assessment report of the intergovernmental panel on climate change. s.l.: WMO, UNEP; 2013. 203
3. Balbus J, Kristie E, Finzer L, et al. Are We Ready? Preparing for the Public Health Challenges of Climate Change | Adaptation Clearinghouse [Internet]. Environmental Defense Fund; 2008 [cited 2022 Jan 31]. Available from: https://www.edf.org/sites/default/files/7846_AreWeReady_April2008.pdf
4. Patz JA, Engelberg D, Last J. The Effects of Changing Weather on Public Health. *Annual Review of Public Health*. 2000; 21(1):271–307
5. Romanello M, McGushin A, Napoli CD, et al. The 2021 report of the Lancet Countdown on health and climate change: code red for a healthy future. *The Lancet*. 2021;398(10311):1619–62
6. Silva RA, West JJ, Lamarque J-F, et al. Future global mortality from changes in air pollution attributable to climate change. *Nature Clim Change*. 2017 Sep 1; 7(9):647–51
7. Kovats RS, Kristie LE. Heatwaves and public health in Europe. *Eur J Public Health*. 2006; 16(6):592–9
8. Crowley RA, Health and Public Policy Committee of the American College of Physicians. Climate Change and Health: A Position Paper of the American College of Physicians. *Ann Intern Med*. 2016 May 3;164(9):608–10
9. Global Family Doctor - WONCA Online [Internet]. [cited 2021 Dec 21]. Available from: <https://www.globalfamilydoctor.com/>
10. Healthy Planet. Healthy People. [Internet]. CAPE. [cited 2022 Jan 31]. Available from: <http://cape.ca/>
11. Dupraz J, Burnand B. Role of Health Professionals Regarding the Impact of Climate Change on Health—An Exploratory Review. *International Journal of Environmental Research and Public Health*. 2021 Jan; 18(6):3222
12. González CA, Bonet C, de Pablo M, et al. Greenhouse gases emissions from the diet and risk of death and chronic diseases in the EPIC-Spain cohort. *European Journal of Public Health*. 2021 Feb 1; 31(1):130–5
13. Hampshire K, Ndovu A, Bhambhani H, et al. Perspectives on climate change in medical school curricula—A survey of U.S. medical students. *The Journal of Climate Change and Health*. 2021 Oct 1; 4:100033
14. Moser S. Communicating climate change: history, challenges, process and future directions. 2010
15. Wachholz S, Artz N, Chene D. Warming to the idea: university students' knowledge and attitudes about climate change. *International Journal of Sustainability in Higher Education*. 2014 Jan 1; 15(2):128–41

16. De Paula Baer A, Sestili C, Cocchiara RA, et al. Perception of Climate Change: validation of a questionnaire in Italy. *Clin Ter.* 2019 Jun; 170(3):e184–91
17. Hibberd M, Nguyen A. Climate change communications & young people in the Kingdom: A reception study. *International Journal of Media and Cultural Politics.* 2013 Mar 1; 9
18. Ojala M, Lakew Y. Young People and Climate Change Communication. *Oxford Research Encyclopedia of Climate Science.* 2017 Mar 6; On line first
19. Leombruni L. How you talk about climate change matters: A communication network perspective on epistemic skepticism and belief strength. *Global Environmental Change.* 2015 Nov 1; 35:148–61
20. Norgaard KM. *Living in Denial: Climate Change, Emotions, and Everyday Life.* Cambridge, MA, USA: MIT Press; 2011; 304
21. Ojala M. Regulating worry, promoting hope: How do children, adolescents, and young adults cope with climate change? *International Journal of Environmental and Science Education.* 2012 Oct 1; 7:537–61
22. Extinction Rebellion | Join The Fight Against Climate and Ecological Collapse [Internet]. Extinction Rebellion. [cited 2021 Dec 21]. Available from: <https://rebellion.global/>
23. Extinction Rebellion - Italia [Internet]. Extinction Rebellion - Italia. [cited 2021 Dec 21]. Available from: <https://extinctionrebellion.it/>
24. Home | Fridays For Future Italia [Internet]. 2020 [cited 2022 Jan 31]. Available from: <https://fridaysforfutureitalia.it/>
25. Alleanza Italiana per lo Sviluppo Sostenibile - Sito Ufficiale [Internet]. asvis.it. [cited 2022 Jan 31]. Available from: <http://www.asvis.it>
26. Leiserowitz A, Smith N, Marlon JR. American Teens' Knowledge of Climate Change [Internet]. New Haven, CT: Yale University; 2011. (Yale Project on Climate Change Communication). Available from: <https://resources.environment.yale.edu/climate-communication-OFF/files/American-Teens-Knowledge-of-Climate-Change.pdf>
27. Yang L, Liao W, Liu C, et al. Associations between Knowledge of the Causes and Perceived Impacts of Climate Change: A Cross-Sectional Survey of Medical, Public Health and Nursing Students in Universities in China. *Int J Environ Res Public Health.* 2018 Dec; 15(12):2650
28. Brulle RJ. From Environmental Campaigns to Advancing the Public Dialog: Environmental Communication for Civic Engagement. *Environmental Communication.* 2010 Mar 1; 4(1):82–98
29. Walz KA, Kerr SC. 'Holes' in Student Understanding: Addressing Prevalent Misconceptions Regarding Atmospheric Environmental Chemistry. *J Chem Educ.* 2007 Oct 1; 84(10):1693
30. Busch KC. Polar Bears or People? Exploring Ways in Which Teachers Frame Climate Change in the Classroom. *International Journal of Science Education, Part B.* 2016 Apr 2; 6(2):137–65
31. Philipsborn RP, Sheffield P, White A, et al. Climate Change and the Practice of Medicine: Essentials for Resident Education. *Academic Medicine.* 2021 Mar; 96(3):355–67
32. Omrani OE, Dafallah A, Paniello Castillo B, et al. Envisioning planetary health in every medical curriculum: An international medical student organization's perspective. *Medical Teacher.* 2020 Oct 2; 42(10):1107–11
33. H-135.938 Global Climate Change and Human Health | AMA [Internet]. [cited 2022 Feb 3]. Available from: <https://policysearch.ama-assn.org/policyfinder/detail/climate%20change?uri=%2FAMADoc%2FHOD.xml-0-309.xml>
34. Mercer C. Medical students call for more education on climate change. *CMAJ.* 2019 Mar 11; 191(10):E291–2
35. Wellbery C, Sheffield P, Timmireddy K, et al. It's Time for Medical Schools to Introduce Climate Change Into Their Curricula. *Acad Med.* 2018 Dec; 93(12):1774–7
36. Yi. Is Italy the first country to require Climate Change Education in all schools? [Internet]. Bureau international d'éducation. 2020 [cited 2022 Feb 3]. Available from: <http://www.ibe.unesco.org/fr/news/italy-first-country-require-climate-change-education-all-schools>
37. Goshua A. Medical schools must prepare students to work in a world altered by climate change [Internet]. STAT. 2019 [cited 2022 Feb 3]. Available from: <https://www.statnews.com/2019/03/19/climate-change-medical-school/>