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ORIGINAL RESEARCH

Knowledge and perception about climate change among healthcare professionals and students: A cross-sectional study

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Abstract

Aim: The aim of this study was to assess knowledge on Climate Change (CC) and related consequences among students and professionals of healthcare setting.
Methods: A cross-sectional study involving 364 people was conducted. The survey was performed at Sapienza University (Rome) using questionnaire previously developed and validated by the same research group.
Results: Findings indicate awareness about CC and its effects and correct identification of practices that could help to mitigate its repercussions. The majority of the participants believed that CC had an impact on the health of humans (96.7%), animals (99.5%) and on the environment (99.7%). Results from the multivariate analysis regarding overall knowledge, show an increased odd in professionals (OR=2.08; 95%CI=1.02-4.26), individuals from the North (OR=3.34; 95%CI=1.37-8.15) and from the Center (OR=2.07; 95%CI=1.17-3.66). Regarding factors able to modify Earth's climate, correct answer had higher odds of being chosen by professionals (OR=2.83; 95%CI=1.41–5.70), and from individuals from South/Islands than by the ones from the Center (OR=0.65; 95%CI=0.40-1.06). The main sources of information resulted to be TV and school/university.
Conclusions: These new evidences could guide policymakers on increasing the awareness of the population about this fundamental subject.

Keywords: *climate change, cross sectional, health professionals, Italy, students, survey.*

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Conflicts of interest: None declared.

Introduction

In 2009, the first Lancet Commission for Global Health identified Climate Change (CC) as "the biggest global health threat of the 21st century" (1). Ten years later, the World Meteorological Organization registered that the global mean surface temperature in 2018 was about 1.0 °C higher than pre-industrial levels (1850-1900) (2). Seventeen out of the 18 warmest years in the 136-year record conducted by NASA have all occurred since 2001, except for 1998 (3). This observed pattern of warming is known to be related to anthropogenic activity, and particularly to the use of fossil fuels. That is correlated to the increase of greenhouse gases, mainly carbon dioxide (CO_2). As consequence, sea levels are rising, glaciers are melting, weather-related natural disasters are becoming more frequent and precipitation patterns are changing. CC is strongly impacting on humans' health: reduction in air quality; threatened food production and safety; increased water-related illnesses; increased morbidity and mortality from extreme temperatures; increased and new infectious disease exposures; negative consequences for mental health (e.g. anxiety, depression and substance abuse) (4,5). The best forecast for a low gas emission scenario, a world that takes sustainable energy use as a priority, is an air warming of 1.8°C. However, in a world that mainly uses fossil fuels and has rapid economic and global population growth, the best estimation is that temperatures will rise by 4.0°C (2.4°C to 6.4°C) (6).

In order to mitigate the rising of Earth temperature, it is essential that the population is aware of CC, its consequences and the actions that could be taken into account to avoid it. For this reason, an effective communication is fundamental. They need information in order to have an attitude of constructive engagement (7). In particular, health professionals could deeply contribute in making recommendations and supporting favorable policies as they have the expertise to recognize the health consequences related to CC and they have a strong impact on the public opinion (8). The scientific literature was investigated in order to assess the presence of studies addressing knowledge on CC of health professionals and students. A review was performed in June 2019 searching PubMed database. The following search string was used: "(Climate Change) AND Education AND University students AND (Nurses OR Medicine)". Out of 59 studies, that were firstly retrieved, 14 were recognized as relevant for our purposes (9-22). The topic appears widespread all over the continents: four studies were performed in Europe; four were conducted in Asia; three were from Oceania; two from America; one was performed in Africa. These researches were published from 2009 on, with a peak that was recorded in 2018. The aim of the studies was to measure the knowledge and perceptions of health professionals and students about CC and its consequences. In this regard, surveying the population's knowledge on this topic becomes necessary, because these data could show what is already known, what are people's sources of information on CC and what are the knowledge gaps that need to be filled for allowing a proper adaptation of the society. The studies included in the review applied validate questionnaire: Children's Environmental Health Knowledge Questionnaire (9); Children's Environmental Health Skills Questionnaire (9); Sustainability Attitudes in Nursing Survey (SANS-2) (11,18,20).

According to the scientific evidences from the literature, the potential of communication and social marketing as means to influence population health and environmental outcomes is clear, but it has to be put into practice (23). It has been found, for example, that mass media could be an important source of information (13,24), but the issue has not gained much attention from it. A literature review concluded that most residents of developed countries have little knowledge about the health relevance of CC (7) and, according to other researches, this awareness could be related to level of education, country of residence and living environment (13,25).

Although surveys have been conducted in that matter, to our knowledge none has included the Italian population. Thus, the aim of this study was to collect data from Italy to verify knowledge on CC within a population of students and professionals from the healthcare settings.

Methods

Study design

A cross-sectional study, according to the STROBE statement (26) was performed during the period February 2018-March 2019.

Participants and Setting

A total of 569 individuals were invited to take part to the survey. Respondents were contacted through a mailing list of students of medical area (medicine,

nursing, prevention technicians) of Sapienza University of Rome and health professionals (nurses, doctors, technicians of the prevention). The link to access the anonymous online questionnaire, which also contained the informed consent form, was shared via mail with the audience.

Questionnaire

An Italian questionnaire previously developed and validated by the same research group on a sample of 64 individuals was used (27). The questionnaire contained a sociodemographic section on age, sex, marital status and educational level. The subsequent section contained 19 questions about CC. To complete the survey respondents were required to choose specific answers or enter free text in specific box. Questions could include more than one correct answer. The survey covered different categories of questions: 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. Annex 1 reports the administered questionnaire.

Approval by Ethical Committee was not required for this study, since this was an observational study.

Statistical analysis

The statistical analysis was performed using Statistical Package for Social Sciences (SPSS) version 25. Descriptive analysis was 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.

A scoring system was created by assigning one point for each correct answer to questions that evaluated CC knowledge. The highest achievable punctuation was 13. In the question about the possible implications of CC, in which more than one answer was possible, the assigned score went from 0 to 1, according to the number of chosen alternatives; the score 1 was given to those who pointed out all the correct options.

Furthermore, multivariate analysis including logistic regression and linear regression were performed. For logistic regression model, in order to verify the relationship between participants' answers and gender, age, occupation and civil status, all the variables were dichotomized including the sum of the correct answer. Zero was attributed to the ones who achieved less than mean score (9.2) and 1 to the ones who achieved 9.2 or more. A multiple linear regression analysis with stepwise using the backward wald selection was used to confirm the relationship between score and socio-demographic variables. The goodness of fit of linear regression model was assessed using the R^2. A statistically significant difference was accepted at a p-value of less than 5%.

Results

Sample demographic characteristics

A total of 364 people completed the questionnaire (Chronbach alpha = 0.74), with a global response rate of 64.2%%. Among students, the highest response rate was observed for medical students (77%) and the lowest for nursing students (23.5%). Conversely, among professionals, no substantial differences between these two groups were observed (nurses 68.7% vs. doctors 68.9%). The mean age was 23.7 (SD: 6.6). All respondents lived in Italy, mostly in the centre (56.3%). Most of the respondents were female (65.1%). Regarding civil status, 77.1% were single. As to professional situation, most of participants were medical students (63.7%), followed by nurse professionals (15.7%) (Table 1).

Table 1. Sample's Socio-demographic information

Variables	N(%) or mean (SD)
Gender	
Females	237 (65.1)
Males	127 (34.9)
Total	364
Age	23.7 (6.587)
Civil Status	
Married	31 (8.5)
Cohabitant	47 (12.9)

Separated	3 (0.8)
Single	281 (77.1)
Widow(er)	2 (0.5)
Professional status	
Other	2 (0.5)
PhD Student	1 (0.3)
Nurse	57 (15.7)
Doctor	20 (5.5)
Nursing student	24 (6.6)
Medical student	232 (63.7)
Prevention and Environmental technician student	23 (6.3)
Prevention and Environmental technician	5 (1.4)
Region of residence (Macroarea)	
North	35 (9.6)
Center	205 (56.3)
South and islands	66 (18.1)
Missing	58 (15.9)

Participants' source of information about climate change

Most respondents (98.1%) had already heard about CC, 72.3% of them in TV, the most common source, followed by school/university (33%) and internet (22.2%). Statistically significant associations were found between having heard about CC and being under 24 years old (p=0.002) and from center (p=0.002). Having school as a source of information was related with being under 24 (p< 0.001), single (p< 0.001), student (p< 0.001) and from the center of Italy (p= 0.011). Being female (p= 0.01) was also related with having newspaper as a source. Being single was statistically associated with having the scientific literature as source of information (p=0.037). Students and subjects younger than 24 showed statistically significant association with having heard about CC at home (p=0.007; p=0.012). Lastly, hearing it from congresses was statistically associated with being male (p= 0.004). Only 25.8% affirmed that university courses addressed global warming, mainly females (p= 0.010), people younger than 24 (p<0.001), single (p=0.003) and students (p< 0.001) (Table 2).

Table 2. Participants' knowledge and source of information

Question	Yes/True	Gender N(%)		Age N(%)		Civil Status N(%)		Professional Status N(%)		Macro Area N(%)		
	N(%)	female	male	<=24	>24	single	cohabitant /married	student	professional	North	Center	South/ islands
Have you heard of Climate Change before?	357 (98.1)	292(64.7)	141(35.3)	261 (73.1)	96 (26.9)	280(78.4)	77(21.6)	278(77.9)	79(22.1)	35(11.5)	203(67)	65(21.5)
		0.429[a]		**0.002**[a]		0.642[a]		0.192[a]			**0.002**[a]	
Where did you hear about it? TV	263(72.3)	166(63.1)	97(36.9)	189(71.9)	74(28.1)	203(77.2)	60(22.8)	200(76.9)	63(23.1)	27(12.3)	146(66.1)	48(21.6)
		0.129[a]		0.144[a]		0.994[a]		0.582[a]			0.838[a]	
Where did you hear about it? School/Unive	120 (33)	73(60.8)	47(39.2)	104 (86.7)	16 (13.3)	105 (87.5)	15 (12.5)	107 (89.2)	13 (10.8)	11 (9.9)	84 (75.7)	16 (14.4)
		0.090[a]		**<0.001**		**<0.001**[a]		**<0.001**[a]			**0.011**[a]	

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Where did you hear about it? Internet	81 (22.2)	54(66.7)	27(33.3)	54(66.7)	27(33.3)	58(71.6)	23(28.4)	59 (72.8)	22 (27.2)	8(11.4)	47(67.1)	15(21.4)
		0.896 [a]		0.716 [a]		0.484 [a]		0.722 [a]			0.781 [a]	
Where did you hear about it? Newspaper	83(22.8)	46 (55.4)	37 (44.6)	52 (62.7)	31 (37.3)	59 (71.1)	24 (28.9)	61 (73.5)	22 (26.5)	13 (18.3)	40 (56.3)	18 (25.4)
		0.015 [a]		0.773 [a]		0.540 [a]		0.507 [a]			0.249 [a]	
Where did you hear about it? Scientific Literature	23 (6.3)	16(69.6)	7(30.4)	18(78.3)	5(21.7)	21(91.3)	2(8.7)	19(82.6)	4(17.4)	3(16.7)	9(50)	6(33.3)
		0.819[a]		0.087 [a]		**0.037** [a]		0.129 [a]			0.448 [a]	
Where did you hear about it? Home	15 (4.1)	8(53.3)	7(46.7)	14(93.3)	1(6.7)	14(93.3)	1(6.7)	15(100)	0(0)	2(14.3)	12(85.7)	0 (0)
		0.260 [a]		**0.012** [a]		0.071 [a]		**0.007** [a]			0.114 [a]	
Where did you hear about it? Conventions	5 (1.4)	0 (0)	5 (100)	3 (60)	2 (40)	3 (60)	2 (40)	2 (28.6)	5 (71.4)	0 (0)	4(100)	0 (0)
		0.004 [a]		0.516 [a]		0.516 [a]		0.676 [a]			0.296 [a]	
Where did you hear about it? Associations/ ONGS	6 (1.6)	2 (33.3)	4 (66.7)	4 (66.7)	2 (33.3)	5(83.3)	1 (16.7)	6(100)	0(0)	1(16.7)	3(50)	2(33.3)
		0.075[a]		0.800 [a]		0.557 [a]		0.093 [a]			0.796 [a]	
Where did you hear about it? Radio	4 (1.1)	2(50)	2 (50)	4(100)	0(0)	3(75)	1 (25)	4(100)	0 (0)	0(0)	4(100)	0(0)
		0.469 [a]		0.301 [a]		0.914 [a]		0.175 [a]			0.302 [a]	
During the course of your university studies was the subject of global warming addressed?	94 (25.8)	51 (54.3)	43 (45.7)	82 (87.2)	12 (12.8)	84 (89.4)	10 (10.6)	87 (92.6)	7 (7.4)	5(5.5)	65(71.4)	19(20.9)
		0.010 [a]		**<0.001** [a]		**0.003** [a]		**<0.001** [a]			0.094 [a]	

[a] p-value of chi-square test
Bold: p<0.05

Participants' knowledge on CC and its consequences

The majority of the participants believed that CC had an impact on human (96.7%), animal (99.5%) and on the environment (99.7%) health. Concerning greenhouse gases, 92.6% of respondents were aware of human responsibility in emissions; 62.6% of participants answered correctly that CO_2, methane (CH4) and nitrous oxide (N_2O) were all responsible for rising Earth's temperature. Still, concerning causes of CC, 54.4% of participants recognized changes that occur in solar radiation, variations of the albedo and the introduction of gases as factors that could modify the chemical composition of the atmosphere. Answering this correctly was related to be over 24 (p= 0.001).

Respondents (93.4%) mostly agreed that a healthcare professional could contribute in reducing the impact of CC, and this was associated with being younger. When asked in what way, most of them marked all alternatives as correct in the questions regarding transportation (67.3%), energy use (86.5%) and waste disposal (81.6%). Correct answers regarding transports were associated with being over 24 years old (p=0.020) and student (p=0.018); regarding waste disposal, with being single (p=0.005) and from the center (p=0.012) (Table 3 and Table 4).

Table 3. Knowledge on the consequences of CC

Question	Yes/True	Gender N(%)		Age N(%)		Civil Status N(%)		Professional Status N(%)		Macro Area		
	N(%)	female	male	<=24	>24	Single	cohabitant / married	student	professional	North	Center	South and 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?	337 (92.6)	215(63.8)	122(36.2)	245(72.7)	92(27.3)	265(78.6)	72(21.4)	262(77.7)	75(22.3)	33(11.7)	193(68.4)	56(19.9)
		0.123 [a]		0.541 [a]		0.927 [a]		0.751 [a]			0.238 [a]	
Do you think global warming can have an impact in the environment's health?	363 (99.7)	236(65)	127(35)	262(72.2)	101 (27.8)	286(78.8)	77(21.2)	282(77.7)	81(22.3)	35(11.4)	205(67)	66(21.6)
		0.464 [a]		0.109 [a]		0.214 [a]		0.063 [a]			0.917 [a]	
Do you think global warming can have an impact in animals' health?	362 (99.5)	237(66.5)	125(34.5)	262(72.4)	100(27.6)	285(78.7)	77(21.3)	281(77.6)	81 (22.4)	35(11.5)	204(66.9)	66(21.6)
		0.053 [a]		**0.023 [a]**		0.323 [a]		0.351 [a]			0.802 [a]	
Do you think global warming can have an impact in humans' health?	352 (96.7)	229(65.1)	123(34.9)	255(72.4)	97(27.6)	276(78.4)	76(21.6)	272(77.3)	80(22.7)	35(11.7)	200(67.1)	63(21.2)
		0.908 [a]		0.285 [a]		0.683 [a]		0.621 [a]			**0.009 [a]**	
Do you think a health professional can contribute to reduce the impact of climate change?	340 (93.4)	222(65.3)	118(34.7)	250(73.5)	90(26.5)	268(78.8)	72(21.2)	267(78.5)	73(21.5)	34(11.8)	193(67)	61(21.2)
		0.781 [a]		**0.013 [a]**		0.659 [a]		0.069 [a]			0.190[a]	

[a] p-value of chi-square test
Bold: p<0.05

Table 4. Results of the bivariate analysis concerning Causes, Consequences and Actions towards CC

		N (%)	Gender N(%)		Age N(%)		Civil Status N(%)		Professional Status N(%)		Macro Area N(%)		
			female	male	<=24	>24	single	cohabitant/ married	student	professional	North	Center	South/ islands
In what way can a health professional contribute to diminish the impacts of climate change by transport?	All are correct	245(67.3)	163(66.5)	82 (33.5)	167 (68.2)	78(31.8)	189 (77.1)	56 (22.9)	181 (73.9)	64 (26.1)	25 (12.3)	142 (70)	36 (17.7)
	Error	119(32.7)	74 (62.2)	45(37.8)	95 (79.8)	24(20.2)	97 (81.5)	22(18.5)	101 (84.9)	18 (15.1)	10 (9.7)	64 (61.5)	30 (28.8)
	p-value[a]		0.414		**0.020**		0.341		**0.018**		0.081		
In what way can a health professional contribute to diminish the impacts of climate change by energy use?	All are correct	315 (86.5)	203 (64.4)	112 (35.6)	223(70.8)	92(29.2)	245 (77.8)	70 (22.2)	240 (76.2)	75 (23.8)	33 (12.4)	180 (67.7)	53 (19.9)
	Error	49 (13.5)	34 (69.4)	15 (30.6)	39(79.6)	10(20.4)	41 (83.7)	8 (16.3)	42 (85.7)	7 (14.3)	2 (5)	25(62.5)	13 (32.5)
	p-value[a]		0.525		0.202		0.454		0.197		0.147		

In what way can a health professional contribute to diminish the impacts of climate change regarding waste disposal?	All of the above are correct	297 (81.6)	198 (66.7)	99 (33.3)	209(70.4)	88(29.6)	225 (75.8)	72(24.2)	224(75.4)	73(24.6)	31(12.3)	174(68.8)	48(18.9)
	Error	67 (18.4)	39(58.2)	28(41.8)	53(79.1)	14(20.9)	61 (91)	6 (9)	58(86.6)	9(13.4)	4(7.5)	31(58.5)	18(34)
	p-value[a]		0.203		0.150		**0.005**		0.052			**0.012**	
What are the main factors able to modify the climate on the Earth?	All are correct	198(54.4)	136 (68.7)	62(31.3)	111(63.1)	65(36.9)	156(78.8)	42(21.2)	150 (75.8)	48 (24.2)	22(13.1)	109(64.9)	37(22)
	Error	166(45.6)	101(60.8)	65(39.2)	151(80.3)	37(19.7)	130(78.3)	36(21.7)	132(79.5)	34(20.5)	13(9.4)	96(69.6)	29(21)
	p-value[a]		0.118		**<0.001**		0.912		0.392			0.718	
Which gases that are rising in the atmosphere as a consequence of human activities cause an increase in Earth's temperature?	All of the above	228(62.6)	150 (65.8)	78 (34.2)	142(71.7)	56(28.3)	168(73.7)	60(26.3)	160(70.2)	68(29.8)	29 (15.8)	117(63.5)	38(20.7)
	Error	32(37.4)	25(78.1)	7(21.9)	120(72.3)	46(27.7)	21(65.6)	11(34.4)	18(56.3)	14(43.8)	2(9.5)	11(52.4)	8(38.1)
	p-value[a]		0.164		0.904		0.338		0.112			0.181	
Which are the main repercussions of climate change? (More than one answer was possible to this question)	Rising of Earth's temperature	328 (90.1)	209 (63.7)	119 (36.3)	244 (7.4)	84 (25.6)	261(79.6)	67(20.4)	260 (79.3)	68 (20.7)	33 (11.7)	193 (68.7)	55 (19.6)
	p-value[a]		0.993		**0.002**		0.160		**0.013**			**0.017**	
	Melting of ice caps	313 (86)	203(64.9)	110(35.1)	231(73.8)	82(26.2)	249(79.6)	64(20.4)	243(77.6)	70(22.4)	31 (11.6)	186 (69.7)	50 (18.7)
	p-value[a]		0.801		0.055		0.258		0.853			**0.006**	
	Ice retraction	262 (72)	160(61.1)	102(38.9)	191(72.9)	71(27.1)	210(80.2)	52(19.8)	210(80.2)	52(19.8)	28 (12.4)	161 (71.2)	37(16.4)
	p-value[a]		**0.010**		0.530		0.239		**0.050**			**0.001**	
	Rising of sea level	254 (69.8)	149 (58.7)	105 (41.3)	188(74)	66(26)	201(79.1)	53(20.9)	205(80.7)	49(19.3)	25 (11.5)	153 (70.5)	39 (18)
	p-value[a]		**<0.001**		0.188		0.691		**0.025**			0.054	
	Biodiversity will be reduced	236 (64.8)	150(63.6)	86(36.4)	172(72.9)	64(27.1)	188(79.7)	48(20.3)	185(78.4)	51(21.6)	20(9.8)	141(68.4)	45(21.8)
	p-value[a]		0.399		0.602		0.492		0.569			0.393	
	The food production will be at risk	176 (48.4)	105 (59.7)	71 (40.3)	129(73.3)	47(26.7)	135(76.7)	41(23.3)	141(80.1)	35(19.9)	14(9.3)	106(70.2)	31(20.5)
	p-value[a]		**0.035**		0.588		0.401		0.243			0.401	
	Increased water shortage	163 (44.8)	93 (57.1)	70 (42.9)	117(71.8)	46(28.2)	126(77.3)	37(22.7)	130(79.8)	33(20.2)	17(12)	98(69)	27(19)
	p-value[a]		**0.004**		0.939		0.595		0.348			0.598	
	Weather-related natural disasters will occur more frequently: storms, droughts. floods and heat waves	307(84.3)	200(65.1)	107(34.9)	221(72)	86(28)	245(79.8)	62(20.2)	238(77.5)	69(22.5)	29(11)	176(66.9)	58(22.1)
	p-value[a]		0.973		0.993		0.183		0.956			0.786	
	The economy will suffer	126 (34.6)	74(58.7)	52(41.3)	89(70.6)	37(29.4)	99(78.6)	27(21.4)	98(77.8)	28(22.2)	9(8.6)	75(71.4)	21(20)
	p-value[a]		0.063		0.678		1.000		0.919			0.407	
	Population will face	200 (54.9)	123(61.5)	77(38.5)	153(76.5)	47(23.5)	160(80)	40(20)	163(81.5)	37(18.5)	19(11.1)	120(70.2)	32(18.7)

food and water shortages. leading to conflicts and migration													
p-value[a]			0.111		**0.034**		0.463		**0.042**			0.352	
Catastrophic transformations can occur	210 (57.7)	132(62.9)	78(37.1)	162(77.1)	48(22.9)	167(79.5)	43(20.5)	168 (80)	42 (20)	16(9.1)	126(71.6)	34(19.3)	
p-value[a]			0.292		**0.010**		0.605		0.178			0.118	
Diseases will spread	153 (42)	91(59.5)	62(40.5)	114(74.5)	39(25.5)	119(77.8)	34(22.2)	122(79.7)	31(20.3)	14(10.7)	91(69.5)	26(19.8)	
p-value[a]			0.055		0.360		0.753		0.378			0.727	

[a] p-value of chi-square test
Bold: p<0.05

Regarding the consequences of CC, the rising of Earth temperature was selected by 90.1% of participants. Being female was associated with marking ice retraction (p=0.010), rising of the sea level (p<0.001), risks for food production (p=0.035) and increased water shortage (p=0.004) as consequences. Being younger resulted associated with considering that higher Earth temperature (p=0.002), conflicts/migrations (p=0.034) and catastrophic transformations (p=0.010) could occur. Other important associations are shown in Table 4. A sum of all correct answers per participant was calculated, being 13 the highest achieved value, with all answers correct, and 4.42 the lowest; only 0.8% of participants reached the highest score. However, the mean sum was 9.2 (SD 1.76), which shows a high level of knowledge (Figure 1).

Multivariate analysis

Results from the multivariate analysis regarding the dichotomous score show an increased odd for good knowledge in professionals (OR=2.08; 95%CI=1.02-4.26), individuals from North (OR= 3.34; 95%CI= 1.37-8.15) and Center (OR=2.07; 95%CI=1.17-3.66). Regarding factors able to modify Earth's climate, correct answers had higher odds of being chosen by professionals (OR=2.83; 95%CI=1.41–5.70), and individuals from South/Islands than from Center (OR=0.65; 95%CI= 0.40-1.06). The correct predicted increase in temperature for 2100 was associated with males (OR=0.47; 95%CI=0.27–0.81) and cohabitant/ married participants (OR=2.38; 95%CI=1.22–4.64). Rising of Earth's temperature was recognized as possible repercussion for CC with higher odd by cohabitant/married individuals (OR=2.38; 95%CI=1.22-4.64), and with lower odd from females (OR=0.47; 95%CI= 0.27-0.81).

Females were associated with reductions in odds of having knowledge about CC repercussions, such as ice-retraction (OR=0.48; 95%CI=0.27-0.86), rising of sea level (OR= 0.35; 95%CI=0.19–0.64), risks to food production (OR=0.66; 95%CI=0.41–1.06), increased water shortage (OR= 0.52; 95%CI=0.32–0.83) and conflicts and migration due to lack of resources (OR=0.63; 95%CI=0.39–1.02). Twenty-four year-old participants or older had a reduction on odds of choosing conflicts/migration (OR=0.50; 95%CI=0.29–0.88) and catastrophic transformations (OR= 0.44; 95%CI= 0.25–0.77) as consequence of CC.

Participants from Center Italy were associated with choosing ice retraction, rising of sea level, melting of ice caps and catastrophic transformations (respectively OR= 2.97; 95%CI=1.63–5.41; OR=2.06; 95%CI= 1.12–3.78; OR=2.42; 95%CI=1.22–4.77; OR=1.55; 95%CI=0.95-2.52). Conversely, participants from the North of Italy showed a higher odd of choosing ice retraction (OR=3.50; 95%CI=1.32-9.27) and rising of sea level (OR=2.34; 95%CI=0.92-5.97).

Students had higher odds of choosing rising of sea level as repercussion of CC (OR= 0.47; 95%CI=0.24–0.95). On the questions about possible contributions that they could give to diminish these effects, choosing the correct answer regarding means of transportation had an increase in the odds for participants belonging to the professional category (OR= 2.07; 95%CI=0.97–4.44) and from the Center (OR=1.6; 95%CI=0.96-2.66). On the subject of waste disposal, higher odds of giving the correct answer were found for participants from the North (OR=2.77; 95%CI=0.84–9.15) and Center (OR= 2.41; 95%CI= 1.22–4.76), and also married/cohabitants people (OR=6.47; 95%CI=1.50–27.9) (Table 5).

Figure 1. Knowledge score's distribution

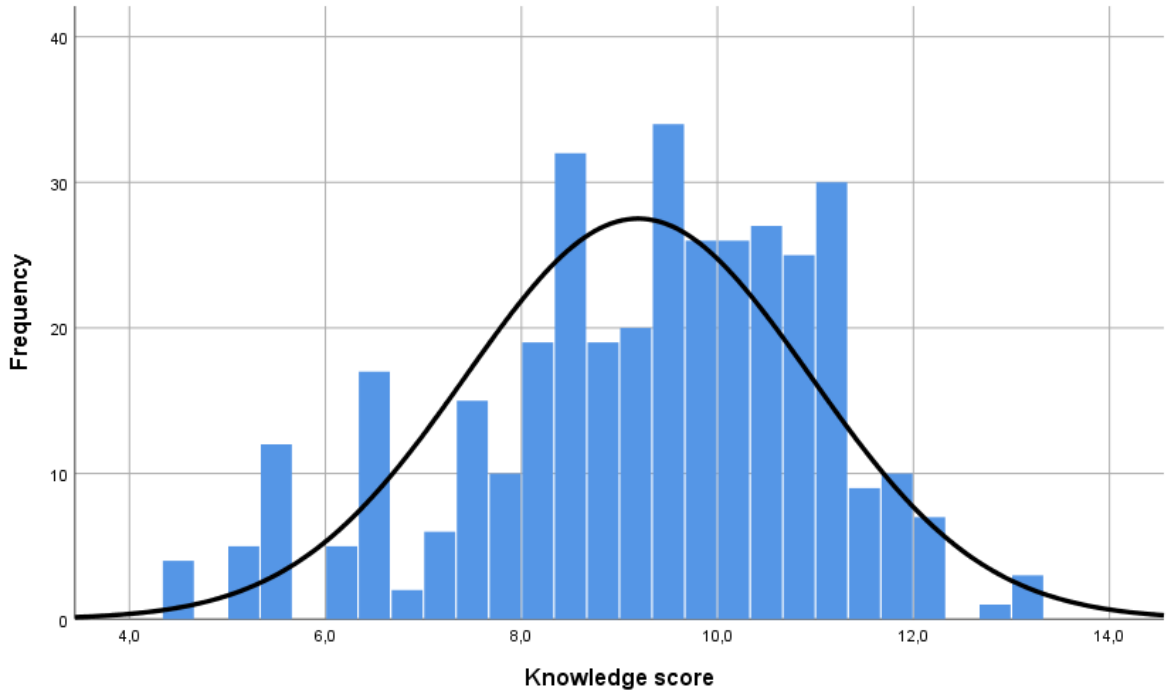

Table 5. Multivariate analysis: Logistic Regression with "backward wald" elimination procedure

Question	Gender		Age		Civil Status		Professional Status		Macro Area		
	OR (95% CI)		OR (95% CI)		OR (95% CI)		OR (95% CI)		OR (95% CI)		
	female	male*	<=24*	>24	Single*	cohabitant/ married	student *	professional	North	Center	South/ islands *
Binary codification of knowledge score							1	2.08 (1.02-4.26)	3.34 (1.37-8.15)	2.07 (1.17-3.66)	1
In what way can a health professional contribute to diminish the impacts of climate change by transport? All are correct							1	2.07 (0.97-4.44)		1.6 (0.96-2.66)	1
In what way can a health professional contribute to diminish the impacts of climate change regarding waste disposal?					1	6.47 (1.50-27.9)			2.77 (0.84-9.15)	2.41 (1.22-4.76)	1

All are correct										
What are the main factors able to modify the climate on the Earth? All are correct						1	2.83 (1.41-5.70)		0.65 (0.40-1.06)	1
Which are the main repercussions of climate change? Rising of Earth's temperature	0.47 (0.27-0.81)	1		1	2.38 (1.22-4.64)					
Which are the main repercussions of climate change? Ice retraction	0.48 (0.27-0.86)	1						3.50 (1.32-9.27)	2.97 (1.63-5.41)	1
Which are the main repercussions of climate change? Rising of sea level	0.35 (0.19-0.64)	1				1	0.47 (0.24-0.95)	2.34 (0.92-5.97)	2.06 (1.12-3.78)	1
Which are the main repercussions of climate change? Melting of ice caps									2.42 (1.22-4.77)	1
Which are the main repercussions of climate change? The food production will be at risk	0.66 (0.41-1.06)	1								
Which are the main repercussions of climate change? Increased water shortage	0.52 (0.32-0.83)	1								
Which are the main repercussions of climate change? Population will face food and water shortages. leading to conflicts and migration	0.63 (0.39-1.02)	1	1	0.50 (0.29-0.88)						
Which are the main repercussions of climate change? Catastrophic transformations can occur			1	0.44 (0.25-0.77)					1.55 (0.95-2.52)	1

Do you think a health professional can contribute to reduce the impact of climate change? Yes			1	0.31 (0.12-0.83)		
What temperature increase do UN climate experts predict by 2100? 1.4°–5.8°C	0.47 (0.27-0.81)	1			1	2.38 (1.22-4.64)

*reference group
White cells indicate p-value>0.05

Linear regression showed that being older is predictor for having higher knowledge scores (β=0.124; p=0.030).

Discussion

Results show that participants were sufficiently aware of CC and its effects, and mostly could identify individual practices that could help to mitigate its repercussions. Significant differences on the amount of information regarding the consequences of global warming were found mainly related to the region of residence and to gender, with females having lower odds of giving the correct answers. Most of participants had already heard about CC, with the main sources of information being TV and school/university. The results from this study show to be similar to the ones from a previous study conducted in China with health professionals (28), in which TV also appeared as main source. The importance of mass media is also highlighted in a survey conducted in Bangladesh (29), while the key role of school as a source of information appears in a study made with Iranian students, in which school was the main source, with 38, 5% of answers (30). However we cannot deny the role of social media in this field. Lewandowsky et al. (31) underline the role of Internet blogs that became a very useful tool for discussing scientific issues, and CC is now one of the most chosen in the discussions. These authors believe that the use of blogs, and particularly the comment sections of blogs, can play a very important role in disseminating different positions around this issue.

It is possible to conclude that mass media have a fundamental role on the dialogue with the Italian population about CC, and therefore should be used to disseminate information to the public. However, television coverage of public health issues has problems, such as individual selection of information of viewers, journalists' unfamiliarity with the topics and spread of misinformation (32). Taking this into account, television should be used carefully, and it should be as well important to valorize the key role that educational institutions play, being a more reliable information disseminator.

Also, it is worth paying attention that, although the question "Where have you heard about Climate Change?" was open answered, no participant cited doctors or other health professionals. A research conducted at Yale University showed that, for information about CC-related health problems, Americans mostly trust their primary-care doctor (33). Another study done in the USA concluded that the public health community has an important perspective about CC that, if shared, could help the public to better understand CC issues. Their findings also suggest that the communication should not be focused on the problem of CC, but on solutions and co-benefits: a healthier future offers environmental benefits (34). The potential of health professionals as disseminators of information on global warming, according to these results, seems to be underused.

Concerning the causes of global warming, more than 50% of participants understood that greenhouse gases were CO_2, N_2O and CH_4, although a significantly amount choose only CO_2.

Still, on the matter of greenhouse gases, most of respondents (92.5%) were aware of human's responsibility on their emissions and on scientists' agreement on the subject, showing a positive consonance between Italian population's knowledge and scientific consensus. Also, in the USA research (35), more than one third of participants from 2009 mentioned mainly anthropogenic causes as "things that could cause global warming", such as cars and industries, and 26% specifically mentioned fossil fuel use. Similar reasons were mentioned by the China participants (28). However, in the USA 18% affirmed that natural causes were also primary drivers of global warming and also in the study made with nursing students in Arab countries respondents

believed CC was due to a balance between nature and human causes (13). In the Arab region, most of respondents said that all presented health-related effects had already increased due to CC; similar findings were presented by a study conducted in Montana with nursing students (36). Although this research did not specifically focus on the consequences of CC for health, options such as the spread of diseases, water shortage and risks to food production were chosen by less than 50% of participants, with the exception of the one related to conflicts and migration (54.2%). Being this a cohort of mostly health professionals and students, the found results disagree with the existing literature. This should be seen as an aspect worthy of improvement: past experiences with smoking cessation, HIV prevention, physical activity promotion and other health issues have proved that health professionals can have an important and effective role on educating and empowering people about health. However, little of this understanding on effective health communication has been applied to CC (37). The proportion of male students that recognized possible consequences of CC was significantly higher compared to women. This gender difference was also found in the studies conducted in the Arab region. It is known that some population groups are more vulnerable to the health effects of CC, and among these there are women, children and elderly, people with previous health problems or disabilities, and poor and marginalized communities (38). A study from 2016 in the USA showed that approaching CC as a health issue is an effective way of communicating with vulnerable audiences, specially addressing individual, immediate-term health effects and practical advices for protective behaviors (39).

Regarding the level of education, significant differences were found between students and professionals, related to source of information – students, younger and single had higher odds of having heard of it in school and during university studies. This evidence suggests the importance that education should have in informing new generations. The implementation of courses and conferences will help to increase the awareness among both students and professionals of the healthcare setting and this could also contribute to widespread correct information about CC within the society.

In the multivariate analysis, professionals had higher odds of having a sum of correct answers above the mean. In other studies, dose-response associations were found between CC knowledge and the educational level (29). In this survey, associations were also related to age, with younger participants having bigger odds of having heard of CC and higher accuracy odds on the question about the related causes.

Regarding region of residence, South and Islands were associated with lower odds of having a higher score. This might be related to socio-economic and cultural differences among different areas within the Country, although no scientific evidence about this data was found.

The limitations of this study include a small sample size and the recruitment of participants. The population was made of individuals specifically belonging to the university setting, which makes it difficult to generalize the results for the entire Italian population. More important, the participants were professionally related to the health area and this even more limits the potential of this study to make generalizations. Also, it must be underlined that the study design does not allow to derive inference from the results, since cross-sectional studies refer to punctual evidences in time and space.

Strengths of this study concern the geographic distribution of the sample size that offers a wide description of the Italian scenery and gives robustness to the evidences. Secondly, this study fills the gap in the scientific literature furnishing an innovative focus on this emerging issue. Furthermore, it will be possible to replicate this investigation in order to assess changes in knowledge over time.

Conclusions

It is possible to conclude that, although the Italian students and professionals included in the study have a good knowledge on CC, it is essential to invest in informing the most vulnerable population groups and also to potentialize the role that health professionals can have on disseminating information on the subject. The results presented on this study will allow improvements in communication and in creating policies related to CC in this country and elsewhere, with the final objective of avoiding the rapid progression of CC and its consequences. Finally, we must recognize the concept of “one world, one health”. We cannot forget the deep link between animal diseases, public health, and the environment (40). The use of the One Health approach can be very important to increase the awareness of the usefulness of cooperation activities in this field.

On the basis of these considerations, at Sapienza University of Rome a didactic project has started for implementing a thematic course on planetary health. Future research should recruit more participants

with more diverse levels of education and occupation.

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ANNEX 1: Climate change and health

Dear participant, Sapienza University of Rome, a member of the Planetary Health Alliance, is conducting a survey on the perception of the climate change issue.
Please answer with the most sincerity, thank you.

Socio-demographic

1. Age: …

2. Gender:
- Male
- Female

3. Marital status:
- Single
- Married
- Divorced
- Widower
- Cohabitant

4. Where do you live? Specify the Italian Region…

5. Occupation:
- Medical Doctor
- Nurse
- Preventative health experts
- Scientist (biological, natural, environmental, chemical, physical and mathematical)
- Medical student
- Nursing student
- Student of preventative health
- Science student (biological, natural, environmental, chemical, physical and i. mathematical)
- High school student
- Middle school student
- Other: ____

Climate Change

1. *Have you heard of Climate Change before?*
   - Yes
   - No
2. *Where did you hear about it? ….*
3. *During the course of your university studies was the subject of global warming addressed?*
   - **Yes**
   - No
4. *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?*
   - **Yes**
   - No
5. *What is the average temperature of the Earth today?*
   - 22°C
   - 18°C

- **15°C**
- 12°C
- I don't know

6. *What temperature increase do UN climate experts predict by 2100?*
   - *1°–3,8°C*
   - **1,4°–5,8°C**
   - 1,9°–6,8°C
   - I don't know
7. *Do you think global warming can have an impact in the environment's health?*
   - **Yes**
   - No
8. *Do you think global warming can have an impact in animals' health?*
   - **Yes**
   - No
9. *Do you think global warming can have an impact in humans' health?*
   - **Yes**
   - No
10. *Do you think a health professional can contribute to reduce the impact of climate change?*
    - **Yes**
    - No
11. *In what way can a health professional contribute to diminish the impacts of climate change by transport?*
    - Going on foot
    - Taking public transports
    - Taking the bus
    - Moving by driving their own cars
    - Taking the bike
    - Using car pooling
    - Taking flights
    - **All previous answers are correct**
    - None of the answers are correct
    - I don't know
12. *In what way can a health professional contribute to diminish the impacts of climate change by energy use?*
    - Reducing the consumption of home appliances
    - Lowering the temperature of the heating systems
    - Keeping chargers always plugged in
    - Using devices with reduced consumption
    - Keeping lights always on
    - Turning off the lights that are not needed
    - **All previous answers are correct**
    - None of the answers are correct
    - I don't know
13. *In what way can a health professional contribute to diminish the impacts of climate change regarding waste disposal?*
    - Differentiating waste
    - Using single-use devices
    - Reusing the packaging
    - Using plastic objects
    - Reducing waste

- **All previous answers are correct**
- None of the answers are correct
- I don't know

14. *What are the main factors able to modify the climate on the Earth?*
    - Changes that occur in solar radiation
    - Variations of the albedo: the fraction of solar radiation that is reflected in various parts of the Earth
    - The introduction of gases that modify the chemical composition of the atmosphere
    - All of these answers are correct
    - None of the answers are correct
    - I don't know
    - **All of these answers are correct**

15. *Which gases that are rising in the atmosphere as a consequence of human activities cause an increase in Earth's temperature?*
    - Carbon dioxide
    - Methane
    - Nitrogen oxides
    - **All previous answers are correct**
    - None of the answers are correct
    - I don't know

16. *Which are the main repercussions of climate change? (More than one answer was possible)*
    - **Rising of Earth's temperature**
    - **Melting of ice caps**
    - **Ice retraction**
    - **Rising of sea level**
    - **Biodiversity will be reduced**
    - **The food production will be at risk**
    - **Increased water shortage**
    - **Weather-related natural disasters will occur more frequently: storms. droughts. floods and heat waves**
    - **The economy will suffer**
    - **Population will face food and water shortages. leading to conflicts and migration**
    - **Catastrophic transformations can occur**
    - **Diseases will spread**