

What do Final Year Medical Students in Germany know and think about Climate Change? – The ClimAttitude Study

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ABSTRACT

Climate change (CC) is adversely affecting human health and will become far more dangerous in the future, if no substantial measures are taken. Young people in particular are taking an energetic stand for CC awareness. Some CC experts argue that medical doctors are especially well positioned to inform about the impact of CC on public health, as it is well established that they are among the most trusted members of society. However, medical doctors seem to be unsure of their role in addressing CC. This study aimed to investigate future doctors', i.e., final year medical students' (FYMS), attitudes towards CC and their personal role in CC education and health care. A questionnaire was developed to examine (1) the expected consequences of CC for FYMS, (2) their perceived individual responsibility, and their attitudes towards an additional (3) professional responsibility. To examine the climate-questionnaire's component correlations, we ran a factor analysis using oblique (promax) rotation and conducted a one-way ANOVA with repeated measures to compare the mean scores of the factors. Data are presented as mean \pm SD or percentage, as appropriate. $n = 65$ FYMS (response rate: 87%) were participating and all of them completed the questionnaire. Items of the factor professional responsibility showed the lowest level of agreement (47.2 ± 21.2), while the 2 other factors showed higher levels of agreement (expected consequences (75.6 ± 18.4), individual responsibility (75.1 ± 20.6). Future doctors at Heidelberg University Hospital are well-informed about the expected health consequences of CC. They recognize human contributions to CC and make personal decisions to mitigate the impact. However, the opinion that they have a professional responsibility as physicians to patients or society in regard to CC is weaker. Specific teaching could help to change the way future doctors see their role and responsibility in tackling CC.

ARTICLE HISTORY

Received 24 December 2020
Revised 10 March 2021
Accepted 11 April 2021

KEYWORDS

Climate change;
responsibility; final year
medical students; medical
training

Introduction

Climate change is already adversely affecting human health, and will worsen in the future, if no significant measures are taken [1–3]. Extreme weather events such as storms, floods, high tides, heavy rains and heat waves can lead to accidents, stress on the organism and even death [4,5]. The temperature increases associated with climate change are for example assumed to cause more frequent infections, wound healing disorders and reduced food safety [4,5]. Tick-borne encephalitis, borreliosis and infectious diseases such as dengue, Zika and chikungunya, or West Nile fever, which first appeared in Germany in 2019 [6], are also more frequent as a result of climate change [7]. Climate change continues to increase the incidence of allergic diseases, as the phases of allergen formation become longer [4,5].

The Paris Agreement's long-term temperature goal is to hold global average temperature increase to well below 2°C above preindustrial levels and pursue efforts to limit the temperature increase to 1.5°C

above pre-industrial levels [8]. If the global temperature increase could be limited to 1.5°C compared to a 3°C scenario, 1,000 heart attack events per year could be avoided in Germany alone [9], where 20,200 heat-related deaths among people over age 65 were recorded in 2018 [10]. In this context, the number of heat-related deaths in Germany has risen impressively over the past 20 years as temperatures and the proportion of people over 65 in the population have increased [10]. Accordingly, the World Health Organization has named climate change the greatest threat to global health of our time [11] which is a call for immediate action.

Despite these facts about climate change, a significant controversy remains on how to address this global threat. The undeniable complexity of the issue and the wide range of interests involved represent a major obstacle to political action [12], highlighting the need for trusted climate change advocates. It is well established that health professionals are among the most trusted members of

society [13]. As skilled communicators and as mediators between science, policy and practice [14], health professionals may be particularly well placed to become climate crisis and planetary health educators [15], although only some physicians are actively involved in scientific and clinical research [16]. Of course, it should not go unmentioned that – due to the central social position and the high reputation of the physician – any topic of social relevance could somehow be associated with medicine, which, however, does not oblige every physician to also stand up for these topics. Moreover, there are quite a few physicians who deliberately do not want to be politically active in order to maintain a neutral position.

The belief that climate change is adversely affecting human health and therefore calls for immediate action is the basis of a new ‘Hippocratic Oath’ that various representatives of health professions have put forward for discussion in 2020. This ‘pledge for planetary health to unite health professionals in the Anthropocene’ [14] was developed especially for the generation of young physicians, as an oath is classically used in many graduation ceremonies. But is there any evidence at all that members of a new generation of medical students and future physicians have an interest in planetary health or recognize their responsibilities?

The existing literature suggests that medical students are aware of the health hazards associated with climate change [17] and the Fridays For Future movement, a global strike movement that started in August 2018, when Greta Thunberg began a school strike for climate in Sweden [18], demonstrates how the younger generation can drive action on climate change. However, we feel it would be relevant to find out whether medical students also feel a responsibility to inform society about the effects of global climate change and take on the role of a climate advocate. After all, education on climate crisis and planetary health could encourage patients to become active against climate change themselves [19]. In addition, future doctors could potentially help their patients develop appropriate strategies to reduce the health risks of climate change at an individual level [2,20]. In a similar way, health professionals contributed substantially that smoking today is considered a harmful behaviour, leading to the assumption that systematic education of physicians could also result in more educated patients regarding climate change [21]. In a definition published in 2012 [22], the European Health Literacy Consortium emphasized that health literacy also means that people can make independent judgments and decisions in everyday life in the areas of disease prevention and health promotion that ultimately maintain or improve their quality

of life. Thus, educating patients about the many health hazards of climate change (just like educating them about the dangers of smoking) can be seen as an opportunity to turn patients into health literates.

In order for health professionals to be able to meet the aforementioned ethical responsibility, far-reaching organizational and structural change processes must be initiated. Ultimately, a so-called “tension for change” must emerge. Various conditions must be fulfilled for this, starting with a curricular reorientation of medical faculties, because future doctors should acquire a planetary health-oriented attitude during their studies. In times of increasing competence orientation within medical education, it is not uncommon for medical schools to teach not only knowledge and skills to future doctors, but also attitudes.

There are some analytical dimensions that have been used in previous studies on attitudes towards global climate change: Essentially, cognitive, affective and conative aspects of attitudes can be distinguished [23]. Core dimensions in people’s attitudes towards global climate change are their beliefs, their concern and their knowledge: For the development of an attitude it is crucial to what extent someone believes that climate change is actually occurring [24]. Being concerned about global climate change includes the problem’s perception, which is a cognitive process, as well as affective components [25]. The knowledge dimension also reflects the cognitive component of attitudes in regard to global climate change [26]. Finally, there are behavioural components of attitudes, which include the willingness to act related to climate change [25,26].

We are not aware of any representative survey on the attitudes of (German) medical students, this new generation of potential educators, with regard to global climate change. Up to date there are only data on the attitudes of (American) physicians. A large majority of family medicine and community health physicians surveyed in an American study stated that they believe climate change is happening and 64% claimed they had witnessed climate change affecting their patients’ health. However, the study from 2019 also showed that physicians are unsure of their role in addressing this difficult or even uncomfortable topic [27]. Overall, it can probably be summarised that some physicians have chosen to learn about climate change and to speak about it in public, while others do not see the ethical obligation to engage themselves in this field [28] or are unable to see their personal role in confronting the consequences of climate change [29].

However, to the best of our knowledge the current study is the first to examine attitudes toward climate change among a new generation of physicians.

Since we postulated a high level of media competence for our target group, i.e., final year medical students (FYMS) from the Medical faculty of Heidelberg working at Heidelberg University Hospital, and since we in Germany have experienced a lot of media attention for global climate change over the last years [30], we assumed that the students had plenty of knowledge, which would be consistent with other research data [17]. Since medical students differ from their fellow students from other faculties in the level of responsibility they take on [31], we expected that the FYMS would also be characterized by a high degree of climate responsibility – as a private individual and as a future doctor. Therefore, our research question was to evaluate FYMS' attitudes towards climate change with the following three hypotheses:

In line with Boland (2019) and Macpherson (2017), we hypothesized that

- (1) FYMS know the anticipated consequences of global climate change (e.g., climate change leads to an increased number of infectious diseases) and that
- (2) FYMS see their individual responsibility in tackling climate change (i.e., are aware that climate change is man-made and that everyone should do something about it) but that in line with Macpherson (2017),
- (3) FYMS probably don't see a professional responsibility in tackling climate change in their role as physicians (e.g., having an informational role for one's patients with regard to climate change).

Methods

Design: The factor analysis presented is based on data generated in a cross-sectional study design using a specially developed questionnaire.

Context: In Germany, it is extremely competitive to apply for a degree course in medicine. A diploma from a German secondary school ('Abitur'/A levels certificate) is required for matriculation. Only very good school-leaving certificates guarantee the student a direct start at the university. The earliest age for starting a degree course in medicine is usually 18 years (with a few exceptions), although a study published in 2019 (characterizing $n = 3511$ medical students) indicated that over one-third of students are 21 and older [32]. The degree course takes at least 12 semesters (six years). Its final year is comparable with sub-internships in the USA [33] and is divided into three clinical rotations (internal medicine, surgery, and an elective), lasting 4 months each. These rotations can be served in any order. Hence, all FYMS must attend 16-week internships in internal medicine and surgery.

Participants: All FYMS ($n = 75$) starting their clinical rotation in internal medicine ($n = 43$), surgery ($n = 24$) or neurology ($n = 8$) at Heidelberg University Hospital (inpatient settings only) in summer 2019 were invited to participate in this study. FYMS were recruited in the context of the interdisciplinary introduction courses for all FYMS of these specialties. Students from internal medicine were also recruited at the beginning of their rotation. All participants signed a consent form before entering the study. Participants' demographic data can be found in (Table 1).

Instruments: We used a questionnaire which aimed to examine [1] the expected consequences of global climate change for FYMS [2], their perceived individual responsibility and their attitudes towards an [3] additional professional responsibility as future doctors (with a mission to also educate patients about climate change and its health implications). As we were unable to find an extant instrument addressing this or comparable subject matters, we developed the questionnaire for our specific sample ourselves (thus creating a tailored evaluation tool): In accordance with Artino et al. [34], the first step was to conduct a nonsystematic literature search in PubMed. Although there was a large body of research on the topic (i.e., broadly defined attitudes toward climate change in the context of medical education), there was no study that examined this specific aspect in medical students and no study could be found in which a questionnaire was developed on the topic. Thus, the literature search supported the need to develop a new instrument. To develop such a questionnaire and to better define the construct of attitudes toward climate change in medical students, we formed an expert group of physicians and psychologists and surveyed final-year medical students on the topic. In a next step, we developed the items and then obtained feedback on the items through expert validation (i.e., by the formed expert group). Within the expert group, we used cognitive interviewing to ensure that respondents understood the items as they were intended. Otherwise, rephrasing was necessary. Last, we conducted pilot tests with the participating FYMS. The resulting questionnaire consisted of 12 items and three dimensions, with four items exploring FYMS' knowledge of the expected consequences, three items assessing their feelings of individual responsibility, and five items on their sense of professional responsibility. For all items, a graphic rating scale was used (0–100). The anchor points in the scale were labeled *not applicable at all* (0) versus *absolutely applicable* (100). The 12 questions are shown in (Figure 1) as well as in (Table 2).

Procedure and data analysis: Data were analysed using the software package IBM SPSS Statistics 25

Table 1. FYMS’s characteristics (n = 65).

		n (%)
Sex	Male	45 (69)
	Female	20 (31)
Age in years		
Median (IQR)	26 (25–28)	
Age distribution	23–25	32 (49)
	26–28	20 (31)
	29–31	7 (11)
	32–34	4 (6)
	35 – 36	2 (3)
Number of completed semesters	10–12	40 (63)
	13–15	22 (34)
	16–18	2 (3)
Current clinical rotation (out of three)	1 st rotation	43 (66)
	2 nd rotation	9 (14)
	3 rd rotation	13 (20)
Specialty in the current rotation	Internal Medicine	38 (59)
	Surgery	21 (32)
	Neurology	6 (9)
Career aspirations	Physician	62 (95)
	Researcher (fulltime)	3 (5)
Marital status	Married	2 (3)
	Single/extra-marital cohabitation	62 (95)
	Other	1 (2)
Religion	Protestant	18 (28)
	Roman-Catholic	25 (38)
	Islam	4 (6)
	Orthodox	3 (5)
	No religion	15 (23)
Country of birth	Germany	50 (77)
	Abroad (Europe)	6 (9)
	Abroad (outside Europe)	9 (14)
Country of high school graduation	Germany	52 (80)
	Abroad (Europe)	5 (8)
	Abroad (outside Europe)	8 (12)
Activities before medical school (multiple selections possible)	Started apprenticeship	4 (6)
	Finished apprenticeship	7 (11)
	Started other university education	10 (15)
	Finished other university education	9 (14)
	Civil service/ Voluntary Year of Social Service	8 (12)
	Military service	3 (5)
	Not applicable	35 (54)

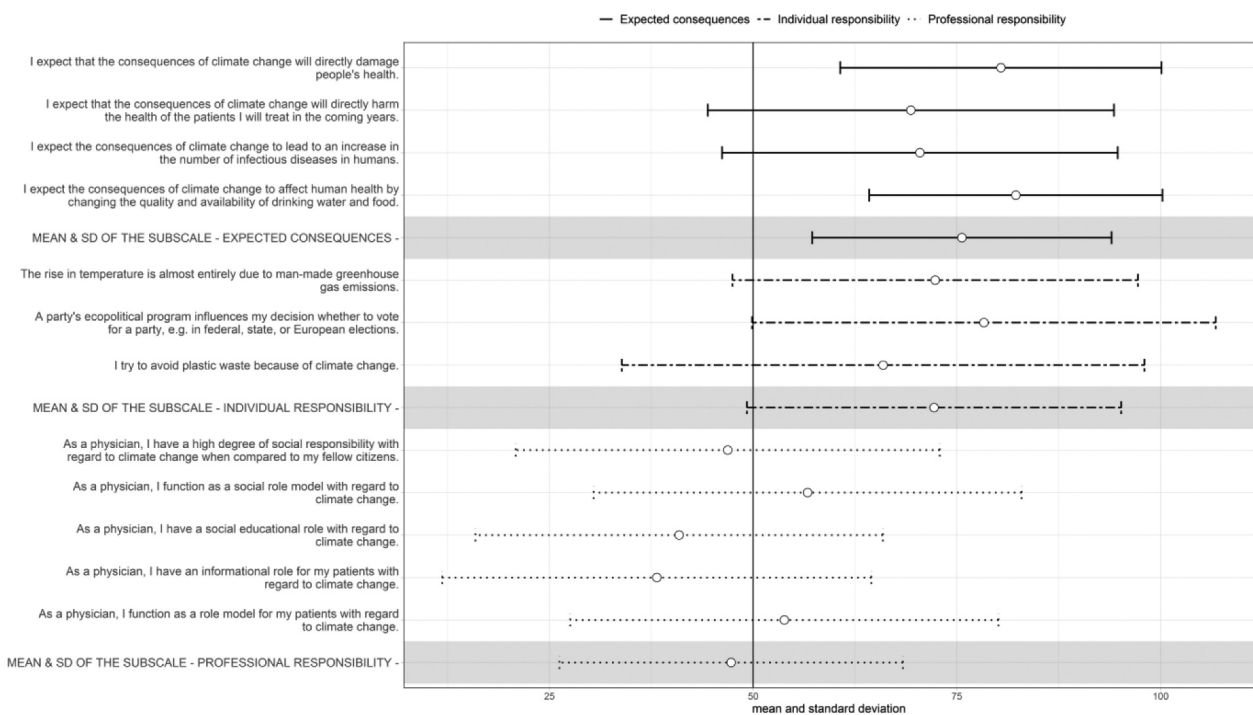


Figure 1. Single item mean scores as well as mean values of the three question topics assessed by FYMS (n = 65).

Table 2. Rotated factor loadings for the climate questionnaire (n = 65).

	Mean	1	2	3
Expected consequences	80.4	-0.1	0.9	0.1
1.) I expect that the consequences of climate change will directly damage people's health.				
2.) I expect that the consequences of climate change will directly harm the health of the patients...	69.4	0.0	0.7	-0.1
3.) I expect the consequences of climate change to lead to an increase in the number of...	70.5	0.1	0.7	0.0
4.) I expect the consequences of climate change to affect human health by changing the quality...	82.2	0.0	0.9	0.0
Individual responsibility	72.3	-0.1	-0.0	0.5
1.) The rise in temperature is almost entirely due to man-made greenhouse gas emissions.				
2.) A party's ecopolitical program influences my decision whether to vote for a party...	74.6	0.1	0.1	0.7
3.) I try to avoid plastic waste because of climate change.	78.3	0.1	0.0	0.7
Professional responsibility	46.4	0.7	0.2	-0.2
1.) As a physician, I have a high degree of social responsibility with regard to climate change...				
2.) As a physician, I function as a social role model with regard to climate change.	56.7	0.8	0.1	-0.0
3.) As a physician, I have a social educational role with regard to climate change.	40.9	0.8	-0.1	0.1
4.) As a physician, I have an informational role for my patients with regard to climate change.	38.2	0.8	-0.1	0.1
5.) As a physician, I function as a role model for my patients with regard to climate change.	53.8	0.7	0.1	0.0

Data are single item mean scores and item loadings to the 3 factors (1 to 3) with eigenvalues greater than 1.

(SPSS Inc., Chicago, IL). First, to describe characteristics of the study group (demographic data, such as age, sex, etc.), descriptive statistics, such as means, standard deviations, frequency counts, and percentage distributions, were generated. Second, to validate the structure of the developed questionnaire, we examined its component correlation. Therefore, we ran a factor analysis using oblique (promax) rotation in order to assign the items to the emerging factors. Then, we calculated Cronbach's alpha to measure internal consistency of the new scale. Within this step, only items with factor loadings greater than 0.4 were retained in the respective factor [35]. For the purpose of our main research question (i.e., are there differences among FYMS in the expected consequences vs. perceived individual responsibility vs. professional responsibility?), we conducted a one-way ANOVA with repeated measures to compare the mean scores in order to detect possible differences between these mean scores of the three emerging components (i.e., factors) within the study group (i.e., expected consequences, individual responsibility, professional responsibility). In post-hoc pairwise

comparisons, the mean scores of the three factors were compared with each other and examined for differences (i.e., professional responsibility vs. individual responsibility; professional responsibility vs. expected consequences; individual responsibility vs. expected consequences). A p-value <.05 (two-tailed) was considered statistically significant. To control the familywise error rate, post-hoc analyses (pairwise comparisons) were conducted using the Bonferroni correction. The datasets analysed during the current study are available from the corresponding author on reasonable request.

Ethical approval: Ethical principles according to the World Medical Association Declaration of Helsinki Ethical Principles for Medical Research Involving Human Subjects of 2013 were adhered to. The study protocol was approved by the Ethics Committee of the University of Heidelberg (application No. S-532/2019).

Results

(Table 1) depicts FYMS' characteristics. A total of n = 75 FYMS were invited to participate in the survey. Of these students, n = 65 (response rate: 87%) participated and all of them completed the questionnaire. Cronbach's alpha for the 12-item questionnaire used in this study was 0.9, and sampling adequacy was high (Kaiser-Meyer-Olkin = 0.8). Three eigenvalues were greater than 1, accounting for 69% of all variance. Factor 1 consisted of professional responsibility (five items; $\alpha = 0.9$); factor 2 of expected consequences (four items; $\alpha = 0.9$); factor 3 of individual responsibility (three items; $\alpha = 0.7$). Items of the factor professional responsibility showed the lowest level of agreement (mean = 47.2, SD = 21.2), while the two other factors showed higher levels of agreement (expected consequences (mean = 75.6, SD = 18.4), individual responsibility (mean = 75.1, SD = 20.6)).

(Table 2) lists all questions from the study-questionnaire and depicts their individual mean scores as well as their item loadings to the three factors with eigenvalues greater than 1, while (Figure 1) illustrates the results of the questionnaire study and gives the mean values of the three dimensions.

The one-way ANOVA with repeated measures was conducted to compare the mean sum scores of the three factors (expected consequences, individual responsibility, professional responsibility). There was a significant effect of factor, Wilks' Lambda = 0.3, $F [2,63] = 73.9$, $p < .001$, $\eta^2 = 0.7$. Pairwise comparisons using the Bonferroni correction showed that the mean scores for the three factors were statistically significantly different between factor 1 professional

responsibility and factor 2 expected consequences ($p < .001$), and factor 1 professional responsibility and factor 3 individual responsibility ($p < .001$), but not between factor 2 expected consequences and factor 3 individual responsibility ($p > .05$).

Discussion

This study was the first to assess FYMS' understanding of the effects of global climate change on people's health, the FYMS' sense of personal responsibility regarding global climate change and finally, the FYMS' opinion of a professional responsibility as a role model and educator regarding climate change. The questionnaire's items of the factor professional responsibility showed the lowest level of agreement, while the two other factors (expected consequences and individual responsibility) showed higher levels of agreement. While the majority (mean > 50) of FYMS agreed with their function as social role models as well as their function as role models for patients regarding climate change, fewer students (mean < 50) recognized their social responsibility, educational role, and informational role regarding climate change. This reflects that although FYMS are aware of their important role as future physicians, they do not translate this responsibility into direct action, such as educating patients about the consequences of climate change and the impact on patients' medical health. Nevertheless, we are hopeful that this next generation of doctors could play an active role in educating society about global climate change, as future doctors at Heidelberg University Hospital are generally well-informed about the expected health consequences of global climate change, recognize human contributions to climate change and make personal decisions to mitigate the impact.

However, their opinion on professional responsibility is consistent with the opinion of fully trained doctors: The aforementioned study from America indicates that only a minority of family medicine and community health physicians believe that it should be part of their medical role to promote climate change with patients [27].

So the question arises why future doctors know about climate change and its health risks and still do not see themselves as professionally responsible, which is in contradiction to the assessment of numerous expert commissions. For example, as early as 2016, the American College of Physicians drafted a position paper on climate change and its impact on human health. It states that physicians, both individually and collectively, are explicitly encouraged to communicate about the health co-benefits of tackling climate change to their community [5]. The position paper postulated that physicians have a role in

combatting climate change and to make the earth a safe and sustain place for the next generations [5]. It is not even the big gestures and publicity measures that are urgently required of physicians, but often small steps in the sphere of action of every clinician are sufficient. The Climate and Health Council in the UK has made a series of recommendations for medical doctors that are easy to implement. These include, for example, advice on being a role model in relation to climate change, or encouraging patients to walk and cycle whenever possible, which would benefit their cardiovascular health and the climate [36]. The fact that these steps are very easy to implement is also important in that there is a so-called value-action gap, i.e., it is well known that it can be difficult to draw action from existing knowledge. Measures that are too complicated and demand a great deal of the individual physician would make it even more difficult to incorporate action into a medical career. Nevertheless, it should not be forgotten that medical doctors are perceived as trusted voices in the community and that many physicians are associated with numerous organizations [36]. There is plenty of potential to influence climate policy in these fields.

FYMS are apparently quite willing to draw action from existing knowledge privately, which further complicates the interpretation of our study results. Accordingly, there were high approval rates for efforts to avoid plastic waste or for efforts to vote ecopolitically responsibly in federal, state, or European elections.

This willingness to act on an individual level is very important because there are many things medical doctors can do in their personal lives, as it remains questionable whether the climate crisis can be overcome by innovation and competition alone [37]. However, the question of what causes a person to become active against climate change - not only as a citizen but also as a clinician [38] - cannot be answered by the present study. In a model that summarizes the results of this study and identifies further research needs we assume that some unknown factors seem to influence the development of this additional form of responsibility (Figure 2). The question derived from this model, why some medical students develop professional responsibility in addition to the knowledge of the expected consequences and the feeling of individual responsibility, while this additional responsibility is not perceived by other FYMS, should be addressed in future studies.

In addition to individual (personality) factors, external circumstances could also lead to medical students and doctors taking on this extra level of professional responsibility. Therefore, doctors and medical students should be informed about how

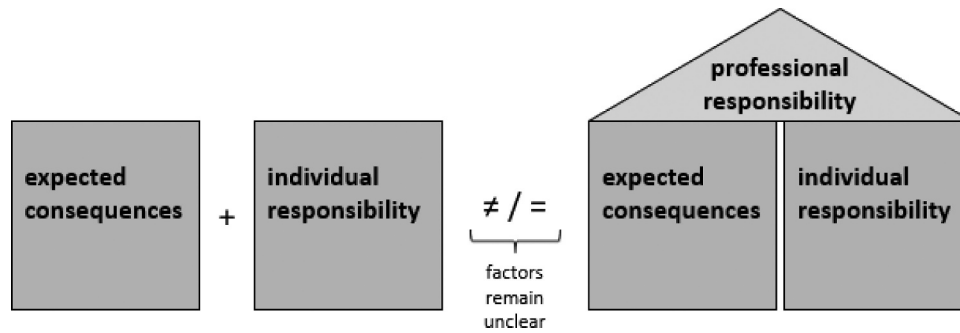


Figure 2. Model for the emergence of professional responsibility.

their future working environment will change due to global climate change at an early stage in their medical education. This requires specific teaching units and coordinated curricula at our medical faculties. Although it was not the purpose of this study to explore in how far medical school curriculum changes would influence individual FYMS' opinion on tackling global climate change as part of their daily work as a doctor, previous research on the subject confirms our assumption that this connection exists. As early as 2011, an American research group showed in a series of experiments that the opinions of medical students on climate change are mutable [39]. There is thus a great opportunity for the medical profession to educate students about the emerging problem of global climate change, its health effects and their future role in addressing this global threat.

In summary, our results suggest that awareness of the consequences of global climate change and the recognition of our personal or individual responsibility could be prerequisites for the development of a professional sense of responsibility as doctors, but this additional level of responsibility is often not perceived by medical students. Several limitations exist in this study. The sample consists of German FYMS from a single university and therefore cannot be considered representative. While the gender ratio in our study is not atypical of the situation in final year medical education at Heidelberg University Hospital, it does not represent the general gender distribution in medical school. It is also important to point out that the study only gives an impression of the students' reflections on climate change and their role in this context, and the results cannot be generalized. Although the response rate was high (87%), it is still possible that those who completed the survey had a higher interest in the subject matter. Despite the anonymous processing of the questionnaire, it cannot be ruled out that individual subjects felt a sense of obligation towards the researchers or felt the urge to behave politically

correctly. Finally, it should not go unmentioned that the questionnaire used is not yet established – it was developed especially for this study.

Conclusions

Young people in particular, i.e., those generations who will have to suffer the consequences of a warming world the longest, are taking an active part in raising awareness for climate change. Our study suggests that young people at a German university hospital (future doctors) recognize the threats and consequences connected to a global climate change and accept their individual responsibility as global citizens. However, the medical students seemed to be unsure of their professional responsibility, i.e., of the social role that the medical profession might play in tackling climate change. For the medical schools, there is a great opportunity to educate future doctors about the topic of climate change and health. We are hopeful that one day medical doctors will see themselves as ecological role models, especially since data from other researchers suggest that medical students' attitudes towards climate change are mutable.

Acknowledgments

The authors thank Dr. Anna Cranz, MSc for proofreading.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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