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Short communication

Climate-specific health literacy and medical advice: The potential for health co-benefits and climate change mitigation. An exploratory study

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ABSTRACT

Background: Despite scientific consensus about the risks of climate change on human health, patients' knowledge on climate change related health risks is largely unexplored. The current study aimed to investigate the current state of *climate-specific healthy literacy* in patients and the impact of climate-specific medical advice on patients' behavior regarding health co-benefits.
Methods: In December 2020 and January 2021, a total of 449 questionnaires comprising 23 items were completed by patients of general practitioners (GPs) and gynecologists.
Results: The majority of general consultations by physicians (86.6% patients from GPs, 84.5% from gynecologists) did not contain any information about climate change or planetary health. Results indicated that climate change is regarded as a global health threat (84.3%) rather than a concern for patients' own health (66.4%). Patients who received climate-specific medical advice by their physician showed higher knowledge about and awareness of climate change related health risks ($p = 0.002$) as well as emotional concern for their own health ($p = 0.04$) than patients who did not receive advice. Climate-friendly behavior was associated with greater concern about climate change related health-risks ($p<0.0001$).
Conclusions: Climate-specific health literacy may play an important role for health co-benefits and climate change mitigation. In order to promote and protect both individual and planetary health, it is crucial to improve the status of climate-specific health literacy.

1. Introduction

Anthropogenic climate change and its variety of upcoming tipping points presents interwoven threats for society, economy and nature [1]. Harmful impacts of climate change include direct and indirect consequences for human health. Direct effects include, for example, mortality due to heatstroke, natural disasters or extreme weather events. Indirect effects include the spread of vector- and waterborne infectious diseases, intensification of allergies, air pollution, and respiratory diseases, morbidity from dehydration or cardiovascular stress, and other conditions [2–4]. Many of these effects are already present throughout the world, such as increased morbidity during heat periods [5]. In order to safeguard human health in the Anthropocene epoch, planetary health (defined as "the health of human civilization and the state of the natural systems on which it depends") needs to be protected and promoted [6].

The concept of health co-benefits combines individual factors and global mitigation strategies, such that climate protection also entails acting beneficially for one's own health [7]. For example, a change in diet by reducing over-consumption of meat and animal by-products has positive effects on reducing greenhouse gases and health [8]. In addition, a shift towards active mobility and public transportation increases individuals' levels of physical activity and reduces air pollution [9].

Despite scientific consensus regarding the risks of climate change on human health in international research [10] and the mitigation potential of health co-benefits, few studies have examined the role of physicians regarding communicating climate-related health risks and medical advice related to climate change mitigation [11]. Previous research has focused on awareness regarding climate change related health risks [12]. To the best of our knowledge, the current study is the first on climate-specific medical advice in the context of health literacy.

Our goal was to assess the status of climate-specific health literacy among patients in practices of general practitioners (GPs) and gynecologists and the impact of climate-specific medical advice on their behavior related to health co-benefits.

2. Materials and methods

2.1. Setting and time

Data collection was carried out in December 2020 and January 2021. Physicians providing outpatient care (e.g., GPs and

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gynecologists) were recruited. Medical practices were chosen based on geographical indicators. The process considered regional and urban-rural differences and was done randomly. The 24 voluntarily participating practices received paper-based questionnaires for distribution to their patients in their waiting rooms.

Data collection was conducted anonymously and entirely voluntarily. The only socio-demographic data collected were age, gender and setting (GP or gynecologists). Patients who stated their gender as non-binary were not further considered to protect their anonymity due to the small number of cases. One GP routinely provided climate-specific medical advice by instructing patients to adhere to a health-promoting and climate-friendly lifestyle in his general patient visits when appropriate. The questionnaires of this GP were analyzed separately ("GP with climate advice").

The ethics committee of the University of Regensburg assured that the study posed no danger to patients' data or well-being.

2.2. Study instrument

The current study was based on a planetary health approach meaning that the term "climate-change and health" is understood in a broader sense by implicating all risks exceeding planetary boundaries [6]. In this vein, we refer to the term "climate-specific medical advice" as a patient receiving any type of medical advice for his or her individual health in the context of climate change or planetary health during a clinic visit.

The paper-based, German language questionnaire used for the current quantitative study was developed based on scientific literature on health co-benefits and consisted of items regarding environmental psychology, climate change and health. To our knowledge, it is the first of its kind. (A.1) The questionnaire was pilot-tested in a training session on climate-related health risks among medical staff (n = 28) and was subsequently not revised.

The questionnaire consisted of 23 closed-ended questions with single (yes/no) or multiple-choice items or 5-point Likert-type items. The questionnaire was subdivided into four sections: 1) General questions about the awareness of climate change; 2) Climate-friendly behavior; 3) Climate change and health; and 4) Climate change mitigation in the healthcare system.

2.3. Data analysis

Descriptive statistics and exploratory data analyses were conducted. Frequencies and proportions were calculated for categorical data.

Medians and interquartile ranges were calculated for continuous data. We used multivariate regression analyses to examine relations of climate-specific health literacy to status of medical advice; awareness, concern, and risk perception of climate-change related health risks; and willingness to engage in climate-friendly behavior. Ordinal logistic regression was used for responses on the ordinal scale (e.g., Likert scale).

Logistic regression was used for binary responses. All regression models were adjusted for the potential confounding variables of age and gender. Models regarding climate-specific health literacy of participants were also mutually adjusted for status of medical advice and status of personal concern about health risks. All tests were two-sided and a p-value of <0.05 was considered statistically significant.

Statistical analyses were performed using R (statistical software version 4.0.3) [13].

Table 1
Demographic characteristics of respondents according to setting and gender (n = 449).

	GP (n = 329)	GP – with climate advice (n = 29)	Gynecologists (n = 91)
Gender			
female	197	19	89
male	116	10	–
non-binary	1	–	–
NA	15	–	2
Age			
Median	51.0	57.0	42.5
25th percentile	34.0	49.5	26.8
75th percentile	60.0	68.0	56.3

3. Results

3.1. Demographic characteristics

The 24 participating practices (21 GPs, 3 gynecologists) returned a total of 449 valid questionnaires from their participating patients by mail (out of 800 distributed questionnaires, response rate 56%).

Table 1 shows demographic characteristics of the total sample. Individuals were aged 12 to 91 years with a median age of 51 years. Of the 449 participating patients, the majority (73.3%) came from GPs. Women accounted for 59.9% of patients from GP practices.

3.2. Climate-specific medical advice

The majority of patient visits (86.6% of visits to GPs, 84.5% of visits to gynecologists) did not contain any information on climate change and health (Table 2). In the practice of the GP with climate advice, 85.7% of participating patients received advice about climate change and health. In total, 80 participants (65.8% women) of the total sample stated they had received medical advice on climate change.

The advised group of patients (n = 80, median age 55 years; 65.8% women) included GPs' patients (n = 42, median age: 45), patients from the *GP with climate advice* (n = 24, median age: 57.5) and gynecologists' patients (n = 14, median age: 52.5).

3.3. Knowledge about the health-related impacts of climate change

When patients (independent of their status of climate-specific medical advice) were asked about their perception of the most challenging effects of climate change, most reported *ice melting and*

Table 2
Number of patients who received climate-specific medical advice, by setting (n = 449).

	With climate-specific medical advice**:**	**Without** climate-specific medical advice:
Total	*n = 80*	*n = 369*
Median age	55.0	48.0
Female (%)	65.8	72.3
GP		
(n = 329)	**13.4%**	**86.6%**
Median age	54.0	50.5
Female (%)	53.6	64.8
GP – with climate advice		
(n = 29)	**85.7%**	**14.3%**
Median age	57.5	43.5
Female (%)	66.6	50.0
Gynecologists		
(n = 91)	**15.5%**	**84.5%**
Median age	52.5	39
Female (%)	100.0	100.0

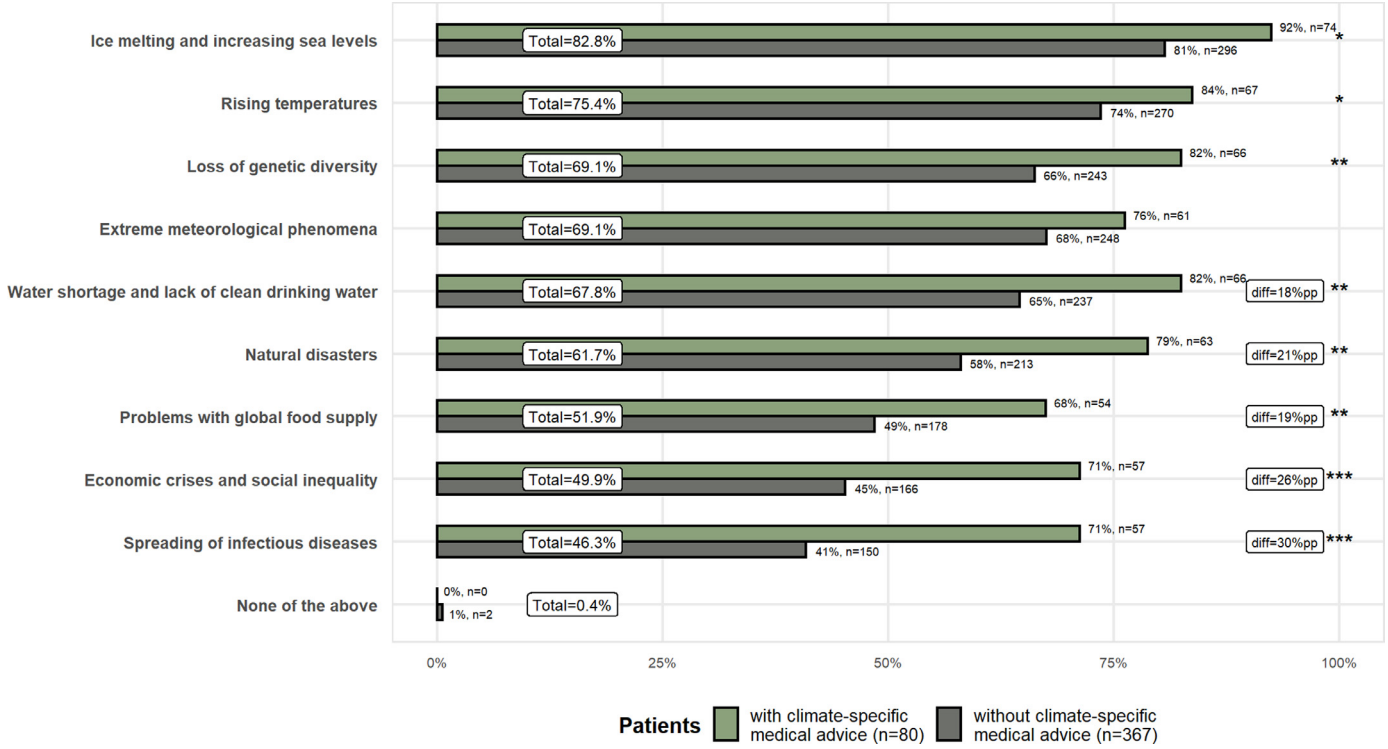

Fig. 1. Patients' perception of the most challenging effects of climate change.Results are presented by status of climate-specific medical advice. Logistic regression adjusted for age and gender, $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$). Multiple choice was possible. A difference greater than 15 percentage points is highlighted. Results are presented in%. $n = 447$.

increasing sea levels (82.8%), *rising temperatures* (75.4%), *extreme weather events* (69.1%) and *loss of biodiversity* (69.1%) (Fig. 1).

Health threats (regarding spreading of infectious diseases; 46.3%) and impacts related to society and the economy (49.9%) were considered less challenging and less relevant.

A comparison of patients according to their status of climate-specific medical advice indicated that individuals who had received advice had a higher awareness regarding climate change consequences than those without advice. The greatest differences were found for societal issues (economic crises and social inequality, $p<0.001$) and health related effects (infectious diseases, $p<0.001$).

While 12% of respondents without climate-specific medical advice were unaware of any health-related effects of climate change, 41% of respondents reported to be well-informed about the health impacts of climate change (Fig. 2).

Among all respondents, air pollution/respiratory symptoms (75.9%) and malnutrition (60.4%) were the most commonly reported health-effects of climate change. Least stated were heatstroke/heat-stress (41.7%) and mental health effects (40.7%).

When comparing patients according to their status of climate-specific medical advice, awareness about health-related consequences of climate change was higher in patients with climate-specific medical advice compared to patients without such advice, especially regarding their knowledge about climate change related cardiovascular issues ($p<0.001$), mental health effects of climate change ($p = 0.003$) and an overall good level of knowledge on health-related risks of climate change ($p<0.001$).

3.4. Awareness and risk perception of climate-change related health-risks

The majority (84.3%) of participants perceived climate warming as causing global health risks. Two thirds of respondents (66.4%) perceived climate change as a risk for their own health. Within that group, 16.7% were very concerned that climate change is a serious threat for their own health. (A.2)

Patients with climate-specific medical advice showed a statistically greater ($p = 0.04$) perception of risks to their own health than non-advised patients.

3.5. Factors regarding behavioral change

The majority of both non-advised (81%) and advised (90%) participants indicated that their personal consumption behavior had an impact on climate change. Thus, climate-specific medical advice was associated with a greater belief that one's own behavior affects climate change ($p = 0.04$).

Furthermore, asking participants about their willingness to change their habits towards climate-friendly and health promoting behaviors indicated that greater knowledge about health co-benefits (88.6%) and direct health benefits (88.3%) was more relevant than the influence of peers (67.5%; Fig. 3).

3.6. Patients' behavior according to health co-benefits

When participants were asked about their willingness to engage in climate-friendly and health-promoting behavior in everyday life, the most likely behavior was to pay a higher price for climate-friendly products/food (88%) or to ride a bicycle (71.9%).

When comparing patients according to their status of climate-specific medical advice, statistically significant differences were found only for engaging in a vegetarian diet ($p = 0.04$), but not for the other behavioral items. In contrast, perceiving climate change as a risk to one's own health had a statistically significant impact on all other climate-friendly behaviors (Fig. 4). A comparison between patients with greater concern about climate change-associated health risks and those less concerned showed that 66.4% patients perceived climate change as a health risk for themselves (answering *"yes, a lot"* or "*yes, mostly*"), whereas the remaining 33.6% of patients

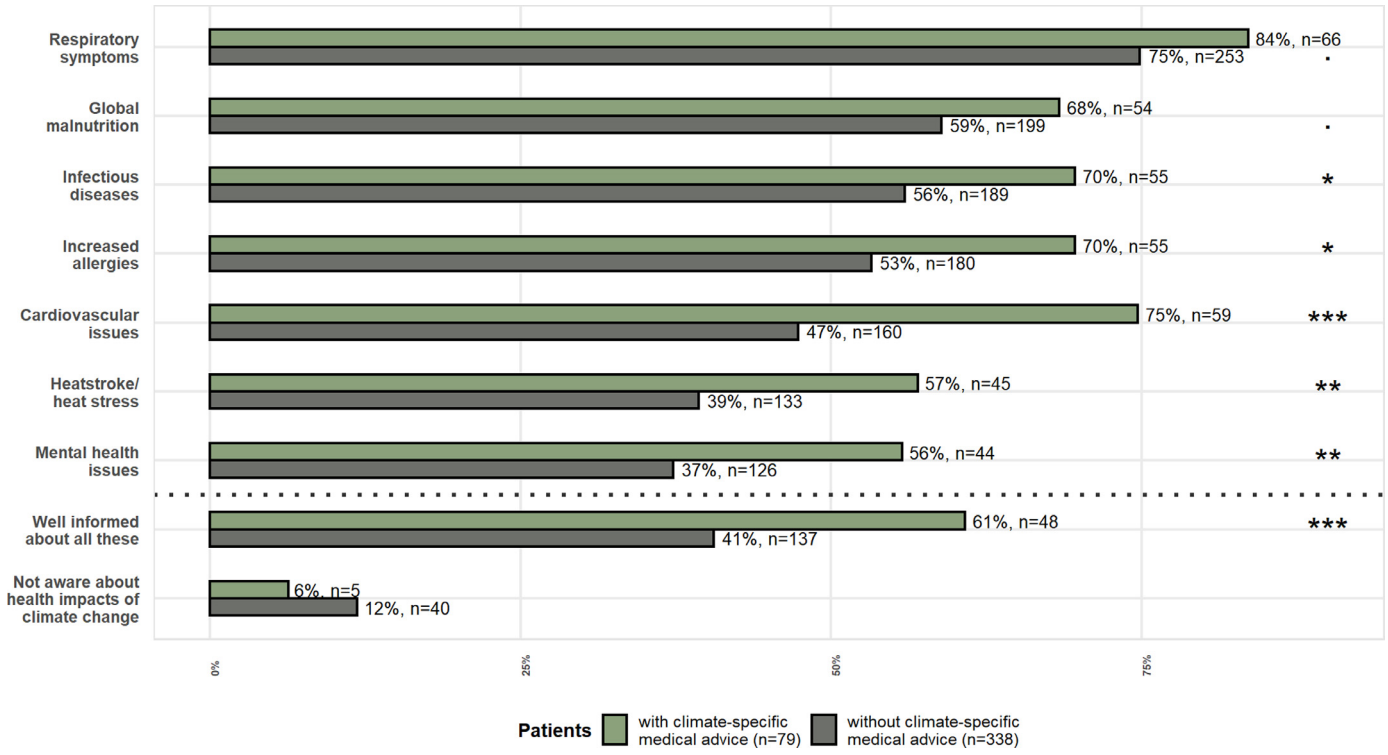

Fig. 2. Patients' awareness of health-related effects of climate.Results are presented by status of climate-specific medical advice. Logistic regression adjusted for age and gender. •$p<0.1$, *$p<0.05$, **$p<0.01$, ***$p<0.001$). Results are presented in%. Missing responses were removed. Multiple choice was possible. $n = 432$.

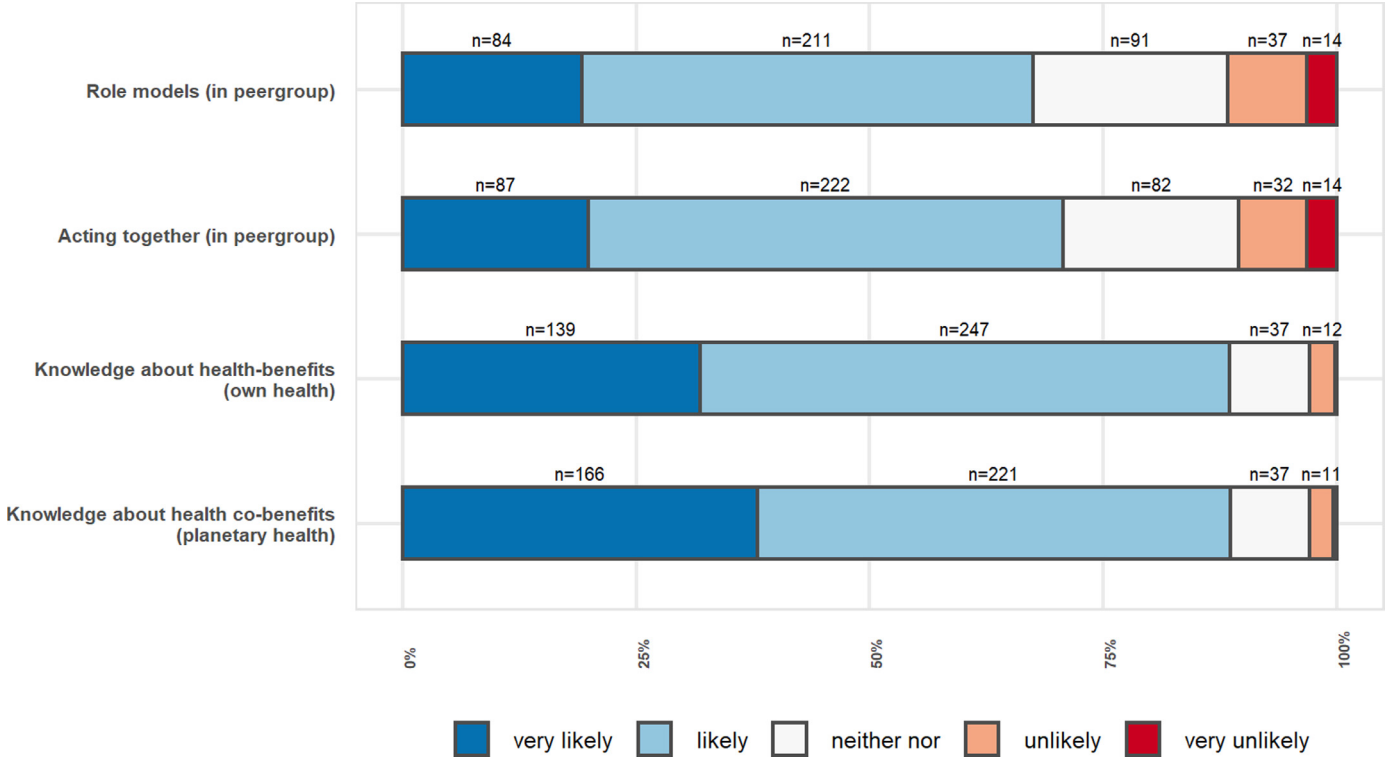

Fig. 3. Factors that increase climate-friendly behavior.Results are presented in%. Absolute values are also displayed. Missing data were removed. $n = 437$. For clarity, the responses "very unlikely" to questions 7c and 7d are not shown ($n = 1$ and $n = 2$).

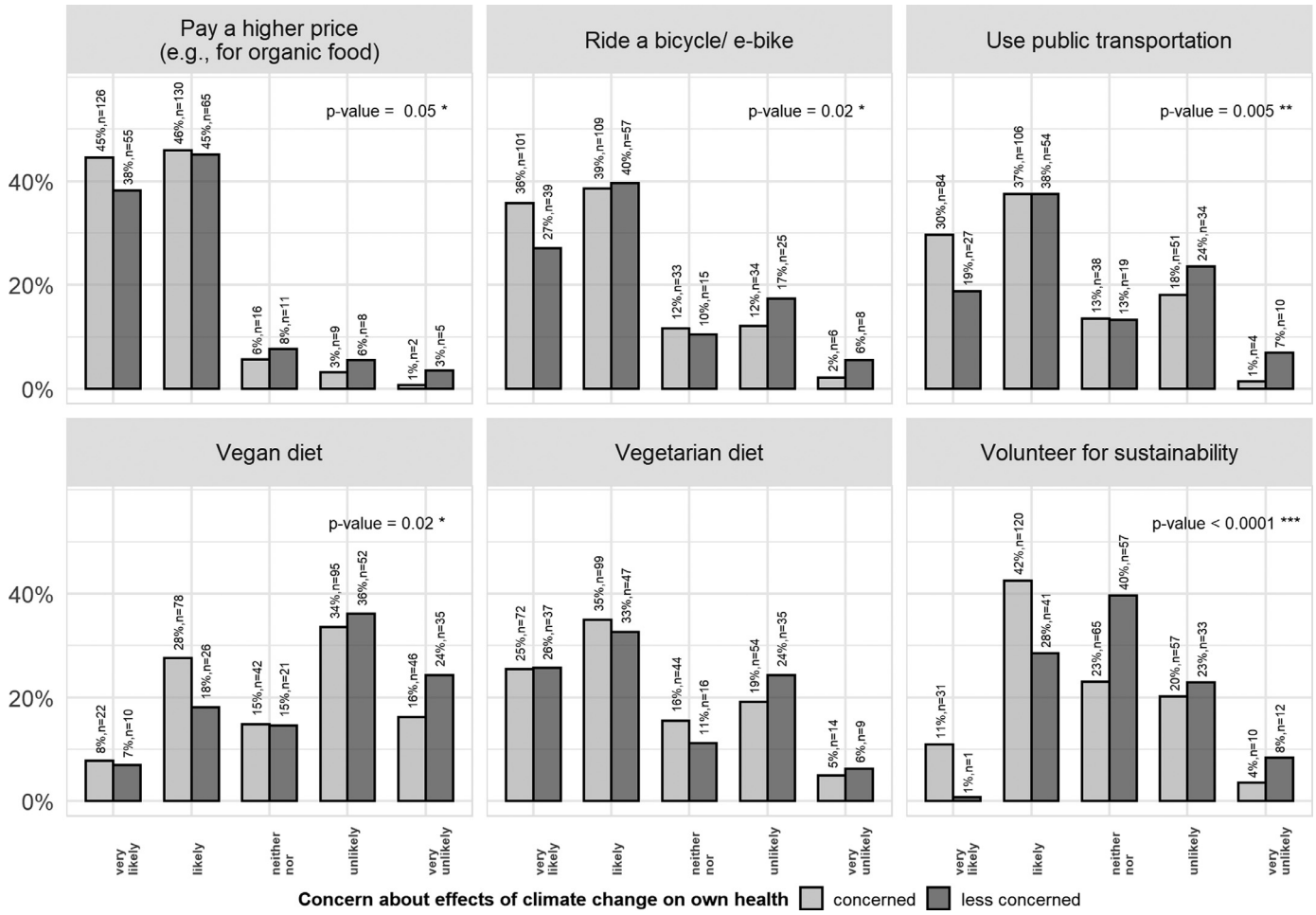

Fig. 4. Willingness to engage in climate-friendly behavior in different behavior-items.Percentage of respondents who self-reported their willingness to implement health co-benefits in everyday life. Results are presented by concernedness about the effects of climate change on patients own health. *$p<0.05$, **$p<0.01$, ***$p<0.001$. Ordinal logistic regression adjusted for age, gender, and status of climate change-related medical advice. Missing responses were removed. $n = 437$.

were less concerned about climate change posing a personal health threat.

3.7. Climate-specific health literacy and its conditions

Having received climate-specific medical advice was associated with greater knowledge and awareness of health risks related to climate change ($p = 0.002$). Specifically, a strong sense of the urgency of responding to the threat of climate change and a strong effort to reduce greenhouse gases in their everyday life were more frequently found in advised than non-advised patients (Table 3).

After adjusting for age, gender and status of climate-specific medical advice, concern about health effects of climate change was associated with a sense of urgency, knowledge about health risks and emissions-reducing behavior.

Additionally, 70.8% of all participants indicated a willingness to engage in climate-friendly behavior if physicians informed them about climate-related health risks. This was more pronounced among those who received climate-specific medical advice, those concerned about climate change and health and female patients.

4. Discussion

The main results of our study were: 1) The majority of patient visits by physicians contained no information about climate change and health; 2) Climate change was seen as a global health threat rather than a concern for patients' own health; 3) Patients who received climate-specific medical advice showed greater awareness of climate change-related health risks compared to non-advised patients; 4) Pro-environmental behavior was associated with greater concern about climate change related health-risks.

4.1. Potential of climate-specific health literacy in health communication

We found that patients with climate-specific medical advice indicated greater knowledge about health risks related to climate change as well as emotional concern about climate change as a risk for their own health. This finding is in line with a representative study conducted by the *Scientific Institute of the General Health Insurance funds (WIdO)* in 3006 German adults reporting that people with better information and higher concern for the health consequences of climate change are much more likely to use protective and health-promoting measures such as warning systems than less-informed people. Furthermore, due to a low level of knowledge about the health consequences of climate change in large parts of the public, there is a need for information about climate-related health risks [12]. Our study shows that a majority of people fail to recognize climate change as a serious threat concerning their own health, despite scientific evidence for such risks. Thus, it is crucial to improve the status of climate-specific health literacy to protect and promote both individual and planetary health.

Table 3
Climate-specific health literacy of patients according to gender, status of climate-specific medical advice, and concern about climate-related health risks.

	Climate-specific health literacy of patients				
	Feeling well informed about health risks[+] (*n* = 432)	High knowledge in general about climate change (*n* = 449)	Strong sense of urgency regarding climate change (*n* = 448)	Strong engagement in climate-friendly behavior (*n* = 426)	Tendency for climate-friendly behavior if physicians informed about climate-related health risks (*n* = 419)
Gender	*p = 0.48*	*p = 0.67*	*p = 0.28*	*p = 0.01* *	*p<0.0001* ***
Female (*n* = 305)	42.6	6.6	51.3	21.2	72.1
Male (*n* = 126)	46.8	6.3	47.6	16.0	66.1
Climate-specific medical advice	*p = 0.002* **	*p = 0.28*	*p = 0.29*	*p = 0.27*	*p<0.0001* ***
Advised (*n* = 80)	61.3	10.0	60.0	25.0	82.5
not advised (*n* = 369)	40.7	6.3	49.6	18.8	68.2
Concern about climate-related health risks	*p<0.0001* ***	*p = 0.03* *	*p<0.0001* ***	*p<0.0001* ***	*p<0.0001* ***
concerned (*n* = 287)	51.6	7.7	58.9	23.0	78.6
less concerned (*n* = 145)	29.0	5.5	34.0	13.9	54.0

* $p<0.05$,.
** $p<0.01$,.
*** $p<0.001$ (Mutually adjusted for gender, age, concern and advice; ordinal logistic regression). [+]Logistic regression.
Other results in%. For clarity, only percentages of the highest likert-scale option are displayed in the table. Results refer to questions 11, 2, 3, 5 and 15 of the questionnaire (A.1).

Other studies arrive at a similar conclusion. For example, a national survey of 1275 US adults conducted by the Yale Project on Climate Change Communication found that most adults (61%) are not concerned by the health consequences of global warming [14].

Based on current research, a need emerges for a modified narrative regarding health literacy: by framing the climate crisis in a health perspective, climate-specific health literacy and, thus, behavioral change may increase [15].

Surveys of the German Umweltbundesamt (UBA; Federal Environment Agency) found that the majority of the population of Germany perceives health as the most important factor for their quality of life [16]. Therefore, connecting the factors health and awareness about climate change may lead to a stronger commitment to a health-promoting and climate-friendly lifestyle.

4.2. Potential of communicating health co-benefits for behavior change

Research in environmental psychology demonstrates the potential of addressing climate change in outpatient care: according to Moser behavioral change towards a climate-friendly lifestyle is impeded by distant impacts, such as lack of immediacy and lack of influence [17]. By comparison, addressing health co-benefits renders the effects of climate change mitigation more tangible due to increased context specificity, combining personal, geographic, and temporal relevance [18,19].

In our study, climate-specific medical advice showed statistically significant effects on beliefs about self-efficacy. On the other hand, concern about risks to patients' own health had a statistically significant impact on their behavior. Furthermore, our results indicated that the motivation for behavior change was increased by knowledge about health co-benefits.

In brief, climate-friendly and preventive health-promoting behavior of patients may be increased by medical advice related to the health co-benefits of this behavior.

4.3. Integration of climate-specific health literacy in health care settings

At present, health literacy guidelines and policies advocated in Germany lack statements about climate change, greenhouse gas emissions, health co-benefits, or mitigation strategies [20]. As climate-friendly behavior has a positive impact on short- and long-term health, those guidelines should be expanded.

According to the WHO Health Literacy Questionnaire (HLQ), health literacy '. . .is the cognitive and social skills which determine the motivation and ability of individuals to gain access to, understand and use information in ways which promote and maintain good health' [21]. As an extension of the concept of health literacy, in the current study we made the following assumptions about what climate-specific health literacy entails:

1) Knowledge about the present and long-term health risks of climate change.
2) Knowledge about the health-co-benefits of preventative behaviors related to climate change.
3) Emotional integration of knowledge and feelings of concern related to climate change and health.
4) The ability of to implement this knowledge into action and climate-friendly behavior.

One example of communication about health co-benefits is the GP involved in the current study known for his "climate advice". He addresses his patients' values and connects their diseases and issues with planetary health values with the aim of creating interest and motivation to behave in a climate-friendly, healthy way. This does not apply to every patient visit but he gives advice on health co-benefits whenever appropriate. [22]

Such patient-centered communication is consistent with our findings: advice and knowledge alone were less associated with behavioral impacts than concern about patients' own health risks. (Table 3)

At present, implementing climate-specific medical advice in outpatient care may be challenging due to limited knowledge and training of physicians as well as limited financial support and lack of coordination by health insurance providers [23,24]. Creating an adequate framework such as health insurance providers reimbursing physicians for climate-specific medical advice may represent a possible approach. Nevertheless, further research is needed to identify and establish the principles of communication about climate change and health as well as perspectives of health insurance providers and other medical disciplines.

4.4. Strengths and limitations of the study

To our knowledge, this is the first study that evaluated patients' climate-specific health literacy based on advice received by physicians. Our study indicates the need for future research regarding the

optimal type, duration and method (e.g., patient-centered communication) of climate-specific medical advice.

Our study encompassed different areas in Germany to ensure broad geographic coverage and diverse socioeconomic representation, thereby enhancing generalizability of the findings. We specifically targeted GPs and gynecologists because they spend a large proportion of their time in patient communication during office hours [25].

Notwithstanding, we cannot rule out, the potential for selection bias due to non-random participation and social desirability bias of both patients and physicians. Therefore, the actual level of climate-specific medical advice may be lower than that reported in our results.

Our analyses were adjusted for potential confounders such as age and gender. Future studies should include information on marital status, education level, socioeconomic status and ethnicity. Also, large, representative studies are needed to compare levels of climate-specific health literacy across countries.

The current study showed that awareness of health co-benefits is associated with behavioral attitudes. The correlation between self-report and actual performance of climate-friendly behavior is about 0.54 in the field of environmental behavior, which is above average compared to effect sizes through behavioral meta-analysis in other behavioral fields [26]. However, it was not within the scope of the current study to assess current climate-related behavior and the potential for emission reductions in individuals.

4.5. Conclusion

In conclusion, our study shows that the vast majority of patients in German outpatient settings do not receive medical advice about health risks of climate change despite the potential of communicating health co-benefits by their physician.

We also found that among patients, climate-specific medical advice is associated with higher knowledge levels regarding climate change and health-related risks. In addition, patients with higher levels of climate-specific health literacy including emotional concern about their own health risks, show potential for behavior change towards a climate-friendly lifestyle with health co-benefits and positive effects on climate change mitigation. Thus, it is important to enhance patients' climate-specific health literacy in outpatient care and to create optimal conditions such as providing financial support for physicians advising on planetary health. Because climate-specific health literacy leads to a better understanding of the effects of climate change and increases the motivation for climate-friendly and healthy behavior, it is conceivable that climate-specific health literacy may lower health care costs due to increased participation in exercise, in consumption of healthier food or improved preparation for extreme heat.

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Declaration of Competing Interest

The authors declare they have no conflict of interest.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.joclim.2021.100072.

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