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# Knowledge, behaviours, practices, and expectations regarding climate change and environmental sustainability among health workers in France: a multicentre, cross-sectional study



Jérémy Guihenneuc, Guillaume Cambien, Pauline Blanc-Petitjean, Emeline Papin, Noëlle Bernard, Bernard Jourdain, Isabelle Barcos, Cécile Saez, Antoine Dupuis, Sarah Ayraud-Thevenot, Virginie Migeot



## Summary

**Background** Faced with climate change, hospitals are confronted with a dual challenge. On one hand, they need to embark on a far-reaching ecological transformation to reduce their contribution to greenhouse gas emissions and other environmental impacts; on the other hand, they need to limit the effects of climate change on their activities. We aimed to evaluate the knowledge, behaviours, practices, and expectations of health workers in French hospitals regarding climate change and environmental sustainability.

**Methods** This multicentre, cross-sectional study was carried out in six French hospitals from June 1, 2021 to Dec 31, 2022. All health workers at the hospitals were eligible to participate and were recruited through internal publicity. We designed a structured questionnaire consisting of five parts: participant characteristics, knowledge and perceptions of climate change, pro-environmental behaviours, practices concerning environmental sustainability actions, and expectations. A multilevel logistic regression model was used to evaluate associations between the knowledge, behaviours, and practices of health workers and the characteristics of the health workers and hospitals.

**Findings** Of 57 034 health workers across the six hospitals, 4552 (8·0%) participated in the study. Of those for whom gender data were available, 3518 (78·2%) participants were women and 979 (21·8%) were men. Participants considered energy consumption (71·0%) and waste and discharges related to medical activities (55·6%) and non-medical activities (50·2%) to be the three activities with the greatest environmental impact. On a scale of 1 (not a priority) to 10 (high priority), the median rating attributed by the participants to the commitment of their hospitals to ecological transformation was 5·0 (IQR 3·0–6·0). 1079 (23·7%) of 4552 participants had already initiated at least one environmental sustainability action in their hospital. Barriers reported by participants to the implementation of environmental sustainability-related projects were the lack of dedicated time (40·4%), hierarchical support (32·5%), methodological support (28·9%), and access to training (23·7%). The presence of a sustainable development steering committee, especially one with more than 5 years of activity, was positively associated with health workers feeling better informed about the ecological transformation of their hospital (adjusted odds ratio 1·78 [95% CI 1·29–2·45]), having better knowledge of the environmental impacts of their hospital (1·83 [1·32–2·53]), and initiating a larger number of environmental sustainability actions (1·74 [1·33–2·29]).

**Interpretation** We showed that health workers in French hospitals seem to be committed to the ecological transformation of their workplaces, and identified some drivers and barriers to further support these essential transformations. There is an urgent need to bolster training for all health workers, enhance structural frameworks within hospitals, and encourage future interdisciplinary research on the vulnerability of health-care facilities to climate change.

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## Introduction

Climate change has been identified as one of the most important challenges of our time, with major threats to human health and wellbeing.<sup>1</sup> Faced with increasingly frequent and intense climatic events—such as heatwaves, floods, and droughts—health systems remain on the front line to meet the health needs of populations. But health systems, which are already under stress, are also directly and indirectly affected by climate change,

especially health workers and all components of health-care facilities.<sup>2,3</sup> Over the past 10 years, frameworks for building and measuring resilient health systems have been developed.<sup>3–6</sup>

Conversely, health systems themselves have a considerable environmental impact, particularly through the emission of greenhouse gases.<sup>7–10</sup> In European countries, the activities in this sector that have the greatest effects on climate are related to medicines, medical devices, and

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### Research in context

#### Evidence before this study

Multiple scientific studies have highlighted the effects of climate change on human health and wellbeing. Health systems, hospitals, and health workers are on the front line in terms of meeting health needs while remaining able to cope with climate change. We searched PubMed and Web of Science—initially on Oct 10, 2022 and again on Nov 20, 2023—for studies published in English from database inception to search date using the search terms (hospital OR “healthcare facilit\*” OR “health worker\*” OR “health professional\*” OR “health system\*”) AND climate change. The available evidence indicates that hospitals are confronted with a dual challenge: reducing their contribution to climate change and other environmental impacts and limiting the effects of climate change on their activities. Although previous studies have shown that health workers are aware of the effects of climate change on health and feel a responsibility to bring these health issues to the attention of the population, unknowns and uncertainties still need to be addressed to promote the ecological transformation of hospitals. Previous studies have involved small groups of health professionals in specific specialities and do not represent all health workers working in hospitals. Additionally, few studies have focused on health workers in Europe and none have been conducted in France. Finally, the factors associated with the knowledge, behaviours, and practices of health workers with regard to climate change and environmental sustainability in health-care facilities have not been studied. Addressing these limitations is crucial for transforming these organisations into environmentally sustainable and climate-resilient hospitals.

#### Added value of this study

Involving more than 4500 participants, this study is—to our knowledge—the largest multicentre nationwide study among health workers in hospitals worldwide. We evaluated the knowledge, behaviours, and practices—and associated factors—of health workers regarding climate change and environmental sustainability in six French hospitals, and specified the expectations of the workers in these areas. We found that although their knowledge of climate change and environmental sustainability is low, health workers are committed to taking action despite major barriers such as the lack of dedicated time, support, and training. The presence of a sustainable development steering committee, especially one with more than 5 years of activity, was positively associated with health workers feeling better informed about their hospital’s ecological transformation, having better knowledge of their hospital’s environmental impacts, and initiating a larger number of environmental sustainability actions.

#### Implications of all the available evidence

Our findings suggest that health workers seem to be committed to, and want to become more involved in, making hospitals environmentally sustainable and climate-resilient. However, commitment is also required at an institutional level, and levers to promote such commitment have been identified. Addressing individuals and institutions, structuring organisations, and raising awareness through training for all health workers can help hospitals to implement more effective adaptation and mitigation actions in the face of climate change.

other health products, including purchasing and the entire supply chain.<sup>11</sup> A global assessment of environmental impacts is needed to achieve comprehensive understanding of these issues.<sup>12</sup>

Health-care facilities therefore face a two-fold challenge: addressing both the direct and indirect consequences of climate change on human health and their organisational functions, while also mitigating their own contributions to climate change. As such, to effectively enact pertinent strategies, decision makers and health workers must acknowledge this dual challenge and enhance their roles in initiating strategies and actions to tackle it.<sup>13</sup>

The implementation of a sustainable development approach in the health sector seems to be essential as a means of reducing its environmental impact and strengthening the responsiveness of health-care facilities.<sup>4</sup> Also important is enhancing the societal responsibility of health sectors in a context of transformation, in which climate change coincides with persistently wide health inequalities and inequities.<sup>14</sup> An increasing number of sustainable actions are being implemented and assessed regarding green building design, energy efficiency, food, and transportation, as well as care

practices—particularly in operating rooms and maternity wards.<sup>15,16</sup>

Although many initiatives are under way, faster progress is required in order to modify and evolve health-care facilities and prepare them to function in a new and changing context. Several studies have explored the knowledge, attitudes, and practices of selected groups of health workers—including public health nurses and operating theatre staff—with regard to climate change, environmental sustainability, and sustainable development in health care.<sup>17,18</sup> However, despite their high level of commitment and a desire to receive education and training on these subjects, health workers report a lack of knowledge regarding the links between climate change and health and about environmental sustainability and sustainable development in the health field.<sup>19–21</sup>

In France, although a few studies have focused on the knowledge, attitudes, and practices of health students or specific groups of health professionals concerning health and the environment, we are not aware of any studies that surveyed broad groups of health workers on climate change and environmental sustainability at a nationwide

level.<sup>22,23</sup> We therefore assumed that all health workers had a low level of knowledge on these topics in relation to the health sector. Because such knowledge and a commitment to action is required to address these challenges, we aimed to assess training needs and the factors that would enable commitment through a survey based on knowledge, attitudes, and practices methods. We aimed to evaluate the knowledge, behaviours, and practices of health workers—and factors associated with these—concerning climate change and environmental sustainability in hospitals, and to identify the expectations of health workers in this regard towards their workplaces.

## Methods

### Study design and participants

This multicentre, cross-sectional, observational survey was conducted between June 1, 2021 and Dec 31, 2022 in six hospitals in southwest France: the Hospital of Niort, the University Hospital of Limoges, the University Hospital of Bordeaux, the University Hospital of Toulouse, the University Hospital of Tours, and the University Hospital of Poitiers (figure 1).<sup>24</sup> The study was conducted and reported according to the STROBE guidelines for cross-sectional studies.<sup>25</sup> All health workers who were employed at one of the six hospitals were eligible to participate. Using a convenience sampling method, participants were recruited through a poster campaign in the areas reserved for health workers, email, and a posting on the intranet page of each health-care facility. On the basis of the international standard classification, health workers who responded to the survey were categorised into seven distinct groups: nursing staff (eg, nurses and physiotherapists); medical staff (eg, doctors, pharmacists, and residents); administrative staff; medicotechnical staff (eg, medical electroradiology technicians and laboratory technicians); technical staff; socioeducational staff; and students and trainees.<sup>24</sup> There were no exclusion criteria. The study was approved by the institutional board of each of the six hospitals.

### Data collection

A 33-question, online survey of knowledge, behaviours, and practices was developed in French. The survey was based on a review of various studies and existing questionnaires on climate change, such as Questionnaire: Climate Change and Health; Views of Health Professionals on Climate Change and Health; and Knowledge and Attitudes Regarding Climate Change.<sup>17,19,26–28</sup> A working group of health workers from three different health-care facilities and several disciplines (doctors, pharmacists, a manager in charge of sustainable development, and health and economics students) developed the questionnaire, which consisted of five parts: participants' characteristics; participants' knowledge and perception related to climate change; participants' pro-environmental behaviours; participants' practice concerning ecological transformation actions; and participants' expectations.

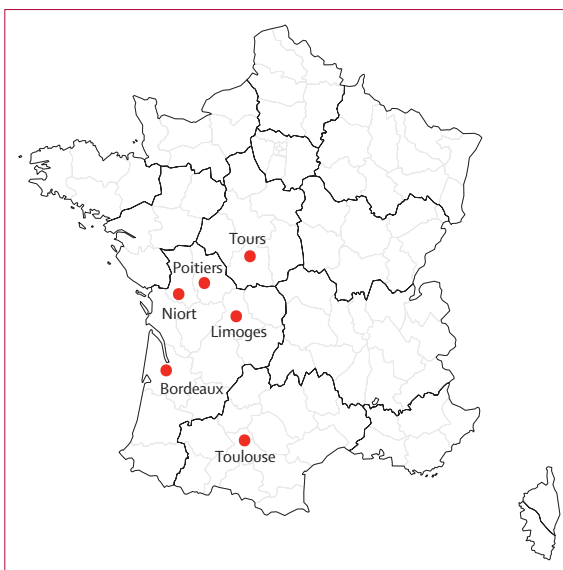


Figure 1: Locations of the six hospitals in metropolitan France, 2023

The survey was pilot-tested by hospital health workers for clarity, scientific accuracy, and length. The finalised questionnaire, which was distributed to all six hospitals, consisted of 20 questions, including two conditional questions and inquiries regarding participants' characteristics, and required approximately 12 min to complete. A version translated into English is available in the appendix (pp 1–3). The completion rate was calculated on the basis of responses to the unconditional questions.

We also collected information on the hospitals: capacity, measured in terms of full hospitalisation (number of beds) and partial hospitalisation (number of places); whether it was a university or local hospital; whether the hospital had a sustainable development steering committee and, if so, the seniority of the committee (ie, how long it had been active) at the time of the survey; whether the hospital had a health worker with dedicated time for sustainable development; and whether the hospital had a structured network of health workers to whom sustainable development inquiries could be referred.

### Contact procedure

After the questionnaire had been validated by the working group and presented to the management of the six hospitals, the information technology department at each hospital created the questionnaire in digital format and made it accessible for all health workers via a link and a QR code available on posters, by email, and via the hospital intranet. Only health workers in the institutions had access to the survey. The survey remained open for 6 weeks, with a single email reminder sent after 3 weeks. Each hospital used a single survey link throughout the duration of the survey period.

See Online for appendix

	University Hospital of Poitiers	Hospital of Niort	University Hospital of Bordeaux	University Hospital of Limoges	University Hospital of Toulouse	University Hospital of Tours
Number of beds and places*	2650	1303	3041	1954	2912	1918
University hospital or local hospital	University	Local	University	University	University	University
Presence of a sustainable development steering committee	No	Yes	Yes	Yes	Yes	Yes
Duration of sustainable development steering committee, years	..	12	13	0	4	14
Presence of a health worker with time dedicated to sustainable development	No	Yes	Yes	No	Yes	No
Presence of a network of health workers for sustainable development referrals	No	Yes	Yes	No	No	No

\*Hospital capacity considers full hospitalisation (number of beds) and partial hospitalisation (termed the number of places).

**Table 1: Characteristics of the six hospitals at the time of the survey**

	n/N (%)
<b>Gender</b>	
Woman	3518/4497 (78.2%)
Man	979/4497 (21.8%)
Missing data	55
<b>Age, years</b>	
≤29	481/4493 (10.7%)
30–39	1386/4493 (30.8%)
40–49	1376/4493 (30.6%)
50–59	1068/4493 (23.8%)
≥60	182/4493 (4.1%)
Missing data	59
<b>Occupation</b>	
Nursing staff	1933/4489 (43.1%)
Administrative staff	836/4489 (18.6%)
Medical staff	752/4489 (16.8%)
Medicotechnical staff	452/4489 (10.1%)
Technical staff	387/4489 (8.6%)
Socioeducational staff	103/4489 (2.3%)
Students and trainees	26/4489 (0.6%)
Missing data	63
<b>Seniority, years</b>	
≤2	442/4424 (10.0%)
3–5	630/4424 (14.2%)
6–10	887/4424 (20.0%)
11–20	1346/4424 (30.4%)
>20	1119/4424 (25.3%)
Missing data	128

Percentages may not total 100 owing to rounding.

**Table 2: Sociodemographic characteristics of the study participants (n=4552)**

**Data management and statistical analysis**

The perception of health workers regarding the level of commitment of their hospital to ecological transformation, obtained as a score ranging from 1 (not a priority) to 10 (high priority), was compared according to the

health workers' seniority (ie, length of employment at their hospital) through use of a one-way ANOVA.

To evaluate associations between the knowledge, behaviours, and practices of health workers and the characteristics of the health workers and hospitals, we used a multilevel logistic regression model with random intercept (level 1, health workers and level 2, hospital). We estimated the proportion of variance explained by the cluster effect. To identify the factors associated with the knowledge, behaviours, and practices of health workers within hospitals, we evaluated four outcomes: the level of knowledge of health workers concerning the activities within their hospital that have the greatest environmental impact (outcome 1); the perception of health workers concerning the level of commitment of their hospital to ecological transformation (outcome 2); how well informed health workers feel about the current status of the ecological transformation of their hospital (outcome 3); and whether a health worker had already initiated an action in favour of the ecological transformation within their hospital (outcome 4). The binary variables were constructed as follows: outcome 1 (knowledge of activities with the greatest environmental impact) was coded 1 if the participant had identified either pharmacy or purchasing as having the greatest impact and 0 otherwise; outcome 2 (perception of the hospital's level of commitment to ecological transformations) was coded 1 if the score was at least 7/10 and 0 if the score was less than 7/10; outcome 3 (feeling informed related to the ecological transformation of the hospital) was coded 1 if the participant answered that they felt fully or moderately informed and 0 otherwise; and outcome 4 (having already initiated an action in favour of ecological transformation within the hospital) was coded 1 if the participant indicated that they had initiated an action and 0 otherwise. After the bivariate analyses of health workers and hospital characteristics with the outcomes, we integrated all health worker and hospital variables into the multilevel logistic regression model. For each outcome, we compared two models: the model containing only participant characteristic variables

cross-tabulated with each outcome (models 1, 3, 5, and 7) and the full model (models 2, 4, 6, and 8) including participant characteristic variables and hospital characteristic variables cross-tabulated with each outcome. The full models are presented as forest plots for each outcome.

Statistical analysis was conducted using RStudio software (version 12.0.353) and Stata software (version 16.0).

### Role of the funding source

The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report.

### Results

Of 57034 eligible health workers at the six hospitals, 4552 (8.0%) participated in the study. The participation rate varied by hospital: 12.0% (386 of 3207 health workers) at the Hospital of Niort, 10.7% (689 of 6435) at the University Hospital of Limoges, 8.8% (1280 of 14497) at the University Hospital of Bordeaux, 7.6% (1214 of 16064) at the University Hospital of Toulouse, 7.5% (705 of 9408) at the University Hospital of Tours, and 3.7% (278 of 7423) at the University Hospital of Poitiers. The characteristics of the six hospitals are detailed in table 1. The questionnaire completion rate was 77.8%, with 3543 participants answering all non-conditional questions.

Of the participants for whom data on these characteristics were available, 1867 (41.6%) of 4493 were younger than 40 years and 2626 (58.4%) were 40 years or older. 3518 (78.2%) of 4497 were women and 979 (21.8%) were men. The participants were mainly nursing staff (1933 of 4489; 42.9%), administrative staff (826; 18.5%), and medical staff (752; 16.7%). 2465 (55.7%) of 4424 participants had been working in their institution for more than 10 years and 1959 (44.3%) for 10 years or less. The sociodemographic characteristics of the participants are detailed in table 2.

Participants considered energy consumption (3230 of 4552; 71.0%), waste and discharges related to medical activities (2529; 55.6%), and waste and discharges related to non-medical activities (2283; 50.2%) to be the three activities with the greatest environmental impact (figure 2). Only 701 (15.4%) health workers correctly identified either or both of pharmacy and purchasing as the activities with the greatest environmental impact (outcome 1).

On a scale of 1 (not a priority) to 10 (high priority), the median rating attributed by the participants to the commitment of their hospitals to ecological transformation was 5.0 (IQR 3.0–6.0). 1102 (24.4%) of 4515 participants indicated a score of 7 or higher and 3413 (75.6%) indicated a score of less than 7 (outcome 2). The mean ratings varied significantly depending on the seniority of individuals within the hospital: 4.8 (SD 2.4) for those who had worked at their hospital for 2 years

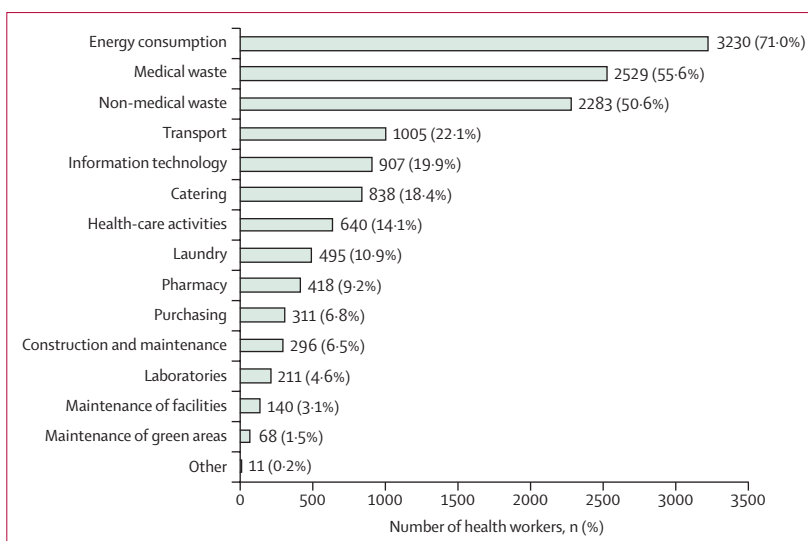


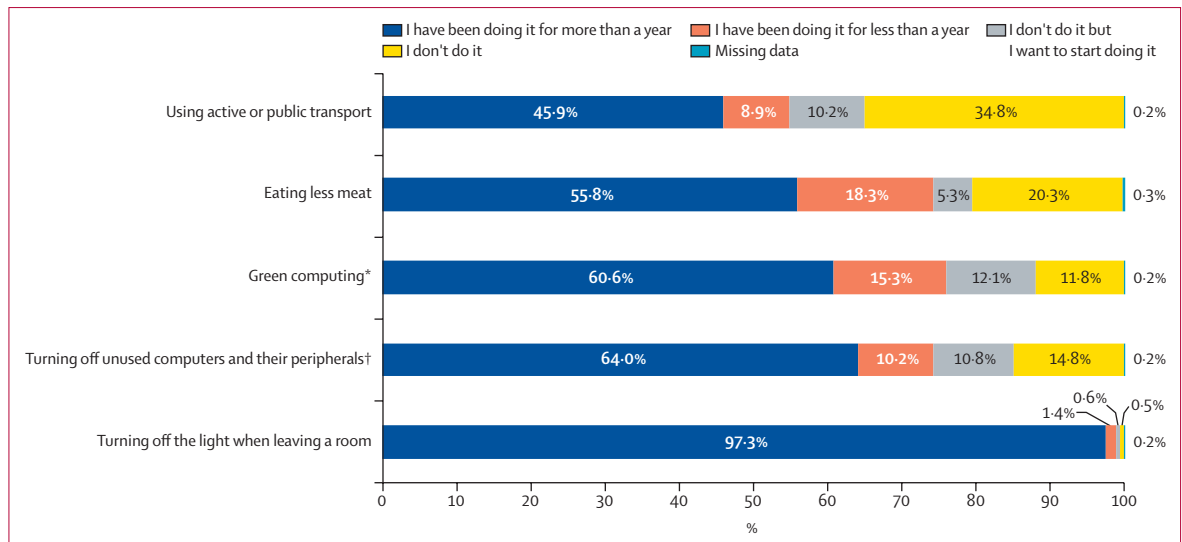
Figure 2: Hospital activities perceived by participants (n=4552) as having the greatest impact on the environment

or less, and 4.7 (SD 2.4) for those with 3–5 years, 4.6 (SD 2.4) for those with 6–10 years, 4.8 (SD 2.3) for those with 11–20 years, and 5.2 (SD 2.3) for those with more than 20 years of service ( $p < 0.0001$ ).

3378 (74.4%) of 4541 participants declared that they were little or not at all informed about the ecological transformation of their health-care facility, and 815 (17.9%) that they were moderately or fully informed (outcome 3). 342 (7.5%) participants said that nothing was happening concerning sustainable development and ecological transformation within their institution.

On a personal daily basis, most participants have adopted behaviours in favour of environmental sustainability, such as turning off unused computers and their peripherals (eg, printers and monitors; [3376/4552] of 4552 participants) and eating less meat (3373 [74.1%]; figure 3). 2492 (54.8%) of 4552 participants used active (eg, walking or cycling) or public transport and 2048 (45.0%) did not; however, 465 (10.2%) did not use such transportation but wanted to start. To obtain the latest news on sustainable development in their institution, participants mainly used the intranet page (1934 [42.5%] of 4552), email (1314; 28.9%), the hospital newspaper (1064; 23.4%), word of mouth (1010; 22.2%), meetings (518; 11.4%), posters in dedicated areas (322; 7.1%), social networks (234; 5.1%), and the press (116; 2.5%). In addition, 413 (9.1%) participants declared using other means of communication, and 505 (11.1%) did not access information on the hospital's ecological transformation.

1079 (23.7%) of 4552 participants had previously initiated at least one action in favour of ecological transformation at their hospital, including 326 (35.5%) of 1280 participants at the University Hospital of Bordeaux, 320 (26.4%) of 1214 at the University Hospital of Toulouse, 192 (27.2%) of 705 at the University Hospital of Tours, 124 (18.3%) of 677 at the University Hospital of



**Figure 3: Participants' (n=4552) pro-environmental behaviours**

\*Green computing consists of optimising the use of information technology equipment to reduce its environmental impact. †Includes devices such as printers, keyboards, speakers, and monitors.

Limoges, 61 (22.3%) of 274 at the University Hospital of Poitiers, and 56 (14.5%) of 386 at the Hospital of Niort (outcome 4). Many initiatives pertained to care, such as recycling paper syringe and tubing packaging in care departments, implementing a new recycling channel for paper surgical masks, and preferring reusable and washable equipment over disposable equipment. Other initiatives were geared towards managing natural resources, such as using detergents and disinfectants more judiciously in favour of other methods for cleaning surfaces, turning off lights and electronic equipment when not in use, minimising paper printing, and installing sensors on the water taps. Some initiatives addressed health and environmental concerns, such as avoiding the use of plastic food containers.

To obtain information about sustainable development in their institution in the future, participants expressed interest in greater use of the intranet (2543 [55.9%] of 4552), email (2258; 49.6%), and the hospital newspaper (1508; 33.1%; appendix p 4).

To implement projects related to ecological transformation, participants indicated that they mainly needed dedicated time (1841 [40.4%] of 4500), hierarchical support (1480; 32.5%), and methodological support (1315; 28.9%). Other needs, such as access to training (1079; 23.7%) and a simplified project validation circuit (1247; 27.4%), were also identified.

784 (17.3%) of the 4530 participants who responded to this question wished to join a working group and 1307 (28.9%) expressed their willingness to take concrete action for the ecological transformation of their hospital. Conversely, 908 (20.0%) participants did not wish to be involved in an ecological transformation process.

For the four outcomes studied, we found a significant cluster effect. However, this cluster effect explained only

a small proportion of response variability ( $\leq 5\%$  for the four outcomes). The proportions of variance explained by the hospital level of the model containing only participant characteristic variables cross-tabulated with each outcome empty model are: 1.2% for outcome 1 ( $p=0.0005$ ), 0.3% for outcome 2 ( $p=0.14$ ), 5.0% for outcome 3 ( $p<0.0001$ ), and 1.9% for outcome 4 ( $p<0.0001$ ). Health workers had a better knowledge of activities with environmental impacts (outcome 1) if they worked in a hospital with a steering committee dedicated to sustainable development ( $p=0.0018$ )—more so if this committee was long standing ( $>5$  years; adjusted odds ratio 1.78 [95% CI 1.29–2.45]; figure 4, outcome 1). Health workers had a lower perception of the level of commitment to sustainable development within their hospital (figure 4, outcome 2) if it was a university hospital (0.57 [0.37–0.88]) rather than a local hospital. However, the greater the seniority of health workers, the better their perception of their hospital's level of commitment. Having an administrative or technical function was associated with a better perception than being a medical professional. Working in a university hospital rather than a local hospital was associated with health workers feeling less well informed (figure 4, outcome 3; 0.44 [0.25–0.76]), whereas the existence of a steering committee in the hospital was associated with a feeling of being better informed. In addition, the longer health workers had worked at their hospital, the better informed they felt. Having an administrative or technical function was associated with a greater sense of being well informed about sustainable development issues in the hospital than being a medical professional. Finally, having a sustainable development steering committee was positively associated with the initiation of environmental sustainability actions (figure 4, outcome 4)

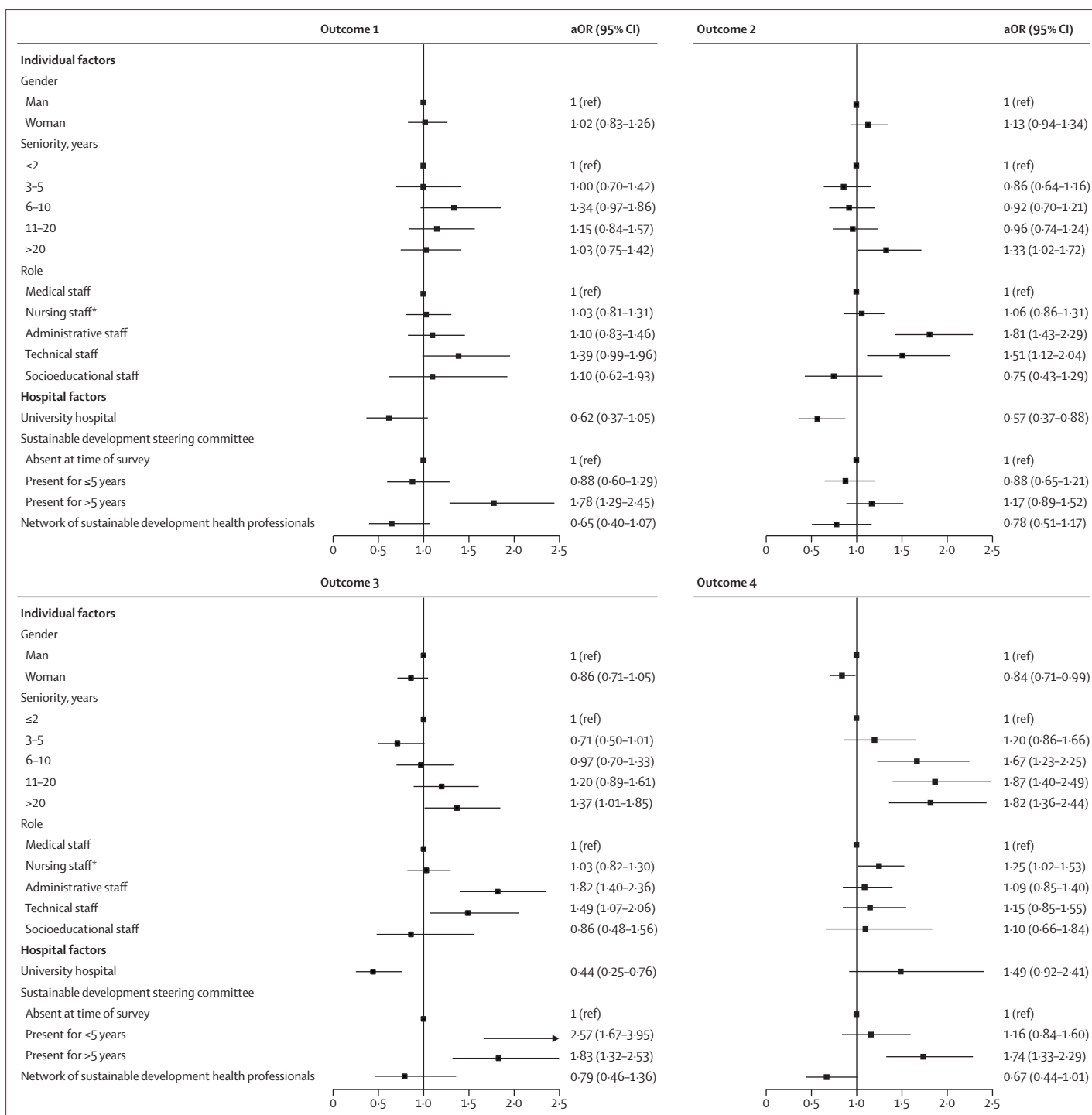


Figure 4: Forest plots of the multilevel multivariate models for the four outcomes by individual-level and hospital-level variables (n=4552)

Outcome 1 is knowledge of activities with the greatest environmental impact, outcome 2 is perception of the hospital's level of commitment to ecological transformations, outcome 3 is the level of information related to the ecological transformation of the hospital, and outcome 4 is initiation of actions in favour of ecological transformation within the hospital. The variables relating to the age of participants, the number of beds and places in the hospital, and the presence of a health worker with time dedicated to sustainable development were not included in the regression models owing to collinearity. The proportions of variance explained by the hospital level of the model containing only participant characteristic variables cross-tabulated with each outcome are: 1.2% for outcome 1 (p=0.0005), 0.3% for outcome 2 (p=0.14), 5.0% for outcome 3 (p<0.0001), and 1.9% for outcome 4 (p<0.0001). aOR=adjusted odds ratio. \*Includes nursing staff, medicotechnical staff, and students and trainees.



if this committee was long standing (>5 years; 1.74 [1.33–2.29]). In terms of individual characteristics, being a woman was associated with a lower level of initiation of an environmental sustainability-related action within the hospital (0.84 [0.71–0.99]), and the longer health workers had been working at the hospital, the more they declared having initiated an environmental sustainability action. All results of the multivariate multilevel models are shown in the appendix (p 5). The variables related to the age of participants and the capacity of the hospital, and to the presence of a health worker with time dedicated to sustainable development, were not included in the regression models because age was collinear with the variable seniority and because the capacity was collinear with the variable relating to hospital type. These variables therefore do not appear in figure 4 and the appendix (p 5).

## Discussion

To our knowledge, this study is the first to assess the knowledge, behaviours, and practices—as well as associated factors—of health workers regarding climate change and environmental sustainability in French hospitals and to identify their expectations regarding these issues in the workplace. This large-scale, multiregional study involved thousands of health workers, making it one of the largest nationwide studies on the subject in the world.<sup>17,19,20,29–31</sup> One such multinational study involved 3977 health professionals who completed a survey, including 320 from the British Medical Association, but none were from a French or other European organisation.<sup>19</sup> In our study, the participation rate was 8.0% (range 3.7–12.0), which could be perceived as low, reflecting a lack of interest in the subject among health workers. However, this rate aligns with those reported in other observational, questionnaire-based, cross-sectional studies.<sup>17–19</sup> In our study, the distribution of respondents broadly reflected the distribution of health workers working in the six hospitals, as reported by hospital data. However, we observed a notable over-representation of administrative staff and an under-representation of nursing staff. This discrepancy could be attributed to administrative staff having easier access to a computerised questionnaire than nursing staff. The completion rate of 77.8% was comparable to that in other cross-sectional studies using online questionnaires for health workers.<sup>32,33</sup> If we exclude the open-ended question regarding the proposal for environmental sustainability action—which takes longer to answer, necessitates having ideas of actions to propose, and consequently led to a lower response rate from participants—the completion rate is 93.7%.

International studies have shown that health professionals have a strong understanding that climate change is happening and is caused by human activities<sup>19,34</sup> and that they comprehend the negative impacts of climate change on human health.<sup>19</sup>

Given the dual challenge of climate change—in which hospitals need to reduce their environmental impacts as well as limit the effects of climate change on their activities—all health workers should be trained in and committed to the ecological transformation of their workplaces. However, the knowledge of the French health workers in our study regarding climate-impacting activities is, overall, inaccurate. The activities with the greatest environmental impact were not identified by most of the participants. In European countries, the most impactful activities in the health sector are related to medicines, medical devices, and other health products, including purchasing and the entire supply chain.<sup>11,35</sup> These sources of greenhouse gas emissions are included in scope 3 of a greenhouse gas balance, which corresponds to so-called indirect emissions.<sup>11</sup> Such emissions account for the vast majority of emissions in the health-care sector.<sup>11,35</sup> Health workers' perceptions could originate from the fact that waste is an important safety issue and is one of the most visible aspects to them; several articles address this issue specifically.<sup>36,37</sup> Furthermore, the links between energy, climate, and health described in the scientific literature—as well as the recurrent association of the issues of energy and climate in politics, the media, and public debate—could influence perceptions in the professional health-care setting.<sup>38</sup>

The level of commitment of hospitals to climate change was perceived by participants as average. It therefore seems important for hospitals to set up a sustainable development steering committee to drive the institutional dynamic, make initiatives more visible and—especially with the long-term anchoring of such a steering committee—help to develop environmental sustainability actions. A long-term, structured approach seems necessary. Such institutional dynamics, which have been developing over approximately the past 15 years, cannot solely rely on goodwill but need to be organised and structured by dedicated medical and non-medical professionals. The National Health Service (NHS) England plan Delivering a Net Zero NHS specifies that it will be necessary to have upskilled health-care professionals leading and implementing these interventions and changes.<sup>11</sup> The recent roadmap for ecological planning of the French health-care system—published in May, 2023 and updated in December, 2023—aims to encourage the health-care system, and particularly health-care facilities, to make several ecological transformations.<sup>39</sup> A new nationwide strategy should not only encourage more concrete sustainable actions in hospitals, but also make the sustainable development strategy in health care more transparent for health workers. In the UK, commitments and actions go even further and include all stakeholders, for example by setting constraints on suppliers.<sup>40,41</sup>

Regarding pro-environmental behaviours, most health workers have taken actions and individual initiatives that have a positive effect on the environment, such as eating

less meat. This finding is consistent with that of other studies on food consumption in France.<sup>42,43</sup> The motivations behind these dietary changes are being studied as part of the French NutriNet-Santé cohort.<sup>44</sup> However, given the self-reporting method used in this study, a social desirability bias is possible, although less important than in studies that involve an interviewer.<sup>45–47</sup> The use of public or active transportation by health workers could be influenced by the availability of infrastructure. For example, those living in rural areas might lack access to adequate public transport or mobility networks found in urban areas. These individual initiatives are reinforced by commitment on the professional side. Nearly 25% of participants have initiated environmental sustainability actions in the hospitals in which they work, indicating that, although there is a strong desire for commitment among health workers, as indicated in other studies,<sup>30,31,48</sup> concrete actions still need to be developed. The readiness of health workers to act and the evolution of their actions are crucial because they face a dual challenge in the context of climate change. A 2024 French study of health professionals working in head-and-neck surgery found that almost all viewed making efforts for the environment in surgical procedures as important.<sup>49</sup> This finding illustrates the increasing sense of responsibility felt by health workers for climate education and advocacy, associated with an increased willingness to participate in advocacy on climate policies.<sup>50,51</sup> However, investigating the position occupied by climate risk among all other risks—and why, considering the participation rate, awareness of this risk still appears to be low among health workers—would be of interest. These individual or team initiatives should also be combined with clinical guidelines that include eco-responsibility issues in care; some learned societies, such as the French Society of Anesthesia and Intensive Care Medicine, have developed recommendations to help to change practices.<sup>52</sup>

In addition, we identified some expectations of health workers in terms of climate change and their institutions. Despite their strong commitment and sense of responsibility to the population, health workers face several obstacles to action—including time constraints, lack of support, and lack of training courses. Although our study shed light on several obstacles, there exist others that are described in previous studies<sup>30</sup> and others that have yet to be identified. These findings were also reported in a multinational study.<sup>19</sup> In the study of health professionals working in head-and-neck surgery,<sup>49</sup> 93% identified training courses as a lever for reducing the environmental impact of their surgical practices. The demand and need for training is a shared expectation among health students and health workers alike.<sup>19,53</sup> Although a major challenge, the provision of initial and continuous training to students and health workers could help to remove this obstacle to action, increase the sense of purpose among health workers, and raise awareness of environmental issues.<sup>19,54</sup> Our study has

identified, for the first time to our knowledge, factors associated with the level of knowledge of health workers on environmental sustainability in hospitals in France, their perception of the level of commitment given by hospitals, the level of information they received, and their initiation of environmental sustainability action. Having a structured organisation with a steering committee was associated with better information, better knowledge, and more environmental sustainability actions. These findings are in line with the usual missions of a steering committee in the health sector, notably oriented towards governance, coordination, communication, training, and support for actions in connection with a roadmap.

Working in a university hospital, rather than a local hospital, was associated with a poorer perception of the information received and a lower perception of the hospital's commitment. Yet communication is particularly important as a means of informing all health workers about ecological transformation, raising their interest in the topic, and mobilising them to action. Larger hospitals, such as university hospitals, tend to have a more complex hierarchy and organisational structure, which can lead to challenges in communication. In smaller hospitals—which often have a flatter organisational structure and closer collaboration—more direct, more frequent, and better communication between health workers is facilitated, including with management.

Although new legislation compels health systems to tackle climate change, the environmental impacts of the health sector and health-care facilities are even broader.<sup>7,12</sup> The development of a global strategy on the environmental, social, and economic issues of health-care facilities is therefore essential. Actions and their evaluation must be carried out with a sustainable development vision that fully integrates climate issues—including, for example, biodiversity and water resources, gender equality, and sustainable communities. To meet the environmental, social, and economic challenges of sustainable development, hospital roadmaps should include several goals that cover not only decarbonisation but also other issues related to sustainable development, and have indicators that enable the assessment of trajectories and achievement of objectives.

Raising awareness among health workers about the dual challenge of climate change is a relatively new approach.<sup>13</sup> However, to enable comprehensive consideration of these issues, it is imperative that decision makers, health workers, and future health workers are equipped to engage actively and become catalysts for this dynamic shift. This study identified several barriers and potential drivers for such commitment. For instance, there is a pressing need to bolster training for all health workers, and potentially also for students, to provide better support to stakeholders.<sup>19,55</sup> Additionally, identifying the vulnerability of health-care facilities to climate change,<sup>56</sup> enhancing structural frameworks within hospitals, integrating hospital

risk management with sustainable development initiatives,<sup>2</sup> establishing financial incentives, and fostering regional collaboration for the adaptation, mitigation, and anticipation initiatives in health-care facilities could be essential. Climate simulation exercises, or stress tests, could be developed to aid health-care facilities in increasing preparedness and fostering a collective understanding of associated risks, thereby contributing to a climate-resilient health system.<sup>3</sup> Moreover, to strengthen the transition towards a proactive stance on anticipation, there could be a need to encourage interdisciplinary research on the vulnerability of health-care facilities to climate change that—unlike classic research strategies—emphasises resource utilisation rather than solely focusing on risk reduction.<sup>57</sup> Consistent with this trajectory, an increasing number of hospitals have been adopting the ethos of Health Promoting Hospitals. These endeavours align with the principles of health prevention, health promotion, and anticipation of climate change impacts.

We acknowledge some limitations of this study. First, we included only public-sector hospitals; we did not include health workers in private-sector (private not-for-profit and private for-profit) hospitals. The public sector employs nearly 80% of all health workers in the hospital sector and covers all types of care, including the most complex;<sup>58</sup> however, despite this coverage, the results are not necessarily generalisable to all health-care settings in France. Second, given the cross-sectional nature of this study and the use of a questionnaire, a volunteer bias was possible, and the sample could have been biased towards health workers from particular disciplines or those feeling most concerned by the topics of climate change and environmental sustainability. However, the characteristics of the participants in terms of gender, age, and role are similar to those of health workers in public hospitals nationwide in France.<sup>59</sup> In addition, the multicentric and multiregional nature of the study, and the large sample size, reinforce the validity of the findings. Third, new hospitals (public and private) from across France are still asking to take part in the survey, with the aim of making an initial assessment of their sustainable development strategy. The main results from these hospitals seem similar to our findings, reinforcing the value of our study. Finally, the questionnaire was available online through a link or QR code, allowing participants to access it multiple times. However, although it was possible for health workers to complete the questionnaire more than once, it seemed unlikely owing to the time investment required, and we assessed this risk as low.

This study has shown that, despite some misperceptions regarding which hospital activities exert the greatest environmental impact, French health workers seem to be committed to the ecological transformation of their hospitals. We identified some drivers and obstacles to the pursuit of these transformations, which are essential if hospitals are to commit to a sustainable development strategy in the fight against climate change.

#### Contributors

JG, NB, BJ, IB, CS, SA-T, and VM conceptualised the study. JG, GC, PB-P, NB, BJ, IB, CS, SA-T, and VM developed the methods. JG conducted the investigation and curated the data. JG, GC, PB-P, EP, SA-T, and VM did the formal analysis. JG, GC, PB-P, EP, SA-T, and VM created the figures and tables. All authors validated and approved the results. JG, NB, BJ, SA-T, and VM were responsible for project administration. JG, NB, BJ, SA-T, and VM supervised the project. JG, GC, PB-P, SA-T, and VM wrote the original draft of the manuscript, which was reviewed and edited by all authors. JG, VM, and SA-T accessed and verified the raw data. All authors had full access to all the data in the study and had final responsibility for the decision to submit for publication.

#### Declaration of interests

We declare no competing interests.

#### Data sharing

The data used in our analyses will be made available from 30 days after publication and can be obtained from the corresponding author. Data will be shared after the approval of a proposal with a signed data access agreement.

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