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Open database for international and national indoor environmental quality guidelines

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The United Nations has mandated clean air as a human right.[1] In addition, many influential international and national organizations have declared the right to a healthy environment.[2] There is growing evidence that projected climate change has the potential to significantly affect public health directly or indirectly. Developing effective mitigation

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AUTHOR CONTRIBUTION

All authors are active members of ISIAQ STC34 and have equally contributed to writing this editorial. Therefore, the authors are listed in alphabetical order of last name except for three: Oluyemi Toyinbo has contributed to populating the database and analyzing its content. Ulla Haverinen-Shaughnessy and Linda Hägerhed are the chair and vice-chair of the STC34, respectively.

CONFLICT OF INTEREST

We have no conflict of interest to declare.

DISCLAIMER

The views expressed are the authors and do not necessarily represent the views of their organizations.

policies for residential and non-residential environments requires a better understanding of how parameters that affect indoor environmental quality (IEQ) (i.e., indoor air quality, ventilation, thermal comfort, noise, and lighting) interact, and how current and emerging trends in building construction, materials, infrastructure design, and use may affect these IEQ parameters and hence our health and wellbeing.[3,4] In this context, developing IEQ guidelines and setting standards are at the very core of defining and providing clean and healthy indoor environments.

Globally, there is no consensus about IEQ standards, regulations, or guidelines. However, national regulations and guidelines from some individual countries and guidelines from professional organizations exist, as well as IEQ guidelines developed by international agencies such as the World Health Organization (WHO). While regulations are enforced by the law of a country, guidelines are voluntary. Obtaining and referencing individual countries' existing IEQ regulations or guidelines are useful for policy makers, scientists, and practitioners globally. However, getting access to such information can be challenging, for example, due to language barriers and the lack of an open database. Prior to the 2018 Indoor Air conference, a group of International Society of Indoor Air Quality and Climate (ISIAQ) members discussed the challenges of international IEQ guidelines. They noted that using the existing guidelines in an international context opens many questions about the applicability of the guidelines in different settings, their comparability, and limitations. To help overcome these challenges, an ISIAQ Scientific and Technical Committee (STC34) was initiated in September 2020. The committee aims to continuously monitor, collect, and organize information about IEQ guidelines worldwide, and to develop IEQ recommendations. In 2021, STC34 created an open IEQ database that is freely accessible through our website, www.ieqguidelines.org. Currently, the database is focused on indoor air quality (IAQ) parameters. In 2022, we intend to extend the database to include standards, regulations, and guidelines related to ventilation, comfort, acoustics, and lighting.

The current database includes information from over 30 countries, mostly from Asia and Europe. At present, we have no data from the African continent (Figure 1). There are over 70 individual indoor air pollutants in the database.

Overall, the regulations and guidelines for indoor air pollutants assembled in the current IEQ database present great diversity and complexity, not only among countries, but also within countries. The practice showed that they are not always used to achieve the best impact. In addition, not all countries have government-regulated IEQ standards (i.e., permitted levels of indoor air pollutants). There are countries where specific premises, like schools or offices, are regulated. Moreover, there are countries, where government ordinances regulate many pollutants, but there are limited procedures to enforce such laws.

Occupational exposure limits (OELs) for workplaces cover a much wider range of chemicals, are set at high time-averaged concentrations, and applied to healthy adults who are exposed over time at workplaces. Therefore, the IEQ database does not include OELs since they are not appropriate for the general population, which includes vulnerable groups such as children and the elderly. There are health-based guideline values for a limited number of indoor air pollutants issued by the WHO[5,6] and other health organizations

worldwide. WHO has recently revised the global air quality guidelines, expressed as long-term and short-term concentrations for major health-damaging pollutants, namely particulate matter (PM_{25}, PM_{10}), ozone, nitrogen dioxide, sulfur dioxide, and carbon monoxide.[7] These health-based guidelines are not legally binding standards, but they can inform legislation and policy development in countries choosing to adopt the guidelines. In principle, the guidelines are applied both to outdoor and to indoor environments. However, for some pollutants (e.g., particulate matter and ozone), the evidence for guideline development is derived only from outdoor studies, so the difference in toxicity of particulate matter between outdoors and indoors might not have been considered.

Although the newly revised WHO guidelines[7] for a limited number of pollutants provide health-based guideline values, standards/regulations for many other pollutants set by individual countries are not health-based. Our current IEQ database also indicated large variation among countries in the number of indoor pollutants that are regulated or guided by governmental entities, and in the guideline values for the same pollutants. This seems true, even after considering the dependency of the guidelines on health endpoint, target population, and duration of exposure. The variation among countries seems more perceivable for pollutants without health-based exposure limits. Therefore, it would be challenging for users to interpret individual countries' regulations or guideline values in the database without knowing the specific criteria for setting those values.

It appears that health-based international guideline values would best guide individual countries' policy makers in establishing their own regulations with consideration for local factors such as specific climate, degree of risk acceptability, available technologies, economy, and policies. However, establishing health-based guideline values is extremely time consuming and challenging because it requires a significant amount of representative epidemiological and toxicological data. To document these scientific criteria with reliable research, the sampling and analytical methods used should also be standardized. Evidence from high-quality epidemiologic studies of individual indoor pollutants and selected health outcomes showing exposure-response relationships are also crucial. Unfortunately, we do not have sufficient scientific information to support the health-based guideline values for many of the indoor pollutants included in the database. Nonetheless, indoor pollutants still need to be controlled or managed to protect occupants' health indoors. Thus, setting non-health-based guideline values accompanied with adequate documentation would be a good start. In addition, it would be beneficial to develop a consensus guideline for policy makers to help them set their own provisional limits to maintain acceptable IAQ until more universal health-based guidelines values are available.

Although guidelines and regulations exist for numerous individual pollutants, the complexity of exposure to pollutants is increased by the fact that in the real world, we are simultaneously or sequentially exposed to multiple pollutants indoors. When setting standards, we should also bear in mind that different pollutants might interact under different conditions to produce additive, synergistic, or antagonistic effects on human health. Generally, there is a lack of tools to evaluate complex health effects of mixed exposures. We can refer to the recently published WHO screening tool for assessment of health risks from combined exposure of children to multiple chemicals inside schools.[8] When further

developing guidelines, it could also be useful to develop proxy measures representing mixed exposure scenarios.

The open database has already proven to be a time-saving resource for researchers and those working on building design standards and guidelines. For example, one author is leading an effort to write a guideline to protect building occupants from wildfire smoke, and the committee (ASHRAE GPC44P) was interested in the availability of national and international PM guidelines. Such an effort could take a researcher days to find and collect just a few values, but with access to the database, the author easily assembled a list of nearly 40 values from 20 countries and organizations.

With respect to utilizing and further developing the IEQ database, we need to consider that guidelines may change over time, creating the need to follow the individual countries' regulations or guideline values and continuously update the database. In addition, assembling any criteria documents supporting the current non-health-based guideline values of individual countries in the future would be greatly beneficial for the users. Although the database already has some historical data, we envisage that adding more historical data would give insight into tracking improvements in the guidelines and regulations and help with future predictions. In addition, it is possible that historical data are still in use for some old buildings (including historical buildings) that may or may not meet the current standards. It is also possible that countries that are not currently represented have these historical guidelines or regulations. Because most of the national guidelines and regulations are written in their own languages, it is essential to maintain a committee whose members represent as many countries as possible.

With this editorial and other forms of dissemination, and by continuously updating the database with new information as it emerges, we hope that in the future the database can be used as a stepping-stone to establish and improve the situation in countries that currently have fewer representative regulations or guidelines. For countries that are currently missing from the database, but have regulations or guidelines in place, we would be grateful to be contacted and provided with appropriate documents to populate the database. Overall, we hope that sharing the information will help to develop more comprehensive, uniform, and science-based guidelines in the future.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this editorial are available at www.ieqguidelines.org.

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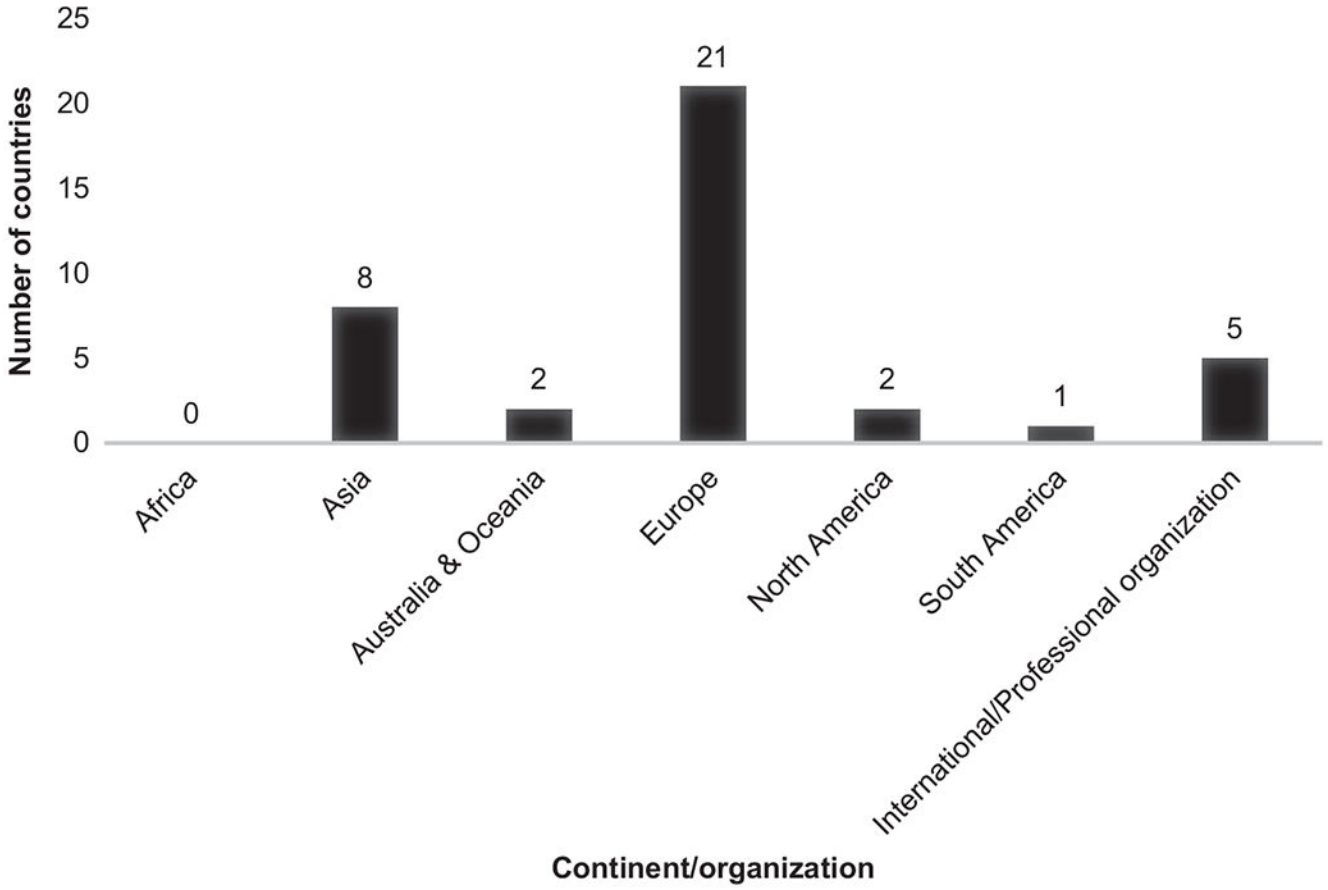

FIGURE 1.
Distribution of countries by continent/organization in the open IEQ database