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Climate change impacts on working people: how to develop prevention policies

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The evidence on negative consequences from climate change on human health and well-being is growing (1–5). The Intergovernmental Panel on Climate Change (IPCC) described climate change as a threat to the climate system that sets the basis for life and human health conditions (6). The changing climate is expected to affect basic requirements needed to support and sustain human health such as good food, clean water, and unpolluted air, with negative effects that are expected to be unequally distributed.

Climate change has several direct adverse effects on working people such as heat exhaustion and heat stroke (7), as well as indirect effects including increased risks for infectious diseases, changing distribution and transmission patterns of vector-borne diseases, malnutrition, water and sanitation problems, and injuries due to extreme weather events (5). The poorest countries and the most vulnerable and marginalized individuals in all countries will experience the worst consequences from climate change (5, 8, 9). Regardless of the wealth of any nation, those who are poor, sick, very young or old, and those working intensely in high heat exposure are most at risk (10).

Climate change and health is a relatively new research field that has a number of gaps in both current evidence and future projections. Strong calls have been made (5) to develop and implement strategies for mitigation and adaptation to the changing climate to protect health. Some of the predicted risks to health will be reduced by general improvements in public health in line with the Millennium Development Goals (9). Other risks can be managed by 'adaptation policies and actions,' the success of which will depend on the speed and extent of climate change and the level of global cooperation to implement measures to support and protect vulnerable regions and populations. The reduction of negative effects of excessive direct heat exposure on the health and productivity of

working people are more difficult as air conditioning cannot be applied in all workplaces.

The world is getting hotter and projections suggest that temperatures will continue to increase. During the last 100 years, the global average surface temperature has increased about 0.74°C and over the past 50 years more widespread changes in extreme temperatures and precipitation have been reported and the rate of change has increased over time (6).

Areas with very hot seasons will be particularly affected, as the heating world brings extreme heat conditions. Heat waves and increasing temperatures are reported to have fatal and severe non-fatal impacts on human health (11). It is expected that mortality associated with increased temperatures, including those from extreme heat events, will become more extensive geographically with increased climatic variability (12).

In this special issue of *Global Health Action* a collection of papers are published in connection with COP 16 (Cancun, Mexico, December 2010) focusing on the impact of the current climate and climate change on working people. Most of the papers deal with conditions related to heat exposure and some relate to other occupational health problems linked to climate change. The impact of a changing climate on health, well-being, and productivity of working people is an area with consequences at all levels of society: family, community, region, country (7). There are also economic consequences for individual workers and their families, employers, and countries that deserve special attention.

Potential links between work, health, and climate change

High temperatures and humidity will have an increasing impact on occupational heat exposures, morbidity, and mortality (13). Climate change effects of extreme weather events, increased temperatures and precipitation, and

effects due to air pollution are examples where there already is an impact on working people and the negative health consequences from these changes are expected to increase.

In a paper in this issue, Hollowell discusses heat-related risks as part of the history of different approaches to heat and its effects on the daily life and health of working people (14). One of many perspectives discussed by the author is the lack of focus on women at work, a situation that probably reflects the underrecording and lack of value placed on women's labor at home and traditional family-based agriculture and small-scale industry. Gender is an underrepresented or non-existent variable in research and policy in the field of climate change and health as reported by Preet et al. (15). Work during pregnancy may be particularly affected and a key policy issue is the extent to which occupational health practices and regulations reflect the prevention needs of vulnerable groups. Encouraging and funding research on this topic is also an important issue for policy development.

Bennett and McMichael address a number of impacts on worker health that are not associated with exposure to heat, including vector-borne diseases, infectious diseases, extreme weather events, malnutrition, stress, and mental health issues (16). The risks due to extreme weather events create major demands on the health care system and often put workers under great psychological pressure and stress. Impacts on workers health and well-being will occur in all countries but low-income countries are at greatest risk. Farmers and other outdoor workers are vulnerable and recovery from extreme events may take months or years.

The main industrial sectors in hot countries that are directly affected by increasing average heat exposures include agriculture, fisheries, forestry, and construction work with indirect affects in the tourism, health, and finance/insurance sectors. Almost two billion of the world's farmers are vulnerable to impacts from climate change as they are poor and live in rural areas, mainly in Africa and Asia. Their subsistence living from agriculture is dependent on a specific range of temperature and rainfall and their capacity to adapt and protect themselves is limited. For example, avoiding heat stress during work by spending more time working at dawn or dusk is according to Bennett and McMichael likely to increase the risk of dengue fever as the mosquitoes are more actively biting during those parts of the day (16).

Several papers in this collection deal with direct effects of occupational heat exposure. Holmer points out that there is no global agreement on which heat exposure variable to use for analysis of current and future health risks (17). The Wet Bulb Globe Temperature (WBGT) is the most commonly used in international and national standards and for monitoring at workplace level, but there are also advantages with other variables such as the

Predicted Heat Strain (PHS). The different approaches proposed in the scientific literature over recent decades (including the new Universal Thermal Climate Index, UTCI) need to be compared and assessed for future use.

The majority of study settings reported in this collection are from low- and middle-income countries. Three of them aim at increasing understanding about occupational heat stress conditions in order to establish a basis for future interventions. In *Nigeria*, Balogun et al. studied and compared heat levels in rural and urban environments in a medium sized city, highlighting the importance of better understanding of seasonal variations and factors interacting with heat stress conditions to be able to prevent heat-related health problems among working people (18). Ayyappan et al. carried out case studies in 10 different industrial settings in *South India* to explore the perceptions on occupational heat stress among workers and management (19). The lack of control of heat exposure originating from outside the workplace was mentioned as a perceived weak link for managing work-related heat stress. Crowe et al. evaluated heat stress conditions for sugar cane workers in *Costa Rica* and showed a clear risk of heat stress for workers even in the non-harvest season considered to be the least intense season for heat (20).

Two other studies also explored perceptions of workers regarding their work environment in a hot climate. In a study carried out in *Thailand*, Langkulsen et al. examined the relationship between the climatic conditions, workers' health status, and productivity in two occupational settings: one industrial and one agricultural (21). The authors concluded that the climatic conditions had the potential to affect both workers health and productivity. Mathee et al. reported in a *South African* study that people working in sun-exposed conditions in hot parts of the country experienced heat-related health effects with impacts on their well-being and productivity (22).

Overall, these studies show that in low- and middle-income countries with long periods of high heat exposure for certain groups of working people, most workers express concern about heat. Productivity reductions down to half of 'normal levels' are reported in some situations. However, more quantitative data are needed to document the full impact of heat, which naturally varies considerably between individual workers.

In a study from *Cameroon*, Dapi Nzefa et al. assessed the impact of indoor heat on the health of high school children (age 12–16) while attending school and adverse symptoms including headache, fatigue, and vertigo were reported (23).

A paper by Hyatt et al. shows maps of heat exposure (as the calculated indoor WBGT during afternoons) in 1975 and 2000 in four regions: Australia, South Asia, Southern Africa, and the Mexican Gulf region (Central America and southern USA). These maps provide a

powerful visual presentation of the geographic heat exposure variations in work places (indoors or in the shade). As an indication of future occupational heat stress, WBGT maps with a 3°C increase above the 2000 levels were produced. These show how heat stress may increase during this century, particularly for India, Pakistan, and southern parts of the USA. The maps also show what is already happening to outdoor workers by adding 3°C to WBGT, a calculation similar to the additional heat stress caused to people working outdoors in the sun (24).

Current policies and practices to reduce occupational health impacts

The effects of excessive heat exposure on working people may have substantial social and economic impacts on the exposed communities. Preventive policies, oriented to both mitigation and adaptation, will need to be strengthened or initiated. Particularly vulnerable sectors and populations need to be identified and protected from future adverse effects.

Considerable knowledge exists about the physiological and pathological mechanisms behind direct effects of climate variables on human health and performance at an individual level (13, 25). However, the knowledge and awareness on how climate change can and will affect the health and productivity at population level is lacking and the indirect impacts on enterprises, communities, and the national economy need to be considered.

There are existing occupational health and safety policies and practices that are either relevant for climate change mitigation and adaptation or that directly address the problem of heat in the workplace. Such policies and practices range from the global to the local level and a few examples follow. At the international level, the World Health Organization promotes occupational health and the improvement of working conditions. In 1996, the WHO Global Strategy on Occupational Health for All was endorsed by the World Health Assembly, followed in 2007 with the WHO Global Plan of Action on Workers' Health (GPA). The objectives of the GPA support a broad array of actions that are all relevant for protection of workers from climate change impacts (26). For example:

1. Strengthening of national health systems to respond to the specific health needs of working populations.
2. Providing a basic level of health protection at all workplaces to decrease inequalities in workers' health between and within countries and that strengthen the promotion of health at work.
3. Creating access for all workers to preventive health services and linkage of occupational health to primary health care.
4. Improving knowledge for action on the protection and promotion of the health of workers and the establishment of linkages between health and work.
5. Stimulating actions on workers health into other policies, such as sustainable development, poverty reduction, trade liberalization, environmental protection, and employment.

However, beyond encouraging words WHO has done little to link occupational health to the protection of people from the direct health hazards of climate change. The most recent scientific document from the WHO on the risks of workplace heat exposures was published more than 40 years ago (27).

Another international agency, the International Labor Organization (ILO) has become more active on climate change mitigation and adaptation during recent years. One example is their climate neutrality objective included in the ILO Strategic Policy (28). However, the important issue of occupational health and safety in relation to climate change hazards appears to have been overlooked. This is somewhat surprising as ILO is tripartite with a strong formal influence from trade unions.

The World Meteorological Organization (WMO) could also play a role in developing policies and programs to protect working people from the changing climate. The recently developed UTCI is an attempt to create a heat stress index that can be used in a similar way in all countries, but unfortunately it is limited to 'general public' heat stress perception and specifically does not apply to worksite situations (29). Hopefully, further development of UTCI can incorporate guidance for workplace heat assessment and protection.

International Standards have a role to play in addressing problems related to climate change. The International Organization for Standardization (ISO) makes recommendations relevant to climate change mitigation and adaptation. ISO's voluntary technical standards can contribute to mitigation via recommendations for air and water quality, vehicle emissions, and environmental management systems (30). In addition, the series of ISO standards on the 'thermal environment,' which recommend methods for measuring and interpreting heat stress in workplaces, provide clear guidance for prevention of health effects on working people. These ISO standards have been the basis for development of national guidelines in a number of countries (13).

Need for new policy initiatives and preventive actions

In 1991 the WHO's third international conference on health promotion emphasized the association between health, environment, and sustainability in its declaration: 'The issues of health, environment and human development cannot be separated. Development must imply

improvement in the quality of life and health while preserving the sustainability of the environment' (31). This holistic view is more valid than ever. We need new long- and short-term policy initiatives and preventive measures that are broad and take a multidisciplinary approach based on current knowledge and concerns for the ecological and climatic system. Such measures can both protect the health of individuals while contributing to sustainable development.

The impacts on workers health and productivity from increased heat due to climate change have to be recognized and given sufficient attention in policies and practices. This issue requires a new focus at all levels: global, national, regional, and local (see Fig. 1) addressing both long-term and short-term goals and measures. Binding primary mitigation agreements at the global level are needed to reduce health threatening climate change. Populations in low-income countries are the most vulnerable to the adverse health effects, while being the least responsible so any global agreements should include strategies on how high-income countries can contribute to the protection of more vulnerable nations and populations. National legislation needs to be adapted as the next link in the mitigation chain and incentives created for a climate resilient industrial and technical development.

Decision makers have a responsibility to develop, implement, evaluate, and improve guidelines and standards that protect workers health under changing climatic conditions. Governments and their national and local agencies, employers, workers, and their organizations need to discuss and agree on effective policies and prevention programs that will sustain and improve productivity and workers health. Such a dialogue is crucial to share information and to build knowledge, trust, and a willingness to adapt. New tools and strategies based on local conditions will have to be developed.

Fig. 1. From global policy to local practice for workers health and productivity.

Resilience building that minimizes negative health impacts includes general improvement of public health and occupational health in each location and country. The capacity of health systems need to be improved and their capacity for the diagnosis and control of threats to health emerging from climate change must be strengthened so they are able to intervene and give appropriate support and treatment. The health sector has to be prepared for new challenges from climate change and need to broaden their ability to work with different sectors in society such as authorities for emergency and crisis management, municipalities, employers and workers organizations, non-governmental organizations (NGOs), and others. Resilience building to lower exposure to heat involves the creation and adaptation of workplaces by changes to the design of buildings and urban areas in order to minimize the urban heat island effect (32). Such measures include the use of materials with increased reflectivity, tree planting, and so on.

Governments must also act to protect the most vulnerable workers by initiating programs that will enable them to have a sustainable working life in the face of climate change. In some situations the pressure for economic profit conflicts with health promotion activities so other types of directed support systems may have to be created by national governments and other decision makers to protect more vulnerable groups. One large group that deserves special attention is workers who do heavy labor, both indoor and outdoor, in hot climates, and who are paid a 'piece rate' for what they produce. This group is vulnerable in terms of health and economic, living, and working conditions, with poor or non-existent bargaining possibilities. The appropriate way for workers to protect their own health while working in heat would be for them to take more frequent and longer breaks, but more workers might be required to achieve the same production results, leading to less profit for an employer, and reduced income for an individual worker. Such contradictions must be discussed and solved at a national level.

Adaptive capacity must be developed at all levels including interventions for individual workers such as educational programs to create awareness about heat effects and symptoms, how to reduce risks by taking regular breaks, drinking water, working in shade, and so on. Interventions at the company level could include heat warning systems, changes in work practices such as rest periods and the provision of sufficient drinking water for rehydration, mechanization of certain jobs, and surveillance for heat stress at the workplace.

Research is needed to develop and evaluate the effectiveness of preventive measures in different countries and sectors and to estimate the economic costs and benefits of such policies and interventions. An increasing number of research teams are now getting involved in this

work, many of them involved in the Hothaps program (High Occupational Temperature Health and Productivity Suppression) (7). This includes the Climate Change and Health research teams at Australian National University, Umea University, University of Tromso, University College London, and most recently in Quebec, Canada. An update of the previous publication describing the Hothaps program (7) is on its way to describe the continued progress.

Conclusions

Climate change mitigation will affect the daily life of many people. If green house gas emissions are to be reduced, there must be changes in the old ways of living and doing things. Some changes will be costly while others have cobenefits and could lead to resource savings and health benefits. A more climate resilient economic and social development brings opportunities. As part of mitigation efforts, new solutions will be needed asking for new ways to work and continued technical development. This process will create work in old and new sectors. High-income countries have a special responsibility to be in the forefront of mitigation and development of environmental friendly technology and in a fair way support low-income countries for a sustainable future. To progress in such a process, stronger global governance is needed.

High hopes were expressed before COP 15 in Copenhagen on the possibilities to get a new, fair, and binding agreement on reduction of greenhouse gases. The results did not meet expectations, setting new demands for COP 16. Awareness on the relationship between the changing climate and millions of workers health, well-being and productivity may serve as a motivation for governments and the industrial sector to cooperate and act for an enhanced mitigation and adaptation. The impacts from climate change pose a threat to achievements made toward the Millennium Development Goals up until now but also in the future, unless international agencies and organizations, governments, regional and local decision makers, communities, and researchers succeed to unite in the fight for mitigation.

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