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Why you should read this article:

- To recognise the effects of climate change on children and young people's physical and mental health
- To understand the importance of involving children and young people in climate change discussions
- To identify some practical actions that nurses could take to support children and young people in the context of climate change

Effects of climate change on the health of children and young people

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Abstract

The effects of climate change, such as air pollution and extreme heat events, can adversely affect the physical and mental health of children and young people at all ages. This article explores the effects of climate change on children and young people's development and explains the effects of air pollution and heatwaves on their health. The article also discusses how children and young people are knowledgeable and concerned about the effects of climate change and can offer new perspectives on addressing these effects. Finally, the authors consider the role of nurses in raising awareness of the adverse effects of climate change on children's health, incorporating climate change in their practice and promoting opportunities for children's involvement in healthcare decision-making, strategies and policy development.

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Keywords

advocacy, child and adolescent mental health, child development, child health, climate change and sustainability in healthcare, professional, professional issues

The existence of anthropogenic climate change – that is, climate change directly or indirectly caused or influenced by people – has been confirmed by leading scientists worldwide and is considered the greatest threat to humanity (Rousell and Cutter-Mackenzie-Knowles 2020). Although children have the least accountability for the global climate crisis, they are the most vulnerable to its ramifications.

Almost all children worldwide are exposed to one or more risks to their health related to climate and the environment (Helldén et al 2023, Royal College of Paediatrics and Child Health 2023). According to the United Nations Children's Fund (UNICEF) (2021) Children's Climate Risk Index, which uses data to generate up-to-date global evidence on the numbers of children exposed to climate and environmental hazards, shocks and stresses, up to half of all children globally (around one billion) are at 'extremely high

risk' of climate change consequences. It also emphasises that the rights of the child should be the central focus of climate change decisions (UNICEF 2021).

It is vital that nurses and nursing students who are caring for children and young people understand the potential adverse health effects and risks posed by climate change for this population. In a previous *Nursing Standard* article, the first author (ES) explored the effect of climate change on adult patients with respiratory and cardiovascular conditions (Squires 2023). In this subsequent article, the authors examine the adverse effects of climate change on children's development and health, using air pollution and heatwaves as examples. The authors also consider how children and young people are knowledgeable and willing to engage in addressing the effects of climate change, as well as the role of nurses in raising awareness of these issues in their practice and

ensuring that children's concerns and ideas are heard.

Effects of climate change on child development

There is a growing body of research on the adverse effects of climate change on children's development (Helldén et al 2023), with evidence suggesting that such effects can begin in the prenatal period (Kidd et al 2023). A scoping review by Kidd et al (2023) concluded that changing climate patterns and extreme weather events have significant and wide-ranging consequences for developing human brains through direct causes, such as hyperthermia, and indirect causes, such as vector-borne diseases or malnutrition. Any interference with brain development in the prenatal period can have significant implications throughout the subsequent child developmental stages and into adulthood.

The World Health Organization (WHO) (2022) has brought growing attention to the adverse effects of climate change on brain health in general. Healthy and unhealthy environments have a significant effect on brain health, particularly during developmentally sensitive periods such as early childhood, adolescence and older age; therefore, the consequences of climate change, such as air pollution and wildfires, threaten the brain health of all individuals (WHO 2022).

The prenatal, infancy and early childhood developmental stages are particularly vulnerable to the negative and potentially lifelong effects of climate change, due to children's rapid metabolisms and developing organ systems (Anderko and Pennea 2022). For example, exposure to air pollutants during prenatal and early childhood periods can result in irreversible effects on lung development, leading to respiratory conditions in adulthood (Royal College of Paediatrics and Child Health 2023). In addition, environmental factors such as air pollution have been linked to brain development and mental health in children and adolescents (Ferschmann et al 2022).

Since children have immature respiratory and immune systems, exposure to ambient air pollutants in the prenatal and postnatal period may initiate, accelerate or exacerbate health conditions such as asthma and allergies, including those associated with pollen (Urrutia-Pereira et al 2022). Furthermore, children with pre-existing health conditions are highly vulnerable to environmental change and stresses; for example, those with human immunodeficiency virus are increasingly vulnerable to infection and vector-borne diseases such as malaria and dengue (Rylander et al 2013, UNICEF 2021).

Table 1 provides some examples of the adverse effects of climate change on child development.

Effects of climate change on children's health

Research on the effects of climate change on children has tended to focus on respiratory conditions; however, issues such as increased air pollution and extreme heat events or heatwaves have been linked to a wider range of health conditions (Son et al 2017). According to the Royal College of Paediatrics and Child Health (2023), issues such as air pollution, extreme weather, drought, food insecurity and vector-borne diseases will increasingly affect the determinants of children and young people's physical and mental health.

Air pollution

Air pollutants are a notable concern associated with climate change

Table 1. Examples of the adverse effects of climate change on child development

Health system or health-related issue	Adverse effects
Reproductive	<ul style="list-style-type: none"> » The effects of climate change have been linked to premature birth and low birth weight » Reduced lung function in infancy and asthma in childhood have been linked to maternal air pollution exposure during pregnancy » Concerns about climate change may influence young people's decisions regarding their own future childbearing (Smith et al 2023)
Respiratory	<ul style="list-style-type: none"> » Prenatal and postnatal exposure to extreme heat, wildfires and increased carbon dioxide levels can result in the development of asthma, wheezing and rhinitis, as well as deteriorating lung function
Heat	<ul style="list-style-type: none"> » Conditions such as heat stroke, heat stress, dehydration, congenital cataracts and sudden infant death syndrome have been linked to exposure to extreme heat
Neurodevelopmental	<ul style="list-style-type: none"> » Climate change can have significant and wide-ranging consequences for developing brains in the prenatal and postnatal period, such as reduced cognitive capacity and structural neural alterations
Cardiovascular	<ul style="list-style-type: none"> » Evidence suggests there is an association between maternal heat exposure during early pregnancy and increased risk of congenital heart defects in infants (Zhang et al 2019)
Infection	<ul style="list-style-type: none"> » Maternal exposure to vector-borne and water-borne diseases can result in the development of conditions such as Lyme disease, malaria, Zika virus disease and cholera, which can adversely affect the development of the fetus (Levine 2020)
Malnutrition	<ul style="list-style-type: none"> » Changes in climate adversely affect food production and crop yield, which can result in maternal, prenatal and postnatal malnutrition
Mental health	<ul style="list-style-type: none"> » Concerns about climate change can induce feelings of stress and anxiety, sleep disorders, depression, panic, phobias and impending feelings of doom about the future in children and young people

(Adapted from Anderko and Pennea 2022, World Health Organization 2022, Kidd et al 2023)

because exposure to fine particulate matter has an adverse effect on children's lung function, particularly in those with asthma and reduced peak expiratory flow (Brumberg et al 2021, Helldén et al 2023). Furthermore, air pollutants make children's airways vulnerable to constriction due to their narrower physiology (Schraufnagel et al 2019, Perera and Nadeau 2022). Children are exposed to higher levels of air pollutants because, compared with adults, their breathing rates are higher and their intake of air is greater per kilogram of body weight, while their shorter physical height means they breathe the air closer to the ground, where some pollutants become concentrated, such as car exhaust fumes (European Environment Agency 2023).

Prenatal and postnatal exposure to ambient air pollutants has been found to accelerate or increase the morbidity and mortality rates of various health conditions, including allergic diseases (Urrutia-Pereira et al 2022). Ambient air pollutants can alter the environmental microbiota, which subsequently can interfere with the immature immune response in infants, changing the balance of microorganisms and resulting in altered allergic sensitisation (Urrutia-Pereira et al 2022). Zhao et al (2023) discussed how global climate change and urbanisation have led to increased prevalence of allergic diseases caused by airborne allergenic pollen in children. Their study found positive associations between pollen concentration and allergic rhinitis in children in Beijing, China, and the researchers called for greater attention to be paid to this issue, particularly for those aged 7-18 years.

Ambient air pollution has also been shown to affect children's cognitive development through exposure to toxins such as lead and mercury (UNICEF 2021). A systematic review by Clifford et al (2016) found that children living in areas of high pollution had reduced cognitive development compared with children living in areas of lower pollution.

In a report on air pollution and child health, the WHO (2018)

stated that there is evidence of an association between prenatal exposure to traffic-related air pollution and an increased risk of developing some childhood cancers, such as leukaemia. In addition, children exposed to air pollution in the prenatal and early childhood periods are potentially at increased risk of developing long-term conditions, such as cardiovascular disease, in adulthood (WHO 2018).

Heatwaves

UNICEF (2022) estimated that, in 2022, 559 million children worldwide were exposed to 'high heatwave frequency' – that is, where there are on average 4.5 or more heatwaves per year – and that this figure would increase to 2.02 billion by 2050. Heatwaves affect children physically and psychologically. A time-stratified, case-crossover study in New York City, US, revealed a direct association between maximum daily temperature and emergency department visits among children aged under four years who were experiencing symptoms such as heat stroke, fever, convulsions and dehydration (Sheffield et al 2018).

Other risks to children posed by heatwaves include reduced physical activity and outdoor play, which can have implications for the development of asthma, obesity and overall child well-being (Vanos 2015, McNicol 2019). There is also evidence of a direct link between heatwaves and sleep disturbances among children, which could have negative effects on their physical and psychological well-being (Berger et al 2023). Disrupted sleep can negatively affect a child's ability to learn and problem-solve, and their educational attainment can be adversely affected by higher temperature exposure in prenatal and early childhood years (Berger et al 2023).

Children and young people's concerns about, and interest in, climate change

As mentioned previously, around one billion children worldwide are at extremely high risk of the effects

Key points

- There is growing evidence on the adverse effects of climate change on children's development, which may begin in the prenatal period
- Issues associated with climate change such as air pollution, extreme weather, drought, food insecurity and vector-borne diseases will increasingly affect children and young people's physical and mental health
- Many children and young people are aware of the potential effects of climate change on various aspects of their lives, and want their concerns and ideas on how to address related issues to be heard
- Nurses have an important role in raising awareness of the effects of climate change on children and young people's health, as well as promoting their involvement in decision-making and policy development

of climate change, including lack of access to food and water and essential services such as health and education (UNICEF 2022). Evidence suggests that they are aware of the potential effects on various aspects of their lives and want their concerns and ideas on how to address issues related to climate change to be heard. For example, Kiang (2021) provided insight into young people's perspective on climate change by publishing short essays written by three Australian students aged 11-12 years, which demonstrated their depth of knowledge and understanding of the associated effects on their health. One young person wrote (Kiang 2021): 'Rising temperatures and decreased air quality affect kids by increasing asthma attacks and allergies. Now would you like to have asthma attacks so often you have to go to the hospital every week? Or be allergic to pollen because more intense pollen seasons have become longer because of higher [carbon dioxide levels] and forms of air pollution?'

Léger-Goodes et al (2023) undertook a qualitative study to gain insight into eco-anxiety

among children aged 8-12 years and their parents. Findings from interviews with the children revealed that they understood and were worried about climate change and used a range of coping mechanisms, including emotion-related techniques, to reduce the perceived seriousness of the associated issues. The children used phrases such as 'We still have a lot of time' and suggested practical actions to address climate change, such as litter collection, reducing plastic use or going to school on foot, bike or bus. Léger-Goodes et al's (2023) study not only demonstrated children and young people's engagement with climate change, but also their willingness to take action.

While children and young people understand and are concerned about climate change, evidence suggests their perceived powerlessness to limit its harms increases their anxiety, particularly since the consequences will adversely affect their future (Hickman et al 2021). Hickman et al (2021) undertook a survey of 10,000 young people aged 16-25 years in ten countries to explore climate anxiety and its relationship with perceived government responses. More than 50% of respondents had experienced feelings of sadness, anger, anxiety, helplessness, guilt and powerlessness, while 75% felt that the future was frightening. Furthermore, respondents rated government responses to climate change negatively and described feelings of betrayal rather than reassurance (Hickman et al 2021).

Other researchers have reported similar findings regarding the negative effects of climate change on children and young people's emotional well-being, with Sampaio and Sequeira (2022) suggesting that young people who express climate anxiety require therapeutic support to protect their mental health. Importantly, Gislason et al (2021) noted that children and young people are increasingly engaged in climate risk reduction discussions, initiatives and policies, recognising that they are 'experts in their own lives' and have a 'unique capacity to

perceive risks that are particular to their age and circumstances'. Therefore, if given the opportunity, they could offer new perspectives on addressing the effects of climate change.

Role of the nurse

Nurses are recognised globally as trusted experts and advocates for change (Nicholas et al 2021), so they have a vital role in increasing awareness of the effects of climate change on children's health (Adlong and Dietsch 2015, Anåker et al 2015). Therefore, it is essential that nurses understand the effects of air pollution and heatwaves, for example, on the health of developing fetuses, neonates, infants, children and young people.

Nurses should also be able to identify health conditions that are directly or indirectly related to climate change and to anticipate the environmental conditions that make children more susceptible to adverse effects (Oerther 2023). School nurses have an important role in supporting the care of children who have developed climate change-associated health conditions, for example asthma or allergic conditions that have been triggered by environmental factors. Their role may include raising awareness of environmental triggers, such as air pollution or pollen, and providing health promotion information.

Philipsborn et al (2021) outlined a framework for the provision of climate-informed primary care and provided practical recommendations for integrating climate change into primary care visits. Although the framework was aimed at paediatricians, school nurses and other primary care professionals could incorporate some of the recommendations into their practice. For example, they could encourage safe participation in physical activities by ensuring children have access to fluids and shade. They could also limit the intensity of exercise on extreme heat days and signpost schools or parents to credible sources of information on air quality and pollen count (Philipsborn et al 2021). Outdoor spaces and physical

activities have been shown to increase children's enjoyment of learning outside the classroom and improve their understanding of climate change (Turner and Wilks 2022).

Ma et al (2022) emphasised the importance of understanding the risk factors and protective factors in relation to the effects of climate change on people's mental health to support their well-being. School nurses could explore these factors to assist children and young people in recognising and addressing the adverse mental health effects of climate change, while also supporting them to develop resilience (Reiner and Haas-Howard 2022). The topic could also be included in personal, social, health and economic (PSHE) education.

Community and primary healthcare nurses have an opportunity to discuss health threats associated with the effects of climate change with families and to protect vulnerable patients using person-centred assessments (Anderko and Pennea 2022). Incorporating climate change into assessment visits can enable nurses, such as health visitors, to identify children at risk of local environmental threats and provide age-specific health promotion advice and information to families, for example on physical activity, mental health and specific healthcare needs (Philipsborn et al 2021).

Another important aspect of the nurse's role is to advocate for, and support, children and young people to voice their concerns about climate change and their health. This could be achieved by encouraging young people to become involved in healthcare service development and decision-making, for example through youth forums and engagement activities (Whiting et al 2020).

Table 2 provides some examples of practical actions that nurses could take to support children and young people in the context of climate change.

Conclusion

Children have the least accountability for the global climate crisis yet

are the most vulnerable to its ramifications, with almost all children worldwide already exposed to climate-related risks to their health. There is a growing body of evidence on the adverse effects of climate change on children's physical and mental health as they move through the developmental stages. Air pollutants and heatwaves are particularly concerning issues related to climate change that may affect children's health and can have long-term health implications.

Nurses have a vital role in increasing awareness of the adverse effects of climate change on children's health and in incorporating climate change in their practice, for example through person-centred assessments and health promotion activities. In addition, nurses can support children to have their concerns and ideas about climate change heard and acknowledged, thereby enabling them to contribute to healthcare decision-making and policy development.

Table 2. Practical actions that nurses could take to support children and young people in the context of climate change

Area	Actions
Continuing professional development (CPD)	<ul style="list-style-type: none"> » Nurses should engage in relevant CPD activities to ensure they are aware of, and understand, the effects of climate change on child development, as well as on children and young people's physical and mental health » CPD may also enable nurses to incorporate climate change into their practice, for example when undertaking person-centred assessments and providing information or advice to children, families and schools
Nursing care	<ul style="list-style-type: none"> » When caring for children and young people, nurses should consider whether the presenting health issues may be a result of, or exacerbated by, the effects of climate change. For example, a nurse could talk to a young person with asthma and their parents about any concerns they may have about deteriorating health status and whether this may be related to air pollution, particularly if they live in an urban area » Nurses should offer children and young people the opportunity to express their opinions and concerns about climate change and the effects on their physical and mental well-being. This could be achieved by using regular screening or verbal feedback. Nurses can use the subsequent findings to inform individual care
Children and young people's engagement in climate change and health-related discussions and policy development	<ul style="list-style-type: none"> » Nurses could promote opportunities for children and young people to become involved in decision-making and policy development in relation to the environment and their healthcare through national or local youth forums, often located in GP surgeries, local councils or schools » An example of a national forum in England is the NHS Youth Forum (www.england.nhs.uk/get-involved/get-involved/how/forums/nhs-youth-forum), which aims to give a voice to young people to express their thoughts on the health issues that matter most to them and enables the NHS to seek advice from them on important areas, thereby informing strategic healthcare policies and national programmes (Whiting et al 2020) » The NHS Youth Forum approach has been replicated at local level throughout the UK. Nurses could find out if there is a forum in their area or could consider establishing such a forum

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