**Engagement with health in national climate change commitments under the Paris Agreement: A global mixed-methods analysis of the Nationally Determined Contributions**

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**ABSTRACT**

**Background:** Instituted under the Paris Agreement, Nationally Determined Contributions (NDCs) outline countries’ plans for mitigating and adapting to climate change. They are the primary policy instrument for protecting people’s health in the face of rising global temperatures. However, evidence on engagement with health in the NDCs is limited.

**Methods:** We analysed the NDCs in the UNFCCC registry submitted by 185 countries. Using content analysis and natural language processing (NLP) methods, we developed measures of health engagement. Multivariate regression analyses examined whether country-level factors (e.g. population size, GDP, climate-related exposures) were associated with greater health engagement. Using NLP methods, we compared health engagement with other climate-related challenges (economy, energy, agriculture) and examined broader differences in the terms used in countries with higher and lower engagement.

**Findings:** Countries making no mention of health in their NDCs are clustered in the richer Global North while greater health engagement is concentrated in the Global South. Lower GDP per capita and being a Small Island Development State were associated with greater health engagement. In addition, greater population exposure to temperature change and ambient air pollution were associated with more health coverage. Variation in health engagement is greater than for other climate-related issues, and reflects wider differences in countries’ approaches to the NDCs.

**Interpretation:** A focus on health in the NDCs is patterned in line with broader global inequalities. Poorer and climate-vulnerable countries that contribute least to climate change are more likely to engage with health, while richer countries anchor their NDCs in non-health sectors such as energy and the economy.

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**RESEARCH IN CONTEXT**

**Evidence before this study**

The flexible structure of the Nationally Determined Contributions (NDCs) enables countries to include population health in their plans for climate mitigation and adaptation. An engagement with health may therefore provide a unifying focus for countries committed to realising the ambitions of the Paris Agreement. A small number of studies have examined references to health in the NDCs and have pointed to marked national and regional variations in the prominence given to health. A larger body of social science research has analysed the NDCs as political documents that shed light on the priorities of countries signed up to the Paris Agreement. However, health has not been a focus of this research. Our study addresses this gap.

**Added value of this study**

Our study provides an in-depth analysis of the place of health in the NDCs. It then examines whether country-level factors like national wealth and climate-related exposures are associated with greater health engagement in the NDCs. In addition, it compares the prominence given to health compared to other climate-related sectors (the economy, energy and agriculture) to identify further potential differences between countries. To undertake the analyses, we develop measures of health engagement using content analysis andnatural language processing methods, which we use to identify factors associated with greater and lesser engagement with health. Taken together, the findings indicate that lower-income and climate-vulnerable countries are more likely to discuss the health dimensions of climate change while higher-income countries adopt a narrower economic perspective.

**Implications of all the available evidence**

Our study adds to evidence on the place of health in the NDCs, which form the backbone of the Paris Agreement. In line with previous studies, the study found that most countries refer to health. But our study suggests that, in many NDCs, references are limited and not anchored in a wider alignment between public health and action on climate change. Such evidence can help the research and policy community to appreciate that protecting and promoting people’s health is not currently providing a shared and unifying global focus. Instead, engagement with health in the NDCs varies in systematic ways with wider inequalities between countries. As countries ratchet up their mitigation and adaptation ambitions, the challenge is to ensure that health does not remain the concern of climate-vulnerable regions of the global South but becomes a common platform for action across all countries.

**Engagement with Health in National Climate Change Commitments Under the Paris Agreement**

**Introduction**

Climate change is threatening human health; it is irrevocably damaging the planetary systems on which life depends.[[1]](#endnote-1),[[2]](#endnote-2),[[3]](#endnote-3) Addressing these threats is fundamental to the United Nations Framework Convention on Climate Change (UNFCCC), the global climate governance framework designed to protect current and future generations from ‘dangerous anthropogenic interference with the climate system’.[[4]](#endnote-4) In line with this ambition, the UNFCCC’s 2015 Paris Agreement seeks to hold the increase in global temperature to well below the critical 2°C threshold beyond which the climate system becomes increasingly inimical to public health.[[5]](#endnote-5) Achieving this ambitious goal rests on Nationally Determined Contributions (NDCs). As of January 2020, 185 nations had submitted their first NDCs.

NDCs are voluntary and non-binding commitments to emissions reduction made by state parties to the Agreement; they are also encouraged, but not required, to include adaptation plans in their NDCs.[[6]](#endnote-6) Because the NDC regime consolidates the position of state parties as the primary agents of climate action[[7]](#endnote-7), NDCs are the key global policy instrument for protecting the health of today’s and tomorrow’s population. Both mitigation and adaptation are essential to protect public health.[[8]](#endnote-8),[[9]](#endnote-9)

The flexible structure of the NDCs facilitates this health focus. It enables mitigation, urgently required by high-emitting countries, and adaptation, of particular concern to low-income countries, to be aligned with public health priorities. Indeed, the majority of NDCs do reference ‘health’, though with differences in the extent to which NDCs include health-related actions and plans.[[10]](#endnote-10),[[11]](#endnote-11),[[12]](#endnote-12) Synergies between health and climate policy are especially important because health is an issue of personal and public concern[[13]](#endnote-13); it therefore offers the potential to build public and political support for more ambitious climate change mitigation and adaptation.[[14]](#endnote-14),[[15]](#endnote-15) Such buy-in is regarded as essential for the long-term success of the Paris Agreement. With pledges made in the 2015 set of NDCs falling well short of containing global temperature increases to below 2°C, there is an urgent need to strengthen the commitments countries make in the 2020 round of enhanced NDCs. A health framing of action on climate change could help rachet up these ambitions.[[16]](#endnote-16)

The flexible structure of the NDCs also enables them to serve wider political functions. As well as being aimed at a domestic audience, they can further national interests in global negotiations, for example by signalling countries’ differential responsibility for climate change and its unequal impacts and the case for economic development and adaptation funding.[[17]](#endnote-17),[[18]](#endnote-18),[[19]](#endnote-19),[[20]](#endnote-20) Important here is the wider structure of the UNFCCC, in which countries exert leverage through membership of negotiating groups, including the Least Developed Countries and Small Island Developing States (SIDS).[[21]](#endnote-21) Studies of the NDCs have found that the climate mitigation and adaptation commitments of low-emitting and climate-vulnerable countries differed markedly from those of high-emitting countries.[[22]](#endnote-22),[[23]](#endnote-23),[[24]](#endnote-24),[[25]](#endnote-25) Hence, the NDCs can be read as *political* texts that ‘reveal deeper tensions, ideas, and values about international climate policy’.[[26]](#endnote-26)

Against this background, we examine how public health is incorporated in the NDCs, and how different patterns of engagement may be related to broader inequalities and tensions in global climate politics. We address this question by examining (1) the extent and types of engagement with health; (2) what factors are associated with different levels of health engagement; and (3) whether there are broader differences between NDCs with higher health and lower health engagement.

**Methods**

*Study Design*

This study is based on an analysis of the NDCs submitted by 185 countries (with EU member states producing a joint NDC). We collected the NDCs from the UNFCCC registry[[27]](#endnote-27), and examined levels of health engagement using both content analysis and natural language processing (NLP) methods. This analysis also enabled us to produce two measures of health engagement: (1) *Health Engagement Scores* (HES), which reveals the *depth* of countries’ engagement based on the specificity and detail of health references; and (2) *Health Topic Proportion* (HTP), which measures the *breadth* of health engagement by measuring the proportion of a state’s NDC discussing a health theme. We used these measures in a multivariate regression analysis to examine the country characteristics associated with different levels of health engagement. We then turned to NLP methods to analyse the differences in the content of NDCs with lower health engagement and NDCs with higher health engagement.

*Content Analysis*

We assessed engagement with health by conducting a content analysis of health references in the NDCs. Two coders independently identified references to health in each NDC based on both automated and manual searches, using search terms developed iteratively through the course of search (appendix p.1; Table A1). Based on this, each NDC was given a *Health Engagement Score* (HES) between 0 and 5 – where 0 indicates no health reference, and 5 represents the highest level of health engagement. Any mention of health was allocated an initial score of one. This score was amended based on more *specific* or *detailed* references, up to a highest score of 5:

* Impact
	+ General: includes the impact of climate change on health generally or the health sector
	+ Specific: includes the impact of climate change on specific health outcomes
* Adaptation
	+ General: includes the need for an adaptation plan, mentioning health, but with no further detail
	+ Specific: includes the need for an adaptation plan, mentioning a specific health outcome, but with no further detail
	+ Detailed: includes detailed information and plans about necessary provisions for adaptation in the area of health
* Mitigation: includes a link between health and mitigation
* Co-benefits
	+ General: includes information about measures that would have co-benefits for health and climate change
	+ Specific: includes co-benefit measures with information about specific health benefits
* Trade-offs: refers to mentions of financial trade-offs involved in addressing both climate change and health
* Background: refers to descriptions of a country’s health profile and health challenges

This HES measure sheds light on the depth of countries’ engagement with health (see Table 1). It is worth noting that while the framework distinguishes between *mitigation* and *co-benefits,* they are closely connected in that *co-benefit* refers to mentions of mitigation measures that have a health co-benefit. We provide a more detailed discussion of the scoring framework with examples of different types of health mentions in the appendix (pp.1-3).

|  |  |  |  |
| --- | --- | --- | --- |
| **Type** | **Specificity** | **HES entry:** | **Example** |
| Any mention |  | 1 |  |
| Impact | General | 1 | “Other effects [of climate change] have been observed or measured in the sectors of agriculture and **human** **health**, as well as biodiversity” (Cuba’s NDC) |
| Specific | 3 | “Examples of direct impacts include **death, injury, psychological disorders** and **damage to public health infrastructure**” (Cambodia’s NDC) |
| Adaptation | General | 2 | “El Salvador has resorted to sectoral adaptation strategies with an emphasis on agriculture, resources, infrastructure and **health**, contained in the National Strategy for Climate Change and in the Plan National Climate Change” (El Salvador’s NDC) |
| Detailed | 3 | “Minimize climate‐related **health risks** through:• Strengthening integrated risk monitoring and early warning systems and **response for climate sensitive diseases**” (Bhutan’s NDC) |
| Mitigation |  | 2 | “This strategy seeks to articulate and link effective energy and environmental plans by establishing goals and objectives in the area of energy, water, waste and **health** for the long, medium and long-term” (Chile’s NDC) |
| Co-Benefit | General | 2 | “Regarding mitigation… sets a clear obligation to give priority to the least costly mitigation actions, that at the same time derived in **health and well-being** co-benefits to the Mexican population” (Mexico’s NDC) |
| Specific | 3 | “Create a market for clean and efficient household cooking solutions in order to **save lives**, improve livelihoods, empower women, and *protect the environment*” (Lesotho’s NDC) |
| Trade-off |  | 2 | “As a developing country, the lack of fiscal space to finance priority issues including poverty reduction policies including investments in education, **health** and basic infrastructure constrains the country's effort to finance and implement climate mitigation and adaptation policies” (Ghana’s NDC) |
| Background |  | 1 | “Equatorial Guinea is a developing country, whose economy depends exclusively on extractive industries and has to face a series of development challenges, such as: poverty, education, **health**, road infrastructure, etc.” (Equatorial Guinea’s NDC) |

**Table 1.** Types of health reference in the NDCs and their impact on initial entry HES.

*Natural Language Processing (NLP)*

We also used NLP methods, which have been applied more widely to political texts to examine government engagement and position on various issues in world politics.[[28]](#endnote-28) We employed two different NLP methods. The first was an application ofa version of the frequently used Latent Dirichlet Allocation probabilistic topic model to the NDC corpus.[[29]](#endnote-29) Probabilistic topic models are algorithms for discovering the main themes in large unstructured collections of textual data and have been widely applied to genetic and medical data, images, and social networks. Here, we use the keyword assisted topic model (keyATM), which allows us to provide the topic model with a small number of keywords to improve topic identification and labelling, and enhance the stability and reproducibility of the model (see appendix p.5; Table A2). *[[30]](#endnote-30)* We identified keywords in the corpus of NDC documents associated with four themes (*health*, *economics*, *energy*, and *agriculture*), which were used in the keyATM to produce six topics (consisting of four topics based on the specified themes and two residual topics that capture any remaining semantic content). We used the proportion of the *health* topic in each NDC document as an alternative measure of health engagement, the *Health Topic Proportion* (HTP). We provide a more detailed discussion of the keyATM topic model analysis and the HTP measure in the appendix.

The second NLP method is based on the concept of *keyness*, a concept used in text analysis to indicate that particular words and phrases reflect important themes within a document, and can be used to uncover the principal differences between groups of documents.[[31]](#endnote-31) Specifically, we identified the terms that are statistically most distinct in NDCs with higher health engagement compared to NDCs with lower health engagement. Hence, the keyness analysis sheds light on broader differences in the content of NDCs with higher HES compared to those with lower HES.

*Statistical analysis*

We examined the factors associated with higher levels of health engagement in the NDCs using a multivariate regression analysis. We used three different outcome variables to measure health engagement: (1) any reference to health; (2) HES; and (3) HTP. We used a logistic regression for the first, and ordinary least squares (OLS) regressions for the latter two. In the appendix, we provide results from additional analysis using alternative outcome variables (e.g. the total count of health terms in the NDCs) to conduct a sensitivity analysis of our findings.

We included several country co-variates in our regression models linked to political and economic factors, as well as variables associated with climate change and health, which could influence health engagement. Selection of variables is discussed further in the appendix. This includes the size of a country’s population, GDP per capita, and level of democracy. Previous studies have found that the SIDS lead engagement on climate change and health in multilateral fora[[32]](#endnote-32), so we include a dummy variable for whether a country belongs to the SIDS. Our climate change and health variables include health spending (% of GDP), coal rents (% of GDP) as a measure of the importance of fossil fuel revenues for the national economy, population-weighted change in a country’s temperature, and exposure to air pollution. The last two variables relate directly to the connection between health and climate change.

The data for most of these variables comes from the World Bank’s World Development Indicators.[[33]](#endnote-33) The democracy measure combines Freedom House and Polity scores[[34]](#endnote-34); the air pollution measure is from the WHO’s data on average country exposure to ambient air pollution based on concentrations of fine particle matter (PM2.5)[[35]](#endnote-35); and the population-weighted temperature change variable, which measures average temperature change experienced by human populations, is from the report of the Lancet Countdown on Health and Climate Change.[[36]](#endnote-36) We use data from 2016, as most NDCs were published in that year, and fill any missing observations with data from 2014 or 2015. As data is unavailable for some countries, the sample size in the regression analysis is 175. Summary statistics are provided in the appendix (p.14; Table S10).

*Role of the funding source*

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

**Results**

The majority of NDCs (73%, 135 countries) include a reference to health. However, there are significant differences in the extent of health engagement (see Figure 1). For example, 51% (94 countries) make a brief general reference to health or do not mention health at all. Examples of limited engagement can be seen in the NDCs of countries such as Saudi Arabia, Switzerland, and South Korea; for instance, the latter makes a brief single reference to strengthening adaptation ‘for the management of the negative impacts of climate change on health’.[[37]](#endnote-37) One in three NDCs (32%, 60 countries) make specific mentions of health and note specific climate-related health outcomes and/or adaptation measures (e.g. Argentina, Canada, and Bangladesh), 22% (40 countries) contain detailed health adaptation plans (e.g. Burkina Faso, India, and Vanuatu). Therefore, the NDCs also vary in terms of the types of health references included (see Figure 1). The most frequent type of health reference is to the general adaptation of climate change on health, which is included in 46% of NDCs (86 countries). Just over half of NDCs (51%, 95 countries) refer to health adaptation (general or specific), and 18% of NDCs (34 countries) refer to health co-benefits of climate action, including Antigua, Cameroon, and Mexico.

**Figure 1**. Proportion of NDCs using different types of health reference. Based on content analysis of NDCs.

To examine how engagement with health in the NDCs compares to other topics, we turn to the topic model analysis. Figure 2 shows a frequency polygon of the four fitted topics: *health*, *economy*, *energy*, and *agriculture*. The figure shows the total number of NDCs with different topic proportions for each of the four topics. For *health*, we find that the highest concentration of NDCs at a very low topic proportion, further demonstrating that most NDCs make only brief references to health. In contrast, we find that a greater number of NDCs have higher topic proportions for *agriculture* and *economy*, and *energy* is discussed most in the NDCs. The figure also indicates that there is much higher variation in the topic proportion for *health* compared to the other three topics. This can also be seen in a density plot of the four topics, which is presented in the appendix (p.7; Figure S10), in which the area under the curve is normalised for each topic, enabling more direct comparisons. It further demonstrates the higher variation in how much countries discuss *health* compared to other topics. It also shows that fewer countries discuss *health* in detail compared to other topics, and that countries devote a higher proportion of their NDCs to discussing *energy* than other topics.



**Figure 2**. Frequency polygon of topics in NDCs. Based on topic model analysis.

The marked variation in health engagement across NDCs can be seen when we consider differences in countries’ HES, as in Figure 3. The figure points to a divide between high-income countries that have no or lower engagement with health, and low- and middle-income countries that have higher levels of health engagement. The countries that make no mention of health are predominantly high-income countries, including the USA, Japan, Australia, New Zealand, and the EU member states. In contrast, most countries in Africa, Asia, and Latin America make some reference to health in their NDCs. The figure also indicates the degree of health engagement based on the HES, showing that countries in Sub-Saharan Africa, South Asia, and parts of South-East Asia have higher health engagement. The SIDS also have higher HES; however, most are not visible on the map due to their small size. We provide additional analysis of the distribution of HES across the NDCs in the appendix (pp. 3-4).



**Figure 3**. World map showing countries’ *Health Engagement Scores* (HES), 0-5. Grey indicates countries that are either not parties to the Paris Agreement or have not submitted an NDC as of January 2020.

To further investigate the patterning of health engagement scores and topic proportion, we consider the factors associated with health engagement in the NDCs using a multivariate regression analysis. Table 2 presents the results of the regression analysis looking at country characteristics associated with health engagement in the NDCs. The first model presents the results of a logistic regression to examine factors associated with any mention of health in the NDCs. The second and third models use an ordinary least squares (OLS) regression to examine factors linked to higher engagement with health, based on two alternative outcome variables, the HES and the HTP.

**Table 2**: Association between country characteristics and health engagement in NDCs using (1) logistic regression and (2) OLS regression with heteroscedasticity-robust standard errors.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Any mention of health (logistic regression) | Health Engagement Score (OLS regression) | Health Topic Proportion (OLS regression) |
|  | *Coefficient (95% CI)* | *p value* | *Coefficient (95% CI)* | *p value* | *Coefficient (95% CI)* | *p value* |
| Population (logged) | 0.206 (-0.100 to 0.512) | 0.19 | 0.048 (-0.070 to 0.165) | 0.43 | -0.002 (-0.006 to 0.003) | 0.43 |
| SIDS | 3.594 (1.520 to 5.667) | 0.001 | 0.880 (0.214 to 1.546) | 0.010 | 0.111 (0.086 to 0.136) | <0.0001 |
| GDP per capita (logged) | -0.532 (-0.971 to -0.093) | 0.018 | -0.453 (-0.589 to -0.318) | <0.0001 | -0.016 (-0.022 to -0.011) | <0.0001 |
| Democracy | -0.119 (-0.356 to 0.119) | 0.33 | 0.012 (-0.086 to 0.110) | 0.81 | -0.002 (-0.006 to 0.001) | 0.22 |
| Health expenditure (% of GDP) | -0.092 (-0.274 to 0.089) | 0.32 | -0.019 (-0.113 to 0.076) | 0.70 | -0.003 (-0.006 to 0.000) | 0.052 |
| Coal rents (% of GDP) | -0.103 (-1.258 to 1.052) | 0.86 | -0.473 (-0.793 to -0.153) | 0.0041 | 0.012 (-0.010 to 0.034) | 0.27 |
| Temperature change | 0.704 (-0.528 to 1.937) | 0.26 | 0.551 (-0.036 to 1.139) | 0.066 | 0.026 (0.005 to 0.047) | 0.016 |
| Air pollution exposure | 0.062 (-0.002 to 0.126) | 0.059 | 0.011 (-0.007 to 0.028) | 0.23 | 0.001 (0.000 to 0.001) | 0.033 |
| Pseudo-R2 | 0.55 | -- | -- | -- | -- | -- |
| R2 | -- | -- | 0.30 | -- | 0.53 | -- |
| N | 175 | -- | 175 | -- | 175 | -- |

In the first model in Table 2, there are two factors that have statistically significant relationships with whether a country mentions health in its NDC. These are whether the country is a SIDS (3.594, 95% CI 1.520 to 5.667), and GDP per capita (-0.532, 95% CI -0.971 to -0.093), demonstrating that SIDS have a higher likelihood of referring to health, and that richer countries are less likely to mention health in their NDCs than poorer countries. The results indicate that exposure to ambient air pollution has a positive relationship with mentioning health in NDCs, however this falls outside the 95% CI (p=0.062). Population size, level of democracy, health expenditure, coal rents, and population-weighted temperature change are not associated with whether a country mentions health in its NDC.

Table 2 also presents the results of the OLS regression analysis looking at factors associated with health engagement using the HES and HTP measures. The results here also indicate that SIDS and GDP per capita have statistically significant associations with both measures of health engagement (HES and HTP). The higher a country’s GDP per capita, the less it engages with health, indicating that income is closely related to engagement with health in the NDCs.

The results suggest additional factors may be related to health engagement, although these are statistically significant for either HES or HTP, rather than both. Coal rents (% of GDP) has a negative effect of -0.473 on the HES (95% CI -0.793 to -0.153), suggesting countries with higher coal revenues engage in less depth with health in the NDCs. Greater temperature change and exposure to air pollution are associated with more discussion of health in countries’ NDCs. The population-weighted temperature change has a statistically significant positive effect of 0.016 on the HTP (p=0.016, p=0.066 for HES). When we use the total count of health terms as an outcome variable (appendix p.13; Table S8), we also find temperature change has a significant effect. The results show that higher exposure to ambient air pollution is positively associated with HTP, though not with HES. Population size, democracy, and health expenditure are not related to health engagement with either measure. The results of the sensitivity analysis broadly support the findings here, in particular providing further evidence that GDP per capita is negatively correlated with health engagement.

We next turn to consider whether differences in levels of health engagement reflect wider dissimilarities in the content of NDCs. In other words, we examine the more general differences in the approach taken in NDCs that have higher health engagement compared to those with lower health engagement. We do this through the NLP *keyness* analysis. Figure 6 presents the terms in the NDCs that are statistically most likely to appear in the NDCs with lower health engagement in comparison to terms most likely to appear in NDCs with higher engagements. It shows the most statistically distinct terms that appear in NDCs with low engagement with health, with an HES of 0-1 compared to the most statistically distinct terms that appear in the NDCs with an HES of 2-5. We provide additional keyness analysis comparing the differences in the content of NDCs with higher and lower engagement with health in the appendix (pp.14-17).



**Figure 4**. Keywords distinguishing countries with low health engagement and those with higher health engagement. Bigram of statistically distinct words in NDCs for HES 0-1 (blue) vs. HES 2-5 (red).

The keywords identified in the *keyness* analysis are closely related to issues included in the Paris Agreement.[[38]](#endnote-38) However, there are significant differences in the aspects of the Paris Agreement that countries with lower health engagement emphasise in their NDCs compared to those with higher engagement. The results indicate that NDCs with no or low health engagement have a narrower focus on emissions, energy use, and the UNFCCC framework itself. This can be seen in Figure 4 (and in the additional analysis provided in the appendix pp.15-16; Figures S19-S21) with terms such as *greenhouse\_gas*, *emissions\_level*, *base\_scenario,* and *energy\_consumption*. The emphasis on the framework around the Paris Agreement is demonstrated by terms such as *level\_conference* and *kyoto\_protocol*. These NDCs also make greater reference to economic factors (e.g. *economic\_diversification* and *gdp\_growth*).

In contrast, NDCs with higher health engagement tend to have a much broader focus on issues related to climate change mitigation and adaptation included in the Paris Agreement. This includes, for example, *climate\_adaptation*, *climate*\_*resilient*, *mitigation\_adaptation*. There is also more reference to health-related domains impacted by climate change. Thus, in addition to health, we find keywords linked to agriculture and food (e.g. *smart\_agriculture* and *food\_security*), water and waste, and references to *rural\_electrification*, *disaster\_risk*, and *urban\_development*. An important feature of NDCs with higher health engagement is the emphasis on international finance and technology transfer, included in Articles 9-11 of the Paris Agreement. This can be seen by terms such as *finance\_building*, *technology\_building*, and *conditional*\_*unconditional* (referring to plans that are conditional on external funding).

**Discussion**

Our analysis has shown that, while the majority of NDCs mention health, there is considerable variation in the types and depth of this engagement. Furthermore, we find that this variation in countries’ engagement with health is much greater than for other topics, such as the economy or energy. This variation is largely explained by differences in countries’ income levels, whereby poor low-emitting countries, particularly the SIDS, engage much more with health compared to richer high-emitting countries, who make little or no mention of health in their NDCs. Furthermore, we find some evidence that those countries more exposed to the effects of climate change (e.g. with populations experiencing greater temperature change) engage more with health, while those receiving higher coal rents engage less with health in their NDCs.

We also find that these differences in health engagement are grounded more broadly in different approaches to the NDCs. Those countries that engage less with health in their NDCs tend to have a narrower focus on the objectives set out in the Paris Agreement, and a more economic-centred approach. In contrast, countries that engage more with health in their NDCs embrace the Paris Agreement’s a broader societal perspective on climate impacts, mitigation and adaptation. They also emphasise the need for international funding and technology transfers in meeting the goals of the Paris Agreement. These differences are consistent with differences noted elsewhere in the weight that higher and lower income countries give to adaptation, sustainable development and climate finance in their NDCs.[[39]](#endnote-39), [[40]](#endnote-40),[[41]](#endnote-41)

Our study adds a health perspective to these earlier studies. As an issue that resonates strongly with the public, references to health in the NDCs could strengthen commitment to climate action at national and global level. However, our study suggests that health is being mobilised in ways that reflect existing divides in global climate politics. It is the poorest and most vulnerable countries that emphasise the health dimensions of climate change in their NDCs – and do so in part to remind wealthy nations of their commitments in the Paris Agreement, particularly providing financial and technological resources to developing countries. Thus, low-income countries such as the Comoros and Ethiopia explicitly connect health impacts and adaptation plans in their NDCs to calls for wealthier nations to provide financial and technological assistance. In contrast, we see little engagement with health by the richer high-emitting states, with countries such as the USA, Australia, and the EU members making no reference at all to health. Very few governments of high-income countries discuss health adaptations plans in their NDCs, although they published detailed national health adaptation plans elsewhere.[[42]](#endnote-42)

Our study has several limitations. First, as we have noted in the methods section, the EU member states submitted a single joint NDC. In our analysis, we assess the individual EU member states separately; however, this assumes that all 28 countries (the UK was included in the EU’s first NDC) have an identical position on approaches to climate change adaptation and mitigation, which is unlikely to be the case. Hence, due to the submission of a single NDC for the EU, we were unable to capture potential variations in health engagement across the member states. Second, for several variables included in our regression models, there was missing data for some countries, which meant that these countries were excluded from the regression analysis, reducing our sample size to 175. These countries were either low-income countries (e.g. Eritrea and Somalia) or small states (e.g. Grenada), which introduces some potential bias into our analysis. Third, as we have discussed, the Health Engagement Scores (HES) developed in this analysis is based on the manual content analysis of health references in the NDCs, which were scored according to the framework we developed (see appendix pp.1-3). This introduces a degree of subjectivity in interpreting and scoring each health reference, which we have sought to minimize by using a detailed scoring framework and ensuring two coders independently scored each NDC. Fourth, our analysis includes the application of probabilistic topic models to the NDC corpus. As we have discussed, we have sought to address the potential unreliability of this approach through the use of a keyword assisted topic model (keyATM), which has been shown to yield more stable and reproducible results. However, some degree of variability in the results remains. Despite these limitations, the results of our analysis produce strong evidence that poorer and more vulnerable countries emphasise the health impacts of climate change in their NDCs, while wealthy high-emitting countries make little or no reference to health.

These findings suggest that engagement in the health dimensions of climate change in the current round of NDCs is an indication of a country’s broader response to climate change, and reflects deeper inequalities across the world. From this perspective, the lack of engagement with health by wealthy high-emitting nations is part of a more general effort to frame climate change as an issue that can be addressed without far-reaching political action and resource transfers from richer to poorer nations.[[43]](#endnote-43) This also means that, as countries ramp up their NDCs, there is a risk that health is again side-lined by higher-income countries, with lower-income and climate-vulnerable countries left to draw attention to the significant health impacts of climate change that many countries experience. Health, an issue of concern for peoples across the world, is not currently providing a shared and unifying focus in the major instrument of global climate action. In this regard, the COVID-19 pandemic has provided a stark reminder that global health challenges do not respect national boundaries. As such, it may offer an important opportunity to reintegrate health into the politics of climate change in ways that can motivate global cooperation and rachet up countries’ climate change ambitions.

**Contributors**

All authors contributed to the study design. PL did the data collection of NDCs. ND and PL did the content analysis, and SJM did the NLP analysis. SJM and ND conducted the statistical analysis, with all authors contributing to data interpretation. ND and HG wrote the first drafts of the manuscript. All authors contributed to the final manuscript. Furthermore, all authors had access to all of the data used in the study, and accept responsibility to submit for publication.

**Declaration of Interests**

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