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# Predictors of compliance with COVID-19 guidelines across countries: the role of social norms, moral values, trust, stress, and demographic factors

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## Abstract

Despite the devastating impacts of the COVID-19 pandemic, it provided the opportunity to investigate factors associated with compliance with public health measures that could inform responses to future pandemics. We analysed cross-country data ($k = 121$, $N = 15{,}740$) collected one year into the COVID-19 pandemic to investigate factors related to compliance with COVID-19 guidelines. These factors include social norms, moral values, trust, stress, and demographic factors. We found that social norms to follow preventive measures were positively correlated with compliance with local prevention guidelines. Compliance was also predicted by concern about the moral value of harm and care, trust in government and the scientific community, stress, and demographic factors. Finally, we discuss country-level differences in the associations between predictors and compliance. Overall, results indicate that the harm/care dimension of moral foundations and trust are critical to the development of programs and policies aimed at increasing compliance with measures to reduce the spread of disease.

**Keywords** Compliance · COVID-19 · Norms · Trust · Stress · Moral values

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## Introduction

Developing effective measures to reduce the spread of disease requires an understanding of the psychological factors that determine people's decisions and compliance with public health guidelines. People's moral values, trust in the institutions providing guidelines, levels of stress, and demographic characteristics have all been connected to levels of compliance. In particular, research has emphasised the role of social norms in fostering people's intentions to abide by public health guidelines and engage in good practices, and perception of social norms has been strongly associated with subsequent behavioural intentions (e.g., Fishbein & Yzer, 2003; Habersaat et al., 2020; Noar & Zimmerman, 2005; Peterson et al., 2021; Van Bavel et al., 2020).

However, the prolonged transmission of COVID-19 posed an additional challenge to public health communication. Behavioural guidelines for the public and normative messages devised during the early stages of the pandemic were aimed at engendering rapid behavioural changes among the public to achieve a short-term 'flattening of the curve' of transmission. But behavioural guidelines for the public, communication measures by governments and global organisations (e.g., World Health Organization [WHO]), and opinions, norms and behaviours within the society have changed since the early stage of the pandemic (e.g., World Health Organization, 2022). From a public health and communication perspective, it is therefore critical to understand how people's perceptions of social norms, as well as their compliance with public health guidelines, have evolved during later stages of the pandemic.

In this research, we investigated factors that might influence compliance with guidelines to reduce the spread of COVID-19 using a large, cross-country dataset collected from late May to August 2021, over one year into the COVID-19 pandemic (Blackburn et al., 2022). We explored the associations between individuals' compliance behaviours with social norms, moral values, trust in government, trust in the scientific research community, stress, and demographic variables. For each, we examined the extent to which the associations with compliance behaviours differ across nations. Understanding the influence of social norms and other factors that impact compliance a year into a health crisis can help policymakers to implement effective strategies and respond quickly in future crises. This is critical for a global response that is effective both in the short- and long-term. We begin with a review of the relevant literature.

## Key Factors Influencing Compliance with Health Guidelines

### Drivers of Compliance

Previous research has examined several factors that might function as drivers of or barriers to compliance behaviour. Here we outline literature on the role of social norms, moral values, trust, stress, and demographic factors.

#### Social Norms

Social norms are rules or standards of behaviour that serve as guides for people's actions, setting expectations about others' actions and promoting coordination in social life (Smith, 2020). The use of social norms in behavioural guidelines is a relatively effective communication strategy (e.g., Terrier & Marfaing, 2015), and particularly effective when signaling not only what the majority does (*descriptive norm*) but also what the majority (dis)approves of (*injunctive norm*) (Cialdini et al., 1991; Griskevicius et al., 2008).

Descriptive norms motivate individuals by communicating what may be the most effective and adaptive course of action based on the actions of others (Cialdini et al., 1991). Contrary to descriptive norms, injunctive norms motivate individuals by allowing them to expect informally sanctioned rewards and punishments for their own actions (Cialdini et al., 1991). Thus, it is critical to examine both perceptions of others' opinions regarding the importance of social norms and the actual implementation of preventative measures by others. The COVID-19 pandemic has made descriptive and injunctive norms especially relevant as a key factor that may influence compliance on a broader scale.

When a behaviour becomes normative, it can induce compliance through conformity (e.g., Neville et al., 2021). In the context of COVID-19, some cross-sectional (e.g., Goldberg et al., 2020; Smith et al., 2020; van Rooij et al., 2020) as well as longitudinal research (Gerber et al., 2021; Rudert & Janke, 2021) have indicated that descriptive norms are associated with an individual's compliance with COVID-19 restrictions, such as adherence to personal protective measures.

Although other factors such as self-efficacy (Jørgensen et al., 2021), social cognitive variables (Raude et al., 2020), or personality traits (Singogo, 2021) affect compliance, social norms are one of the most relevant indicators of compliance (Gerber et al., 2021). Accordingly, Goldberg et al. (2020) and van Rooij et al. (2020) found a positive relationship between social norms and compliance within the context of COVID-19. Normative beliefs have also been shown to be of importance for adherence to protective measures in a 58-nation study (Hensel et al., 2020). Similarly, Bicchieri et al. (2021) reported that both empirical expectations and normative expectations significantly influenced compliance with social distancing and stay-at-home measures in a large-scale survey experiment conducted in nine countries.

While Hensel et al.'s (2020) study included a diverse global representation, most of their findings regarding the relationship between social norms and compliance are limited to Western samples and from the early stages of the pandemic. In the present global study, we are focused on social norms of the COVID-19 pandemic that were based on international recommendations for guidelines implemented by many governments and health authorities to control the spread of the virus. These included social norms regarding a number of public health guidelines, such as wearing masks, practicing social distancing, and avoiding large gatherings.

Because social norms so heavily influence compliance, there is a need to understand these relationships and how they differ across countries and demographics to maintain and consolidate norms that may enhance public adherence to public health guidelines (Gerber et al., 2021). Gelfand et al. (2021) have suggested that cultural differences in the strictness of social norms and permissiveness of deviance from them may be a key factor in COVID-19 cases and deaths. Therefore, we have investigated both the relationship between social norms and compliance as well as whether this relationship differs across countries.

### Moral Values

Besides social norms, another consistent predictor of compliance is moral values (e.g., Kuiper et al., 2020). Individuals with low acceptance of moral rules and low shame/guilt were less likely to comply with COVID-19 guidelines (Nivette et al., 2021). Conversely, those who endorsed a higher moral obligation not to spread the disease were more likely to comply (Kuiper et al., 2020). Indeed, the

Indeed, the COVID-19 pandemic has been construed as a moral crisis (McHugh et al., 2022), whereby responses required behaviours that affected various aspects of the population in different (and often unequal) ways (Patel et al., 2020; Templeton et al., 2020). The moralization of the COVID-19 pandemic was seen in public health messaging which often appealed to people's sense of morality to increase compliance, emphasising the need to protect other people, particularly the vulnerable (e.g., Lewnard & Lo, 2020; Prosser et al., 2020).

Compliance with COVID-19 preventive measures has been explored within the framework of Moral Foundations Theory (MFT). MFT clarifies how people make judgments between perceived right and wrong by employing five central moral criteria (Graham et al., 2009, 2011): harm/care, fairness/reciprocity, ingroup/loyalty, authority/respect, and purity/sanctity. While harm/care and fairness/reciprocity are called individualizing morals as they deal with how individuals interact with each other, the other three are known as binding morals because they focus on uniting groups and institutions for optimal functioning. Harm/care and fairness/reciprocity have been shown to predict COVID-19 compliance behaviours, including staying at home and social distancing (Chan, 2021), and have been associated with trust in the scientific research community and behavioural intentions (Pagliaro et al., 2021). These findings for harm/care and fairness/reciprocity contrast with those observed for binding morals of ingroup/loyalty and authority/respect, which have been negatively associated with trust in the scientific research community (Pagliaro et al., 2021). Given such discrepancies found in the prior studies, it is necessary to examine connections between moral foundations and compliance further within the context of COVID-19.

### Trust in Government and the Scientific Research Community

Trust in institutions has been found to be a significant predictor of compliance. Trust in the scientific research community, police, and politicians has been shown to increase during the early COVID-19 lockdowns (Sibley et al., 2020). Notably, public trust in the government facilitated citizens' compliance in general (Travaglino & Moon, 2021a, Uddin et al., 2021), and with government policies in particular (e.g., Güzel et al., 2019; Levi & Stoker, 2000). Additionally, trust in the scientific research community has been shown to have a more substantial and significant effect on increasing compliance likelihood compared to trust in the government. For example, country-level trust in the scientific research community has been demonstrated to be a strong predictor of compliance at the aggregate level (Bicchieri et al., 2021).

However, some studies have reported that the association between trust and compliance depends on context (Clark et al., 2020). To elaborate, while trust in government positively predicted compliance with guidelines in some cases (e.g., Almutairi et al., 2020), this relationship depended in part on the information being provided by governments. For instance, in Singapore, higher trust in government was linked to underestimating risks, leading to lower compliance (Wong & Jensen, 2020).

In contrast, a longitudinal study across 12 Western countries early in the pandemic (March to December 2020) found that trust in the scientific research community was the most important predictor of compliance with COVID-19 mitigation measures (Algan et al., 2021).

Other research has highlighted differences across countries, and even within countries. For instance, Kemmelmeier and Waleed (2021) showed that within the United States of America (USA), mask-wearing behaviour was influenced by the culture in each state (depending on factors such as conservatism, collective interdependence, and collectivism). The initial COVIDiSTRESS Global Survey, conducted in March 2020, revealed that trust in government and concerns

about COVID-19 were positively related when government lockdown response was strict (Lieberoth et al., 2021). That is, for individuals worried about COVID-19, seeing the government respond strongly was related to higher levels of trust. Whereas, if the government was lax about COVID-19, the least concerned individuals had the highest trust, and the most concerned had the lowest (Lieberoth et al., 2021). Therefore, in this study, we predicted that cross-country differences would exist in the relationship between trust and compliance.

## Stress

The amount of stress an individual experiences may impact their compliance. An individuals' perceived stress is not only associated with primary stressors such as exposure to COVID-19 but also with secondary stressors such as not being able to find a job during the pandemic (Ntontis et al., 2023). Although overall perceived stress is not well studied as a predictor of COVID-19 compliance, it appears that stress specifically related to the COVID-19 pandemic may increase compliance with certain measures designed to reduce the spread of the virus.

A study comparing Polish and Italian residents during the pandemic found both higher perceived stress and greater compliance with lockdown restrictions in the Polish group compared to the Italian group (Grabowski et al., 2021). In other words, higher perceived stress was associated with greater compliance with measures to refrain from disease-spreading activities (e.g., going to work or meeting with friends). However, Hansen et al. (2021) showed that general stress levels did not predict compliance with social distancing measures during the COVID-19 pandemic. Instead, perceived susceptibility to COVID-19 predicted higher compliance. Thus, primary stressors related to the pandemic may influence compliance with measures perceived to protect oneself. Similarly, those who appraised the pandemic as having consequences and implications central to their lives and saw the pandemic as threatening demonstrated higher levels of compliance (Landy et al., 2022). Hence, compliance may be linked to primary stressors related to perceiving COVID-19 as threatening on a personal level and protecting oneself. It remains to be seen whether perceived stress predicts compliance more generally.

It is important to consider that the relationship between stress and compliance may be modulated by demographic factors. In particular, women tend to exhibit higher compliance than men (e.g., Almutairi et al., 2020; Barber & Kim, 2021; Clark et al., 2020), and women were more likely to fall into a group of individuals whose stress appraisal of the pandemic and problem-focused coping related to the pandemic was high as opposed to exhibiting typology of low stress appraisal and problem-focused coping (Landy et al., 2022). Prior research has also shown that women and individuals with lower socioeconomic status (SES), two factors associated with compliance, report higher levels of stress than men and individuals with higher SES (Ntontis et al., 2023). Thus, demographic factors are important to consider when evaluating the relationship between stress and compliance, and to understand compliance behaviour more generally.

## Demographic Factors and Compliance

Compliance with public health and safety guidelines have also been predicted by differences in age, gender, marital status, SES, education, work situation, cohabitants, and ethnicity.

### Age

Overall, research has shown that older adults were typically more compliant with COVID-19 guidelines than younger adults (Almutairi et al., 2020; cf. Clark et al., 2020; Dai et al., 2020; Wright et al., 2022). To illustrate, Dai et al. (2020) reported that people aged 46 to 61 years showed significantly greater protective behaviours than people aged 18 to 25 years. However, others reported that compliance with preventive behaviours decreased with age (Barber & Kim, 2021).

### Gender and Marital Status

Women were more likely to comply with measures such as social distancing, washing hands, avoiding travel, wearing masks, and other compliant behaviours compared to men (Almutairi et al., 2020; Barber & Kim, 2021; Clark et al., 2020; Dai et al., 2020; Galasso et al., 2020; Nivette et al., 2021; Perrotta et al., 2021). Ruling out alternative explanations in relation to social desirability bias, studies conducted across multiple countries demonstrate that women were more likely than men to perceive COVID-19 as a severe health issue, agree with the new public health rules, and exhibit higher compliance with the imposed public policies (Galasso et al., 2020; Yildirim & Guler, 2020). These gender differences in COVID-19 responses align with Moran and Del Valle's (2016) pre-COVID meta-analysis on the association between gender and protective behaviours.

Algara et al. (2020) suggested that gender differences might occur in part because women are more likely to use scientific knowledge to determine the safety of social activities during the COVID-19 pandemic; and this might be especially the case among women with children (Uddin et al., 2021). Furthermore, women were more likely to perceive greater risk (Yıldırım et al., 2021), a factor linked to engagement in preventive behaviours (Wise et al., 2020). Men with

more egalitarian gender role beliefs were also more likely to comply than those with more traditional gender role beliefs (Paramita et al., 2021). Finally, married individuals were more likely to comply with COVID-19 measures than unmarried individuals (Almutairi et al., 2020).

#### Socio-Economic Status (SES) and Education

Social inequality affects people's capacity to comply with public health recommendations (e.g., Templeton et al., 2020), both at the individual (Van Bavel et al., 2020) and country levels of analysis (Ferreira, 2021). Individuals from low-income backgrounds have been disproportionately affected by the pandemic, particularly in terms of COVID-19 mortality (e.g., Elgar et al., 2020). Within the USA, individuals in lower SES areas were less likely to comply with lockdown/shelter-in-place restrictions (Wright et al., 2022). A range of factors, many practical, contribute to people of lower SES being less able to adhere to restrictions, including an increased likelihood of living in overcrowded accommodation, less access to personal outdoor space, and employment with fewer opportunities to work from home (see Patel et al., 2020). Indeed, the practical ability to comply with restrictions is a predictor of compliance (Kooistra et al., 2020; van Rooij et al., 2020; Webster et al., 2020). Research has also shown that higher levels of education are associated with greater engagement in preventive behaviours (Yıldırım et al., 2021).

However, others have shown that individuals with higher SES and higher levels of education were less compliant than their counterparts with respect to certain aspects of compliance such as hygiene (e.g., Nivette et al., 2021). Likewise, residents of countries with a lower Human Development Index (HDI) were found to be more compliant than those with a higher HDI (Lin et al., 2021). Lacking the capacity to follow specific measures decreased compliance (Kuiper et al., 2020), and structural inequalities can make it difficult for vulnerable groups to follow guidelines (Templeton et al., 2020).

#### Work Situation and Cohabitants

Related to SES, work and home situations, such as working remotely or in-person and living with children or other adults, may affect both one's ability and willingness to comply with measures to reduce the spread of disease. Liu et al. (2022) conducted a cross-sectional study to investigate the factors influencing compliance with preventive behaviours among employees returning to work during the post-COVID-19 epidemic period. They found that office staff had better compliance with preventive behaviours compared to other types of employees, suggesting that work location can influence compliance with COVID-19 preventive measures. Additionally, higher knowledge of COVID-19 and quarantining were associated with more compliance, while high anxiety levels were associated with lower compliance. Therefore, both work location may interact with personal factors, such as anxiety levels, to influence compliance during COVID-19.

Similarly, home situations have been shown to be linked to protective behaviours during COVID-19. Özden et al. (2023) reported that the relationship between COVID-19 perceived protective norms and physical distancing is moderated by household crowding, with a stronger positive relationship observed at higher levels of domestic crowding. This finding is in line with a seminal work on COVID-19 spread in Italy (Liotta et al., 2020), which suggests that individuals facing structural constraints, such as household crowding, may feel compelled to take on more responsibility to mitigate the risk of COVID-19 transmission to others. These factors are partly tied to SES and differences in culture across country. Although the information about work and home situations is limited, it is important to consider these variables in any discussion of compliance.

#### Ethnic Minority Groups

It is difficult to disentangle associations between levels of compliance and ethnic minority groups from the historical inequalities that characterise many countries. However, ethnic minorities have been found to suffer greater consequences of COVID-19. In the USA, Black and African American, Hispanic, and Indian/Alaskan Native groups have been particularly affected by the pandemic (for a review, see DeZouche & Blackburn, 2022). Lower compliance observed among some minority groups (Block et al., 2020) could also be due to these groups historically having lower trust in science (Kazemian et al., 2021) and government institutions (Bagasra et al., 2021), lowering compliance (Templeton et al., 2020). This is exacerbated by technological barriers to information and accessibility, resulting in exacerbation of compliance and recovery among minority populations (DeZouche & Blackburn, 2022). It should be noted that our dataset did not include information about race and ethnicity, but special care should be given to the circumstances of minority groups when considering compliance with government-imposed COVID-19 guidelines.

### Present Study

In the present study, we analysed a global dataset collected one year into the COVID-19 pandemic to investigate levels of compliance. We investigated factors that impact compliance, including social norms, moral values, trust in government and scientific entities, stress, and demographic factors.

We also explored cross-country differences in individuals' compliance behaviours, social norms, trust in government and scientists, and stress. For each predictor, we examined the extent to which the associations differ across nations.

We predicted that social norms to follow preventive measures would be positively correlated with compliance with local prevention guidelines, and that there would be between-country differences in this relationship (H1). We also predicted that moral values, trust, stress, and demographic factors, would predict compliance (H2). Despite specific directions not being proposed in the pre-registration, based on the literature review, we expected that moral values, trust, and stress would be positively associated with compliance. Regarding demographics, we anticipated that older participants, women, and married individuals would exhibit higher compliance. Since prior findings on SES are rather mixed, we did not propose a specific direction. For completeness, we included work location and number of cohabitants in the demographic analysis, but specific directions were not proposed for due to the paucity of prior research. Finally, we predicted country-level differences in the relationship between compliance and trust. We expected cross-country random slope differences in the relationship between trust and compliance (H3).

## Methods

### Sample and Design

We performed secondary data analysis on an open large-scale dataset (available online here: https://doi.org/10.17605/OSF.IO/36TSD) that was collected as a part of the *COVIDiSTRESS II Global Survey* (Blackburn et al., 2022), and measures psychological outcomes one year into the COVID-19 pandemic. The data collection was pre-registered (see https://doi.org/10.17605/OSF.IO/TB64S) and the current study was approved by the Ethical Committee of the University of Salford, UK [ref. 1632] as well as by local ethical approval boards. Responses were collected from May 28, 2021 through August 29, 2021 via online surveys. The scales were translated (using back-translation) into 48 languages and dialects across 137 countries. The cleaned dataset included 15,740 participants (out of 20,601 responses) from 121 countries in total (10,558 women, 5,009 men, 163 reported other/would rather not say, $NA = 10$); detailed sample characteristics are reported in Blackburn et al. (2022).

#### Measures

**Compliance Scale (CS)** Compliance with guidelines to reduce the spread of COVID-19 was measured with a six-item scale developed and validated by Blackburn et al., (2023; see Supplementary Materials for the full scale). It consists of 6 items (e.g., "I stayed away from crowded places generally") rated on a Likert scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). The items were adapted from previous scales (Lieberoth et al., 2021; Van Bavel et al., 2022; Yamada et al., 2021) and relevant guidelines for reducing the spread of COVID-19 (WHO, 2022). The validation study on the COVIDiSTRESS II dataset demonstrated satisfactory internal consistency, and factorial and convergent validity (Blackburn et al., 2023).

**Social Influence Norms Scale (SINS)** The SINS is a newly developed scale adapted from Rubin et al. (2014) and Vignoles et al. (2021). It measures two dimensions of social norms, each with 6 items (Blackburn et al., 2022; e.g., "washing their hands regularly").[1] The first dimension measured participants' estimation of the extent to which people around them perceived the importance of preventive measures (i.e., perceived injunctive norm), with a scale ranging from 1 (*not important at all*) to 6 (*very important*). The second dimension was related to how many people around the participants implemented the preventative measures (i.e., perceived descriptive norm), measured from 1 (*nearly nobody*) to 6 (*nearly everybody*). Each participant was presented with two items per dimension via block randomization. Due to the random nature of missingness (missing completely at random, MCAR), the missing values were calculated via a multiple imputation procedure.

**Short-Form Moral Foundations Questionnaire (SF-MFQ)** Due to space constraints, we used the SF-MFQ (Iurino & Saucier, 2020), which represents a brief version of the MFQ (Graham et al., 2009, 2011), measuring five dimensions of moral foundations: harm/care, fairness/reciprocity, ingroup/loyalty, authority/respect, and purity/sanctity. For each of the dimensions, two items were presented to participants. Thus, the SF-MFQ consists of 10 items (e.g., harm/care: "Compassion for those who are suffering is the most crucial virtue") rated on a scale ranging from 1 (*not at all relevant*) to 7 (*highly relevant*), and it showed sufficient factorial validity (Iurino & Saucier, 2020). Because only two items per dimension were used, we were not able to conduct a confirmatory factor analysis (CFA). Instead, we used the composite score for each value for further analyses.

**Trust in Institutions** Participants' trust in institutions (government, police, health care, the WHO, and the scientific

[1] Note that the original scale had 8 items, but following Blackburn et al. (2022), two items, "wear a face covering in public when outdoors" and "met with people outside of your household for non-essential reasons" were excluded from our analysis.

research community) was assessed via 7 items (e.g., "Parliament/government") rated from 1 (*no trust*) to 10 (*complete trust*). This scale was also newly developed and showed sufficient internal consistency for most countries in the COVIDiSTRESS II dataset (Cronbach's αs varied from 0.589 to 0.931; Blackburn et al., 2022). However, we used these items individually (not as a derived score) in further analyses because we were particularly interested in trust in government and scientists.

**Perceived Stress Scale (PSS-10)** The PSS-10 is a validated measure of perceived stress (Cohen et al., 1983) consisting of 10 items (e.g., "In the last month, how often have you felt nervous and stressed?") rated from 0 (*never*) to 4 (*very often*). The scale showed sufficient psychometric properties, especially internal consistency, test–retest reliability, and factorial validity (for a review, see Lee, 2012). In the COVIDiSTRESS II dataset, the internal consistencies (Cronbach's α) varied between 0.810 and 0.924 across countries (Blackburn et al., 2022).

**MacArthur Scale of Subjective Social Status (SSS-fam)** The SSS-fam represents a single-item measure of perceived social status relative to others in a social group (Adler et al., 2000). Participants choose their position on a 10-point ladder (1 = *lowest social status*, 10 = *highest social status*). The SSS-fam was employed as a demographic variable, SES, in our analyses.

### Demographic Factors

Besides the SSS-fam detailed above, other demographic factors included age, gender (woman or man), workplace (working at home, working at a location requested by an employer or client, not working, or working at a workplace other than home), the number of cohabiting adults and minors (ages 0–4, 5–11, and 12–17), and relationship status (single, dating, cohabitating, separated/divorced, widowed, or other).

## Analytical Strategy

All hypotheses, data cleaning procedures, and data analyses were pre-registered at the Open Science Framework (see https://doi.org/10.17605/OSF.IO/TB64S for data collection and https://doi.org/10.17605/OSF.IO/5WA3C for data analysis). Questionnaires used (see https://doi.org/10.17605/OSF.IO/36TSD), as well as the code necessary for reproducing the results (see the project GitHub repository at https://github.com/hyemin-han/COVIDiSTRESS2_Compliance), are available online. Data analyses were conducted using *R* statistical software (R Core Team, 2021) with the packages *Amelia* (Honaker et al., 2011), *lavaan* (Rosseel, 2012), *semTools* (Jorgensen et al., 2022), *lmerTest* (Kuznetsova et al., 2017), *brms* (Bürkner, 2017), *BayesFactor* (Morey et al., 2022), *merTools* (Knowles et al., 2020), and *bayestestR* (Makowski et al., 2019).

First, consistent with the pre-registered data exclusion criteria (see Lieberoth et al., 2021 and Vestergren et al., (2021) for further details) we excluded a subset of responses with 99 or fewer participants per language for the analysis of measurement invariance (resulting in 15,103 responses from 28 languages), and a subset of responses with 29 or fewer participants per country for the main analyses using multilevel modelling (resulted in 14,600 responses from 43 countries).

Second, before testing our hypotheses, we performed the measurement invariance test via multigroup confirmatory factor analyses (MG-CFA) for multiple-item measures assuming underlying latent factors (i.e., PSS-10, SINS and SC) (Han et al., 2022). The measurement invariance test is highly important in cross-cultural research (Milfont & Fischer, 2010). For our purposes, scalar invariance (i.e., fixed factor structure, loadings, and intercepts) needed to be established (Lacko et al., 2022). For an evaluation of measurement (non-)invariance, we applied the traditional criteria proposed by Hu and Bentler (1999) for configural level, RMSEA and SRMR $< 0.08$, and CFI $\geq 0.90$, and by Chen (2007) for metric, $\Delta$RMSEA and $\Delta$SRMR $< +0.30$, and $\Delta$CFI $\geq$ -0.01, and scalar levels, $\Delta$RMSEA and $\Delta$SRMR $< +0.15$, and $\Delta$CFI $\geq$ -0.01.

Where scalar invariance was not established, we employed the alignment optimization to test the measurement invariance of factor loadings and intercepts across groups (Asparouhov & Muthén, 2014). When no more than 25% of the parameters (factor loadings and intercepts combined) are non-invariant, the model can be considered acceptably invariant across groups and to produce trustworthy latent means (Asparouhov & Muthén, 2014). Monte Carlo simulations (on randomly generated datasets with 500 iterations each; $N1 = 100$, $N2 = 200$, $N3 = 500$) were also performed to provide additional support for the quality of the alignment solution. In this process, the correlation coefficients between the true and estimated factor means, and that between the true and estimated factor variances, $R^2_{loadings}$ and $R^2_{intercepts}$, respectively, were examined (values higher than 0.95 were considered satisfactory). The calculation of factor means and variances, and correlation coefficients for the Monte Carlo simulations were conducted following Muthén and Asparouhov (2018).

Third, we tested our main hypotheses using multilevel modelling (MLM). Because we intended to explore whether models including random effects at the country level were superior to those without random effects in a data-driven manner, we decided to employ the Bayesian method for best model exploration. Previous studies have demonstrated that Bayesian methods were more

appropriate for data-driven model exploration than frequentist methods because they are more likely to produce more robust models that avoid overfitting and bias (e.g., Han & Dawson, 2022; Han et al., 2023). Then, once the best model was identified, we applied both Bayesian and frequentist MLM. For Bayesian MLM, we employed the default Cauchy prior, Cauchy (0, 1). We first started by comparing three models as follows:

M0 (baseline model): dependent variable ~ demographics (1|country)
M1 (random intercept model): dependent variable ~ predictors + demographics + (1|country)
M2 (random slope model): dependent variable ~ predictors + demographics + (1 + predictors|country)

The model comparisons were assessed according to BFs. After performing Bayesian MLM, we examined which model demonstrated the highest model BF when it was compared with the baseline model. Once the best model was identified, we examined whether each predictor of interest was statistically significant from both frequentist ($p < 0.05$) and Bayesian (Bayes Factor $\geq 3$) perspectives. We also examined the effect size of each predictor of interest in terms of its standardised coefficient to get insights into whether the predictor was practically significant (whether the effect was not trivial) regardless of statistical significance (whether the effect was non-zero).

To test each hypothesis, we implemented several additional procedures. As for H1, we performed multiple imputations of missing values in SINS (which was possible due to the MCAR nature of data) with the expectation–maximisation bootstrap-based (EMB) algorithm which is suitable for cross-section multilevel data (Honaker & King, 2010). The imputation was done on 20 parallel EM chains that were consequently pooled.

For H2 and H3, items from SF-MFQ and Trust in Institutions were entered into models individually instead of one composite score reflecting the underlying latent construct. To reduce the complexity of the models, we performed Bayesian Generalised Linear Model (GLM) before MLM to identify which indicators should be included in the models by comparing all possible models with predictors of interest including country as a random effect (for a similar approach, see Han, 2022). The decision was made by exploring which model demonstrated the highest BF from Bayesian GLM.

To test H1 and H3, we also estimated the coefficients of the random slopes of each country. We identified countries demonstrating significant non-zero random slopes. Whether a random slope coefficient was significantly different from zero was tested by examining whether its 95% Bayesian *CI* included zero. For additional information regarding effect sizes, we also examined to what extent the 95% highest density interval (HDI) of the posterior distribution of each predictor overlapped with the region of practical equivalence (ROPE, Kruschke, 2018). When an estimated ratio of ROPE was greater than zero, we deemed that the effect size of a predictor of interest would not be practically substantial, but trivial, even if its estimated coefficient was significantly different from zero (see Han, 2022 for methodological details).

## Results

### Measurement Invariance Testing

We examined the measurement invariance of multiple-item measures involving the use of latent factor scores. In the cases of SC and PSS-10, we conducted the measurement invariance test with MG-CFA. Neither measure demonstrated even metric invariance (see Table S1), so we examined measurement invariance with the alignment method. Measurement alignment was completed successfully in both SC, $R^2_{loadings} = 0.97$, $R^2_{intercepts} = 1.00$, and PSS-10, $R^2_{loadings} = 0.99$, $R^2_{intercepts} = 0.99$. Monte Carlo simulations indicated that the alignment results are reliable and consistent (see Table S2). Hence, we employed latent factor scores calculated after alignment for analyses involving SC and PSS-10.

Because we performed planned missingness while collecting SINS responses, we conducted multiple imputations while testing their measurement model. As social norms were measured in two independent dimensions, we performed multiple imputation-applied MG-CFA for each dimension. Both dimensions successfully achieved scalar invariance (see Table S1). Thus, for both dimensions of social norms, we utilised composite scores for further analyses.

#### *H1: Associations Between Social Norms and Compliance*

We tested if social norms to follow preventive measures were significantly associated with compliance with local prevention guidelines with Bayesian MLM, employing multiple imputations. When the three proposed models were compared, we found that M2 with both random intercepts and slopes were best, $\log(BF_{10}) = 1{,}207.69$, $\log(BF_{20}) = 1{,}263.43$, $\log(BF_{21}) = 55.68$. When predictors in M2 were examined by Bayesian and frequentist MLM, both the first dimension of social norms (perceived injunctive norm), $b = 0.28$, $SE = 0.02$, 95% Bayesian *CI* [0.24, 0.32], $\log(BF) = 35.26$, $t(4{,}317{,}505.33) = 15.32$, $p < 0.001$, and the second dimension of social norms (perceived descriptive norms), $b = 0.19$, $SE = 0.02$, 95% Bayesian *CI* [0.16, 0.23], $\log(BF) = 37.75$, $t(2{,}462{,}306.43) = 13.33$, $p < 0.001$,

significantly predicted compliance. Given M2 was identified as the best model, it appears there were significant between-country differences in the association between social norms and compliance (Table S3). H1 was, therefore, supported.

When the random slopes for injunctive social norm were examined, there was a significant positive random slope for Bulgaria even with 0% overlap with the ROPE. In addition, although ROPE %s were not completely zero, Belarus, Bosnia and Herzegovina, Czech Republic, Germany, Russia, and Ukraine all had non-zero positive random slopes, and Brazil, Honduras, Malaysia, Portugal, Taiwan, and the USA had negative random slopes. In these countries, except Bulgaria, the random slopes might be deemed to be trivial although non-zero. When examining the random slopes for descriptive social norm, no country had 0 ROPE%. Bulgaria and Switzerland had non-zero positive random slopes, which may suggest the presence of non-zero but trivial random slopes.

#### *H2: Predictors of Compliance*

We examined if moral values, trust, perceived stress, and demographic factors significantly predicted compliance. First, to explore which moral value and trust variables should be included in the MLM, we performed model exploration based on Bayes Factors.[2] The model exploration indicated that the model with trust in government (trust 1), trust in the WHO (trust 5), trust in the scientific research community (trust 7), and the harm/care moral foundation was the best among all possible models, $\log(BF) = 269.32$.

We then performed MLM with the identified best model. When M0, M1, and M2 were compared, M2 with both random intercepts and slopes was found to be the best model, $\log(BF_{10}) = 2{,}378.51$, $\log(BF_{20}) = 2{,}444.59$, $\log(BF_{21}) = 66.47$. Thus, we conducted Bayesian and frequentist MLM with M2. The results are presented in Table S4. In this model, significant predictors with $2\log(BF) \geq 2$, which indicates the presence of a significant non-zero effect, were the harm/care foundation, trust in government, trust in the WHO, trust in the scientific community, perceived stress, age, gender (woman vs. man), and workplace (working at home, working at a location requested by an employer or client, not working [vs. working at a workplace other than home]). Hypothesis 2 was also supported.

[2] We initially planned to use *generaltestBF* implemented in *R* package *BayesFactor*. However, due to the complexity of the model (five moral value and seven trust variables), running *generaltestBF* was computationally infeasible. Thus, we conducted frequentist MLM for all 4,096 ($2^{12}$) combinations and then estimated their *BIC*s. With the calculated *BIC*s, we estimated model *BF*s (vs. the baseline model) since *BF*s can be approximated with *BIC*s.

#### *H3: Variability in the Association Between Trust and Compliance Across Countries*

We also tested whether the association between trust and compliance significantly varied across countries. To test H3, we started with performing Bayesian model selection with *generaltestBF* to explore which trust items should be included in the model to be tested via MLM. When all seven trust items were examined, similar to the case of H2 testing, the model with three trust items (i.e., trust in government, trust in the WHO, and trust in the scientific research community), was identified as the best model, $\log(BF) = 742.98$. When M0, M1, and M2 (with these selected trust items) were compared, M2 including random slopes was found to be best among them, $\log(BF_{10}) = 429.46$, $\log(BF_{20}) = 495.75$, $\log(BF_{21}) = 66.27$. Thus, these results indicate significant between-country differences in the associations between these trust items (government, WHO, the scientific research community) and compliance. Hypothesis 3 was also supported.

To explore which countries demonstrated significant random slopes, we examined the estimated coefficients of the random slopes in terms of whether they were significantly different from zero. More specifically, we evaluated whether the estimated 95% Bayesian *CI* included zero. Table S5 reports the coefficients of the random slopes of these selected trust items were examined: trust in government, trust in the WHO, and trust in the scientific community. When trust in government was examined, the estimated 95% Bayesian *CI*s for Bulgaria, Finland, and Russia were positive and did not include zero. In the case of trust in the WHO, the coefficient for Bulgaria was significantly positive while that of Japan was significantly negative. When trust in the scientific research community was examined, the coefficients for Bulgaria and the Czech Republic were significantly positive. However, in all the cases, the reported ROPE %s were not zero, so the effect sizes were deemed to be small and trivial.

## Discussion

In the present research, we investigated factors impacting compliance with public health guidelines by analysing responses a year into the COVID-19 pandemic. We also explored cross-country differences in individuals' compliance, stress, trust in government, trust in the scientific research community, behaviours, and social norms.

#### H1: Compliance and Social Norms

We predicted that social norms to follow preventive measures would be positively correlated with compliance with

local prevention guidelines and that this relationship would differ across countries. We measured social norms across two dimensions: estimation of the extent to which others perceived the importance of preventive measures (perceived injunctive norm), and the extent to which others implemented the preventative measures (perceived descriptive norm). We found that both dimensions of social norms significantly and positively predicted compliance. This aligns with findings by Goldberg et al. (2020) and van Rooij et al. (2020) emphasising a positive relationship between social norms and compliance, particularly within the context of COVID-19. Furthermore, Gerber et al. (2021) suggests that social norms are the most relevant indicator of compliance, highlighting the need for interventions that uphold and consolidate norms to enhance public adherence.

We also found significant between-country differences in the association between social norms and compliance (see Table S3 for the full results). However, we found variations in the random slopes, especially for the second (descriptive norm) dimension (see results). To summarise, Bulgaria had a significant positive random slope, and the random slopes were deemed to be trivial in all other countries. Further inspection of countries with trivial but non-zero slopes revealed that Belarus, Bosnia and Herzegovina, Czech Republic, Germany, Russia, and Ukraine reported non-zero positive random slopes while Brazil, Honduras, Malaysia, Portugal, Taiwan, and the USA demonstrated negative random slopes. When the descriptive norm dimension was examined, no country showed substantial effects, but Bulgaria and Switzerland reported trivial non-zero positive random slopes.

Perhaps differences in social cognition across different regions may be associated with the significant random slopes. When compared with people living in Western European countries, people living in Central and Eastern European countries are reported to demonstrate a greater degree of holistic and interdependent social cognition (Varnum et al., 2008). If such differences in social cognition are related to how people perceive and become compliant with social norms, then a significantly greater association between social norms and compliance might also emerge accordingly. This may account for Central and Eastern Europe demonstrating a stronger association between social norms and compliance. However, there are caveats with this interpretation, especially when considering that the Americas patterned with Southern Asia as both demonstrated negative random slopes. Thus, further research investigating these relationships across countries within this theoretical framework is warranted.

In summary, we found the predicted result, that social norms to follow preventive measures was positively correlated with compliance with local prevention guidelines. Our exploratory analysis showed that this relationship differed across countries, but with the exception of Bulgaria, the effect sizes of their random slopes were mostly trivial. Further research is needed to investigate the relationships between compliance and social norms across countries. We propose looking at country-level variables such as social cognition that might predict relationships between compliance and social norms. We are also currently testing whether other country-level variables such as individualism vs. collectivism predict compliance.

### H2: Factors that Predict Compliance

Besides the important role of social norms, we also predicted that compliance would also be predicted by moral values, trust, stress, and demographic factors. We found that the greater harm/care moral value, trust in government, trust in the WHO, and trust in the scientific community predicted higher levels of compliance, while greater perceived stress predicted lower compliance. The finding regarding the harm/care moral foundation is consistent with what has been reported in research in moral psychology. It has been argued that one's moral judgement and behaviour in diverse contexts are fundamentally determined by harm/care foundation while the other foundations play auxiliary roles (Schein & Gray, 2015). For instance, in predicting one's moral reasoning (Darnell et al., 2019), moral identity, and empathy, which are central in predicting prosocial behaviour, harm/care foundation was found to consistently predict the outcome variables (Dawson et al., 2021; Han & Dawson, 2022). Thus, it would be plausible to assume that harm/care foundation is also the most central foundation predicting one's compliance with preventive measures, which is deemed to be prosocial. There were significant between-country differences in the slopes, indicating that these relationships differ across countries.

In addition, compliance was predicted by predicted demographic factors. Consistent with the results from the previous studies (Lin et al., 2021), age was positively correlated with compliance. Women were also more likely to report compliance than men, in line with previous research (e.g., Carreras et al., 2022; Galasso et al., 2020; Lin et al., 2021). Paramita et al. (2021) provided some explanations regarding gender and compliance, arguing that those with more egalitarian views on gender roles were more likely to comply with the COVID-19 preventive measures. Regardless of the underlying mechanism, our findings confirm that, compared to men, women tend to exhibit higher compliance.

Working from home or being unemployed was associated with greater compliance, while working at one's place of employment or upon client request was negatively associated with compliance. This was expected, as working from home might be favoured by more compliant individuals and in

countries where guidelines were enforced for both employees and employers. Working from home or not having a job naturally enables greater compliance with guidelines.

Interestingly, SES was not significant in the model. Previous studies reported significant influence of socio-economic status on compliance with COVID-19 preventive measures (Ahmadi et al., 2022; Caplanova et al., 2021; Zhao et al., 2020). However, SES has been neglected as a variable of influence when assessing the compliance with the COVID-19 measures and its impact on public health (Khalatbari-Soltani et al., 2020). Importantly, unlike many of the other factors we investigated, SES has inconsistently predicted compliance in previous studies. Some studies show that individuals with higher SES and higher levels of education were less compliant with preventative behaviours and public health guidelines than their counterparts (e.g., Nivette et al., 2021) while other studies show the opposite (e.g., Kooistra et al., 2020; van Rooij et al., 2020; Yıldırım et al., 2021). This may be due to other moderating variables. SES is a complex variable that reflects education as well as occupation and economics that impact the practical ability to comply with restrictions (Kooistra et al., 2020; van Rooij et al., 2020; Webster et al., 2020). Lower SES may reflect both less access to information and increased barriers to the ability to comply with guidelines (e.g., less opportunity to isolate; Patel et al., 2020). These opposing forces could account for inconsistencies across countries and a lack of effect in this global study.

Country-level differences may also play a larger role for SES than other demographic factors. For instance, residents of countries with a lower Human Development Index (HDI) were found to be more compliant than those with a higher HDI (Lin et al., 2021). But this is in contrast with research showing decreased compliance when there are practical obstacles to compliance (Kuiper et al., 2020; Templeton et al., 2020). It is critical to further investigate these complex underlying variables in future studies.

Furthermore, different measures used to assess SES influence both results and explanations provided. The MacArthur Scale of Subjective Social Status used in the present study asks participants to place themselves on a ladder to indicate where they stand in comparison to others in society, and perhaps that influenced the ways participants responded and evaluated themselves. Perceptions of SES, as measured on this scale, are likely to vary across countries because the scale asks participants to estimate their SES in comparison with the other people from their surroundings.

To summarise, higher levels of compliance are predicted by greater harm/care moral values, trust in government, trust in the WHO and trust in the scientific community, while lower levels of compliance are predicted by greater perceived stress. In addition, compliance increased with age and was higher in women and those working from home or unemployed. SES as measured here did not predict compliance, and future studies should investigate SES on a deeper level.

### H3: Cross-Country Differences Between Compliance and Trust

We predicted country-level differences in the relationship between compliance and trust (see Table S5 for the full results). As hypothesised, we found significant random effects, non-zero random slopes in several countries. Although such countries reported significant non-zero random slopes, the effects were trivial in terms of ROPE %. First, when the association between trust in government and compliance was examined, Bulgaria, Finland, and Russia reported positive non-zero random slopes. Second, in the case of trust in the WHO, Bulgaria showed a positive random slope, while Japan reported a negative random slope. According to Okada et al. (2023), Japanese individuals trusted the physicians and infected patients the most, while their trust to local health experts and health institutions declined over time. This can explain how in some countries people choose to trust those they perceive closer to them (their doctors and their infected neighbours or friends), while trust in experts and institutions declines. Further research is needed to determine how these variables interact within and across countries.

Third, in the case of trust in the scientific research community, Bulgaria and Czech Republic reported positive random slopes. This cross-country heterogeneity in the random slopes suggests the existence of moderating variables affecting the relationship between trust and compliance. For instance, differences in the perceived or objective quality of institutions (Letki, 2006), country-level cultural values (Gheorghiu et al., 2009), or historical relationships with supranational agencies (Mishler & Rose, 2001) might contribute to explain why the relationship between trust and compliance weakened or changed in some contexts. Additional research is needed to assess the impact of these variables across countries and territories.

## Significance of the Present Study

Compliance with public health guidelines is arguably one of the most important factors to slow the spread of disease. There are a myriad of factors that impact compliance, and a large-scale global study investigating these factors was necessary to understand not only what these factors are but also if they are globally consistent. The COVID-19 pandemic afforded the opportunity to investigate a number of previously identified factors on a global scale: social norms, moral values, trust in government and scientific entities, stress, and demographic factors. We also explored

cross-country differences in individuals' compliance behaviours, social norms, moral values, trust in government and scientists, and stress to examine the extent to which the associations differ across nations.

We found that social norms to follow preventive measures were positively correlated with compliance. We also identified significant demographic factors and beliefs that predicted compliance on a global level: older age, gender (women), work situation (home/unemployed), harm/care moral values, greater trust in government, greater trust in the WHO, greater trust in the scientific community, and lower perceived stress. Finally, we showed a positive relationship between compliance and trust in institutions. Importantly, these relationships were consistent overall with other studies, both in smaller populations and more globally (e.g., Almutairi et al., 2020; Goldberg et al., 2020; Hensel et al., 2020; Kuiper et al., 2020; Nivette et al., 2021; Smith et al., 2020; van Rooij et al., 2020; Zajenkowski et al., 2020).

Finally, we found country-level differences in the relationships between compliance and both social norms and trust. Although this analysis was exploratory, it shows that these relationships between factors may vary across countries, which opens the door to future research investigating the precise country-level factors that influence these relationships. Understanding which factors predict compliance and how this differs across countries is an important first step in determining how to increase compliance with guidelines to reduce the spread of disease in the future.

## Limitations

One limitation of this study is the self-report nature of survey research. The cross-sectional nature of the data also makes it difficult to identify causal pathways. Nonetheless, this research provides important insights into factors associated with compliance. Moreover, our results are mostly consistent with other smaller-scale studies and highlight slight differences across countries. Additionally, we focused on compliance as measured by the Compliance Scale, which incorporates different aspects of compliance. While it was beyond the scope of this paper to explore each aspect of compliance independently, this scale has been validated across languages (Blackburn et al., 2023) and we have further delved into different aspects of compliance as measured by this scale in other work (Garcia et al., 2022). Finally, we could not consider country-level factors that might predict compliance, such as the Human Development Index and per capita gross domestic product, since they were out of the scope of this paper as we focused on psychological predictors. Thus, it would be necessary to conduct additional multilevel analysis including country-level factors as variables in a follow-up study.

## Implications and Future Directions

Research has shown that long-term changes in social norms are possible by appealing to social identity and in-group values (Lede et al., 2019). Hence, an effective way to promote social compliance is to recognize how adherence to social norms may reinforce social identity, for example by means of protecting others (see e.g., Neville et al., 2021). It is important to highlight that compliance with rules during the COVID-19 pandemic should not be regarded solely as a temporary or circumstantial aspect. Instead, it can be interpreted as a manifestation of the likelihood that people continue to adhere to the norms established by the State under normal conditions and for unexpected events that occur in the country.

Therefore, although confinement and the dissemination of social behaviour guidelines during the pandemic may seem like specific actions to address an unusual health event, the degree of compliance by citizens can be seen as an expression of their perception and commitment to established norms. In other words, it reflects their identification and adherence to these norms in general. From there, we could consider that one of the implications of this finding is that it allows for hypotheses to be raised not only about the levels of social identification with the norm but also about the type of normativity and the modulation that is applied in its presentation according to the type of society. This point illustrates the importance of continuing research on this topic. In particular, to further understand how different aspects of compliance change over time, and how this might be affected by changes in trust over time. Another area to expand exploration is the relationships between moral values, levels of identity, and compliance.

Trust and the harm/care dimension of social norms impacts is critical to the development of programs and policies aimed at increasing compliance with measures to reduce the spread of disease. First, measures to increase trust, especially in government, the WHO, and the scientific community, should be a priority. For instance, unified guidelines from these three entities might bolster trust in all three. Comparing countries in which government guidelines aligned with the WHO vs. those that did not would shed light on the importance of a unified message in bolstering trust.

Additionally, this research suggests the value of programs targeted at the moral value of compliance, especially addressing the harm/care foundation. Several studies from moral psychology have suggested that developed moral reasoning, empathy, and moral identity, central to moral and prosocial behaviour, are most strongly tied with the harm/care foundation compared with the other foundations (Dawson et al., 2021; Han & Dawson, 2022). Furthermore,

Rosenfeld et al. (2022) addresses how to promote pro-sociality within the context of the current pandemic and suggests that interventions need to focus on the dimension of harm and threat. Hence, interventions and programs that intend to promote compliance should consider the harm/care foundation as a central theme.

## Conclusion

We analysed survey responses a year into the COVID-19 pandemic to investigate factors that impact compliance with public health guidelines. We found that social norms to follow preventive measures were positively correlated with compliance with local prevention guidelines and that this relationship differed across countries. Moral values (especially harm/care), trust, age, gender, and work location also impacted compliance. Trust in government, the World Health Organization (WHO), and the scientific community should be taken into consideration when predicting compliance. It is important to note that there were significant differences in the slopes between countries. Knowing that trust and the harm/care dimension of social norms impact compliance is critical to developing programs and policies aimed at increasing compliance with measures to reduce the spread of disease.

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**Data availability** The data analysis was pre-registered (https://doi.org/10.17605/OSF.IO/5WA3C). The dataset is available in the Open Science Framework repository: COVIDiSTRESS II Consortium, 2021. COVIDiSTRESS II Global Survey (https://osf.io/36tsd/). Source code files are available via GitHub (https://github.com/hyemin-han/COVIDiSTRESS2_Compliance).

## Declarations

**Ethics** The current study was approved by the Ethical committee of the University of Salford, UK [ref. 1632] as well as by local ethical approval boards.

**Conflicts of interest/Competing interests** We have no competing interests to disclose.

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