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Letter to the Editor

COVID-19 and mass gatherings: emerging and future implications of the Brazilian carnival for public health

The current Coronavirus Disease 2019 (COVID-19) outbreak, caused by the viral, zoonotic pathogen named Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), has caused an evolving global public health and economic crisis. This viral pandemic was first reported in December 2019 in Wuhan, Hubei province, China. About two months later, it was declared as a Public Health Emergency of International Concern (PHEIC) by the World Health Organization (WHO) on January 30, 2020. Like has been shown in other countries worldwide, Brazil was also dramatically affected by the current pandemic, and declared COVID-19 as a public health emergency on February 3, 2020.

As a result of insufficient efforts made by the government, up to date, Brazil is considered the Latin America's worst-hit country by COVID-19 pandemic, and became the world's 2nd country in cases, overcoming the milestone of two million cases. On July 26, 2020, the Brazilian Ministry of Health, through the Health Surveillance Secretariat, confirmed a total of 2,419,091 cases and 87,004 deaths.[1] Despite the record of COVID-19 surges as the world has seen, the following issue is on the rise in the country: what are the implications of the current COVID-19 outbreak for the celebration of the Brazilian carnival in 2021?

The Brazilian carnival is one of the most famous annual mass gatherings in the country, which is responsible for attracting millions of people from different states and nationalities, as well as by injecting billions of reals into the economy. According to data released by the Brazilian Ministry of Tourism, the carnival in 2020 was marked by records, in which the cities of Salvador, São Paulo, and Rio de Janeiro registered an average of 16.5, 15.0, and 6.4 million of people, respectively.[2,3] During the celebration, the country commonly also received foreign tourists, mainly from Argentina, France, United States of America (USA), Germany, Spain, and England.[2]

São Paulo, Rio de Janeiro, and Salvador - three of the main carnival destinations in Brazil - have shown a constant and alarming increase in the number of cases and deaths by COVID-19 during the last few months as shown in Fig. 1. Therefore, this Brazilian event calls for extreme concern and highlights an unprecedented threat to global health. This note gains special attention due to the high transmission rate presented by SARS-CoV-2, which can be transmitted by contact with infected individuals, including symptomatic,[4,5] presymptomatic,[6] and asymptomatic[7] individuals. Corroborating this, the present Journal recently has published an article that addressed this issue. Wu et al. (2020),[8] through a retrospective cohort study, showed that the form and frequency of contacts are the determining factors for the SARS-CoV-2 transmission.

Huang et al. (2020)[9] in a prospective contact-tracing study showed that SARS-CoV-2 could be transmitted quickly by asymptomatic individuals during the incubation period. In addition, another route of transmission may involve contamination of the air and the environment surface by patients infected with SARS-CoV-2 through their respiratory droplets and possibly by fecal shedding.[5] Therefore, the Brazilian public authorities need to take into account each peculiarity about the modes and times of viral transmission before making a decision regarding the approval of the carnival in 2021, a public event where the social distancing is almost unattainable.

Another concern that needs to be raised is related to the role of travelers in the rapid spread of COVID-19. Zheng et al. (2020)[10] showed a significant and positive correlation between the frequency of imported cases via flights, trains, and buses with the number of COVID-19 cases. Thus, if the Brazilian carnival is held in 2021, it will probably bring together people from different regions and nationalities, which would potentialize, at the same time, travelers bringing the virus to the event or taking it to their cities.

It is essential to highlight that the current COVID-19 outbreak is ongoing worldwide, and from an international perspective, maybe it is too early to discuss the future course of this pandemic in Brazil, a country that has failed to address the coronavirus pandemic in any meaningful way. Due to the lack of antiviral therapy and vaccine availability, public health measures to control the current coronavirus pandemic remains based on classical control of epidemics, such as physical distancing, the use of masks, environmental decontamination, and hygiene measures. In contrast, mass meetings, such as carnival, are marked by numerous social behaviors that are extremely incompatible with the health measures adopted to face COVID-19.

Despite the recent augmentation in discussions by the Brazilian authorities on whether or not to hold this event scheduled for February 12–26, 2021, to date, only the government of São Paulo decided to postpone the carnival, suggesting that the celebrations may be held in May or July of 2021.[11] However, it is not the first time that the Brazilian carnival has been postponed. In 1892 and 1912, despite the postponement of the celebration, the population did not accept the change and celebrated on both dates: the official and the new one that had been determined.[11] Thus, the postponement of the carnival does not guarantee that

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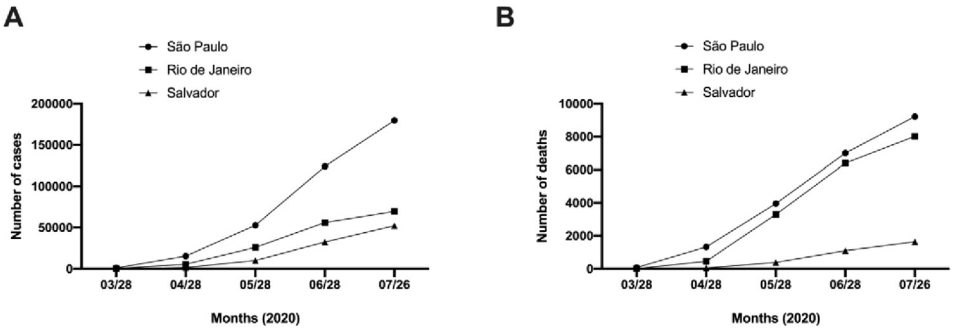

Fig. 1. (**A**) Number of cases and (**B**) deaths caused by the current COVID-19 pandemic in the Brazilian cities of São Paulo, Rio de Janeiro, and Salvador during the months of March to July of 2020. The number of cases and deaths were obtained from the 'Brazilian Ministry of Health. Coronavirus Brazil'.[1]

the celebrations will not be made by the population on the date initially proposed.

At the moment, dates seem to on the distant horizon, but the scenario is increasingly unpredictable. On July 15, 2020, the dean of the Federal University of São Paulo (UNIFESP) stated that the apparently most effective vaccine against COVID-19 developed by the University of Oxford from the United Kingdom, which has been tested in Brazil, may have its registration only in June 2021.[12] In this current scenario, the cancellation or postponement of the carnival in 2021 are key determinants of the outbreak expansion, as well as for the pandemic mitigation. Postponing the carnival, without effective medical countermeasures available or complete immunization of the population, represents considerable public health challenges for Brazilian health authorities and federal government, and requires considerable preparation and multifaceted public health interventions.

If the decision is made to proceed with the carnival, the Brazilian health authorities should take into account some recommendations for managing public health aspects, based on the main planning recommendations for mass meetings developed by the WHO[13] and in accordance with technical guidance on COVID-19[14] during the current COVID-19 outbreak (see Box 1). However, if the carnival is allowed, mitigating the current pandemic will be a huge public health challenge for Brazil.

Box 1

Proposed public health recommendations during the carnival in the context of the current COVID-19 outbreak.[13,14]

- Event organizers must provide advance warnings and recommendations to participants about the outbreaks in the region, highlighting the risks to which they would be exposed.
- Disclose public health messages specific to COVID-19.
- Provide information on event cancellation and limitations on the number of people.
- Encourage social distance, the use of masks, and periodic hand hygiene.
- Ensure adequate decontamination of avenues, streets, hotels, restaurants, airports, bus stations, and others.
- Health authorities should provide measures of prevention and accompaniment of travelers.
- Support the establishment of a postcarnival surveillance system to quickly diagnose, provide rapid epidemiological data, manage and treat all ill persons.

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Editor's note

The editors wish to express their concerns regarding the authorship of the paper entitled 'Segmented regression analysis of interrupted time series data to assess outcomes of a South American road traffic alcohol policy change' Public Health, Volume 150, September 2017, Pages 51–59. Stanford University have informed us that the listed author has never been affiliated with Stanford and that additional authors, Rebecca Walker and Alex McMillan, should have been included in the author list. The Complejo Hospitalario Universitario de A Coruna have declined to participate in our investigation concerning this paper.

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Original Research

Factors associated with adherence to self-isolation and lockdown measures in the UK: a cross-sectional survey

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ABSTRACT

Objectives: To investigate factors associated with adherence to self-isolation and lockdown measures due to COVID-19 in the UK.
Study design: Online cross-sectional survey.
Methods: Data were collected between 6th and 7th May 2020. A total of 2240 participants living in the UK aged 18 years or older were recruited from YouGov's online research panel.
Results: A total of 217 people (9.7%) reported that they or someone in their household had symptoms of COVID-19 (cough or high temperature/fever) in the last 7 days. Of these people, 75.1% had left the home in the last 24 h (defined as non-adherent). Men were more likely to be non-adherent, as were people who were less worried about COVID-19, and who perceived a smaller risk of catching COVID-19. Adherence was associated with having received help from someone outside your household. Results should be taken with caution as there was no evidence for associations when controlling for multiple analyses. Of people reporting no symptoms in the household, 24.5% had gone out shopping for non-essentials in the last week (defined as non-adherent). Factors associated with non-adherence and with a higher total number of outings in the last week included decreased perceived effectiveness of government 'lockdown' measures, decreased perceived severity of COVID-19 and decreased estimates of how many other people were following lockdown rules. Having received help was associated with better adherence.
Conclusions: Adherence to self-isolation is poor. As we move into a new phase of contact tracing and self-isolation, it is essential that adherence is improved. Communications should aim to increase knowledge about actions to take when symptomatic or if you have been in contact with a possible COVID-19 case. They should also emphasise the risk of catching and spreading COVID-19 when out and about and the effectiveness of preventative measures. Using volunteer networks effectively to support people in isolation may promote adherence.

Introduction

During the coronavirus pandemic, governments have imposed restrictions of movement to prevent the spread of the virus. Commonly used measures are self-isolation, in which people who are ill separate themselves from others, and quarantine, in which people who may have been exposed to the illness separate themselves from others.[1] On 23rd March 2020, the UK government introduced 'lockdown' measures to slow the spread of COVID-19.[2,3] These required people to: stay at home except for several, limited reasons; not leave the home at all for 7 days, if suffering from a new continuous cough or fever; and not leave the home at all for 14 days, if someone else in the household developed cough or fever.

Adherence to these measures may be influenced by multiple factors. According to Protection Motivation Theory,[4] uptake of a

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protective behaviour is influenced by your appraisal of a threat, including its severity and your susceptibility to it, and your appraisal of the behaviour, including perceptions about its efficacy, your ability to perform it and the costs associated with it. A review of quarantine measures in previous public health crises found that knowledge and perceived social norms were also associated with adherence to quarantine.[5] Conversely, fear of missing out, perceived social pressure, perceived legal consequences, running out of supplies (e.g. food or medicine) and financial pressures were associated with decreased adherence. There is some evidence that people who think they have had COVID-19 are less likely to adhere to lockdown measures.[6]

In this study, we investigated factors associated with adherence to lockdown measures in a demographically representative sample of the UK adult population.

Method

Design

We commissioned the market research company YouGov to carry out this cross-sectional survey, between 6th and 7th May 2020.

Participants

Participants ($n = 2240$) were recruited from YouGov's online research panel ($n = 800{,}000+$ UK adults) and were eligible if they aged 18 years or older and living in the UK. Quota sampling was used, based on age, gender, social grade, level of education and Government Office Region, to ensure that the sample was broadly representative of the UK general population. In total, 74 participants were excluded because of a lack of data for sociodemographic variables, suspiciously fast completion of the survey or providing identical answers to multiple consecutive questions. Participants were reimbursed in points equivalent to approximately 50p.

Study materials

Full survey materials are available in the Supplementary Materials.

Outcome measures

We asked participants how many times they had left their home 'in the past 24 h' and 'in the past seven days': to go to the shops for groceries, toiletries or medicine; to go to the shops for other items; for exercise; for a medical purpose excluding going to the shops/pharmacy for medicine; to go to work; to help someone else; and to meet friends or family who they did not live with.

Psychological and situational factors

We asked participants if they or a household member had experienced any of 13 symptoms, including cough and high temperature/fever, in the past 7 and 14 days, respectively.

We asked participants whether they thought they had 'had, or currently have, coronavirus' and if they were currently self-isolating.

We asked participants a series of true/false statements about the current UK government guidance.

We asked participants how worried they were about COVID-19 on a five-point Likert-type scale from 'not at all worried' to 'extremely worried'.

To measure perceived social norms, we asked participants to estimate the percentage of people the same age as them who were fully following the UK government's recommendations to stay at home.

We asked participants whether they thought the current lockdown had made their physical health better or worse. Possible answers were 'a lot better', 'a little better', 'no difference', 'a little worse' and 'a lot worse'.

We asked participants to rate their general health on a five-point Likert-type scale from 'poor' to 'excellent' using one item from the SF-36.[7]

Table 1
Participants' personal and clinical characteristics, by report of symptoms in the household.

Participants' characteristics	Level	No symptoms in household; $n = 1945$	Symptoms in household; $n = 217$	*P*-value
Gender	Male	915 (47.0)	124 (57.1)	0.01*
	Female	1030 (53.0)	93 (42.9)	
Age, years	18–24	76 (3.9)	10 (4.6)	0.46
	25–34	259 (13.3)	35 (16.1)	
	35–44	347 (17.8)	37 (17.1)	
	45–54	363 (18.7)	31 (14.3)	
	55 and older	900 (46.3)	104 (47.9)	
Child in the household	None	1428 (74.3)	153 (72.9)	0.65
	Child present	494 (25.7)	57 (27.1)	
Clinically extremely vulnerable (self)	No	1760 (93.1)	190 (90.9)	0.25
	Yes	131 (6.9)	19 (9.1)	
Employment status	Not working	903 (46.6)	102 (47.0)	0.87
	Working	1042 (53.6)	115 (53.0)	
Highest educational or professional qualification	GCSE/vocational/A-level/No formal qualifications	856 (44.9)	86 (40.4)	0.21
	Degree or higher (Bachelors, Masters, PhD)	1052 (55.1)	127 (59.6)	
IMD	More deprived area	851 (43.8)	103 (47.5)	0.30
	Less deprived area	1094 (56.2)	114 (52.5)	
Social grade	ABC1	1184 (60.9)	133 (61.3)	0.91
	C2DE	761 (39.1)	84 (38.7)	
Urban/rural	Urban	1462 (77.2)	166 (79.4)	0.46
	Rural	433 (22.8)	43 (20.6)	
Living alone	Yes	402 (20.7)	34 (15.8)	0.09
	No	1543 (79.3)	181 (84.2)	
Marital status	Married/civil partnership/living as married	1233 (63.8)	142 (65.4)	0.62
	Separated/divorced/widowed/never married	701 (36.2)	75 (34.6)	

*$P \leq 0.05$.

Table 2
Associations between personal and clinical characteristics of participants who reported symptoms in their household in the last week and having left the home in the past 24 hours.

Participants' characteristics	Level	Did not go out in the past 24 h; $n = 54$	Went out in the past 24 h; $n = 163$	Odds ratio (95% CI)	Adjusted odds ratio (95% CI)[a]
Gender	Male	23 (18.5)	101 (81.5)	Reference	Reference
	Female	31 (33.3)	62 (66.7)	0.46 (0.24–0.85)*	0.32 (0.14–0.76)*
Age, years	18–24	4 (40.0)	6 (60.0)	Reference	Reference
	25–34	8 (22.9)	27 (77.1)	2.25 (0.51–9.99)	2.37 (0.29–19.26)
	35–44	6 (16.2)	31 (83.8)	3.44 (0.74–16.03)	2.58 (0.31–21.54)
	45–54	10 (32.3)	21 (67.7)	1.40 (0.32–6.10)	1.22 (0.17–8.81)
	55 and older	54 (24.9)	163 (75.1)	2 (0.52–7.64)	2.40 (0.33–17.55)
Child in the household	None	44 (28.8)	109 (71.2)	Reference	Reference
	Child present	7 (12.3)	50 (87.7)	2.88 (1.21–6.85)*	2.88 (0.90–9.21)
Clinically extremely vulnerable (self)	No	44 (23.2)	146 (76.8)	Reference	Reference
	Yes	8 (42.1)	11 (57.9)	0.41 (0.16–1.09)	0.38 (0.10–1.48)
Employment status	Not working	34 (33.3)	68 (66.7)	Reference	Reference
	Working	20 (17.4)	95 (82.6)	2.37 (1.26–4.48)*	2.51 (0.92–6.83)
Highest educational or professional qualification	GCSE/vocational/A-level/No formal qualifications	22 (25.6)	64 (74.4)	Reference	Reference
	Degree or higher (Bachelors, Masters, PhD)	29 (22.8)	98 (77.2)	1.16 (0.61–2.20)	0.70 (0.28–1.76)
IMD	More deprived area	25 (24.3)	78 (75.7)	Reference	Reference
	Less deprived area	29 (25.4)	85 (74.6)	0.94 (0.51–1.74)	1.91 (0.73–5.02)
Social grade	ABC1	37 (27.8)	96 (72.2)	Reference	Reference
	C2DE	17 (20.2)	67 (79.8)	1.52 (0.79–2.92)	2.39 (0.89–6.39)
Urban/rural	Urban	39 (23.5)	127 (76.5)	Reference	Reference
	Rural	12 (27.9)	31 (72.1)	0.79 (0.37–1.69)	0.62 (0.22–1.78)
Living alone	Yes	11 (32.4)	23 (67.6)	Reference	Reference
	No	41 (22.7)	140 (77.3)	1.63 (0.73–3.63)	0.52 (0.12–2.15)
Marital status	Married/civil partnership/living as married	27 (19.0)	115 (81.0)	Reference	Reference
	Separated/divorced/widowed/never married	27 (36.0)	48 (64.0)	0.42 (0.22–0.78)*	0.42 (0.12–1.46)
Clinically extremely vulnerable (household member)[b]	No	38 (23.6)	123 (76.4)	Reference	Reference
	Yes	3 (21.4)	11 (78.6)	1.13 (0.30–4.27)	3.47 (0.47–25.46)
Home includes access to outside space	No	4 (36.4)	7 (63.6)	Reference	Reference
	Yes	50 (24.3)	156 (75.7)	1.78 (0.50–6.34)	0.36 (0.03–4.00)
Pet ownership	No	31 (31.6)	67 (68.4)	Reference	Reference
	Yes	23 (19.3)	96 (80.7)	1.93 (1.04–3.60)*	1.72 (0.72–4.11)

*$P \leq 0.05$.
[a] Adjusting for gender, age, having a child in the household, being extremely clinically vulnerable oneself, employment status, highest level of education or professional qualification, indices of multiple deprivation, social grade, living in a rural or urban area, living alone, marital status and region.
[b] Adjusted analyses for this variable did not control for living alone, as by definition all participants asked this question lived in a household with someone else.

We asked participants if they had helped someone, or received help from someone, outside their household in the past 7 days (yes/no).

We asked participants to rate 14 perception statements on a five-point Likert scale from 'strongly disagree' to 'strongly agree'. Statements included the perceived severity of COVID-19, perceived effectiveness of government measures, perceived likelihood of catching and spreading COVID-19, perceived costs of following government measures, fear of losing touch with friends and relatives, social pressure from friends and family to follow government measures, perceived legal consequences of not following government measures and positive consequences of the lockdown.

Personal and clinical characteristics

We asked participants to report their age, gender, employment status, highest educational or professional qualification and marital status. We also asked whether there was a child in their household, whether they or someone else in their household received a letter from the National Health Service telling them they were extremely clinically vulnerable to COVID-19, and whether they lived alone. Participants were asked for their postcode to determine indices of multiple deprivation (IMD) and whether they lived in an urban or rural area. We also collected social grade.

We asked participants if their primary home had access to any outdoor space, and whether they were pet owners.

Table 3
Associations between psychological and situational factors and having left the home in the past 24 hours in participants who reported symptoms in the household.

Participants' characteristics	Level	Did not go out in the past 24 h; $n = 54$	Went out in the past 24 h; $n = 163$	Odds ratio (95% CI)	Adjusted odds ratio (95% CI)[a]
Had, or currently have, COVID-19	Think have not had COVID-19 and do not have it now	27 (20.8)	103 (79.2)	Reference	Reference
	Think have had COVID-19 or have it now	17 (37.0)	29 (63.0)	0.45 (0.21–0.93)*	0.32 (0.09–1.17)
Self-isolating	Not self-isolating	25 (17.5)	118 (82.5)	Reference	Reference
	Self-isolating	29 (39.2)	45 (60.8)	0.33 (0.17–0.62)**	0.23 (0.09–0.61)*
Understanding of government measures if no-one in household was symptomatic	Incorrect/unsure	34 (26.6)	94 (73.4)	Reference	Reference
	Correct	20 (22.5)	69 (77.5)	1.25 (0.66–2.35)	0.95 (0.40–2.23)
Understanding of government measures if someone in household was symptomatic	Incorrect/unsure	49 (24.1)	154 (75.9)	Reference	Reference
	Correct	5 (35.7)	9 (64.3)	0.57 (0.18–1.79)	1.31 (0.29–5.96)
Worry about COVID-19	5-point scale, 1 = not at all worried to 5 = extremely worried	N = 54, M = 3.70, SD = 0.92	N = 163, M = 3.44, SD = 1.02	0.77 (0.56–1.05)	0.61 (0.37–0.98)*
Perceived social norms	Percentage (range 0–100)	N = 46, M = 72.13, SD = 20.53	N = 151, M = 69.84, SD = 17.39	0.99 (0.97–1.01)	0.99 (0.97–1.02)
Perceptions about impact on mental health	5-point scale, 1 = a lot better to 5 = a lot worse	N = 54, M = 3.37, SD = 1.07	N = 160, M = 3.57, SD = 0.96	1.22 (0.90–1.67)	1.61 (1.03–2.500)*
Perceptions about impact on physical health	5-point scale, 1 = a lot better to 5 = a lot worse	N = 54, M = 3.54, SD = 0.91	N = 162, M = 3.38, SD = 0.91	0.82 (0.58–1.16)	0.77 (0.48–1.25)
Self-reported general health	5-point scale, 1 = poor to 5 = excellent	N = 54, M = 2.33, SD = 1.13	N = 161, M = 2.75, SD = 0.96	1.51 (1.10–2.06)*	1.53 (0.99–2.38)
Helped someone outside household	No	44 (28.6)	110 (71.4)	Reference	Reference
	Yes	9 (14.8)	52 (85.2)	2.31 (1.05–5.09)*	2.38 (0.86–6.61)
Received help from someone outside household	No	37 (20.8)	141 (79.2)	Reference	Reference
	Yes	16 (43.2)	21 (56.8)	0.34 (0.16–0.73)*	0.30 (0.09–0.96)*
If I completely follow the government's advice, I will lose touch with my friends and relatives	5-point scale, 1 = strongly disagree to 5 = strongly agree	N = 53, M = 1.96, SD = 1.16	N = 161, M = 2.25, SD = 1.26	1.23 (0.94–1.61)	1.20 (0.82–1.76)
My friends or family will disapprove if I don't follow the government's advice	5-point scale, 1 = strongly disagree to 5 = strongly agree	N = 52, M = 3.92, SD = 1.19	N = 159, M = 4.05, SD = 0.90	1.14 (0.83–1.56)	1.17 (0.76–1.80)
If I don't follow the government's advice, I could get in trouble with the police	5-point scale, 1 = strongly disagree to 5 = strongly agree	N = 53, M = 3.98, SD = 0.84	N = 159, M = 3.83, SD = 0.93	0.83 (0.58–1.18)	0.89 (0.56–1.39)
If I follow the government's advice, it will help save lives	5-point scale, 1 = strongly disagree to 5 = strongly agree	N = 54, M = 4.54, SD = 0.88	N = 161, M = 4.39, SD = 0.89	0.81 (0.55–1.19)	0.73 (0.43–1.23)
If I follow the government's advice, it will help protect the NHS	5-point scale, 1 = strongly disagree to 5 = strongly agree	N = 54, M = 4.57, SD = 0.66	N = 161, M = 4.47, SD = 0.81	0.82 (0.53–1.27)	0.90 (0.51–1.57)
If I catch coronavirus, I may become very ill	5-point scale, 1 = strongly disagree to 5 = strongly agree	N = 53, M = 4.51, SD = 0.72	N = 156, M = 4.45, SD = 0.90	0.92 (0.63–1.34)	1.06 (0.64–1.74)
If I catch coronavirus, it will have a severe impact on my family's well-being	5-point scale, 1 = strongly disagree to 5 = strongly agree	N = 52, M = 4.15, SD = 1.04	N = 158, M = 4.18, SD = 1.04	1.03 (0.76–1.39)	1.34 (0.87–2.08)
If I leave home and meet other people, I could pass coronavirus to someone else	5-point scale, 1 = strongly disagree to 5 = strongly agree	N = 53, M = 4.62, SD = 0.56	N = 157, M = 4.52, SD = 0.75	0.79 (0.49–1.28)	0.61 (0.29–1.27)
If I leave home and meet other people, I could catch coronavirus	5-point scale, 1 = strongly disagree to 5 = strongly agree	N = 54, M = 4.74, SD = 0.48	N = 161, M = 4.5, SD = 0.73	0.51 (0.29–0.92)*	0.40 (0.16–0.99)*
If I follow the government's advice, it will have a negative impact on how much money I have	5-point scale, 1 = strongly disagree to 5 = strongly agree	N = 53, M = 2.55, SD = 1.29	N = 159, M = 2.71, SD = 1.28	1.11 (0.87–1.41)	1.16 (0.85–1.60)
Because of the current lockdown, there is more conflict between people that I live with	5-point scale, 1 = strongly disagree to 5 = strongly agree	N = 52, M = 2.15, SD = 1.13	N = 160, M = 2.28, SD = 1.27	1.08 (0.84–1.40)	1.26 (0.85–1.85)
		N = 50, M = 2.58, SD = 1.49			1.08 (0.77–1.49)

Table 3 (*continued*)

Participants' characteristics	Level	Did not go out in the past 24 h; $n = 54$	Went out in the past 24 h; $n = 163$	Odds ratio (95% CI)	Adjusted odds ratio (95% CI)[a]
If I follow the government's advice, I will not be able to carry out important religious activities	5-point scale, 1 = strongly disagree to 5 = strongly agree		N = 148, M = 2.69, SD = 1.31	1.06 (0.84 −1.35)	
I am enjoying spending more time at home during the lockdown	5-point scale, 1 = strongly disagree to 5 = strongly agree	N = 54, M = 3.46, SD = 1.21	N = 162, M = 3.19, SD = 1.22	0.82 (0.64 −1.07)	0.83 (0.59−1.18)
Because of coronavirus, I feel a sense of community with other people in my neighbourhood	5-point scale, 1 = strongly disagree to 5 = strongly agree	N = 54, M = 2.98, SD = 1.22	N = 162, M = 3.25, SD = 1.14	1.22 (0.94 −1.60)	1.52 (1.03−2.24)*

*$P \leq 0.05$.
**$P \leq 0.001$.
[a] Adjusting for gender, age, having a child in the household, being extremely clinically vulnerable oneself, employment status, highest level of education or professional qualification, indices of multiple deprivation, social grade, living in a rural or urban area, living alone, marital status and region.

Ethics

Ethical approval for this study was granted by the King's College London Research Ethics Committee (reference: LRS-19/20-18687).

Power

We calculated achieved power for the analyses (in households with and without symptoms) using *post-hoc* power calculations. Achieved power is presented underneath relevant analyses.

Analysis

For all variables, unless stated otherwise, we coded answers of 'don't know' as missing data.

We investigated whether out-of-home activity (total number of outings, percentage of people reporting shopping for non-essentials, going to meet friends or family, and having visitors to their home) differed by presence of symptoms in the household.

We split the sample by presence of symptoms in the household. Among those who reported symptoms in their household in the last 7 days, we defined those who reported having gone out in the last 24 h as not adhering to self-isolation measures. We ran a series of logistic regressions investigating univariable associations between personal and clinical factors, psychological and situational factors, and having left the home in the past 24 h. We ran a second set of logistic regressions controlling for personal and clinical characteristics.

Among those who reported no symptoms in the household, we used UK government guidelines that were in force at the time of data collection[2] to define non-adherence (shopping for non-essentials, meeting friends or family and having visitors to your home). We ran a series of linear regressions investigating univariable associations between personal and clinical factors, psychological and situational factors, and total number of outings reported in the past 7 days. We ran a second set of linear regressions controlling for personal and clinical characteristics (personal and clinical characteristics entered as the first block, other independent variables as the second block). We ran a series of logistic regressions investigating univariable associations between personal and clinical factors, psychological and situational factors, and going out shopping for items other than groceries, toiletries or medicines (non-essentials) in the past 7 days. We ran a second set of logistic regressions controlling for personal and clinical characteristics.

Weighting data by age, gender, social grade, highest level of education and region altered prevalence of outcome behaviours only slightly. We therefore used unweighted data in our analyses.

Sensitivity analyses

Owing to the large number of analyses ($n = 39$) run on each outcome, we applied a Bonferroni correction to our results ($P \leq 0.001$). Those meeting this criterion are marked by a double asterisk (**) in the tables.

Results

Results of adjusted analyses are reported narratively; unadjusted results are reported in tables.

A minority of participants (9.7%, $n = 217$) reported that either they or a household member had a cough or a high temperature/fever in the last 7 or 14 days, respectively. Participants' characteristics are shown in Table 1. Male participants were more likely to report symptoms in their household. There were no other differences between groups.

Symptoms in household

Of participants who reported symptoms in their household ($n = 217$), 75.1% ($n = 163$, 95% confidence interval [CI; 69.3−80.9]) reported leaving the home at least once in the past 24 h. This finding has been reported elsewhere.[8]

A few participants ($n = 54$, 2.4%) reported going out many times; we grouped responses of over 20 times in the past 7 days. There was no difference in out-of-home activity by presence of symptoms in the household (total number of outings made in the last week, $t(2160) = 0.20$, $P = .84$; percentage of people reporting shopping for non-essentials, χ^2 (1, 2162) = 0.38, $P = .54$; having had a visitor to one's home, χ^2 (1, 2076) = 0.40, $P = .53$; or going to meet friends or family, χ^2 (1, 2162) = 1.34, $P = .25$).

Of those who reported symptoms in the household, 34.1% ($n = 74$) reported that they were self-isolating. Of those 'self-isolating', 60.8% ($n = 45$) nonetheless reported having gone out in the last 24 h.

Men were more likely to leave the home in the last 24 h (see Table 2).

Non-adherence to self-isolation (reporting having left home in the last 24 h) was associated with: thinking that the lockdown had made your mental health worse; feeling a greater sense of community with your neighbourhood due to COVID-19 (see Table 3).

Table 4
Associations between personal and clinical characteristics and total number of outings in the past week in participants who reported no symptoms in the household.

Participants' characteristics	Level	Number of outings	Total number of outings in the past week									
			Unadjusted analyses					Adjusted analyses[a]				
			Model			Regression coefficient		Model			Regression coefficient	
			F	Adjusted R^2	*P*-value	B	*P*-value	*F*	Adjusted R^2	*P*-value	β	*P*-value
Gender	Male, $n = 915$	M = 7.22, SD = 5.27										
	Female, $n = 1030$	M = 6.37, SD = 4.85	13.89	0.007	<0.001**	−0.08	<0.001**				−0.09	<0.001**
Age, years	18–24, $n = 76$	M = 5.04, SD = 5.26										
	25–34, $n = 259$	M = 7.50, SD = 5.05										
	35–44, $n = 347$	M = 7.35, SD = 4.68										
	45–54, $n = 363$	M = 7.63, SD = 5.22										
	55 and older, $n = 900$	M = 6.13, SD = 5.04	7.61	0.003	0.01*	−0.06	.01*				0.00	0.91
Child in the household	None, $n = 1428$	M = 6.59, SD = 5.13										
	Child present, $n = 494$	M = 7.34, SD = 4.91	7.84	0.004	0.01*	0.06	0.01*				0.00	0.95
Clinically extremely vulnerable (self)	No, $n = 1760$	M = 6.97, SD = 5.00										
	Yes, $n = 131$	M = 4.39, SD = 5.27	32.22	0.017	<0.001**	−0.13	<0.001**				−0.10	<0.001**
Employment status	Not working, $n = 903$	M = 5.48, SD = 4.72										
	Working, $n = 1042$	M = 7.88, SD = 5.11	114.62	0.055	<0.001**	0.24	<0.001**				0.24	<0.001**
Highest educational or professional qualification	GCSE/vocational/A-level/No formal qualifications, $n = 856$	M = 6.59, SD = 5.26										
	Degree or higher (Bachelors, Masters, PhD), $n = 1052$	M = 6.96, SD = 4.93	2.47	0.001	0.12	0.04	0.12				0.01	0.56
IMD	More deprived area, $n = 851$	M = 6.35, SD = 5.17	10.22	0.005	0.001**	0.07	0.001**				0.06	0.007*
	Less deprived area, $n = 1094$	M = 7.09, SD = 4.97										
Social grade	ABC1, $n = 1184$	M = 6.94, SD = 4.84										
	C2DE, $n = 761$	M = 6.50, SD = 5.40	3.45	0.001	0.06	−0.04	0.06				0.03	0.29
Urban/rural	Urban, $n = 1462$	M = 6.62, SD = 5.08										
	Rural, $n = 433$	M = 7.01, SD = 4.97	2.04	0.001	0.15	0.03	0.15				0.05	0.04*
Living alone	Yes, $n = 402$	M = 6.34, SD = 5.19										
	No, $n = 1543$	M = 6.88, SD = 5.04	3.59	0.001	0.06	0.04	0.06				0.01	0.83
Marital status	Married/civil partnership/living as married, $n = 1233$	M = 6.92, SD = 4.98										
	Separated/divorced/widowed/ never married, $n = 701$	M = 6.52, SD = 5.24	2.79	0.001	0.10	−0.04	0.10				−0.01	0.81
Model			–	–	–	–	–	13.71	0.079	<0.001**		
Clinically extremely vulnerable (household member)[b]	No, $n = 1374$	M = 6.92, SD = 4.95										
	Yes, $n = 125$	M = 6.59, SD = 5.65	0.50	0.000	0.48	−0.02	0.48	9.86	0.070	<0.001**	−0.01	0.60
Home includes access to outside space	No, $n = 146$	M = 6.60, SD = 5.16										
	Yes, $n = 1799$	M = 6.78, SD = 5.07	0.19	0.000	0.67	0.01	0.67	12.65	0.078	<0.001**	0.00	0.88
Pet ownership	No, $n = 1072$	M = 6.19, SD = 4.80										
	Yes, n = 873	M = 7.48, SD = 5.30	31.13	0.015	<0.001**	0.13	<0.001**	14.56	0.090	<0.001**	0.11	<0.001**

*$P \leq 0.05$.
**$P \leq 0.001$.
[a] Adjusting for gender, age, having a child in the household, being extremely clinically vulnerable oneself, employment status, highest level of education or professional qualification, indices of multiple deprivation, social grade, living in a rural or urban area, living alone, marital status and region. Personal and clinical characteristics entered as first block, other independent variables entered as second block.
[b] Adjusted analyses for this variable did not control for living alone, as by definition all participants asked this question lived in a household with someone else.

Adherence to self-isolation (reporting not having left home in the last 24 h) was associated with: reporting that you were self-isolating; increased worry about COVID-19; having received help from someone outside your household in the last seven days because of COVID-19; and increased perceived likelihood of catching COVID-19.

Power

For analyses where symptoms were present in the household, we achieved 94% power to detect small effect sizes in logistic regression analyses (odds ratio [OR] = 1.68,[9] $\alpha = .05$, sample size $n = 217$, probability of having left the home = 0.75, one-tailed logistic regression; 89% power when using a two-tailed logistic regression).[10]

No symptoms in household

Of those who reported no symptoms in their household, 24.5% reported having gone out to shop for items other than groceries, toiletries or medicines ($n = 476$, 95% CI [22.6–26.4]), 5.9% reported meeting up with friends and/or family that they did not live with ($n = 114$, 95% CI [4.8–6.9]), and 4.3% reported having had visitors to their home in the last 7 days ($n = 81$, 95% CI [3.4–5.3]). The mean number of outings made by participants was 6.77 (standard deviation [SD] = 5.07, median = 6, mode = 0).

Personal and clinical factors (gender, age, having a child in the household, being extremely clinically vulnerable oneself, employment status, highest level of education or professional qualification, IMD, social grade, living in a rural or urban area, living alone, marital status and region [results for region not reported]) explained 8.0% of the variance in number of outings in the past week (see Table 4). More outings were made by men, those who reported working and who lived in rural areas. Fewer outings were made by those who were clinically extremely vulnerable and who lived in more deprived areas. Having a pet was also associated with going out more often.

More outings in the past week were associated with: helping someone outside your household; decreased perceived effectiveness of government measures; thinking that you would lose touch with friends and relatives if you followed government advice; not enjoying spending more time at home during the lockdown; better self-reported general health; decreased perceived severity of COVID-19; decreased perceived likelihood of spreading COVID-19; decreased perceived legal consequences of not following government advice; decreased perceived social pressure from friends and family to follow government measures; full, correct knowledge of government measures if no-one in the household was symptomatic; believing that you have had or currently have COVID-19; increased perceived financial cost of following government measures; and decreased perceived social norms (see Table 5). Fewer outings were associated with: receiving help from someone outside your household; decreased perceived impact of lockdown on physical health; reporting that you were self-isolating; increased worry about COVID-19; and increased perceived likelihood of catching COVID-19.

Going out shopping for non-essentials in the past week was associated with male participants, working and lower social grade (see Table 6).

Shopping for non-essentials in the past week was associated with: thinking you have had COVID-19; helping someone outside your household; thinking that you will lose touch with friends or relatives if you follow government guidance; and thinking that following government guidance will negatively impact you financially (see Table 7). Not going out shopping for non-essentials was associated with: having received help from someone outside your household in the last 7 days; reporting that you were self-isolating; increased perceived likelihood of catching and spreading COVID-19; increased worry about COVID-19; increased perceived effectiveness of government advice; increased perceived severity of COVID-19; increased perceived disapproval from friends or family if you do not follow government advice; increased perceived legal consequences of not following government advice; not knowing or being unsure about government measures; and decreased perceived social norms.

Power

For analyses where no symptoms were present in the household, we achieved 100% power to detect small effect sizes in logistic regression analyses (OR = 1.68,[9] $\alpha = .05$, sample size $n = 1945$, probability of having gone out shopping for items other than groceries, toiletries or medicines = 0.25, one-tailed and two-tailed logistic regression). We achieved 94% power to detect small effect sizes in linear regression analyses ($f^2 = 0.02$,[10] $\alpha = .05$, sample size $n = 1945$, number of tested predictors = 39, total number of predictors = 39).

Discussion

To the best of our knowledge, this is the first comprehensive study to investigate factors associated with self-isolation and behaviour during lockdown in the UK. Almost 10% of participants reported that either they or a household member had symptoms of COVID-19 (a cough or high temperature/fever) in the last week. Prevalence estimates by the UK Office for National Statistics indicate that at the time of data collection, 0.27% of the community population had COVID-19.[11] Government regulations required all those with symptoms, or with symptoms in their household, to self-isolate. Our results suggest that adherence to this is poor. Three-quarters of those with symptoms in their household reported leaving their home in the past 24 h. We found no difference in out-of-home behaviour by presence of symptoms in the household. The UK will shortly enter a new phase of the pandemic, in which extensive testing, contact tracing and isolation will be required to keep the spread of COVID-19 in check.[12] For this to succeed, adherence must be improved. There is some evidence that institution-based isolation is more effective compared to home-based isolation, in part because this is less reliant on personal adherence to guidelines.[13] Some countries have used large-scale, temporary shelter hospitals, which are primarily for patients with mild and moderate symptoms of COVID-19. Shelter hospitals allow patients to isolate effectively from their family and community; be triaged, reducing pressure on other health care services; provide basic medical care; frequent monitoring and rapid referral if a patients' symptoms worsen; and provide living and social support.[14]

Our findings highlight several risk factors for poor adherence. Notably men were more likely to report having been out in the last 24 h if they or someone in their household was symptomatic, having gone out more times in the last week and shopping for non-essentials. Lower adherence among men was also noted in the UK during the 2009/10 H1N1 influenza pandemic.[15] Communication campaigns that specifically target men may therefore have merit.

Adherence with self-isolation was associated with increased worry about COVID-19 and increased perceived likelihood of catching COVID-19. As incidence declines, it is possible that worry will also decline, reducing adherence further. Although it may be tempting to use fear-based messaging to combat this, this may influence other behaviours that the government may wish to encourage, such as return to work.[16]

Adherence was also associated with having received help from someone outside your household. This makes intuitive

Table 5
Associations between psychological and situational factors and total number of outings in the past week in participants who reported no symptoms in the household.

Participants' characteristics	Level	Number of outings	Total number of outings in the past week									
			Unadjusted analyses					Adjusted analyses[a]				
			Model			Regression coefficient		Model			Regression coefficient	
			F	Adjusted R^2	*P*-value	β	*P*-value	*F*	Adjusted R^2	*P*-value	β	*P*-value
Had, or currently have, COVID-19	Think have not had COVID-19 and do not have it now, $n = 1532$	M = 6.58, SD = 5.00										
	Think have had COVID-19 or have it now, $n = 155$	M = 8.00, SD = 5.34	11.21	0.006	0.001**	0.08	0.001**	11.90	0.084	<0.001**	0.07	0.006**
Self-isolating	Not self-isolating, $n = 1491$	M = 7.66, SD = 4.85										
	Self-isolating, $n = 454$	M = 3.85, SD = 4.67	174.65	0.083	<0.001**	−0.29	<0.001**	23.73	0.142	<0.001**	−0.28	<0.001**
Understanding of government measures if no-one in household was symptomatic	Incorrect/unsure, $n = 1052$	M = 6.41, SD = 5.23										
	Correct, $n = 893$	M = 7.19, SD = 4.85	11.66	0.005	0.001**	0.08	0.001**	13.21	0.082	<0.001**	0.06	0.01*
Understanding of government measures if someone in household was symptomatic	Incorrect/unsure, $n = 1834$	M = 6.77, SD = 5.10										
	Correct, $n = 111$	M = 6.68, SD = 4.66	0.3	0.000	0.86	0.00	0.86	12.67	0.079	<0.001**	−0.01	0.59
Worry about COVID-19	5-point scale, 1 = not at all worried to 5 = extremely worried, $n = 1938$	M = 6.78, SD = 5.07	127.48	0.061	<0.001**	−0.25	<0.001**	20.85	0.127	<0.001**	−0.23	<0.001**
Perceived social norms	Percentage (range 0–100), $n = 1742$	M = 6.89, SD = 5.03	8.48	0.004	0.004*	−0.07	0.004*	10.79	0.073	<0.001**	−0.07	0.004*
Perceptions about impact on mental health	5-point scale, 1 = a lot better to 5 = a lot worse, $n = 1922$	M = 6.80, SD = 5.08	1.09	0.000	0.296	0.02	0.296	12.92	0.081	<0.001**	0.03	0.25
Perceptions about impact on physical health	5-point scale, 1 = a lot better to 5 = a lot worse, $n = 1927$	M = 6.79, SD = 5.07	26.54	0.013	<0.001**	−0.12	<0.001**	14.43	0.090	<0.001**	−0.10	<0.001**
Self-reported general health	5-point scale, 1 = poor to 5 = excellent, $n = 1930$	M = 6.78, SD = 5.06	88.52	0.043	<0.001**	0.21	<0.001**	16.36	0.101	<0.001**	0.16	<0.001**
Helped someone outside household	No, $n = 1469$	M = 6.00, SD = 4.79										
	Yes, $n = 459$	M = 9.30, SD = 5.16	159.54	0.076	<0.001**	0.28	<0.001**	23.89	0.150	<0.001**	0.26	<0.001**
Received help from someone outside household	No, $n = 1665$	M = 7.15, SD = 5.04										
	Yes, $n = 263$	M = 4.54, SD = 4.74	61.89	0.031	<0.001**	−0.18	<0.001**	14.44	0.090	<0.001**	−0.11	<0.001**
If I completely follow the government's advice, I will lose touch with my friends and relatives	5-point scale, 1 = strongly disagree to 5 = strongly agree, $n = 1925$	M = 6.78, SD = 5.07	36.17	0.018	<0.001**	−0.14	<0.001**	16.48	0.102	<0.001**	0.15	<0.001**
My friends or family will disapprove if I don't follow the government's advice	5-point scale, 1 = strongly disagree to 5 = strongly agree, $n = 1894$	M = 6.82, SD = 5.06	26.75	0.013	<0.001**	−0.12	<0.001**	14.25	0.090	<0.001**	−0.12	<0.001**
If I don't follow the government's advice, I could get in trouble with the police	5-point scale, 1 = strongly disagree to 5 = strongly agree, $n = 1916$	M = 6.79, SD = 5.07	32.29	0.016	<0.001**	−0.13	<0.001**	15.22	0.095	<0.001**	−0.13	<0.001**
If I follow the government's advice, it will help save lives	5-point scale, 1 = strongly disagree to 5 = strongly agree, $n = 1930$	M = 6.78, SD = 5.07	51.30	0.025	<0.001**	−0.16	<0.001**	17.02	0.105	<0.001**	−0.16	<0.001**
If I follow the government's advice, it will help protect the NHS	5-point scale, 1 = strongly disagree to 5 = strongly agree, $n = 1929$	M = 6.78, SD = 5.08	30.05	0.015	<0.001**	−0.12	<0.001**	15.26	0.095	<0.001**	−0.13	<0.001**
If I catch coronavirus, I may become very ill	5-point scale, 1 = strongly disagree to 5 = strongly agree, $n = 1917$	M = 6.77, SD = 5.09	49.66	0.025	<0.001**	−0.16	<0.001**	15.90	0.099	<0.001**	−0.15	<0.001**
If I catch coronavirus, it will have a severe impact on my family's well-being	5-point scale, 1 = strongly disagree to 5 = strongly agree, $n = 1894$	M = 6.78, SD = 5.08	41.30	0.021	<0.001**	−0.15	<0.001**	15.21	0.096	<0.001**	−0.15	<0.001**
If I leave home and meet other people, I could pass coronavirus to someone else	5-point scale, 1 = strongly disagree to 5 = strongly agree, $n = 1924$	M = 6.79, SD = 5.08	24.87	0.012	<0.001**	−0.11	<0.001**	15.27	0.095	<0.001**	−0.13	<0.001**
If I leave home and meet other people, I could catch coronavirus	5-point scale, 1 = strongly disagree to 5 = strongly agree, $n = 1929$	M = 6.78, SD = 5.08	77.12	0.038	<0.001**	−0.20	<0.001**	18.48	0.114	<0.001**	−0.19	<0.001**
If I follow the government's advice, it will have a negative impact on how much money I have	5-point scale, 1 = strongly disagree to 5 = strongly agree, $n = 1893$	M = 6.81, SD = 5.09	5.22	0.002	0.02*	0.05	0.02*	12.37	0.078	<0.001**	0.06	0.02**
			2.67	0.001	0.10	0.04	0.10	12.36	0.080	<0.001**	0.04	0.10

Table 5 (*continued*)

Participants' characteristics	Level	Number of outings	Total number of outings in the past week									
			Unadjusted analyses					Adjusted analyses[a]				
			Model			Regression coefficient		Model			Regression coefficient	
			F	Adjusted R^2	*P*-value	β	*P*-value	*F*	Adjusted R^2	*P*-value	β	*P*-value
Because of the current lockdown, there is more conflict between people that I live with	5-point scale, 1 = strongly disagree to 5 = strongly agree, *n* = 1859	M = 6.81, SD = 5.08										
If I follow the government's advice, I will not be able to carry out important religious activities	5-point scale, 1 = strongly disagree to 5 = strongly agree, *n* = 1719	M = 6.79, SD = 5.09	1.75	0.000	0.19	0.03	0.19	11.67	0.081	<0.001**	0.05	0.07
I am enjoying spending more time at home during the lockdown	5-point scale, 1 = strongly disagree to 5 = strongly agree, *n* = 1931	M = 6.76, SD = 5.07	27.82	0.014	<0.001**	−0.12	<0.001**	16.71	0.103	<0.001**	−0.16	<0.001**
Because of coronavirus, I feel a sense of community with other people in my neighbourhood	5-point scale, 1 = strongly disagree to 5 = strongly agree, *n* = 1925	M = 6.79, SD = 5.08	0.84	0.000	0.36	0.02	0.36	12.69	0.079	<0.001**	0.03	0.21

*$P \leq 0.05$.
**$P \leq 0.001$.
[a] Adjusting for gender, age, having a child in the household, being extremely clinically vulnerable oneself, employment status, highest level of education or professional qualification, indices of multiple deprivation, social grade, living in a rural or urban area, living alone, marital status and region. Personal and clinical characteristics entered as first block, other independent variables entered as second block.

Table 6
Associations between personal and clinical characteristics of participants who reported no symptoms in their household in the last week and having gone shopping for items other than groceries, toiletries or medicines (non-essentials).

Participants' characteristics	Level	Adherence to lockdown measures			
		Had not gone out shopping for non-essentials; *n* = 1469, *n* (%)	Had gone out shopping for non-essentials; *n* = 476, *n* (%)	Odds ratio (95% CI)	Adjusted odds ratio (95% CI)[a]
Gender	Male	653 (71.4)	262 (28.6)	Reference	Reference
	Female	816 (79.2)	214 (20.8)	0.65 (0.53–0.80)**	0.64 (0.51–0.80)**
Age, years	18–24	57 (75.0)	19 (25.0)	Reference	Reference
	25–34	187 (72.2)	72 (27.8)	1.16 (0.64–2.08)	0.84 (0.43–1.65)
	35–44	267 (76.9)	80 (23.1)	0.90 (0.51–1.60)	0.63 (0.32–1.24)
	45–54	268 (73.8)	95 (26.2)	1.06 (0.60–1.88)	0.74 (0.38–1.44)
	55 and older	690 (76.7)	210 (23.3)	0.91 (0.53–1.57)	0.87 (0.45–1.66)
Have a child in the household	No	1090 (76.3)	338 (23.7)	Reference	Reference
	Yes	363 (73.5)	131 (26.5)	1.16 (0.92–1.47)	1.14 (0.86–1.52)
Clinically extremely vulnerable (self)	No	1333 (75.7)	427 (24.3)	Reference	Reference
	Yes	101 (77.1)	30 (22.9)	0.93 (0.61–1.41)	0.89 (0.57–1.38)
Employment status	Not working	711 (78.7)	192 (21.3)	Reference	Reference
	Working	759 (72.7)	284 (27.3)	1.39 (1.12–1.71)*	1.61 (1.24–2.09)**
Highest educational or professional qualification	GCSE/vocational/A-level/No formal qualifications	623 (73.8)	224 (26.2)	Reference	Reference
	Degree or higher (Bachelors, Masters, PhD)	810 (77.0)	24 (23.0)	0.84 (0.68–1.04)	0.89 (0.71–1.13)
IMD	More deprived area	631 (74.1)	220 (25.9)	Reference	Reference
	Less deprived area	838 (76.6)	256 (23.4)	0.88 (0.71–1.08)	0.86 (0.68–1.08)
Social grade	ABC1	909 (76.8)	275 (23.2)	Reference	Reference
	C2DE	560 (73.6)	201 (26.4)	1.19 (0.96–1.46)	1.29 (1.01–1.63)*
Urban/rural	Urban	1110 (75.9)	352 (24.1)	Reference	Reference
	Rural	319 (73.7)	114 (26.3)	1.13 (0.88–1.44)	1.23 (0.94–1.62)
Living alone	Yes	308 (76.6)	94 (23.4)	Reference	Reference
	No	1161 (75.2)	382 (24.8)	1.08 (0.83–1.40)	1.02 (0.70–1.49)
Marital status	Married/civil partnership/ living as married	928 (75.3)	305 (24.7)	Reference	Reference

(*continued on next page*)

Table 6 (*continued*)

Participants' characteristics	Level	Adherence to lockdown measures			
		Had not gone out shopping for non-essentials; $n = 1469$, n (%)	Had gone out shopping for non-essentials; $n = 476$, n (%)	Odds ratio (95% CI)	Adjusted odds ratio (95% CI)[a]
	Separated/divorced/ widowed/never married	531 (75.7)	170 (24.3)	0.97 (0.79 −1.21)	1.03 (0.75−1.42)
Clinically extremely vulnerable (household member)[b]	No	1041 (75.8)	333 (24.2)	Reference	Reference
	Yes	92 (73.6)	33 (26.4)	1.12 (0.74 −1.70)	1.17 (0.74−1.84)
Home includes access to outside space	No	111 (76.0)	35 (24.0)	Reference	Reference
	Yes	1358 (75.5)	441 (24.5)	1.03 (0.69 −1.53)	1.09 (0.69−1.70)
Pet ownership	No	813 (75.8)	259 (24.2)	Reference	Reference
	Yes	656 (75.1)	217 (24.9)	1.04 (0.84 −1.28)	0.97 (0.77−1.23)

*$P \leq 0.05$.
**$P \leq 0.001$.
[a] Adjusting for gender, age, having a child in the household, being extremely clinically vulnerable oneself, employment status, highest level of education or professional qualification, indices of multiple deprivation, social grade, living in a rural or urban area, living alone, marital status and region.
[b] Adjusted analyses for this variable did not control for living alone, as by definition all participants asked this question lived in a household with someone else.

Table 7
Associations between psychological and situational factors and having gone shopping for items other than groceries, toiletries or medicines (non-essentials) in the past 7 days in participants who reported no symptoms in the household.

Participants' characteristics	Level	Adherence to lockdown measures			
		Had not gone out shopping for non-essentials; $n = 1469$, n (%)	Had gone out shopping for non-essentials; $n = 476$, n (%)	Odds ratio (95% CI)	Adjusted odds ratio (95% CI)[a]
Had COVID-19	Think have not had COVID-19	1176 (76.8)	356 (23.2)	Reference	Reference
	Think have had COVID-19	104 (67.1)	51 (32.9)	1.62 (1.14 −2.31)*	1.72 (1.17 −2.53)*
Self-isolating	Not self-isolating	1098 (73.6)	393 (26.4)	Reference	Reference
	Self-isolating	371 (81.7)	83 (18.3)	0.63 (0.48 −0.81)**	0.61 (0.45 −0.83)*
Understanding of government measures, if no-one in household was symptomatic	Incorrect/unsure	768 (73.0)	284 (27.0)	Reference	Reference
	Correct	701 (78.5)	192 (21.5)	0.74 (0.60 −0.91)*	0.77 (0.61 −0.97)*
Understanding of government measures, if someone in household was symptomatic	Incorrect/unsure	1392 (75.9)	442 (24.1)	Reference	Reference
	Correct	77 (69.4)	34 (30.6)	1.39 (0.92 −2.11)	1.27 (0.81 −1.99)
Worry about COVID-19	5-point scale, 1 = not at all worried to 5 = extremely worried	N = 1465, M = 3.40, SD = 0.97	N = 473, M = 3.01, SD = 1.00	0.67 (0.60 −0.74)**	0.66 (0.59 −0.75)**
Perceived social norms	Percentage (range 0−100)	N = 1312, M = 74.19, SD = 15.62	N = 431, M = 70.35, SD = 17.54	0.99 (0.98 −0.99)**	0.99 (0.98 −0.99)**
Perceptions about impact on mental health	5-point scale, 1 = a lot better to 5 = a lot worse	N = 1452, M = 3.43, SD = 0.87	N = 470, M = 3.43, SD = 0.92	1.00 (0.89 −1.13)	1.01 (0.89 −1.14)
Perceptions about impact on physical health	5-point scale, 1 = a lot better to 5 = a lot worse	N = 1457, M = 3.15, SD = 0.91	N = 470, M = 3.11, SD = 0.98	0.95 (0.85 −1.07)	0.95 (0.84 −1.07)
Self-reported general health	5-point scale, 1 = poor to 5 = excellent	N = 1457, M = 3.05, SD = 1.06	N = 473, M = 3.06, SD = 1.01	1.01 (0.92 −1.12)	1.05 (0.94 −1.17)
Helped someone outside household	No	1138 (77.5)	331 (22.5)	Reference	Reference
	Yes	321 (69.9)	138 (30.1)	1.48 (1.17 −1.87)**	1.56 (1.21 −2.01)**
Received help from someone outside household	No	1234 (74.1)	431 (25.9)	Reference	Reference
	Yes	225 (85.6)	38 (14.4)	0.48 (0.34 −0.69)**	0.53 (0.36 −0.78)**
If I completely follow the government's advice, I will lose touch with my friends and relatives	5-point scale, 1 = strongly disagree to 5 = strongly agree	N = 1456, M = 1.94, SD = 1.04	N = 469, M = 2.25, SD = 1.18	1.28 (1.17 −1.40)**	1.30 (1.17 −1.44)**
My friends or family will disapprove, if I don't follow the government's advice	5-point scale, 1 = strongly disagree to 5 = strongly agree	N = 1428, M = 4.11, SD = 0.93	N = 466, M = 3.8, SD = 1.05	0.73 (0.66 −0.81)**	0.73 (0.65 −0.81)**
If I don't follow the government's advice, I could get in trouble with the police	5-point scale, 1 = strongly disagree to 5 = strongly agree	N = 1448, M = 3.98, SD = 0.85	N = 468, M = 3.77, SD = 0.97	0.77 (0.69 −0.87)**	0.78 (0.69 −0.88)**
If I follow the government's advice, it will help save lives	5-point scale, 1 = strongly disagree to 5 = strongly agree	N = 1458, M = 4.54, SD = 0.72	N = 472, M = 4.26, SD = 0.95	0.67 (0.59 −0.75)**	0.66 (0.58 −0.75)**
If I follow the government's advice, it will help protect the NHS	5-point scale, 1 = strongly disagree to 5 = strongly agree	N = 1458, M = 4.56, SD = 0.74	N = 471, M = 4.32, SD = 0.90	0.71 (0.62 −0.80)**	0.71 (0.62 −0.81)**
If I catch coronavirus, I may become very ill	5-point scale, 1 = strongly disagree to 5 = strongly agree	N = 1448, M = 4.43, SD = 0.82	N = 469, M = 4.18, SD = 0.94	0.73 (0.65 −0.82)**	0.72 (0.63 −0.81)**
If I catch coronavirus, it will have a severe impact on my family's well-being	5-point scale, 1 = strongly disagree to 5 = strongly agree	N = 1431, M = 4.12, SD = 1.01	N = 463, M = 3.86, SD = 1.10	0.80 (0.72 −0.88)**	0.79 (0.71 −0.88)**
If I leave home and meet other people, I could pass coronavirus to someone else	5-point scale, 1 = strongly disagree to 5 = strongly agree	N = 1453, M = 4.44, SD = 0.81	N = 471, M = 4.14, SD = 0.97	0.69 (0.62 −0.78)**	0.66 (0.58 −0.75)**

Table 7 (*continued*)

Participants' characteristics	Level	Adherence to lockdown measures			
		Had not gone out shopping for non-essentials; $n = 1469$, n (%)	Had gone out shopping for non-essentials; $n = 476$, n (%)	Odds ratio (95% CI)	Adjusted odds ratio (95% CI)[a]
If I leave home and meet other people, I could catch coronavirus	5-point scale, 1 = strongly disagree to 5 = strongly agree	N = 1459, M = 4.45, SD = 0.74	N = 470, M = 4.14, SD = 0.88	0.64 (0.56–0.72)**	0.59 (0.52–0.68)**
If I follow the government's advice, it will have a negative impact on how much money I have	5-point scale, 1 = strongly disagree to 5 = strongly agree	N = 1426, M = 2.47, SD = 1.20	N = 467, M = 2.64, SD = 1.24	1.12 (1.03–1.22)*	1.13 (1.03–1.24)*
Because of the current lockdown, there is more conflict between people that I live with	5-point scale, 1 = strongly disagree to 5 = strongly agree	N = 1406, M = 2.08, SD = 1.15	N = 453, M = 2.23, SD = 1.16	1.11 (1.01–1.22)*	1.07 (0.97–1.19)
If I follow the government's advice, I will not be able to carry out important religious activities	5-point scale, 1 = strongly disagree to 5 = strongly agree	N = 1294, M = 2.59, SD = 1.35	N = 425, M = 2.70, SD = 1.33	1.06 (0.98–1.15)	1.08 (0.99–1.18)
I am enjoying spending more time at home during the lockdown	5-point scale, 1 = strongly disagree to 5 = strongly agree	N = 1458, M = 3.29, SD = 1.20	N = 473, M = 3.21, SD = 1.21	0.95 (0.87–1.03)	0.94 (0.86–1.03)
Because of coronavirus, I feel a sense of community with other people in my neighbourhood	5-point scale, 1 = strongly disagree to 5 = strongly agree	N = 1455, M = 3.36, SD = 1.07	N = 470, M = 3.30, SD = 1.06	0.94 (0.86–1.04)	1.00 (0.90–1.11)

*$P \leq 0.05$.
**$P \leq 0.001$.
[a] Adjusting for gender, age, having a child in the household, being extremely clinically vulnerable oneself, employment status, highest level of education or professional qualification, indices of multiple deprivation, social grade, living in a rural or urban area, living alone, marital status and region.

sense—having someone else to run errands should reduce the need for you to leave home. Much has been made recently of the remarkable altruism of 750,000 people who signed-up to volunteer for the National Health Service, and the lack of jobs for them to do.[17] Allowing those in self-isolation to submit requests for help may be a pragmatic way to improve adherence.

Adherence to lockdown measures among those not reporting symptoms in their household was better, but still not perfect, with 75% reporting not going out to shop for non-essential items. Percentages reporting not meeting up with friends or family from outside one's household and not having visitors to the home were higher (94% and 95%, respectively). Adherence was lower in men and those who reported working. It is plausible that workers may be more likely to be out and about for work and while out, go shopping for non-essentials. Those working may also be more financially able to shop for non-essential items. Although perceiving greater negative financial consequences of government measures was associated with non-adherence to lockdown measures, there was no longer evidence for an association after correcting for multiple adjustments. This is different from research finding decreased intention to adhere to quarantine measures in Israel.[18] Adherence to lockdown measures was also associated with higher threat appraisals and positive appraisals of the coping response. These findings mirror research in other countries.[19–21] Non-adherence was associated with decreased perceived social norms,[19,22] lower perceived social pressure to adhere to measures and decreased knowledge of measures.[5] These findings suggest that improvement in adherence to lockdown measures is likely to be achieved by emphasising these are actions that most people are taking, that are having a positive impact, and that others around you want you to do.

This study has several limitations. First, despite using quota sampling, we cannot be sure that survey respondents are representative of the general population.[23,24] Second, all data were self-reported and may have been susceptible to social desirability bias.[25] However, preliminary data indicate that self-reported physical distancing is associated with real-world behaviour.[26] Third, we did not ask participants if they came into close contact with anyone from another household while they were out and about. Clearly, non-adherence does not always increase the risk of disease transmission. Fourth, we used a cumulative measure of 'outings' for our outcome measure. It is possible that participants may have shopped for essentials and non-essentials in the same trip, which might be double-counted in our questionnaire. Fifth, the cross-sectional nature of data collection means we are unable to draw causal inferences. Sixth, although the total sample size was large, a small percentage of the population reported that they or someone in their household had experienced symptoms of COVID-19 in the last week. Thus, analyses investigating adherence to self-isolation were based on smaller sample sizes, resulting in decreased power and wider confidence intervals.

Overall, our data suggest that self-reported adherence to self-isolation measures was poor. This has important implications for policies that attempt to prevent the spread of COVID-19 through self-isolation, such as contact tracing. Psychological factors including perceived effectiveness of lockdown measures, should be emphasised in communications. Effective use of volunteer programmes and help within the neighbourhood or community may also improve adherence.

Author statements

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Statement of ethical approval

Ethical approval for this study was granted by the King's College London Research Ethics Committee (reference: LRS-19/20-18687).

Data sharing statement

Anonymised data will be made available on reasonable request.

Author contribution statement

The study was conceptualised by RA, HL, IO, CR, LY and GJR. LS completed all analyses, using data from YouGov Plc. All authors contributed to, and approved, the final manuscript. For any enquiries about the data in this report please contact King's College London.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.puhe.2020.07.024.

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Original Research

Global Matrix 3.0 physical activity report card for children and youth: a comparison across Europe

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ABSTRACT

Objectives: The Global Matrix of report card grades on physical activity serves as a public health awareness tool by summarising the status of child and youth physical activity prevalence and action. The objectives were to: (1) provide a detailed examination of the evidence informing the 'School' and 'Community and Environment' indicators across all participating European Global Matrix 3.0 countries; (2) explore the comparability of the grades for these two indicators across Europe; (3) detail any limitations or issues with the methods used to assign grades; and (4) provide suggestions on how future grading of the indicators could be improved.

Study design: A comparative review of published methods on the grading of Global Matrix 3.0 indicators across European countries.

Methods: Key documents relating to the European countries involved in the 2018 Global Matrix 3.0 were collated and a template used to extract data for both the 'School' and 'Community and Environment' indicators.

Results: Seventeen of the 20 European Report Card countries (85%) had a grade for schools, and 15 countries (75%) had a grade for community and environment. All countries considered between one and five factors when assigning the grade for these indicators. There were wide disparities in the number and sources of evidence used to assign the grades for both indicators, limiting the comparability of the evidence between different countries.

Conclusion: To enable comparability, the authors recommend moving towards an agreed standardised set of metrics for grading each indicator. Furthermore, it would be useful to develop and share common tools, methods and instruments to collect data in a uniform way across countries, where possible. Such action will ultimately make the Global Matrix a more robust and useful tool for the future.

Introduction

Reaching a sufficient level of moderate-to-vigorous physical activity (MVPA) is recognised as a key determinant of health.[1] Yet, an estimated 80.9% of youth (11–17 years) in Central and Eastern Europe do not reach the minimum recommendation of 60 min of daily MVPA.[2] This is disturbing, as physical inactivity among school-aged children and youth has been found to be associated with adverse physical, mental, social and cognitive health

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outcomes, lower physical fitness, as well as lower physical activity levels in adulthood.[3–6]

The Global Matrix of Physical Activity Report Cards was launched in 2014 to benchmark physical activity promotion efforts targeted at children and youth. The matrix serves as an advocacy and information tool for decision makers and stakeholders from across the world by highlighting the global variation in physical activity prevalence and promotion across different countries and where representative data are lacking for specific indicators within countries.

A total of 15 and 38 countries took part in the Global Matrix 1.0 (2014)[7] and 2.0 (2016),[8] respectively. In 2018, the Global Matrix 3.0 was initiated, involving 49 countries in the harmonised procedure to develop national report cards. Ten common indicators (see Box 1) were assigned a letter grade (A+ to F) by using common benchmarks to guide the grade assignment process.[7] When grading was not possible, typically due to insufficient data, a grading of INC (incomplete) was assigned. A total of 490 grades, including 369 letter grades and 121 INC grades, were assigned in the Global Matrix 3.0.[9]

The Global Matrix 3.0 confirmed that physical activity levels of children and youth are low,[9] and actions to reduce inactivity are variable across Europe.[10] Schools and the wider community and environment are critical influences on the physical activity levels of children and youth;[11–14] therefore, changes in these indicators have the potential to affect many children. Consequently, we sought to examine the factors considered when assigning these grades across European countries, to inform future practice. The objectives were to: (1) provide a detailed examination of the evidence informing the 'School' and 'Community and Environment' indicators across all participating European countries; (2) explore the comparability of the grades for these two indicators across Europe; (3) detail any limitations or issues with the methods used to assign grades; and (4) provide suggestions on how future grading of the indicators could be improved.

Methods

A total of 20 European countries contributed to the Global Matrix 3.0 (see Table 1 for a summary of grades). The process for assignment of the grades involved the establishment of a team within each country that developed a set of indicators and appraised the country's performance. The process and grades are published in long and short forms, as well as in the main scientific paper (www.activehealthykids.ca). Key documents relating to the participating European countries were collated. A template was developed to aid with data extraction (see Additional file 1), which captured information on: the grade assigned for each indicator; details of the data used to assign the grade; the source of the data; an indication of the quality of the data; and any reported issues or challenges in assigning the grade.

The template was piloted whereby four members of the team (AC, EM, KM and TC) each completed the template for two countries. The data were reviewed to determine consistency in the types of information and the level of detail provided. Where inconsistencies were evident, revisions to the template were made and more explicit guidance on completion was added. Only publicly available information contained within the scientific and/or long and short forms of the report cards was used, and only sources of evidence used to inform the 2018 report card grade were considered. Subsequently, all members of the team were informed on how to use the template and what information was to be extracted.

The relevant team member(s) took responsibility for leading the data extraction for their own country. All other countries were allocated arbitrarily among the team members. If anything was unclear or information was unavailable, the original author and/or country card lead for that country was contacted for further information.

Box 1
The 10 indicators in the Global Matrix 3.0.

- Overall physical activity
- Organised sports and physical activity
- Active play
- Active transportation
- Sedentary behaviours
- Physical fitness
- Family and peers
- School
- Community and environment
- Government

Results

Fig. 1 displays the School and Community and Environment grades for European countries.

Schools

Table 2 provides a summary of the factors used to assign the school grade for each country. In total, 17 of the 20 European Report Card countries (85%) had a grade for schools, using between one and five school factors to assign their grade. Guernsey, Scotland and Wales did not have a grade for schools and were excluded (shaded in Table 2). Details of the factors considered in assigning the grades are provided below in order of the number of countries using that factor.

Physical education

The most frequently reported factor on which the school grades were based was physical education (PE), with all but two countries (Finland and the Netherlands) considering this indicator ($n = 15$). For some countries, this indicator was based on PE being compulsory, as mandatory in legislation (Czech Republic, Estonia, Germany, Lithuania, Portugal, Slovenia and Sweden). In addition to mandatory PE, some countries were asked to self-report their adherence to the legislative requirement, which was also considered when assigning the grade (Denmark, France, Jersey and Spain). For one country, the average minutes of PE offered to pupils were used (England). For some countries, the PE indicator was based on the proportion of children reporting to take part in a mandatory amount of PE (Belgium and Poland). For Bulgaria, the indicator was based on children and their parents' assessment of the quality of PE classes.

Qualifications/quality of teachers delivering PE

Two-thirds of schools that considered PE as a factor also considered the qualifications or quality of the teachers responsible for PE ($n = 10$). For France, this indicator was based on it being mandatory for PE lessons (in high schools) to be delivered by a trained specialist. For the majority, however, it was based on the proportion of PE teachers with specialist PE training (Belgium, Czech Republic, Denmark, England, Estonia, Germany and Lithuania). Bulgaria used children and their parents' perceptions of the quality of teachers; Slovenia reported that they have 'highly competent PE teachers' with no further explanation offered.

Table 1
A summary of the grades for each European country included within the Global Matrix 3.0.

Country[a]	BE	BG	CZ	DE	DK	EN	EE	ES	FI	FR	GG	JE	LT	NL	PL	PT	SC	SE	SL	WA
Overall physical activity	F	D+	D	D–	D–	C–	D–	D	D	D	D	D–	C–	C	D–	D	F	D+	A–	D+
Organised sports and physical activity	B	C+	B–	B	A–	D+	C	B	C+	C–	C+	INC	C	B	D	B–	B	B+	C+	C+
Active play	INC	C+	D–	D–	INC	INC	F	C–	C	INC	INC	INC	INC	B	INC	INC	INC	INC	D	C–
Active transport	C+	B–	C+	C–	B+	C–	D	B–	B+	C–	D	D+	C–	B–	C	C–	C	C	C	D+
Sedentary behaviour	C	D	D–	D–	D+	D+	F	B+	D–	D–	C	C	C–	C–	D	C–	F	C+	B+	F
Physical fitness	INC	INC	C+	INC	INC	C–	INC	INC	C	B–	INC	D	C+	INC	C–	C	INC	INC	A–	INC
Family and peers	C+	D	C+	B–	INC	INC	D	INC	B–	INC	INC	C	D	INC	C–	C	INC	INC	B+	D
School	B–	C	B+	B+	A–	B+	C+	C+	A	B	INC	B–	C+	C	B	A	INC	C+	A	INC
Community and environment	B	C	B	B+	B+	C	B	INC	B+	INC	INC	C	C	INC	C	B	B–	A	B	INC
Government	B	INC	C+	INC	A–	INC	B	INC	A–	C	D	D	C	INC	C+	B	C	B	A	C+
Average	**C**	**C–**	**C**	**C**	**B–**	**C–**	**D+**	**C+**	**C+**	**C–**	**D+**	**D+**	**C–**	**C+**	**C–**	**C+**	**D+**	**C+**	**B**	**D+**

[a] BE = Belgium; BG = Bulgaria; CZ= Czech Republic; DE = Germany; DK = Denmark; EN = England; EE = Estonia; ES = Spain; FI = Finland; FR = France; GG = Guernsey; JE = Jersey; LT = Lithuania; NL = the Netherlands; PL = Poland; PT = Portugal; SC = Scotland; SE = Sweden; SI = Slovenia; WA = Wales.
INC, incomplete.

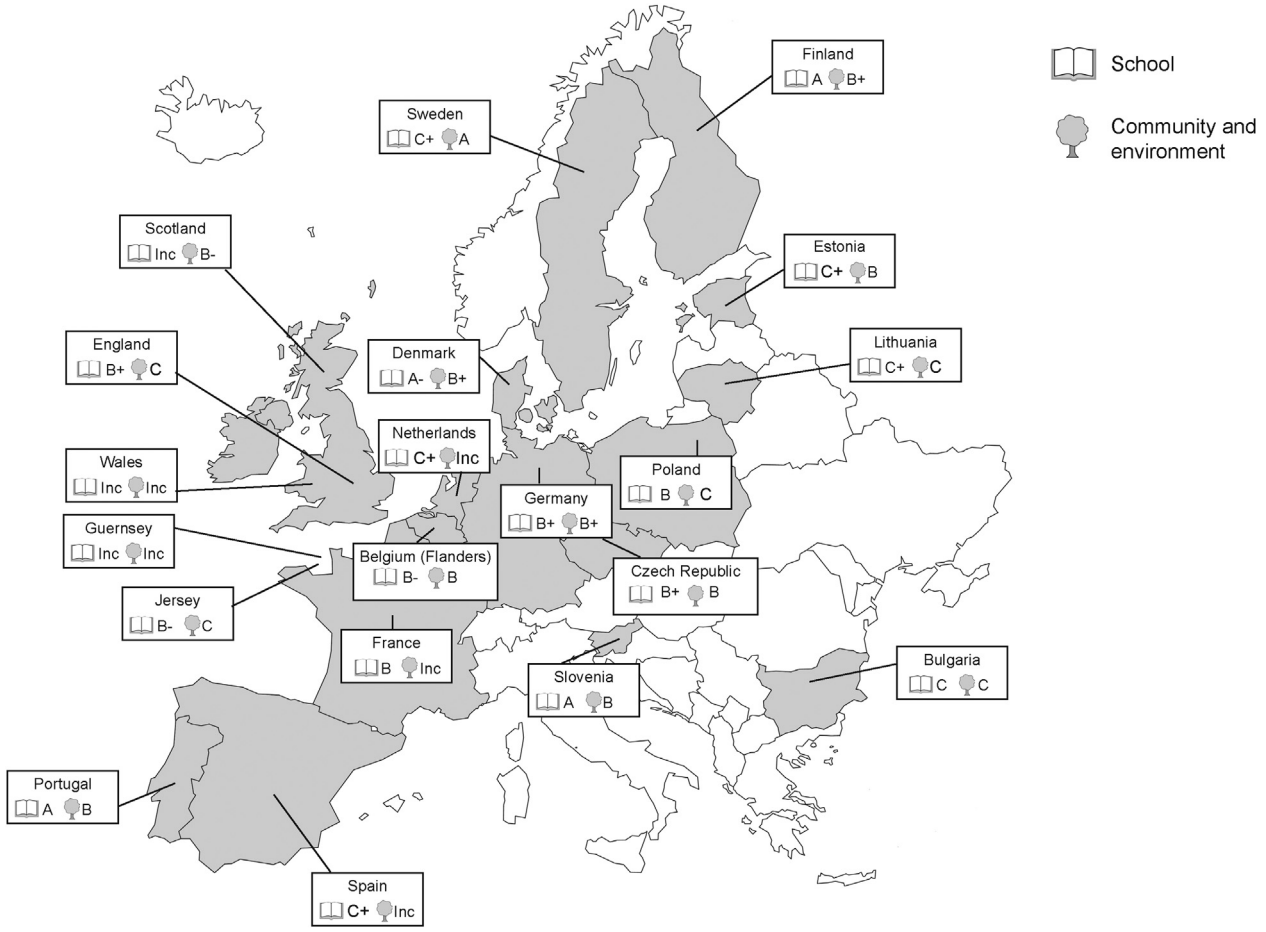

Fig. 1. A map depicting the School and Community and Environment grades for European countries. INC, incomplete.

Sports facilities/equipment

The quality of physical activity and sports facilities and equipment at school was considered in less than half of the included countries ($n = 8$). For most countries, this factor was based on 'access' to facilities and equipment (Czech Republic, England, Germany, Jersey, the Netherlands and Slovenia). Bulgaria based this factor on children and parents' views on the quality of sports facilities at school. Denmark considered both access and teacher appraised quality.

Active school policies

Six countries considered the number of schools that had developed policies that promote physical activity as part of the school day (Czech Republic, Denmark, England, Finland, Jersey and Lithuania).

After school/extra-curricular sports and physical activity

Five countries considered the provision of after school/extra-curricular activities (Belgium, Czech Republic, England, Estonia

Table 2
Summary of indicators for each school grade, by country and frequency.

Country[a]	BE	BG	CZ	DE	DK	EN	EE	ES	FI	FR	GG	JE	LT	NL	PL	PT	SC	SE	SL	WA	Total
Grade	B−	C	B+	B+	A−	B+	C+	C+	A	B	INC	B−	C+	C	B	A	INC	C+	A	INC	
Physical education	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓		**15**
Qualifications/Quality of teachers teaching PE	✓	✓	✓	✓	✓	✓	✓			✓			✓						✓		**10**
Sports facilities/equipment		✓	✓	✓	✓	✓						✓		✓					✓		**8**
Active school policies			✓		✓	✓			✓			✓	✓								**6**
After-school/Extra-curricular sports and physical activities	✓		✓			✓	✓												✓		**5**
Sports and PA during sports/lunch							✓	✓													**2**
National active school initiative									✓										✓		**2**
Health education lessons	✓																				**1**
Access to facilities outside school hours								✓													**1**
Total	4	3	5	3	4	5	4	3	2	2		3	3	1	1	1		1	5		

[a] BE = Belgium; BG = Bulgaria; CZ= Czech Republic; DE = Germany; DK = Denmark; EN = England; EE = Estonia; ES = Spain; FI = Finland; FR = France; GG = Guernsey; JE = Jersey; LT = Lithuania; NL = the Netherlands; PL = Poland; PT = Portugal; SC = Scotland; SE = Sweden; SI = Slovenia; WA = Wales.
INC, incomplete.

and Slovenia), which was based on the availability of physical activity and sports opportunities. Estonia also included having an opportunity to take part in sports competitions out-of-school hours.

Sports and physical activity during recess/lunch

The provision of pupil-reported physical activity opportunities during break and lunch times was considered in two countries (Estonia and Spain).

National active school initiative

Taking part in a national 'active school' initiative was considered in two countries (Finland and Slovenia). The school grade for Finland was exclusively based on the number of schools participating in the Finnish Schools on the Move initiative,[15] which aims to add physical activity opportunities into a recess and academic lessons. In Slovenia, the Healthy Lifestyle Programme was introduced to build more and better-quality physical activity opportunities into primary schools, with two additional PE lessons per week.

Health education lessons

One country (Belgium) specifically referred to 'health education' lessons as distinct from PE.

Access to facilities outside of school hours

Only Spain considered the accessibility of sports facilities outside of school hours to be important in assigning the school grade.

Community and environment

Overall, 15 countries (75%) had a grade for the community and environment, and Table 3 provides a summary of the one to five factors considered when assigning the grade. France, Guernsey, the Netherlands, Spain and Wales did not have a grade and were excluded from the analysis (shaded in Table 3). Details of the factors considered in assigning the grades are provided below, in order of the number of countries using that factor.

Perceptions of neighbourhood safety

The most frequently considered factor of the Community and Environment was perceptions of neighbourhood safety, which was considered in 10 of the 15 countries (Belgium, Bulgaria, Czech Republic, England, Estonia, Germany, Jersey, Lithuania, Scotland and Sweden). In three countries, this was based on the proportion of children that reported living in a safe neighbourhood where they can be physically active (Czech Republic Estonia and Sweden), whereas in four other countries, the judgement was based on parental ratings of safety (England, Germany, Lithuania and Scotland). In Jersey, the rating could be made by children or parents, and in Bulgaria, it was not specified whose perception was considered. Belgium was the only country to consider specific aspects of safety including road traffic and crime.

Parks/green space

A total of eight countries considered an indicator of parks and green space. For some countries, this indicator was based on the presence of public playgrounds in communities (Germany) or the proportion of children with access to a park (England), with no further detail on how these indicators were assessed. In Belgium

Table 3
Summary of indicators for each community and environment grade, by country and frequency.

Country[a]	BE	BG	CZ	DE	DK	EE	EN	ES	FI	FR	GG	JE	LT	NL	PL	PT	SC	SE	SI	WA	TOTAL
Grade	B	C	B	B+	B+	B	C	INC	B+	INC	INC	C	C	INC	C	B	B-	A	B	INC	
Perceptions of neighbourhood safety	✓	✓	✓	✓		✓	✓					✓	✓				✓	✓			**10**
Green space/parks	✓	✓	✓	✓			✓					✓					✓	✓			**8**
Sports/recreation facilities	✓	✓		✓	✓	✓	✓		✓			✓									**8**
Supportive environments/opportunities					✓								✓		✓	✓					**4**
Supportive policies									✓			✓							✓		**3**
Sidewalks/cycle paths	✓	✓																			**2**
Health promotion programmes/initiatives													✓								**1**
Sport perceived as valued												✓									**1**
Total	**4**	**4**	**2**	**3**	**2**	**2**	**3**		**2**			**5**	**3**		**1**	**1**	**2**	**2**	**1**		

[a] BE = Belgium; BG = Bulgaria; CZ= Czech Republic; DE = Germany; DK = Denmark; EN = England; EE = Estonia; ES = Spain; FI = Finland; FR = France; GG = Guernsey; JE = Jersey; LT = Lithuania; NL = the Netherlands; PL = Poland; PT = Portugal; SC = Scotland; SE = Sweden; SI = Slovenia; WA = Wales.
INC, incomplete.

and Bulgaria, the indicator was explicitly based on children reporting easy access to parks. In Scotland, the rating was based on the number of children with at least one play area within their neighbourhood, and in Sweden, it was based on the proportion of children with access to green space within 300 m of their home. In the Czech Republic, access to parks was assessed objectively via a geographic information system. In addition to the presence of green space, the extent to which parks and playgrounds are well maintained was factored into the grade assigned in Belgium. The grade in Jersey was based on perceptions of maintenance of parks, rather than provision.

Sports/recreation facilities

A total of eight countries considered sports and recreational facilities when assigning the Community and Environment grade. For two countries, this was based on children's self-reported access to facilities (Bulgaria and Denmark); for one, it was based on once per week usage (England) and another considered resident satisfaction with sports and recreational facilities (Belgium). In Estonia, the importance of accessible sporting facilities was acknowledged, although no system was in place for assessing provision. Similarly, in Germany, most cities provided facilities such as soccer pitches, although it was not clear how such provision was assessed. As with parks and green space, the grade for Jersey was based on perceptions of maintenance of facilities, rather than provision. In Finland, the grade was based on school facilities and sports grounds being provided free of charge. In Denmark, in addition to the proportion of children reporting access to sporting facilities, the equitability of access was taken into consideration.

Supportive environments/opportunities

Four countries considered whether residents perceived the neighbourhood environment to be supportive of physical activity. These perceptions came from children and adolescents (Denmark and Poland), parents (Lithuania), or not specified (Portugal).

Supportive policies

The presence of supportive policies for physical activity was factored into the grade assigned to three countries (Finland, Jersey and Slovenia). Jersey based their grade partly on the Fit for the Future strategy,[16] which committed to investing in infrastructure for physical activity. The grade in Slovenia was largely based on the legal requirement for municipalities to produce an annual programme of sport, whereas Finland considered the proportion of municipalities with a physical activity strategy.

Sidewalks/cycle paths

Two countries considered children's self-reported access to sidewalks and/or cycle paths (Belgium and Bulgaria).

Health promotion programmes/initiatives

In Lithuania, the grade was partly based on the number of municipalities implementing health promotion programmes.

The public's value of physical activity and sport

In Jersey, the grade was partly based on the proportion of the public that perceives sport and physical activity as important and valued.

Discussion

This analysis provides a comparison of the factors considered when assigning the grades for the School and Community and Environment indicators of the Global Matrix 3.0 on physical activity for children and youth among participating European countries.

Of 17 European countries (85%) that had a grade for schools, PE was the most common factor considered when assigning the grade, followed by qualifications/quality of teachers delivering PE and sports facilities/equipment. The current evidence-base suggests that whole-of-school programmes that include multiple components across the whole school day are most effective for increasing physical activity levels in the school setting.[14] Despite this, many countries considered just one or two specific actions when assigning their grade. This could introduce some bias in the results by providing an incomplete assessment and undermining the role of schools in providing opportunities for children's physical activity. For example, research indicates that having an active school travel policy can lead to increases in physical activity.[17] However, this was not considered when assigning the school grade, as active transportation (including to and from school) is a separate indicator in the Global Matrix. In addition, the playground environment was not explicitly considered by any of the included countries. It is possible that this was considered within the 'facilities and equipment' factor, whereby some parents and pupils were asked to rate the school facilities and equipment, but whether playgrounds were considered within this indicator was not explicit.

Of the 15 countries (75%) that had a grade for Community and Environment, perceptions of neighbourhood safety were the most common factor considered, followed by the presence of green space/parks and sports/recreation facilities. Research demonstrates that these are important indicators of children's physical activity. For example, positive associations have been found between perceptions of safety and physical activity in youth, with children who perceive their local areas as safe to be more likely to have higher levels of physical activity.[11] Conversely, crime is associated with a perceived lack of safety, and as a result, is often cited as a barrier to physical activity.[12] In addition, children (aged 9–12 years), whose parents perceived a higher presence of recreational facilities in their neighbourhood, have also been found to be more active in these recreational spaces.[13]

There was a large variation in how the grades were assigned by different countries across Europe. Such subjective assessment may provide an unreliable comparison across Europe. This was evident in both the number and types of factors taken into consideration for each indicator. For the school indicator, for example, among the three countries that achieved grade A (Slovenia, Finland and Portugal), Slovenia based their grade on five factors (PE, qualifications/quality of teachers teaching PE, sports facilities/equipment, after school/extra-curricular sports and physical activity, national active school initiative); Finland on two factors (active school policies and national active school initiative) and Portugal on one element of school provision (PE). Similarly, in relation to Community and Environment, Sweden was graded an A based on two factors (perceptions of neighbourhood safety and green space/parks) in comparison with Jersey, which was graded a C based on five factors (perceptions of neighbourhood safety, green space/parks, sports/recreation facilities, supportive policies and sport perceived as valued). It is possible that Jersey may have scored higher if it had considered only the two factors that were considered by Sweden.

To increase comparability between countries and add clarity to the process, more detailed instructions for the indicators and benchmarks are needed.[18] This could be facilitated by a basic set of common metrics for each indicator. For example, given that 85% of European countries considered PE when assigning the school grade and two-thirds of countries based their Community and Environment grade on perceptions of safety, it may be beneficial for all European countries to use these metrics in the future, as standard.

In addition to a common metric, common sources of evidence should also be considered and/or the use of standardised questions or tools. For example, data related to schools, community and environment from the WHO Health Behavior in School-Aged Children (HBSC) survey[19] could be used as one of the common data sources due to it being used by 49 countries, every 4 years (http://www.hbsc.org/). The WHO Global Monitoring Framework,[20] which is being used to monitor implementation of the Global Action Plan on Physical Activity,[21] may also provide useful comparable data for some of the report card indicators.

It is also important to ensure that the factors considered when assigning grades for each indicator remain consistent over time. Spain was included in the Global Matrix 2016 when the National Active School Initiative was considered when assigning the school grade. Despite continuing to have the National Active School Initiative in 2018, as no 'new' sources of data were available, this and other factors were not taken into consideration. This may have led to a lower grade than warranted, due to failure to account for ongoing initiatives. It could also lead to confusion within a country as to whether these initiatives are in place.

Despite the differences highlighted with each of indicators, there does appear to be some commonality among the countries. Slovenia, Finland and Denmark are the countries scoring best for both indicators (A or A− for school, B or B+ for community). Future research would benefit from examining these countries in more detail to determine what lessons could be learnt and applied to other countries in the region.

This is the first study globally to scrutinise the comparability of the report card indicators globally. Moreover, it did so following a systematic process, minimising the likelihood of misreporting. The biggest limitation of this study was that the main sources of data (i.e. the short and long forms of the report card and/or the scientific paper) were not all available for all countries. In addition, for some countries, the information was not available in an accessible format. For example, the short and long report cards were only available in the national language, not in English, for Estonia, Denmark and the Czech Republic. We liaised with contacts in these countries to populate the data extraction template in an attempt to overcome this limitation.

Although this paper only focused on the School and Community and Environment indicators, issues with comparability are likely to be present across all report card indicators. To improve the methods used for assigning grades for all report card indicators, the authors recommend:

- Advocating for common questions and/or tools to be used in nationally representative surveys;
- Providing information on the most commonly used metrics for assigning indicator grades globally;
- Providing future Global Report Card contacts with a mandatory/basic metric that should be included to assign a grade. Based on our European analysis, we suggest 'PE' for the school grade and 'perceptions of safety' for the Community and Environment grade;
- Adopting standardised methods to conceptualise and measure all indicators to ensure clarity on the definitions used for all indicators and benchmarks to allow comparisons to be made across countries;
- Allocating more weighting to the factors for which there is strong evidence of effectiveness, for example, for the school indicator, whole-of-school policies to promote physical activity[14] and PE delivered by qualified teachers.[22] These factors should also become mandatory to assign the grade; and
- Requiring countries to provide more detail on the measurement method(s) used.

It should be acknowledged that the European region is one of the most advanced globally in terms of national surveillance of physical activity behaviour and its determinants.[23] Because of its capacity for surveillance, it is well-positioned to review and better align the methods used for assigning grades for the report card indicators across countries to improve comparability. In other parts of the world, and particularly low- and middle-income countries, surveillance systems are less well-established and resources are often limited. Furthermore, other parts of the world have important contextual differences, which present challenges to the ways in which data are collected and interpreted. It remains important to include these countries in such global initiatives, despite limitations in our ability to draw direct comparisons on the report card indicators. We propose that the European countries trial any standardised approaches developed for future indicators and benchmarks used in the Global Matrix initiative to explore whether more standardised approaches are possible, at least in some parts of the world.

Conclusion

Public health surveillance is the cornerstone of public health practice.[24] Surveillance of physical activity is essential for monitoring progress towards benchmarks, setting priorities and informing policy.[25] The Global Matrix provides a useful method of consolidating the best available evidence and information on children's physical activity and its promotion globally, enabling comparisons and trends to emerge. However, this study demonstrates that there is a high degree of variability in the factors and data sources used to assign grades in two key settings that impact children's physical activity. To enable comparability, the authors recommend moving towards an agreed standardised set of measures that all countries adhere to, where possible, which will ultimately make the Global Matrix a more robust and useful tool for the future.

Author statements

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Competing interests

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Author's contributions

AC conceived the idea for the paper. AC, TC, KM and EM conceptualised the scope and methods. TC coordinated the data

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Appendix A. Supplementary data

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Original Research

Identifying research questions for HIV, tuberculosis, tuberculosis-HIV, malaria, and neglected tropical diseases through the World Health Organization guideline development process: a retrospective analysis, 2008–2018

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ABSTRACT

Objectives: World Health Organization (WHO) guidelines for health programmes and healthcare delivery are the foundation of its technical leadership in public health and essential to decision-making globally. A key function of guideline development is to identify areas in which further evidence is needed because filling these gaps will lead to future improvements in population health. The objective of this study was to examine the knowledge gaps and research questions for addressing those gaps generated through the WHO guideline development process, with the goal of informing future strategies for improving and strengthening the guideline development process.

Study design: We did a systematic, retrospective analysis of research questions identified in the published guidelines.

Methods: We analyzed guidelines published between January 1, 2008, and December 31, 2018, by the Communicable Diseases Cluster in five disease areas: tuberculosis (TB), HIV, malaria, TB-HIV, and neglected tropical diseases (NTDs). Research questions were extracted independently by two researchers. We analyzed the distribution of research questions by disease and by topic category and did a qualitative assessment of optimum practice for research question generation during the guideline development process.

Results: A total of 48 guidelines were included: 26 on HIV, 1 on malaria, 11 on TB, 5 on TB/HIV, and 5 on NTDs. Overall, 36 (75%) guidelines encompassed a total of 360 explicit research questions; the remainder did not contain specific research questions. The number of research questions that focused on TB was 49, TB/HIV was 38, HIV was 250, and NTDs was 23. The number of research questions that focused on diagnosis was 43 (11.9%) of 360, prevention was 62 (17.2%), treatment was 103 (28.6%), good practice was 12 (3.3%), service delivery was 86 (23.8%), and other areas was 54 (15%). Research questions were often not formulated in a specific or actionable way and were hard to identify in the guideline. Examples of good practice identified by the review team involved the generation of specific and narrowly defined research questions, with accompanying recommendations for appropriate study design.

Conclusions: The WHO must strengthen its approach to identifying and presenting research questions during the guideline development process. Ensuring access to research questions is a key next step in adding value to the guideline development process.

Introduction

One of the most important normative roles of the World Health Organization (WHO) is to develop guidelines for health programmes to support best practice in healthcare delivery. Producing

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robust guidelines is essential to inform decisions regarding diagnosis, management, and treatment, in support of evidence-based approaches to the prevention and control of diseases.[1–4] WHO guidelines aim to promote the achievement of the Sustainable Development Goals and access to universal health coverage and reflect the core WHO value of the 'right to health.'[3,4]

The WHO and other national and international guideline development groups strive to ensure that their guidelines meet the highest international standards and are impactful at the country level. In 2007, the WHO Guidelines Review Committee (GRC) was established to oversee the processes and methods used to develop WHO guidelines and to ensure the quality of all published guidelines. The GRC re-established a set of guideline development standards and adopted the GRADE (Grading of Recommendations Assessment, Development and Evaluation) approach in formulating evidence-based recommendations.[5] The guideline development process involves carrying out systematic reviews of the evidence for each of the key questions underpinning recommendations in a guideline, with assessment of the quality or certainty of the body of evidence, and the explicit and transparent formulation of recommendations based on the balance of benefits and harms of an intervention and other important considerations such as acceptability, resource use, and effects on equity. In addition, guideline development groups should formulate research questions needed to address identified gaps in knowledge.[6,7]

There has been significant improvement within the WHO in developing public health guidelines.[8,9] However, there has been little emphasis on the opportunity provided by the guideline development process to identify, formulate, and compile relevant research questions that address knowledge gaps. This approach has been promoted for informing the development of a public health research agenda for the WHO.[6,7] Since 2014, the *WHO Handbook for Guideline Development* has included the following advice: 'When gaps in the evidence are such that significant uncertainty exists with respect to the balance of an intervention's benefits and harms, such knowledge gaps should be described and questions and methods for addressing the gaps should be suggested.'[4] Answering the research questions identified through the guideline development process fills knowledge gaps directly relevant to programmes and contributes to improved delivery of interventions and better health. Systematically compiling and disseminating the research questions identified through the WHO guideline development process can therefore help maximize public health relevance of future research.[7,10,11,12]

For a selected set of WHO guidelines, i.e., those developed by the WHO Communicable Diseases Cluster on tuberculosis (TB), HIV, malaria, TB-HIV, and neglected tropical diseases (NTDs) between 2008 and 2018, we therefore assessed the extent to which the guideline development process identifies research questions that address knowledge gaps. The objective of this study was to examine the research questions generated through the WHO guideline development process with the goal of informing future strategies for improving and collating these questions into an open-access online directory.

Methods

Inclusion and exclusion criteria

We did a systematic, retrospective analysis of research questions contained in all WHO guidelines approved by the GRC and published between January 1, 2008, and December 31, 2018, by the CDS at WHO headquarters in Geneva, Switzerland. This unit produces guidelines on TB, HIV, malaria, TB-HIV, and NTDs. A research question was defined as an answerable or actionable enquiry generated through the guideline development process describing an identified knowledge gap or where it was explicitly stated in the guideline to be a research question.

The GRC Secretariat provided a database containing all WHO guidelines published during the relevant time period. From this database, we identified guidelines related to the five disease areas of interest (TB, HIV, malaria, TB-HIV, and NTDs). The most recent guidelines were used when multiple guidelines were available on the same topic.

Data extraction

Research questions were extracted from the published guideline documents independently and in duplicate by J.H. and S.H. This involved a systematic search of the guideline for the following terms: research, research questions, research gaps, research needs, research priorities, knowledge gaps, outstanding research, quality of evidence, and implications of research. Research questions were extracted verbatim into an Excel file and assigned to the relevant disease area. Where research questions were present in paragraphs of text pertaining to research gaps or research questions, we disaggregated the text into separate research questions, wherever possible.

Analysis and validation

We categorized research questions into six broad areas: diagnosis, prevention, treatment, specific procedural/operational needs to establish good practice, service delivery, and 'other.' Once all data had been extracted from the guidelines and categorized, we analyzed the number of guidelines for each disease and the distribution of research questions by disease grouping and by topic area. We did a qualitative assessment of optimum approaches for defining actionable research questions, which involved two researchers doing an in-depth reading of all included guidelines to explore areas of good and bad practice in the generation of research questions and knowledge gaps during the guideline development process. The researchers took detailed notes during the process, which were discussed during a face-to-face review team meeting to agree on optimum approaches, to inform the guideline development process going forward.

Because we planned to use the identified research questions to populate an open-access online directory, identified research questions underwent an internal validation process by senior WHO technical staff with responsibility for each of the five disease areas under study to assess which research questions were still relevant to the current disease context. An Excel (Microsoft, Redmond, WA, USA) spreadsheet of research questions identified from the guidelines was sent via email to each of the staff members who then coordinated a discussion within their department to assess which research questions were still relevant. Irrelevant and outdated questions were removed.

Results

Distribution of guidelines and research questions by disease

A total of 48 guidelines were included in total (2008–2018), including 26 on HIV, 1 on malaria, 11 on TB, 5 on TB-HIV, and 5 on NTDs (see Fig. 1). Among the 48 guidelines reviewed, 30 (62.5%) were developed before the updated guidance[4] on identifying research questions in 2014.

There was considerable heterogeneity across the guidelines in terms of research questions generated, with some disease areas showing a higher emphasis than others on generating a set of

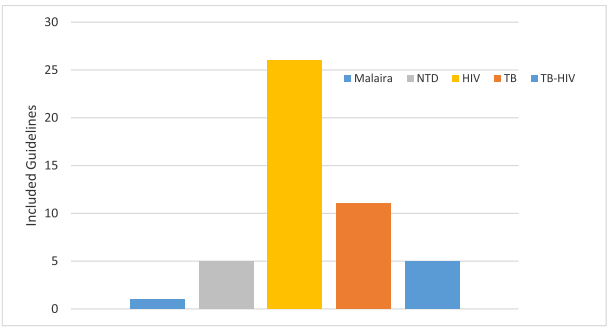

Fig. 1. Included guidelines by disease area. NTD = neglected tropical disease; TB = tuberculosis.

defined research questions as part of the guideline development process (Fig. 2). Of the 48 guidelines, 36 (75%) encompassed explicit research questions, including 360 research questions in total: HIV, 250 (69.4%); TB, 49 (13.6%); TB-HIV, 38 (10.6%); NTDs, 23 (6.4%), and malaria, 0 (Fig. 2). Only one guideline was identified for malaria, which did not explicitly state any research questions. Rarely did the guideline development groups propose an appropriate study design to accompany a defined research question.

Distribution of research questions by category

Of the 360 research questions, the focus was on diagnosis in 43 (11.9%), prevention in 62 (17.2%), treatment in 103 (28.6%), good practice in 12 (3.3%), service delivery in 86 (23.8), and 'other' in 54 (15%) questions.

There was variation in the emphasis of questions generated by research area across the disease categories. Among the 250 research questions on HIV, the most commonly reported were those on treatment ($n = 82$), followed by service delivery ($n = 64$). Among the 49 research questions on TB, those on treatment were also most frequently reported ($n = 16$). The main focus of the 38 TB/HIV research questions was on service delivery ($n = 14$), followed by prevention ($n = 10$). The main focus of the 23 research questions on NTDs was on prevention ($n = 15$).

Validation of research questions

Table 1 shows the number of validated research questions. The full data set of extracted research questions is available as Supplementary Information. The key reasons cited by Disease Leads as to why research questions were removed from the list of identified research questions include the following:

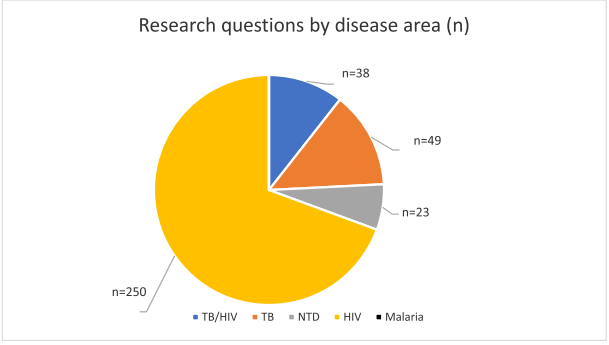

Fig. 2. Research questions by disease area (%). NTD = neglected tropical disease; TB = tuberculosis.

(i) The guideline from which the research question was extracted is no longer valid.
(ii) Research questions were reframed and incorporated into a newer guideline.
(iii) The research question is now obsolete or no longer relevant.
(iv) The research question is not well formulated.

Qualitative assessment of optimum approaches

We found that research questions were commonly dispersed across the guideline in various sections, making it difficult for the reader to clearly see the research gaps generated by the guideline development process. Research questions were often not formulated in a specific or actionable way, with interventions not specified, study design not defined, and research questions too broad.

In many cases, guideline development groups did not specify explicit research questions or knowledge gaps but rather opted for paragraphs of interconnected text containing a broad discussion on research gaps, which makes it difficult for the reader to clearly identify the research questions. In guidelines published after the 2014 guidance—in which guideline development groups (GDGs) were specifically asked to address the issue of research question generation—we found that guideline development groups began to generate a defined section of 'research questions,' 'research gaps,' or 'research priorities.'

We noted a number of good examples of research questions in the cohort of guidelines that we examined, with specific and narrowly defined questions, accompanied by recommendations regarding study design. Examples include the following:

> *"Large RCTs are needed to compare the effectiveness of topical amorolfine and butenafine in order to establish an alternative to oral treatments for toenail infections, in both HIV-infected and the general population."*

> *"Field evaluations of commercially available point-of-care technologies are needed to confirm the accuracy of results and the strategic placement of this technology within national programmes."*

The *'Consolidated and Updated Guidelines on the Programmatic Management of Latent Tuberculosis Infection'* published in 2018[13] was highlighted by the review team as an example of good practice in research question generation. The guideline concludes with the research questions based on existing knowledge gaps, to support the improvement of quality of care (Table 2), with recommended study designs stated.

Discussion

The cohort of guidelines on infectious diseases that we assessed varied considerably in the extent to which they identified research questions as part of the guideline development process. Of the included guidelines, 75% contained explicit research questions, most frequently focusing on disease treatment. A relevant study design accompanying the research questions was rarely proposed. The better examples involved the generation of specific and narrowly defined research questions, in its own defined section of the guideline that is easily accessible to the reader, with accompanying recommendations for appropriate study design.

This analysis provides evidence of the lack of a systematic approach in identifying research questions during the guideline development process, which is relevant to the WHO's guideline development groups and other organizations generating guidelines

Table 1
Included guidelines and research questions after validation.

Disease area (number of guidelines and research questions)
HIV: 7 guidelines; 107 research questions
TB: 8 guidelines; 63 research questions
TB-HIV: 3 guidelines; 27 research questions
Malaria: 0
NTDs: 3 guidelines; 20 research questions

NTD = neglected tropical disease; TB = tuberculosis.

in the field of public health. Explicit guidance on how to identify knowledge gaps and actionable research questions and to present them in WHO guidelines would add value to each guideline and to the setting of evidence-informed public health research agendas. This guidance could build on existing work on the generation of research agendas through systematic reviews.[14]

Guidance is needed on when in the guideline process, developers should start thinking about research questions and how reseach question formulation can be better integrated into the guideline development process. Consideration must be given to what expertise is needed to identify and formulate optimal questions and to the approaches that may be useful for subsequent prioritization among these research questions.

There were limitations identified with respect to this review. Primarily, the review team may have missed regional guidelines or research questions within these guidelines. However working directly with disease leads for each disease means that this would have been unlikely. We are not aware of any other organizations involved in guideline development that have analyzed and assessed their approach to research question generation through the guideline development process. Nor were we able to identify any published or gray literature from other organizations on how to generate research questions. Organizations such as the Guidelines International Network (https://www.g-i-n.net/) may be well placed to strengthen approaches in generating research questions and highlighting evidence gaps during guideline development.

This review has generated some key new considerations to inform the standardized and systematic identification and compilation of research questions for guideline development in the future, which may be relevant to other health guideline development groups. There should be sufficient expertise in research among members of the guideline group to help generate research

Table 2
Research questions extracted from a WHO guideline:[13] an example of good practice in research question generation.

Evidence on the risks of a number of at-risk populations for progression from LTBI to active disease will be crucial for determining the potential benefits of LTBI treatment and for designing appropriate public health interventions. In particular, strong evidence from clinical trials is lacking for the following groups: patients with diabetes, people with harmful use of alcohol, tobacco smokers, underweight people, people exposed to silica, patients receiving steroid treatment, patients with rheumatological conditions, indigenous populations and cancer patients.
Evidence is required on differential harm and the acceptability of testing and treatment for LTBI in specific risk groups, including socially adverse events such as stigmatization.
Defining the best algorithm for ruling out active TB: Operational and clinical studies should be conducted to exclude active TB before preventive treatment is given. The performance and feasibility of the algorithms proposed in these guidelines should be assessed. In particular, few data are available on children and pregnant women. Strategies to save cost and improve feasibility (e.g. use of mobile chest radiography) should also be explored.
The performance of LTBI tests should be evaluated in various at-risk populations, such as the best way of using the available tools (e.g. combination or sequential use of TST and IGRA) in each at-risk population.
Research to find shorter, better-tolerated treatment regimens than those currently recommended is a priority.
Studies of efficacy and adverse events in certain risk groups (e.g. people who use drugs, people with alcohol use disorder and elderly people) are essential. In particular, there are no or very limited data on the use of rifapentine in children <2 years and pregnant women. Studies should be conducted of the pharmacokinetics of interactions between rifamycin-containing regimens and other drugs, particularly antiretroviral drugs.
The durability of protection by preventive treatment should be evaluated in settings in which TB is endemic, including the efficacy of repeated courses of preventive treatment.
Monitoring of adverse events: Prospective randomized studies are required to determine the incremental benefits of routine monitoring of liver enzyme levels over education and clinical observation alone for preventing severe clinical adverse events, with stratification of the evidence by at-risk population.
Risk of drug resistance following LTBI treatment: Programme-based surveillance systems and clinical studies are needed to monitor the risk for bacterial resistance to the drugs used in LTBI treatment. Particular consideration should be given to rifamycin-containing regimens because of the dearth of data.
Adherence to and completion of treatment: Carefully designed studies, including RCTs, are required to generate evidence on the effectiveness of context specific interventions for enhancing adherence and completion of treatment. The studies should include specific risk groups, depending on the available resources and the health system infrastructure. Use of "digital health" to improve adherence is an important area. Further research is required on the effectiveness of self administration of the 3-month regimen of weekly rifapentine plus isoniazid.
Although a number of studies of the cost-effectiveness of TB preventive treatment are available, their wide heterogeneity obviates a comprehensive appraisal of the cost-effectiveness of LTBI management stratified by population group and type of intervention. Direct measurement of cost-effectiveness in certain settings and populations would allow extension of the LTBI strategy at national or local level.
Preventive treatment for contacts of people with MDR-TB: RCTs with adequate power are urgently needed to update the recommendation on preventive treatment for contacts of people with MDR-TB. Trials should be performed with both adult and paediatric populations and with at-risk populations such as people living with HIV. The composition, dosage and duration of preventive treatment regimens for MDR-TB should be optimized, and the potential role of newer drugs with good sterilization properties should be investigated. The effectiveness and safety of preventive treatment for contacts of people with MDR-TB should be evaluated in operational conditions. Further evidence on the risk of contacts of people with MDR-TB for progression to active TB will be important for understanding the benefits of preventive treatment.
Epidemiological research should be conducted to determine the burden of LTBI in various geographical settings and risk groups and as a basis for nationally and locally tailored interventions, including integrated community based approaches. Research is also needed on service delivery models to ensure that patients are properly managed including the provision of additional interventions for tobacco smokers, illicit drug users, and people with harmful use of alcohol. Household implementation models could improve the effectiveness and efficiency of delivery of interventions. Tools should be developed and assessed to facilitate monitoring and evaluation of programmatic management of LTBI.

WHO = World Health Organization; LTBI = latent tuberculosis infection; TB = tuberculosis; IGRA = interferon gamma release assay; TB = tuberculosis; TST = tuberculin skin tests; RCT = randomised controlled trial; MDR-TB= multidrug-resistant TB.

questions. In addition, research questions are more easily accessible to guideline end users if they are short and clearly defined and in a defined section of the published guideline.

Opportunities for the WHO to ensure the research questions identified through its guideline development process are made more widely available, including the compilation of an online directory of research questions hosted by the WHO Global Observatory on Health R&D[15] and presentation on the WHO website where guidelines are published.[16] Work is currently underway to disseminate research questions using these fora.

Conclusions

This analysis shows the variable extent to which the WHO guideline development process identifies research questions. The results indicate the need for the WHO to strengthen its guideline development process by systematically identifying and compiling research questions that address key knowledge gaps. Such an approach will facilitate the formulation of relevant and impactful research agendas that will ultimately help to improve health programmes and achieve the Sustainable Development Goals for health.

Author statements

Ethical approval

None sought.

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Competing interests

S.L.N. was the Secretary of the World Health Organization (WHO) Guidelines Review Committee, until 2020 and in that position, she was responsible for supporting and overseeing the methods used and standards implemented for WHO guidelines, including for many of the guidelines included in the study cohort. She was the lead author of *WHO Handbook for Guideline Development* (2nd edition, 2014). All other authors report no competing interests.

Availability of data sets

The data set supporting the conclusions of this article is included as an additional supplementary file.

Author contributions

D.M., N.F., and S.L.N. conceived the idea for this study. S.H. led the investigation and data analysis, with input from L.B.N. and J.H. G.B., A.F.G., N.G., and M.Z. validated the data extraction. S.H. and D.M. drafted the manuscript, and all authors provided input and approved the final manuscript.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.puhe.2020.03.028.

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Short Communication

Policy determinants of COVID-19 pandemic–induced fatality rates across nations

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ABSTRACT

Objectives: Coronavirus disease 2019 (COVID-19) is the most devastating pandemic to affect humanity in a century. In this article, we assessed tests as a policy instrument and policy enactment to contain COVID-19 and potentially reduce mortalities.

Study design: A model was devised to estimate the factors that influenced the death rate across 121 nations and by income group.

Results: Nations with a higher proportion of people aged 65+ years had a higher fatality rate ($P = 0.00014$). Delaying policy enactment led to a higher case fatality rate ($P = 0.0013$). A 10% delay time to act resulted in a 3.7% higher case fatality rate. This study found that delaying policies for international travel restrictions, public information campaigns, and testing policies increased the fatality rate. Tests also impacted the case fatality rate, and nations with 10% more cumulative tests per million people showed a 2.8% lower mortality rate. Citizens of nations who can access more destinations without the need to have a prior visa have a significant higher mortality rate than those who need a visa to travel abroad ($P = 0.0040$).

Conclusion: Tests, as a surrogate of policy action and earlier policy enactment, matter for saving lives from pandemics as such policies reduce the transmission rate of the pandemic.

As of July 29, 2020, severe acute respiratory syndrome coronavirus 2, which causes coronavirus disease 2019 (COVID-19), has already infected more than 16.6 million people, causing 658,861 mortalities globally.[1] The majority of deaths have occurred in the 65+ years age-group, with most having medical preconditions.[2,3] Policies for social distancing, lockdowns, testing, isolating, and tracking are necessary to contain the spread of the virus, although they come with a cost of an economic recession with its negative side-effects.[4]

Here, we assessed tests as a policy instrument and the start of policy enactment to contain COVID-19 and potentially reduce mortalities across 121 nations. To achieve this, a cross-sectional ecological study was conducted for numerous nations around the world, and a model was estimated to explain the pattern of the crude case fatality rate (CFR)[5] as of July 21, 2020. The objective was to estimate, using regression analysis, the direction and strength of the association with the death rate, as the response variable, controlling for (1) the percentage of the population aged 65+ years, (2) the delay in enacting policies, which was measured as the number of days from January 1, 2020, until the stringency index, which is composed of all containment policies, which took on a positive value showing that policy action was taken by the nation on that date, (3) tests per million people (i.e. the COVID-19 test rate) conducted as a surrogate of policy action to contain the spread of COVID-19, and (4) the freedom of nations' citizens to travel abroad as measured by the number of destinations a citizen of a nation has access to without the need for a visa. Citizens of rich countries can travel abroad and visit other destinations relatively more easily. This is supported by a strong positive correlation between gross domestic product per capita and the Henley Passport Index. The pairwise Pearson correlation (r) was 0.763 (95% confidence interval [CI] = 0.676, 0.828). This freedom to travel abroad heightens the risk of infection or transmission. In turn, mortality being a function of the incidence of infections, should be significantly higher relative to nations whose citizens are restricted from entering other

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nations, controlling for all other factors. We also controlled for tourist arrivals and the presence of city-states, such as Bahrain, Kuwait, Hong Kong, Qatar, and Singapore, to determine if the fatality rate was lower in city-states relative to that of nations that is composed of many cities (Supplementary file). Elasticities were estimated, showing the percentage change in the response variable for a 1% change in the explanatory variable, for all variables with a log-log specification model to account for non-linear associations. Details of the data sources and definitions may be found in the Supplementary file.

A total of 121 nations were assessed: 46 high-income nations, 36 upper-middle-income nations, and 39 low-income nations (Supplementary Table S1). As expected, high-income nations were affected the most by the pandemic relative to the other two groups in terms of deaths per million people, i.e. crude death rate (CDR), and in terms of CFR. The CDR for the high-income group was 2.16 times higher than that for the upper-middle income group (i.e. 166 vs 77 deaths per million people, respectively) and 6.1 times higher than that of the low-income nations (i.e. 166 vs 27 deaths per million people, respectively). The difference in CFR for high-income nations relative to that for the other two groups combined was 1.98% ($P = 0.007$, 95% CI = 0.0057, 0.034).

High-income nations conducted significantly more tests per million people than the other two income groups (i.e. 3.87 and 9.9 times more than upper-middle-income and low-income nations, respectively). In addition, high-income nations had 15%, middle-income nations had 9%, and low-income nations had 4.6% of their population aged 65+ years. High-income nations reacted earlier on average than the other nations in terms of social distancing, lockdowns, and testing as they were hit harder by the virus.

The regression results are shown in Table 1, which includes all 121 nations, and also divide them into the three income groups. Supplementary Table S2 shows the regression with deaths per million people (CDR) as a response variable, and Supplementary Table S3 shows results with tourist arrivals and city-states added as explanatory variables. For all nations grouped together, the results show that the COVID-19 test rate is statistically significant, affecting CFR negatively ($P < 0.0001$, 95% CI = -0.367, −0.186). A 10% higher COVID-19 test rate results in a 2.8% lower CFR. Age of 65+ years is also significant, with a positive impact on CFR ($P = 0.0001$, 95% CI = 0.273, 0.758). A 10% increase in the percentage of the population with an age more than 65 years results in a 5.2% increase in CFR. The policy variable (days since first policy enactment) is positive and significant on CFR ($P = 0.0013$, 95% CI = 0.148, 0.594). A 10% delay in enacting policy results in a 3.7% higher CFR. To illustrate this, a 7-day/one full week delay (30-day/a month delay) relative to a nation that enacted policies from day 1 represents a 600% (2900% for a one-month delay) increase in delay time, which resulted in a 3.23-fold (11.76-fold for a one-month delay) higher fatality rate relative to those nations that enacted policies from day 1. During a worldwide pandemic, delaying to act has a significant effect on the infection rate. An example would be to delay restrictions on international travel from and to high-risk nations or other policies to contain the spread of the virus such as testing policies. Access to destinations around the world using as a surrogate, namely, the Henley Passport access numbers, also had a positive and significant effect on CFR ($P = 0.004$, 95% CI = 0.194, 0.996). For the high-income nations, the percentage of the population aged 65+ years positively impacted CFR ($P = 0.0017$) and had a significantly positive impact from days since first policy enactment ($P = 0.012$), with the COVID-19 test rate having a negative impact on CFR ($P = 0.041$). For the upper-middle-income nations, the days to first policy enactment and passport access were the significant variables explaining CFR across these nations ($P = 0.0002$ and $P = 0.0126$, respectively). For the low-income nations, conducting more tests per million people was also an important factor explaining the pattern of CFR across these nations ($P = 0.0003$) and the age more than 65 years variable ($P = 0.0463$). Supplementary Table S2 shows that one cannot reject the null hypothesis that deaths per million people have an elasticity equal to unity with respect to cases per million people. As a result, the remaining confounding factors affected CDR in a very similar way to their effect on CFR, as shown in Table 1. Supplementary Table S3 shows that the number of tourist arrivals may have positively impacted fatality rate as measured by CDR or CFR ($P = 0.11$), but was especially significant for the high-income nations ($P = 0.029$). City-states had a lower fatality rate relative to the rate observed at the national level ($P = 0.007$).

The results show that more tests per million people lead to a lower CFR relative to other nations that conduct less tests per million people. Because tests remain an important policy instrument for COVID-19, conducting tests acts as a surrogate of policy action. It is true that more tests lead to more cases being reported, so more deaths will be observed as a result. However, the aforementioned findings suggest that mortalities will increase by a lower percentage than the percentage increase in cases when a nation conducts more tests per million people relative to other nations that do not. Robust testing allows COVID-19 to be detected earlier, which in turn allows a health system to provide some assistance to patients by reducing their risk of premature death,

Table 1
Least squares estimation of CFR as of July 21, 2020, and by income group.

Explanatory variables	All nations		High-income nations		Upper-middle-income nations		Low-income nations	
	Coefficients	*P*-values	Coefficients	*P*-values	Coefficients	*P*-values	Coefficients	*P*-values
Constant	−6.1261	0.0000	−8.5644	0.0013	−7.5655	0.0001	−5.0814	0.0002
Age more than 65 years (% of the population)	0.5154	0.0001	0.6160	0.0017	−0.1622	0.5180	0.4833	0.0463
Days for first policy enactment	0.3711	0.0013	0.5959	0.0115	0.5300	0.0002	0.1721	0.2051
Cumulative tests per million	−0.2766	0.0000	−0.2436	0.0410	−0.1820	0.1303	−0.2719	0.0003
Passport access	0.5952	0.0040	0.8123	0.2014	0.8599	0.0126	0.5259	0.1260
Number of nations		121		46		36		39
Standard error		0.782		0.847		0.719		0.716
Adjusted R^2		0.406		0.533		0.285		0.265
Overall F-test		21.47		13.82		4.49		4.42
P-values for F-test		0.0000		0.0000		0.0056		0.0055

CFR = case fatality rate.
Estimation was conducted using the Eviews 11 software with Huber-White-Hinkley (HC1) heteroskedasticity-consistent standard error and covariance terms being reported. Delaying was measured as the number of days since the enactment of first policy as per the stringency index. Passport access was measured as the number of destinations a citizen can visit without the need of a visa.

thereby potentially reducing CFR. Delay in taking action to contain the spread of the virus also matters. Nations that acted earlier have a lower CFR. Nations that delayed the implementation of policies, international travel restrictions, public information campaigns, and testing policies showed a higher mortality rate than those nations that did not delay the enactment of international travel restrictions, public information campaigns, and testing policies (Supplementary Table S4). In contrast, across 50 countries that had the highest COVID-19 cases, mortality was impacted by the prevalence of obesity and gross domestic product, but evidence for rapid border closures, full lockdowns, and widespread testing was inconclusive.[6] In a sample of 185 nations, tourist numbers were associated with COVID-19 mortality.[7]

There are a number of limitations in this research. First, the issue of ecological fallacy cannot be ignored. This ecological study was performed at the level of nations, and inference of these results at the individual level cannot be made. In the future, it would be worthwhile to examine data at the city level rather than at the nation level. The second issue is the potential of missing other important confounding factors (e.g. obesity levels, smoking prevalence[8]), which could be correlated with the variables of this study. Their omission could cause the estimated coefficients of this study to be biased. However, when we estimated the factors that influence the number of deaths per million people, controlling for cases per million people, we found that the estimated coefficients were relatively stable and that the factors explained more than 80% of the variation of the mortality rate (see Supplementary Table S2). The third issue is that the reported fatality rates can be biased and may cause overestimation or underestimation of estimates.[5,9,10] However, using data across nations, the bias should not affect the main results of the study, provided the bias occurs in a similar fashion across all nations around random noise. Furthermore, the data were taken from the public domain, which may not be accurate or not be confirmed by nations' public health units. What is a confirmed COVID-19 case between different nations can also vary. This study was conducted for the outcomes of COVID-19 as of July 21, 2020. The size effects and the significance of these factors could be influenced if the study is reassessed in the future. Cognizant of such limitations, this study shows that more tests and earlier policy enactment matter and can save lives from pandemics because such policies reduce the transmission rate of the pandemic.

Author statements

Author contributions

The authors, who are co-corresponding authors, contributed equally to the intellectual discussion underlying this article; literature exploration; data analysis; and writing, reviews, and editing and accept responsibility for its content.

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The authors declare no conflicts of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.puhe.2020.08.008.

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Short Communication

Political partisanship and mobility restriction during the COVID-19 pandemic

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ABSTRACT

Objectives:: Non-pharmaceutical interventions (NPIs) are effective in curbing the spread of severe acute respiratory syndrome coronavirus 2. All US states have adopted NPI policies, but the compliance to these measures and influence of sociopolitical factors on NPI adherence is unknown. NPI adherence may be approximated by personal mobility in a population that is tracked by anonymous mobile phone data.
Study design: This is a cross-sectional study of state-level mobility changes across the US.
Methods: State-level mobility was based on anonymous mobile phone data from multiple participating carriers collected by the University of Washington's Institute for Health Metrics and Evaluation (http://www.healthdata.org). Pearson's correlation coefficient was used to examine the strength and direction of the relationship between political affiliations and mobility restriction across states. Multivariable linear regression analyses were used to assess other factors that may impact personal travel.
Results: All states experienced a decline in personal mobility but had varying nadirs ranging from a 34% to a 69% reduction in mobility, which was not temporally related to the timing of state-level NPI measures. There was a statistically significant linear and negative correlation ($r = -0.79$) between the proportion of Republicans/leaning Republicans and NPI adherence across US states. The negative association between Republicans and NPI adherence was significant even when adjusting for urbanization, proportion of essential workers, population, Gini index, and poverty rates.
Conclusions: Political orientation affects risk perception, which may contribute to the unwillingness of some individuals to perceive the coronavirus disease 2019 pandemic as a risk and to comply with NPIs. Our results highlight the importance of sociopolitical factors in disease control and emphasize the importance of bipartisan efforts in fighting the pandemic. These results may have implications for the development, dissemination, and communication of public health policies.

Non-pharmaceutical interventions (NPIs) including travel restrictions, social distancing, and avoidance of social gatherings are effective in reducing the spread of severe acute respiratory syndrome coronavirus 2.[1] All US states have adopted NPIs between March and April 2020, but compliance with NPIs is not broadly enforced and likely limited. Sociopolitical factors may influence compliance with NPIs, given that the timing of state-level NPI policies has been associated with political partisanship among state governments.[2] At the individual level, sociopolitical factors including race, sex, and political party affiliation are known to affect the perception of risk and antisocial attitudes.[3,4] As the perceived risk of the coronavirus disease 2019 (COVID-19) pandemic to individual health or to the public may influence the willingness of persons to adopt NPIs, we sought to evaluate the relationship between compliance to NPI measures and political party affiliations.

Mobile phone tracking has been used for contact tracing and ensuring that exposed individuals remain in quarantine during the COVID-19 pandemic.[5] Given that mobile phone use penetration is very high across all US states, mobile phone data can also be used to track personal movements across the US population and may be used to infer adherence to NPI policies.[6] In aggregate, a decline in mobility reflects decreased population travel outside the home or baseline location, which is in accordance with NPI policies that limit social interactions.

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We analyzed mobility data collected by the University of Washington's Institute for Health Metrics and Evaluation (http://www.healthdata.org) which show that all US states exhibited a decline in population mobility with a nadir reached between March 30 and April 9 (Fig. 1A). The date of the nadir in mobility changes, representing the time when adherence to NPI mandates was greatest, did not correlate with the timing of NPI mandates (Fig. 1B). In fact, for nearly every state, decreases in mobility were perceptible before any statewide mandate. In addition, the depth of the nadir was not uniform between states and ranged from a 34% to 69% reduction in mobility.

To assess the association between NPI adherence and party affiliation, we plotted the greatest percentage reduction in mobility, reflecting the greatest degree of compliance, against the proportion of individuals who identified as Republicans or leaning Republicans as per the most recent Gallup USA Poll in 2018. This revealed a significant and negative linear correlation between the two parameters (two-tailed $P < 0.001$) (Fig. 1C). A Pearson's correlation equal to −0.79 (95% confidence interval: −0.88 to −0.66) indicates that 62% of the variance in the greatest reduction in mobility among US states is explained by the proportion of Republicans and Republican-leaning persons. The slope of the best-fit regression line is −0.79, indicating that for every 10% increase in the proportion of Republicans in a state, NPI compliance declines 8%. We also used party affiliation data from the 2014 Pew Religious Landscape Study that yielded similar results (Pearson coefficient = −0.82, $P < 0.001$). Inversely, there was a positive correlation (Pearson coefficient = 0.77, $P < 0.001$) between reductions in mobility with the number of Democrats/leaning Democrats across states. No associations were found between total deaths or daily infection rate on the date of the nadir and the greatest reductions in mobility across states.

Given that US President Donald Trump repeatedly expressed his opposition to NPIs during the early stages of the COVID-19 pandemic, we also assessed whether voter support for Trump during the 2016 US presidential election was also a determinant of NPI adherence. In a multivariable linear regression model including the proportion of President Trump voters and proportion of Republicans as predictor variables, we found that the percentage of Republicans (standardized coefficient = −0.51, $P = 0.004$) and the percentage of voters for President Trump (standardized coefficient = −0.35, $P = 0.046$) were both negatively associated with mobility restriction. The variance inflation factor of the linear regression was 4.45, suggesting a moderate degree of collinearity. Nonetheless, these results suggest that in addition to political affiliation, the voter strength of President Trump across states may impact compliance to NPI policies.

Differences in population mobility between states may also be related to urbanization, essential workers (which were exempt from some NPI measures), or the population size. Univariable linear regression analyses show that the percentage of the state population living in urban areas and the percentage of the state population that held essential jobs, but not the state population, are associated with mobility restriction (Table 1). However, in a multivariable linear regression model including the aforementioned variables, the proportion of Republicans in each state, and socio-economic factors, only the proportion of Republicans and urban percentage remained significantly associated with mobility restriction (Table 1). This is not unexpected as people in urban areas may need to travel less to access essential services. Of importance is that the proportion of Republicans remained strongly predictive independent of urbanization, suggesting ideological opposition to the recommended mobility guidelines.

Although socio-economic factors have been predicted to be associated with NPI adherence, we did not observe any statistically

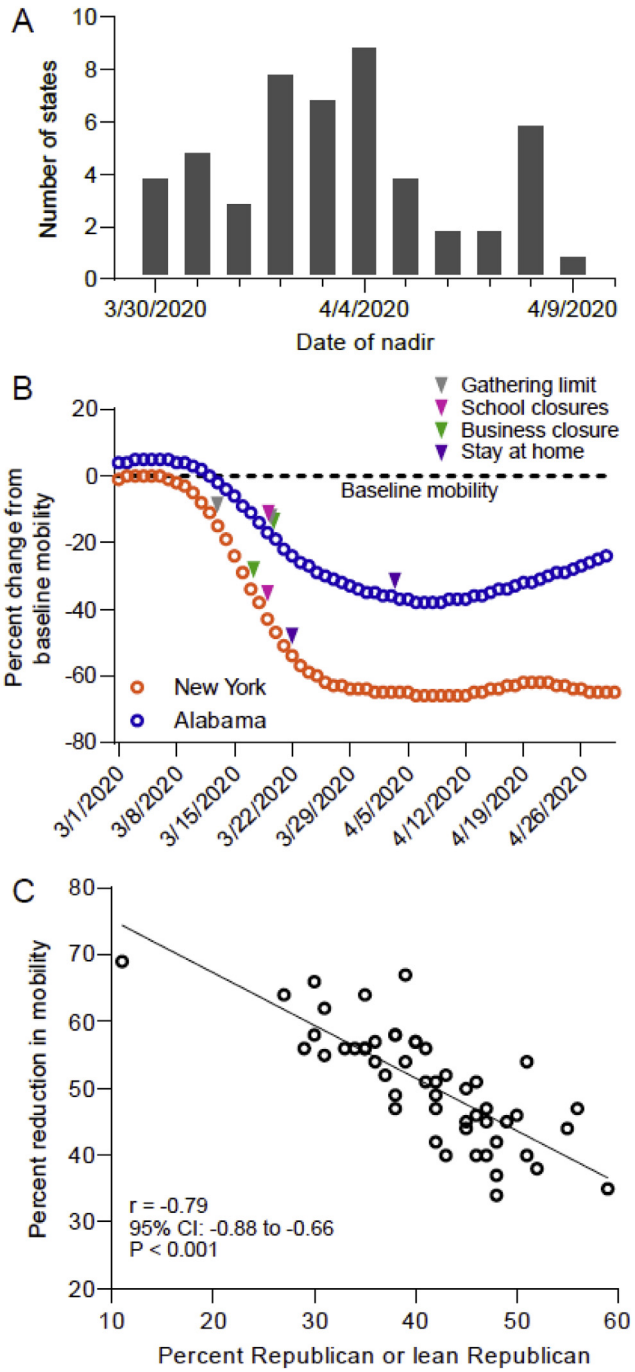

Fig. 1. Decreases in mobility and its association with political affiliations during the COVID-19 pandemic. (A) Distribution of dates when states reached their nadir in mobility restriction. (B) Plot of daily percentage change in mobility aggregated from cell phone data in New York and Alabama that demonstrates a nadir in response to the adoption of NPIs. Data from New York and Alabama are shown as they represent the two stages with the greatest and least percentage change in mobility. (C) The relationship between the proportion of individuals identifying as Republicans or leaning Republicans and the greatest percentage reduction in mobility across the 50 US states and the District of Columbia. COVID-19 = coronavirus disease 2019; NPI = non-pharmaceutical intervention; CI = confidence interval.

significant relationships between poverty rates or income disparity (Gini coefficient) and mobility restriction at the state level in univariable or multivariable regression analyses (Table 1). This suggests that socio-economic factors do not substantially explain variations in state-level differences in mobility restriction, but it

Table 1
Multivariable linear regression models of predictors of state-level mobility restriction.

Predictor variables	Multivariable		Univariable	
	Standardized coefficient	*P*-value	Standardized coefficient	*P*-value
Percentage of Republicans	−0.775	<0.001	−0.817	<0.001
Urban percentage	0.223	0.026	0.596	<0.001
Percentage of essential workers	−0.002	0.987	−0.312	0.026
Population	0.089	0.337	0.266	0.060
Gini index	−0.203	0.057	0.247	0.080
Poverty rate	0.034	0.726	−0.046	0.749

does not exclude the possibility that socio-economic factors contribute to NPI adherence.

Our work indicates that political affiliation and possibly the actions of political leaders are determinants of NPI adherence in the US. These results cannot be explained by the adoption of state-specific NPI policies as states with the least reduction in mobility such as Mississippi and Alabama also had very restrictive policies including stay-at-home orders and closures of non-essential businesses. The linear relationship also indicates that regardless of the ruling party in each state, the degree of NPI compliance is intimately tied to the political alignment of the population. Although we attempted to control for confounder variables, additional factors may influence the difference in mobility restriction between states. For example, the percentage of urbanization may not wholly capture differences in transportation patterns between urban and rural areas and access to essential services. In addition, as our study assessed state-level data, concerns of an ecological fallacy are present as aggregated patterns of mobility do not indicate individual behavior. However, recent surveys of individuals from nationally representative samples demonstrate that individuals who identify as Republicans were less concerned with the personal and public health risks of COVID-19 and less likely to adopt NPI measures.[7–9]

Perceptions of risk from environmental and other external hazards are known to differ between sexes and racial groups.[10] The role of sociopolitical factors in attitudes toward risk has also been demonstrated by the fact that Republican affiliation and conservative values are associated with low-risk perception and a willingness to take risks.[4,11] Such politically driven beliefs now extend to the COVID-19 pandemic as demonstrated by surveys conducted during the early stages of the pandemic in the US, indicating that Republicans perceived COVID-19 to be less lethal than seasonal influenza, believed the official COVID-19 death toll to be overstated, and were less willing to avoid social gatherings.[7] Our study suggests that differences in risk perception linked to political affiliation rather than other socio-economic factors may account for a large degree of the variance in NPI adherence in the US.

These results underlie the importance of bipartisan efforts in combating the COVID-19 pandemic and suggest that public health awareness and education should be targeted and delivered by respected Republican officials based on the fact that individual beliefs including risk perception are shaped by homophily.[12] Other factors influence NPI compliance, but policies are unlikely to be effective without addressing entrenched sociopolitical divisions. This is a matter of urgency as US states have begun to relax restrictions that still require a high degree of participation and it remains difficult to capture and monitor compliance to other NPIs such as face mask wearing and avoiding close contact.

Methods

State-level mobility was based on anonymous mobile phone data from multiple participating carriers collected by the University of Washington's Institute for Health Metrics and Evaluation (http://www.healthdata.org). Mobile phone geolocation reports were obtained from four sources: Google, Facebook, Descartes Labs, and SafeGraph. We abstracted daily changes in mobility for all 50 US states and the District of Columbia and determined the time of the nadir as the earliest date when the greatest reduction in mobility was achieved. Political affiliations per state were abstracted from the most recent Gallup USA Poll in 2018, which was conducted through phone interviews across the US. Pearson's correlation coefficient was used to examine the strength and direction of the relationship between political affiliations and mobility restriction across states. The percentage of the state population that was considered essential workers was determined from employment data from the US Bureau of Labor Statistics (2019 data). Essential occupations included those identified by the USA Department of Homeland Security's Cybersecurity and Infrastructure Security Agency advisory memorandum, which encompassed the law enforcement, public safety, health care/public health, food processing, agriculture, energy, waste management, water, public and social services, transportation, and communication workforce.

Author statements

Ethical approval

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Competing interests

None declared.

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Short Communication

Trend change of the transmission route of COVID-19–related symptoms in Japan

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ABSTRACT

Objectives: The Japanese prime minister declared a state of emergency on April 7 2020 to combat the outbreak of coronavirus disease 2019 (COVID-19). This declaration was unique in the sense that it was essentially driven by the voluntary restraint of the residents. We examined the change of the infection route by investigating contact experiences with COVID-19–positive cases.

Study design: This study is a population-level questionnaire-based study using a social networking service (SNS).

Methods: To assess the impact of the declaration, this study used population-level questionnaire data collected from an SNS with 121,375 respondents (between March 27 and May 5) to assess the change in transmission routes over the study period, which was measured by investigating the association between COVID-19–related symptoms and (self-reported) contact with COVID-19–infected individuals.

Results: The results of this study show that the declaration prevented infections in the workplace, but increased domestic infections as people stayed at home. However, after April 24, workplace infections started to increase again, driven by the increase in community-acquired infections.

Conclusions: While careful interpretation is necessary because our data are self-reported from voluntary SNS users, these findings indicate the impact of the declaration on the change in transmission routes of COVID-19 over time in Japan.

Introduction

The World Health Organization officially declared the outbreak of coronavirus disease 2019 (COVID-19) to be a pandemic on March 11, 2020. Since the first deaths were reported in early January,[1] as of May 6, 215 countries and territories have confirmed COVID-19 cases, with 3,595,662 cases and 247,652 deaths reported worldwide.[2,3] In response, the Japanese prime minister, Shinzo Abe, declared a state of emergency in 7 of the 47 prefectures on the

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evening of April 7,[4] and this was extended to become nationwide on April 16[5] owing to a gradual increase in polymerase chain reaction–positive COVID-19 cases with an untraceable pathway of infection. The declaration had limited legally enforceable measures, which is different from the so-called 'lockdowns' (e.g., city blockades with penalties) that have been in place in the US, the UK, France, Germany, Italy and India, and it is essentially driven by the voluntary restraint of the residents in Japan.[4] In this sense, Japan has a unique Japanese-style lockdown policy based on the voluntary efforts of residents to weaken the spread of the infection, with no penalties for going out or commercial activities.

In infectious disease control, capturing the real-time epidemiological situation is a key factor to control the spread of the infection. To address this issue, COOPERA (COvid-19: Operation for Personalized Empowerment to Render smart prevention And care seeking), a new healthcare monitoring system, has recently been launched in a collaboration with the Kanagawa prefectural government and LINE Corporation as a way to monitor the spread of COVID-19 and associated societal factors.[6] LINE provides Japan's largest mobile messenger application, with 83 million monthly active users (covering 65% of Japan's total population). COOPERA asks participants about their individual information, including medical and psychiatric conditions, and contact experiences with other individuals. In response to the given information, COOPERA provides personalised assistance, such as telephone consultation for participants who report serious symptoms.[7] Data collected by COOPERA have been used to monitor the real-time situation of COVID-19 and its usefulness for medical decision-making has already been shown.[8–10]

In this study, we focus on the change of association between COVID-19–related symptoms and (self-reported) contact experience with COVID-19–positive cases over time, including before and after the state of emergency. In particular, we investigate the time trend of (1) domestic infections (i.e., within-household infection) and (2) community-acquired infections with an unknown route of transmission. In addition, by examining the impact of the voluntary Japanese-style lockdown policy, this study provides a useful insight not only for Japan but also for other countries that are preparing to relax their lockdowns in the near future.

Methods

COOPERA used LINE's chatbot system to request (1) basic characteristics of the participants, including age, gender, occupation, medical history, preventive actions and postcode, and (2) health conditions, including current and past month's symptoms (presence or absence of fever, strong feeling of weariness or shortness of breath) and duration of these symptoms. In particular, we focused on fever in this study. Participants with any COVID-19–related symptoms were asked additional questions about their contact experiences with COVID-19–infected individuals, and if yes, they were asked about their relationships with these individuals (e.g., if they were colleagues, classmates or family members). Participants with any COVID-19–related symptoms were followed up daily and those without any symptoms were followed up once every 4 days. COOPERA recruited participants either via the QR code page on the prefecture's website or via the banner at the top of the screen. We used data from 1,386,330 participants who lived in the Tokyo metropolitan area, including Tokyo, Kanagawa and Saitama prefectures, between March 27 and May 5, 2020. In these prefectures, the declaration of emergency was in effect from April 7. In addition, the Governor of Tokyo, Yuriko Koike, requested cessation of non-essential or/and non-urgent travel from/to other prefectures and requested that individuals stayed at home from March 25.[11] Owing to the LINE Corporation's policy, users (and the COOPERA participants) are restricted to individuals aged $\geq$15 years. Participants who reported contact with a COVID-19–infected individual when the relationship was with a family member who did not live in the same household or was with some other person (i.e., not a colleague or classmate) were excluded from the analysis. Proportions were plotted after taking a rolling 7-day window average with confidence intervals derived from 1000 bootstrap iterations. To examine the change points in the proportion, a piece-wise linear regression model was fitted with (at most) ten knots.[12] The difference in slopes before and after the estimated change point(s) was tested using the Davies test.[13] For those who had multiple answers, only the first answer was extracted. It should be noted that the populations of Tokyo, Kanagawa and Saitama prefectures were 13.9, 9.20 and 7.34 million, respectively, as of March 2020.

Results

Characteristics of the participants

Table S1 in the supplementary material shows the basic characteristics of the participants. In total, 121,375 of 1,386,330 respondents (8.76%) reported that they had a COVID-19–related symptom, and among them, 2937 (0.21%) reported having been in contact with a COVID-19–infected individual; these individuals were defined as the contact group. In addition, among those in the contact group, 2570 (93.1%) participants reported that the COVID-19–infected person with whom they had contact with was a colleague or classmate, whereas 207 (7.50%) reported that it was a family member in their household.

Comparisons of fever rate

Fig. 1 shows the proportion of participants reporting a fever at each study time point, stratified by contact experience (left) and relationship with the COVID-19–infected individual (right). The daily proportion of participants experiencing fever was higher in the contact group than in the non-contact group throughout the study period. Between April 17 and 24, there was a significant change ($p < 0.001$), with no upward trend in the contact group; however, after April 24, the proportion with fever in the contact group started increasing again and was parallel to the non-contact group. In terms of the proportion of individuals experiencing fever, stratified by the relationship with the infected persons, the proportion remained higher in the group with infected family members living together than in the group having contact with infected colleagues or classmates throughout the study period. The difference between the group having contact with infected family members living together and the group having contact with infected colleagues or classmates has widened since March 30 (1.71 times higher in the former group) and peaked on April 27 (2.56 times higher in the former group).

Discussion

This is the first study to examine the real-time COVID-19 epidemic in Japan stratified by contact experience and relationship with COVID-19–infected persons by using a surrogate indicator (i.e., fever). The proportion of those who had a fever showed an increasing trend in the contact group, followed by a stable trend between April 17 and 24 (10–17 days after the declaration of the state of the emergency on April 7 among the prefectures in this study). However, the proportion of individuals with fever in the non-contact group, which corresponds to infections of the unknown transmission route, steadily increased throughout the study period. In addition, the proportion of those experiencing fever among those

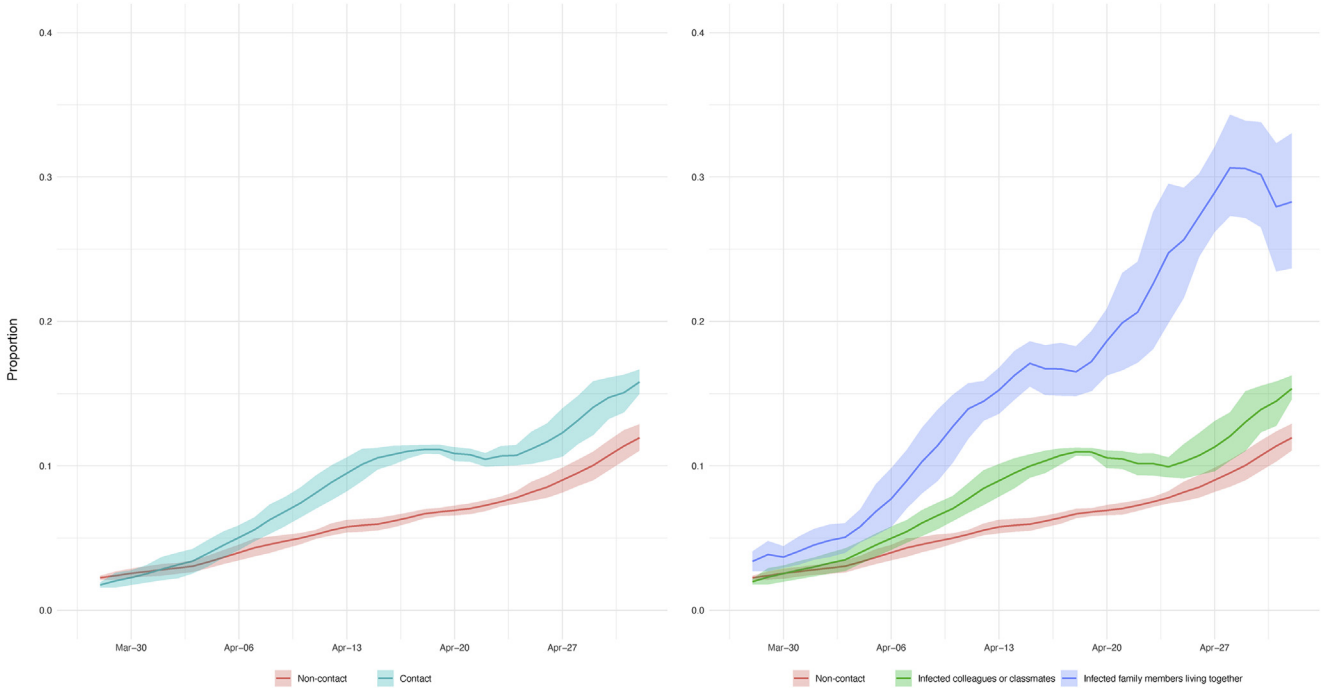

Fig. 1. Plot of the rolling 7-day window average of the proportion of participants who had a fever with bootstrap confidence intervals. The left pane is a comparison between contact/non-contact groups, and the right pane is a comparison between the relationship status of the participant with the COVID-19–infected persons. COVID-19, coronavirus disease 2019.

in the group who had contact with infected family members living together and the group who had contact with infected colleagues or classmates continually increased; the gap between these two groups was greatest at around April 27. There were no special events around April 27 that would have impacted the time trend other than the declaration of emergency that was issued on April 7. This evidence implies that the declaration may have reduced the number of contacts mainly at workplaces and classrooms, with an approximate 2-week time lag, and the epidemic was moved to the domestic transmission phase because most people were staying in their homes. This impact of the declaration was effective during the initial stage, but approximately 2 weeks after the declaration, workers staying home were exposed to the risk of the infection (measured by a fever) as the number of community-acquired infections with an unknown route of transmission started to grow.

This study has several limitations. First, fever is one symptom, although not an absolute indicator, of COVID-19 infection. Second, the number of participants who reported having contact with an infected individual and with an infected family member living in the same household was approximately 1 of 50 and 1 of 500, respectively, of the total number of participants who reported no contact with infected individuals (see Fig. S1 in the supplementary material). Therefore, it should be noted that the proportion may not be stable on some days owing to a small number of respondents. Third, the difference in available information about the symptoms of family members and those of colleagues and classmates might be a source of bias (e.g., information on family members was easy to obtain, but that of classmates and colleagues was relatively difficult to obtain). Other limitations are discussed extensively in the studies by Yoneoka[10] and Nomura.[14]

In conclusion, given that Japan has a unique and weak lockdown policy with limited legally enforceable measures, the results of this study provide a useful insight for preparing for second or third waves of COVID-19 without enforcing a strong lockdown in other countries, such as Europe, the US and low- and middle-income countries.

Author statements

Ethical approval

Ethical approval was granted by the Ethics Committee of Keio University School of Medicine, under authorisation number 20190338.

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Competing interests

H.M. reports a grant from the Ministry of Health, Labour and Welfare, Japan and K.M. reports personal fees from Janssen Pharmaceutical Companies of Johnson & Johnson, Japan outside the submitted work. All other authors declare no competing interests.

Author contributions

All authors took responsibility for the integrity of the data and the accuracy of the data analysis. All the authors made critical revisions to the manuscript for important intellectual content and gave final approval of the manuscript. The opinions, results and conclusions reported in this article are those of the authors and are independent from the funding bodies.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.puhe.2020.08.020.

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