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Good night: Experimental evidence that nighttime curfews may fuel disease dynamics by increasing contact density

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ABSTRACT

Background: Nighttime curfews have been discussed and implemented in many countries as a means of controlling the COVID-19 pandemic. However, there is evidence that such curfews have little or no effect on disease dynamics when other measures such as bans on gatherings or business and school closures are already in place. There are two possible explanations for this. First, nighttime curfews may elicit reactance—a feeling of anger that drives non-adherence; second, nighttime curfews may motivate people to shift activities from night to daytime, thereby increasing contact density.

Methods: A survey experiment was conducted with German participants ($N = 997$) to investigate public perceptions of nighttime curfews and possible detrimental effects on contact behaviors.

Results: Most participants perceived nighttime curfews as ineffective. The introduction of a hypothetical curfew did not affect intentions to reduce private contacts but instead elicited reactance, motivating participants to violate curfew hours or to shift a fictitious dinner meeting to an earlier time rather than cancelling it.

Conclusions: When people do not support nighttime curfews or do not understand the rationale behind them, introduction of this measure may fuel the spread of the disease. For that reason, nighttime curfews should be a measure of last resort and should be accompanied by a public communication campaign explaining the importance of contact reduction during both nighttime and daylight hours.

To control and eventually end the COVID-19 pandemic, transmission of the coronavirus must be stopped. Fortunately, the early evidence suggests that vaccination not only protects against infection but limits transfer of the pathogen from one individual to another (Levine-Tiefenbrun et al., 2021). However, as vaccines are scarce and most countries have only begun their rollout campaigns (Warren and Lofstedt, 2021), various interim measures are still needed to reduce social contact, including bans on gatherings and the closure of schools, non-essential shops, restaurants, and cultural venues (Haug et al., 2020). Many countries have also implemented nighttime curfews (Jones et al., 2021); for instance, recent German legislation (Infection Protection Act, 2021) requires residents in districts with 7-day incidence rates greater than 100 to remain indoors between 10pm and 5am. The rationale is that nighttime curfews can be expected to reduce private meetings, thus limiting the spread of the virus. One recent study modelling the effectiveness of different interventions reported that nighttime curfews could indeed reduce infection levels (Sharma et al., 2021). However, that reduction was small when compared to other interventions such as closing non-essential businesses or banning gatherings of more than two people. Other research confirms that finding; when other interventions have already been imposed, nighttime curfews have little or no effect on pandemic dynamics (Brauner et al., 2021; De Haas et al., 2021). There are several possible explanations for this marginal impact of nighttime curfews. In particular, because curfews restrict personal freedom, they may elicit reactance, a feeling of anger, motivating efforts to regain that freedom (Brehm, 1966; Dillard and Shen, 2005). Because of reactance, individuals could be motivated to violate regulations and meet with others during curfew hours (the boomerang effect), or they could refuse to observe other pandemic restrictions such as bans on gatherings (Miron and Brehm, 2006). Even in the absence of such reactance, nighttime curfews may prompt individuals to shift activities to an earlier time (Dimeglio et al., 2021), resulting in higher contact density during daytime hours. Additionally, time constraints may drive people to combine meetings that they do not want to cancel. Ironically, then, a curfew may fuel the spread of disease when people do not support the measure or do not understand the underlying rationale. To clarify these

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issues and to support evidence-based policy making, we conducted a survey experiment to investigate perceptions of nighttime curfews and possible detrimental effects on disease dynamics.

1. Method

1.1. Participants and design

Based on previous reactance-related research (Sprengholz et al., 2021), we assumed medium effect sizes ($f^2 = 0.20$), an error probability of .05 and a power of .80 in our regression analyses. By expecting that higher ratings of curfew effectiveness attenuate the effects of nighttime curfews on reactance and contact behavior, a required sample size of 826 was calculated, using G*Power 3.1 (Faul et al., 2009) and the correction proposed by Giner-Sorolla (2018).

The experiment was conducted on April 20–21, 2021, shortly before nighttime curfews were added to Germany's Infection Protection Act, as part of the COVID-19 Snapshot Monitoring (COSMO) cross-sectional online study series (Betsch et al., 2020a, 2020b). Participants were recruited from a non-probabilistic German sample ($N = 997$), which was quota-representative for age × gender and federal state. Participants ranged in age from 18 to 74 years ($M = 45.44$, $SD = 16.07$) and included 490 males and 507 females. Participants were randomly assigned to one of two experimental conditions: *curfew* or *no curfew*.

1.2. Procedure and materials

After collecting the relevant demographic information, we explored perceptions of COVID-19-related risk and asked monitoring questions used elsewhere (Betsch et al., 2020a, 2020b). Participants were also asked to indicate how many private contacts they had during a typical day in the last month, and how effective they believed nighttime curfews to be. After assigning participants to one of the experimental conditions, their level of reactance to the given policy (curfew/no curfew) was assessed. To estimate individual contact reduction intention, participants were asked about future private contacts. Finally, participants in the *curfew* group were asked about their intention to cancel or reschedule a fictitious dinner meeting. As participants were not allowed to skip items, there were no missing data.

1.2.1. Perceptions of risk

Perceived risk was assessed on two dimensions. To measure cognitive risk, we asked *How susceptible do you consider yourself to an infection with COVID-19?* Participants responded on a scale ranging from 1 (*not at all susceptible*) to 7 (*very susceptible*) (Brewer et al., 2007). Affective risk was assessed using three questions, again on 7-point scales (Bradley and Lang, 1994): how much they feared COVID-19, how worried they were about it, and how often they thought about it. Responses were mean-averaged (Cronbach's $\alpha = 0.82$).

1.2.2. Previous private contacts

Referring to the previous month, participants were asked *On a typical day, how many people outside your household did you have private contact with that would make infection possible?* Response options included *none, 1, 2, …, 15, more than 15, more than 20*, and *I don't know*.

1.2.3. Curfew effectiveness

Participants were asked how effective they believed curfews to be as a pandemic response tool. Their responses were again captured on a 7-point scale, ranging from *not effective at all* to *very effective*.

1.2.4. Experimental conditions

Participants in the *curfew* condition were asked to imagine that the 7-day incidence rate in their district was above 100, and that a nighttime curfew had been implemented. Participants in the *no curfew* condition were asked to imagine the same incidence rate but were told that the government had refrained from introducing a nighttime curfew.

1.2.5. Reactance

Using an adapted version of the experience of reactance subscale of the Salzburg State Reactance Scale (Sittenthaler et al., 2015), participants were asked how frustrated, annoyed, and disturbed they felt about the introduction or non-introduction of a nighttime curfew, and whether they perceived this as restricting their freedom. Each of the four items was assessed on a 7-point scale ranging from 1 (*not at all*) to 7 (*very much*), and the analyses were based on mean scores (Cronbach's $\alpha = 0.91$).

1.2.6. Projected private contacts

As in the question about previous contacts, participants were asked *On a typical day, how many people outside your household will you have private contact with that would make infection possible?* Response options again included *none, 1, 2, …, 15, more than 15, more than 20,* and *I don't know*. In the *curfew* condition, participants were also asked to imagine that they had invited a friend for dinner this weekend. They were then asked whether the dinner would go ahead as planned despite the curfew, whether it would be cancelled, or whether it would be moved to an earlier pre-curfew time.

2. Results

Only 37% of participants rated nighttime curfews as (fairly) effective pandemic response tools (options 5 to 7 on the 7-point scale), and 10% were undecided (option 4) ($M = 3.43$, $SD = 2.22$). A linear regression analysis explored whether age, gender, and cognitive or affective risk influenced perceptions of curfew effectiveness ($R^2 = 0.12$). Curfews were rated as more effective when participants were older ($\beta = 0.07$, $b = 0.01$, 95% CI = [0.001, 0.017], $f^2 = 0.004$), male ($\beta = 0.07$, $b = 0.31$, 95% CI = [0.046, 0.567], $f^2 = 0.005$), felt more susceptible ($\beta = 0.11$, $b = 0.17$, 95% CI = [0.068, 0.230], $f^2 = 0.010$) and reported more affective risk ($\beta = 0.26$, $b = 0.40$, 95% CI = [0.302, 0.505], $f^2 = 0.061$).

A further regression analysis explored the influence of curfew policies, curfew effectiveness ratings and their interaction on reactance ($R^2 = 0.18$). As shown in Fig. 1A, all three predictors were significant. Reactance depended in particular on perceived effectiveness of nighttime curfews (solid line); those who perceived curfews as less effective expressed greater anger about the policy (interaction effect: $\beta = -0.43$, $b = -0.38$, 95% CI = [-0.482, −0.273], $f^2 = 0.050$).

Most participants (364, or 37%) indicated that they would have no private contacts on a typical future day beyond household members while 21% (212) indicated that they would have one private contact, and 19% (187) said they would have two private contacts. Only 2 (6) indicated that they would have more than 15 (20) private contacts, and 15 did not know how many contacts they would have on a typical day. Individual contact reductions were calculated as the difference between estimated future and previous contacts. As no exact difference could be calculated for participants who indicated they had or would have more than 15 or 20 contacts or did not know how many contacts they had or would have (32 in total), these were excluded from the linear regression analysis investigating the effects of curfew policy, curfew effectiveness ratings, and their interaction on contact reduction. As Fig. 1B shows, no significant effects were found, indicating no difference in intention to reduce contacts between the *curfew* and *no curfew* conditions (for details, see online supplement).

When participants in the curfew condition ($n = 491$) were asked about their intentions in relation to the dinner scenario, 229 (47%) said they would cancel the dinner. A further 189 (38%) opted to move the meeting to an earlier time, and 73 (15%) indicated that the dinner would go ahead as planned despite the curfew. A multinomial logistic regression revealed that these decisions were related to reactance; people who were angry about the introduction of a nighttime curfew were less likely to cancel the dinner and instead moved it to an earlier time (OR = 1.32,

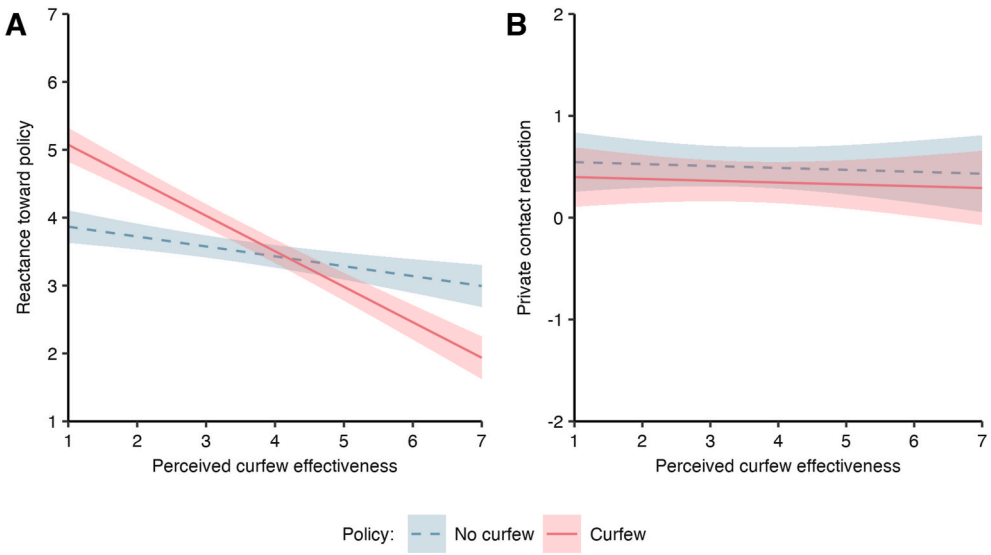

Fig. 1. Consequences of curfew policies. *Note:* When a nighttime curfew was perceived as ineffective, its introduction elicited greater reactance (A). However, introduction of a nighttime curfew had no effect on projected reduction of private contacts as compared to no curfew (B). Results from linear regression analyses; ribbons visualize 95% confidence intervals.

95% CI = [1.204, 1.452]) or ignored the curfew and went ahead as planned (OR = 1.75, 95% CI = [1.515, 2.029]).

3. Discussion

Only about a third of participants perceived nighttime curfews as an effective pandemic response measure. Overall, effect sizes indicate that psychological aspects have a stronger impact on curfew perceptions than demographic characteristics. Higher effectiveness ratings were associated with higher perceived risk of getting ill. Those who felt at risk of severe infection may have supported any measure and were therefore more likely to overestimate the effectiveness of nighttime curfews. Furthermore, younger individuals rated nighttime curfews as less effective than older people. As younger age is possibly related to more nighttime activities, this result points to a major problem of nighttime curfews: they are less accepted and likely less followed by those whose contact behavior should be affected. Interestingly, as compared to men, women tended to perceive nighttime curfews as less effective. As previous research indicates that women are also less likely to support COVID-19 vaccination mandates (Sprengholz et al., 2021), their lower ratings of curfew effectiveness may be linked to a lower general trust in freedom-restricting measures. However, future research should investigate in greater depth why women are more likely to perceive nighttime curfews as less effective.

Introducing a hypothetical nighttime curfew did not affect the intention to reduce private contacts. There are two possible reasons for this. First, the results indicate that introduction of a nighttime curfew can elicit strong reactance among those who perceive curfews as ineffective (which most of the participants did). According to previous research, individuals whose freedom has been restricted are motivated to engage in the proscribed behavior (Steindl et al., 2015); similarly, our findings indicate that individuals who exhibited strong reactance were more likely to ignore the curfew and to proceed as planned with a fictitious dinner meeting. Second, the fact that many said they would move the dinner meeting to an earlier time indicates a desire to adhere to the curfew without limiting private contacts. This suggests that nighttime curfews are not only ineffective for contact reduction but may increase contact density earlier in the day (Dimeglio et al., 2021). For a number of reasons, this increases the risk of transmission. Imagine for instance that person A wants to meet successively with persons B and C at A's home. If B is carrying the coronavirus, B will exhale infectious aerosols at A's home. Under a nighttime curfew, the interval between A's meetings with B and C is likely to shorten, thereby increasing the risk that C will contract the virus from B's aerosols. Worse, the curfew may prompt A to merge the two meetings, further increasing the infection risk for C.

While our findings point to the potentially detrimental effects of nighttime curfews, the study has some limitations. We need to highlight that no manipulation checks were used. However, while we cannot verify if every participant carefully read and imagined the respective curfew scenario, the significant effects on reactance indicate that the manipulation was working. Furthermore, the fictitious scenario and assessment of contact intention may not perfectly capture contact behavior during nighttime curfews. Although intention tends to predict behavior, there is a gap between the two (Sheeran, 2002). As individuals are likely to feign adherence to nighttime curfews for legal or social reasons, our results should be considered a conservative estimate. We further need to point out that the effects of nighttime curfews may differ depending on local disease dynamics and cultural background. While our results were drawn from a German sample quota-representative for age × gender and federal state, participants with low education and those not adhering to COVID-19 protection measures in general may be underrepresented. Furthermore, generalization to other countries with varying incidence rates and different public attitudes towards the restriction of individual freedoms could be difficult. Implementation details play a role as well. For instance, Dimeglio and colleagues (2021) estimated that the introduction of an 8 pm curfew in the Toulouse region reduced virus circulation by 38%, but a subsequent curfew starting at 6 p.m. led to opposite effects.

In summary, policy makers must be careful when considering the introduction of nighttime curfews to control the pandemic, as recent evidence suggests that such measures are of little or no benefit when others are already in place (Brauner et al., 2021; De Haas et al., 2021; Sharma et al., 2021). Our findings show that nighttime curfews are unlikely to reduce the absolute number of contacts, as many people would adhere to the rules by meeting earlier, potentially increasing contact density during the day. According to previous reactance research, mandatory regulations can also trigger other detrimental behaviors (Sprengholz et al., 2021). This means that nighttime curfews may not only be ignored but may also reduce compliance with other measures (such as mask wearing and social distancing), undermining trust in government policy and putting public health at risk. To reduce

social contacts, the available evidence suggests that policy makers should focus on other measures like closing non-essential businesses, banning gatherings of more than two people (Sharma et al., 2021), or closing schools (Brauner et al., 2021). Where these interventions prove insufficient to bring infections under control, nighttime curfews can be considered as a last resort. However, successful implementation would depend on the application of evidence-based recommendations, such as those regarding appropriate curfew hours (Dimeglio et al., 2021), and on communicating the importance and effectiveness of this contact reduction strategy to the public. Educational campaigns should especially focus on younger individuals as they seem to perceive nighttime curfews as less effective than older people while being more likely to be active during nighttime. Unless most members of the public believe in the effectiveness of nighttime curfews, introducing such regulations may do more harm than good.

Credit author statement

Philipp Sprengholz: Conceptualization, Methodology, Investigation, Formal analysis, Visualization, Writing – original draft. Regina Siegers: Conceptualization, Methodology, Formal analysis, Writing – review & editing. Laura Goldhahn: Conceptualization, Methodology, Investigation, Writing – review & editing. Sarah Eitze: Conceptualization, Methodology, Writing – review & editing. Cornelia Betsch: Conceptualization, Methodology, Writing – review & editing, Supervision, Funding acquisition.

Online supplement

Materials, data and the data analysis script can be found at https://dx.doi.org/10.17605/OSF.IO/TM62D.

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Ethical declaration

Our research obtained ethical clearance from the University of Erfurt's IRB (#20200302/20200501), and all participants provided informed consent prior to data collection.

Declaration of competing interest

None declared.

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