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Exploring teachers' risk perception, self-efficacy and disease prevention measures during the outbreak of 2019 novel coronavirus disease in Taiwan



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ABSTRACT

Background: The 2019 novel coronavirus disease pandemic (COVID-19) is one of the most serious health risks facing the global population. Teachers' responses are important in the management of the outbreak in schools. The purpose of this study is to examine teachers' risk perception, self-efficacy, response efficacy, and approach to disease prevention during the COVID-19 outbreak in Taiwan.

Methods: A descriptive, cross-sectional online survey was completed by 344 teachers across four levels of education. Pearson correlations between major variables were calculated. General linear model with a posthoc test was used to estimate the least squares means for each level of the independent variables and test the mean differences between the response scores.

Results: The teachers with a higher risk perception showed a stronger adoption of disease prevention measures, but they also showed lower self-efficacy. In addition, teachers with higher self-efficacy had higher response efficiency. Female teachers had relatively stronger adoption of disease prevention measures than their male colleagues, and age was associated with a 0.040 point increase in adoption scores. Elementary school teachers were significantly stronger in this regard than teachers at junior high schools, high schools and universities in terms of behavior scores.

Conclusions: High implementation rate of Taiwanese teachers' disease prevention measures came from their higher risk perceptions. Among them, older female teachers, especially those who teach at elementary schools, are key to implementing disease prevention measures.

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Introduction

The World Health Organization declared the outbreak of the 2019 novel coronavirus disease (COVID-19) a global health emergency on January 30, 2020 [1], bringing the pandemic to global attention. Since viruses can be transmitted among faculty, staff, and students, and also within their families and communities, schools are seen as a high-risk environment for spreading of the infectious disease [2]. Therefore, it is critical to control the disease at edu-

cational facilities. Teachers have a crucial role on the front lines of campuses since they are required to adhere to infection control measures and ensure their students exercise proper personal hygiene [3] to prevent the spread of the disease.

The public's perception of disease risk is among the factors that may influence their willingness to adopt disease prevention behaviors [4–6]. Risk perception has two components: (1) perceived personal vulnerability relative to the severity of the threat and (2) the likelihood that the threat will come to pass [6,7]. Previous studies have suggested that the success of strategies taken to control an epidemic depends largely on the public's perception of risk and its response to it [8]. Against a respiratory infectious disease, non-pharmaceutical interventions in particular are recommended, such as self-protective measures, including hand-washing, avoiding public places, and wearing masks [9–11], social distancing [12–14], and environmental disinfection and cleansing [11]. These

Abbreviations: ADPM, adoption of disease prevention measures; COVID-19, coronavirus disease 2019; CVI, content validity index; GLM, general linear model.

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prevention measures not only safeguard individuals but also those around them, and have a significant effect on epidemic control [11,15]. Taiwan's government has been striving to encourage these measures in a bid to reduce the threat of COVID-19.

The two essential components of an effective control strategy are response efficacy and self-efficacy. Response efficacy is defined as the belief that adopting a particular behavioral response will be effective in reducing the threat [6], and has been linked to behaviors that are undertaken to protect against infectious diseases [16]. Self-efficacy can be thought of as an individual's confidence in their own ability to engage in protective behaviors [17,18]. To assess the level of risk during a pandemic, the public will consider if cases have been rising or if they are under control, based on the information available to them at the time. When they are aware of the gravity of the situation, their own vulnerability and the effectiveness of the response, they will be more willing to adopt measures for their own protection.

In a bid to avoid losing control of the current pandemic, most countries have implemented school closures by extending the start date of a new semester at schools and some universities, in the hope that the education sector will have sufficient time to plan comprehensive response strategies. Although each educational institution in Taiwan has set up its own emergency response team to handle infections, each school's approach to prevention and its resources vary depending on its location and the level of education it provides. In this way, there may be variations in the perception of risk among teachers.

However, the COVID-19 pandemic is unprecedented and there remain doubts over whether the results of previous international studies about the public's perception of risk and their behavioral response can be directly applied as a reference for disease control. Nevertheless, Taiwan's epidemic prevention measures have performed relatively well at this time, leading to hopes that the country can substantially lower the threat of COVID-19 infections in the community to a minimum. Through this study, we set out to understand the correlation between teachers' perception of risk and their behavioral response toward this outbreak in Taiwan. This study also aims to understand how teachers have adapted to the situation. Its main research hypotheses are:

H1. Adoption of disease prevention measures (ADPM) in terms of risk perception, self-efficacy, and response efficacy depend on an individual's personal characteristics.

H2. Teachers' risk perceptions, self-efficacy, and response efficacy can be associated with personal ADPM.

H3. The educational level of schools and their location influence personal ADPM during the COVID-19 outbreak.

The success of epidemic prevention depends on ADPM implementation. H1 aims to analyze the type of personal characteristics of the first-line antiepidemic personnel with better ADPM; these individuals can be assigned as seed teachers to lead the team to improve their effectiveness in preventing the epidemic. Additionally, H2 aims to identify the key factors (e.g., risk perception, self-efficacy, or response efficacy) that can prove that teachers have better ADPM, serving as a reference point for subsequent intervention. Finally, H3 aims to investigate the level of schools and their location, with teachers with poor ADPM, to assist the government or relevant agencies in strengthening their advocacy.

Materials and methods

Participants

The target population included full-time school teachers working at universities (colleges and junior colleges), high schools

Table 1
Participants' demographic characteristics (n = 344).

Mean age		44.4 (±9.08)	Range 24–70 years
Categorical variables		Number	Percentage
Gender	Female	249	72.4%
	Male	95	27.6%
Area	Northern area (Taipei, New Taipei, Taoyuan, Hsinchu)	63	18.3%
	Central area (Taichung, Miaoli, Changhua, Nantou, Hualien)	73	21.2%
	Southern area (Tainan, Kaohsiung, Pingtung)	208	60.5%
Level of school	Elementary school	110	32.0%
	Junior high school	46	13.4%
	High (vocational) school	56	16.3%
	University (college)	132	38.4%

(including vocational schools), junior high schools, and elementary schools. Teachers in kindergartens and cram schools were excluded from this study due to the informal nature of these institutions. Sample size was estimated using the G-Power 3.1.0 (www.psychologie.hhu.de/arbeitsgruppen/allgemeine-psychologie-und-arbeitspsychologie/gpower.html) online program. A priori power analysis for multiple regression with eight predictors using an effect size of 0.10, power of 0.80, and $\alpha = 0.05$ yielded a minimum sample size of $n = 159$ [19,20]. In total, 368 responses were retrieved during a 3-week period. After excluding 24 invalid responses, 344 valid responses were analyzed with a response rate of 93.5%. The demographic information of all the participants was recorded according to age, gender, regions of Taiwan (north, central and south), and educational level of their schools. The respondents' demographic characteristics are presented in Table 1.

Study design and instruments

This descriptive, cross-sectional study took place from April 28 to May 17, 2020. A questionnaire was designed with items developed based on a review of the literature. The questionnaire in this study was presented in an electronic version and was conducted online. The self-reported questionnaire included 35 items in five variables to measure risk perception (6 items), self-efficacy (4 items), response efficacy (5 items), the adoption of personal disease prevention measures (15 items), and demographic data (5 items). The variables of risk perception, self-efficacy and response efficacy were rated on a scale of 1 (strongly disagree) to 5 (strongly agree). Participants were asked to identify their risk of becoming infected. Finally, respondents were asked to rate their self-efficacy and response efficacy toward a set of behavioral measures that might be considered adequate to mitigate threat. Although the respondents' ADPM formed a dichotomous scale, we scored this by adding the number of items wherein participants answered "yes" out of a total of 15 items. The higher the score, the more measures a participant had taken.

Participants were expected to complete the questionnaire within 10 min. The questionnaire was reviewed and evaluated by three experts [21], including the director of an emergency department, a university vice-president, and an elementary school nurse. The psychometric properties of the questionnaires were acceptable, with an item-level content validity index (CVI) of 0.98 and scale-level CVI of 0.93. Cronbach's alpha ranged from 0.73–0.81 and the KR20 coefficient was 0.59 (95% CI, 0.26–0.99).

Table 2
Pearson correlations between risk perception, self-efficacy, response efficacy, and ADPM (n = 344).

Items	Mean (SD)	1	2	3	4
1 Risk perception	3.2 (0.63)	–			
2 Self-efficacy	3.9 (0.66)	–0.241*	–		
3 Response efficacy	4.3 (0.50)	–0.076	0.506*	–	
4 ADPM	8.5 (2.45)	0.182*	0.037	0.094	–

ADPM = adoption of disease prevention measures.

* p < 0.01.

Data analysis

Data were coded and analyzed using the 23.0 Statistical Package for the Social Sciences (SPSS Inc., Chicago, IL, USA) and the significance level was set at $\alpha < 0.05$. Descriptive statistics were used for all of the study variables. The frequencies and percentages for categorical variables, and the mean and standard error for continuous variables were calculated. Correlations between major variables were also calculated. General linear model (GLM) with posthoc test [22] was used in estimating the least squares means for each level of the independent variables and to test the mean differences of the response scores.

Results

Description of the participants

Table 1 presents the demographic characteristics of the 344 participants. The average age of the participants was 44.4 ± 9.08 years (range 24–70 years). 249 (72.4%) were females. The majority of the teachers (208, 60.5%) came from southern Taiwan. Furthermore, 110 teachers (32.0%) worked at elementary schools, 46 (13.4%) at junior high schools, 56 (16.3%) at high or vocational schools, and 132 (38.4%) at universities, including colleges and junior colleges.

Correlation between risk perception, self-efficacy, response efficacy and ADPM

Table 2 presents the bivariate correlation coefficients between risk perception, self-efficacy, response efficacy, and ADPM among teachers in the study. The magnitude of the correlations ranged from 0.037 to 0.506. Pearson correlations between risk perception, self-efficacy, and ADPM were -0.241 ($p < 0.001$) and 0.182 ($p = 0.001$), respectively. They showed that the higher a participant's risk perception, the higher their ADPM, but the lower their self-efficacy. In addition, Pearson correlation between self-efficacy

and response efficacy was 0.506 ($p < 0.001$). This means that the higher the participant's self-efficacy, the higher their response efficacy.

Teachers' disease prevention measures

As far as personal preventions were concerned, the behavior of teachers included 4 items in daily life and 11 items during class. In terms of daily life, the rate of frequent hand washing and measuring body temperature daily was very high, reaching 99.4% (342/344) and 94.5% (325/344), respectively. The other two items (using hand sanitizer and disinfecting the workplace daily) also achieved implementation rates of 77.3% (266/344) and 73.5% (253/344), respectively. It can be seen that teachers in Taiwan attached great importance to their own disease prevention activities in daily life. In terms of preventions during class, it was found that 93% (320/344), 91% (313/344), and 85.2% (293/344) of teachers would open windows, wear masks, and require their students to do so too, which together accounted for the top three behaviors. In addition, 53.2% (184/344) would use a personal microphone and 41.0% (141/344) would use disinfectant to wipe down doorknobs.

Teachers' prevention measures at all levels of education

We also observed a variety of different prevention measures taken by teachers at different levels of education (Table 3). We found that among the four measures used in daily life, the implementation rate among teachers at all levels of education was good, and it was difficult to determine which were stronger or weaker. The overall implementation rate was between 62% and 100%. In terms of preventions during class, we found that in addition to using personal microphones and wearing masks, elementary school teachers had the highest implementation rate of 8 out of 10 different prevention measures. It can be seen that the measures adopted by elementary school teachers during class were stronger than those taken by teachers at other levels of education. This may be due to the young age of the students in their charge, and need more measurements to prevent them from getting infected.

Factors associated with ADPM

Using GLM analysis to test the relationship between various factors (age, gender, area, levels of school) and prevention measures (Table 4), we found a relationship between age, gender, and level of institution in terms of prevention adopted. Male teachers scored 0.586 points lower than their female colleagues (95% CI $-1.137 \sim -0.036$, $p = 0.007$), while age was associated with a

Table 3
Teachers' ADPM at different levels of education (n = 344).

ADPM	Elementary school (%)	Junior high school (%)	High school (%)	University (%)
Implementation rateNumbers	(n = 110)	(n = 46)	(n = 56)	(n = 132)
Taking temperature at least once a day	95.45	97.83	94.64	99.42
Washing hands correctly and frequently	99.09	100	100	99.24
Bringing hand sanitizer liquid to wash hands	75.45	69.57	85.71	78.03
Using disinfectant to clean workplace every day	85.45	76.09	75.00	62.12
Social distancing among students in class	39.09	32.61	23.21	37.12
Opening windows	97.27	95.65	94.64	87.88
Using disinfectant to clean platforms before and after class	48.18	32.61	37.50	37.88
Using disinfectant to clean desks/chairs before and after class	57.27	28.26	35.71	25.00
Asking students to wear masks	90.00	80.43	71.43	88.64
Using a personal microphones	40.00	67.39	71.43	51.52
Wearing masks	90.91	89.13	94.64	90.15
Using disinfectant to clean doorknobs after class	68.18	32.61	39.29	21.97
Separating students at intervals	30.91	17.39	16.07	24.24
Installing dividers in class	5.45	2.17	1.79	3.79

Table 4
Parameters to estimate ADPM by the analysis of generalized linear model.

Parameters	β	SE	95% CI		Wald χ^2	P-value
(Intercept)	1.765	1.5754	-1.323	4.853	1.255	0.263
Male	-0.586	0.2809	-1.137	-0.036	4.355	0.007
Female	ρ_a					
North area	-0.121	0.3463	-0.800	0.557	0.123	0.726
Center area	0.590	0.3368	-0.070	1.251	3.072	0.080
South area	ρ_a					
University (college)	-1.199	0.3221	-1.830	-0.568	13.853	0.000
High (Vocational) school	-0.809	0.3806	-1.555	-0.063	4.520	0.034
Junior high school	-1.073	0.4126	-1.881	-0.264	6.763	0.009
Elementary school	ρ_a					
Age	0.040	0.0150	0.011	0.070	7.213	0.007
Risk perception	0.133	0.0339	0.067	0.200	15.455	0.000
Self-efficacy	0.054	0.0562	-0.056	0.164	0.928	0.335
Response efficacy	0.110	0.0576	-0.003	0.223	3.639	0.056
(Scale)	5.208 ^b	0.3971	4.485	6.048		

Dependent variable: **ADPM** a: Set to zero because this parameter is redundant. b: Approximate value.

Table 5
Comparison of ADPM, risk perception, self-efficacy, and response efficacy at different types of institution.

School level elements	Elementary school (E)	Junior high school (J)	High school (H)	University (U)	Wald χ^2	Posthoc test
ADPM	9.18 \pm 0.24	8.10 \pm 0.35	8.37 \pm 0.31	7.98 \pm 0.25	15.84*	E > J; E > H; E > U
Risk perception	19.48 \pm 0.38	20.27 \pm 0.55	19.50 \pm 0.49	19.58 \pm 0.39	1.68	
Self-efficacy	15.20 \pm 0.23	15.33 \pm 0.34	15.71 \pm 0.30	15.85 \pm 0.24	5.16	
Response efficacy	20.94 \pm 0.23	21.92 \pm 0.33	21.02 \pm 0.29	21.35 \pm 0.23	7.33	

Mean \pm SEM.

* $p < 0.001$.

0.040-point increase (95% CI 0.011~0.070, $p = 0.007$). Moreover, university, high (vocational) school, and junior high school teachers scored 1.199 ($p < 0.001$), 0.809 ($p = 0.034$), and 1.073 ($p = 0.009$) points lower on preventions than elementary school teachers, respectively. However, teachers in different areas of Taiwan showed no significant difference in their approach to ADPM.

Comparison of ADPM, risk perception, self-efficacy, and response efficacy at different types of institution

In response to the preventions taken by teachers at different institution types, we conducted a posthoc analysis to distinguish the differences between these. The results showed that elementary school teachers took significantly greater preventions than teachers at junior high school, high school, and university, in terms of behavior scores (Wald $\chi^2 = 15.84$; $p < 0.001$) (Table 5). However, there was no statistical difference in risk perception, self-efficacy, and response efficacy among teachers at different types of institution.

Influence of age on ADPM, risk perception, self-efficacy and response efficacy

We found age to be associated with an increase in the prevention measures (Table 4). We further observed the effect of age on risk perception, self-efficacy and response efficacy, which revealed that age was associated with a 0.055 ($p = 0.018$) and 0.028 ($p = 0.055$) point decrease in the scores for risk perception and self-efficacy, respectively (Table 6). However, there was no statistical difference in the teachers' response efficacy according to age.

Comparing ADPM, risk perception, self-efficacy and response efficacy between genders

The data showed that women had a more thorough approach to taking disease prevention measures than men ($p = 0.037$) (Table 4)

and we further observed the influence of gender on risk perception, self-efficacy and response efficacy. The results showed that there was no statistical difference between gender in risk perception, self-efficacy, and response efficacy (data not shown).

Discussion

This is the first empirical study on the disease prevention measures taken by teachers and it provided clear evidence of the epidemic prevention situation in Taiwan about 4 months after the COVID-19 outbreak began. It found that age affected the measures adopted and perception of risk: The older the participants, the more precautions they will take. This is consistent with previous studies [16,23,24]. In contrast, older teachers' risk perception and self-efficacy were relatively low (Table 6). Moreover, the implementation rate of prevention measures by female teachers was significantly higher than that of male teachers (Table 4). However, there was no gender difference in risk perception, self-efficacy and response efficacy. This indicates partial support for Hypothesis 1. This study found that when adopting a strategy to control the prevalence of COVID-19, the precautions taken by women were higher than those by men. Possible reasons for this include a higher rate of compliance among women with national and school policies [16,23–25] and a greater concern among women for the safety of their working environment than among men [26,27]. In view of the shortcomings of male teachers in epidemic prevention work, some targeted measures or publicity should be initiated by the government or relevant agencies. When implementing epidemic prevention measures, the male perspective should be considered, emphasizing and advocating the responsibility and importance of men in the epidemic prevention work. For example, to prompt male teachers to engage in preventive behaviors, we need to make them concerned about the health status of a member in their household. In other words, even if disease transmission is slightly possible, men may still engage in preventive behaviors if the perceived severity or risk of poor health outcomes is high for themselves

Table 6
The influence of age on ADPM, risk perception, self-efficacy and response efficacy.

Elements	β	SE	95% CI	Wald χ^2	P-value
ADPM	0.040	0.0150	0.011 ~ 0.070	7.213	0.007
Risk perception	-0.055	0.0234	-0.101 ~ -0.009	5.588	0.018
Self-efficacy	-0.028	0.0144	-0.056 ~ 0.001	3.673	0.055
Response efficacy	-0.009	0.0141	-0.037 ~ 0.018	0.444	0.505

or a family member who has contracted the disease. Meanwhile, male teachers who actively participated in this survey were few (27.6%), indicating gender-unequal participation. Considering the poor performance of men's epidemic prevention behaviors, a study consisting of a larger sample size is required to further assess the correlation between men's risk perception and epidemic prevention behaviors.

We also corroborated the relevant results of Hypothesis 2. In this study, the adoption of prevention measures was significantly positively correlated with risk perception (Table 2). This result was consistent with previous studies [25,28]. During the COVID-19 pandemic, risk perception has encouraged teachers to take stronger safety precautions. We suggest that the government announces clear and accurate information via media and social media and provides sufficient resources to encourage greater risk perception among the public so they can protect themselves effectively. Furthermore, even though teachers' self-efficacy in epidemic control was positively correlated with response efficacy, these were not related to precautionary behavior. This is not consistent with previous research [25]. Neither self-efficacy nor response efficacy in this study can affect precautionary behavior. Until effective COVID-19 epidemic prevention guidelines are established, it is not easy to directly translate the self-efficacy and response efficacy into behavior.

Finally, we verified the results of Hypothesis 3, and these shown that the precautions taken by elementary school teachers were obviously better than that at other levels of education (Table 5). A possible reason for this is that the immune system of elementary school students is not as mature as that of high school and university students, and their hygiene habits are also poorer than those of older students. In addition, there are more opportunities for close contact between elementary school students (such as playing games). As a result, elementary school students are more susceptible to epidemic diseases than other high school and college students [29]; therefore, elementary school teachers must adopt more thorough precautions to avoid infection and reduce the chance of spreading the virus in the environment in a bid to protect school children [30]. Disease prevention measures adopted by teachers in this study included opening windows in class, wearing masks and requiring their students to wear masks, bringing their own microphones, and cleaning desks, chairs and doorknobs in the classroom with disinfectant. In addition, teachers have always been regarded as important figures for children to imitate [31]. Therefore, teachers can lead by example, and by taking rigorous measures, they can be held up as role models for students so that campus prevention strategies can be thoroughly implemented. The disease prevention measures adopted did not differ significantly between regions (Table 4). One of the possible reasons for this is that a majority (60.5%) of the participants were from the southern region of Taiwan in this study. However, the number of people infected with COVID-19 in the southern area has been less than that in the north, so it was difficult to determine the statistical differences that could be used to predict risk perception, self-efficacy, and response efficacy. Given that the number of confirmed COVID-19 cases in Taiwan has been low, the cumulative total number of cases confirmed at the end of the study was only 440, of which 386

were imported cases; in addition, most of them were adults with business contacts [32]. Therefore, the number of student cases was insufficient to perform a correlation analysis between the diagnosis status of students at all school levels and the degree of implementation of epidemic prevention. In the future, the correlation between the epidemic prevention rate of schools at all levels and the spread of COVID-19 must be continuously observed.

As shown in Table 3, some of the percentages of teachers implementing ADPMs were quite low. For example, only 16% of high school teachers separated their students. This phenomenon may be related to the current teacher-student ratio in the classroom and the standard of classroom space. According to the regulations of the Ministry of Education in Taiwan [33,34], the number of students in each class in the elementary and junior high schools is 29–30, whereas that in high school can reach 40. However, the classroom space prescribed by schools at all levels in Taiwan is roughly the same. Therefore, this finding may be one of the reasons for the low implementation rate (16.07%) of “separation of classes” by high school teachers. Although the number of students per class in junior high and elementary schools is similar, the implementation rate of junior high school teachers (17.39%) in separating the students is clearly lower than that of elementary schools (30.91%), even close to high schools (16.07%). This finding may be explained by the fact that junior high school students are at the beginning stage of puberty, and their physique is significantly larger than that of elementary school students. Consequently, the arrangement of classroom space in junior high school is more limited than in elementary school. Moreover, in the initial stage of the implementation of epidemic prevention measures, most of the advocacies focused on wearing masks and washing hands frequently. The promotion of maintaining social distance only started in the second stage. The research was conducted in a phase between the end of the first stage and the beginning of the second stage. Most people were still beginning to establish the concept of maintaining social distance. Therefore, the implementation rate of keeping distance between students was generally considerably lower than other items, such as mask wearing or body temperature measurement.

This study has some limitations. First, as the epidemic developed rapidly, the government's policies were updated accordingly. These were likely to change the participants' response to disease prevention, so this study can only show the situation of the COVID-19 epidemic in Taiwan about 4–5 months after it first emerged. Whether the different timelines at the beginning of the outbreak or during the stable control period show the same results still need to be clarified by subsequent research and analysis of different epidemic prevention stages. Second, there have been differences in the severity of the epidemic situation in different regions of Taiwan, and also the public's approach to adopting disease prevention measures, so that self-efficacy and risk perceptions should also be different [35–37]. However, the number of participants in this study was significantly higher in the southern region; therefore, no regional differences affecting teachers' ADPM was observed in this study. Whether the smaller number of participants in the north affected the results between regions still needs to be clarified by recruiting more evenly distributed participants to join the study.

Conclusion

This study explored the behavior of frontline teachers in Taiwan during the COVID-19 outbreak. It was found that risk perception was positively related to teachers' ADPM. Teachers in Taiwan have been very efficient in implementing their own prevention strategies, especially elementary school teachers. In addition, older female teachers have shown relatively higher prevention behaviors. Our results can be used as a reference for enhancing the faculty's awareness and motivation of emerging infectious diseases or related disasters, as a way to promote epidemic prevention education in the future.

Funding

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Ethical approval

The institutional review board of National Cheng Kung University Hospital approved this study (No. A-ER-109-087). All the participants provided online informed consent before answering the questionnaire. If a participant chose not to provide their consent, no questions were presented.

Conflicts of interest

The authors declare no conflict of interest. The founding sponsors had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, and in the decision to publish the results.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:<https://doi.org/10.1016/j.jiph.2020.12.021>.

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