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**The Role of Behavioural Immune System and Belief in
COVID-19 Misinformation on COVID-19 Protective
Behaviours in Indonesia**

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Abstract:	This study (N=1306) investigated the role behavioural immune system and specific beliefs in COVID-19 misinformation in predicting COVID-19 protective behaviours. By analysing the data from an online survey, we found that germ avoidance significantly predicted social distancing and was negatively correlated to transportation use. Belief in conspiracy theories and non-psychological cures and prevention methods were negatively associated to social distancing, while the latter also predicted lower preventive commodities purchasing. These findings suggested that germ aversion should be incorporated in the promotion of COVID-19 prevention behaviours and that any misinformation related to COVID-19 should be minimised to improve people's protective behaviours.

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Introduction

As of February 25th 2021, SARS-CoV-2 has infected more than 1.3 million people and caused more than 35 thousand COVID-19-related deaths since the first COVID-19 case in Indonesia on March 2nd 2020 (Satuan Tugas Penanganan COVID-19, 2021). The pandemic has placed Indonesia as the country with the highest number of infected people, confirmed deaths, and fatality rate in Southeast Asia (Roser et al., 2020).

With the level of infection accelerating, as well as new regulations taking place, various behaviours deemed to be protective against the pandemic were observed in Indonesia, which include psychological and non-psychological preventive measures. Throughout the pandemic, the government indeed pushed the idea that negative thoughts were important predictors of one's immunity towards COVID-19 (Hasibuan, 2020; Utami, 2020) and that prayer and faith were essential to prevent COVID-19 infection (Detik, 2020; Satuan Tugas Penanganan COVID-19, 2020). The statement tended to misled people and trigger the emergence of misinformation related to psychological prevention in Indonesia (Hidayatullah, 2020; Satuan Tugas Penanganan COVID-19, 2020; Wicaksono, 2020). As a country with abundant medical plants and extensive use of traditional medicines (Elfahmi et al., 2014), Indonesia has also been experiencing the increase use of herbal medicine to prevent and cure COVID-19 (Abrori, 2020; Djalante et al., 2020). To avert COVID-19 infection, people, for instance, consume ginger and curcuma (Amir, 2020), gargle with warm lemon water (Asrianti, 2020), and sunbathe in the morning (Djalante et al., 2020). Other emerging behaviours of non-psychological COVID-19 prevention were impulsive and massive purchase of protective commodities, such as disposable masks and hand sanitizers, particularly at the beginning of the pandemic period (Nurrachmi et al., 2021) as well as the avoidance of activities involving people's gathering, such as the use of public transportation use (Ariyani et al., 2020) and public places (Nurhayati-Wolff, 2021; Syawaluddin, 2020), and shopping in market centres (Ipsos, 2021).

In this study, we propose the two factors that might be related to the emergence of COVID-19 protective behaviours within the Indonesian context: behavioural immune system (BIS) and belief in COVID-19 misinformation. BIS is the motivational system that drives the behavioural, affective, and cognitive mechanism which serves an organism by making them avoid pathogens (Ackerman et al., 2018; Schaller et al., 2015). The BIS proposes two components predicting pathogen avoidance behaviours, the first being germ aversion and the other is perceived infectability (Duncan et al., 2009). Germ aversion (GA) is one's feeling of discomfort in situations where there is a risk of infection. Perceived infectability (PI) is one's belief in their own vulnerability to infection. There have been several findings that showed BIS predicts the protective behaviours during the COVID-19 pandemic (Makhanova and Shepherd, 2020; Shook et al., 2020). PI and GA have also predicted different COVID-19 prevention behaviours (*ibid*). However, these research findings came from different regions with different histories of infectious diseases and immediate pathogen threats from Indonesia. The country is one of the worst hit in the region. Only within a month from the first case, Indonesia held the highest mortality rate in Asia (Wahyuni, 2020). As differences in the history of infectious diseases (Murray and Schaller, 2010) and immediate pathogen threats may contribute in the formation of norms, social behaviours, and health behaviours that differ across regions (Hamamura and Park, 2010; Schaller, 2011; Schaller et al., 2015), we are inclined to

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3 explore the specific role of GA and PI in relation to different COVID-19 protective behaviours in
4 Indonesia, where the pathogen threat is highly salient.

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6 The second factor that might be related to COVID-19 protective behaviours is misinformation.
7 Misinformation, whether in the form of conspiracy theories, hoaxes, or snake oils, has run rampant, even
8 in the early days of the COVID-19 crisis. A descriptive study conducted by Islam, et al. (2020) found at
9 least 2,311 unique pieces of misinformation regarding COVID-19, circulating in various platforms, in 25
10 languages, and 87 countries from December 2019 to April 2020. This study categorized COVID-19
11 misinformation into several topics: the origins of the disease and COVID-19 infections, cure, prevention,
12 control rumours, conspiracy theories, and stigma regarding COVID-19. Similarly, a survey conducted
13 throughout April 2020 in Indonesia using questions based on WHO's COVID-19 misinformation
14 classification found that misinformed beliefs might have already caught on in the country (Nasir et al.,
15 2020). The study found that a portion of the participants are misinformed, for example, on basic facts such
16 as believing that Indonesia's climate is uninhabitable for the virus (13.2%) or that using soap is
17 unnecessary when washing hands, as water is enough to protect oneself against the virus (24.9%). These
18 descriptive studies indicate the speed and variety of the spread of COVID-19 related misinformation.

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20 Belief in COVID-19 related misinformation is also known to predict the occurrence of various
21 protective behaviours, such as hand washing, physical distancing, and staying at home. Studies have
22 shown this correlation is present in Bangladesh (Barua et al., 2020), the UK (Allington et al., 2020),
23 Croatia (Erceg et al., 2020), and the US (Earnshaw et al., 2020; Romer and Jamieson, 2020). There is also
24 a significant increase in searching and purchasing behaviours following misinformation regarding
25 unproven treatments advocated by Donald Trump (Niburski and Niburski, 2020). However, some studies
26 found inconsistencies in the relationships between misinformation and conspiracy beliefs and COVID-19
27 protective behaviours. A German study found that political COVID-19 misinformation only predicts
28 physical distancing, but not hygiene behaviours (Pummerer et al., 2020). Imhoff and Lamberty (2020)
29 found that believing COVID-19 to be a hoax decreased preventive behaviours, while believing the disease
30 to be engineered increased prepping behaviours. Other studies have shown the correlation between belief
31 in misinformation and conspiracy regarding COVID-19 and preventive behaviours to be weak,
32 inconsistent, or indirect (Alper et al., 2020; Díaz and Cova, 2020; Hornik et al., 2021).

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34 These inconsistencies may have occurred due to differences in the measurement of misinformation
35 beliefs (Hornik et al., 2021). Some studies do not differentiate between the topics and combine various
36 misinformation together to form a single misinformation scale. Others structure belief in COVID-19
37 misinformation as several distinct and specific beliefs (Erceg et al., 2020; Imhoff and Lamberty, 2020).
38 Due to this inconsistency, as well as the lack of research on the topic of COVID-19 misinformation in
39 Indonesia, this study defines COVID-19 misinformation beliefs as beliefs towards specific and distinct
40 misinformation. We also assessed the relationship between the misinformation beliefs and COVID-19
41 prevention-related behaviours other than behaviours commonly suggested in prevention protocols.

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43 The current research assessed both the BIS and COVID-19 misinformation as predictors of
44 preventive behaviours. Research by Díaz and Cova (2020) already found that pathogen disgust, a variable
45 similar to germ avoidance factor in BIS, is predictive of compliance with COVID-19 health protocols,
46 while pseudoscientific and conspiracist beliefs are not. We also compare perceived vulnerability to
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3 disease, a measure derived from the BIS framework, as well as belief in various COVID-19 related
4 misinformation. Our study will improve upon Díaz and Cova's (2020) in two ways. First, we will utilize
5 the full BIS framework, and include both germ aversion and perceived infectability. Second, we will
6 investigate misinformation from the ground up and in a more direct manner. Rather than using a general
7 measure of conspiracist and pseudoscientific belief, **we will generate and validate a measure of COVID-**
8 **19 related misinformation based on actual misinformation that are spread during the pandemic in**
9 **Indonesia.** Our study aims to compare both variables, as well as their distinct components, in terms of how
10 they predict specific COVID-19 protective behaviours. In addition, we also want to explore the differences
11 between genders in all variables as there is evidence of difference on GA & PI level, belief in
12 misinformation and COVID-19 protective behaviours between genders (Makhanova and Shepherd, 2020;
13 Roozenbeek et al., 2020; van Rooij et al., 2020) in other countries. This is also needed in order to inform
14 public health interventions to reduce the cost of COVID-19 protective behaviours while optimizing the
15 benefits in an Indonesian sample.

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17 As the study focuses on a novel subject, and since we do not have an established scale in the case
18 of COVID-19 protective behaviour and misinformation, the current study is strictly exploratory. Thus, we
19 do not predict specific hypotheses regarding the direction and magnitude of the main variables, namely
20 BIS and belief in misinformation. Based on the above review, we formulated the following research
21 questions:

- 22 1. **Is the BIS related to COVID-19 protective behaviours?**
- 23 2. **Does believing in COVID-19 misinformation have significant association to COVID-19 protective**
24 **behaviours?**

35 36 **Methods**

37 ***Participants***

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39 We conducted two pilot studies and one main study for our main analysis. All phases of our study
40 combined convenience and quota sampling methods to recruit participants (Coolican, 2014). Our
41 exclusion criteria were as follows: non-Indonesian nationals, below 18 years of age, not active social
42 media users, people with COVID-19 infection history or suspects, being a medical worker, and pregnant
43 women. Pregnancy (Murray and Schaller, 2016), infection history, and proximity to disease as a medical
44 worker are used as exclusion criteria to prevent bias from having a more activated BIS. Workers and
45 people who have infection history likely perceive themselves as having been exposed to pathogens and
46 have received extended and authoritative information on COVID-19. Prior to data collection we planned
47 for at least 900 participants to be included in the main study, which would at least detect a small effect
48 size of $f^2 = 0.02$, with a power of .95 in a multiple regression, as calculated using Gpower (Faul et al.,
49 2009). Sampling quota was proportional with the population for each region in the Greater Jakarta Area
50 (Jakarta, Bogor city/district, Depok city, Tangerang city/district, and Bekasi city/district).

Study Measures

Demographics

Demographic characteristics included living area, the main activities over the past week, type of job, social media usage. For this study, we also asked age, sex, educational level and background and history of COVID-19 related training for control variables.

Behavioural Immune System (BIS)

The Perceived Vulnerability to Diseases (PVD) scale (Duncan et al., 2009) was used to measure latent variables related to the BIS. We used a version of the scale that was translated to Bahasa Indonesia (Hudiyana, Prawira, Kartika, Mahendra & Putra, under review), and confirmed the two factors of the original scale, **germ aversion (GA, McDonald's $\omega = .69$, Chronbach's $\alpha = .69$)** and **perceived infectability (PI, McDonald's $\omega = .85$, Chronbach's $\alpha = .85$)**, using confirmatory factor analysis (Rosseel, 2012). The scale uses a 4-point Likert scale (1 = Completely disagree, 4 = Completely agree). Measures for COVID-19 misinformation beliefs and protective behaviours were constructed via a series of pilot studies (Appendix 1 and Appendix 2).

Belief in COVID-19 Misinformation

The scale measuring COVID-19 misinformation beliefs was roughly based on the Generic Conspiracist Beliefs Scale (Brotherton et al., 2013), as its items consists of broader, more general beliefs that represent specific misinformation found in our pilot studies. Participants rate their beliefs on each of the statements (1 = Do not believe at all, 4 = Absolutely believe). Exploratory factor analysis found three factors: non-psychological cure and prevention (**McDonald's $\omega = .86$, Chronbach's $\alpha = .85$**), **conspiracy theories (McDonald's $\omega = .87$, Chronbach's $\alpha = .87$)**, and **psychological prevention and cure (McDonald's $\omega = .78$, Chronbach's $\alpha = .77$)**.

COVID-19 Protective Behaviours

We measured COVID-19 protective behaviours by asking participants of their history in engaging with certain COVID-19 related behaviours (1 = Never, 4 = Always). Factors found via exploratory factor analysis were purchase of prevention commodities (**McDonald's $\omega = .82$, Chronbach's $\alpha = .82$**), transportation use, and social distancing. No reliability estimate could be obtained for transportation use and social distancing due to low number of items. Detailed results of the psychometric assessment of the measures, which was conducted using JASP (JASP Team, 2019), can be found in Appendix 3.

Procedure

Data collection for our main study started from the 3rd to the of August 2020 to 26th August 2020. Our online survey was hosted on Typeform and distributed via social media (Facebook, Twitter, Instagram, and WhatsApp). Participants were asked for their consent on the first page, where if they agreed to participate in the study, they would be taken to the main survey questions. They then responded to a series of measures for perceived vulnerability to disease, beliefs regarding COVID-19 misinformation, COVID-19 protective behaviours, and demographic questions.

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Data was anonymized and any personal contact information used to randomize reward raffles was separated from the main data. We did not collect IP Addresses, and used Typeform to mask IPs as a set of codes as identifiers. On the final page, participants were given links to COVID-19 information centres to prevent adverse effects due to the exposure to fake news (<https://kawalcovid19.id/>, <https://www.who.int/indonesia/news/novel-coronavirus/>, <https://turnbackhoax.id/>). We held a raffle offering Rp 50.000 Go-Pay/OVO credits for 50 randomly selected participants as rewards. A total of 1,683 people responded, but only 1306 passed our exclusion criteria. Data were also truncated to clean outliers using the Grubbs test with .99 confidence level in STATA (Couderc, 2007). The study was approved Atma Jaya Catholic University of Indonesia Institute of Research and Community Service (ref number 627A/III/LPPM.PM.10.05/05/2020).

Statistical analysis

Descriptive statistics were performed for preliminary analysis (see Appendix 5). Our descriptive statistics of dependent, independent, and control variables with mean differences and t-statistic is divided for male and female, as previous studies show that BIS (De Coninck et al., 2020; Duncan et al., 2009; Makhanova and Shepherd, 2020) and belief in COVID-19 misinformation (Roozenbeek et al., 2020) for men and women are significantly different (see Appendix 4).

A hierarchical regression analysis (HRA) was applied to test main hypothesis. The HRA is performed to predict the role of BIS and belief in misinformation on COVID-19 protective behaviours and to explore whether the inclusion of belief in misinformation may predict the significances, magnitudes, and signs of BIS' coefficients. As seen in Table 2, the HRA resulted in three-step regressions for each dependent variable: 1) a regression including only control variables, 2) a regression estimating control variables and BIS, and 3) a regression incorporating control variables, BIS, and belief in misinformation. Adding in BIS in the second step and misinformation in the third step significantly improved the models, except in the model predicting purchase of protective commodities (See Table 2). The third model predicting the purchase of protective commodities was collectively significant ($F(11, 1288) = 2.39, p < .01, R^2 = .02$), and so was the model predicting the use of public transportation and **app-based ridesharing services** ($F(11, 1288) = 5.63, p < .01, R^2 = .04$) and social distancing ($F(11, 1288) = 14.29, p < .01, R^2 = .11$).

Data sharing statement

The de-identified data set from the main study that consists of all variables used in the analyses, the JASP file containing psychometric analyses STATA do file and log file is available in OSF (<https://osf.io/mkg4q/>). They will be uploaded to the journal's Figshare repository upon publication.

Results

Descriptive statistics

Among 1306 study participants, more than one-third of our respondents reside in Jakarta (37%). The main activities of respondents over the past week are working (54.2%), and almost all of those who are working are public and private employees (91.4%). Furthermore, more than three-fourths of our

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3 respondents perceive their social media use frequency as “often” and “very often” (50% and 27.3%
4 respectively).

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6 The outcome variables for men and women are not significantly different, except for the social
7 distancing index that is significantly higher for women than its male counterparts (3.02 vs 2.80). In
8 contrast with preceding evidence, none of the BIS index is significantly different between men and
9 women. Compared with women, men are more likely to believe in misinformation, specifically regarding
10 COVID-19 conspiracies (1.98 vs 2.13). As for the demographic variables, our male respondents’ ages are
11 slightly higher than their female counterparts. In addition, we also showed other demographic
12 characteristics of the respondents that may add certain values to our main analysis (see Appendix 5).
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16 *Correlation between BIS & misinformation and COVID-19 protective behaviours*

17 An overall correlation table is provided below (Table 1). We found that distancing history
18 correlates negatively with usage of public transport and **app-based ridesharing services**, and positively
19 with the purchase of COVID-19 preventive commodities. Usage of public transport and **app-based**
20 **ridesharing services** correlates negatively with GA, while distancing correlates positively with GA.
21 Distancing history has significant and negative correlation with all three misinformation beliefs.
22 Misinformed beliefs in non-psychological cures for COVID-19 correlates positively with GA, but
23 negatively with PI. Neither conspiracy beliefs nor beliefs in psychological cures and prevention for
24 COVID-19 had significant correlation with both GA and PI. The three misinformation beliefs were found
25 to correlate positively with one another.
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Table 1. Correlation table

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
1. COVID-19 prot. behaviours: purchase of preventive commodities	1													
2. COVID-19 prot. behaviours: the use of public transportation and app-based ridesharing services	0.0515	1												
3. COVID-19 prot. behaviours: social distancing	0.0666*	-0.0753**	1											
4. Age	0.0465	-0.123***	-0.0391	1										
5. Age squared	0.0541	-0.130***	-0.0384	0.991***	1									
6. Male	-0.00158	-0.0558*	-0.120***	0.0692*	0.0676*	1								
7. Higher ed. status	0.0557*	-0.0446	0.107***	0.478***	0.440***	-0.00767	1							
8. Health related higher ed.	-0.0114	-0.0263	0.0741**	-0.0951***	-0.102***	-0.0840**	0.0867**	1						
9. COVID-19 training	0.054	-0.00595	0.104***	-0.109***	-0.102***	0.000902	-0.0343	0.140***	1					
10. BIS: GA	0.00589	-0.0586*	0.0663*	0.0504	0.0446	-0.0523	0.0194	-0.0709*	-0.0578*	1				
11. BIS: PI	0.049	-0.0335	-0.0207	-0.102***	-0.102***	-0.0256	0.0348	0.0369	-0.0267	0.00187	1			
12. Belief in misinformation: non-psych. cure and prevention	0.0277	0.0519	-0.171***	0.279***	0.268***	-0.0166	0.0752**	-0.117***	-0.0214	0.0628*	-0.0661*	1		
13. Belief in misinformation: conspiracy theories	-0.00625	0.0508	-0.260***	0.0204	0.019	0.117***	-0.0924***	-0.149***	-0.0435	-0.0124	-0.00955	0.391***	1	
14. Belief in misinformation: psych. cure and prevention	-0.0447	0.0585*	-0.125***	0.145***	0.143***	-0.00155	-0.05	-0.124***	-0.0129	0.054	-0.049	0.568***	0.339***	1

* p<0.05, ** p<0.01, *** p<0.001

Table 2. Hierarchical regression results of the impact of BIS and belief in misinformation on COVID-19 protective behaviours during COVID-19 pandemic

Explanatory Variables	Dependent Variable								
	COVID-19 protective behaviours: purchase of preventive commodities			COVID-19 protective behaviours: the use of public transportation and app-based ridesharing services			COVID-19 protective behaviours: social distancing		
	Step 1	Step 2	Step 3	Step 1	Step 2	Step 3	Step 1	Step 2	Step 3
Age	-0.0267** (0.0120)	-0.0274** (0.0120)	-0.0285** (0.0120)	0.0194* (0.0102)	0.0172* (0.0099)	0.0130 (0.0099)	-0.0255* (0.0152)	-0.0291* (0.0152)	-0.0179 (0.0149)
Age square	0.0004** (0.0002)	0.0004** (0.0002)	0.0004** (0.0002)	-0.0003*** (0.0001)	-0.0003** (0.0001)	-0.0003** (0.0001)	0.0003 (0.0002)	0.0003 (0.0002)	0.0002 (0.0002)
Male	0.0015 (0.0404)	-0.0033 (0.0402)	-0.0015 (0.0396)	-0.0583* (0.0352)	-0.0721** (0.0347)	-0.0699** (0.0348)	-0.1965*** (0.0509)	-0.1900*** (0.0508)	-0.1623*** (0.0498)
Higher educational status	0.0829* (0.0440)	0.0867** (0.0440)	0.0774* (0.0444)	-0.0066 (0.0454)	0.0095 (0.0444)	0.0262 (0.0442)	0.2714*** (0.0599)	0.2902*** (0.0598)	0.2372*** (0.0593)
Status of higher education with health background	-0.0356 (0.0922)	-0.0677 (0.0887)	-0.0735 (0.0894)	-0.1053 (0.0758)	-0.1486** (0.0705)	-0.1143 (0.0703)	0.1281 (0.1055)	0.1559 (0.1060)	0.0183 (0.1051)
Having an experience of COVID-19 training	0.0904** (0.0434)	0.0931** (0.0432)	0.0928** (0.0429)	-0.0094 (0.0396)	-0.0206 (0.0381)	-0.0236 (0.0378)	0.1885*** (0.0520)	0.1837*** (0.0521)	0.1801*** (0.0504)
BIS: germ avoidance		0.0214 (0.0741)	0.0226 (0.0749)		-0.1480** (0.0681)	-0.1559** (0.0679)		0.2425*** (0.0934)	0.2407*** (0.0915)
BIS: perceived infectability		0.1341* (0.0696)	0.1354* (0.0695)		-0.1104 (0.0687)	-0.1051 (0.0688)		-0.1233 (0.0926)	-0.1277 (0.0916)
Belief in misinformation: non-psychological cure and prevention			0.1020* (0.0527)			0.0716 (0.0528)			-0.1711*** (0.0631)
Belief in misinformation: conspiracy theories			-0.0001 (0.0361)			0.0191 (0.0333)			-0.2780*** (0.0434)
Belief in misinformation: psychological cure and prevention			-0.0878** (0.0365)			0.0376 (0.0338)			0.0115 (0.0424)
Observations	1306	1300	1300	1306	1300	1300	1306	1300	1300
R-squared	0.0114	0.0153	0.0207	0.0217	0.0296	0.0378	0.0456	0.0531	0.1100
F-statistics	2.45	2.58	2.39	7.36	6.53	5.63	9.96	8.66	14.29
Prob (F-statistics)	0.0232	0.0086	0.0062	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
				Diff. Step X - Step X-1					
R-Squared change	-	0.004	0.005	-	0.008	0.008	-	0.008	0.057
F-statistics change	-	2.438	2.36	-	4.973	3.659	-	4.964	27.420
Prob (F-statistics) change	-	0.088	0.070	-	0.007	0.012	-	0.007	0.000

Standard errors in parentheses

* p < 0.1,

** p < 0.05

*** p < 0.01

Hierarchical regression analysis: Predictors of COVID-19 protective behaviours

Based on the results of hierarchical regression in Table 2, BIS did not perform universally since only GA was found to significantly predict two COVID-19 protective behaviours, namely the use of transportation and social distancing. In particular, the higher score of GA was associated with higher social distancing ($B = .24, p < .01$) and lower use of public transportation and **app-based ridesharing services** ($B = -.10, p < .01$). Although the PI seemed to predict the purchase of preventive commodities, the effect was not statistically significant at 5% level ($B = .13, p < .10$). These results were only slightly predicted by the additions of belief in misinformation: the effects of BIS coefficients remained largely the same in terms of its significance and magnitude.

Belief in misinformation was associated with COVID-19 protective behaviours with various significance and signs across regressions. Belief in the non-psychological cure and prevention was negatively linked with social distancing ($B = -.17, p < .01$), while another strong evidence was found in the inverse association between belief in conspiracy and social distancing ($B = -.28, p < .01$). The more surprising correlation was with the belief in psychological cure and prevention, which had a significant negative effect on the purchase of preventive commodities ($B = -.09, p < .05$). The more people believed in the power of psychological cure and prevention, the more unlikely they were to buy preventive commodities, such as masks and hand sanitizers.

Discussion

The present study has added more evidence on the significance of BIS in the pandemic context, especially in Indonesia. We found that entering the effects of misinformation beliefs after BIS did not reduce the effect of BIS on protective behaviours, likely indicating that both predict behaviours independently. We also found that only GA predicts higher social distancing and reduced use of public transportation **and app-based ridesharing services**, while different beliefs in COVID-19 misinformation predict reduced physical distancing and purchase of prevention commodities. This is slightly different from Díaz and Cova's (2020) findings that show pathogen disgust significantly predicts adherence to COVID-19 health protocols, while beliefs in conspiracy theory less so, as we found both germ avoidance and different beliefs in misinformation predict different protective behaviours.

For each BIS component, we found that only GA predicts social distancing and reduced transportation use, even after controlling for age, sex, educational level and background, and history of COVID-19 related training; while perceived infectability did not significantly predict all three behaviours. This differs from the study conducted by Shook, et al. (2020), which found that both GA and PI predict social distancing behaviours. However, another study by Makhanova and Shepherd (2020) showed similar results, where GA was negatively correlated with history of direct social interactions, and PI did not. A similar pattern was found in transportation use. This pattern might have occurred due to both transport use and social distancing likely being associated, or that in both transportation and social distancing, face-to-face interaction was involved. Public transportation usage inevitably has one travel in crowds, while **app-based ridesharing services** require direct interaction with the driver. Transportation is more likely to place one at risk of being

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3 surrounded by pathogens (Shen et al., 2020), thus inciting fear of infection in particularly crowded
4 means of transport (Gutiérrez et al., 2020) regardless of one's history of risk to infectious disease,
5 which might explain the negative association between GA and transport over PI, as GA was more
6 directly associated with pathogens. This might reflect that people in Greater Jakarta area might not
7 be predicted by how they think themselves as vulnerable to infections, but they are rather more
8 cautious to any context and interactions that are considered to increase their risk to germ exposure.
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11 Our findings also contribute to the literature on COVID-19 misinformation in several ways.
12 First, through factor analysis we found that COVID-19 conspiracy beliefs are grouped into a single
13 factor. Though another study on COVID-19 conspiracy beliefs has differentiated between
14 believing that COVID-19 is an engineered bioweapon and that COVID-19 is a hoax (Imhoff and
15 Lamberty, 2020), both beliefs were found to converge on a single factor in our study. Though these
16 two beliefs are not necessarily contradictory, they may be inconsistent with one another (e.g.
17 "COVID-19 is a manufactured bio-weapon that was accidentally let out" vs. "The government
18 exaggerates COVID-19 infection figures to control citizens' lives"). Believing in multiple
19 inconsistent conspiracy theories is not a novel phenomenon. Earlier studies suggest that those
20 beliefs may coexist due to the existence of a broader belief: that authorities are conspiring in one
21 way or another (Wood et al., 2012). Thus, our findings suggest that multiple, possibly inconsistent,
22 conspiracy beliefs regarding COVID-19 can coexist, which might be due to the existence of a
23 similar superordinate belief regarding conspiracy in general.
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26 However, although we found convergence in belief in conspiracy theories regarding
27 COVID-19, the distinct factors we discovered in COVID-19 misinformation beliefs predict
28 behaviours differently. This finding supports the argument made by Hornik, et al. (2021), that
29 inconsistencies in misinformation and COVID-19 protective behaviours may be due to differences
30 in the measurement and analysis of misinformation. It may be argued that future studies on
31 COVID-19 misinformation must directly assess specific misinformation beliefs and refrain from
32 merging them into a single misinformation index, as it may obscure the distinct effects of specific
33 beliefs.
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36 Belief in non-psychological prevention and cure was positively associated with one's
37 purchase of prevention commodities. This finding is consistent with research on consumer's
38 pseudoscientific beliefs and its role in the purchase of various medical commodities believed to be
39 beneficial to health (Bryden et al., 2018; Verbeke et al., 2005). Meanwhile, belief in non-
40 psychological cures and prevention was also found to have a negative association with social
41 distancing. This association may be explained as one believing in the effectiveness of such
42 methods having a higher degree of confidence in their safety against the SARS-CoV-2 virus, and
43 therefore they might not feel the need to forego face-to-face work interactions or to hold off on
44 traveling. Erceg, et al. (2020) similarly found that unfounded beliefs on COVID-19 treatments
45 negatively predict proven COVID-19 prevention behaviours, such as social distancing.
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48 Our findings showed that conspiracy beliefs regarding COVID-19 were negatively
49 associated with past social distancing. This finding is in line with another study in the UK (Swami
50 and Barron, 2020), where support for COVID-19 conspiracy theories negatively predicts social
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3 distancing behaviours. Pummerer, et al. (2020) similarly found that in a German sample, exposure
4 to political conspiracy theories about COVID-19 reduces social distancing tendencies. These
5 findings might be explained by the novelty and restrictive nature of social distancing, which may
6 depend on people's trust towards authority for those restrictions to be observed. However, we
7 found that belief in conspiracy did not predict the buying of preventive commodities. This might
8 be because masks and hand sanitizers were already commonly used commodities even before the
9 pandemic, and thus does not necessarily require trust in authority for people to continue or to
10 further buy these commodities (Pummerer et al., 2020). Therefore, believing in COVID-19
11 conspiracy might have less effects on this more established and commonplace behaviours.
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15 Interestingly, we also found that believing in the primacy of psychological prevention and
16 cure was negatively associated with the buying of said commodities. In our scale, we used items
17 that reflect this narrative, but one that is more extreme where psychological conditions are the
18 primary means by which one protects oneself against COVID-19. In health product use,
19 individuals tend to take into account trade-offs in time, price, and psychological costs (Grew et al.,
20 2020). Therefore, our findings might be explained in that due to being relatively low-cost means
21 of protection, at least compared to buying and using commodities, one might prefer the lower cost
22 option. We did not find belief in the primacy of psychological prevention and cure to be associated
23 with social distancing frequency. This might reflect the general pattern of pseudoscientific beliefs
24 being found to be unrelated to COVID-19 protocol adherence in general (Díaz and Cova, 2020).
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28 We found that none of the misinformation beliefs were associated with transportation
29 usage. This might be due to the fact that none of our beliefs in COVID-19 misinformation items
30 was directly related to public transportation or **app-based ridesharing services**. Another possible
31 explanation is as work-from-home policies are not universally and consistently applied in the
32 Greater Jakarta area (Ashari and Valerosdela, 2020; Fachriansyah, 2020; The Jakarta Post News
33 Desk, 2020), thus participants have no choice but to use transportation services regardless of their
34 belief in misinformation.
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38 Additionally, we also compared all examined variables between male and female
39 participants. We found that men were more supportive of COVID-19 conspiracies compared to
40 women. This finding echoes that of Romer and Jamieson's (2020), which found that men were
41 more likely to believe in COVID-19 conspiracy regarding the CDC in the United States, as well
42 as Cassese, Farhart, and Miller's (2020) findings that also showed that in the US, men were more
43 likely to endorse more COVID-19 conspiracies regardless of their politics. Thus, although gender
44 differences regarding COVID-19 misinformation differ by country (Roozenbeek et al., 2020), we
45 found that in our Indonesian sample, men were somewhat more likely to support the idea that
46 COVID-19 is a conspiracy. We also found that the difference between men and women in their
47 germ aversion and perceived infectability scores is not significant. This result is surprising given
48 the numerous findings that showed differences in germ aversion and perceived infectability
49 between genders (De Coninck et al., 2020; Duncan et al., 2009; Makhanova and Shepherd, 2020).
50 Two studies that similarly showed no difference between genders in the two variables were
51 conducted in Iran (Ahmadzadeh et al., 2013) and Saudi Arabia (Pasay-an, 2020). **This might be**
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3 explained because these countries have a dominant Islamic culture that emphasizes on personal
4 hygiene for its followers, therefore both genders do not show significant difference on GA and PI
5 as they hold to the same religious practices deemed to protect their hygiene from pathogens,
6 diseases, and unclean products (Taheri, 2009). Further studies may investigate how cultural and
7 religious practices relate with gender differences in GA and PI. For COVID-19 protective
8 behaviours, only social distancing was found to differ significantly across genders, with women
9 reporting more social distancing compared to men. This is in line with other findings from various
10 countries (Murphy et al., 2020; Pedersen and Favero, 2020; van Rooij et al., 2020). One possible
11 explanation for this difference is that women are likely more concerned with their health and are
12 more likely to engage in preventive behaviours in general (Hiller et al., 2017).

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17 One of the strengths of our study is that we constructed the COVID-19 protective
18 behaviours and misinformation scales through a grounded approach via media analysis and
19 surveys. We managed to classify several categories of COVID-19 protective behaviours and
20 misinformation that is likely relevant to the Indonesian public. Our findings also show that both
21 the BIS and COVID-19 misinformation needs to be investigated with respect to their different
22 components, as they have distinct influences on behaviours. This study also expands on existing
23 research on the BIS in the context of Indonesia.

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There are several limitations to this study. In terms of COVID-19 protective behaviours,
our initial plan was to construct a scale to measure reactive behaviours, to follow the BIS
framework on reactive and proactive behaviours in face of a pathogen threat. However, our pilot
study produced an item pool dominated by several categories of prevention behaviours. It is
important to note that other prevention behaviours, especially those typically endorsed by the
government (e.g. mask-wearing) are not within the scope of our research. Further investigations
are needed to explore a more comprehensive range of COVID-19 related behaviours that may be
predicted by BIS and different beliefs in misinformation, which includes both protocol-endorsed
behaviours and behaviours that naturally emerges as a response to the unfolding pandemic. Our
study also only collected data from an online survey with quota sampling, which might induce
voluntary response bias and can only describe social media users in Jakarta, Bogor, Depok,
Tangerang, and Bekasi, which might not represent the Indonesian population. Further research will
need to be carried out to provide findings that may represent the whole Indonesian population.

Though further studies are needed to provide robust insights into policy, we offer some
recommendations based on our preliminary findings. The findings suggest several courses of
action to increase desirable behaviours in the COVID-19 pandemic with cautions of costs
associated with the activated germ avoidance and more detailed attention needed towards different
types of misinformation. Germ aversion might be used in health communication to improve
people's compliance of practicing physical distancing and less use of public transportation and
app-based ridesharing services, while messages related to perceived infectability might not be too
beneficial. Hence, the government should refine its public health strategy by incorporating germ
aversion and feeling of disgust in public health messages. Visual cues such as a depiction of a
person who coughs or sneezes directly to others' faces and a disgusting depiction of the virus in

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3 educational posters about COVID-19 placed around public spaces might be more useful
4 (Pellegrino et al., 2016) compared to public messages containing statistical information about
5 individual and group risks of infection, infection, and mortality rates.
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7 Another important practical implication is that the government needs to develop a specific
8 strategy to counter specific misinformation related to COVID-19. Our findings show that belief
9 in misinformation needs to be tackled individually, as different beliefs produce different
10 behaviours, and likely also require different approaches for debunking. Consistent and massive
11 counteraction of misinformation and the provision of truth and factuality, which has been effective
12 mechanisms to combat COVID-19 misinformation (Lewandowsky et al., 2012; WHO, 2020), may
13 indirectly help increase the purchase of preventive commodities and improve social distancing.
14 Our findings also suggest that promoting one's psychological well-being is important in protecting
15 oneself against COVID-19 may inadvertently also promote the view that psychological well-being
16 is the be-all end-all in COVID-19 prevention and may cause neglect in adhering to other prevention
17 protocols. As our findings are preliminary, future studies that investigate whether promoting the
18 psychological aspect of immunity and disease prevention crowds out other forms of prevention
19 behaviours may be insightful in this regard. Additionally, our findings suggest that men are more
20 susceptible to COVID-19 misinformation compared to women. This finding warrants further
21 investigation and may indicate that a more targeted approach in countering misinformation with
22 regards to gender is necessary.
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30 **Conclusion**

31 This study found that only GA predicts physical distancing and reduced transportation use.
32 Belief in COVID-19 misinformation generally only predicts the buying of prevention commodities
33 and social distancing. Social distancing is predicted negatively by beliefs in conspiracy and non-
34 psychological prevention and cure. Belief in psychological prevention and cure was associated
35 with lower commodity buying frequency, while the opposite was true for beliefs in non-
36 psychological prevention and cure. These results suggest that germ aversion should be explored as
37 a possible leverage in promoting COVID-19 prevention behaviours. Misinformation should be
38 addressed in a specific manner, as beliefs towards different pieces of misinformation predict
39 COVID-19 related behaviours differently. Practical implications for communication strategies to
40 promote specific COVID-19 protective behaviours are discussed.
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Declarations of Conflicting Interest

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Appendix 1

Pilot Study 1

Our variables of interest are fairly novel. There is yet to be a comprehensive list of misinformation and protective behaviour related to COVID-19 in Indonesia at the time of this research. Therefore, to measure those variables we must construct our own scales. We started by conducting a media analysis and an elicitation survey to generate a pool of item candidates.

Method

We used three different data sources to generate an initial item pool. We collected online news sources to search for emerging behaviours reacting to the pandemic. For hoaxes, two additional sources were utilized, which were the government's own fact checking and fake news monitoring website (cekhoaks.id) and another similar site owned by the fact checking civil organization, MAFINDO (turnbackhoax.id). Both websites document fact checks of misinformation spread in social media. We used the search terms "coronavirus" and "COVID-19" to look for articles related to the coronavirus pandemic. We catalogued any articles containing the terms from the date of the search (31st of March 2020). We found 418 articles in cekhoaks.id, with the earliest dated 6th of May 2019, and 220 articles in turnbackhoax.id dating back to 24th of January 2020.

We coded each article depending on whether it was a fact check on misinformation regarding COVID-19 based on four categories: symptoms, origin, risk factors, and treatment. After we generated the themes, we verified our findings by checking whether these themes are represented in news on mainstream media. Fifty-three themes were then used as the initial item pool. To generate the initial item pool for protective behaviours, we used findings from our media analysis.

After the initial set of items were generated, we conducted a survey. The survey serves two purposes: to confirm our initial items and to elicit other behaviours and misinformation topics that we did not find via media analysis. The misinformation items were tested by asking participants whether they think the presented information is true (True/False/Don't Know). These items were interspersed with correct COVID-19 factoids as distractors to prevent participants from guessing that all items were misinformation. Four open-ended questions were asked to elicit other beliefs people hold on COVID-19's symptoms, origins, method of infection, and cure. Responses to these open questions were thematically categorized. Protective behaviour items were validated by whether they have been conducted by participants or not.

The questionnaire was distributed through social media (Facebook, Instagram, Whatsapp, and Twitter) over the span of 14 days (3-14th June 2020). We used Typeform to host the questionnaire (typeform.com). We excluded participants who were pregnant, inactive on social media, was or had previously been a COVID-19 patient or suspect.

Results

The total number of participants that passed the criteria is 153 (104 females). All personal information collected in the study was omitted from the analysis. To eliminate rare beliefs, we decided arbitrarily on a 20% agreement rate, where if less than 20% of all participants responded "True" on an item, then that item was excluded (Table X1). To eliminate protective behaviours that were deemed rare, we used the same 20% agreement rate as the elimination criteria or to at least discuss the item for elimination (Table X2).

Table X1

Results for misinformation items

Item	N total	N True	% True
COVID-19 can spread via paper money	153	110	72
Keeping our throat humid by drinking warm water and consuming vitamin C can prevent COVID-19	153	105	69
COVID-19 can spread via coins	153	100	65
COVID-19 can spread airborne, in everyday condition without any effects from medical treatments	153	92	60
COVID-19 patients must sunbathe, consume vitamin C and E, and eat one egg a day to recover from COVID-19	153	86	56
COVID-19 was initially spread from people consuming bat soup	153	82	54
Dettol can kill the virus that causes COVID-19	153	82	54
Consumption of vitamin E is one way to protect ourselves from COVID-19	153	70	46
Sunlight can kill the virus that causes COVID-19	153	69	45
Consumption of vitamin D can prevent COVID-19	153	68	44
Drinking ginger can prevent and cure COVID-19	153	57	37
A habit of eating wild animals from a young age were part of the reason for the initial spread of COVID-19	153	51	33
Spraying alcohol or chlorine onto someone's body can kill the COVID-19 virus	153	48	31
Drinking plenty of warm water can prevent COVID-19	153	46	30
Consuming lemons can prevent COVID-19	153	40	26
Eating bananas can prevent COVID-19	153	34	22
Consuming antibiotics can prevent and cure COVID-19	153	34	22
Goods imported from China can bring the COVID-19 virus with them	153	30	20
Drinking 25 litres of water per day can prevent COVID-19	153	30	20
Chloroquine can be used to cure COVID-19	153	30	20

Table X2

Results for protective behaviour items

Item	N	N Never	% Never	N Has	% Has
I have refrained from traveling for vacation during the pandemic	153	10	7	143	93
I have, to the best of my abilities, refrained from using public transportation such as the train or MRT unless I had no other choice	153	21	14	132	86
I have avoided going to markets, shopping centers, and malls to shop during the pandemic	153	29	19	124	81
I have, to the best of my abilities, refrained from using online cabs for transportation	153	34	22	119	78
I have avoided visiting COVID-19 positive/suspect patients in the hospital or going to their funeral	153	46	30	107	70
I have cancelled a professional meeting where many would have met physically	153	47	31	106	69
I have cancelled a personal event such as a marriage, birthday, or reunion which would have had many attend physically	153	47	31	106	69
I avoid physical contact as much as possible with people who have visited China	153	74	48	79	52
I have bought N95 or surgical masks to prevent COVID-19 infection	153	77	50	76	50
I've purchased more hand sanitizers than I normally do since COVID-19 was first reported in Indonesia	153	78	51	75	49
I've bought ginger and curcumin to prevent COVID-19	153	87	57	66	43
I have bought wedang susu and empon-empon to prevent COVID-19	153	113	74	40	26
I have bought a sizeable amount of masks and hand sanitizers for personal use	153	115	75	38	25
I've purchased more surgical masks than I normally do since COVID-19 was first reported in Indonesia	153	118	77	35	23
I feel uneasy when meeting a Chinese during the pandemic	153	126	82	27	18
I think it will be better if healthcare workers stay in lodgings far away from where I live	153	127	83	26	17
I think it makes sense to protest against burying a deceased COVID-19 positive person near my neighborhood during the pandemic	153	129	84	24	16
I feel that it makes sense to protest if a building in my neighborhood is used as a place to host COVID-19 patients	153	131	86	22	14
I have spread personal information of COVID-19 patients to keep away from areas with COVID-19 risk	153	142	93	11	7
I feel reluctant to live near a healthcare worker who takes care of COVID-19 patients in this pandemic	153	147	96	6	4

I bought chloroquine because of its purported effects in curing COVID-19	153	153	100	0	0
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For Peer Review

Appendix 2

Pilot study 2

A survey was conducted to test the psychometric characteristics of the item candidates generated from pilot study 1.

Method

The survey form was distributed via social media in the same manner as pilot study 1. Data collection lasted for 8 days (13-20th July 2020), with the exclusion criteria: pregnant women, healthcare workers, not active users of social media, was or had been diagnosed with COVID-19 or designated as a suspect, and having already participated in pilot study 1. In this study, misinformation items now use a 4-point Likert scale (1 = Completely Disagree, 4 = Completely Agree). Protective behaviour items did not change.

Results

We collected 253 samples that were fit for analysis (194 females). We conducted an exploratory factor analysis using JASP (JASP Team, 2020), with a promax rotation. According to parallel analysis and the resulting scree plot, beliefs in COVID-19 misinformation likely consist of three factors, with sum of square loadings that range from 2.41 to 5.02. The three factors were “cure and prevention”, “global conspiracy”, and “other conspiracies” (Table X3). The cure and prevention factor consists of items that represent belief in unverified substances or methods that purportedly cure or prevent COVID-19 infection (e.g. “Ginger can be used to cure COVID-19”). Global conspiracy beliefs refer to items that represent belief that the virus was engineered or taken advantage of by foreign nations or organizations for political gains (e.g. “The coronavirus was engineered by an actor or a country that aims to control the global order”), while other conspiracies are items that represent more general conspiracist beliefs regarding the virus (e.g. “Experts deliberately misled the public and exaggerated the dangers of COVID-19”). We initially planned for the results from this survey to be used as the basis for the misinformation beliefs questionnaire, however, we decided to redo the psychometric analysis once more using samples from the main study. This decision was made in light of new fake news and conspiracy theories emerging in the time that we conducted and analyzed pilot study 2, and additional items were deemed to be necessary.

Table X3

Results of the cluster of misinformation items from the pilot study

Factor	Code	Item	Loading
Cure and prevention	ObatC.5	Self-suggestion is the best way to prevent oneself from getting COVID-19	0.602
	ObatA.6	Consuming lemons can prevent COVID-19	0.56

	ObatC.4	Anxiety is the sole factor that significantly increases one's risk of getting infected with COVID-19	0.555
	ObatA.1	COVID-19 can be prevented by drinking plenty of warm water	0.659
	ObatC.2	Avoiding stress is the most effective way to cure COVID-19	0.638
	ObatA.8	To prevent COVID-19, we must keep our throats humid by drinking warm water and vitamin C	0.692
	ObatA.4	Jamu can cure COVID-19	0.634
	ObatC.3	Prayers and worship are enough to protect us from COVID-19	0.445
	ObatA.3	COVID-19 can be cured by antibiotics	0.444
	ObatA.5	Drinking 25 litres of water per day can prevent COVID-19	0.45
	ObatA.2	Ginger can be used to cure COVID-19	0.617
	ObatC.1	Only through positive thinking can the body's immune system gain a boost in order to prevent COVID-19 infection	0.679
Global conspiracy	KonsA.1	The coronavirus is an engineered bioweapon that had leaked from a lab	0.793
	KonsA.2	The coronavirus was engineered by an actor or a country that aims to control the global order	0.872
	KonsB.1	Most media are in the pocket of parties that want to exaggerate the impact of COVID-19	0.468
	KonsA.5.R	The coronavirus appeared and spread in the pandemic naturally, it is not a manmade virus	0.782
	KonsB.2	There is a global political interest in sowing fear around the impact of COVID-19	0.693
	KonsA.3	Bill Gates created and spread the coronavirus	0.49
Other conspiracy	KonsB.4	The government purposefully exaggerates the number of positive COVID-19 cases to assert control over the public (e.g. to ban public worship)	0.448
	KonsB.3	Experts deliberately misled the public and exaggerated the dangers of COVID-19	0.517
	Tran.2	COVID-19 can spread through 5G waves	0.447

After evaluating the descriptive results of the protective behaviour items, we decided on splitting the scale into two: past protective behaviours and attitude towards protective behaviours. This decision was due to many behaviours being rather rare or inappropriate if they are asked in terms of past frequency (e.g. "I feel that it makes sense to protest if a building in my neighborhood is used as a place to host COVID-19 patients"), and would be more appropriate if participants were

asked about their attitude or preference regarding said behaviour. However, we did not include these in the main analysis since our primary interest lies in actual behaviour.

Appendix 3

Factor Analysis of Protective Behaviour and COVID-19 Misinformation

For the final factor analyses, we used data from the main study (N=1,306).

Factor Analysis of the COVID-19 Protective Behaviour Scale

We conducted an exploratory factor analysis to examine the factors that form the protective behaviour scale. We used a promax rotation to anticipate correlation between factors. A parallel analysis suggests that we assume the existence of three factors. Prior to the analysis, we omitted the item coded reac.his.21 (“I bought chloroquine because of its purported effects in curing COVID-19”), which was a very rare behaviour (only 4% of our sample stated that they have done this). Recent developments also have made it difficult to find chloroquine in online marketplaces. Table X4 shows all items in the analysis as well as their factor load. This scale showed a generally acceptable fit with low RMSEA and a TLI close to .90 (Table X5).

Tabel X4

Factor loading of the COVID-19 protective behaviour scale

Item	Code	F1	F2	F3	Unq
In every chance, I took public transports such as the train or the MRT during the pandemic	reac.his.22	-0.109	0.723	0.058	0.535
In every chance, I used online cabs as my transport during the pandemic	reac.his.23	-0.105	0.702	0.089	0.574
In every chance, I had in-person meetings during the pandemic	reac.his.24	0.062	0.145	-0.203	0.91
In every chance, I had online meetings for professional or personal purposes instead of an offline one during the pandemic	reac.his.25	0.011	0.118	0.497	0.778
In every chance, I visited COVID-19 positive/suspect patients in the hospital or went to their funeral	reac.his.26	0.09	0.203	0.035	0.944
In every chance, I went to the market to shop for essentials during the pandemic	reac.his.27	-0.035	0.159	-0.208	0.909
In every chance, I went to the mall during the pandemic	reac.his.28	-0.011	0.242	-0.119	0.909
I have refrained from traveling for a vacation during the pandemic	reac.his.29	-0.026	0.015	0.42	0.829
I have bought N95/surgical masks to protect myself from COVID-19	reac.his.30	0.482	0.166	0.274	0.638

I've purchased more surgical masks than I normally do since COVID-19 was first reported in Indonesia	reac.his.31	0.764	0.016	0.125	0.385
I've purchased more hand sanitizers than I normally do since COVID-19 was first reported in Indonesia	reac.his.32	0.855	-0.149	-0.052	0.324
I have bought a sizeable amount of masks and hand sanitizers for personal use	reac.his.33	0.827	-0.115	-0.108	0.361
I have spread personal information of COVID-19 patients to keep away from areas with a COVID-19 risk	reac.his.34	0.304	-0.019	-0.094	0.906

Table X5

Fitness index of the COVID-19 protective behaviour scale

RMSEA	RMSEA 90% CI	TLI	BIC
0.069	0.061 - 0.076	0.837	-2.677

The three factors of the scales (Table X6) were purchase of preventive commodities (4 items), transportation use (2 items), and social distancing (2 items). The table also include the final items used in the study. The first factor, purchase of preventive commodities, describes the purchase of items such as masks and hand sanitizers. The second factor describes the use of public transportation during the pandemic. The third factor represents questions on whether one refrained from holding offline meetings or went on vacations. Correlations between the three factors are presented in Table X7.

Table X6

Factors of the COVID-19 protective behaviour scale

Factor	Code	Item	Loading
Factor 1: Purchase of preventive commodities	reac.his.30	I have bought N95/surgical masks to protect myself from COVID-19	0.482
	reac.his.31	I've purchased more surgical masks than I normally do since COVID-19 was first reported in Indonesia	0.764
	reac.his.32	I've purchased more hand sanitizers than I normally do since COVID-19 was first reported in Indonesia	0.855
	reac.his.33	I have bought a sizeable amount of masks and hand sanitizers for personal use	0.827
Factor 2: Transportati on use	reac.his.22	In every chance, I took public transports such as the train or the MRT during the pandemic	0.723
	reac.his.23	In every chance, I used online cabs as my transport during the pandemic	0.702
Factor 3: Social	reac.his.25	In every chance, I have had online meetings for professional or personal purposes instead of an offline one during the pandemic	0.497

distancing	reac.his.2 9	I have refrained from traveling for a vacation during the pandemic	0.42
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Table X7

Correlation between factors in the COVID-19 protective behaviour scale.

	Factor 1	Factor 2	Factor 3
Factor 1	1	0.298	0.096
Factor 2	0.298	1	-0.405
Factor 3	0.096	-0.405	1

Factor Analysis of the COVID-19 Misinformation Belief Scale

We conducted an exploratory factor analysis on the COVID-19 misinformation belief scale. We used promax rotation to account for potential correlations between factors. Item Obat.9 (“Prayers and worship are enough to protect us from COVID-19”) was omitted after the initial analysis due to mismatched loading, as it loaded with scales representing conspiracy even though it is an item about cures. As we had no satisfactory explanation on why this is so, the item was omitted, and the remaining items were analyzed once more. The new scale and its factor loadings can be found in Table X8. The scale had satisfactory RMSEA and a TLI close to .90 (Table X9).

Table X8

Factor loading of the COVID-19 misinformation belief scale

Item	Code	F1	F2	F3	Unq
The coronavirus appeared and spread in the pandemic naturally; it is not a manmade virus	Kons.6	-0.025	0.534	-0.069	0.75
Consuming lemons can prevent COVID-19	Obat.3	0.68	-0.11	0.037	0.571
Using masks when exercising can be harmful even if it is a low intensity exercise	Add.1	0.052	0.253	0.104	0.881
Thermometer guns are harmful to brain cells	Add.2	0.332	0.329	-0.069	0.712
The coronavirus is an engineered bioweapon that had leaked from a lab	Kons.1	0.056	0.704	-0.074	0.501
The government purposefully exaggerates the number of positive COVID-19 cases to assert control over the public	Kons.4	-0.065	0.722	0.098	0.467

Drinking 2.5 litres of water per day can prevent COVID-19	Obat.11	0.668	-0.171	0.087	0.57
Most media are in the pocket of parties that want to exaggerate the impact of COVID-19	Kons.3	-0.151	0.762	0.14	0.439
Anxiety is the sole factor that significantly increases one's risk of getting infected with COVID-19	Obat.4	0.014	0.182	0.501	0.633
Ginger can be used to cure COVID-19	Obat.12	0.757	0.049	-0.076	0.457
The government purposefully injects the virus during COVID-19 rapid tests to bend the population to their will	Kons.5	0.077	0.667	-0.061	0.531
Self-suggestion is the best way to prevent oneself from getting COVID-19	Obat.2	0.254	0.077	0.477	0.498
Jamu can cure COVID-19	Obat.8	0.657	0.111	-0.033	0.511
Eucalyptus pendants can effectively prevent COVID-19 infection	Add.5	0.514	0.105	-0.082	0.724
COVID-19 can be prevented by drinking plenty of warm water	Obat.5	0.834	-0.079	0.026	0.339
Eating bananas can prevent COVID-19	Obat.1	0.737	-0.046	-0.009	0.498
COVID-19 can be cured by antibiotics	Obat.10	0.536	0.11	-0.025	0.659
To prevent COVID-19, we must keep our throats humid by drinking warm water and vitamin C	Obat.7	0.475	-0.126	0.307	0.568
Only through positive thinking can the body's immune system gain a boost in order to prevent COVID-19 infection	Obat.13	0.045	-0.008	0.804	0.31
Avoiding stress is the most effective way to cure COVID-19	Obat.6	-0.021	-0.107	0.871	0.324
Hospitals purposefully diagnose patients with COVID-19 for monetary gains	Add.3	-0.084	0.72	0.035	0.519
Disinfectant chambers are effective in stopping the spread of COVID-19	Add.4	0.347	0.013	0.044	0.853
The coronavirus was engineered by an actor or a country that aims to control the global order	Kons.2	-0.026	0.853	-0.06	0.329

Table X9

Fitness index of the COVID-19 misinformation belief scale

RMSEA	RMSEA 90% CI	TLI	BIC
0.073	0.069 - 0.076	0.864	137.151

We found that this scale consists of three factors: non-psychological cure and prevention (8 items), conspiracy (7 items), and psychological cure and prevention (3 items). The items included in these factors were used in the final scale. The cure and prevention factors consist of items representing unverified substances or methods purportedly effective at curing or preventing COVID-19. The conspiracy factor represents conspiracy theories on COVID-19. The psychological cures and prevention scale represent beliefs that place psychological factors such as optimism as the most effective form of defense against COVID-19. McDonald's Omega and Cronbach's Alpha were calculated as an estimate of reliability, and "non-psychological cure and prevention" had an Omega of 0.86 and Alpha of 0.85, "conspiracy" had an Omega of 0.87 and an

Alpha of 0.87, and “psychological prevention and cure” was found to have an Omega of 0.78 and an Alpha of 0.77.

Table X10

Factors of the COVID-19 misinformation belief scale

Factor	Code	Item	Loading
Factor 1: Psychological cure and prevention	Obat.3	Consuming lemons can prevent COVID-19	0.68
	Obat.11	Drinking 2.5 litres of water per day can prevent COVID-19	0.668
	Obat.8	Jamu can cure COVID-19	0.657
	Add.5	Eucalyptus pendants can effectively prevent COVID-19 infection	0.514
	Obat.5	COVID-19 can be prevented by drinking plenty of warm water	0.834
	Obat.1	Eating bananas can prevent COVID-19	0.737
	Obat.10	COVID-19 can be cured by antibiotics	0.536
	Obat.7	To prevent COVID-19, we must keep our throats humid by drinking warm water and vitamin C	0.475
Factor 2: Conspiracy	Kons.6	The coronavirus appeared and spread in the pandemic naturally; it is not a manmade virus	0.534
	Kons.1	The coronavirus is an engineered bioweapon that had leaked from a lab	0.704

	Kons.4	The government purposefully exaggerates the number of positive COVID-19 cases to assert control over the public	0.722
	Kons.3	Most media are in the pocket of parties that want to exaggerate the impact of COVID-19	0.762
	Kons.5	The government purposefully injects the virus during COVID-19 rapid tests to bend the population to their will	0.667
	Add.3	Hospitals purposefully diagnose patients with COVID-19 for monetary gains	0.72
	Kons.2	The coronavirus was engineered by an actor or a country that aims to control the global order	0.853
Factor 3: Psychological cure and prevention	Obat.4	The government purposefully exaggerates the number of positive COVID-19 cases to assert control over the public	0.501
	Obat.13	Only through positive thinking can the body's immune system gain a boost in order to prevent COVID-19 infection	0.804
	Obat.6	Avoiding stress is the most effective way to cure COVID-19	0.871

Table X11

Correlation between factors in the COVID-19 misinformation belief scale

	Factor 1	Factor 2	Factor 3
Factor 1	1	0.557	0.721

Factor 2	0.557	1	0.439
Factor 3	0.721	0.439	1

Perceived Vulnerability to Diseases Scale

The Perceived Vulnerability to Disease (PVD) scale (Duncan, Schaller, & Park, 2009) was used to estimate the latent variables related to the Behavioural Immune System. The scale used was a translation of the original to Bahasa Indonesia (Hudiyana, Prawira, Kartika, Mahendra & Putra, under review). The dataset from the aforementioned study was used to evaluate the scale (N = 1547). A confirmatory factor analysis using JASP (JASP Team, 2020), in which the 15 items were grouped into the two factors described in its original development (perceived infectability and germ aversion), suggests that the adaptation has a similar structure to the original scale (see Table X12). Germ Aversion (GA) consists of 8 items pertaining to discomfort towards perceived infection vectors (e.g. "I prefer to wash my hands pretty soon after shaking someone's hand), while Perceived Infectability is measured using 7 items that describes belief regarding one's vulnerability to infection (e.g "In general, I am very susceptible to colds, flu and other infectious diseases."). Responses were collected using a 4-point Likert scale (1 = Completely disagree, 4 = Completely agree). We found that the items' load on their respective factor lies within a range of 0.31 to 0.66. We calculated both McDonald's Omega and Cronbach's Alpha as estimates of reliability. We found GA to possess an Omega of 0.69 and an Alpha of 0.69, while PI has an Omega of 0.85 and an Alpha of 0.85. No items were omitted. Scores on each factor were separately calculated and we did not combine the factors to form an index. A higher score on each scale corresponds to a higher germ aversion or perceived infectability.

Table X12

Factors of the Perceived Vulnerability to Disease Scale

Factor	Code	Item	Loading
Factor 1: Perceived Infectability	PI1	In general, I am very susceptible to colds, flu and other infectious diseases.	0.658
	PI2	I am unlikely to catch a cold, flu or other illness, even if it is 'going around'.	-0.572
	PI3	If an illness is 'going around', I will get it.	0.497
	PI4	My immune system protects me from most illnesses that other people get.	-0.471
	PI5	I am more likely than the people around me to catch an infectious disease.	0.532

	PI6	My past experiences make me believe I am not likely to get sick even when my friends are sick.	-0.515
	PI7	I have a history of susceptibility to infectious disease. (Item	0.549
Factor 2: Germ Avoidance	GA1	I prefer to wash my hands pretty soon after shaking someone's hand.	0.515
	GA2	I avoid using public telephones because of the risk that I may catch something from the previous user.	0.523
	GA3	I do not like to write with a pencil someone else has obviously chewed on.	0.527
	GA4	I dislike wearing used clothes because you do not know what the last person who wore it was like.	0.536
	GA5	I am comfortable sharing a water bottle with a friend.	-0.404
	GA6	It really bothers me when people sneeze without covering their mouths.	0.307
	GA7	It does not make me anxious to be around sick people.	-0.304
	GA8	My hands do not feel dirty after touching money	-0.418

Appendix 4

Descriptive statistics of analysis variables by sex

Variable names	Variable descriptions	Female		Male		Mean Diff
		Mean	SD	Mean	SD	
COVID-19 protective behaviour: purchase of preventive commodities	The index of the purchase of preventive commodities (ranging from 1 to 4)	1.59	0.65	1.59	0.65	-0.00184
COVID-19 protective behaviour: transportation use	The index of the use of public and app-based ride sharing services (ranging from 1 to 4)	1.48	0.60	1.41	0.59	0.0656
COVID-19 protective behaviour: social distancing	The index of social distancing (ranging from 1 to 4)	3.02	0.79	2.80	0.87	0.221***
Behavioural immune system: germ avoidance	The index of germ avoidance (ranging from 1.75 to 3.63)	2.71	0.24	2.69	0.26	0.0262
Behavioural immune system: perceived infectability	The index of perceived infectability (ranging from 1.29 to 3.43)	2.35	0.25	2.33	0.27	0.0140
Belief in misinformation: non-psychological cure and prevention	The index of belief in misinformation about non-psychological cure and prevention (ranging from 1 to 4)	2.40	0.45	2.38	0.51	0.0192
Belief in misinformation: conspiracy	The index of belief in misinformation about conspiracy (ranging from 1 to 4)	1.98	0.55	2.13	0.63	-0.152***

1							
2							
3							
4	Belief in	The index of belief in	2.81	0.63	2.80	0.63	0.00746
5	misinformation:	misinformation about					
6	psychological	psychological cure and					
7	cure and	prevention (ranging					
8	prevention	from 1 to 4)					
9							
10	Age	Age	33.02	12.16	34.93	12.59	-1.912*
11							
12	Age square	Squared age	1237.78	912.43	1378.09	952.81	-140.3*
13							
14	Higher	(1) If the latest finished	0.66	0.48	0.65	0.48	0.00984
15	educational	education >= S1					
16	attainment	(undergraduate), (0)					
17		otherwise					
18							
19	Higher	(1) If higher education	0.05	0.22	0.01	0.11	0.0366**
20	education with	with health background;					
21	health	(0) otherwise					
22	background						
23							
24							
25	COVID-19	(1) If the respondent has	0.23	0.42	0.23	0.42	-0.00156
26	training	attended COVID					
27		training; (0) Otherwise					
28							
29	Observation		926		381		
30							

* $P < 0.1$, ** $P < 0.05$, *** $P < 0.01$

Appendix 5
Frequency of demographics and information characteristics

Characteristics	Obs	Frequency	Percentage (%)
Sex	1307		
Male		381	29.2
Female		926	70.8
Age	1306		
Under 24			
24-44			
45-65			
Living area	1307		
Depok city		132	10.1
Bekasi city/district		231	17.7
Bogor city/district		223	17.1
Tangerang/Tangerang Selatan city/district		238	18.2
Jakarta city		438	37
Main activity	1307		
Work		708	54.2
Housewife/househusband		142	10.9
Looking for a job/preparing a business		189	14.5
Student		154	11.8
Other		114	8.7
Type of job	708		
Owns a business with permanent workers/paid labors		9	1.3
Owns a business with temporary workers/unpaid labors		3	0.4
Self-employed		18	2.5
Civil servant/public employee		409	57.8
Private employee		238	33.6
Free worker		26	3.7
Family/unpaid worker		5	0.7
Social media usage	1307		
Very rarely		18	1.4
Rarely		100	7.7
Neutral		179	13.7
Often		653	50
Very often		357	27.3