Factors Associated With Physical Activity and COVID-19 Preventive Behaviors: A Cross-Sectional Study in Indonesian Adults

Novita Intan Arovah[1]*, Juni Kurniawaty[2], and Hartiah Haroen[3]

[1] Department of Sports Science, Sports Science Faculty, Yogyakarta State University, Yogyakarta, Indonesia
[2] Department of Anaesthesiology, Faculty of Medicine, Gadjah Mada University, Yogyakarta, Indonesia
[3] Department of Nursing, Faculty of Nursing, Universitas Padjajaran, Bandung, Indonesia
* Novita Intan Arovah, corresponding author. Email: novita@uny.ac.id
Submitted: 23 January 2022. Accepted: 23 September 2022. Published: 2 January 2023
Volume 31, 2023. pp. 318-336. http://doi.org/10.25133/JPSSv312023.019

Abstract

Studies have shown that coronavirus disease (COVID-19) preventive measures and regular physical activity are essential for reducing disease risk. As such, utilizing the health belief model (HBM) framework, this cross-sectional study aimed to assess the association between sociodemographic and social-cognitive explored factors with physical activity and COVID-19 preventive behaviors in a nationally represented sample of 871 Indonesian adults. The Global Physical Activity Questionnaire was used to assess physical activity levels. The COVID-19 preventive behaviors and the social-cognitive factors were measured using instruments adapted from the WHO-COVID-19 Snapshot Monitoring and based on the HBM framework. Logistic regression was used to evaluate the association between the outcomes and each potential correlate, adjusted for potential confounders. The results showed that women were more likely to engage in sufficient COVID-19 preventive behaviors, while older adults were less likely to be physically active. Participants with high social-cognitive processes were also more likely to engage in sufficient COVID-19 preventive behaviors and be physically active. The perceived barrier, however, was not associated with COVID-19 preventive practices. The findings support using the HBM in understanding COVID-19 preventive and physical activity behaviors. Interventions to improve COVID-19 preventive practices in this target population should focus more on men, while physical activity promotion should focus more on older adults.

Keywords

COVID-19; exercise; health belief model

Introduction

Indonesia has been inundated by the ongoing global COVID-19 pandemic, with more than 4 million confirmed COVID-19 cases and almost 150,000 deaths by the end of 2021 (Ministry of Health of the Republic of Indonesia, 2021). In mid-2021, Indonesia reported the highest number of active COVID-19 cases in Southeast Asia, second in Asia in fatalities (World Health Organization, 2021). In response, early on in 2020, the Indonesian government imposed a 'large-scale social restriction' to contain COVID-19 transmission, which later was modified in mid-2021 into the 'community activities restrictions enforcement' (Rosha et al., 2021) to regulate work-school, trade, social, and transportation activities.

Although the social restriction policy did not regulate physical activity specifically, it may have hindered communal movement, such as group exercise, thus potentially decreasing physical activity levels. The decline in physical activity could negatively affect the immune system, which would be counterproductive in curbing COVID-19 transmission. Regular moderate to vigorous physical activity (MVPA) increases antipathogenic activities of tissue macrophages, immunoglobulins, anti-inflammatory cytokines, neutrophils, natural killer cells, cytotoxic T cells, and B-cells, thus, increasing resistance to bacterial and viral infections, including coronavirus infection (da Silveira et al., 2021; Nieman, 2021). In addition, MVPA also reduces cortisol which could suppress immune cell function (Wood et al., 2018), improves metabolic parameters (Arovah & Kushartanti, 2019), and reduces systemic inflammations (Arovah & Kushartanti, 2020; Simpson et al., 2015); thus, boosting the immune system (Zheng et al., 2015) and contributing to preventing COVID-19 transmission. Individuals who consistently meet physical activity recommendations also have a reduced risk of experiencing severe COVID-19 symptoms once infected (da Silveira et al., 2021; Nieman, 2021; Scudiero et al., 2021). Therefore, interventions to promote the adoption of an active lifestyle and COVID-19 preventive behaviors should be a public health priority to curb COVID-19 transmission and fatality rates in Indonesia.

Since the enactment of the social restriction policy, several studies have reported resistance and non-compliance in following COVID-19 preventive measure policies among Indonesian adults, such as the lack of mask-wearing and limited physical distancing (Rosha et al., 2021; Yanti et al., 2020). Identifying those who need more support to adopt recommended COVID-19 preventive and physical activity behaviors to minimize non-compliance is recommended through exploring various correlates. The health belief model (HBM) is one of the most widely used behavior change theories for explaining health-related behaviors (Glanz et al., 2008), including COVID-19 preventive and physical activity behaviors. The HBM covers relevant constructs, which include perceived susceptibility, perceived severity, perceived benefits and barriers, and self-efficacy (Glanz et al., 2008). The HBM has been used to analyze COVID-19 preventive behaviors such as physical distancing (Raamkumar et al., 2020), quarantining (Al-Sabbagh et al., 2022), travel behavior (Naseer et al., 2021), attitudes toward contact tracing (Walrave et al., 2020), and vaccination (Chen et al., 2021; Erawan et al., 2021; Iacob et al., 2021).

While the HBM has been used to explore COVID-19 preventive behaviors correlates in many countries worldwide, the use of HBM in studies in Indonesia is still limited. Moreover, studies of COVID-19 preventive behaviors and physical activity levels in Indonesia have mainly been conducted regionally, such as in East Java (Winarti et al.,

2021), West Nusa Tenggara (Duarsa et al., 2021), and Greater Jakarta (Rosha et al., 2021). A few studies conducted at the national level only targeted specific demographics such as students (Aminah & Amaliyah, 2021; Saefi et al., 2020) and healthcare workers (Jamil et al., 2020; Rizki et al., 2021). The need for nationally representative data is concerning since Indonesia is heterogeneous, demographically and geographically, and what is applied in one regional area does not necessarily reflect the condition in other areas. Therefore, based on the HBM framework, this study aimed to assess the association between sociodemographic and social-cognitive explored factors with physical activity and COVID-19 preventive behaviors in a nationally represented sample of Indonesian adults. The findings from this study could be used as a basis for designing theoretically based interventions for promoting the adoption of recommended COVID-19 preventive and physical activity behaviors that best suit the target population.

Methods

Study design, settings, and ethical approval

This research was an observational cross-sectional study conducted among Indonesian adults between September to December 2020. This study was performed according to the ethical standards for human study and was approved by the Human Clinical Research Committee from the Gadjah Mada University (No: KE/0523/06/2020). Participants were provided with online informed consent prior to the study.

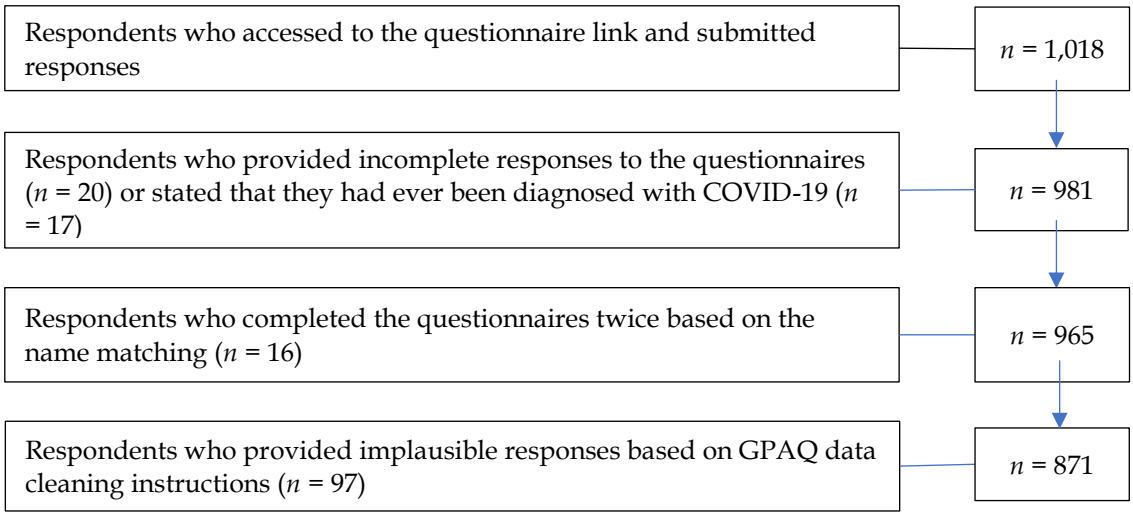
Sampling, data cleaning, and screening

As of January 2021, there were over 201 million internet users in Indonesia (approximately 73% of the population). Of those, 170 million were active social media users (Kemp, 2021), spending an average of three hours accessing social media daily (Nurhayati-Wolff, 2021). It is reasonable to expect that those connected with social media represent the general adult population in Indonesia. Therefore, to ensure that all 34 provinces in Indonesia were represented, relying on the authors' and research assistants' networks, the data were collected using an online questionnaire distributed through Indonesia's most popular social media platforms such as WhatsApp, Instagram, and Facebook (Kemp, 2021; Nurhayati-Wolff, 2021).

Non-probability sampling was conducted using the convenience sampling method. The inclusion criteria for the participants were 18 years of age or above, familiarity with Bahasa Indonesia (the official and national language of Indonesia), and adequate internet literacy to respond to the online survey. The exclusion criteria for the participants were those who did not fully complete the online questionnaire and those who had ever been diagnosed with COVID-19. The exclusion due to COVID-19 diagnosis was included as studies suggested that a significant proportion of COVID-19 survivors reported some psychopathological problems such as depression, anxiety, and insomnia (Mazza et al., 2020; Mazza et al., 2021); thus, these complications may influence their responses. Data from 1,018 respondents were entered into the initial database, followed by the removal of incomplete responses and those diagnosed with COVID-19. Next, further reduction of duplications based on name matching was conducted, followed by data cleaning based on the guidelines from the physical activity instrument scoring (Armstrong & Bull, 2006).

The data screening and cleaning process are illustrated in Figure 1. There were a total of 871 responses included for further analysis.

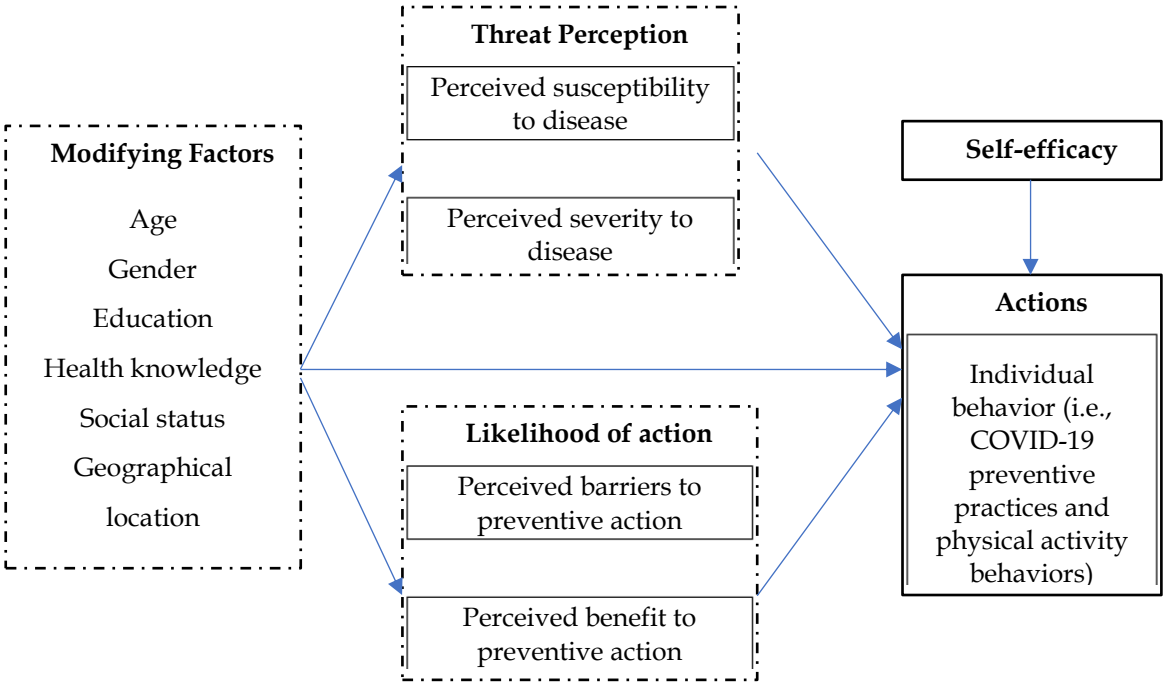
Figure 1: Flow Chart of Data Cleaning and Screening



Outcomes and predictors

Figure 2 summarizes the interactions among factors that influenced behaviors based on the HBM framework. As seen in Figure 1, this study focused on two behaviors (i.e., the COVID-19 preventive practices and physical activity levels). Based on the HBM, the behaviors were influenced by modifying factors (i.e., social demographic factors and health knowledge), individuals' beliefs (i.e., threat perception and the likelihood of action), and self-efficacy. Those factors, therefore, were assigned as potential predictors of COVID-19 preventive practices and physical activity levels.

Figure 2: Conceptual Framework of the Health Belief Model



Outcomes

The COVID-19 preventive practices were assessed using 14 behavior options adopted from the COVID-19 Snapshot Monitoring (COSMO) developed by the World Health Organization (WHO) (2020) to monitor public knowledge, risk perceptions, behaviors, and trust. Participants were allowed to select any combination of behaviors. Participants who chose none scored '0', while those who selected all responses scored '100'. Participants with a score above '50' were considered to be engaging in 'sufficient' COVID-19 preventive measures, while scores up to '50' were considered practicing 'insufficient' preventive measures.

Physical activity levels were measured using the Global Physical Activity Questionnaire (GPAQ). This questionnaire was selected because it was developed by the WHO for the surveillance of physical activity and was validated in adult populations in several countries (Armstrong & Bull, 2006; Bull et al., 2009). The questionnaire comprises 16 items related to work, active travel, recreational-related physical activity, and sedentary behavior (Armstrong & Bull, 2006). The total metabolic equivalent of tasks (METs) per week in three domains (i.e., work, active travel, and recreational) was calculated according to the standard GPAQ scoring (Armstrong & Bull, 2006).

First, the total METs for moderate physical activity were calculated by multiplying the time (minutes per week) spent walking, cycling, or moderate-intensity physical activity by 4. Second, the total METs per week for vigorous-intensity physical activity was calculated by multiplying the time (minutes per week) spent in vigorous activity by 8. Finally, the total METs per week were calculated by adding the total METs in moderate physical activity with total METs in vigorous physical activity (Armstrong & Bull, 2006). Based on the scoring guideline, participants meeting the threshold of 600 METs per week (150 minutes of moderate-intensity or 75 minutes of vigorously intense physical activity) were classified as participants with 'sufficient' physical activity levels. Participants who did not meet these criteria were considered to be engaging in 'insufficient' physical activity levels.

Predictors

Based on the framework illustrated in Figure 1, the potential predictors of COVID-19 preventive practices and physical activity behaviors are summarized in Table 1.

Table 1: Potential Correlates of COVID-19 Preventive Practices and Physical Activity Levels

Predictors/Outcome	COVID-19 Preventive Practices	Physical Activity levels
Social demography	Age, sex, marital status, education level, employment status, and area of residence (rural, suburban, or urban areas).	
Knowledge	COVID-19 sign symptoms COVID-19 transmission COVID-19 preventive measures COVID -19 incubation period	Recommended physical activity duration Recommended physical activity type Recommended physical activity intensity
Perceived Susceptibility	How susceptible are you to being infected with COVID-19?	
Perceived Severity	How severely will COVID-19 affect you if you get infected?	

Predictors/Outcome	COVID-19 Preventive Practices	Physical Activity levels
Perceived Benefit (likelihood)	How likely would you benefit from conducting safety precautions related to COVID-19 transmission prevention?	How likely that you would benefit from being physically active?
Perceived Benefit (Importance)	How important is the benefit that you may obtain from practicing safety measures again COVID-19?	How important is the benefit that you may obtain from being physically active?
Perceived Barrier	How challenging is the obstacle you face when engaging in COVID-19 prevention behaviors?	How challenging is the obstacle you face from being physically active?
Self-efficacy	How confident are you being able to conduct adequate safety measures to prevent the COVID-19 infection	How confident are you being able to be physically active?

Questions assessing the knowledge level of COVID-19 were also adapted from the COSMO questionaries (World Health Organization, 2020). The questions included signs, transmission routes, preventive measures, and the incubation period of the COVID-19 disease. The response options for the first three items were checkbox fields, while the last item was to choose one correct answer. The first three items were scored proportionally. The score ranged from '0' (minimum) to '100' (maximum). The fourth item was '0' for a correct response or '100' for an incorrect response. The total knowledge score was calculated as the mean of the four items, thus ranging from '0' to '100'.

The questions for assessing the level of knowledge on physical activity were developed based on the current physical activity recommendation that requires adults to achieve 150 to 300 minutes of moderate-intensity physical activity per week, which includes both aerobic and strengthening exercises. The questions, therefore, assessed participants' knowledge of the duration, intensity, and type of exercise or physical activity. Each question was provided with one correct response. The proper response scored '100', while the incorrect answer scored '0'. The total knowledge score was calculated as the mean of the three items, thus ranging from '0' to '100'. Participants' knowledge was considered 'high' when they scored more than '50' and 'low' when they scored up to '50'.

The social-cognitive predictors were derived from the HBM framework (see Figure 2 and Table 1). Participants were asked to rate the threat perception (i.e., perceived susceptibility and perceived severity), the likelihood of action (i.e., perceived barriers and perceived benefits), and self-efficacy related to the outcome variables. The Likert scale response options ranged from '1' to '5'. For scoring purposes, '1' was recoded into '0', '2' into '25', '3' into '50', '4' into '75', and '5' into '100', except for the perceived barrier item in which the score was reversed; thus, a higher score reflects a lower barrier. Participants who scored above '50' were considered to have a 'high level' of the social-cognitive process, while those who scored up to '50' were considered to have a 'low' level of the social-cognitive process.

Statistical analysis

Descriptive statistics were used to summarize participants' characteristics. All social demography variables were treated as categorical variables and were presented as percentages. The COVID-19 preventive behaviors and physical activity levels were then

compared between these social demography characteristics using the Kruskal Wallis or Mann Whitney test to account for the non-normality of the data.

The summary statistics also described the overall COVID-19 preventive behaviors, physical activity levels, and each potential predictor. Comparisons were also made between the 'sufficient' and 'insufficient' COVID-19 preventive and physical activity behaviors using the Kruskal Wallis or Mann Whitney test to also account for the non-normality of the data.

Finally, logistic regressions were carried out to calculate the odds ratio of each potential correlate in conducting sufficient COVID-19 preventive behaviors and in engaging with sufficient physical activity, adjusted for potential social demographic confounders. Statistical Package for Social Sciences (SPSS) v. 25.0 and a significance level of 5% were used for data analysis.

Results

Comparisons of preventive behaviors and physical activity behaviors

A total of 871 respondents (55% of whom were women) were included in the study analysis. The complete distribution of participants in each province is summarized and compared in Table 2. All 34 provinces in Indonesia were represented in this study. The Kruskal Wallis analysis reported significant differences in COVID-19 preventive behaviors at H (33) = 98, $p <$ .001, and physical activity behaviors at H (33) = 07, $p <$ .001, among participants from all provinces.

Table 2: Comparison of COVID-19 Preventive Behaviors and Physical Activity Behaviors Based on Provinces of Origin (n = 871)

Provinces			COVID-19 preventive practices		Physical activity levels	
		n	**Mean**	**SD**	**Mean**	**SD**
1.	Aceh	15	46	20	1,277	811
2.	Bangka Belitung	19	57	18	1,048	583
3.	Riau Islands	13	58	18	1,166	720
4.	Riau	16	59	22	795	933
5.	Bengkulu	23	57	24	1,370	633
6.	Lampung	27	90	17	1,787	532
7.	Jambi	39	64	24	1,236	802
8.	West Sumatera	17	58	19	1,016	1,021
9.	South Sumatera	20	63	29	1,472	812
10.	North Sumatera	23	65	17	1,423	548
11.	Banten	39	58	23	1,109	779
12.	Jakarta	65	58	29	1,240	1,181
13.	West Java	52	57	23	1,314	833
14.	Central Java	52	74	24	1,431	588
15.	East Java	60	62	20	1,343	912

Provinces		COVID-19 preventive practices		Physical activity levels	
	n	Mean	SD	Mean	SD
16. Yogyakarta	49	72	28	1,696	567
17. Bali	35	58	24	1,190	832
18. West Kalimantan	23	54	24	1,237	463
19. South Kalimantan	15	58	30	500	574
20. Central Kalimantan	11	55	23	749	812
21. East Kalimantan	20	59	26	1,334	1,004
22. North Kalimantan	12	61	30	1,240	919
23. West Sulawesi	15	48	30	866	1,007
24. South Sulawesi	14	61	28	1,503	863
25. Central Sulawesi	22	64	23	1,045	1,007
26. Eastern South Sulawesi	21	64	25	1,252	173
27. North Sulawesi	23	51	28	899	633
28. Gorontalo	23	53	28	803	683
29. Maluku	16	50	33	445	739
30. North Maluku	14	63	19	970	992
31. West Nusa Tenggara	22	57	31	1,685	805
32. East Nusa Tenggara	22	72	16	1,871	715
33. Papua	21	55	26	1,426	421
34. West Papua	13	49	23	478	406

Note: SD = Standard deviation

Table 3 compares COVID-19 preventive and physical activity behaviors based on participants' social demographics. As seen in Table 3, most participants were young adults aged 18 to 45 with secondary education, employed, married, and living in suburban areas. Table 3 also shows that women scored significantly higher than men in COVID-19 preventive behaviors ($p < .01$), while students were less physically active than non-students ($p < .001$). Based on Tables 2 and 3, the logistic regressions would be adjusted for sex and province of origin for COVID-19 behavior and working status and province of origin for physical activity behavior.

Table 3: Comparisons of COVID-19 Preventive Practices and Physical Activity Levels Based on the Social Demographic Characteristics (n = 871)

Correlates	N (%)	COVID-19 preventive practices	*p*	Physical activity levels	*p*
Sex					
Women	478 (55%)	65 ± 24	**< .01**	1,457 ± 977	.334
Men	393 (45%)	57 ± 24		1,380 ± 967	
Age					
18–45 (young adults)	610 (70%)	62 ± 26	.558	1,454 ± 958	.160
45–64 (middle-aged)	208 (24%)	60 ± 25		1,374 ± 972	
65+ (older adults)	53 (6%)	58 ± 28		1,246 ± 1,120	
Education					
Primary (up to 6 years)	17 (2%)	53 ± 27	.210	1,446 ± 1,107	.564
Secondary (6–12 years)	500 (57%)	61 ± 25		1,395 ± 968	
Tertiary >12 years	354 (41%)	62 ± 26		1,459 ± 974	
Working status					
Students	253 (29%)	59 ± 26	.133	1,224 ± 950	**< .001**

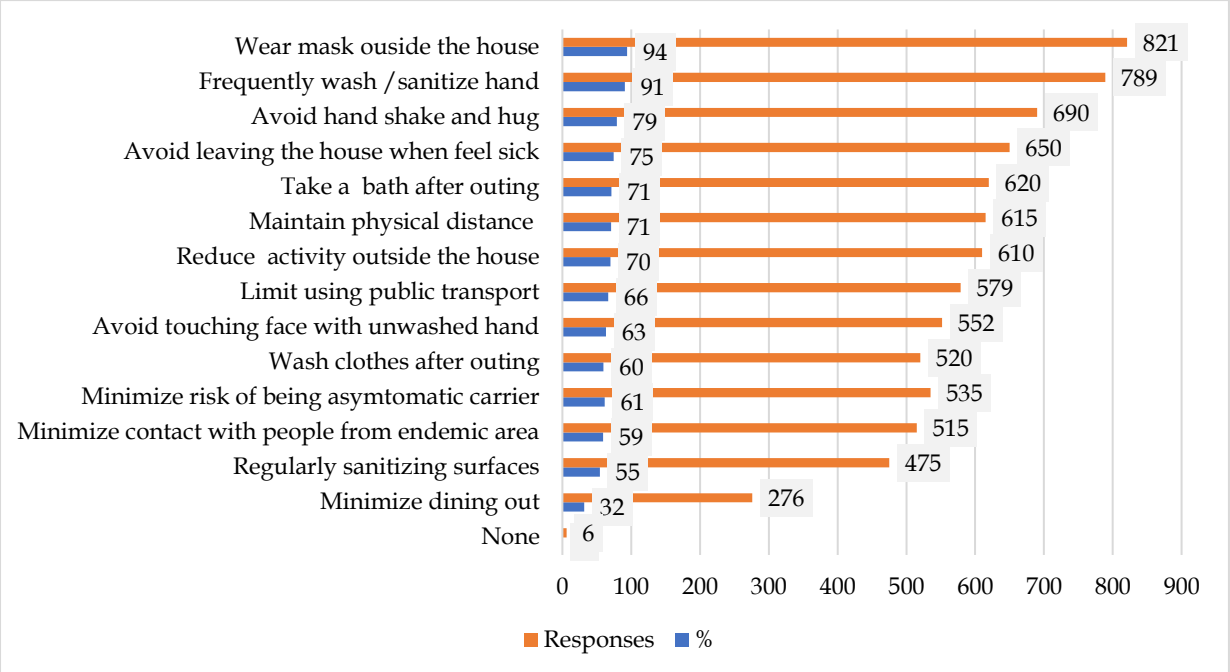
Correlates	N (%)	COVID-19 preventive practices	*p*	Physical activity levels	*p*
Employed	512 (59%)	61 ± 25		1,487 ± 961	
Unemployed/retired	106 (12%)	65 ± 26		1,585 ± 1,016	
Marital status					
Married	691 (79%)	60 ± 26	.118	1,404 ± 961	.285
Not Married	180 (21%)	64 ± 25		1,490 ± 1,015	
Locality					
Urban	198 (23%)	62 ± 26		1,304 ± 943	
Suburban	396 (45%)	63 ± 26		1,485 ± 1,001	
Rural	277 (32%)	58 ± 25	.050	1,304 ± 943	.061

Note: Bold = significant

COVID-19 preventive practices and physical activity levels

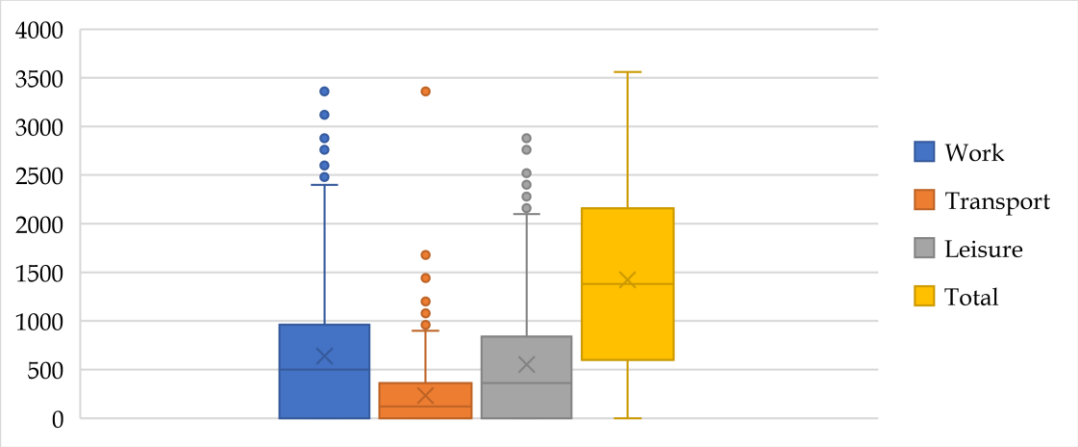
On average, participants engaged in 61 ± 25% of the recommended COVID-19 prevention practice. Figure 3 further illustrates that wearing masks and hand sanitizing were two preventive measures conducted by more than 90% of participants, while avoiding people from endemic areas, sanitizing surfaces, and avoiding dining out were only practiced by less than 60%. Six participants did not practice any of the preventive measures. As illustrated in Table 4, 625 (72%) participants were classified as engaging in 'sufficient' COVID-19 prevention practices, while 246 (28%) were classified as engaging in 'insufficient' practices.

Figure 3: COVID-19 Preventive Practices (*n* = 871)



The average total physical activity was 1422 ± 972 METs per week. The average for work-related, transport-related, and leisure-based physical activity was 639 ± 641, 232 ± 333, and 551 ± 580 METs per week, respectively. Of the 871 participants, 635 (73%) engaged in sufficient physical activity levels, while 236 (27%) did not. Figure 4 further illustrates the distribution of physical activity data.

Figure 4: Physical Activity Levels (n = 871)



Social-cognitive predictors for COVID-19 preventive practices and physical activity levels

As seen in Table 4, participants with sufficient COVID-19 preventive practices and physical activity levels had higher knowledge and HBM-based social-cognitive levels than those with insufficient COVID-19 preventive practices and physical activity levels.

Table 4: Comparisons of the COVID-19 Preventive Practices and Physical Activity Levels Based on the Social Demographic Characteristics

		COVID-19 preventive practices			Physical activity levels			
Social-cognitive predictors	**Total**	**Sufficient n = 625**	**Insufficient n = 246**	p	**Total**	**Sufficient n = 635**	**Insufficient n = 236**	p
Knowledge	79 ± 13	82 ± 8	71 ± 13	**< .001**	87 ± 28	99 ± 9	55 ± 35	**< .001**
Perceived susceptibility	44 ± 38	47 ± 38	38 ± 34	**< .005**	44 ± 38	50 ± 38	29 ± 34	**< .001**
Perceived severity	42 ± 38	44 ± 38	35 ± 32	**< .004**	42 ± 38	48 ± 38	26 ± 32	**< .001**
Perceived benefit (likelihood)	48 ± 38	54 ± 38	33 ± 26	**< .001**	65 ± 33	70 ± 30	53 ± 35	**< .001**
Perceived benefit (importance)	47 ± 33	53 ± 30	33 ± 35	**< .001**	65 ± 33	70 ± 30	52 ± 36	**< .001**
Perceived barriers*	47 ± 37	53 ± 34	32 ± 38	**.004**	62 ± 37	68 ± 34	45 ± 40	**< .001**
Self-efficacy	45 ± 39	52 ± 39	32 ± 25	**< .001**	44 ± 39	49 ± 39	29 ± 33	**< .001**

*Note: * Inversed scoring (higher score reflects low perception); bold = significant*

The association of social demography and social-cognitive processes with COVID-19 preventive practices and physical activity levels

The associations between social demography characteristics and COVID-19 preventive practices and physical activity levels are summarized in Table 5. As seen in Table 5, women were more likely than men to engage in sufficient COVID-19 preventive behaviors in both adjusted and unadjusted models. In the adjusted model, older adults were less likely to engage in sufficient physical activity levels than younger adults.

Table 5: Association of the Social Demographic Characteristics and the Outcomes (n = 871)

	COVID-19 preventive practices						**Physical activity levels**					
	Unadjusted			**Adjusted***			**Unadjusted**			**Adjusted****		
	OR	**95% CI**	***p***	**OR**	**95% CI**	***p***	**OR**	**95% CI**	***p***	**OR**	**95% CI**	***p***
Sex												
Men (ref)	1			1			1					
Women	**1.99**	**1.47-2.68**	**< .001**	**2.03**	**1.50-2.73**	**< .001**	1.17	0.86-1.57	.318	1.19	0.89-1.62	.239
Age												
18–45 (ref)	1						1					
45–64	0.88	0.62-1.25	.471	0.91	0.64-1.30	.612	0.83	0.59-1.18	.308	**0.59**	**0.39-0.88**	**.010**
65+	0.73	0.40-1.31	.294	0.77	0.43-1.44	.436	**0.47**	**0.27-0.85**	**.012**	**0.34**	**0.19-0.64**	**< .001**
Education												
Tertiary (ref)	1						1					
Secondary	0.83	0.61-1.13	.236	0.76	0.55-1.03	.081	0.94	0.69-1.28	.714	0.94	0.69-1.28	.703
Primary	0.39	0.15-1.04	.060	0.47	0.17-1.27	.136	0.65	0.24-1.81	.414	0.65	0.23-1.84	.703
Working status												
Unemployed (ref)	1						1					
Employed	0.97	0.61-1.55	.905	0.82	0.50-1.32	.415	1.02	0.63-1.67	.912	1.02	0.62-1.65	.440
Students	0.91	0.55-1.51	.718	0.82	0.49-1.37	.446	0.62	0.37-1.04	.025	0.62	0.37-1.04	.067
Marital status												
Not married(ref)	1						1					
Married	1.15	0.79-1.66	.476	1.12	0.81-1.73	.374	0.89	0.62-1.29	.543	0.76	0.52-1.11	.161
Locality												
Urban (ref)	1						1					
Suburban	0.95	0.65-1.40	.794	0.91	0.62-1.36	.662	1.04	0.60-1.36	.841	1.03	0.69-1.52	.888
Rural	0.79	0.53-1.19	.258	0.75	0.50-1.14	.176	0.77	0.51-1.16	.210	0.77	0.51-1.16	.209

*Note: * adjusted for sex and provinces; ** adjusted for working status and provinces; bold = significant; OR = odds ratio*

The associations between the level of knowledge and HBM-based social-cognitive processes with the COVID-19 preventive practices and physical activity levels are summarized in Table 6. Participants with higher knowledge and HBM-based social-cognitive processes were more likely to engage in sufficient COVID-19 preventive practices (all $p < .001$) in unadjusted and adjusted models, except for the perceived barriers. The odds ratio (OR) of conducting sufficient COVID-19 preventive practices ranged from OR = 1.43, 95% CI [1.06, 1.94], $p = .020$ for knowledge, and OR = 2.67, 95% CI [1.93, 3.61], $p < .001$ for self-efficacy. Participants with better knowledge and favorable social-cognitive processes were also more likely to engage in sufficient physical activity (all $p < .001$), with odds ratio ranging from OR = 1.08, 95% CI [1.07, 1.09] knowledge of physical activity and OR = 2.74, 95% CI [1.99, 3.75] for perceived barriers of physical activity.

Table 6: The Association of the Health Belief Model Concepts and the Outcomes

	COVID-19 Preventive Practices						Physical Activity levels					
	Unadjusted			Adjusted*			Unadjusted			Adjusted**		
	OR	95% CI	*p*	OR	95% CI	*p*	OR	95% CI	*p*	OR	95% CI	*p*
Knowledge												
Low (ref)	1						1					
High	2.57	1.41-4.74	.002	2.45	1.33-4.52	**.004**	1.85	1.37-2.50	< .001	1.08	1.07-1.09	**< .001**
Perceived susceptibility												
Low (ref)	1						1					
High	1.53	1.18-2.06	.005	1.43	1.06-1.94	**.020**	2.51	1.83-3.42	< .001	2.42	1.77-3.30	**< .001**
Perceived severity												
Low (ref)	1						1					
High	1.65	1.22-2.23	.001	1.54	1.13-2.09	**.006**	2.81	2.03-3.87	< .001	2.67	1.94-3.71	**< .001**
Perceived benefit (likelihood)												
Low (ref)	1						1					
High	2.18	1.62-2.94	< .001	2.14	1.57-2.89	**< .001**	2.63	1.87-3.68	< .001	2.67	1.90-3.76	**< .001**
Perceived benefit (importance)												
Low (ref)	1						1					
High	2.30	1.70-3.12	< .001	2.26	1.67-3.61	**< .001**	2.58	1.83-3.62	< .001	2.66	1.88-3.75	**< .001**
Perceived barrier												
High (ref)	1						1					
Low	1.40	1.03-1.90	.034	1.24	0.90-1.70	.185	2.83	2.06-3.87	< .001	2.74	1.99-3.75	**< .001**
Self-efficacy												
Low (ref)	1						1					
High	2.67	1.98-3.67	< .001	2.67	1.93-3.61	**< .001**	2.33	1.70-3.17	< .001	2.29	1.68-3.13	**< .001**

*Note: * adjusted for sex and provinces; ** adjusted for working status and provinces; bold = significant; OR = odds ratio*

Discussion

Using a nationally representative sample of Indonesian adults, this study is the first to investigate the social demographic and HBM-based social-cognitive correlates of COVID-19 preventive practices and physical activity levels. This study also provides much-needed data on the most common COVID-19 preventive behaviors and physical activity levels among Indonesian adults during the COVID-19 pandemic. Our findings indicate that women are more likely to engage in sufficient COVID-19 preventive practices than men. At the same time, older adults are less likely to engage in sufficient physical activity levels than younger adults. Participants with a high level of social-cognitive processes are significantly more likely to engage in sufficient COVID-19 preventive practices and be

physically active, except for the perceived barrier that was not associated with the COVID-19 preventive practices.

The findings indicate that our participants' three most practiced preventive measures are regularly wearing masks, sanitizing or washing hands, and avoiding physical contact. The results align with Saefi et al. (2020), who reported that the above preventive measures were the three most frequent practices conducted by undergraduate students in Indonesia. Our finding is also in line with Sulistyawati et al. (2021), who found that more than 70% of Indonesian adults reported regular use of hand sanitizer and masks. However, several measures, such as sanitizing surfaces and minimizing dining out, still needed to be adequately practiced. The findings highlight the need to develop public health campaigns to focus more on modifying these behaviors.

In this current study, women are more likely to engage in sufficient COVID-19 preventive practices than men. The finding is consistent with Amarie et al. (2020), who found that females tended to have good practices toward COVID-19 prevention among Javanese adults. In another study on a regional area in Indonesian adults, Muslih et al. (2021) also revealed that women were 1.25 times more likely than men to wear a mask when leaving home and were more likely to comply with regulations regarding social restrictions in the Greater Jakarta, the capital city of Indonesia (Rosha et al., 2021). Similarly, studies on US adults (Guidry et al., 2021), Iran older adults (Zareipour et al., 2020), and Sudanese adults (Mehanna et al., 2021) also reported that women were more likely to engage in COVID-19 preventive practices. These findings indicate that public health campaigns on COVID-19 preventive behaviors among Indonesian adults may need to focus more on men seeing as they are less likely to adhere to COVID-19 preventive measures.

Our study demonstrates that participants with higher HBM-based social-cognitive processes are more likely to engage in sufficient COVID-19 preventive practices. To some extent, the findings aligned with other studies from regional areas in Indonesia (Duarsa et al., 2021; Fikriana et al., 2021; Winarti et al., 2021), as well as studies in other countries such as Sudan (Mehanna et al., 2021), Ethiopia (Shewasinad Yehualashet et al., 2021; Tadesse et al., 2020), Saudi Arabia (Syed et al., 2021), Iran (Fathian-Dastgerdi et al., 2021; Karimy et al., 2021; Shahnazi et al., 2020; Yeganeh & Karami, 2021; Zareipour et al., 2020), and the United States (Guidry et al., 2021). Although low perceived barriers were not associated with the likelihood of engaging in sufficient COVID-19 practice, the overall findings support the potential use of HBM to understand the correlates of COVID-19 preventive behaviors and to use the framework as the basis for developing public health programs for promoting these behaviors.

This current study demonstrates that most participants engage in sufficient physical activity levels. The proportion of participants who engage with sufficient physical activity levels is comparable to that reported in the Indonesian National Health Survey pre-pandemic in 2018 (Ministry of Health of the Republic of Indonesia, 2019). The finding, thus, did not indicate a decline in physical activity levels during the COVID-19 pandemic. The result contrasts with the reductions in physical activity levels during the COVID-19 pandemic reported in a few studies. A study in Thailand reported a decline in physical activity levels from 74.6% in the pre-pandemic period to 54.7% during the pandemic period in the general population (Katewongsa et al., 2021). A study on Italian students also reported a reduction in the number of students who were physically active before the pandemic, which was 72.2%, and decreased to 29.6% during containment measures (Bertocchi et al., 2021). Another cross-sectional multinational study of adults also reported that a sizeable number of individuals

(44.8%) reported a decline in their physical activities during the lockdown, with 43.9% classified as physically inactive (Ding et al., 2021).

The discrepancies between our findings with other studies may be attributed to several factors. First, we used the Global Physical Activity Questionnaire (GPAQ), which was a different physical activity instrument than what was used in the Indonesian National Health Survey 2018, which assessed physical activity levels by only asking participants whether they participated in 150 minutes of moderate-intensity physical activity during the last week. Due to the difference in the instruments, the numbers could not be readily compared. Second, there were differences in the social restriction policy worldwide, including in Indonesia. The term 'lockdown' has never been used in the social restriction policy in Indonesia, illustrating that the country may have had a more lenient social restriction policy compared to several other countries. Solitary or individual physical activity was also not prohibited in Indonesia during the restriction, which might have provided opportunities for Indonesians to be more physically active than in other countries that employed much more restrictive physical activity policies during the COVID-19 pandemic.

Moreover, studies also suggest several classes of growth trajectories of physical activity levels during COVID-19 social restriction, which included regular classes showing little physical activity change or increases over time in other populations during the pandemic (Bu et al., 2021; Spence et al., 2021). These groups may be the majority of our participants, as anecdotal evidence shows a large group of Indonesians who became more physically active during the pandemic due to the health campaign and the more flexible working hours resulting from the 'work from home' policy. We, however, could not rule out the possibility of over-reporting in our participants, as we used a subjective physical activity measure, although we have conducted the data cleaning as suggested by the GPAQ scoring guideline to minimize the tendency of over-reporting. Thus, further research to confirm these findings is recommended. The finding of this study also indicates that older adults were less likely to engage in sufficient physical activity compared to younger adults. Participants with higher knowledge levels and social-cognitive processes were more likely to engage in sufficient physical activity. Our findings align with the physical activity correlates from a national sample of Indonesian adults conducting pre-pandemic, indicating that older age increases the risk of being physically inactive (Pengpid & Peltzer, 2018). We could not compare this finding with physical activity correlate studies during the pandemic as the studies are lacking.

Our results also indicate that HBM-based social-cognitive processes are positively associated with the likelihood of engaging in physical activity. Although the HBM has been widely used to study physical activity correlates pre-pandemic (Ar-yuwat et al., 2013; Hosseini et al., 2017), only a few studies focused on using the HBM to understand physical activity behavior during the COVID-19 pandemic. One of the studies conducted in Yogyakarta, Indonesia, found that social-cognitive processes related to HBM were also correlated with physical activity levels (Zar'in & Arovah, 2021). Our findings confirm the potential use of HBM to understand physical activity behavior in this target population during the pandemic.

We have identified social demography and cognitive correlates of COVID-19 preventive and physical activity behaviors and indicated the potential use of HBM in understanding these behaviors using nationally representative data of Indonesian adults. Several limitations of this study, however, are acknowledged. First, we used an online survey from social media. Our participants, limited to those within the social media network, may limit the generalizability of our findings to populations who usually are not connected with social media. Second, the study was a cross-sectional design. Causation could not be inferred from this study. Therefore,

future studies need to consider sampling techniques to improve the sample's heterogeneity and employ longitudinal design to detect changes across time and intervention studies while allowing for a causation inference.

Conclusion

Extensive health education campaigns on COVID-19 preventive behaviors should be provided to the general population and those less likely to adhere to COVID-19 preventive measures (i.e., men). At the same time, physical activity promotion needs to be emphasized in older adults. The HBM-based COVID-19 prevention and physical activity intervention are recommended for this target population.

Funding

This study was funded by the Yogyakarta State University Unggulan Research Grant (No: T/10.8/UN/34.21/PT.01.03/2020).

Acknowledgments

This study was funded by Unggulan Research from Yogyakarta State University, Indonesia. We thank students in the Sports Science Faculty at Yogyakarta State University: Andri Bangsawan, Ngafiatus Sholihah, Feonika Azhari Damayanti, Arika Umi Zaarin, and Elsa Ariestika, who assisted with the data collection and management.

References

Al-Sabbagh, M. Q., Al-Ani, A., Mafrachi, B., Siyam, A., Isleem, U., Massad, F. I., Alsabbagh, Q., & Abufaraj, M. (2022). Predictors of adherence with home quarantine during COVID-19 crisis: The case of health belief model. *Psychology, Health & Medicine*, *27*(1), 215–227. https://doi.org/10.1080/13548506.2021.1871770

Amarie, A., Udijono, A., Kusariana, N., & Saraswati, L. D. (2020). Description of knowledge, attitude, and practice of coronavirus disease-19 prevention based on gender and age in Java Island community. *Journal of Public Health for Tropical and Coastal Region*, *3*(2), 26–30. https://doi.org/10.14710/jphtcr.v3i2.9487

Aminah, A., & Amaliyah, E. (2021). Knowledge, attitudes and behavior of nursing students towards the Covid-19 pandemic in Indonesia. *Jurnal Aisyah: Jurnal Ilmu Kesehatan*, *6*(1), 91–96. https://doi.org/10.30604/jika.v6i1.436

Armstrong, T., & Bull, F. (2006). Development of the World Health Organization Global Physical Activity Questionnaire (GPAQ). *Journal of Public Health*, *14*(2), 66–70. https://doi.org/10.1007/s10389-006-0024-x

Arovah, N. I., & Kushartanti, B. M. W. (2019). Moderate-vigorous physical activity and clinical parameters in adults with type 2 diabetes mellitus: A report from the Walking with Diabetes study. *Romanian Journal of Diabetes Nutrition and Metabolic Diseases, 26*(2), 107–117. https://www.rjdnmd.org/index.php/RJDNMD/article/view/566

Arovah, N. I., & Kushartanti, B. W. (2020). The acute effect of a moderate intensity ergocycle exercise on the coagulation parameters in type 2 diabetes mellitus patients: A feasibility study. *Clinical Diabetology, 9*(4), 219–225. https://doi.org/10.5603/DK.2020.0029

Ar-yuwat, S., Clark, M. J., Hunter, A., & James, K. S. (2013). Determinants of physical activity in primary school students using the health belief model. *Journal of Multidisciplinary Healthcare*, *6*, 119–126. https://doi.org/10.2147/JMDH.S40876

Bertocchi, L., Vecchio, R., Sorbello, S., Correale, L., Gentile, L., Buzzachera, C., Gaeta, M., & Odone, A. (2021). Impact of the COVID-19 pandemic on physical activity among university students in Pavia, Northern Italy. *Acta Bio Medica: Atenei Parmensis, 92*(S6), Article e2021443. https://doi.org/10.23750/abm.v92is6.12232

Bu, F., Bone, J. K., Mitchell, J. J., Steptoe, A., & Fancourt, D. (2021). Longitudinal changes in physical activity during and after the first national lockdown due to the COVID-19 pandemic in England. *Scientific Reports, 11*(1), Article 17723. https://doi.org/10.1038/s41598-021-97065-1

Bull, F. C., Maslin, T. S., & Armstrong, T. (2009). Global Physical Activity Questionnaire (GPAQ): Nine country reliability and validity study. *Journal of Physical Activity and Health*, *6*(6), 790–804. https://doi.org/10.1123/jpah.6.6.790

Chen, H., Li, X., Gao, J., Liu, X., Mao, Y., Wang, R., Zheng, P., Xiao, Q., Jia, Y., Fu, H., & Dai, J. (2021). Health Belief Model perspective on the control of COVID-19 vaccine hesitancy and the promotion of vaccination in China: Web-based cross-sectional study. *Journal of Medical Internet Research*, *23*(9), Article e29329. https://doi.org/10.2196/29329

da Silveira, M. P., da Silva Fagundes, K. K., Bizuti, M. R., Starck, É., Rossi, R. C., & de Resende e Silva, D. T. (2021). Physical exercise as a tool to help the immune system against COVID-19: An integrative review of the current literature. *Clinical and Experimental Medicine*, *21*(1), 15–28. https://doi.org/10.1007/s10238-020-00650-3

Ding, K., Yang, J., Chin, M. K., Sullivan, L., Durstine, J. L., Violant-Holz, V., Demirhan, G., Oliveira, N., Popeska, B., Kuan, G., Khan, W., Dai, J., Xu, X., Mladenova, Z., Balasekaran, G., Smith, G. A., & on behalf of Global Community Health-Covid-Collaborative Research Team. (2021). Physical Activity among adults residing in 11 countries during the COVID-19 pandemic lockdown. *International Journal of Environmental Research and Public Health, 18*(13), Article 7056. https://doi.org/10.3390/ijerph18137056

Duarsa, A. B. S., Mardiah, A., Hanafi, F., Karmila, D., & Anulus, A. (2021). Health belief model concept on the prevention of coronavirus disease-19 using path analysis in West Nusa Tenggara, Indonesia. *International Journal of One Health*, *7*(1), 31–36. www.doi.org/10.14202/IJOH.2021.31-36

Erawan, M. A. S. P., Zaid, Z., Pratondo, K., & Lestari, A. Y. (2021). Predicting Covid-19 vaccination intention: The role of Health Belief Model of Muslim societies in Yogyakarta. *Al-Sihah: The Public Health Science Journal*, *13*(1), 36–50. https://doi.org/10.24252/al-sihah.v13i1.20647

Fathian-Dastgerdi, Z., Khoshgoftar, M., Tavakoli, B., & Jaleh, M. (2021). Factors associated with preventive behaviors of COVID-19 among adolescents: Applying the health belief model. *Research in Social and Administrative Pharmacy*, *17*(10), 1786–1790. https://doi.org/10.1016/j.sapharm.2021.01.014

Fikriana, R., Fahrany, F., & Rusli, S. A. (2021). Health belief associated with adherence to health protocol in preventing coronavirus diseases on patients' family. *Open Access Macedonian Journal of Medical Sciences*, *9*(B), 1011–1015. https://doi.org/10.3889/oamjms.2021.6762

Glanz, K., Rimer, B. K., & Viswanath, K. (Eds.) (2008). *Health behavior and health education: theory, research, and practice* (4th ed.). Jossey-Bass.

Guidry, J. P., O'Donnell, N. H., Austin, L. L., Coman, I. A., Adams, J., & Perrin, P. B. (2021). Stay socially distant and wash your hands: Using the Health Belief Model to determine intent for COVID-19 preventive behaviors at the beginning of the pandemic. *Health Education & Behavior*, *48*(4), 424–433. https://doi.org/10.1177/10901981211019920

Hosseini, H., Moradi, R., Kazemi, A., & Shahshahani, M. S. (2017). Determinants of physical activity in middle-aged woman in Isfahan using the health belief model. *Journal of Education and Health Promotion*, *6*, Article 26. https://doi.org/10.4103/jehp.jehp_68_15

Iacob, C. I., Ionescu, D., Avram, E., & Cojocaru, D. (2021). COVID-19 pandemic worry and vaccination intention: The mediating role of the Health Belief Model components. *Frontiers in Psychology*, *12*, Article 674018. https://doi.org/10.3389/fpsyg.2021.674018

Jamil, K., Harapan, H., Winardi, W., Yufika, A., Anwar, S., Librianty, N., Prashanti, N. P., Sari, T. W., Utomo, P., Dwiamelia, T., Natha, P. C., Salwiyadi, S., Asrizal, F., Ikram, I., Wulandari, I., Haryanto, S., Fenobileri, N., Wagner, A., & Mudatsir, M. (2020). Knowledge of coronavirus disease 2019 (COVID-19) among healthcare providers: A cross-sectional study in Indonesia. *Asian Pacific Journal of Tropical Medicine, 13*(9), 402–408. https://doi.org/10.4103/1995-7645.290584

Karimy, M., Bastami, F., Sharifat, R., Heydarabadi, A. B., Hatamzadeh, N., Pakpour, A. H., Cheraghian, B., Zamani-Alavijeh, F., Jasemzadeh, M., & Araban, M. (2021). Factors related to preventive COVID-19 behaviors using health belief model among general population: A cross-sectional study in Iran. *BMC Public Health*, *21*(1), Article 1934. https://doi.org/10.1186/s12889-021-11983-3

Katewongsa, P., Widyastari, D. A., Saonuam, P., Haemathulin, N., & Wongsingha, N. (2021). The effects of the COVID-19 pandemic on the physical activity of the Thai population: Evidence from Thailand's Surveillance on Physical Activity 2020. *Journal of Sport and Health Science, 10*(3), 341–348. https://doi.org/10.1016/j.jshs.2020.10.001

Kemp, S. (2021, February 11). *Digital 2021: Indonesia*. DataReportal. https://datareportal.com/reports/digital-2021-indonesia

Mazza, M. G., De Lorenzo, R., Conte, C., Poletti, S., Vai, B., Bollettini, I., Melloni, E. M. T., Furlan, R., Ciceri, F., COVID-19 BioB Outpatient Clinic Study group, & Rovere-Querini, P. (2020). Anxiety and depression in COVID-19 survivors: Role of inflammatory and clinical predictors. *Brain, Behavior, and Immunity, 89*, 594–600. https://doi.org/10.1016/j.bbi.2020.07.037

Mazza, M. G., Palladini, M., De Lorenzo, R., Bravi, B., Poletti, S., Furlan, R., Ciceri, F., COVID-19 BioB Outpatient Clinic Study Group, Rovere-Querini, P., & Benedetti, F. (2021). One-year mental health outcomes in a cohort of COVID-19 survivors. *Journal of Psychiatric Research, 145*, 118–124. https://doi.org/10.1016/j.jpsychires.2021.11.031

Mehanna, A., Elhadi, Y. A. M., & Lucero-Prisno, D. E. III. (2021). Public willingness to adhere to COVID-19 precautionary measures in Sudan: An application of the Health Belief Model. *Pan African Medical Journal*, *39*, Article 135. https://doi.org/10.11604/pamj.2021.39.135.29171

Ministry of Health of the Republic of Indonesia. (2019). *Laporan Nasional Riskesdas 2018 [National Risk Report 2018].* http://labdata.litbang.kemkes.go.id/images/download/laporan/RKD/2018/Laporan_Nasional_RKD2018_FINAL.pdf

Ministry of Health of the Republic of Indonesia. (2021). *Peta sebaran COVID-19 [COVID-19 distribution Map].* Indonesian Health Ministry. Retrieved December 12, 2021, from https://covid19.go.id/peta-sebaran-covid19

Muslih, M., Susanti, H. D., Rias, Y. A., & Chung, M.-H. (2021). Knowledge, attitude, and practice of Indonesian residents toward COVID-19: A cross-sectional survey. *International Journal of Environmental Research and Public Health*, *18*(9), Article 4473. https://doi.org/10.3390/ijerph18094473

Naseer, K., Qazi, J., Qazi, A., Avuglah, B. K., Tahir, R., Rasheed, R. A., Khan, S. K., Khan, B. A., Zeeshan, M., & Humayun, M. A. (2021). Travel behaviour prediction amid Covid-19 underlaying situational awareness theory and health belief model. *Behaviour & Information Technology*, 1–11. https://doi.org/10.1080/0144929X.2021.1984579

Nieman, D. C. (2021). Exercise is medicine for immune function: Implication for COVID-19. *Current Sports Medicine Reports*, *20*(8), 395–401. https://doi.org/10.1249/JSR.0000000000000867

Nurhayati-Wolff, H. (2021, August 16). *Internet penetration rate in Indonesia 2017-2026.* Statista. https://www.statista.com/statistics/254460/internet-penetration-rate-in-indonesia/

Pengpid, S., & Peltzer, K. (2018). Prevalence, social and health correlates of physical inactivity among community-dwelling older adults in Indonesia. *African Journal for Physical Activity and Health Sciences*, *24*(1), 15–27. https://hdl.handle.net/10520/EJC-e35bd2640

Raamkumar, A. S., Tan, S. G., & Wee, H. L. (2020). Use of Health Belief Model-based deep learning classifiers for COVID-19 social media content to examine public perceptions of physical distancing: Model development and case study. *JMIR Public Health and Surveillance*, *6*(3), Article e20493. https://doi.org/10.2196/20493

Rizki, S. A., Kurniawan, J., Budimulia, P., Sylvanus, P., Alexandra, A., Sinaga, T. D., Kurniawan, A., & Lugito, N. P. H. (2021). Knowledge, attitude, and practice in Indonesian health care workers

regarding COVID-19. *Asia Pacific Journal of Public Health*, *33*(5), 662–664. https://doi.org/10.1177/10105395211011017

Rosha, B. C., Suryaputri, I. Y., Irawan, I. R., Arfines, P. P., & Triwinarto, A. (2021). Factors affecting public non-compliance with large-scale social restrictions to control COVID-19 transmission in Greater Jakarta, Indonesia. *Journal of Preventive Medicine & Public Health*, *54*(4), 221–229. https://doi.org/10.3961/jpmph.21.101

Saefi, M., Fauzi, A., Kristiana, E., Adi, W. C., Muchson, M., Setiawan, M. E., Islami, N. N., Ningrum, D. E. A. F., Ikhsan, M. A., & Ramadhani, M. (2020). Survey data of COVID-19-related knowledge, attitude, and practices among Indonesian undergraduate students. *Data in Brief*, *31*, Article 105855. https://doi.org/10.1016/j.dib.2020.105855

Scudiero, O., Lombardo, B., Brancaccio, M., Mennitti, C., Cesaro, A., Fimiani, F., Gentile, L., Moscarella, E., Amodio, F., Ranieri, A., Gragnano, F., Laneri, S., Mazzaccara, C., Di Micco, P., Caiazza, M., D'Alicandro, G., Limongelli, G., Calabro, P., Pero, R., & Frisso, G. (2021). Exercise, immune system, nutrition, respiratory and cardiovascular diseases during COVID-19: A complex combination. *International Journal of Environmental Research and Public Health*, *18*(3), Article 904. https://doi.org/10.3390/ijerph18030904

Shahnazi, H., Ahmadi-Livani, M., Pahlavanzadeh, B., Rajabi, A., Hamrah, M. S., & Charkazi, A. (2020). Assessing preventive health behaviors from COVID-19: A cross sectional study with health belief model in Golestan Province, Northern of Iran. *Infectious Diseases of Poverty*, *9*(1), Article 157. https://doi.org/10.1186/s40249-020-00776-2

Shewasinad Yehualashet, S., Asefa, K. K., Mekonnen, A. G., Gemeda, B. N., Shiferaw, W. S., Aynalem, Y. A., Bilchut, A. H., Derseh, B. T., Mekuria, A. D., & Mekonnen, W. N. (2021). Predictors of adherence to COVID-19 prevention measure among communities in North Shoa Zone, Ethiopia based on health belief model: A cross-sectional study. *PLOS ONE*, *16*(1), Article e0246006. https://doi.org/10.1371/journal.pone.0246006

Simpson, R. J., Kunz, H., Agha, N., & Graff, R. (2015). Exercise and the Regulation of Immune Functions. *Progress in Molecular Biology and Translational Science, 135*, 355–380. https://doi.org/10.1016/bs.pmbts.2015.08.001

Spence, J. C., Rhodes, R. E., McCurdy, A., Mangan, A., Hopkins, D., & Mummery, W. K. (2021). Determinants of physical activity among adults in the United Kingdom during the COVID-19 pandemic: The DUK-COVID study. *British Journal of Health Psychology, 26*(2), 588–605. https://doi.org/10.1111/bjhp.12497

Sulistyawati, S., Rokhmayanti, R., Aji, B., Wijayanti, S. P. M., Hastuti, S. K. W., Sukesi, T. W., & Mulasari, S. A. (2021). Knowledge, attitudes, practices and information needs during the COVID-19 pandemic in Indonesia. *Risk Management and Healthcare Policy*, *14*, 163–175. https://doi.org/10.2147/RMHP.S288579

Syed, M. H., Meraya, A. M., Yasmeen, A., Albarraq, A. A., Alqahtani, S. S., Kashan, A. S. N., Algarni, M. A., & Alam, N. (2021). Application of the Health Belief Model to assess community preventive practices against COVID-19 in Saudi Arabia. *Saudi Pharmaceutical Journal*, *29*(11), 1329–1335. https://doi.org/10.1016/j.jsps.2021.09.010

Tadesse, T., Alemu, T., Amogne, G., Endazenaw, G., & Mamo, E. (2020). Predictors of coronavirus disease 2019 (COVID-19) prevention practices using Health Belief Model among employees in Addis Ababa, Ethiopia, 2020. *Infection and Drug Resistance*, *13*, 3751–3761. https://doi.org/10.2147/IDR.S275933

Walrave, M., Waeterloos, C., & Ponnet, K. (2020). Adoption of a contact tracing app for containing COVID-19: A Health Belief Model approach. *JMIR Public Health Surveill*, *6*(3), Article e20572. https://doi.org/10.2196/20572

Winarti, E., Wahyuni, C. U., Rias, Y. A., Mirasa, Y. A., Sidabutar, S., & Wardhani, D. L. (2021). Citizens' health practices during the COVID-19 pandemic in Indonesia: Applying the health belief model. *Belitung Nursing Journal*, *7*(4), 277–284. https://doi.org/10.33546/bnj.1560

Wood, C. J., Clow, A., Hucklebridge, F., Law, R., & Smyth, N. (2018). Physical fitness and prior physical activity are both associated with less cortisol secretion during psychosocial stress. *Anxiety, Stress, and Coping, 31*(2), 135–145. https://doi.org/10.1080/10615806.2017.1390083

World Health Organization. (2020, July 29). *Survey tool and guidance: Rapid, simple, flexible behavioural insights on COVID-19*. Regional Office for Europe. https://apps.who.int/iris/handle/10665/333549

World Health Organization. (2021). *WHO Coronavirus (COVID-19) Dashboard: Situation by Region, Country, Territory & Area*. Retrieved December 12, 2021, from https://covid19.who.int/table

Yanti, B., Mulyadi, E., Wahiduddin, W., Novika, R. G. H., Arina, Y. M. D., Martani, N. S., & Nawan, N. (2020). Community knowledge, attitudes, and behavior towards social distancing policy as prevention transmission of COVID-19 in Indonesia. *Indonesian Journal of Health Administration, 8*, 4–14. https://doi.org/10.20473/jaki.v8i0.2020.4-14

Yeganeh, L. T., & Karami, H. (2021). Investigating corona preventive behaviors based on health belief pattern. *Journal of Research in Environmental Health*, *7*(2), 183–190. https://dx.doi.org/10.22038/jreh.2021.57705.1426

Zareipour, M. A., Ardakani, M. F., Moradali, M. R., Jadgal, M. S., & Movahed, E. (2020). Determinants of COVID-19 prevention behavior in the elderly in Urmia: Application of Health Belief Model. *Open Access Macedonian Journal of Medical Sciences*, *8*(T1), 646–650. https://doi.org/10.3889/oamjms.2020.5653

Zar'in, A. U., & Arovah, N. I. (2021). Physical activities and construct of Health Belief Models in the Special Region of Yogyakarta in the era of pandemy Covid-19. *Budapest International Research and Critics in Linguistics and Education (BirLE) Journal*, 4(2), 698–709. https://doi.org/10.33258/birle.v4i2.1831

Zheng, Q., Cui, G., Chen, J., Gao, H., Wei, Y., Uede, T., Chen, Z., & Diao, H. (2015). Regular exercise enhances the immune response against microbial antigens through up-regulation of toll-like receptor signaling pathways. *Cellular Physiology and Biochemistry, 37*(2), 735–746. https://doi.org/10.1159/000430391