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Original Article

Association of COVID-19 Knowledge, Adherence to Precautionary Measures, Human Behavior, and Positive Mental Health in the Saudi General Public: Considerations for Innovative Tailored Rehabilitation Approaches

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Abstract

Background: The severe acute respiratory syndrome Coronavirus 2 (SARS-CoV-2, also known as COVID-19) pandemic has wreaked havoc worldwide and affected the mental health of many people by prompting fears of falling sick, dying, helplessness, and stigma. Therefore, timely recognition of mental health issues is needed. This study aimed to assess the relationships of knowledge, adherence to precautionary measures, human behavior, and positive mental health during the COVID-19 pandemic on the general Saudi population. **Methods:** An online survey using snowballing sampling was conducted to collect data on respondents' socio-demographics, COVID-19 knowledge, adherence to precautions, human behavior, and positive state of mental health during the pandemic. Path analysis was used to measure effects among these factors. **Results:** Survey responses revealed that fatigue significantly affected performance, with 47% of participants strongly agreeing that fatigue impacted their cognitive and motor functions. Significant positive correlations were found between the EXP GPD Score and Control GPD Score (0.8031), and between EXP GPD Errors and Control GPD Errors (0.8595). The regression analysis indicated that for every unit increase in the Fatigue Borg Scale, the EXP GPD Score (time) increased by approximately 0.8036 units. Paired samples t-tests confirmed significant differences in performance and perceived fatigue between control and post-fatigue groups. **Conclusion:** In the early stages of the COVID-19 outbreak in Saudi Arabia, knowledge about the disease, and human behavior affected positive mental health. The findings found that positive mental health could be enhanced with clear communication and dissemination of knowledge, and having appropriate human behavior in the early stages of an outbreak. Further research is warranted to explore the effect of adhering to precautionary measures on having positive mental health in future pandemics.

Keywords: COVID-19; human behavior; mental health; precautionary measure; tele rehabilitation, exergaming, Saudi Arabia.

Introduction

Coronavirus 2019 (COVID-19) is a new strain of the severe acute respiratory syndrome coronavirus SARS-CoV-2 (Wang C et al. 2020). The first outbreak of COVID-19 was reported in December 2019 in Wuhan, China (Nishiura H et al. 2020). The World Health Organization (WHO) declared the outbreak to be a Public Health Emergency of International Concern (PHEIC) and attested it to be a global pandemic on March 11, 2020 (WHO. 2021). The first case in Saudi Arabia was reported on March 7, 2020, at which time the number of cases significantly increased all over the world, with the majority of confirmed cases in the United States, Brazil, and Russia (MOH, Saudi Arabia. 2020).

The Saudi government immediately launched a social media campaign that encouraged people to stay at home and follow the instruction of the Ministry of Health (MOH, Saudi Arabia. 2020); on March 23, 2020, a lockdown was imposed in Mecca, Medina, and Riyadh and travel restrictions were implemented all over the country. After 10 days, the curfew was extended to 24 hours (Saudi Press Agency. 2020).

By April 2020, COVID-19 had spread across the world, with many governments beginning to implement actions to limit the spread and reduce the number of deaths and infection rates. Schools and universities in the Kingdom of Saudi Arabia were closed on March 8, 2020, with all education activities moved online and all social gatherings and special events disallowed (Zitoun OA, et al. 2020).

Pandemics and epidemics are not uncommon with several cases occurring in the past 20 years, and these occurrences have corresponding effects on mental health. During the SARS epidemic in China, moderate to severe post-traumatic stress symptoms were reported in highly affected areas (Lau JT, et al. 2005). In the swine flu (influenza A H1N1) outbreak, 9.6% and 32.9% of the general population were either very or moderately worried about the possibility of being infected (Rubin GJ, st al. 2010). The Ebola, Middle East Respiratory Syndrome (MERS), and SARS epidemics also affected mental health, causing depression and substance in some cases (Brooks SK, et al. 2020). During the MERS outbreak in Jeddah, western Saudi Arabia, a significant association was found between anxiety and avoidance behavior (AlNajjar NS, et al. 2017).

The rapid increase in COVID-19 cases and the commensurate changes in people's daily lives left many people feeling alarmed and frightened (Mertens G, et al. 2020). The COVID-19 global public health emergency has had multifaceted consequences on people's lives and their mental health because it disturbed everyday routines and inflicted psychological effects (Domg L, & Nouey. 2020). Infectious disease pandemics are usually accompanied by a hidden silent psychological pandemic (Chan AO, et al. 2004; Nickell LA, et al. 2004; Tam CW, et al. 2004; Wong TW, et al. 2005). Psychiatric symptoms and illnesses are secondary effects of infectious disease outbreaks, and both can appear during the acute pandemic stage or in later stages; their presentations ranging from mild mood and anxiety symptoms to severe psychosis and significant cognitive deficits (Huremovi' c D. 2019).

Some studies conducted in Saudi Arabia focused on the effect of the current pandemic. For example, Ibrahim and Mahmoud found a strong negative correlation between fear of COVID-19 and COVID-19 knowledge and preventive practices in older adults, which was due to their lower knowledge than middle-aged adults (Ibrahim et al. 2020); hence, increasing the awareness of COVID-19 symptoms and preventive practices could effectively decrease COVID-19 fear (Ibrahim et al. 2020) and assist in maintaining positive mental health (Yamaguchi K, et al. 2020).

Therefore, clearly defined strategies are needed to integrate mental health services into the public health response to COVID 19 (Sathyanath SM, & Sathyanath S. 2020). Khan et al. (2020) concluded that while quarantine was an effective and proven

method for preventing the spread of COVID-19, it had a distinct psychological effect that manifested as post-traumatic stress disorder (PTSD), depression, anxiety, or stress in quarantined individuals (Khan T, et al. 2020). Despite that quarantine is a necessary outbreak control measure, governments should be ready to deal with the mental health effects of quarantined individuals (Khan T, et al. 2020).

Before the arrival of the COVID-19 vaccines, the best infection control measure was to control the spread of the virus (Li YC, et al. 2020). AlAteeq et al. (2020) found the prevalence of depression and anxiety in healthcare providers (AlAteeq DA, et al. 2020). In the early stage of COVID-19 pandemic in Saudi Arabia, a moderate to severe psychological effect was found in approximately 25% of the general population; in particular, females and students in the medical field had mental health issues associated with stress, anxiety, and depression. Alkhamees et al. (2020) found that 78.7% of people were very/extremely satisfied with the amount of COVID-19 information available (Alkhamees AA, et al. 2020). Roy et al. (2020) found that the degree of adherence to personal protective measures was directly aligned with the public's COVID-19 knowledge (Roy D, et al. 2020). Given that adherence to specific precautionary measures appeared to result from public knowledge, psychological interventions and public mental health strategies in combination with pandemic response efforts could be directed toward general and vulnerable populations (El Othman R, et al. 2021). Al-Hanawi et al. (2020) found that 40% of the Saudi population were distressed from COVID-19, with 33% of them being mildly distressed and 7% being severely distressed. The distress levels were particularly high in young people, females, private sector employees, and health workers, especially those working on the frontline. The authors stated that limiting psychological damage requires medium- and long-term policy strategies, such as mapping stress and anxiety rates, developing appropriate psychological treatments, and establishing innovative online methods, to promote mental wellbeing (Al-Hanawi et al. 2020).

Alhachem et al. (2020) found that infectious outbreaks have a considerable effect on people's mental health, which has been often underestimated or neglected when seeking to control or limit disease transmission. They stated the importance of raising awareness to prevent anxiety outbreaks during the COVID-19 pandemic. Increased anxiety was significantly correlated with the following: single status, female gender, younger age, unemployment, low education levels, low monthly income, a medical history of respiratory diseases, a history of anxiety, and a personal and family history of mental illness, smoking, living with family/friends, living in Beirut, taking psychiatric medications, and experiencing any kind of confinement/isolation (Alhachem et al. 2020). These factors can exacerbate the challenges faced by physical therapist, particularly regarding deconditioning problems.

No significant associations were found between high anxiety and personal infection, infection of relatives or friends, or confinement duration. However, insufficient evidence is available to indicate the influence of the degree of COVID-19 knowledge on COVID-19 preventive practices, human behavior and mental health. Hence, this study hypothesized that there are relationships among the following variables of COVID-19 knowledge, adherence to precautionary measures, human behavior, and positive mental health during the pandemic.

Methodology

Study Design, Setting, and Participants

This descriptive, quantitative study used a cross-sectional, correlational design. The aim of this study was achieved utilizing the model that explained the relation among knowledge, adherence to precautionary measures, human behavior, and positive mental health, was named after the authors Maizar, Mejel, and Metwally as the "3M Model," which is the first model to explain

regression among these variables. The study adhered to the Strengthening the Reporting of Observational studies in Epidemiology guidelines for cross-sectional studies (STROBE Checklist, 2022). The study was participated by 1,063 respondents, all of whom received the link in WhatsApp groups. Respondents who were residents and citizens of Saudi Arabia, able to read and understand English language, and who were either inside or outside of the country during the COVID-19 pandemic were included to participate in this study.

Instrumentation

Questions included eight demographic statements and 52 statements that measured COVID-19 knowledge, adherence to preventative measures, human behavior, and positive mental health. Six statements measured COVID-19 knowledge by using a four-point Likert scale (0 = No Knowledge, 1 = Low Knowledge, 2 = Medium Knowledge, 3 = High Knowledge). Ten statements measured respondents' adherence to precautionary measures by using a five-point Likert scale (1 = Not at all adherent, 2 = Not adherent, 3 = Somewhat adherent, 4 = Adherent, 5 = Completely adherent). Twenty-one statements measured respondents' human behavior by using a five-point Likert scale (1 = Not at all, 2 = Occasionally, 3 = Some of the time, 4 = Often, 5 = All of the time). Fifteen statements were used to measure positive mental health by using a five-point Likert scale (1 = Not at all, 2 = Occasionally, 3 = Some of the time, 4 = Often, 5 = All of the time). Statements measuring positive mental health were adapted from the studies of Machado and Bandeira (2015) and Lukat et al. (2016) and reframed for the Saudi context (Machado & Bandeira. 2015; Lukat J, et al. (2016).

Three types of validity (face, content, and construct) were assessed. The face validity for the design, reasonableness, and workability was confirmed in a pilot study which was participated by 42 respondents. The 42 pilot study respondents were excluded from the main study. The jury members of the pilot study comprised of one public health full professor, one infection control healthcare personnel, and one full professor registered nurse. They were asked to provide comments on the survey's relevance in accomplishing the aim of the study. In addition, they evaluated and maintained that the questionnaire covered all aspects of the research questions and hypotheses in a systematically relevant manner to confirm the content validity. They stated that the entire survey was clear, organized, and practical for data collection and analysis. They also reported the consistency between the theoretical notions and the intended measuring items to confirm the construct validity. Classical test theory states that the maximum test validity is the square root of reliability (Traub RE. 1968). The entire text of the questionnaire is available as a supplementary document. Table 1 shows the validity and reliability measures for the research instrument.

Table 1. Questionnaire validity and reliability

Section of the Questionnaire	Number of Statements	Alpha-Cronbach Coefficient	Validity
COVID-19 Knowledge	6	0.889	0.934**
Adherence to precautionary measures	10	0.873	0.753**
Human behavior	21	0.849	0.773**
Positive mental health	15	0.925	0.708**
Whole questionnaire	52	0.960	0.730**

*Significant if *p* value ≤ .05; **Significant if *p* value ≤ .01

Data Collection

Quantitative data were collected using an electronic questionnaire. The link to the online questionnaire was generated using Google Forms. Respondents completed the online survey in 25-30 min. Data collection was completed between December 2020 and February 2021.

Ethical Considerations

This study was ethically approved by Central Second Health Cluster H-01-R-012 with IRB number 20-708 on the 24th of November 2020. The researchers adhered to the guidelines and ethical standards while working with human respondents required by the Institutional Review Boards and the Declaration of Helsinki and its revisions.

Statistical Analysis

After collecting the data by using the electronic questionnaire, SPSS Amos was used for analysis. The direct and indirect effects of the four variables, namely, knowledge, adherence to precautionary measures, human behavior, and positive mental health, were measured using the Amos program according to researchers' knowledge and recommendations. Amos with Moodle and the Baron and Kenny approach was used to conduct path analysis and regression analysis to test the hypotheses of the research. Frequency analysis was used to examine quantitative data and determine the density and relevance of a specific factor.

Results

One thousand and two hundred respondents completed the online survey. Of the 1200 responses, 137 were excluded with reasons: 104 had missing data (e.g., did not completely answer at least one part of the survey) and 33 were answered in less than 50 percent of the average time (25-30 min.) to complete the survey (Greszki R, et al. 2015).

Table 2. Study sample demographics

Variable	Values	No	%
Gender	Female	595	56%
	Male	468	44%
Nationality	Saudi	905	85.1%
	Non-Saudi	158	14.9%
Workplace (inside or outside SA)	Inside	967	91%
	Outside	96	9%
Education	Secondary	74	7%
	University	574	54%
	Postgraduate	415	39%
Status	Single	170	16%
	Married	783	73.7%
	Separated	91	8.6%
	Widowed	19	1.8%
Number of family members	1–5	159	15%
	5–10	717	67%
	Above 10	187	18%
Job status	Student	110	10%
	Employee	571	54%
	Retired	201	19%
	Free work	49	5%
	Unemployed	132	12%
Type of job	Civil	542	51%
	Military	52	5%
	Medical	135	13%
	Engineering	102	10%
	Other	232	22%

In total, 1,063 responses were included in the final analysis. In this study, most respondents were educated at the university level (54%) or higher (39%) at the post-graduate level. Table 2 indicates the characteristics of the study sample by gender, nationality, workplace (inside or outside Saudi Arabia), education, social status, number of family

members, job status, and job type.

Association of COVID-19 knowledge, adherence to precautions, human behavior, and positive mental health

Amos with Moodle and the Baron and Kenny approach yielded Figure 1. The path and regression analyses of the study variables showed the lack of direct, statistically significant effect of knowledge on human behavior.

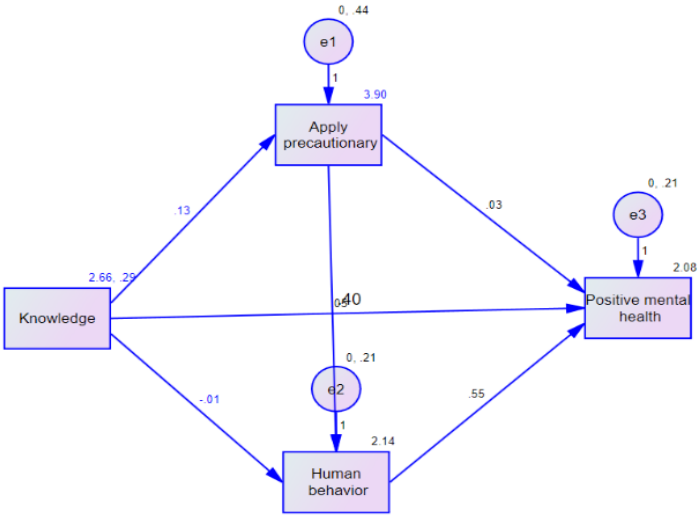

Figure 1. Association of COVID-19 knowledge, adherence to precautions, human behavior, and positive mental health (3M Model).

Meanwhile, human behavior had a direct, statistically significant effect on positive mental health. Moreover, adherence to precautionary measures had a direct effect on human behavior.

Analysis also showed the direct, statistically significant effect of knowledge on adherence to precautionary measures. The results also showed the direct, statistically significant effect of knowledge on positive mental health. However, no significant finding was established regarding the influence of adherence to precautionary measures on positive mental health.

Regression Weights: (Group number 1 – Default model)

The regression analyses found that COVID-19 knowledge had effects on adherence to precautionary measures (p = 0.001) and positive mental health (p = 0.05). Adherence to precautionary measures had effects on human behavior (p = 0.01). Human behavior significantly affected positive mental health as the dependent variable at (p = 0.01). Hence, the study implied that COVID-19 knowledge and human behavior, except adherence to precautionary measures, had a direct significant effect on positive mental health.

Table 3. Regression weights for the model

			Estimate	SE	CR	*p value*
APM	□-	Knowledge	.131	.038	3.463	0.001***
HB	□-	Knowledge	-.010	.026	-.380	0.704
PMH	□-	Knowledge	.054	.026	2.061	0.050*
HB	□-	APM	.395	.021	18.632	0.009**
PMH	□-	APM	.030	.024	1.225	0.220
PMH	□-	HB	.552	.030	18.087	0.008**

*Significant if p value ≤ .05; **Significant if p value ≤ .01; *** Significant if p value ≤ .001; APM = Adherence to Precautionary Measures; CR = Critical Ratio; HB = Human Behavior; PMH = Positive Mental Health; SE = Standard Error

Quality of the 3M Model according to Specific Indicators

Table 4 describes the quality of the 3M Model according to specific indicators. The value of interest in the 3M Model of the current study is the comparative fit index (CFI), particularly for the default model. According to previous studies, a CFI has value truncated between 0 and 1, where a value which is close to 1 shows an acceptable to excellent fit while if the CFI value is 1 represents a perfect fit (Hu L, & Bentler P. 1999; West RF, et al. 2012). Hence, the quality of the 3M Model of this study has a perfect fit with a CFI value of 1.

Table 4. Indicators that confirmed the model quality.

3M Model	Default model	Saturated model	Independence model
NPAR	14	14	8
CMIN	0	0	706.78
DF	0	0	6
p-value			0.001
CMIN/DF			117.8
NFI Delta1	1	1	0
RFI rho1			0
IFI Delta2	1	1	0
TLI rho2			0
CFI	1	1	0
PRATIO	0	0	1
PNFI	0	0	0
PCFI	0	0	0
ECVI	0.026	0.026	0.681
LO 90	0.026	0.026	0.602
HI 90	0.026	0.026	0.766
MECVI	0.026	0.026	0.681

CFI = Comparative Fit Index; CMIN = Chi-square Minimum Discrepancy; DF = Degrees of Freedom; ECVI = Expected Cross Validated Index; HI 90 = Higher Boundary of 90% Confidence Interval; IFI = Incremental Fit Index; LO 90 = Lower Boundary of 90% Confidence Interval; *MECVI = constant multiple of Browne-Cudeck Criterion (BCC);* NFI = Normed Fit Index; NPAR = Number of Parameters for Each Model; PCFI/PNFI = Parsimony-based CFI/NFI; PRATIO = Parsimony Ratio; RFI = Relative Fit Index; TLI = Tucker-Lewis Index

Discussion

The 3M sampling model described the relationships among four variables where COVID-19 knowledge was the independent factor, positive mental health as a dependent variable, and adherence to precautionary measures and human behavior as latent variables. Knowledge of the COVID-19 infection affected the positive mental health and adherence to precautionary measures toward controlling and limiting the spread of COVID-19, but it did not affect human behavior. This finding confirmed that human behavior is affected by several overlapping and interacting factors may be related to subjective factors, such as perception and motives, and environmental factors, such as laws, norms, regulations, and media. Therefore, knowledge as a single factor cannot influence human behavior, as confirmed by Bandura's social cognitive theory stating that "humans have the ability to exercise some control over their lives and not total control" (Bandura A. 2005). Knowledge as a cognitive component has effects on adherence to precautionary measures and positive mental health due to self-awareness. Adherence to precautionary measures also affects human behavior. When knowledge affects adherence to precautionary measures, commitment will affect human behavior because commitment itself is a person's behavior in times of need, such as adherence to the time of taking medicine or praying at its specified time. Human behavior is also based on the estimates of the perceived threat, benefits, and costs that an individual expects to gain, as indicated by the model. The 3M model is considered unique because it links four variables: COVID-19 knowledge influenced adherence to precautionary measures and positive mental health, but did not affect human behavior. Adherence to precautionary measures influenced human behavior, while the latter affected positive mental

health. Thus, the researchers recommend testing the model in different cultures and nationalities to generate new modern theories that explain human behavior during crises, pandemics, and epidemics.

The study findings implied that people who had good knowledge about COVID-19 presented appropriate human behavior to protect themselves from the infection and high adherence to precautionary measures resulting to having positive mental health during the pandemic. These findings are consistent with a systematic review of 13 quantitative studies with combined 26,099 adult respondents (e.g., clinical patients, healthcare personnel, university students and the general population) which showed that health knowledge had vital influence on people's attitudes and behaviors during pandemics (Rincon Uribe FA, et al. 2021). The findings were evident and reported during the COVID-19 pandemic in Bangladesh (Rahman A & Sathi J. 2020), China (Zhang M, et al. 2020), and India (Krishnappa S, et al. 2020). In addition, similar findings were observed in previous pandemic outbreaks such as the Influenza A (H1N1) infection in China (Lin Y, et al. 2011; Keller J, et al. 2014), Egypt (Nabi N, & Edward A. 2011), Hong Kong (Lio Q, et al. 2011), Iran (Askarian M, et al. 2013), Malaysia (Ping L & Ching I. 2011), Singapore (Yap J, et al. 2010; Ho S, et al. 2013), and Unites States of America (Etingen B, et al. 2013) as well as the Middle East respiratory syndrome coronavirus (MERS-CoV) infection in Saudi Arabia (Almutairi K, et al. 2015). Hence, it is important the people have access to and acquire accurate health information, understand, and adhere to preventive measures, have appropriate attitude and human behavior to stay positive and have sound mind in facing future pandemic outbreaks.

Understanding the long-term mental and physiological effects on those who have been affected by COVID-19, alongside social disruptions, will be essential for developing comprehensive support systems. Noteworthy, exploring how positive health influences lifestyle choices and compliance with precautionary measures can inform effective public health messaging. Evaluating the effectiveness of existing rehabilitation programs such as physical and occupational therapy interventions aimed at promoting mental health during pandemics can guide future initiatives.

Study limitations

This study has several limitations to be acknowledged. First, the study followed the cross-sectional study design, which did not prove causation of the influencing factors on positive mental health. Second, the Saudi public respondents were asked to respond using a self-report online survey to rate the study variables, which may result in social desirability bias. Third, the sample was recruited by convenience sampling, which limits the generalizability of the results to other regions of the country. Fourth, another significant limitation pertains to the study's focus on associations between self-reported data rather than direct observations of COVID-19 knowledge, adherence to precautionary measures, and human behavior. Fifth, the study has no anamnestic data on the presence of mental (psychological and/or psychiatric) disturbances within the study sample. Lastly, the researchers did not test the relationship or influence of the sample demographics on the following study variables of COVID-19 knowledge, adherence to precautionary measures, human behavior, and positive mental health. Hence, further investigations are needed to settle the above-mentioned limitations such as, but not limited to conducting longitudinal studies to infer true causal relationships over time and

qualitative studies to explore the views and opinions of the public in maintaining positive mental health during pandemic outbreaks.

Conclusion

In this study, the 3M model results showed a three-factor effect of COVID-19 knowledge, human behavior, and adherence to precautionary measures on positive mental health. However, among the three factors, the adherence to precautionary measures did not show significant influence on positive mental health. The findings could be used to develop mental health interventions directed at vulnerable populations and to implement public mental health strategies in the early stages of future outbreaks.

Future Research

Future research should also focus on the mental health level of the general population and particularly people with disabilities during the COVID-19 crisis and on the examination of the fiscal year statistics as well as the psychological and educational effects of those affected by and recovered from the pandemic, the effect of positive health on lifestyle and adaptation to precautionary measures, and the effect of curative and preventive programs on promoting positive mental health during COVID-19 and future pandemics. Additionally, research may also focus on innovative methods such as virtual physical and occupational therapy, tele rehabilitation, and online exergaming to mitigate mental burdens. These approaches can enhance engagement and provide flexible options for individuals, making rehabilitation more accessible and effective in promoting mental well-being.

Author Contributions

All authors significantly contributed to the work reported, including conception, study design, execution, data acquisition, analysis, and interpretation. They actively participated in drafting, revising, or critically reviewing the manuscript, provided final approval of the version to be published, agreed on the journal submission, and accepted accountability for all aspects of the work.

Data Availability Statement

The authors will transparently provide the primary data underpinning the findings or conclusions of this article, without any unjustified reluctance. If need from editorial team.

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Conflicts of Interest

The authors declare no potential conflicts of interest related to the research, writing, or publication of this work.

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