Ilkogretim Online - Elementary Education Online, 2021; Vol 20 (Issue 1): pp. 7998-8018
http://ilkogretim-online.org
doi: 10.17051/ilkonline.2021.01.825

Invistigting The Role Of Digital Public Health And Tele Medicinces In Prevention Of Covid 19: Moderating Role Of Public Health Ethics

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Received: 28.08.2019	**Accepted:** 22.06.2020	**Published:** 01.01.2021

Abstract

In China, a new pandemic, COVID-19, arose in December 2019. The rarity of this pandemic makes it a public health emergency. Multiple factors contributed to the emergence of covid-19, and preventative measures are required to combat and finally limit it. Telemedicine and other digital means of public health are essential in preventing the spread of covid-19. Many ethical problems are created by using digital public health and telemedicine, which reduces their effectiveness in lowering COVID-19. This quantitative and cross-sectional study investigates how public health ethics moderates the effect of digital public health and telemedicine on Covid-19 prevention. A study's working model and hypotheses are developed by analyzing the existing literature. Three thousand two hundred smartphone owners engaged in the study by completing the closed-ended questionnaires required to validate the research methodology. Examining the data using structural equation modeling (SEM) is consistent with earlier research. The results suggest that public health ethics are a more significant barrier to adopting e-PHTs than telemedicine. Moreover, the conclusions about public health ethics in Pakistan are particularly noteworthy. Public and private organizations in Pakistan may use the findings of this study to develop a pandemic response strategy that incorporates digital public health and telemedicine.

Keywords: Digital Public Health, Tele Medicine, Public Health Ethics

Introduction

With the beginning of the SARS-CoV-2 epidemic, a new concept emerged: digital public health, which utilizes digital platforms for data collection (primary data). Before then, a type of digital public health known as digital epidemiology existed for almost ten years. Secondary data or data from sources outside the public health system were utilized (Cattuto et al., 2020). Telemedicine was vital in preventing the spread of the Covid-19 virus because it enabled medical practitioners to treat both infected persons and those at risk of infection, thereby safeguarding the general public (Portnoy et al., 2020). In 2015, the basic telemedicine conceptual framework for pandemics was implemented and amended for Covid-19 (Ohannessian et al., 2020). In contrast to digital public health, Australian physicians and nurses have utilized telemedicine via radio since the early 1900s (Kelly et al., 2020).

Public health ethics seeks to identify, rank, and justify potential public health action courses using ethical principles, the values and beliefs of stakeholders, and scientific and other facts. The practical ethical difficulties in digital public health are numerous. They can be separated into three layers, each involving a distinct group of stakeholders and potentially having a physical, cultural, or social influence (Brall et al., 2019). The four foundations of public health ethics are the same as those of medical ethics: respect for the patient, beneficence, non-maleficence, and justice (Clark et al., 2010). In the case of telemedicine, however, the situation is different due to the particular ethical problems provided by its manner of operation (Clark et al., 2010). Therefore, healthcare practitioners are morally obligated to educate consumers on telemedicine practices and the related privacy and trust concerns (Nittari, 2020). The field's ethical issues exceed the advantages of digital public health, including better accessibility, productivity, prevention, and management of Covid-19, according to the investigation (Burr et al., 2020). Users must struggle with inequitable access to digital technology, worries about privacy and trust, the potential for social media to contribute to depression among the young (Twenge et al., 2018; Orben et al., 2019), and the disruptive implications of automation on the labor market (Frey & Osborne, 2017).

Given Pakistan's existing economic and cultural milieu and its low doctor-to-patient ratio (0.83:1000), digital public health interventions could prove to be of great use to the country's healthcare system (Kazi et al., 2020). Since 2011, doctor Sehat Kahani, Teeku, and the Dengue Activity Tracking System have been implemented.

Research is being conducted all across the world in preparation for the Covid-19 pandemic. For example, in China, Adhikari et al. (2020) conducted a "scoping review," and researchers in Morocco examined "The pathophysiology of coronavirus disease 2019 (COVID-19): Evaluation and prevention" (Owasso et al., 2020). In 2020, (Ouasso et al.) For example, Brownstein, Freifeld, and Madoff (2009) reviewed the literature on the effectiveness of digital public health in illness identification. The connection between telemedicine and digital public health has been the subject of a great deal of study (Budd et al., 2020). An ethical analysis is conducted on all investigations including digital public health (Brall, Schroder-Back, and Maeckelberghe, 2019; Morley et al., 2020), disease surveillance (Mello & Wang, 2020), COVID-19 (Gasser, 2020), and telemedicine (Chaet, 2017; Nittari, 2020). Public health ethics may act as a moderator, but there is a lack of research that examines all four factors simultaneously. Research reveals that digital public health has a larger impact on preventing the spread of COVID-19 (Burr et al., 2020). There is also a lack of research that takes a comprehensive look at all four factors at once, and digital public health is still a novel idea in Pakistan.

Since the relevant ideas and literature have not yet been developed, this study provides important information regarding the ethical challenges of digital public health and telemedicine in preventing Covid-19. Using SEM, we may determine which parts of digital public health and telemedicine in Pakistan require additional ethical considerations about the population's health. They may play a role in how the Pakistani government implements and shapes public health ethics legislation during pandemics and other public health emergencies.

Literature Review and Theoretical Background

Empirical Justification of DPH and Prevention of COVID-19

Covid-19 differs from previous pandemics in terms of infection, transmission, clinical severity, and the development and application of digital technologies in public health situations (Fagherazzi et al., 2020). Since April 2020, there have been 1,279,722 new cases and 72,616 fatalities attributable to it. It has also had a severe effect on global economy, resulting in a global recession (Mahmood et al., 2020). Until the vaccine is produced, a number of techniques and methods have been created to reduce the crisis's fatality rate (Mahmood et al., 2020). However, digital instruments for public health have proven to be the most beneficial (Fagherazzi et al., 2020).

Components of digital public health initiatives include data collecting, data type, technological tools, and methods for deriving meaning from the data. In other words, it combines social media with data methodologies, data visualisation, and data analysis to provide consumers and decision-makers with important insights (Murray et al., 2020). The data improve treatment, diagnosis, self-management support, and continual updated surveillance (Mahmood et al., 2020). The digital tools of Covid-19 promote data sharing, real-time monitoring of data transfer, the use of virtual menus for everyday chores and meetings, and the delivery of telemedicine (Fagherazzi et al., 2020). Covid19 employs a digital healthcare model that is distinct from previous generations because to its isolation, locking down, and quick transmission. This technique employs telemedicine, the Internet, and digital channels such as websites, chat rooms, and mobile applications. There are four sorts of anti-Covid-19 software: those that assist with proxy tracing, those that assist with symptom screening, those that assist with assuring compliance with quarantine requirements, and those that assist with flow modelling (Gasser et al., 2020).

In a public health emergency, the HRM and time acquired with the use of these instruments are invaluable (Fagherazzi et al., 2020).

Hypothesis 1(H1): Digital public health helps in prevention of COVID-19.

Telemedicine and prevention of COVID-19

The World Health Organization defines telemedicine as "the provision of online healthcare services when the distance between the service provider and the patient matters" (Langarizadeh, 2017). The clinical definition of telemedicine is the use of audio, video, and communication data to facilitate the provision of medical care, the conduct of clinical consultations, the administration of medical care, the dissemination of medical information, and the provision of medical education (Jerant & Epperly, 1997). The internet and other preventative measures recommended by the WHO was crucial in preventing the spread of the Covid-19 virus. Masks, hand washing, staying away from other people, detecting cases, tracking down contacts, and isolating infected people are all preventative measures (Adhikari et al., 2020).

In the early 1900s, Australians began using the telephone (1877), radio (1927), and television (1950s) in flight to communicate with patients/caretakers and health professionals (Kelly et al., 2020). (Clark et al., 2010). In addition to treating Traumatic Brain Injuries sustained in the Iraq and Afghanistan wars, NASA has begun employing the concept of telemedicine through its STARPAHC program (Clark et al., 2010). Improved technology and more accessible internet connections have made it a viable option for the general public over the past few decades (Clark et al., 2010 & Jerant & Epperly, 1997).

Hypothesis (H2): Telemedicine helps in prevention of COVID-19.

DPH- Prevention of COVID-19: Moderating Role of Public Health Ethics

To get the most out of Covid-19, it's best to use dates. However, digital public health raises ethical considerations due to the potential for privacy breaches due to sloppy data handling, which can result in social and personal harm (Mello et al., 2020). Public health ethics seeks to define, prioritise, and justify potential courses of action in public health using ethical principles, the values and beliefs of stakeholders, and scientific and other data. People's mental, emotional, and spiritual health are all affected by the digital public health ethics debate. The lines separating these three levels include use cases, stakeholders, and technological and general governance restrictions. The public, private, and medical sectors are just some of the numerous groups with a vested interest in this topic. There are both technical and non-technical aspects to think about. Examples of technological concerns include data storage and firewalls, whereas examples of non-technical concerns include accountability and transparency (Brall et al., 2019). In contrast to bioethics, which focuses on a specific patient population, public health ethics considers the public at large and the government. The academic and professional domains are separated from one another. Public health ethics is the study of values and principles for directing decision-making at the population level, with the goals of determining the nature of the ethical problem, evaluating potential solutions, and choosing the most morally sound choice (Faden et al., 2010).

Hypothesis(H3): Public health ethics weakens the relationship between digital public health and prevention of Covid -19.

Telemedicine-Prevention of COVID-19: Moderating Role of Public Health Ethics

The prevalence of ethical concerns about telemedicine has grown alongside the field's popularity (langarizadeh, 2017). The United States, which has the most significant death and morbidity rates, has placed an ethical premium on public health reporting and data sharing, contact tracing, and tracking, and clinical scoring tools for critical care (subbing et al., 2020).

Regarding the doctor's essential ethical obligations, telemedicine is no different from traditional in-person medical care; the only difference is in the logistics. The more intricate a telemedicine practice is, the trickier its associated ethical questions become (Chaet et al., 2017). In some nations, doctors are ethically obligated to inform patients about potential privacy risks and how to use telemedicine safely and effectively (Nittari, 2020).

Although telemedicine's many benefits—including its low cost and ease of use—outweigh the increased legal and ethical concerns it raises. Furthermore, the United States, Europe, and Taiwan require uniform telemedicine legislation and policies (Nittari et al., 2020). Misdiagnosis, incorrect diagnosis, malpractice, and neglect are only some of the ethical concerns arising from telemedicine use (Langarizadeh, Moghbeli, & Aliabadi, 2017). (Nittari et al., 2020). In response, the American Medical Association (AMA) plans to roll out a new code of medical ethics, complete with rules and norms that can adapt to technological advancements (Chaet, 2017).

Hypothesis (H4): Public health ethics weakens the relationship between telemedicine and prevention of Covid-19.

Theoretical and Geographical Background

As stated, organizational leadership is required to deal with shifts in behavior and attitude brought on by technological advancements (Rufo, 2012). Furthermore, the outcome of telemedicine usage depends on the mode of communication between the patient and the doctor, which in turn depends on the patient's social norms, self-identity, and self-perception (Gagnon et al., 2003). (Miller,2002).

Clark et al. (2010) state that the four main principles of medical ethics form the basis of the public health ethics observed in telemedicine. The four tenets are trustworthiness, sincerity, nonmaleficence, and utmost regard for the patient's best interests. Based on these ideas, it is clear that the drawbacks of telemedicine win out when it is put into practice. More and more people are opting for telemedicine because it saves them money and time. However, frequent reliance on telemedicine services may cause a disconnection between patients and their doctors, among other problems (Clark et al., 2010). According to Spaulding et al. (2005), converting potential users to regular users of telemedicine is simpler than the reverse. The advantages of digital public health include the growth of digital health practices, the enhancement of efficiency, and the creation of new ideas and

methods made feasible by real-time and large data sets (Moller et al., 2017). Michie et al. (2017) argue that the transformation in public health made possible by digital data should be used to test economic analyses and theories of behavioral change.
Norman Daniels states everyone has the right to equal and equitable healthcare access. Thus, it's important to have policies in place that are reasonable, clear, and adaptable (Brall et al., 2019). The use of an "intervention ladder," the "stewardship model," was introduced in 2007; the intervention ladder ranks problems from most difficult to least, with pandemics at the top (Krebs, 2008).

Research Model

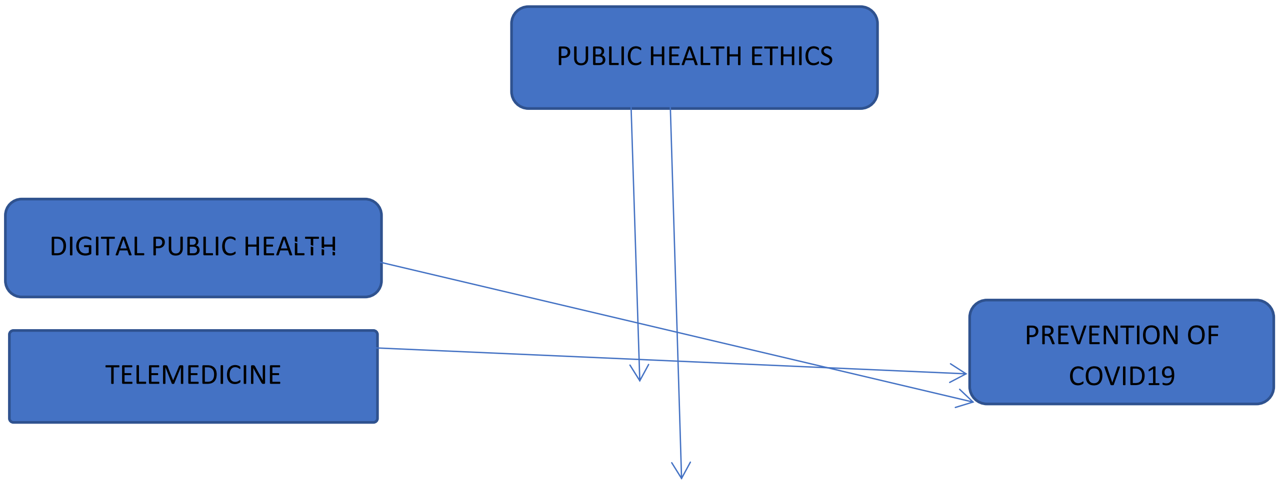

Figure 1: Research model

Method

Participants and Data Collection

A snowball method is used to get the information. The survey is being sent out to smartphone users in Pakistan using Google Forms and published across various social media platforms due to the country being in a state of lockdown and self-isolation. The survey has a two-month time limit, during which participants' identities will be concealed to protect their anonymity. There were 302 responses (response rate = 100%), and because google forms were used, every single questionnaire was valid. Half of the respondents were students, and the other half were employed, while the gender breakdown was 56% female and 43%, male. Sixty-nine percent of respondents are college graduates, thirty percent have a secondary education, and eleven percent have only an elementary education. While 41% called an urban region home, 49% called the countryside their primary residence, and 9% called another type of living arrangement home. Sixty-one percent of those who took the survey were younger than 25.

Measures

The survey questionnaire consists of five sections that specifically address the research topics derived from previous studies, including respondent demographics, the role of telemedicine, digital public health, public health ethics, and COVID-19 prevention, respectively. In this study, the variables were measured using a 5-point Likert scale, although in previous research, dichotomous and dummy scales were employed to measure the variables. Therefore, the questionnaire was adapted from previous studies. However, the measurement scales were modified during the study to fulfill the research requirements: 1 is highly disagreeing, two is disagreeing, three is neutral, four is agreeing, and five is extremely agreeing.

The demographics were evaluated using a 5-item measure established by Haluza, Naszay, Stockinger, and Jungwirth (2016). Eleven items produced by Khasawneh, Humeidan, Alsulaiman, Bloukh, Ramadan, Al-Shatawi, and Saleh were used to quantify COVID-19 prevention (2020). The public health ethics scale consisted of seven items on a Likert scale from 1 to 5, adapted from Morley, Cowls, Taddeo, and Florida (2020). Telemedicine was measured using 16 items borrowed from Haluza, Naszay, Stockinger, and Jungwirth telemedicine (2016). The 5-item scale was utilized by Van der Vaart and Drossaert (2017).

Analysis and Results

Reliability Analysis

Cronbach's Alpha was used to examine the constructs' internal consistency and found that TM had the highest (0.941) and PCOV had the lowest (0.785) values, indicating a positive association between the two.

Table 1: Reliability analysis of the constructs

Constructs	Items	Cronbach Alpha	Item-to-total correlation
Telemedicine (TM)	16	.941	.620 to .746
Digital Public Health (DPH)	5	.855	.568 to .721
Public Health Ethics (PHE)	7	.970	.829 to .941
Prevention of COVID-19 (PCOV)	11	.785	.352 to .559

Exploratory Factor Analysis (EFA)

The Barlett test of sphericity and the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy were performed prior to exploratory factor analysis (EFA) to guarantee that the items are sufficiently inter-correlated to produce representative factors. Both the KMO Measure of Sampling Adequacy and the Barlett's Test of Sphericity were statistically significant at the.000 level, exceeding the acceptable value of 0.927 recommended by Kaiser Permanente (1970).

It was SPSS version 22 that was used for the EFA analysis (Statistical Package for the Social Sciences). After clustering the four constructions, we found that cross loadings on other constructs required the removal of eight elements (TM12, TM13, TN14, TM15, TM16, PCOV4, PCOV8, and PCOV11) (TM, DPH, PHE, and PCOV). Using EFA, we can see that there is a clear four-factor solution for the structure (see Table 2), which indicates that the structure of the four latent variables (i.e., TM, DPH, PHE, and PCOV) is well defined and that these scales are suitable for further exploration. Specific similarities and total variance explanations are listed in the tables below.

Table 2: EFA analysis of all the constructs of the study

Items	Constructs				Communalities
	TM	PCOV	DPH	PHE	
TM1	.716				.536
TM3	.622				.469
TM4	.782				.637
TM5	.695				.525
TM6	.682				.567
TM7	.777				.627
TM8	.718				.546
TM9	.792				.689
TM10	.735				.618
TM11	.731				.580
DPH1			.954		.932
DPH2			.934		.912
DPH3			.944		.908
DPH4			.916		.874
DPH5			.930		.870
PHE1				.751	.597
PHE2				.788	.638
PHE3				.789	.629
PHE4				.735	.549
PHE5				.710	.508
PHE6				.815	.678
PHE7				.749	.574
PCOV1		.847			.793
PCOV2		.817			.733
PCOV3		.795			.709
PCOV5		.811			.702
PCOV6		.812			.733

PCOV7	.785	.675
PCOV9	.799	.670
PCOV10	.768	.669
Total Variance explain		67.159

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
Rotation converged in 6 iterations.

Structural Equation Modelling

First, the validity and fit of the model are tested using confirmatory factor analysis (CFA). Structural equation modeling is then used to test the hypotheses (SEM).

Analysis of Measurement Model

The connections between the constructs are put to the test by the CFA model. Constructs are classified as exogenous or endogenous and shown as ovals and rectangles, respectively, in CFA's first step of the measurement model fitting procedure. Single arrows represent causation, while double arrows show correlation or covariance.

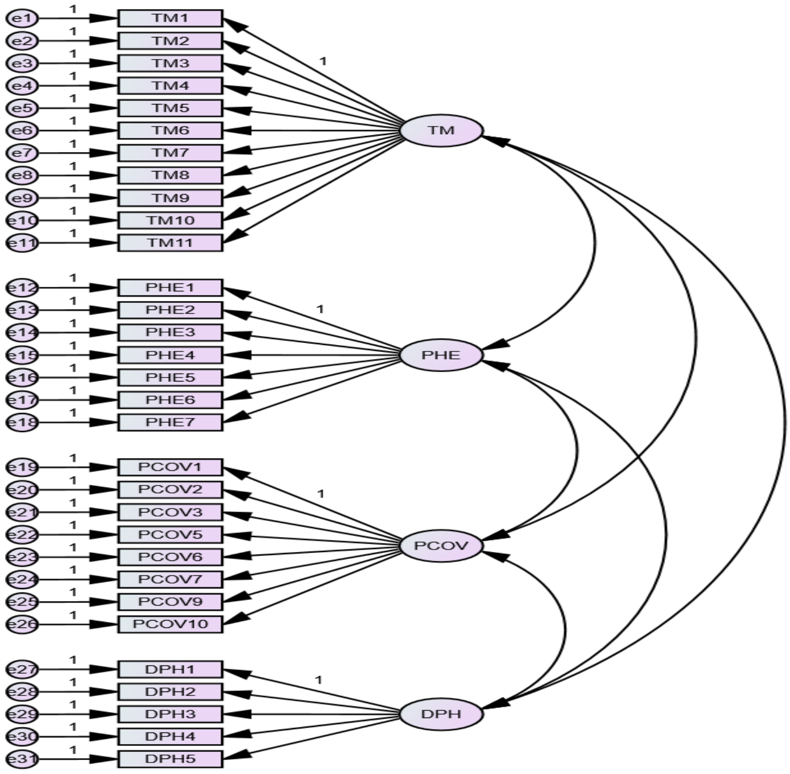

Figure 2: The proposed measurement model of study

Goodness of fit indices

Although only two data points were utilised to determine if the model was a good match, the study's large sample size allows for a definitive rejection of one of the two possibilities (Kline, 2005; Hair et al., 2010; Hu & Bentler, 1999; Hair et al. 2010). Goodness of Fit Index (GFI), Normed Fit Index (NFI), Parsimony Normed Fit Index (PNFI), Root Mean Square Residuals (RMSR), Comparative Fit Index (CFI), Adjusted Goodness-of-Fit Index (AGFI), and Root Mean Square Error of Approximation are all suggested by (Hair, 2010) in addition to the chi-square test and the F-test (RMSEA).

Table 3 displays the accepted fit determined by the data. The model's initial outputs were [2 = 651.522; df= 428; 2/df= 1.522; GFI =.880; AGFI =.861; CFI =.966; RMR =.045; RMSEA =.042]. The measurement model fit is not optimal yet, as seen by these numbers.

Table 3: Summary of model fit indices for the measurement model

Name of Good of Fit Indices	Recommended values as suggested by Hair et al. (2018)	Measurement model
χ^2	Insignificant at P > .05	651.522 Insignificant at P > .05
χ^2/df	Between 1 and 5	1.522
Goodness-of-fit index (GFI)	>.90	.880
Adjusted Goodness-of-fit index (AGFI)	>.80	.861
Comparative fit index (CFI)	>.90	.966
Root mean residuals (RMR)	< 0.05	.045
Root mean square error of approximation (RMSEA)	<.08	.042

AMOS modification indices were used to better the model fit. The limiting value of the standardized residual covariance is |2.58| (Byrne, 2006), factor loading (Standardized regression weight) should be greater than 0.5 and ideally greater than 0.7 (Byrne, 2006), and modification indices (MI) with high covariance and high regression weights are dropped for better model fit (Byrne, 2006; Hair et al., 2010).

Table 4: High modification indices

Items	MI-regression weights
DPH5	76.14
TM2	67.25
TM10	41.24

Table 4 demonstrates that the MI weights for DPH5, TM2, and TM10 are excessive for a satisfactory model fit, prompting their removal one at a time and a subsequent evaluation of the model. GoF index values for the complete model are listed in table 5.

Table 5 Summary of model fit indices for the measurement model after re-specification

Name of Good of Fit Indices	Recommended values as suggested by Hair et al. (2018)	Measurement model
χ^2	Insignificant at P > .05	497.817 Insignificant at P > .05
χ^2/df	Between 1 and 5	1.447
Goodness-of-fit index (GFI)	>.90	.904
Adjusted Goodness-of-fit index (AGFI)	>.80	.875
Comparative fit index (CFI)	>.90	.974
Root mean residuals (RMR)	< 0.05	.040
Root mean square error of approximation (RMSEA)	<.08	.039

Validity and Reliability

Validity and reliability of the construct should be evaluated in light of how the results will impact the study objectives prior to testing the hypothesis (Hair et al., 2010). Since reliability tells us about consistency while validity tells us about correctness, it is possible for a concept to be highly valid but not reliable, and vice versa (Holmes-Smith, 2011). Construct validity and reliability can be evaluated using convergent validity, discriminant validity, and nomological validity, while composite reliability (CR), average variance extracted (AVE), maximum shared squared variance (MSSV), and average shared squared variance (ASV) can be used to determine a construct's overall strength (Hair et al., 2010).

Since can be shown in Table 6, all of the factors are sufficiently dependable and convergently valid, as their average extracted variances are larger than 0.520 and their CR values are greater than 0.885s. Since the correlation value is less than the AVE of all the variables in the model, discriminant validity is not an issue.

Table 6: Construct reliability, convergent validity, and discriminant validity

	CR	AVE	PCOV	TM	PHE	DPH
PCOV	0.941	0.666	**0.816**			
TM	0.907	0.520	0.567	**0.721**		
PHE	0.885	0.526	-0.024	-0.114	**0.725**	

DPH	0.969	0.886	0.104	0.064	-0.290	**0.941**

The refined model in goodness of fit indices dropped DPH5 and TM10 which is shown in Figure 3, apart from validity and reliability.

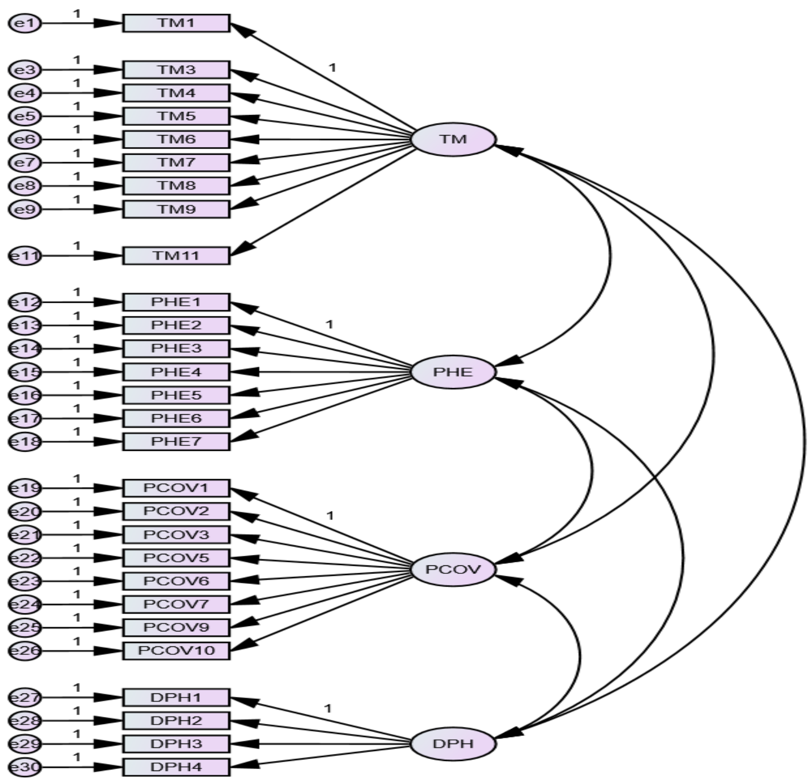

Figure 3: The final measurement model

Analysis of the Structural Model and Hypotheses testing

Exogenous and endogenous latent variables can be analysed in respect to one another in the structural model phase (Arbuckle, 2009; Hair et al., 2010). Two-headed arrows indicate covariance between independent variables; one-headed arrows indicate a causal relationship between an independent variable and a dependent variable, as defined by structural equation modelling (SEM). As can be seen in Figure 4, the relationship between the constructs is revealed as the focus shifts from the measurement model to the structural model.

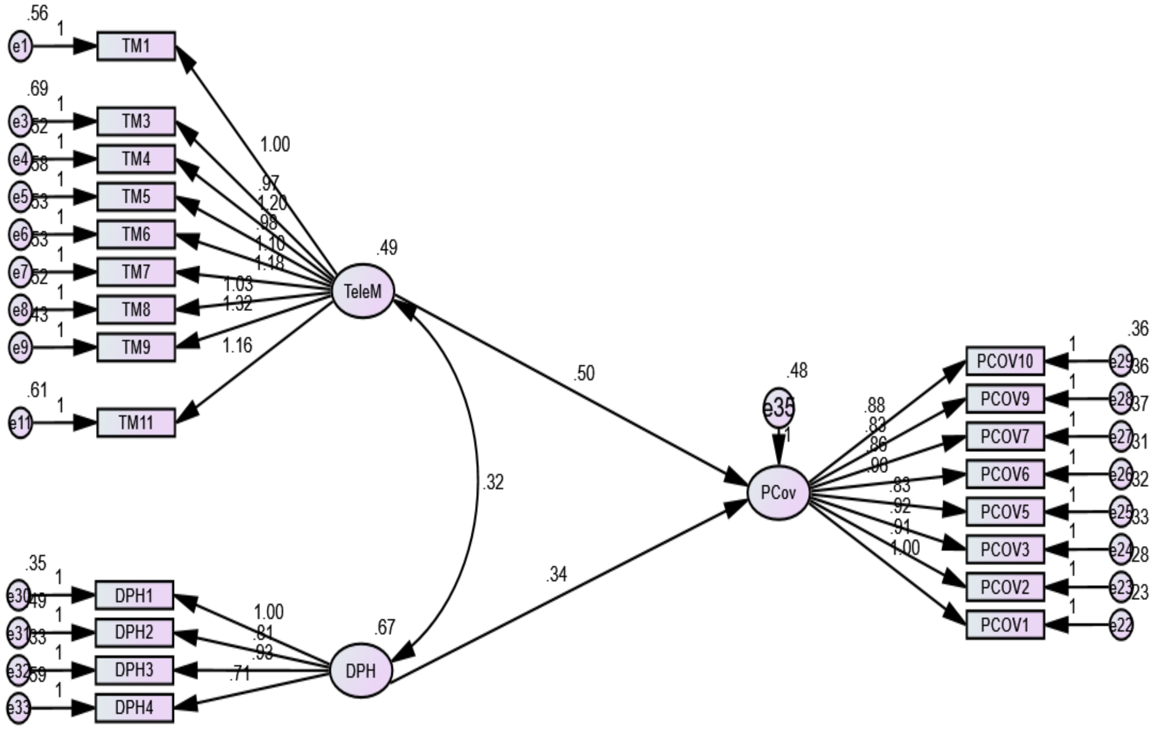

Figure 4: The structural model

Fit indices for the first run were [CMIN=297.306; df= 186; CMIN/DF = 1.598; GFI=.914; AGFI=.894; CFI=.971; RMR=.044, RMSEA=.045], suggesting a very good fit of the model, using the same criteria as the measurement model. As a result, the model's hypothesised connections are examined. In Table 8, we see the path coefficients for the hypothesised relationships within the suggested study model.

Table 8: The summary of hypothesis testing

H#	Relationship	R^2	Beta Weight	SE	C.R	Significance	Result
H1	PCOV ← TM	.48	.396	.088	5.701	***	Accepted
H2	PCOV ← DPH		.311	.075	4.540	***	Accepted

Notes: *** p-value < 0.01; ** p-value < 0.05; * p-value < 0.10

Table 8 shows that both H1 and H2 have been accepted, with the beta weight for H1 being 0.396 and the significance level being less than 0.001, and the beta weight for H2 being 0.311 and the significance level being less than 0.001.

Moderating effect of Public Health Ethics

Multi-group analysis is employed to examine whether or not Public Health Ethics acts as a moderator in the connection between the dependent and independent variables. To do so, we first split the data into two separate sets before applying the structural model to each. Next, we use the dissimilarities in critical ratio to compare path coefficients between the high and low groups in a paired fashion, establishing validity and dependability. But Hair et al. (2010) suggests first examining the effect of moderator on relationship between the components, which requires checking goodness of fit, including discriminant and convergent, and reliability for each construct.

Seven items on a 5-point Likert scale were used in a questionnaire to gauge PHE. Because of the metric character of the moderator, we employed the median-split technique to transform the metric scale into a non-metric scale (Hair et al., 2010). One hundred and eighty of the 302 respondents had a median = 2.4 (the low PHE group), while 194 of the respondents had a median > 2.4. (high PHE group). The mean score of 4.428 out of 5 indicated excellent PHE knowledge.

Each group's measurement model yielded adequate fit of the data ([2 =452.771; df= 344; 2/df= 1.316; GFI =.788; AGFI =.849; CFI =.939; RMSR =.074; RMSEA =.054] and [2 =451.745; df= 344; 2/df= 1.313; GFI =.861; AGFI =.

The findings in Table 9 reveal that the AVE and CR were both greater than 0.5 and CR was greater than 0.7 across both groups, indicating that the reliability and convergent validity of all components is high. In addition, the square root of the averaged validity estimates (AVE) across all constructs is larger than the correlation value, indicating that the two sets of data can be separated.

Table 9. Construct reliability, convergent and discriminant for low and high public health ethics

Factor Correlation Matrix with √AVE on the diagonal (Low PHE group)						
	CR	**AVE**	**TM**	**PHE**	**PCOV**	**DPH**
TM	0.924	0.577	**0.76**			
PHE	0.799	0.517	0.129	**0.466**		
PCOV	0.957	0.734	0.556***	0.136	**0.857**	
DPH	0.86	0.607	0.509	0.191	0.448	**0.779**
Factor Correlation Matrix with √AVE on the diagonal (High PHE group)						
	CR	**AVE**	**TM**	**PHE**	**PCOV**	**DPH**
TM	0.894	0.586	**0.697**			
PHE	0.784	0.545	0.065	**0.495**		

PCOV	0.923	0.599	0.582***	-0.02	**0.774**	
DPH	0.788	0.587	0.572	0.078	0.601	**0.698**

Table 10 reveals that H3 and H4 are accepted, and that PHE moderates the connection between TM and PCOV and DPH and PCOV. A greater beta weight (0.443) exists between TM and PCOV in the low PHE group compared to the association between DPH and PCOV (0.222). In contrast, the association between DPH and PCOV (beta weight = 0.400) is stronger in the high PHE group than the association between TM and PCOV (beta weight = 0.353). PCOV R2 was 35% in the low-PHE group and 45% in the high-PHE group.

Table 10: The summary of the moderating effect of public health ethics

Hypotheses	**Low PHE**		**High PHE**		**Critical Ratio**	**Results**
	R^2	**Beta-Weights**	**R^2**	**Beta-Weights**		
TM → PCOV	.35	.443	.45	.353	-2.291**	Supported
DPH → PCOV		.222		.400	-4.438***	Supported
Notes: *** p-value < 0.01; ** p-value < 0.05; * p-value < 0.10						

Discussion and Conclusions

This study's findings are consistent with those of other studies suggesting that telemedicine is useful for preventing Covid-19 (H1 is accepted), however the SEM analysis yields interesting results with regard to Pakistan in the context of telemedicine. In the case of TM (telemedicine), the SEM analysis eliminated variables TM10, TM12, TM13, TM14, TM15, and TM16; in the case of PCOV (prevention of covid-19), PCOV4 and PCOV8 were eliminated. These results suggest that in the case of TM, factors such as location, administration, multiple diagnoses, quality of care, doctor-patient relationship, and medical care facility are not taken into account, and that in the case of PCOV, factors such as the need for sick people to wear masks and the presence of pneumonia are not taken into account. Overall, the results are consistent with those of other studies, including those by Ohannessian et al. (2020), Blandford et al. (2020), Portnoy et al. (2020), Vidal-Alaball et al. (2020), and Calton, Abedini, and Fratkin (2020).

SEM analysis indicates that while discussing digital public health in the context of Pakistan, DPH4 should be removed because it states that users cannot make decisions about their health while using one of the instruments of digital public health (H2 is allowed). Besides the removal of DPH4, the findings are consistent with those of previous research that have suggested that digital public health tools contributed in the prevention of COVID-19, such as those by Bao (2020), Fagherazzi et al. (2020), Mahmood et al. (2020), Ting et al. (2020), and Budd et al. (2020).

We agree with Hypotheses 3 and 4, respectively, that public health ethics acts as a negative moderator between telemedicine and COVID-19 prevention and between digital public health and COVID-19 prevention. These results corroborate previous research that suggests the exponential performance of digital public health and telemedicine in preventing COVID-19 is counterbalanced by the role of public health ethics (Clark et al. 2010; Chaet et al. 2017; Brall et al. 2019 & Budd 2020).

The results of the low public health ethics vs. high public health ethics groups reveal that the beta weight of digital public health increases from the low group to the high group, however the same trend is not shown for telemedicine. Thus, public health ethics acts as a negative moderator in both telemedicine and digital public health in the prevention of COVID-19, with digital public health facing higher ethical issue when taken in reference to Pakistan. To rephrase, Ethical concerns, policies, rules, and laws serve as a counterbalance to the function of digital public health in preventing COVID-19.

Practical contribution and implications

This study is novel since it provides various recommendations for managers and policymakers in Pakistan's Public Health sector and the surrounding region. Research conducted at COVID19 to examine the moderating effect of public health ethics in telemedicine and digital public health led to the following conclusions and recommendations for public health practise. The results of this study can be used in two ways to protect the people of Pakistan from potential harm associated with the use of telemedicine and other forms of digital public health technologies. Second, the research helps policymakers create a path for telemedicine innovation and business growth by shedding light on the supply side of the public health system. Furthermore, structural equation modelling was employed to investigate the relationship and determine the importance of digital public health in the avoidance of COVID-19. Third, this study's results indicate that policymakers and the health sector should appreciate the significance of telemedicine and digital public health. Government and policymakers need to assess the needs and design a tailored awareness programme within the health sector to develop demand-led training and the value of telemedicine's and digital public health. Fourth, organisations in Pakistan should reevaluate their business strategies, monitoring, and support for telemedicine and digital public health, given the limited role that public and private sector organisations play in these fields.

Theoretical contribution

In terms of the development of the empirical model that identifies the connection between both variables in the prevention of COVID 19, the study contributes significantly to the current literature. To further explore the effects of market forces and organisational variables on digital public health and telemedicine, this study further analysed the interaction between these two fields. Results demonstrated the existence of a statistically significant connection between each of the aforementioned factors.

This study makes a theoretical contribution as well, as for the first time, researchers really put their hypotheses to the test among people who utilise digital public health services in Pakistan. It is consistent with previous research from other nations that public health ethics counteract the impact of digital public health and telemedicine in preventing the spread of COVID-19. A number of study holes were found in the earlier investigations. To begin, there is a dearth of research that considers all four factors simultaneously in Pakistan or elsewhere. Specifically, research suggest that the role of digital public health in preventing COVID-19 can be countered by public health ethics, which is a negative moderator (Burr et al., 2020). Secondly, Pakistan is not a well-studied country, and digital public health is still a relatively new notion there.

Recommendations and Limitations

All of this study has some restrictions on its applicability in the wider world. To begin, a unified approach to research has been used throughout the empirical study. A qualitative approach would likely yield more fruitful results. The sample size was small, and responders were generally less tech-savvy than the average person. Although the population was large, the survey sample size of 302 was very modest. Additionally, this research employed a cross-sectional design. Larger samples and a longer study period would improve the reliability of these findings. The results also showed that the research might be expanded to delve deeper into other important concerns related to public health and telemedicine in third world countries.

Future Research

The purpose of this study was to examine the mediating effect of digital public health, telemedicine, and public health ethics. In the future, researchers may forego digital public health in favour of mobile apps or social media in their quest for knowledge. Converging telemedicine also allows for a greater focus on online consultation or videoconferencing. Since this study placed an emphasis on confidentiality and trust in the public health sector, it is important for researchers to narrow their focus to a specific subset of this multifaceted and complicated subject. It's possible to do this with a variety of economic and psychological factors, as well as monetary and non-monetary assets as moderators and mediators.

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