



CHAPTER -30
A HEALTH BELIEF MATHEMATICAL MODELING BASED ON COVID-19
PERCEPTION STUDY FOR POST LOCKDOWN
IN INDIA
BY

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Abstract: Amidst the corona pandemic, health authorities have introduced interventions like social distancing, wearing masks, and hygienic practices to prevent the transmissions among people. A Cross-sectional study using an electronic survey-based questionnaire was disseminated by snowball sampling post lockdown from June 6 to June 15, 2020, among individuals aged ≥ 18 years. This study focuses on evaluating and developing a strategy to identify people's health beliefs using five dimensions. Response (353) were quantitative values of subjective illustrative, acquire by psychophysically constructed Likert scale. Descriptive statistics were calculated on SPSS V26, with a mean age of 25.45 (σ 5.8). A significant positive correlation was found between the five dimensions of health belief and education which shows the influence of education on an Individual's perception and behaviour. The reliability analysis was found 0.764, which is considerable. The study understands public perception and belief towards these interventions, serving as an excellent ally for conveying policy and public health education.

Keyword(s): Post lockdown, health belief, COVID-19, perception, social intervention, behaviour

Introduction :

An ongoing human infection scenario by a novel corona virus (also named SARS-CoV-2) was encountered for the first time in Wuhan City, China (WHO | [who.int/csr/don/12-January-2020-novel-coronavirus-china/en](https://www.who.int/csr/don/12-January-2020-novel-coronavirus-china/en)). On February 11, 2020, WHO named it as 2019 novel corona virus for COVID-19 that infects the lower part of the respiratory tract WHO announced COVID-19 as a pandemic on March 11, 2020, spread to 46 nations (WHO | [who.int/dg/speeches/detail/who-director-general-sopening-remarks-at-the-media-briefing-on-covid-19-11-march-2020](https://www.who.int/dg/speeches/detail/who-director-general-sopening-remarks-at-the-media-briefing-on-covid-19-11-march-2020)). Till July 8, 2020, total cases worldwide were 11.9 million confirmed cases, and in India, total confirmed cases reached 7,44,328 with a total decrease of 20,671 and the recovery of 4,57,133 cases (Ministry, 2020 | <https://www.mohfw.gov.in>). The key reason for the spreading of infection could be easy movement across all nations. This was managed by public health specialists from a few nations to apply the non-medical controlling method to avoid transmission, for example, social isolation, social distancing, face mask, etc (Kwok KO et al., 2020). In the beginning, few nations, for example, Italy and Spain, have confronted challenges in population stick to these methods (Johns Hopkins University, 2020 | [Gisanddata.maps.arcgis.com](https://gisanddata.maps.arcgis.com)). India has embraced the same method to manage infection spreading.

These conditions currently create havoc, leading to a perceived perception or behaviour to prevent the spread of infection. In this way, understanding the determinants' responses, protection against the infection spread by different methods is essential to understand the benefit of social isolation and social distancing public policies, circumvent or truncate social control. We expect the model for health believes in India to be a determinant for people with many different cultures.



From various sources, the people get the information regarding COVID-19 infected cases and spread rate, which can be perceived differently, leading to the severity and causing a barrier for cues to action, forming a health belief among people (Jones CL et al., 2015). These could connect with the emotions of the public, social responses of their behaviour towards the COVID-19. The population behaviour is a necessary thing for managing this outbreak, especially during the initial stage when no treatment or immunization is available, and the main option is the commitment to alternative methods, for example, wearing masks, frequent hand sanitization, maintaining social distance and isolation (Kwok KO et al., 2020). The development of the health belief model takes place for understanding the failure of people to adapt several methods to prevent themselves from the disease or early detection of infection by screening tests (Darvishpour A et al, 2018). Later this model is used for the patient to check responses and compliance with medication. The health belief model made from cognitive and social theories with the establishment of two health-related perception segments is desired to avoid getting infected and the behaviour of a person towards preventive measures to cure or prevent themselves (Munro S et al., 2007; Hochbaum G, 1970). Ultimately also depends upon individual action towards benefit and barrier perception for their health.

In India, lockdown due to COVID-19 took place in four phases, i.e., the first phase of 21 days from March 25, 2020, & the rest three phases were of 14 days each to control the spread of corona virus, during this time-period only essential services were active like pharmacy, hospital, grocery, etc. Our study starts from the phase Unlock 1.0, which started on June 1, 2020.

This study helps in understanding the perception and belief of people after the first unlock in current situation. The study objectifies to estimate and measure health belief's five dimensions, i.e., perceived susceptibility, perceived severity, perceived barrier, perceived benefit, and pre-health motivation, and to observe the measure of association between them (Rosenstock IM, 1974). The health belief model has high predictive power, so it has general acceptance and popularity (Rosenstock IM et al., 1988). For these, a questionnaire was developed to understand behaviour, and perception for cues to action.

Methodology:

Study Population & Sample

A cross-sectional study design was adopted in this research, and the target population were people between 18-60 age groups. The questionnaire's time frame was ten days post lockdown (i.e., from June 6, 2020, to June 15, 2020), and COVID -19 infection spread exponentially during that study. The data was collected using Google forms online and a composed electronic questionnaire disseminated post lockdown through social networks. The questionnaire was distributed to students and the working professionals from both the government and the private sector.

Survey Development & Rating Instruments

A structured questionnaire was framed based on demographic information including age, gender, education, monthly income, preferred healthcare delivery system, any prior chronic disease, and preferred mode of transport. The key focus was on measuring the health belief model to explore the five dimensions, i.e., perceived susceptibility, perceived severity, perceived barrier, perceived benefit, and pre-health motivation based on behavioural, psychological, and perception characteristics.



The health belief dimension includes 17 characteristics-based questions. The scale was based on a Likert scale vary from strongly agree (1), agree (2), neutral (3) disagree; (4) strongly disagree (5). This scale is one of the best-measuring instruments for diagnosing and screening in clinical practice. One of the valid instruments to assess its consistency, and based on this Likert scale, the separate value of each of the five dimensions were estimated for every individual.

The questionnaire includes perceived susceptibility like routine risk, place or group exposure, prior health condition(diabetes); perceived severity like impairment of daily living activities, population symptoms, COVID-19 symptoms (shortness of breath); perceived benefits like social distancing, prevention by the antiviral drug, prevention by good hygiene practice; perceived barrier like capability to work from home, risk of losing a job, use of alternative transport and pre-health motivation like using vitamin-C tablet, hand washing minimize infection, using sanitizer, mask, gloves and staying home.

Inclusion and Exclusion Criteria

Age groups 18 to 60 were included. Henceforth individuals aged less than 18, and greater than 60 were excluded from the sample. The central focus was on the working population as they have influential health behaviour, which can be studied significantly post lockdown. The study focuses on health belief post lockdown (June) of an individual to perceive preventive and adequate hygiene measures.

Data Analysis

At the time of data collection, there were no missing values found, but duplicate values were part of it, which were removed simultaneously while some of the columns were deleted. The estimation of data analysis was done using IBM SPSS V26.0. A descriptive study approach was applied to assess demographic data through frequency distribution & percentage, and cross-tabulation tab to assess education's impact on health belief. The association's measure as a parametric test (correlation r) was applied to test the association between susceptibility, severity, barrier benefit, and pre-health motivation.

Ethical Consideration

All respondents were informed about the research study, work purpose and were assured with their data's reliability and confidentiality.

Construct	Definition
Perceived Susceptibility	Comments indicating an evaluation of the increased possibility of getting COVID-19 infection, call attention to grow local prevalence and high importation of cases
Perceived Severity	Comments indicating an evaluation of the increase in the perceived seriousness and the repercussion of getting infected by COVID-19 (e.g., hospitalization, pneumonia, death, highlighting mortality risk)
Perceived Benefits	Comments supporting in favour of physical distancing measures (e.g., school shutdown, working from home, abrogation of events, mass gathering) to lower transmission of COVID-19
Perceived Barriers	Comments mentioning the difficulties, provocation, and adverse effects of physical distancing (e.g., loss of freedom, contravention of individual rights, disruption, loss of income, etc.) as well as perceived efficacy of physical distancing
Pre-health Motivation	Comments indicating building blocks that ultimately motivate or de-motivate a person to take necessary healthcare-seeking action are primarily determined and control the peer psychological characteristics.

Table 1: Health Belief Model (Aravind Sesagiri Raamkumar, et al.,2020).



Results:

The results suggested that the study had encountered various beliefs and pre motivation had a positive impact on an individual after lockdown and will influence the daily activities and will lead to perceived cues to action. 353 responses were recorded, indicating the sample's descriptive mean age (μ) was 25.45, and the standard deviation (σ) was 5.8. The overall description of dimensions gives an understanding of critical influencing factors as shown in the supplementary file.

Variable	Characteristics	Frequency
Gender	Male	182 (51.5)
	Female	171 (48.5)
Education	Primary Education	6 (1.7)
	Secondary Education	26(7.3)
	Diploma	10 (2.8)
	Graduate	167 (47.3)
	Postgraduate	132 (37.3)
	Doctorate	12(3.4)
	No Education	0
Monthly Income	Less than 10,000	20 (5.6)
	10,000 to 25,000	64 (18.1)
	25,000 to 50,000	44(12.4)
	More than 50,000	32 (9)
	Unemployed	193(54.6)
Chronic Disease	Hypertension or cardiac disorder	2 (.6)
	Diabetes	8 (2.2)
	Respiratory disorder	8 (2.2)
	Other	8 (2.2)
	None	327 (92.6)
Healthcare system	Government (PHC, CHC)	92 (26)
	Private	261 (74)
Transportation	Public	64 (18.1)
	Personal	225 (63.7)
	Walking	14 (4)
	Private (Ola, Uber, Taxi)	50 (14.2)

Figure 1: Demographic Variable of the respondent sample (N= 353)

A frequency distribution table can show the demographic variable of the sample characteristics in figure 1. It can be observed that among the sample, around 51.5% of respondents were male, and 48.5% were female, 47.3% were graduates & 37.3% were postgraduates, and no respondents without formal education. Chronic disease respondents



were considered, two respondents with hypertension and cardiac disorder, and eight respondents with each Diabetes and Respiratory disorder. Out of 353 respondents' government, the health care delivery system was preferred by 26% only, while 74% preferred a private hospital or clinic. Out of 353 respondent 5.6% earning in rupees is less than 10,000 ,18.1% earns between 10,000 to 25,000, 12.4% earns between 25,000- 50,000 ,9% respondent earns more than 50,000 & rest 54.6% are unemployed (Figure 1). The preferred transportation mode was personal vehicle, i.e., 63.7%, followed by public transport, i.e., 18.1% and 14.2% use the private vehicle (Ola, Uber, and Taxi).

Looking at the self-efficacy of respondents, almost all the respondents agreed/strongly agreed to the designed seventeen statements. Concerning susceptibility statements, most of the respondents either strongly agreed or were agree to three statements as shown in figure 2.

	Questions	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Perceived Susceptibility	Routine Risk	190(53.8)	70(19.8)	63(17.8)	8(2.3)	22(6.2)
	Place or group exposure	239(67.7)	64(18.1)	20(5.7)	8(2.3)	22(6.2)
	Prior health condition(diabetes)	182(51.6)	77(21.8)	50(14.2)	18(5.1)	26(7.4)
Perceived Severity	Impairment of daily living activities	171(48.4)	82(23.2)	64(18.1)	18(5.1)	18(5.1)
	Population symptoms	106(30)	99(28)	98(27.8)	22(6.2)	28(7.9)
	COVID symptoms (shortness of breath)	46(13)	28(7.9)	32(9.1)	28(8)	219(62)
Perceived Benefit	Social distancing	186(52.7)	87(24.6)	46(13)	16(4.5)	18(5.1)
	Prevention by antiviral drug	50(14.2)	59(16.7)	126(35.7)	68(19.3)	50(14.2)
	Using mask	115(32.6)	106(30)	86(24.4)	30(8.5)	16(4.9)
	Prevention by good hygiene practice	189(53.5)	102(28.9)	36(10.2)	8(2.3)	18(5.1)
Perceived Barrier	Ability to work from home	129(36.5)	74(21)	76(21.5)	26(7.4)	48(13.6)
	Risk of losing the job	92(26.1)	62(17.6)	87(24.6)	38(10.8)	74(21)
	Use of alternative transport	197(55.8)	82(23.2)	46(13)	16(4.5)	12(3.4)
Pre-health Motivation	Using a vitamin C tablet	54(15.3)	80(22.7)	150(42.5)	37(10.5)	32(9.1)
	Handwashing minimize infection	147(41.6)	124(35.1)	50(14.2)	20(5.7)	12(3.4)
	Using sanitizer, mask, gloves	205(58.1)	78(22.1)	38(10.8)	24(6.8)	8(2.3)
	Staying home	188(53.3)	80(22.7)	50(14.2)	17(4.8)	18(5.1)

Figure 2: Frequencies (n) and percentages (%) distribution of Health belief model constructs



Most of the respondents agreed/strongly agreed to the three statements of the severity construct. Participants varied with almost half strongly agreed to neutral the first and third while equally distributed to the second statement about statements of the barriers. Regarding pre-health motivation in the last three statements, individuals were responded from strongly agree to agree, while most of the responses are neutral in the first statement (Figure 2).

A correlation study has been observed between all the five dimensions of health belief in figure 4(a). It was found that a positive correlation between all the variables was observed at 0.01 level of significance (2-tailed). A strong correlation between pre-health motivation and perceived benefit depicts that benefits like prevention from acceptable hygiene practices, using a mask, and social distancing promote pre-health motivation of an individual (Figure 4(a)). It was also found a positive correlation between perceived susceptibility & perceived severity, perceived susceptibility & pre-health motivation, perceived benefit & perceived susceptibility, perceived barrier & pre-health motivation; perceived severity & pre health motivation, and so on.

A descriptive cross tabulation was performed to check the association between education with health belief dimensions and how education can influence a person's behaviour, perception, and belief about health and prevent infection (figure 3). As education plays a significant role in developing a person's belief about cues to action post lockdown, the result is significant, showing the drift towards better understanding behavioural aspects and belief combating the current outbreak

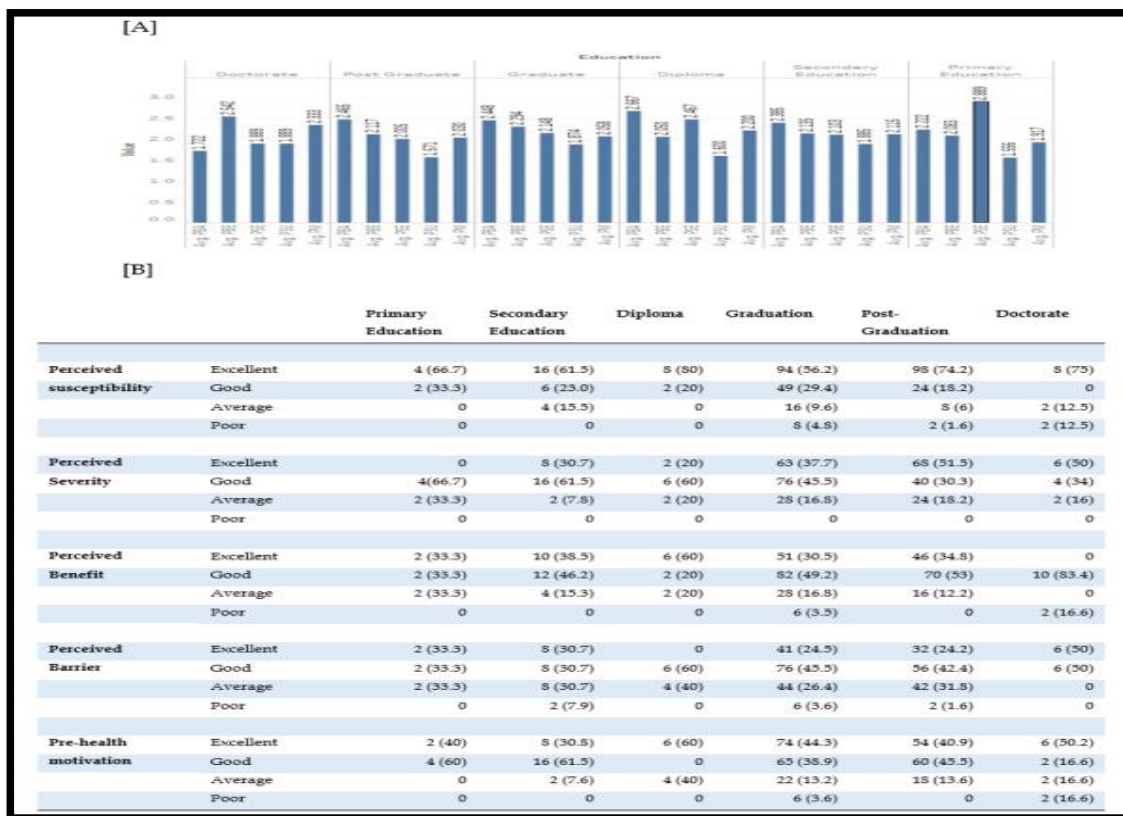


Figure 3: A) Descriptive statistics of five dimensions based on the level of education; B) Cross-tabulation of education with health belief variables.



The result for different health belief dimensions shows education imparts better severity & susceptibility and low perceived barrier leading to better pre-health motivation (cues to action) results in a better psychological and behavioural belief model. (Figure 3)

A		PSU	PSE	PBE	PBA	PM
PSU	Pearson Correlation	1	.322**	.283**	.177**	.372**
	Sig. (2-tailed)		.000	.000	.001	.000
PSE	Pearson Correlation	.322**	1	.050	.077	.215**
	Sig. (2-tailed)	.000		.350	.147	.000
PBE	Pearson Correlation	.283**	.050	1	.172**	.638**
	Sig. (2-tailed)	.000	.350		.001	.000
PBA	Pearson Correlation	.177**	.077	.172**	1	.258**
	Sig. (2-tailed)	.001	.147	.001		.000
PM	Pearson Correlation	.372**	.215**	.638**	.258**	1
	Sig. (2-tailed)	.000	.000	.000	.000	
**. Correlation is significant at the 0.01 level (2-tailed).						

B		Education	PSU	PBE	PSE	PBA	PM
Chi-Square		433.442 ^a	492.884 ^b	221.547 ^c	75.558 ^d	248.057 ^e	182.292 ^a
Df		5	12	14	8	12	13
Asymp. Sig.		.000	.000	.000	.000	.000	.000
a. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 58.8.							
b. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 27.2.							
c. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 23.5.							
d. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 39.2.							
e. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 25.2.							

Figure 4: A) Correlation between perceived susceptibility, perceived severity, perceived barrier, perceived benefit, and pre-health motivation influenced post lockdown: B) Chi-Square (χ) statistics for education and five dimensions of health belief

The association between levels of education with all five dimensions gives the bivariate analysis with the help of non- parametric test, indicating significant chi-square values for perceived severity and pre-health motivation, i.e., the values better fitted the model. The chi-square test model signifies the arithmetic health belief equation, (Figure 4(b)) the better-fitted values for perceived severity promotes health motivation and return cues to action.



The efficacy and reliability of this Likert scale were found high, as the value of Cronbach alpha is 0.764, and the self-developed scale for five-dimension average value gives the reliability of 0.632. This indicates that our study's reliability is excellent, and our scale can be preferred for estimating the health belief perception or behaviour of an individual.

Discussion:

The study attains the objective of mapping the health behavior or perception in contrast with covid-19 risk through the health belief model, which proved to be efficient in identifying the risk behavior post lockdown. The results suggested that some variables were significant to understand an individual's risk behavior. Likewise, People who use Public transportation perceive higher susceptibility than those who use personal vehicle. Similarly the people with low income or pre-existing disorder was found more susceptible for Covid-19. Talking about low income could be a complex and significant factor, as it can be due to less information and hygiene related to Covid-19. These instances can be considered a point of information in adapting policies by policy makers or health authorities.

However, for measuring all the five psychological dimension this model include questionnaire which use the Likert-type scale. This system is imperative on the ground that even a decent survey may have its data gathering incredibly weakened if an insufficient or uninformed questionnaire is preferred. Also psychological measurement scale and psychophysical measurement scale suggested by S.S. Stevens is widely used (Stevens SS, 1946; Stevens SS and Galanter EH, 1957).

Research on health behaviour investigate the capability and application of several models in health behaviour moderation (Hollister MC and Anema MG, 2004). As stated in the structure of the HBM in the situation of COVID-19. Suggests that a person would be more likely to perform with advocated preventive behaviours if he/she perceives being susceptible to the infection (perceived susceptibility), and that the infection could lead to serious consequences (perceived severity). Perceived barriers ((beliefs about obstacles to performing a behaviour, and the negative aspects of adopting a health behaviour) of social distancing and hand hygiene), and perceived benefits (belief in efficacy of the advised action to reduce risk or seriousness of impact) (Glanz K et al., 2015), are also important factors in taking actions on preventive measures. Self-assurance has been shown to relate to various health-related practices, such as smoking cessation, diet, and health-promoting way of living (Berner ES, 2007; Hollister MC and Anema MG, 2004).

As indicated by the health belief model, Individuals to have a suitable degree of self-adequacy to overcome boundaries to perception (Glanz K, et al., 2008). Powe et al. recommended in China demonstrated that the severity was a significant indicator of Covid-19 prevention practices in China (Powe BD, 2001). Li et al. likewise showed that high severity expanded negative feelings, higher cell phone uses in COVID-19 (Li J-B, et al., 2020). About 66.16% of individuals have the right health belief experience post lockdown. It had been observed that among males and females no significant difference in health behaviour was observed: both males and females had almost the same kind of belief. The seventeen statements Likert scale gave a broad idea in estimating the health belief, descriptive gave an idea about average values which were mean and standard deviation for perceived susceptibility 1.74; 0.04, perceived severity 3.10; 0.39, perceived benefit 2.21; 0.038, perceived barrier 2.42; 0.04 and pre-health motivation 2.06; 0.39 respectively. A positive correlation has been observed within the five dimensions scale & education

**Conclusion:**

An attempt is made to estimate the health belief faced by people aged (18-60) years amidst COVID-19 post lockdown. Equal weightage was given to all 5 dimensions. It was found that people were having good psychological behaviour for cues to action.

The health belief model based on the e-questionnaire related to the ratio scale is a powerful tool to comprehend the public behaviour and perception of COVID-19 infection risks in both qualitative and quantitative manner. Our health belief model validates the justification of mainstream perception about COVID-19 infection risks. Our approach's advantage lies in the capability of rapidly, straight, and quantitatively identifying individual perception profiles for all dimensions in the e-questionnaire, serving as an excellent ally for conveying policy and public health education.

Limitation:

The main limitation of this study is that it is conducted with a group of people who are having access to the internet and social media. Due to strict lockdown across, it became tough to reach out to people directly. Also, this study pertains to those people who are having good knowledge of the English language thus depicting that study done with an educated group of people.

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